2 February 2018 Ref No. 30392ZA4let-Rev1



JK Geotechnics GEOTECHNICAL & ENVIRONMENTAL ENGINEERS

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Coronation (28 Shepherd Street) Pty Ltd Level 2, 66 Wentworth Avenue SURRY HILLS NSW 2010

ATTENTION: Mr Aras Labutis

Dear Sir

<u>GEOTECHNICAL OPINION</u> <u>PROPOSED GILD & BINDERY RESIDENTIAL DEVELOPMENT</u> <u>26-28 SHEPHERD STREET, LIVERPOOL, NSW</u> <u>DA-82/2017</u>

INTRODUCTION

At your request, we provide our responses to the issues raised in the following documentation:

- Email from Rodger Roppolo of Liverpool City Council (LCC) to Adam Coburn of Mecone on 30 January 2018 (2:58pm), which stated that LCC require "an amended Geotechnical Report or an addendum to the report that is consistent with the revised development/scope of works, as the report made recommendations for geotechnical issues to be addressed prior to excavation works."
- WaterNSW letter dated 29 June 2017 (addressed to LCC), titled 'Integrated Development referral under s.91A of the Environmental Planning Assessment Act 1979 for 26-28 Shepherd Street, Liverpool', which requested a "thorough hydrogeological assessment of the predicted impacts of the proposed development and calculations of the volumes likely to be extracted."

A site location plan is presented as Figure 1.

Based on the relevant supplied architectural drawings prepared by Woods Bagot (Project No. 120597120809, Drawing Nos. A01002^{D2}, A022B1^{D5}, A022B2^{D4}, A22200^{D2}, A22201^{D3}, A22202^{D2}, A23101^{D3}, A23102^{D2}, A23103^{D3}, A23201^{D3}, A23202^{D2} & A23203^{D2}) and the 'Shoring and Bulk Excavation Full Plan' drawing prepared by Structural Design Solutions Pty Ltd (Project No. ST15106, Drawing No. S1.00^E), we understand that the proposed Gild & Bindery residential development comprises the construction of three separate buildings overlying two common basement levels.



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On the eastern side of 28 Shepherd Street, adjacent to the Georges River, an 18 level tower and a 21 level tower are proposed. On the western side of 28 Shepherd Street, adjacent to Shepherd Street, a 6 storey building is proposed. At the northern end of the site, within 26 Shepherd Street, a 2 level (western side) and 14 level (eastern side) building is proposed site. The lower basement level (Basement 02) has been constructed at RL4.5m and required excavation to depths between 6m and 8.3m below original grade. The survey datum is the Australian Height Datum (AHD). The proposed basement levels extend to the northern southern and western (Shepherd Street) boundaries, and are set back at least 17m from the eastern (Georges River) boundary.

At the time of our engagement on this project, bulk excavation for the proposed basement levels was almost complete. The retention system comprised temporary anchored soldier pile walls with shotcrete infill panels. All soldier piles had been installed, and the shotcreting of the infill panels and temporary rock anchor installations were in progress.

We understand that LCC's concerns relate to the proposed development within the 26 Shepherd Street portion of the site. We have been advised that the basement levels and superstructure up to the Level 2 slab within this portion of the site is subject to a separate Building Certificate that has been lodged with LCC.

BACKGROUND INFORMATION

A chronology and a brief description of the geotechnical investigations completed at 26-28 Shepherd Street are provided below:

- In 2015, a geotechnical investigation was carried out at 28 Shepherd Street by Asset Geotechnical Engineering Pty Ltd (report Ref. '2936-R1 Rev3', dated 2 December 2016). The Asset investigation essentially comprised the drilling and testing of six boreholes (BH1 to BH6). The locations of the previous boreholes have been plotted onto the attached Figure 2. The bedrock in four of the six boreholes was diamond core drilled. Groundwater monitoring wells were installed into BH1, BH2 & BH3. JK Geotechnics measured the groundwater levels in the BH3 well and in BH2 (an open borehole) during an inspection of the riverbank on 2 December 2016. At this time the BH1 well had been destroyed. The groundwater levels in three other wells which had been installed as part of an earlier environmental investigation were also measured by JK Geotechnics on 2 December 2016.
- In 2016, a geotechnical investigation was carried out at 26-28 Shepherd Street by EI Australia (report Ref. 'E23125 GA Rev2' dated 21 December 2016). The EI investigation supplemented the Asset investigation by including the drilling and testing of four additional boreholes (EI101M, EI102M, EI103

& EI104M), which were located in 26 Shepherd Street, as shown on Figure 2. The bedrock in three of the four boreholes was diamond core drilled. Groundwater monitoring wells were installed into EI101M, EI102M & EI104M.

- In 2017, JK Geotechnics completed a supplementary geotechnical investigation at 26-28 Shepherd Street (report Ref. '30392ZA2rpt' dated 22 June 2017). Our investigation included the drilling and testing of four additional cored boreholes (JK101 to JK104) and the installation of four additional groundwater monitoring wells (JK101A, JK102, JK103A & JK104). The borehole locations are shown on Figure 2. Our supplementary geotechnical investigation confirmed the presence and depth of Class III or better quality shale bedrock foundation material across the site. All footings for the proposed Gild & Bindery residential development at 26-28 Shepherd Street were designed by Structural Design Solutions Pty Ltd to be founded in Class III or better quality shale bedrock for a maximum allowable bearing pressure of 3500kPa; reference was made to Structural Design Solutions Pty Ltd (Project No. ST15106) Drawing Nos. S2.00^D, 2.00C^C, 2.00D^C, 2.00E^C, 2.10⁹, 2.20^A & 2.21^A).
- Also in 2017, JK Geotechnics completed a hydrogeological assessment for the proposed residential development at 26-28 Shepherd Street (report Ref. '30392ZA3rpt' dated 18 July 2017). Pump-out tests were completed in the JK101A, JK102, JK103A & JK104 groundwater monitoring wells to assess the permeability of the soil and bedrock profiles. A hydrogeological model, based on all borehole information and the groundwater level monitoring data recorded by Asset, EI & JK Geotechnics, was developed. A groundwater analysis was then completed using Plaxis 3D, a three dimensional finite element computer program, to estimate the groundwater inflow rates (for various river water level cases) into the excavation.
- Between 5 July 2017 & 25 September 2017, JK Geotechnics inspected most internal pad and piled footings (31 site visits), as documented in our site reports (ie. from Site Report 2 dated 6 July 2017, to Site Report 9 dated 27 September 2017).
- Prior to our involvement in this project, we were advised by Coronation (28 Shepherd Street) Pty Ltd that the foundation material below a select number of perimeter piles was inspected by EI.



GEOTECHNICAL OPINION

Liverpool City Council's Concerns

Based on the wording of the supplied LCC email, and the fact that the basement levels and superstructure up to the Level 2 slab is subject to a separate Building Certificate already lodged with Council, it is our interpretation that Council is now concerned about whether the existing footing system can support the remainder of the superstructure proposed at the northern end of the site (ie. within 26 Shepherd Street).

As discussed above, all footings were designed by Structural Design Systems Pty Ltd for the loads of the entire development. It is therefore our opinion, that the existing footings can support the remainder of the superstructure proposed at the northern end of the site.

WaterNSW Concerns

As requested in their letter of 29 June 2017, a hydrogeological assessment was carried out for the proposed Gild & Bindery residential development at 26-28 Shepherd Street, as discussed above and as presented in our report Ref. '30392ZA3rpt' dated 18 July 2017. We were engaged to complete the hydrogeological assessment towards the final stages of bulk excavation. At the time of writing this current report, the construction of the two basement levels was complete. We understand that the river has not flooded since June 2017; that is, from when our groundwater monitoring wells were installed.

For our analysis, groundwater on the western (Shepherd Street) side of the site was adopted at RL6.5m, based on the highest encountered standing water levels measured in the previous boreholes in this portion of the site. Along the eastern (Georges River) side of the site, two river level conditions were considered:

- An 'every day' river level at RL2.9m;
- A flood event river level at RL9.2m, which we understand to be the estimated 1 in 100 year flood level.

Total head boundary conditions were adopted at the sides of the analysis to represent the in-situ conditions. For both the 'every day' and flooding cases, steady-state groundwater flow analyses were completed. For the 'every day' case, we considered this to be a reasonable assumption. However the flooding case was considered to be a conservative assumption, as we had been advised that flood peaks in the river typically last for no more than a few days.

The information on the river flooding characteristics was provided by Royal Haskoning DHV, who have been engaged by Coronation (28 Shepherd Street) Pty Ltd.



In summary, based on our analyses, the groundwater inflow rates tabulated below were estimated:

River Water Level Case	Groundwater Inflow (Litres per day)
'Every Day' RL2.9m	100
Flooding RL9.2m	40,100 to 60,100*

* Based on a sensitivity analyses on the permeability of a soil unit.

For the 'every day' river water level case, the estimated groundwater inflow into the excavation was considered to be minor. Furthermore, whilst we were present on site between July and September 2017 for the footings inspections, negligible groundwater seepage into the open excavation was observed; that is, from between basement wall soldier piles (prior to shotcreting) and from the base of the excavation.

As noted above for the flooding cases, we consider that the adopted steady-state analysis over-estimates groundwater inflow, as the method is not able to model the time lag between the flooding event and the variable groundwater inflow rates associated with rising and falling river level; particularly as it is a short duration event. As such for the flooding case, we consider that the estimated 40,100L/day to 60,100L/day groundwater inflow into the basement (requiring disposal) to be a conservative estimate.

In addition to considering the inflow into the basement during construction, the drawdown of the groundwater levels outside of the basement has also been considered. Whilst drainage is occurring during construction, some drawdown of groundwater may occur immediately adjacent to the basement excavation. However, as the hydraulic gradient of the groundwater drawdown is expected to be relatively steep, we expect that there will be negligible adverse geotechnical effects on the surrounding properties.

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Should you require any further information regarding the above, please do not hesitate to contact the undersigned.

Yours faithfully For and on behalf of JK GEOTECHNICS

Andrew Jackaman Senior Associate | Geotechnical Engineer

- Encl. Figure 1: Site Location Plan Figure 2: Borehole Location Plan
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This plan should be read in conjunction with the JK Geotechnics report.



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Figure No: 2



