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Mingara Pariter Partnership Pty Ltd

Attention: Michael Cardillo
Email: Michael.cardillo@Pariter.com.au

GEOTECHNICAL ASSESSMENT
PROPOSED RESIDENTIAL DEVELOPMENT
12-14 MINGARA DRIVE, TUMBI UMBI, NSW

1 INTRODUCTION

As requested, we have reviewed the factual information presented in the provided geotechnical report (Ref: 15660b-201/3 dated July 2024 [RCA2024]) prepared by RCA Australia. The purpose of the assessment was to inform the provision of comments and recommendations on earthworks for the proposed development, and in particular, the reuse of existing fill and natural soils as engineered fill.

We note that from a brief review, RCA2024 provides comments and recommendations on other geotechnical aspects of the proposed development. We have however not reviewed any of the recommendations in RCA2024 in detail, and have not assessed their suitability for the proposed development.

From the provided architectural drawings prepared by Marchese Partners and civil drawings prepared by Stantec, we understand the proposed development will comprise 4 multi storey residential apartment buildings, 13 residential duplexes, and associated roads and landscaping. Cut and fill earthworks to a maximum depth of about 1.0m (but locally deeper to about 2m for swales and OSD tanks) and height of about 1.5m are expected.

This letter provides specialist advice for use by the structural and civil designers in preparing their designs and no part of this report is intended to be or considered a regulated design in accordance with the Design and Building Practitioners Act 2020.

2 RESULTS OF THE ASSESSMENT

From RCA2024, we summarise the encountered subsurface conditions at the site as follows.

Fill

Fill, comprising sands, clays and silts, was encountered to depths between 0.5m and 2.0m, but generally to between about 0.8m and 1.2m depth. In some of the test pits and boreholes, the fill was logged as being of

low plasticity, and brown in colour. Such material may be old topsoil, and the presence of organic material is also noted on the RCA logs for some locations.

The depth of the fill was generally shallower over the north-eastern portion of the site, increasing in depth to the west and south.

As no records of the placement or compaction of the existing fill are available, the fill must be considered to be 'uncontrolled'. Uncontrolled fill is considered unsuitable to support structures or pavements for the proposed development. This is also noted in Section 5.1 of RCA2024.

Natural Soils

Alluvial soils, comprising interbedded sands and clays, was encountered beneath the fill to significant depth (27.5m to 28.5m), over residual clays where deeper boreholes were drilled. The shallower alluvial soils, immediately beneath the fill and within the depth of the expected earthworks, predominantly comprised clayey soils of firm and stiff strength, but with some soft clays also present at shallower depth below the base of the fill. The moisture content of the shallower soils was predominantly assessed by RCA to be 'wet' of their plastic limit.

Weathered Bedrock

Weathered bedrock (Patonga Claystone) was encountered below the residual soils, from depths between 27.5m and 30.7m, where the boreholes extended to sufficient depth.

Groundwater

Groundwater was measured at moderate depth in the boreholes, generally between 3.0m and 4.9m below existing levels. However, water was also measured at shallower depth, 0.34m to 1.09m depth, in wells installed by RCA about 1 to 2 weeks following installation of the wells, after water levels had likely stabilised. It is unclear what ahs led to the higher water levels in the wells, and we recommend the completion of additional monitoring, possibly with additional wells, to further assess the groundwater conditions.

Shallower water levels were also recorded in most of the RCA CPTs, at between 0m and 2.5m depth, but mostly between 0.5m and 1.3m depth.

It is possible that some of the higher water levels are associated with locally higher perched water within the fill.

3 COMMENTS AND RECOMMENDATIONS

3.1 Earthworks Overview

The subsurface conditions over the depth of the proposed earthworks are poor, with shallow groundwater, elevated moisture content in the soils (fill and natural materials), the presence of silts, and the presence of natural soils of limited strength. The earthworks will be difficult to complete, and we strongly recommend

an earthworks contractor with demonstrated experienced completing projects in similar ground conditions be engaged for this project.

In general, the long term successful performance of pavements is dependent on the satisfactory completion of the earthworks. In order to achieve this, the quality assurance program must not be limited to routine compaction density testing only. Other critical factors associated with the earthworks include subgrade preparation, selection of fill materials, control of moisture content and drainage, etc. The satisfactory control and assessment of these items may require judgment from an experienced engineer. Such judgment often cannot be made by a technician who may not have formal engineering qualifications and experience.

In order to identify potential problems, we strongly recommend that a pre-construction meeting be held so that all parties involved understand the earthworks requirements and the difficulties associated with the poor subgrade and shallow groundwater. This meeting should clearly define the lines of communication and responsibility. This should be detailed in the tender documents.

3.2 Existing Fill

As noted above, the existing fill is considered to be uncontrolled. It is therefore considered unsuitable to support any of the proposed structures for the proposed development. Further if any existing fill is left on site below any pavements, there would be an elevated risk of future poor performance of the pavement due to ongoing consolidation of an unpredictable magnitude of the fill. On this basis, we strongly recommend that below the footprint of the buildings and pavements, as well as for a minimum 2m envelope around the buildings/pavements, the existing fill be removed to the underlying natural soils and replaced with engineered fill to the design levels. However, the fill could be left in situ below future landscaped areas.

For the purposes of this report, we have assumed excavation and replacement of the entire depth of the existing fill with engineered fill.

3.3 Site Preparation and Earthworks

All earthworks recommendations provided below should be complemented by reference to AS3798-2007 'Guidelines on Earthworks for Commercial and Residential Developments'.

3.3.1 Acid Sulphate Soils

From discussions with Michael Cardillo of Pariter, we understand that at least some of the natural soils have been assessed by others to be Potential Acid Sulphate Soils (PASS). We further understand that the strategy for this project is for these soils to be treated with lime as appropriate to neutralise the PASS conditions, and then kept on site.

From a geotechnical perspective, we have no objection to the above strategy, and expect that treatment of the soils with lime will not have any detrimental geotechnical effects on the engineering properties of the soils.

3.3.2 Site Drainage and Seepage

Groundwater was encountered at shallow depth in the monitoring wells installed by RCA, as well as in some of the test pits. Groundwater seepage into excavations completed for the earthworks should therefore be expected. Nevertheless, the shallower, clayey, soils (i.e. within the depth of the expected earthworks depths) at the site will likely be of low permeability, and any seepage would therefore be expected at a relatively slow rate.

The natural clay subgrade, which is expected to be exposed at predominantly between 1m and 1.5m depth, is of limited strength, and is expected to undergo substantial loss of strength when wet. Further, silts were encountered in some of the RCA test locations, and such soils can be very problematic for earthworks. The clay subgrade is also expected to have a moderate shrink-swell reactive potential. Clays and silts can also be dispersive, though this has not been confirmed by testing.

On the basis of the above, we emphasise the importance of providing good and effective site drainage both during construction, to protect against subgrade conditions worsening, and for long-term site maintenance. The principle aim of the drainage is to promote run-off and reduce ponding. A poorly drained clay/silt subgrade may quickly become untraffickable when wet. The earthworks should be carefully planned and scheduled to maintain good cross-falls during construction. Where earthworks will be to below surrounding surface levels, sumps must be formed at appropriate locations to allow for collection and pumping of any seepage to areas outside the earthworks footprint (e.g. temporary detention basins).

3.3.3 Site Preparation and Excavation

Following removal of all vegetation on site, and thorough grubbing out of all root balls, all topsoil and root affected soils should also be stripped. In general, the RCA testing does not describe a formal topsoil layer, but with grass cover on the site, some topsoil is expected to be present. Further, portions of the fill are noted to contain organic material, and such material should be considered as a topsoil.

Stripped topsoil/root affected soils must be stockpiled separately as they are considered unsuitable for reuse as engineered fill. They may however be reused for landscaping purposes. Reference should be made to the Section 4 below report for guidance on the offsite disposal of soil.

All existing fill, where present, must be stripped, but can be generally stockpiled for reuse as engineered fill. Excavation of the fill will be readily achieved with the buckets of hydraulic excavators or dozer.

In any areas where the natural soils are water softened, the water softened material must be boxed out to a sound base and replaced with engineered fill. From RCA2024, softened soils (of stiff and softer strength) are expected to be present over portions of the development footprint following stripping.

Where the depth of softened soils is thicker than say 0.5m below design subgrade level below pavement areas, which will likely be the case in at least some areas, an alternative to extensive boxing out would be to

adopt a granular bridging layer. Detailing of any bridging layers would require inspection of the performance of the subgrade, and test pits, by an experienced geotechnical engineer at the time the softened material is exposed.

The existing fill and natural soils on site are generally considered geotechnically suitable for reuse as engineered fill, though they are expected to have at least a moderate potential for reactive movements with changes in moisture content. They will also mostly require extensive moisture conditioning (drying) to achieve the moisture content specification. We note that such drying out can be time consuming and labour intensive, however, the addition of lime to soils can aid with drying as the lime reacts with the moisture in the soil

Care must be taken when excavating not to remove support from the adjoining properties, structures, or services, however, based on our understanding of the development layout, this does not appear to be a particular concern for this project.

All cuts should be temporarily battered back or benched at no steeper than 1V on 1.5H for stability considerations and to facilitate compaction of engineered fill up against the cut faces. All surcharge loads, e.g. existing footings, traffic loads, stockpiles, etc. must be kept at least 3m back from the crest of any temporary batters. If excavation to within 5m of the site boundaries will be required, further advice on temporary shoring options must be sought prior to excavation commencing.

3.3.4 Subgrade Preparation

Following stripping and excavation to achieve design levels (0.5m below design subgrade level), the exposed subgrade should be proof rolled with at least 6 passes of a minimum 12 tonne deadweight smooth drum roller. The final pass of proof rolling must be witnessed by a geotechnical engineer or experienced geotechnician. Where soft spots or heaving areas are detected during proof rolling, advice on remediation would be provided at the time of the inspection, but could comprise extensive boxing out to a sound base, or incorporation of a thick granular bridging layer.

Following successful proof rolling and/or placement of a bridging layer, in-situ density testing of the upper 0.2m of the subgrade should be completed in accordance with the frequencies detailed in Section 3.2.5 below, with a target density ratio of 98% to 102% of Standard Maximum Dry Density (SMDD) and target moisture content within 2% of Standard Optimum Moisture Content (SOMC). If the tests show the subgrade does not meet this specification, then the subgrade should be tyned to a depth of 0.2m, moisture conditioned to within 2% of SOMC, and recompacted to a density ratio between 98% and 102% of SMDD. In situ density testing must subsequently be completed in accordance with the requirements of Section 3.2.5 below to confirm his specification has been achieved.

If soil softening occurs after rainfall periods, then the clay subgrade should be over-excavated to below the depth of moisture softening and replaced with engineered fill. If the clay subgrade exhibits shrinkage cracking, then the surface must be moistened with a water cart and rolled until the shrinkage cracks are no

longer evident, or the layer tyned, moisture conditioned, and recompacted. Care must be taken not to over-water the subgrade as this will result in softening.

All fill used to raise site levels must be placed as engineered fill.

3.3.5 Engineered Fill

Ideally, engineered fill should comprise a well graded granular material such as crushed sandstone, however, from a geotechnical perspective, the excavated fill and natural soils are considered suitable for reuse as engineered fill on condition the materials are 'clean', free of organic matter and contain a maximum particle size not exceeding 70mm. As noted above, moisture conditioning (drying) of the site won soils will be required.

We note that the silts encountered on site are expected to be problematic for the proposed earthworks, as they are highly sensitive to moisture content at the time of placement. We strongly recommend that all silts be blended with non-silts (e.g. sands/clays) at a ratio of 1 part silt to 4 parts other soil, to improve the workability of the silts.

All clays and blended silty fill should be compacted in layers not exceeding 200mm loose thickness to a density ratio strictly between 98% and 102% of SMDD and within 2% of SOMC. Moisture conditioning most of the site won soils will be required in order to meet this specification. Engineered fill comprising well graded granular materials, such as imported crushed sandstone, should be compacted layers not exceeding 200mm loose thickness to achieve a density ratio of at least 98% of SMDD.

Where filling is completed against temporary batter slopes, horizontal benches must be formed at no greater than 0.4m vertical increments so that the engineered fill can be 'keyed' into the slope.

Permanent batters should be overfilled by at least 1m beyond the design geometry, then trimmed back following the completion of filling to remove the under-compacted edge fill.

Backfilling of service trenches must be carried out using engineered fill in order to reduce post-construction settlements. Due to the reduced energy output of the compaction plant that can be placed in trenches, backfilling should be carried out in layers not exceeding 100mm loose thickness and compacted using a trench roller, a pad foot roller attachment fitted to an excavator, and/or a vertical rammer compactor (also known as a 'Wacker Packer'). Due to the reduced loose layer thickness, the maximum particle size of the backfill material should also be reduced to not more than 40mm. The compaction specifications provided above are applicable.

As for services trenches, retaining wall backfill must also be carried out using engineered fill in order to reduce post-construction settlements. Compaction of the engineered backfill should be carried out using a trench roller or hand operated vertical rammer compactor for the lower layers and immediately behind the wall in the upper layers. Elsewhere a small static roller could be used. As per service trenches, backfilling should be carried out in layers not exceeding 100mm loose thickness and the maximum particle size of the backfill

material should be reduced to not more than 40mm. The compaction specifications provided above are applicable.

Compaction of engineered fill immediately behind retaining walls is time consuming, difficult and not commonly undertaken. The more common method comprises using a single sized hard, durable, free draining aggregate, such as 'Blue Metal' or crushed concrete aggregate (free of fines, brick and tile fragments), in close proximity to the wall (within say 0.5m), as such materials do not require significant compactive effort. More remote from the wall, general engineered fill can be adopted. Single size aggregate backfill should be nominally compacted using a hand operated vibrating plate (sled) compactor in maximum 400mm thick loose layers. A non-woven geotextile filter fabric such as Bidim A34 should be placed as a separation layer immediately above the cut or filled batter slope (prior to backfilling) to control subsoil erosion into the gravel, and this should be wrapped over the surface of the aggregate backfill and capped with at least a 0.3m thick compacted layer of clayey engineered fill, or a reduced thickness of pavement, to reduce the potential for surface water to enter the retaining wall drainage. Provided the aggregate backfill is placed as recommended above, density testing would not be required in that material. Single size aggregate retaining wall backfill would not form a suitable founding material for footings, and this must be considered when zoning backfill to the retaining walls.

In-situ density tests must be carried out on the engineered fill at least meeting the frequency requirements specified in Table 8.1 of AS3798-2007.

Level 1 testing of fill placement and compaction in accordance with AS3798-2007 is recommended for all fill for this project, including for trench and retaining wall backfill. Due to a potential conflict of interest, we strongly recommend that the Geotechnical Inspection and Testing Authority (GITA) be directly engaged by the client, and not by the earthworks contractor or sub-contractors.

We also recommend that the GITA be requested to provide a summary of test results, including a test location plan, and daily site reports on a fortnightly basis for review by the Project Superintendent and/or JK Geotechnics. It is too late at the end of the job to carry out a review as there will be no opportunity to make improvements or take corrective action.

3.4 Additional Comments

3.4.1 Soil Reactivity

The natural clays and clayey fill will be at least somewhat reactive to moisture content change, however, from RCA2024, no testing appears to have been completed to assess the reactivity. There are some comments on soil reactivity in Section 5.3.2 of RCA2024.

On completion of the earthworks, the AS2870-2011 site classification would be Class P due to the placement of fill. However, provided all of the fill is engineered fill as detailed above, then reclassification could be completed based on the reactivity of the soils. Subject to the completion of laboratory testing at a later

stage, we expect that characteristic surface shrink swell movements, following the earthworks, would likely be in the range of a Class H1 site, and this could be used for preliminary design of the floor slabs for the duplex building based on engineering principles as detailed in AS2870-2011. We note that due to the Class P site classification, the standard footing designs in AS2870-2011 would not apply.

For the proposed tower buildings, the reactivity of the soils must also be considered in the design of the ground floor level slabs.

We recommend that additional testing of the reactivity of the soils be completed to allow for advice above to be confirmed.

3.4.2 Pavement Design

From our review of RCA2024, no CBR testing of the site soils, to inform the design of the proposed pavements, appears to have been completed. Based on our extensive experience with similar materials, a relatively low CBR is expected for the clayey fill and natural soils.

We recommend that CBR testing of the fill and natural soils be completed to inform the design of the pavements for this project.

4 GENERAL COMMENTS

The recommendations presented in this report include specific issues to be addressed during the construction phase of the project. As an example, special treatment of soft spots may be required as a result of their discovery during proof-rolling, etc. In the event that any of the construction phase recommendations presented in this report are not implemented, the general recommendations may become inapplicable and JK Geotechnics accept no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full and properly tested, inspected and documented.

Occasionally, the subsurface conditions between the test locations completed by RCA2024 may be found to be different (or may be interpreted to be different) from those expected. Variation can also occur with groundwater conditions, especially after climatic changes. If such differences appear to exist, we recommend that you immediately contact this office.

This report provides advice on geotechnical aspects for the proposed civil and structural design. As part of the documentation stage of this project, Contract Documents and Specifications may be prepared based on our report. However, there may be design features we are not aware of or have not commented on for a variety of reasons. The designers should satisfy themselves that all the necessary advice has been obtained. If required, we could be commissioned to review the geotechnical aspects of contract documents to confirm the intent of our recommendations has been correctly implemented.

A waste classification is required for any soil and/or bedrock excavated from the site prior to offsite disposal. Subject to the appropriate testing, material can be classified as Virgin Excavated Natural Material (VENM),

Excavated Natural Material (ENM), General Solid, Restricted Solid or Hazardous Waste. Analysis can take up to seven to ten working days to complete, therefore, an adequate allowance should be included in the construction program unless testing is completed prior to construction. If contamination is encountered, then substantial further testing (and associated delays) could be expected. We strongly recommend that this requirement is addressed prior to the commencement of excavation on site.

This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. If there is any change in the proposed development described in this report then all recommendations should be reviewed. Copyright in this report is the property of JK Geotechnics. We have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report. The report shall not be reproduced except in full.

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

Nicholas Smith
Principal Geotechnical Engineer
NSW Fair Trading RPE No. PRE0000XXX

Reviewed by:

Adrian Hulskamp
Principal Geotechnical Engineer
NSW Fair Trading RPE No. PRE0000739