2 March 2022

Toronto Investments No. 1 Pty Ltd
4 Parramatta Road
Summer Hill NSW 2130

Attention: Fay Vranas
via email: fayv@napf.com.au

Dear Fay,

Peer Review of Groundwater Assessment for Proposed Development at 118 Cary Street, Toronto, NSW

1 Introduction

Toronto Investments No.1 Pty Ltd (Toronto Investments) is proposing to develop a multi-storey building at 118 Cary Street, Toronto, New South Wales. The proposed development includes a 6 m deep excavation, supported by secant-piled walls, and construction of a two-level fully tanked basement. The excavation will extend below the water table at the site, which is between about 0.6 m to 1.8 m below the surface.

Toronto Investments engaged CMW Geosciences Pty Ltd (CMW) to prepare a groundwater assessment for the development that included groundwater numerical modelling to predict the influence of dewatering during construction on the groundwater regime, and the long-term effect of tanking on groundwater flow. An assessment of potential settlement induced by dewatering was also undertaken. Toronto Investments engaged Australasian Groundwater and Environmental Consultants Pty Ltd (AGE) to peer review the groundwater assessment prepared by CMW (2022)[1]. Relevant sections of a geotechnical report prepared by Chameleon Geosciences (2022)[2] were also reviewed. This letter describes the findings of the peer review of the groundwater assessment and numerical modelling. The letter excludes review of the settlement predicted by CMW as it is outside the expertise of the author.

[1] CMW Geosciences (2022), Groundwater Drawdown Model and Detailed Settlement Analysis – 114-120 Cary Street, 1,2,3,5 Bath Street and 3 Arnot Avenue Toronto, SYD2021-0134AB Rev4

[2] Chameleon Geosciences (2022), Geotechnical Investigation Report, 118 Cary Street (114-120 Cary St, 1, 2, 3, 5 Bath St and 3 Arnott Ave), Toronto NSW 2283 Prepared for Toronto Investments No.1 Pty Ltd, Report No. GS8030-1A Rev 3, 20th January 2022

2 Review summary and conclusions

2.1 Hydrogeology data and conceptual model

CMW Geosciences utilised data collected by Chameleon Geosciences Pty Ltd (Chameleon) to develop a conceptual model of the groundwater regime. Borehole logs from the site provided within the Chameleon report indicate a clay and silty clay layer occurs at the site from ground level to some 13 m to 14 m below surface. The clay layer is underlain by a hard consolidated conglomerate bedrock, where drilling refusal typically occurred, and diamond coring was used to collect samples.

Two series of monitoring bores were installed at the site. The initial series of boreholes (BH1, BH3, BH5, BH7, BH9) were drilled through the upper residual clay to the underlying bedrock, or into the underlying bedrock using coring. These boreholes were cased with long slotted PVC screens within the residual clay layer, but did not have the base of the borehole sealed from the deeper conglomerate bedrock. These monitoring bores therefore record a composite water level influenced by both the residual clay layer and the underlying bedrock. The water table elevation recorded in these monitoring bores was between about RL 0.6 m and RL 1.2 m. Permeability testing using in-situ falling/rising head tests indicated a moderate permeability averaging 0.3 m/day. CMW concluded this was representative of the underlying conglomerate. It is agreed the construction of the initial series of boreholes has likely favoured measurement of the water level and permeability in the conglomerate bedrock, rather than the upper residual clay, in which the proposed basements will be constructed.

A second series of three shallower boreholes (BH101, BH102, BH103) were drilled at the site to a depth of about 6 m. The objective of these boreholes was to intersect the residual clay layer only, and allow more accurate measurement of water level and permeability within the clay in which the proposed basements will be constructed. These monitoring bores recorded a lower average hydraulic conductivity (2.6×10^{-3} m/day), and higher water level (RL 2.3 m to RL 2.5 m) than the deeper monitoring bores indicating the residual clay material is more representative of an aquitard than an aquifer. The higher water table occurring within the residual clay indicates a retarded connection to the underlying conglomerate bedrock, due to the lower permeability of the clays. It also indicates a general downward vertical hydraulic gradient exists, meaning groundwater held within the clays will slowly move downwards towards the conglomerate without anthropogenic interference.

The methodologies adopted for the field characterisation work are considered industry standard and the work conducted at the site has been sufficient to generally characterise the properties of the in-situ materials with regards to groundwater flow. AGE notes that we have not viewed the raw data from the hydraulic testing, and as such need to assume that Chameleon have analysed the data with appropriate experience and due diligence. Given the low permeabilities reported from the residual clay layer, there is a low likelihood that a subsequent analysis of the same dataset would yield significantly varied estimates of permeability.

2.2 Numerical model

2.3 Model design

CMW constructed a groundwater numerical model of the site and surrounding area using the Groundwater Vistas graphical user interface. The constructed model was run with industry accepted code (MODFLOW 2005). This software is considered appropriate to achieve the objectives of the study nominated by CMW.

The numerical model represents a strip of land between Lake Macquarie to the east of the site, and Stony Creek in the west. Ten metre model cells were adopted in the numerical model at the site, which expanded to 20 m cells beyond the site. The spatial extent of the model, and the model cell sizes are considered appropriate to represent the potential effects given the scale of the proposed development. Constant head boundary conditions were assigned at Lake Macquarie and Stony Creek based on mean surveyed water levels which is an appropriate approach to representing these features.

A wetland and shallow drain connected to Stony Creek occurs to the west of the site across Cary Street. These features were represented with MODFLOW river cells and assigned a head of RL 0.55 m and RL 0.43 m respectively based on survey data. Representation of the wetland and drain with river cells effectively allows groundwater to flow into, or out of, the wetland and drain based on surrounding groundwater levels. This is considered an appropriate way to represent these features in the model.

The upper residual clay and underlying conglomerate bedrock were represented in the numerical model as two unique hydrostratigraphic units. Layer 1 in the model was used to represent the residual clay. The base of this layer in the model was set at an elevation of RL -3 m. The ground surface at the site is reported as being at between about RL 3 m and RL 5 m, which means, based on borehole logs in the Chameleon report, the elevation of the contact between the clay and the conglomerate at the site is between about RL -9 m and RL -11 m. The numerical model therefore appears to under represent the thickness of the clay layer. A lesser thickness of clay in the model, than in reality, would result in an overprediction of groundwater inflow to the excavation and overprediction of the zone of influence due to enhanced connectivity with the underlying conglomerate. The representation of the clay in the model therefore appears to be a conservative assumption. This approach in the model may also account for any transition in permeability that occurs around the contact zone between the residual clay and conglomerate layer.

Model layer 1 is underlain by three model layers of varying thickness that represent the conglomerate bedrock, with the base of the model being a now flow boundary assigned at RL -20 m. Given the moderate permeability of the conglomerate, and the presence of the surface water features to the east, the no flow boundary at RL -20 m at the base of the model is considered unlikely to significantly influence the model predictions.

The proposed secant piled wall associated with the basement excavation was represented in the model using the MODFLOW horizontal flow barrier package, with the hydraulic conductivity set about two orders of magnitude lower than the residual clay material. This is a very low hydraulic conductivity but would be appropriate for a well-constructed secant wall. The adoption of a secant piled wall means that the main mechanism for groundwater inflow into the excavation will be through the floor of the proposed excavation, not the walls. MODFLOW drain cells were used to represent dewatering to an elevation of RL -2 mAHD. This is an industry standard approach to representing excavations in MODFLOW models.

The effect of the model setup is that there is effectively a 1 m thick layer of lower permeability residual clay represented in the model between the excavation floor (RL -2 m) and the top of the more permeable conglomerate bedrock (RL -3 m). This 1m layer in the model retards the volume of groundwater flowing from the conglomerate bedrock into the excavation. In reality, the thickness of residual clay material below the excavation floor may exceed that represented in the model, however this setup in the model is a conservative assumption that could lead to an overestimation of groundwater inflow. It may also indirectly account for structures in the residual clay that cannot be represented using the effective porous media modelling approach (required by MODFLOW). It is not considered a fatal flaw.

2.3.1 Model calibration

The model was calibrated by trial and error adjusting of the rainfall recharge in a steady state simulation to achieve a satisfactory representation of measured groundwater levels at the site. This is a relatively simple approach to calibration, but appropriate for a relatively small and simple numerical model with limited long term monitoring data. CMW advised that the adopted recharge rates were equivalent to approximately 3.5% of annual rainfall north of the canal and 8% of annual rainfall south of the canal. Based on experience, these recharge rates are considered relatively high for the encountered lithology, but still within plausible ranges for the regional setting.

CMW concluded in their report that a satisfactory match between the observed groundwater levels in the monitoring bores and the model simulated levels was achieved. This statement appears true based on the water levels and flow directions shown in Figure 3 in the CMW report. It would be preferable for the reader if a table comparing the simulated and observed groundwater levels was included. It is noted that the model predicted water levels more closely replicate the water levels within the underlying conglomerate bedrock, rather than the higher water levels recorded within the residual clay (where the proposed excavation will occur). This is expected as the modelling was steady state, and therefore could not replicate transient water level conditions within the clay that may be influenced by seasonal rainfall. This artefact is also a function of the applied boundary conditions, and the vertical hydraulic conductivity of the residual clay.

The model simulated water table and flow directions presented in the CMW report in Figure 3, appear plausible and indicate the wetland and drain to the west of the site are likely to be sinks in the groundwater regime, fed by groundwater flow. This is appropriate given the low elevation where these features occur.

2.3.2 Model predictions

A transient simulation over a period of 360 days was used to represent the period required for basement dewatering and construction prior to tanking. A groundwater inflow rate of about 0.2 L/sec was predicted by the model. This relatively low inflow is considered plausible based on the relatively low permeability measured in the residual clay occurring within the floor of the excavation and the use of secant pile walls. As discussed previously, the main mechanism for groundwater inflow to the excavation is through the excavation floor. CMW conservatively represented a 1 m thick layer of clay below the excavation floor overlying the more permeable conglomerate bedrock. A sensitivity analysis was conducted to determine how increasing the connectivity with the conglomerate bedrock would increase the rate of groundwater flow into the excavation. In this scenario the vertical hydraulic conductivity of the residual clay was set equal to the horizontal hydraulic conductivity, which represented an order of magnitude increase compared to the calibrated value. This changed resulted in an increase in the rate of groundwater inflow of about 20%, a slight increase, indicating still relatively modest inflow rates to the proposed excavation.

The model indicates the extent of water table drawdown around the proposed basement excavation will slowly grow over the 360-day construction period, with the 0.2 m drawdown contour extending to 120 m beyond the excavation. This is considered a plausible prediction given the low permeability of the residual clays and the relatively short period of construction when continuous dewatering will be required.

CMW assessed the potential impact on the adjacent wetland by comparing water balances for the wetland with and without the proposed basement dewatering. The water balance indicates the potential for a cumulative loss of groundwater flow into the wetland of about 360 m^3 over the 260 day construction period. When this potential loss is distributed across the wetland it indicates a water level decline of between about 15 mm and 21 mm, depending on the wetland area. The minor potential loss of inflow from the wetland predicted by the model is considered plausible, and is not considered likely to be discernible from normal climatically induced water level fluctuations.

The sensitivity analysis conducted by CMW included scenarios that increased the horizontal hydraulic conductivity of layer 1, and reduced the specific yield of layer 1, both changes that could increase the extent of the zone of drawdown around the excavation. These scenarios increased the cumulative impact on the wetland water level by 55 mm and <4 mm respectively after 360 days. Again these potential impacts are unlikely to be detectable at the wetland from normal climatic fluctuations.

CMW also prepared a model scenario where the model cells in the proposed basement were assigned a very low hydraulic conductivity to represent a fully tanked basement after construction. The modelling did not indicate there would be a significant change to the groundwater flow directions in the site locality, which is a logical prediction.

3 Conclusions and recommendations

The reviewer is of the opinion that the documented groundwater assessment is based on sound hydrogeological principals and practice. The model is considered fit for its intended purposes, which are to estimate the magnitude of groundwater inflow to the excavation, the zone of drawdown, and the potential impact on the adjacent wetlands. The predictions provided by the model are considered plausible, and useful for the decision-making process. Groundwater models provide non-unique predictions, and other possible outcomes are also plausible. CMW recognised this situation and conducted a sensitivity analysis on the model predictions designed to determine how changing model parameters could change the predicted impacts. This is an appropriate approach for a proposed development adjacent a wetland feature.

It is recommended that the existing monitoring bores are sealed with cement grout prior to commencing construction so they don't form a conduit for groundwater flow from the underlying conglomerate layer into the excavation during construction.

Yours faithfully,

James Tomlin
Principal Hydrogeologist/Director
Australasian Groundwater and Environmental Consultants Pty Ltd

Australasian Groundwater & Environmental Consultants

James Tomlin

Director | Principal Hydrogeologist | Project Lead

Education

- Bachelor of Science (Environmental Studies), Griffith University, Brisbane, Qld, 1992
- Master of Science (Hydrogeology), University of Technology, Sydney NSW, 1999
- Certificate of Science (Geology), James Cook University, Townsville, Qld, 2001

Memberships

- International Association of Hydrogeologists, Member, Australian Chapter

Employment history

Jan 2000	**–**	**Current**	**Australasian Groundwater and Environmental Consultants Pty Ltd** **Director | Principal Hydrogeologist | Project Lead**
1999	–	2000	Gutteridge Haskins and Davey Environmental Consultant
1998	–	1999	University of Technology, Sydney Masters student
1996	–	1997	Geraghty & Miller International Inc. Cambridge, England Environmental consultant
1994	–	1996	OTEK Australia Pty Ltd, Brisbane, Qld Environmental consultant
1993	–	1994	Department of Environment and Heritage, Brisbane, Qld

Skills

James Tomlin is a Principal and Director of Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). He has a BSc and MSc in Hydrogeology and Groundwater Management and 25 years' experience in the consulting industry. Over the last 19 years with AGE, James has concentrated on delivering groundwater investigations to support feasibility studies and environmental approvals for the resource and government sectors. His skills include:

- identifying key risks and data gaps for projects;
- designing cost effective field programs to collect essential data;
- developing conceptual models of groundwater regimes;
- guiding the development of numerical models;
- advising clients on legislative requirements relating to groundwater;
- preparing technical reports that meet the requirements of all stakeholders; and
- presenting to clients, regulators and landholders.

James Tomlin
Director | Principal Hydrogeologist | Project Lead

Areas of expertise and selected project experience

James has broad experience and over the last ten years James has focussed on providing advice to the mining industry, particularly the coal sector. He has experience investigating and reporting on groundwater regimes in all the major mining districts of Eastern Australia including Galilee Basin, Bowen Basin, Surat Basin, Gunnedah Basin, Hunter Valley and Southern Coalfields. Outside of the coal sector, James has investigated groundwater issues associated with coal seam gas, metalliferous mines, hard rock and sand quarrying and developments including dams, tunnels, landfills and industrial projects. Some examples of his project experience are provided below.

Mining Projects

- Dartbrook mine, NSW, Groundwater assessment for MOD7 (2020)
- Glendell Mine Continued Operations, NSW, Groundwater assessment (2018-2020);
- Hunter Valley Operations, NSW, Groundwater assessment for PFS study (2018/2019);
- BTM Mining Complex, NSW, Numerical model update (2019-2020);
- Cadia Mine, NSW – Cadia Hill Pit Tailings assessment MOD13 (2019);
- United Wambo Project, NSW – Responses to Independent Planning Commission (2019);
- Mount Owen Mine, NSW, SEE report (2017/2018);
- Groote Eylandt, NT, new quarry baseline site groundwater assessment (2018/2019);
- Watermark Project, NSW, Water Management Plan (2017-2020);
- Mangoola Mine Continued Operations, NSW, GIA and response to submissions (2018-2020);
- Newlands Mine, Groundwater Assessment Peer Review (2019);
- Aquila Longwall Mine, Groundwater Assessment (2018-2019);
- Integra Mine, NSW, MOD8 Groundwater Assessment (2017);
- Callide Mine, Qld, various groundwater advice (2014-2018);
- Ironbark Project, Qld, Advice for regulators (2018);
- Hunter Valley Operations Mine, Annual reviews (2017);
- Bylong Coal Project, NSW, Gateway/EIS reports/PAC presentation (2012-17);
- Maules Creek Coal, NSW, EIS investigation and ongoing model updates (2010-17);
- Berrima Colliery, NSW, EIS hydrogeological investigation (2010);
- Boggabri Coal Mine, NSW, EIS hydrogeological investigation and model updates (2008-2018);
- Warkworth Mine, NSW, EIS hydrogeological investigation (2009-2010);
- Narama Mine, NSW, Study for modification to open cut mine (2012);
- Watermark Project, NSW, EIS and annual reviews (2010-2017);
- Cullen Valley Mine, NSW, EIS hydrogeological investigation (2010-11);
- Wilpinjong Mine, NSW, Review of Cumbo Creek diversion (2010-11);
- German Creek Mine, Qld, Investigate new longwall mine (2013);
- Gregory Crinum Mine, Qld, Closure study (2013);
- Norwich Park Mine, Qld, Final void study (2013);
- Minyango Project, Qld, EIS and approvals support (2011-13);
- Wards Well Project, Qld, EIS investigation (2010-2012);
- Wilunga Project, Qld, EIS investigation (2011);
- Newlands Mine, Qld, EIS approvals and mine planning support (2010-2017);
- Togara North Project, Qld, Feasibility Study and EIS (2009-2010);
- Sarum Coal Project, Qld, Feasibility Study and EIS (2008-2010);
- Colton Coal Mine, Qld, EIS hydrogeological /modelling (2008-2010);
- Elimatta Project, Qld, EIS hydrogeological investigation and updates (2008-2017);
- Ellensfield Project, Qld, EIS investigation/modelling, Vale (2008);

Areas of expertise and selected project experience (continued)

- Blackwater Mine, Qld, Hydrogeological review (2008);
- Saraji Mine, Qld, Data review/ongoing advice (2007-2012);
- Carborough Downs, Qld, EIS investigation/modelling (2006);
- Sonoma Mine, Qld, EIS and approvals support (2005-06);
- Ensham Mine, Qld, Various ongoing advice, bores installation and monitoring (2004-2018); and
- Wilke Creek Mine, Qld, Hydrogeological review (2003).

Quarries

- Bajool Limestone Quarry, Qld, Groundwater management plan (2018);
- Innes Park Basalt Quarry, Qld, Hydrogeological investigation (2009-2010);
- Dundowran Quarry, Qld, Hydrogeological investigation (2006);
- Narangba Quarry, Qld, Hydrogeological investigation (2006);
- Petrie Quarry, Qld, Hydrogeological investigation (2006);
- Roseneath Quarry, Qld, Hydrogeological investigation (2007); and
- Bracalba Quarry, Qld, Permeability testing (2003).

Government

- Queensland Govt, Review of Guideline quantifying the volume of associated water taken under a mining lease or mineral development licence (2016);
- Queensland Govt, Review abandoned coal bores in Surat Basin for OGIA (2013); and
- Queensland Govt, Guideline for farm bore surveys for DNRM (2010-2011).

Coal Seam Gas and Oil Shale

- Arrow Energy Gas Fields, Qld, Bore Assessment for four bores (2017);
- Meridian Gas Field, Qld, Groundwater assessment (2010-2011); and
- Stuart Oil Shale Project, Qld, Data review and bore design (2011-2012).

Mineral/Sand Mines

- Lawnton Sand Mine, Qld, Desktop review change of land use (2009);
- Cape Cleveland Sands, Qld, Investigation/numerical modelling (2004);
- Carbrook Sand Mine, Qld, Assessment monitoring data (2006);
- Norwell Sand Mine, Qld, Investigation and modelling (2004); and
- Cudgen Sand Mine, Qld, Hydrogeological study /modelling (2006-2017).

Gold/Base Metal Mines

- Mt Oxide Mine, Qld, EIS investigation (2010-2011);
- Cadia Mine, NSW, Various hydrogeological investigations (2006-2018);
- Kidston Gold Mine, Qld, Stage 1 & 2 contaminated land study (2001);
- Cracow Mine, Qld, Klondyke EMOS and bore installation (2003);
- Endeavour Mine, NSW, Permeability testing for tailings storage (2004);
- Osborne Mine, Qld, Contaminated land assessment (2005); and
- Cadia Mine, NSW, Investigation and bore installation (2007-2008).

Areas of expertise and selected project experience (continued)

Water Supply Investigations

- Wilpinjong Mine, NSW, Supervision of water supply bores (2007);
- Swickers Abattoir, Qld, Water supply assessment (2013);
- Surat Basin, Qld, Water supply for 2 x gas camps (2011-2012);
- Oaky Creek RWS, Qld, Monitoring and bore rehabilitation (2007);
- Wilpinjong Mine, NSW, Installation production bores (2007);
- Town of Clairview, Qld, Pumping test assessment (2003);
- Mundubbera Feedlot, Qld, Water supply options (2004);
- Burnett River Dam, Qld, Aquifer monitoring (2004-2008);
- Auburn Feedlot, Qld, Pumping test assessment (2005); and
- Callide Mine, NSW, Installation level & flow loggers (2007).

Development sites

- Gold Coast Retirement Village, Qld, Review groundwater issues (2014);
- Purga Area, Qld, Groundwater impact assessment (2005); and
- Nestle Coffee Gympie, Qld, Waste water irrigation review (2007).

Tunnelling

- Epping Tunnel, NSW, Analytical inflow estimates (2001);
- Cross City Tunnel, NSW, Analytical inflow estimates (2003);
- Airport Link, Qld, Pump testing and inflow estimates (2005); and
- Clem 7 Tunnel, Qld, Pump testing and monitoring (2005/6).

Landfill Sites

- Redcliffe City Council, Qld, East Talobilla Park, LRAP Investigations (2001);
- Redcliffe City Council, Qld, Western Talobilla Park, Installation Monitoring Bores (2001);
- Redcliffe City Council, Qld, Redcliffe, Post Closure Monitoring Plans (2002);
- Whitsunday Council, Qld, Jubilee Pocket, Monitoring and Spec for Capping (2002);
- Caboolture Council, Qld, River Road Landfill, Hydrogeological Investigation (2003);
- Noosa Council, Qld, Noosa Heads Landfills, Monitoring Bores and Monitoring (2003);
- Noosa Council, Qld, Noosa Heads Landfills, Numerical Modelling (2003);
- Rosalie Shire Council, Qld, Rosalie Area, LRAP Investigation (2003);
- Kingaroy Shire Council, Qld, Kingaroy Landfill, Hydrogeological Investigation (2006);
- Noosa Council, Qld, Noosaville Landfill, Hydrogeological Assessment (2006);
- Cooloola Shire Council, Qld, Four Landfill Sites, LRAP Investigations (2007); and
- Redcliffe City Council, Qld, Redcliffe Landfills, Water Quality Monitoring (2007).

Dams

- Lake Kinchant Dam, Qld, Management of investigation on neighbouring property.

Areas of expertise and selected project experience (continued)

Petrochemical Industry

- Kuwait Oil Fires, Qld, Installation monitoring network, Kuwait Government (2002-2004);
- Bulk Petrol Terminal, Qld, Groundwater monitoring, Neumann Petroleum (2001-2008); and
- Contaminated land investigations at multiple petrol stations and terminals in Australia and the UK (1994 to 1999).

Community consultation

- Present to residents surrounding Boundary Hill South Project for Callide mine, 2015
- Present to residents surrounding Cadia Mine 2018, 2019

Conference presentations

- Expert panel member on mining and coal seam gas - Australian Groundwater Conference, 2019, Brisbane.
- Tomlin, JS 2015. Final voids lakes at open cut coal mines – a perspective on the challenges and opportunities. Australian Groundwater Conference, 3–5 November 2015, Canberra.
- Presenter at “Getting to Know Your Groundwater” workshop for landholders in Emerald Queensland coordinated by 4T consultants, April 2016.