**Hoffmann Drilling Pty Ltd Superannuation Fund v Gold Coast City Council & Ors**

**Planning and Environment Court Appeal No 137 of 2020**

**Joint Expert Report on groundwater issues between Dr Trevor Johnson (TJ) of SLR Consulting, acting for Hoffmann Drilling, Tony McAlister (TM) of Water Technology acting for Gold Coast City Council and Dr Matthew Currell (MC) of RMIT acting for the Australian Rainforest Conservation Society from a joint experts meeting held via email between 16 and 23 October 2020**

## STATEMENT TO COURT

We, the undersigned, hereby acknowledge that we have been instructed on an expert's duty to assist the Court and that, that duty overrides any obligation we may have to any party to the proceedings or to any person who is liable for our fees or expenses.

We furthermore state that no instructions were given or accepted to adopt or reject any particular opinion in preparing this report.

## BACKGROUND

On 24 April 2018, Michel Group acting on behalf of Graeme Hoffmann and Chuda Kaewmongkhon as trustee for the Hoffmann Drilling Pty Ltd Superannuation Fund [**Hoffmann**] made application to Gold Coast City Council [**Council**] for a Development Permit for Material Change of Use for Extractive Industry (Commercial groundwater extraction) on land located at 263 Repeater Station Road, Springbrook. The land is described more particularly as Lot 36 on SP 139816.

By Decision Notice dated 12 December 2019, Council refused the development application, citing a number of reasons for refusal, including the following which are relevant to groundwater hydrology:

1 ***The development does not support and promote the Strategic framework in that:***

   a ***The potential short and long term impacts associated with the proposed use have not been adequately demonstrated. Therefore, the potential for the proposed use to significantly impact upon the environmental features of this area and natural processes cannot be determined at this stage.***

2 ***The development does not achieve the Purpose, Overall outcomes and Performance outcomes of the Environmental significance overlay code in that:***

   a ***The proposed use does not comply with the Purpose 8.2.6.2(1) of the Environmental significance overlay code as it has not been adequately demonstrated that the proposed use will not impact upon matters of environmental significance.***

   e ***The proposed use does not comply with Performance outcome 13 and 17 of the Environmental significance overlay code as the short and long term environmental impacts of the proposed groundwater extraction have been unable to be adequately established. It is consequently unknown if the proposal will impact downstream environments including koala trees.***

3 ***The development does not comply with PO5 of the Water resource catchment overlay code. The potential impacts on environmental features and natural processes, including riparian vegetation, have not been adequately demonstrated.***

***Therefore it cannot be determined that the proposal provides for the protection, maintenance, management and rehabilitation of riparian areas adjacent to waterways.***

***6 The development does not achieve the Purpose, Overall outcomes and Performance outcomes of the Extractive industry development code in that:***

***a The proposed use is not considered to comply with the purpose and performance outcome 1 of the Extractive industry use code. As the potential short and long term impacts of the proposed use on matters of environmental significance have been unable to be accurately established, it is unknown if the proposed use minimises environmental impacts on the site and surrounding areas.***

While these reasons for refusal are broad, they can be summarised succinctly as follows in respect of issues for the groundwater experts to consider:

- Council alleges that the potential environmental effects of the proposed groundwater extraction have not been suitably considered and accurately determined in the technical information submitted in support of the application. Relevant matters which could be affected by the extraction include the ecology of the local area (more specifically any flora which may be groundwater dependent) and surface flows within the two water supply catchments in the area, namely the Nerang River and Little Nerang Creek.

Thynne Macartney Lawyers, acting on behalf of Hoffmann, lodged a Notice of Appeal with the Planning & Environment Court on 17 January 2020 (No 137 of 2020), seeking the refusal to be overturned.

Following the lodgement of the Notice of Appeal, Catherine Ash, the Australian Rainforest Conservation Society [**ARCS**], Gecko Environmental Council Association Inc, Bernie Winter and Gina Winter, and Charles Orsini all, elected to become Co-respondent to the Appeal having been submitters to the application.

Three of the parties to this matter, Hoffmann, Council and ARCS, have each appointed relevant experts on their behalf to consider the groundwater issues associated with this matter.

Previous relevant technical reports which have been submitted to Council by the appellant's consultants include the following:

- Report on Groundwater Assessment for Proposed Commercial Groundwater Extraction, Douglas Partners, November 2017
- Letter dated 13 September 2018, Douglas Partners
- Letter dated 19 June 2019, Douglas Partners
- Water Balance Assessment, 263 Repeater Station Road, Springbrook, SLR Consulting, June 2020

In addition, Council had a 3rd party review of the groundwater information in the application undertaken by Water Technology, who provided a relevant letter dated 22 August 2019 to Council.

**POINTS OF AGREEMENT**

1. It is agreed that the Springbrook area is underlain by the Hobwee Basalt which is part of the more extensive Lamington Basalt Complex. The Hobwee Basalt is likely (according to a previous assessment by PJ Ramsey & Associates) to support one or more aquifers consisting of fractured vesicular basalts. A number of local bores intersect the aquifer(s), including three on the subject land.

2. It is agreed that the water table level in the proposed extraction bores at the time that Douglas Partners completed a pump test on the site (in 2017) was approximately 830 m AHD. However, the water table and/or potentiometric surface patterns in the area surrounding the bores are currently unknown.

3. It is agreed that an existing groundwater extraction business at 133 Repeater Station Road, approximately 1 km north of the subject site, was approved by Council on 9 September 2015. The ground level at 133 Repeater Station Road is approximately 820 m AHD as compared with 910 m AHD at 263 Repeater Station Road, making it some 90m lower than the subject site. In making this determination, Council considered a groundwater impact report prepared by Peter J Ramsay & Associates (Hydrogeological Impact Assessment for the Existing Groundwater Source at 133 Repeater Station Road, 24 July 2014). That report stated that the aquifer was approximately 60 m thick, and that the principal source of groundwater recharge was rain falling directly on the ground surface above. The report also stated that the average hydraulic conductivity of the aquifer was 0.36 m/day, with an effective aquifer porosity of 0.05. The experts disagree as to whether it has been demonstrated that these parameters are appropriate to use in the estimation of impacts from the current proposal (See Points of Disagreement, below).

4. The principal finding of the Peter J Ramsay report was that groundwater extraction of up to 12 ML/annum (constant rate of 0.38 L/s) was possible at 133 Repeater Station Road, and that a) groundwater bores more than 500 m distant would be beyond the radius of influence of drawdown from such extraction and b) short-term hydraulic impacts to springs approximately 500 m from the wells were not likely. However, they noted the potential for long-term drawdown in the aquifer to impact upon baseflow to the springs. The Ramsay report could not confirm whether there would be a long-term impact on water levels in the aquifer since they had not undertaken relevant water balance assessments. It is agreed that Council considered this information when issuing an approval for the extractive industry on that site.

5. It is agreed that Douglas Partners undertook site and desktop groundwater investigations for the 263 Repeater Station Road site as per their 2017 report and two subsequent letters to Council. The adequacy and accuracy of the Douglas Partners analysis is not agreed by the experts (see Points of Disagreement below). Douglas Partners estimated that the maximum impact of groundwater extraction of up to 16 ML/annum at 263 Repeater Station Road would be a reduction in the water table level of approximately 1.5 m at a distance of 270 m from the bores. This was based on an analytical equation only, and was not verified using contemporary field monitoring techniques. The experts disagree as to whether this is an accurate or conservative estimate of the magnitude and extent of drawdown that would occur in response to the proposed groundwater extraction (see Points of Disagreement below).

6. It is agreed that the minimum annual rainfall recorded at the BOM Springbrook Road rainfall recording station since records commenced in 1981 is 1122 mm, although rainfall totals vary among the different nearby monitoring stations – e.g. Springbrook Forestry and Upper Springbrook. The experts disagree regarding the long-term rainfall trend and implications of

future climate change for the sustainability of the proposed development (see Points of Disagreement below).

7. Queensland Government data (see Figure 1) has mapped (with moderate confidence) Groundwater Dependent Ecosystems (GDEs) in the local area surrounding the production bores. Impacts on these GDEs may occur due to groundwater extraction, but this has yet to be studied in detail. TJ believes that this is an ecological issue which should be considered by the expert ecologists. He also believes that the subject site has now been the subject of detailed ecological investigation as a consequence of the current matter; however, MC and TM have not seen the results of this investigation.


Figure 1 – Location of groundwater dependent ecosystems (GDEs) based on Queensland Government spatial datasets (note: these have been assigned a level of confidence based on the level of local expert knowledge of the landscape and availability of detailed spatial datasets supporting the ecosystem identification).

8. The groundwater that would be extracted by the production bores at 263 Repeater Station Road would otherwise flow (via groundwater discharge from seeps and springs) to surface water sites at lower elevations, including any existing GDEs, as well as Twin Falls and Cave Creek, which are sites of considerable environmental and regional tourism significance.

**POINTS OF DISAGREEMENT**

1a TJ says that he caused SLR Consulting to undertake, under his direction, a water balance assessment of inflows to, and outflows from, the designated aquifer underlying 263 Repeater Station Road. This work was undertaken specifically to address concerns raised by Council, and Water Technology as its consultant, in respect of the possible impact of long-term extractions from the aquifer. In particular, TJ notes that he was requested to speak directly to Craig Flavel of Water Technology (also the employer of TM) to determine what additional modelling might be required to address a number of Council concerns. He notes that the specific discussion between TJ and Mr Flavel related to the proposal to set up a water balance model to consider the inflows to and outflows from the aquifer. He also notes that this issue of long-term water balance had also been specifically mentioned by Peter J Ramsay & Associates as a parameter requiring further investigation in their report for the extraction at 133 Repeater Station Road. TJ considered that the most appropriate way to estimate this impact was by setting up a water balance model which estimates infiltration flows into the aquifer from rainfall, and outflows from the aquifer by evaporation, evapotranspiration, deep drainage and surface flows to springs and watercourses such as Little Nerang Creek.

1b MC believes there are significant problems with the methodology used, and that other and/or additional lines of evidence are required (see points 7a, 8a and 9a below) to determine relevant water balance information to assess the impacts of the proposed extraction, such as groundwater recharge rates for the aquifer in which the production bores are constructed, (e.g., based on hydrograph analysis and other techniques) and groundwater discharge to nearby surface water bodies.

1c TM also has significant concerns with the relevance of the SLR Consulting report to the matter at hand, specifically as follows

- It does not respond in any logical or comprehensive manner to the observations of the earlier Water Technology review. Use of a conceptual and analytical hydrogeological model was previously recommended that would **properly** link rainfall to groundwater processes and then enable impacts of the proposed extraction, including consideration of any insights from local groundwater 'springs' and other bore users, to be made. The model that SLR has applied does none of this.
- Regarding the modelling conducted in association with the SLR report, TM has concerns as to its accuracy and applicability to the matter at hand, for the following reasons
    - The '*excellent representation of the recorded flows, particularly for the lower flow rates*' cited in the report is not apparent in their Figure 6, which would appear to grossly overpredict the influences of regular rainfall events;
    - The model is calibrated to data collected on the Nerang River at Numinbah, a site located a significant distance downgradient from the edge of the Springbrook escarpment. The longitudinal slope of the river by the time it reaches Numinbah is quite different to that in the vicinity of the area of interest. As such, lumped conceptual model results from this downstream

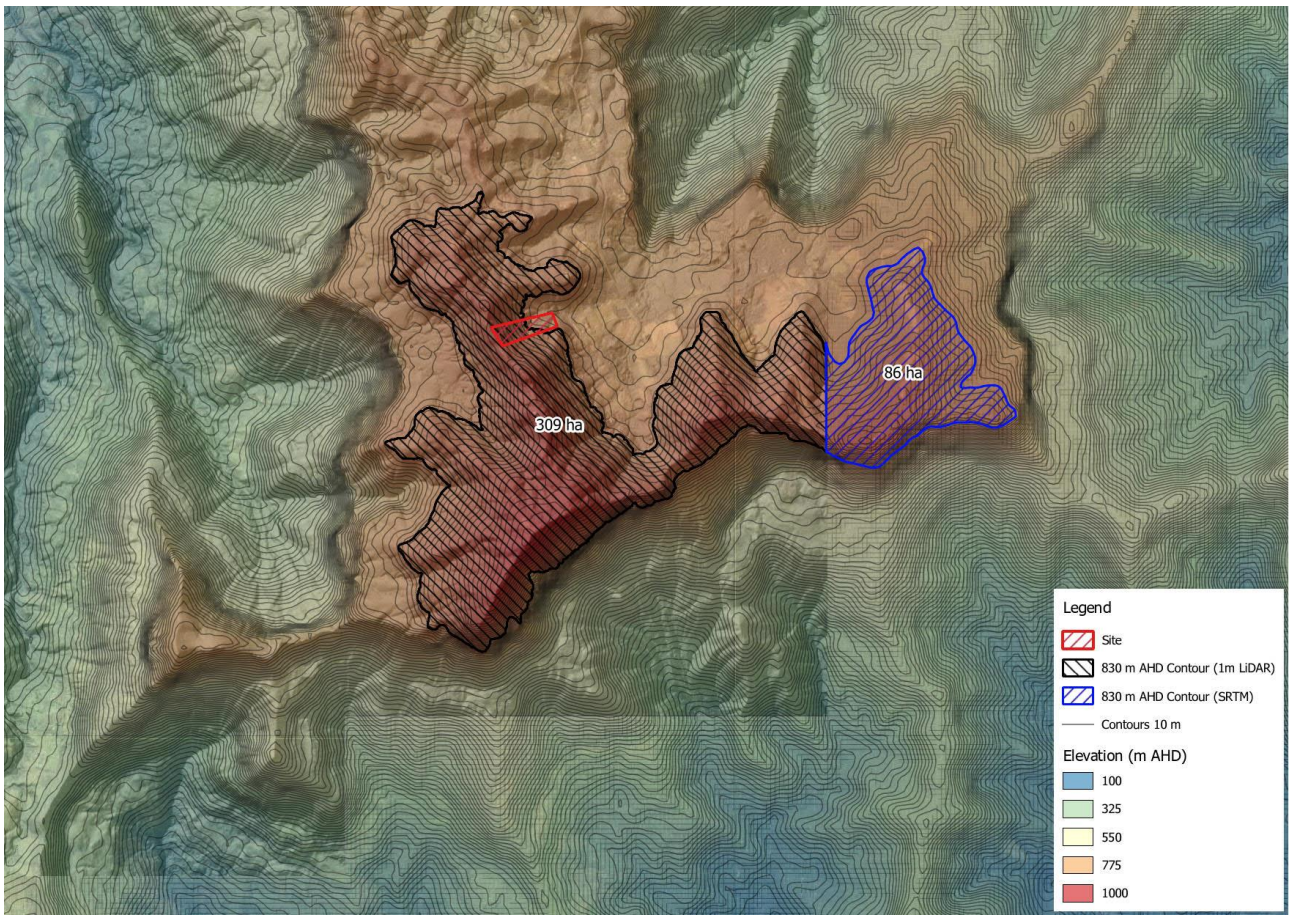
location are not transferable to the upstream, far steeper and more heavily vegetated, part of the catchment; and

- TM disagrees with the catchment area SLR used in their analysis. They state that '*the catchment area draining to the 830m AHD contour was estimated to be 309 Ha*'. When TM undertook his own inspections, he come up with a more realistic catchment area of 82 Ha that would see water recharge to the 830 m AHD contour (realising that such a catchment can have recharge occurring both to the east and west of the drainage divide). Other potential ways of analysing this matter similarly come up with catchments far less than 309 Ha. As such, this will mean that SLR will be underpredicting the potential impact of the groundwater extraction.

1d TJ states that there is only way to determine the catchment area, and this is to trace around the 830 m AHD contour on a topographic map of the area. Please see the following image which shows the extent of the 830 m AHD contour. It is clear and unremarkable that seepage occurring on this area following rainfall will flow into the aquifer. TJ does not understand the "alternative" methods employed by TM to estimate the catchment area. TJ also notes that the SLR response in respect of preparing a water balance model was in accord with discussions held between TJ and Mr Craig Flavel of Water Technology, who was Council's expert at the time. The catchment area adopted by SLR consulting is shown following. It is noted that the analysis is conservative in that we have terminated the catchment area used in the analysis to exclude about 86 ha of the area above 830 m AHD in the far east of the map.

1e. MC notes the analysis above and believes that the connectivity between recharge occurring over the region above elevation of 830m AHD shown in the map, and the aquifer in which the production bores are installed, is not demonstrated. He believes it cannot be assumed that recharge above this elevation occurs across this full area or that it infiltrates into a connected aquifer system in which the bores are installed, without first mapping groundwater elevation contours and documenting the hydrogeological characteristics of the area in more detail.

1f. TM is of the same opinion in regard to this matter as MC and used what he considers to be reasonable judgement in calculating his effective catchment area.




2a TJ says that the above investigation was reported upon in the SLR Consulting report of June 2020. That report concluded that the extraction of up to 16 ML of groundwater from the aquifer per annum would have only a minor impact on the volume of water stored in the aquifer. The water balance model, based on the Goldsim interpretation of the Australian Water Balance Model (AWBM), achieved excellent calibration performance against actual surface flows recorded at the Department of Natural Resources and Mines (DNRM) gauge at Numinbah (Figure 6 in the report).

2b MC believes that the use of streamflow data from the Numinbah gauge to estimate baseflow a significant distance downstream from the site and at far lower topographic elevation, is unlikely to provide reliable estimates of groundwater recharge that are applicable for the aquifer at the site of the proposed bores. He believes this would require other lines of evidence based on site-specific data, such as groundwater hydrographs and/or environmental tracers. MC also says that the volume of water stored in the aquifer has not been determined and there are insufficient data to estimate this currently.

2c TM, as outlined under his commentary provided at Point 1c above, strongly disagrees that the SLR modelling is robust or fit for purpose to the matter at hand. He feels that more appropriate groundwater (as opposed to surface water) oriented modelling and data interpretation investigations are required before any certainty can be provided as to the effects of the proposed operations.

2d TJ says that groundwater modelling has been undertaken by a number of consulting engineers in this area (URS, Peter J Ramsay & Associates, Douglas Partners), each of whom has determined that the short term impacts of groundwater extraction are close to insignificant. TJ notes that SLR Consulting was not undertaking additional groundwater

modelling, but instead setting up a water balance model on the advice of Water Technology acting on behalf of Council. He does not consider the groundwater conditions here to be significantly complex and relies on the previous findings which Council had itself considered and accepted in approving groundwater extraction at 133 Repeater Station Road. He does not believe that more extensive hydrogeological investigations are likely to yield different results than have been obtained so far.

2e TM notes that he has conferred with his colleague Mr Flavel who has confirmed that his earlier advice to TJ related to **site-based** water balance modelling assessments that took appropriate consideration of groundwater and surface water behaviour based on local data, not the whole of catchment surface water balance modelling that TJ has subsequently overseen.

2f MC believes that the modelling referred to by TJ above is overly simplistic, using basic analytical equations which are not demonstrated to be suitable for the setting and are poorly documented, missing supporting data, equations and assumptions. He believes such modelling is nowhere near fit for the purpose of predicting drawdown and/or water budget changes resulting from the development. He notes that more in-depth analytical and/or numerical groundwater modelling tools could potentially achieve this, but this would first require more comprehensive field data from the site to ensure such modelling is an appropriate representation of the hydrogeology of the site.

2g TJ says he has no idea what TM means by a “site-based” water balance model. Water balance modelling is based solely on contributing catchment areas. It would be inaccurate to consider a water balance based only on the area of 236 Repeater Station Road, or any area other than the correct catchment area. The water does not follow site boundaries.

3a TJ says that the model, based on 120 years of rainfall data, indicated that an extraction rate of 16 ML/annum would remove on average less than 1% of the volume of water seeping to the aquifer in the wetter parts of the year, increasing to about 3% of the available volume during the drier months. The model also shows that the maximum impact on flows to Little Nerang Creek would have been 4.6% in the driest month on record. In his opinion, it is apparent that these impacts are much smaller than the annual variation in rainfall totals which occur on the site. The annual extraction rate represents less than 1% of the average volume of rain falling on the catchment.

3b MC believes that these estimates are:

a) Unreliable, as it has not been adequately demonstrated that the estimated recharge rates are appropriate for the site;
b) Misleading, in that they are not reflective of the full possible range of local (as well as regional) impacts of the groundwater extraction. Little Nerang Dam is a significant distance downstream of the bores and receives inflow from a larger catchment and more extensive network of tributaries than would likely be impacted by the bore extraction. As such, comparing the proposed extraction volume at the bores to the relatively large magnitude of inflows from the wider catchment area into Little Nerang Dam, obscures potentially much more significant local impacts upstream of this dam, such as the smaller streams and springs flowing to Twin Falls, Cave Creek and Natural Bridge - sites of considerable significance (see Fig. 1); and
c) Not considerate of the potential for climate change to (further) reduce the amounts and reliability of rainfall in the area in the coming decades (see point 21a below).

3c TM, as outlined under his commentary provided at Point 1a above, disagrees that the SLR modelling is robust or fit for purpose. He feels that the potential impacts from the project are likely to be far greater than those enumerated by TJ as they have:

- Used an inappropriate model;
- Calibrated this model to a site that is topographically very different to the area upstream of and adjacent to 263 Repeater Station Road; and
- Used incorrectly large catchment areas to then extrapolate their model findings to the site in question.

TM highlights, even though he disagrees with the modelling approach used, that if he corrects the SLR analysis to the **actual** catchment area recharging the groundwater table above the 263 Repeater Station Road site derived by his analysis, the impacts predicted by SLR would increase by a factor of 3.8. This means that their predictions of impact would be more like extraction representing **4%** of flow in wetter months and **12%** of flow in drier months. Such changes, especially given the environmental significance of the adjacent and downstream receiving environment, are unacceptable.

3d It is TJ's opinion that the work completed by SLR Consulting, together with the historical hydrogeological analyses previously completed with others, demonstrates that the level of extraction proposed will have no significant impact on the Springbrook aquifer. If the intention of the studies undertaken was to examine the behaviour of the aquifer in minute detail, then the level of investigation proposed by MC and TM might be acceptable. However, the intention has always been to estimate the impact that a relatively minor volume of extraction will have on this aquifer. It has not been to study the aquifer in detail. On that basis, the level and extent of analysis completed is consistent with the insignificant impact which has been estimated to occur by a number of different consulting engineers who have considered this matter.

3e MC believes that the level of investigation he proposes to properly characterise the extent of the impacts of the groundwater extraction - e.g. characterisation of site-specific hydrogeological properties, creation of water level contour maps, monitoring of water level hydrographs (using monitoring bores) and spring flow rates, and sampling for chloride as an indicator of recharge - are basic and fundamental hydrogeological techniques that are appropriate for any analysis of the sustainability of groundwater pumping, including at the rates proposed in this case (noting that these methods are a sub-set of a far more detailed suite of hydrogeological investigation techniques available for larger-scale and more complex sites).

4a TJ says that the SLR Consulting analysis had the benefit of referring to a similar investigation completed by the Queensland University of Technology in relation to groundwater extraction from sites on Tamborine Mountain, which is considered to have very similar geology to the Springbrook area. The QUT study concluded for Mount Tamborine that:

> ***The current volume of groundwater being extracted in any year is less than 3% of the average volume of rainfall that is recharging the resource annually. This balance will of course change for the worse in dry years, while wet years will tend to restore the groundwater resource.***
>
> ***If it is assumed that most groundwater is currently extracted from deeper levels within the system…the proportion of groundwater extraction is still likely to be less than 5 – 6% of average annual recharge. This level of extraction is***

***considered to be sustainable, even in the absence of information on environmental flow requirements.***

TJ says that the volume of water proposed to be extracted from the Springbrook site is substantially less than that estimated for Mount Tamborine while the annual rainfall totals are significantly more. In his opinion, the same conclusion should therefore be applicable to the current proposal, i.e. the level of extraction is considered to be sustainable.

4b MC says that the level of hydrogeological investigation conducted for Tambourine Mountain is significantly more extensive than has been conducted at Springbrook (e.g. it is based on analysis of hundreds of bores, detailed hydrograph records and sampling of environmental tracers), and it is not appropriate to compare the sustainability of extraction rates from the two aquifer systems without further detailed information regarding the Springbrook aquifer's storage capacity, recharge rates, water levels and interaction with surface water. These factors may differ between the two areas in important ways.

MC also believes that the comparison of extraction rates to groundwater recharge rates or total surface water flows is an incomplete and overly simplistic method for assessing the sustainability of groundwater extraction – and this is supported by the best available peer-reviewed scientific literature on this topic[1]. Rather, a full assessment of the changes to water levels and flow patterns, groundwater discharge to surface water and potentially, induced recharge, is required – for example, using a numerical groundwater flow model supported by relevant field data (which are currently absent in this case). Following this, any key environmental or social values associated with each of these changes must be conducted, involving consultation with any affected stakeholders.

4c TM agrees with MC regarding the hydrogeological investigations conducted and also refers to his calculations under Point 1c above that highlight the potential severity of impact associated with the 263 Repeater Station Road project, which he says has been underestimated by TJ's assessments.

4d TJ says that the Tamborine Mountain investigation is in fact an excellent analogue for the Springbrook extraction. Both sites are typified as basalt plateaus in south-east Queensland where groundwater extraction occurs from a fractured rock aquifer, and both were formed by lava flows from the Tweed shield volcano. However, he also notes that this part of Springbrook receives more than double the Mt Tamborine rainfall on average. It would be expected that a higher sustainable groundwater extraction rate was therefore likely to be achievable at Springbrook.

4e MC does not agree, noting that Tamborine Mountain was found by Todd to include a multi-layered aquifer system with multiple basalt aquifers within a thickness of up to 150 m. He notes that the current geological information from the Repeater Station Rd site – while incomplete - indicates a much thinner and less extensive aquifer system with lower storage capacity.

5a MC and TM agree with the Reasons for Refusal given by the Gold Coast City Council relevant to groundwater, namely:

[1] E.g. Alley, W.M., Reilly, T.E., Frank, L. 1999. Sustainability of ground-water resources. U.S. Geological Survey Circular 1186. Available at: https://pubs.usgs.gov/circ/circ1186/pdf/circ1186.pdf; Bredehoeft, J. 2002. The Water Budget Myth Revisited: Why Hydrogeologists Model. Groundwater 40(4): 340-345. Pierce, S.A., Sharp, J.M., Guillaume, J.H.A., Mace, R.E., Eaton, D.J. 2013. Aquifer-yield continuum as a guide and typology for sustainable groundwater management. Hydrogeology Journal 21: 331-340.

- Suitable geological characterisation, groundwater testing and modelling investigations have not been undertaken for the site to demonstrate that the proposed use is acceptable,
- It has not been demonstrated that the proposed extraction will not cause unacceptable environmental impacts, including when considering the cumulative impacts of the proposed extraction with other groundwater extraction operations and climate change.
- It has not been demonstrated that the proposed development will not have unacceptable impacts on matters of National, State and Local environmental significance that are known to occur within the site and surrounding locality, including impacts associated with the reduction in the availability of groundwater resources;

5b TJ says that the groundwater investigations undertaken by Douglas Partners and Peter J Ramsay & Associates in the local area have adequately determined the characteristics of the aquifer underlying the area, and have determined that the impacts of proposed extraction will be acceptable. If the requirement of the investigation is to conservatively determine the impact that planned extraction of groundwater will have on the aquifer, the level of investigation used by the applicant's consultants is adequate.

In respect of the second dot point, TJ says that the analyses and investigations completed by SLR Consulting have determined that the volume of extraction from the aquifer is not significant in comparison to either the volume of rainfall seepage which flows to the aquifer, or the volume of surface expression of groundwater in the Little Nerang Creek catchment.

In respect of the third dot point, TJ says that this is primarily a matter for the ecology experts to determine. However, he notes that he has met with Hoffmann's ecological expert on site, Mr Wayne Moffitt. He and Mr Moffitt located a spring in a gully line east of the proposed extraction point on the subject site. It was determined by GPS that the level of this spring was about 830 m AHD which is consistent with the expectation from the measurement of the standing water level in the bore by Douglas Partners. Mr Moffitt will provide his own statement in regard to this matter, but it was discussed on site that there were no rare or endangered species which were reliant on groundwater in the vicinity of the spring. It was also discussed that the variation in water table level which might result from groundwater extraction was unlikely to alter ecological characteristics of the site, including the area around the spring.

5c MC says that he has seen photographs indicating a number of locations where groundwater appears to discharge to the surface in the vicinity of the bores (see Figure 2 below), and this groundwater may be ecologically important. MC says that the stream network and topographic maps of the site (Fig. 1 & Figure 3, below) also show that springs or seeps of discharging groundwater east of the bores appear to flow to Twin Falls, while those to the west flow to Cave Creek, which sustains Natural Bridge. These are sites of high environmental significance which have a high likelihood of being impacted by reduced flows in response to the proposed groundwater extraction.

5d TJ says that there is no disagreement with MC about either the existence or location of springs on the Hoffmann site, and he fails to understand what point MC is trying to make. The springs observed on the Hoffmann site are all consistent with the nomination of a groundwater level of about 830 m AHD in the aquifer. It is expected that there will be surface expression of water below this level, as evidenced by the MC photographs.

6a TJ says that based on the low porosity of the aquifer, significant changes in groundwater table level are likely to be experienced following rainfall. In his opinion, changes in water level of between 5 and 10 m are likely to be common across the course of a year. The

existing vegetation on site is obviously already resilient and acclimatised to these changes. Minor variations of less than 1 m caused by groundwater extraction are simply insignificant in this context.

6b MC says that the level of water table fluctuation in the vicinity of springs and other potential GDEs (or aquifer porosity) has not been adequately documented with supporting evidence, and that:

a) Any additional drawdown caused by the extraction bores would compound periods of natural decline in groundwater levels in response to low rainfall, and this may reduce water levels below minimum previously experienced (and potentially environmentally important) thresholds,
b) Analysing the impacts of groundwater extraction on surface ecological systems based on water table fluctuation alone overlooks the importance of discharge flux rates, and the potential for pumping wells to capture potentially environmentally significant flows[2].

6c TM agrees with MC that water table fluctuation in the vicinity of springs and other potential GDEs (or aquifer porosity) has not been adequately documented with supporting evidence. As he has stated previously, the modelling conducted by SLR Consulting under TJ's instruction is **surface water balance** modelling that has (incorrectly) inferred groundwater recharge rates at the site in question. It tells us nothing about changes in water table levels or how much and where such water may express in adjacent environmentally significant locations. It also takes no account of potential cumulative impacts of other existing operations in the area (e.g. that at 133 Repeater Station Road).

6d TJ does not agree. He notes that the requirement to prepare a water balance model was the outcome of discussions between TJ and TM's colleague at Water Technology, Mr Craig Flavel. The water balance model calculates the changes in water volumes which are likely to take place in the aquifer as a result of the groundwater extraction proposed, as well as the processes of evapotranspiration and surface expression. He also notes that, based on the aquifer parameters determined by Peter J Ramsay & Associates, the fractured basalt rock aquifer has a low porosity which dictates that there will be significant changes in water table level as a result of even small amounts of rainfall. He notes that Peter J Ramsay & Associates reported on level rises observed by URS in this locality following rainfall which support the TJ position.

[2] E.g., see Alley, W.M., Reilly, T.E., Frank, L. 1999. Sustainability of ground-water resources. U.S. Geological Survey Circular 1186. Available at: https://pubs.usgs.gov/circ/circ1186/pdf/circ1186.pdf

Photo 4 Photo by Andrew Barr-David, 28 April 2020

Photo 1 Photo by Catherine Ceris Ash, 17 September 2020

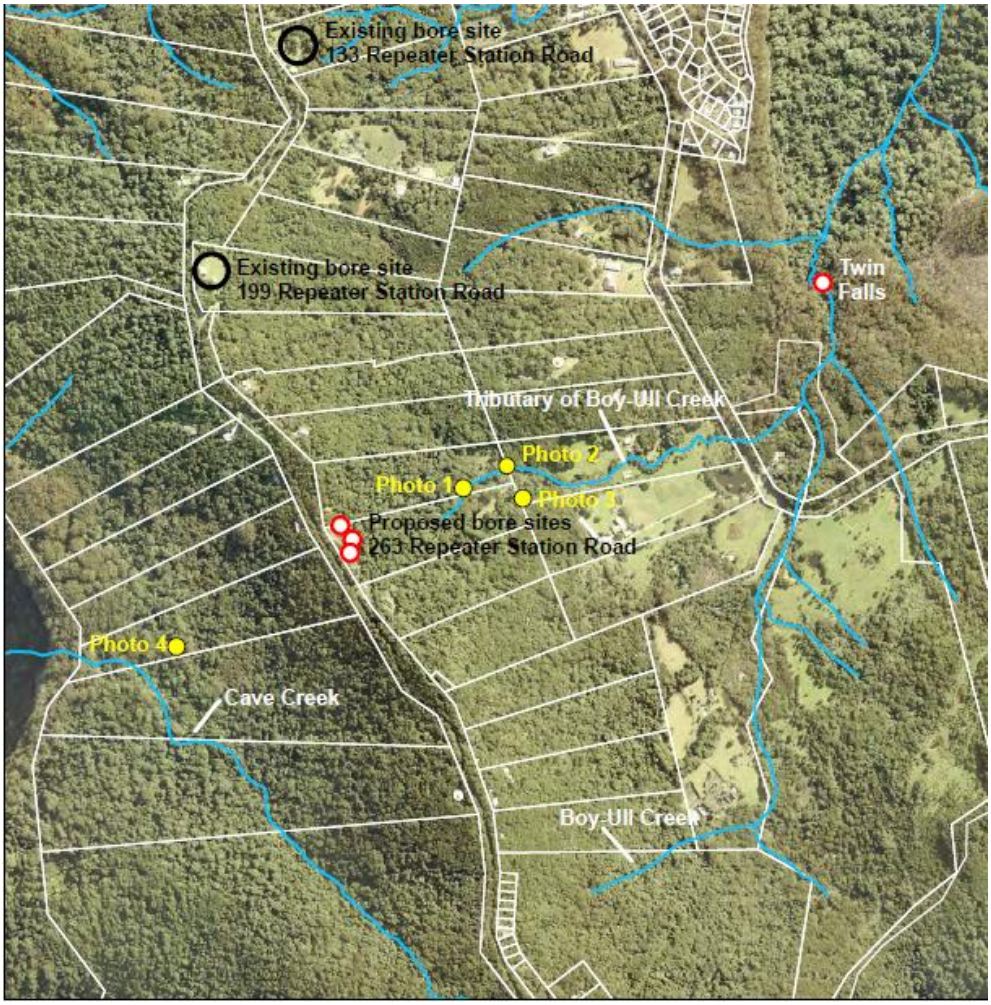



Figure 2 – Site photographs with location map shown. Supplied to MC by Australian Rainforest Conservation Society.

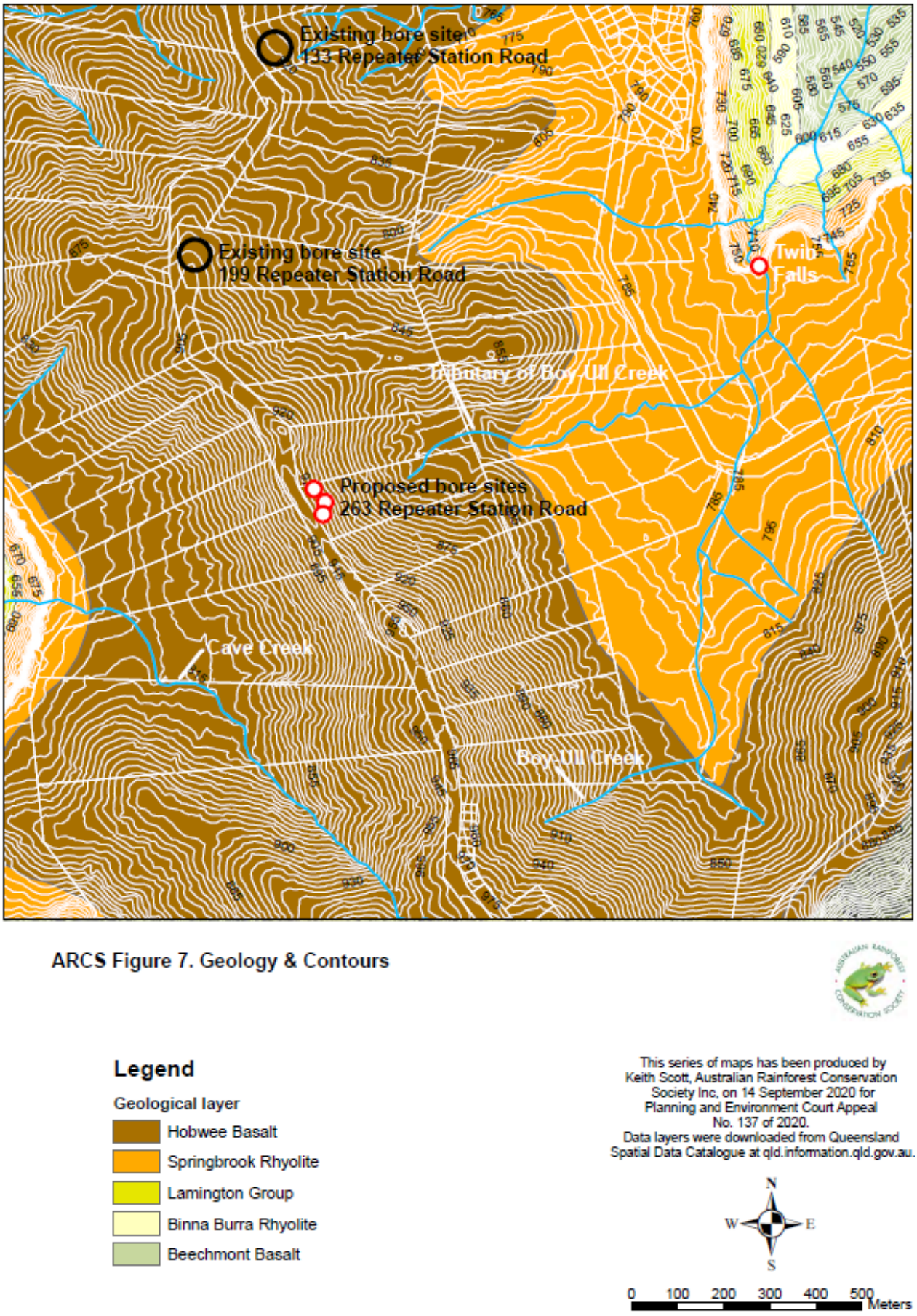



Figure 3 – Topographic and geological map of the site – supplied by ARCS.

7a MC says that key hydrogeological features of the site are not well characterized, such as the depth, thickness and extent of different aquifer units, the nature and extent of porosity and permeability, and the degree of connectivity between the aquifer in which the extraction bore(s) are constructed and:

a) Surface water systems
b) Underlying/adjacent aquifer units

7b TJ notes that MC has already identified this issue in 5a above, and he does not understand what is gained by repeating it. For the sake of completeness, he reiterates that the previous groundwater investigations which have been undertaken in this local area have adequately characterised the aquifer. He also states that the surface expression of groundwater is largely centred on flows to Little Nerang Creek. He considers that the modelling which has been undertaken is suitable and adequate for the task, and has demonstrated that the impacts of extraction will be well within the bounds of normal climatic variation.

7c TM has stated previously that he disagrees with the accuracy and adequacy of the modelling conducted by SLR Consulting under TJ's instructions and also disagrees with the extrapolations TJ has conducted from this modelling as to the scale of potential impacts to groundwater and surface water resources in this environmentally significant area.

8a MC says that groundwater flow patterns and hydraulic gradients have not been characterised in the area of the development – e.g. there are no water table or potentiometric surface maps. MC believes these are required to understand the impacts of drawdown caused by the production bores on groundwater flow and discharge to the surface (which may be environmentally important).

8b TJ states that there has been adequate characterisation of the aquifer parameters, and that a detailed groundwater investigation is not warranted because of the predicted minor impacts of extraction. There is no requirement to complete the level of investigation sought by MC and TM unless the aim is to study the aquifer in minute detail. TJ notes that the level of investigation completed for this application is greater than was undertaken by Peter J Ramsay & Associates for the extraction activity approved by Gold Coast City Council at 133 Repeater Station Road. On the basis that there are no recorded issues with that operation, TJ contends that the level of investigation for 263 Repeater Station Road is adequate provided that suitable operational water level monitoring takes place.

8c TM has stated previously that he disagrees with the accuracy and adequacy of the modelling conducted by SLR Consulting under TJ's instructions and also disagrees with the extrapolations TJ has conducted from this modelling as to the scale of potential impacts to groundwater and surface water resources in this environmentally significant area. In his opinion these impacts are likely to be of such significance and magnitude that far more detailed site-specific groundwater (as opposed to surface water balance) oriented investigations are required.

8d MC has reviewed the Peter J Ramsay & Associates investigation and sees aspects of the investigation which are more detailed than was undertaken at the current site (although this investigation also contains significant data gaps). He believes that the cumulative impacts of the development at 133 Repeater Station Road and the current proposal may be significant, warranting more in-depth and careful consideration than has been conducted at either site individually to date.

9a MC says that hydraulic parameters, including transmissivity, hydraulic conductivity, porosity and storativity have not been reported for the site from the aquifer where extraction is proposed, or other adjacent aquifer units, noting that such parameters may be highly site-specific in fractured rock aquifers. MC believes these parameters may be highly variable and those estimated at 133 Repeater Station Road (using a pumping test) may not be representative for the area surrounding the bores in the current application.

9b TJ believes hydraulic parameters (hydraulic conductivity and porosity) determined from the pumping test conducted at 133 Repeater Station Road are reasonable to adopt in assessing impacts of the current applications. TJ says that the work completed by Peter J Ramsay has determined these parameters if MC wishes to undertake additional investigations. However, he notes that both Douglas Partners and Peter J Ramsay & Associates have determined that the impacts of extraction will be insignificant. Further investigations simply for the sake of them are not warranted.

9c TM states that in his opinion the impacts of the proposed operation are likely to be of such significance and magnitude that far more detailed, site-specific, groundwater (as opposed to surface water balance) oriented investigations are required before any approval can be considered.

9d TJ notes that he does not agree with TM's representation of the SLR Consulting model, and he does not agree that the proposed extraction will have unacceptable adverse impacts. He further notes that any adverse impacts will be adequately determined and quantified as a consequence of the operational monitoring requirements which will be imposed on any approval. If such impacts occur, then the extraction rate can be suitably modified.

10a MC believes that the above hydrogeological information (outlined in 7a, 8a and 9a) is critical for understanding and/or modelling likely drawdown patterns, and the potential influence of the pumping wells on groundwater flow, recharge and discharge to surface water. This in turn is critical to understanding potential impacts of the development on environmental values of the area.

10b TJ does not agree. The level of investigation is suitable and adequate for the insignificant impacts which have been predicted.

10c TM states that in his opinion the impacts of the proposed operation are likely to be of such significance and magnitude that far more detailed, site-specific, groundwater (as opposed to surface water balance) oriented investigations are required.

11a MC says surface water bodies in the area where pumping is proposed may be sustained by discharge of groundwater (e.g. from springs, seeps and/or direct baseflow to streams) and this may be environmentally and socially important (e.g. supporting tourism values in Springbrook National Park).

11b TJ agrees that surface water bodies in the area are sustained by flows from groundwater. However, the results of modelling show that the potential impacts of extraction are well within the bounds of normal climatic variation. Provided that suitable monitoring is undertaken during the operational phase of the project, impacts will be readily determined and measured, and can be suitably ameliorated by reduction of the extraction rate. TJ also notes it would be possible to impose seasonal extraction limits based on actual rainfalls, such that extraction is geared towards wetter periods where such extraction is a significantly lower percentage of total seepage than estimated by SLR Consulting, which he already considers to be insignificant.

11c TM has stated previously that he disagrees with the accuracy and adequacy of the modelling conducted by SLR Consulting under TJ's instructions and also disagrees with the extrapolations TJ has conducted from this modelling as to the scale of potential impacts to groundwater and surface water resources in this environmentally significant area. In his opinion these impacts are likely to be of such significance and magnitude that far more detailed, site-specific, groundwater (as opposed to surface water balance) oriented investigations are required.

11d TJ does not understand TM's reference to extrapolation. It is common in water resource engineering to extrapolate known information from one location to an ungauged situation in another nearby catchment. All that has happened here is that information obtained from a geologically similar area in the locality has been used to predict likely behaviour. This is standard practice in estimation of information such as rainfall intensities and catchment yields. There is no reason to consider that the application of the Mt Tamborine parameters to the subject site should not be acceptable, particularly in the context where there is no evidence that previous extraction activities on the Springbrook aquifer have had adverse environmental impacts.

12a MC says the connectivity between groundwater and surface water in the immediate area where pumping is proposed has not been studied during the appellant's assessment of the possible impacts of pumping groundwater from the bores.

12b TJ does not agree. The level of investigation is adequate in terms of the scale of the operation and the findings that the impacts of extraction will be insignificantly small.

12c TM has stated previously that he disagrees with the accuracy and adequacy of the modelling conducted by SLR Consulting under TJ's instructions and also disagrees with the extrapolations TJ has conducted from this modelling as to the scale of potential impacts to groundwater and surface water resources in this environmentally significant area. In his opinion these impacts are likely to be of such significance and magnitude that far more detailed, site-specific, groundwater (as opposed to surface water balance) oriented investigations are required.

13a MC says the proposed pumping of groundwater is highly likely to influence the amount of groundwater discharging to surface water bodies which sustain sites of high environmental and tourism significance, e.g., Twin Falls, Cave Creek and Natural Bridge. This may have negative consequences such as reducing the flow of water to these sites and GDEs in the area.

13b TJ says that pumping will have an impact on groundwater conditions. However, he considers that the level of investigation is adequate in terms of the scale of the operation and the findings that the impacts of extraction will be insignificantly small. Issues in relation to the presence of Groundwater Dependent Ecosystems are matters for the ecological experts.

13c TM has stated previously that he disagrees with the accuracy and adequacy of the modelling conducted by SLR Consulting under TJ's instructions and also disagrees with the extrapolations TJ has conducted from this modelling as to the scale of potential impacts to groundwater and surface water resources in this environmentally significant area. In his opinion these impacts are likely to be of such significance and magnitude that far more detailed, site-specific, groundwater (as opposed to surface water balance) oriented investigations are required.

14a MC says there has been no in-depth analysis of the rates, location(s) and mechanism(s) of groundwater recharge for the aquifer from which groundwater is proposed to be extracted.

14b TJ says that the extent of analysis has been more than adequate to conservatively determine that the impacts of extraction will be insignificant.

14c TM has stated previously that he disagrees with the accuracy and adequacy of the modelling conducted by SLR Consulting under TJ's instructions and also disagrees with the extrapolations TJ has conducted from this modelling as to the scale of potential impacts to groundwater and surface water resources in this environmentally significant area. In his opinion these impacts are likely to be of such significance and magnitude that far more detailed, site-specific, groundwater (as opposed to surface water balance) oriented investigations are required. Regarding the 'conservatively determine' comment made by TJ, TM's catchment analysis has shown that the analysis reported by TJ is definitely not conservative.

15a MC says the use of a surface water/rainfall-runoff model is a highly uncertain method to estimate groundwater recharge, without additional lines of field evidence (e.g. bore hydrographs and sampling of environmental tracers).

15b TJ does not agree. The level of investigation sought by MC is out of all proportion to the possible impacts which could arise from the low rates of extraction sought.

15c TM has stated previously that he disagrees with the accuracy and adequacy of the modelling conducted by SLR Consulting under TJ's instructions and also disagrees with the extrapolations TJ has conducted from this modelling as to the scale of potential impacts to groundwater and surface water resources in this environmentally significant area. In his opinion these impacts are likely to be of such significance and magnitude that far more detailed, site-specific, groundwater (as opposed to surface water balance) oriented investigations are required.

16a MC says calibration of a rainfall-runoff model based on a stream gauge at significantly lower elevation than the site is not reliable for determining recharge rates for the area where groundwater is proposed to be extracted. MC says that the AWBM may be a useful tool for conducting water balance assessments where the input data and model parameters are well-constrained and demonstrated to be applicable to the site/context in which water balance terms are being estimated. However, this is not demonstrated in this case, and the use of such a model to estimate groundwater recharge to the aquifer in which the bores are installed is likely to provide misleading (or at best, highly uncertain) information.

16b TJ says MC's opinion is not correct in respect of the use of the AWBM model for this purpose. The calibration of the AWBM model against known streamflows is an established and acceptable procedure. TJ says that the Australian Water Balance Model (AWBM) is an acceptable and accepted tool to enable water balance assessments to be undertaken for groundwater and surface water analysis purposes.

16c TM states that he too is a very experienced hydrologic (the actual matter of concern in this case) and hydraulic modeller and that he disagrees with TJ's assertion. The use of a lumped conceptual whole of catchment water balance model to then assess recharge rates within a smaller, steeper, upper part of the catchment grossly averages processes and provides no insights to such matters at the subject site.

17a MC says the assumption that recharge occurs uniformly across the area above the topographic elevation of the point of groundwater extraction (SLR, 2020) has not been tested and is questionable without further field data.

17b TJ says that this assumption is reasonable in the context of the application which has been made.

17c See TM's comment under 16c, he agrees with MC.

18a MC says that the area of 309 ha over which it is assumed the aquifer recharge takes place may significantly over-estimate of the actual land-area above the elevation of the bore intake level from which groundwater flows towards the bores and that this requires. This in turn means that the recharge volumes outlined in SLR, 2020 could over-estimate the true volume.

18b TM agrees as this was a finding of his earlier analyses.

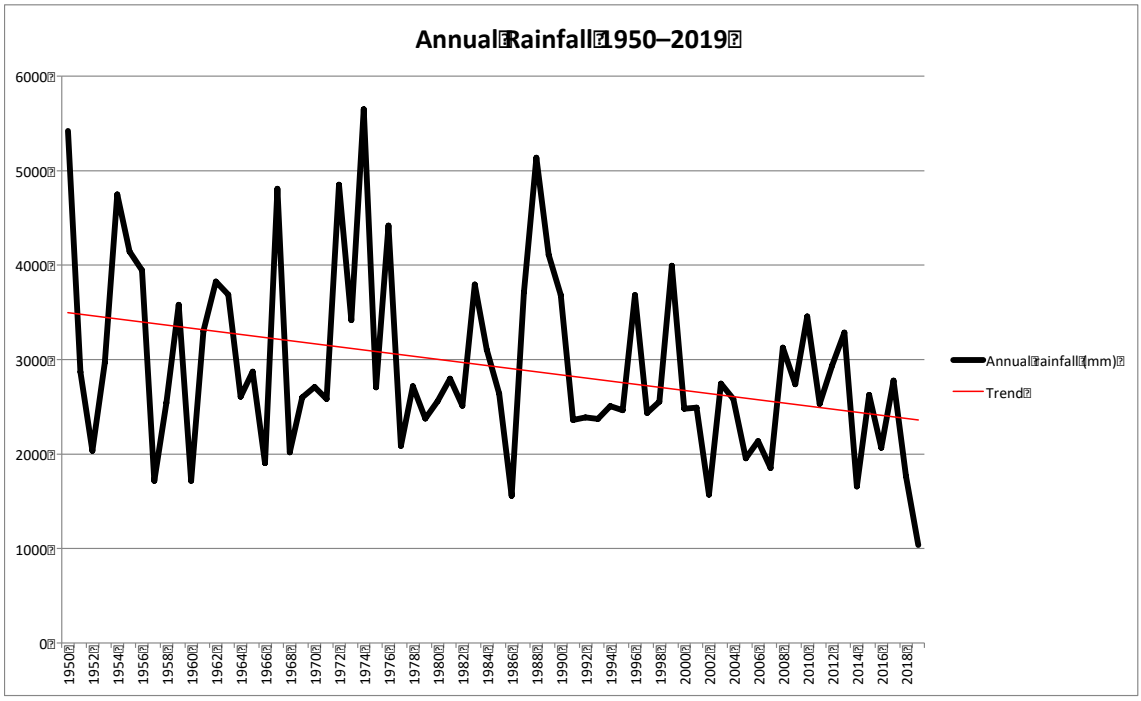
18c TJ does not understand how MC and TM can come up with different estimates of the catchment contributing to the aquifer. It is simply a matter of geometry. TJ accepts the MC point that infiltration may not be uniform across this catchment, but notes that the level of investigation and the assumptions made are reasonable in the context of a proposal to remove what seems to be a small proportion of the infiltration which finds its way to the aquifer. There is no doubt that the only catchment contributing to the Springbrook aquifer is the ground surface overlying it. Rain falls on the catchment. Some runs off as surface flow, some is converted into seepage flowing to the aquifer and a significant amount is lost to evaporation and evapotranspiration before finding its way elsewhere. There is no need to overcomplicate the model, particularly when there have been no reported instances of adverse impacts resulting from existing extraction activities.

19a MC says the relationship between climate variability (e.g. rainfall intensity) and groundwater recharge rates has not been adequately explored at the site.

19b TJ does not agree that this has not been done. The variation in rainfall patterns is explicitly included in the AWBM model which uses daily rainfall totals over a period of 120 years to determine likely response. The scale and extent of modelling is compatible with the minor impacts which are likely to occur as a consequence of extraction.

19c See TM's comment at 16c, he agrees with MC. The SLR modelling has used a long climatic record, and a water balance model, and this may be able to quantify the relationship between climate variability and surface water flows at the site where the model was calibrated, that is Numinbah. However, it cannot then be used to extrapolate such to the relationship between climate variability and groundwater recharge at a site a considerable distance upstream within the catchment being modelled which has totally different rainfall, land use and slope characteristics.

20a MC says that according to data from the Springbrook Forestry and Upper Springbrook rainfall gauging stations, annual rainfall has been declining since 1950 (see Figure 4 below), and there is a strong likelihood this will continue in coming decades.



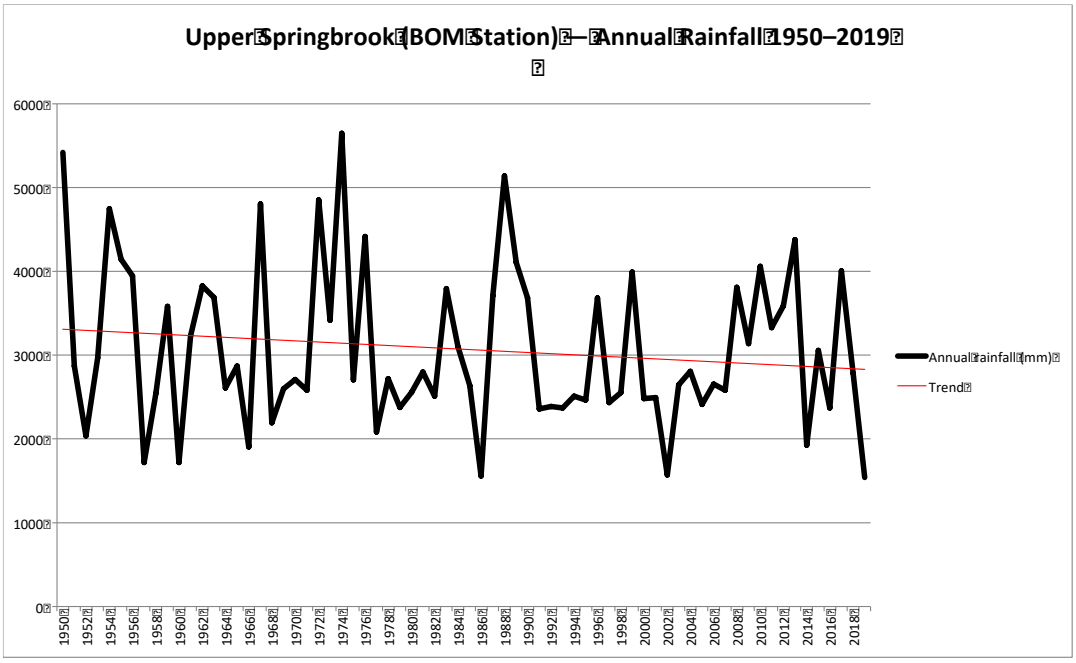
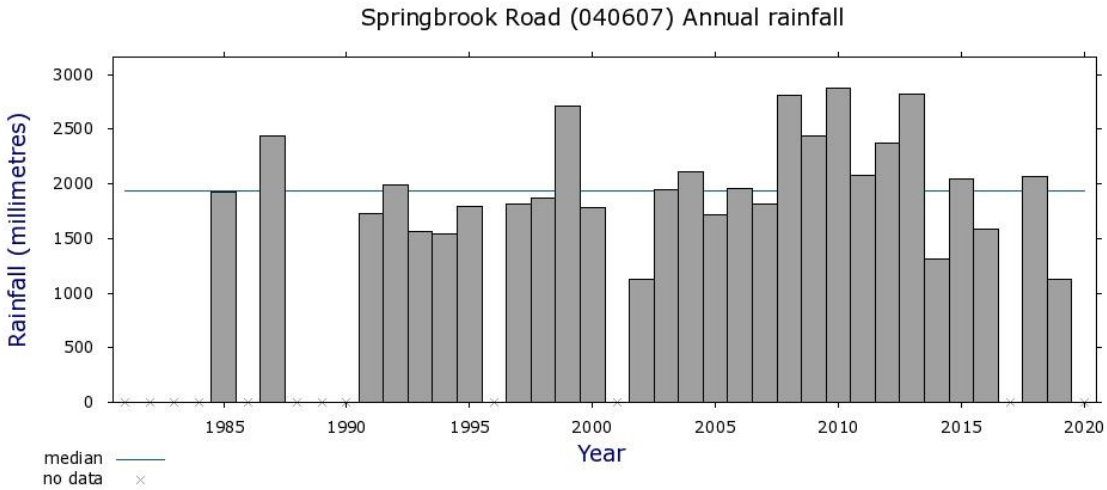




Figure 4 – Annual rainfall totals from Springbrook Forestry and Upper Springbrook monitoring stations from 1950. Data supplied by Australian Rainforest Conservation Society.

20b TJ does not agree with this conclusion based on the records for Springbrook Road since 1981, as represented by the following Bureau of Meteorology graph. This shows no long term consistent trend since 1985, although it is accepted that recent years have been relatively dry. However, it is also apparent that the period from 2009 to 2013 was wetter on average.




21a MC notes that the Queensland Government's *Future Climate Dashboard* predicts that by 2070, under the RCP4.5 and 8.5 global emissions trajectories, Springbrook is predicted to experience:

- A decrease in daily precipitation (Figure 5)
- Increase in frequency of severe and extreme droughts (Figure 5)
- Increase in duration of droughts

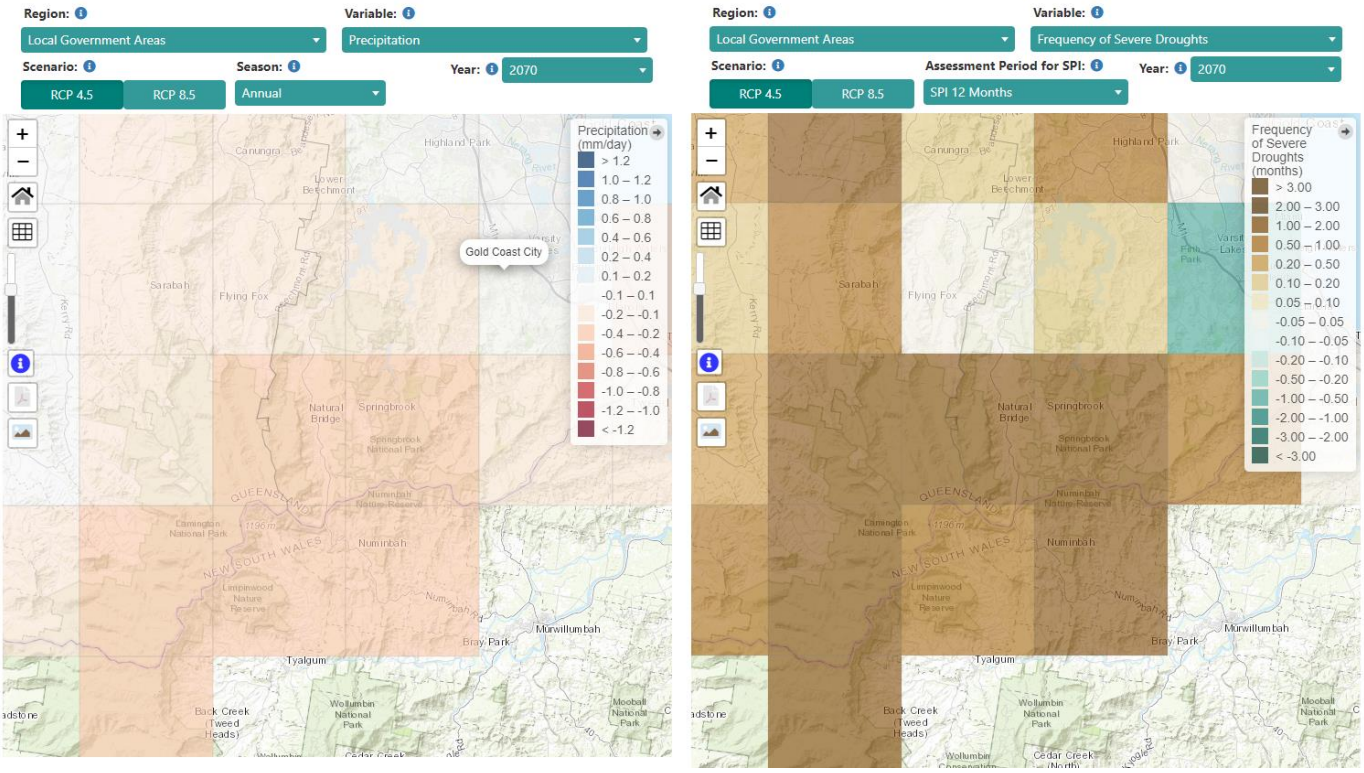



Figure 5 – Climate modelling predictions from the Queensland Government's Long Paddock Queensland Future Climate Dashboard (Skytus et al., 2020)[3]

[3] Syktus, J, Trancoso, R, Ahrens, D, Toombs, N & Wong, K 2020, 'Queensland Future Climate Dashboard: Downscaled CMIP5 climate projections for Queensland.', accessed from <https://www.longpaddock.qld.gov.au/qld-future-climate/>.

MC believes these climate predictions must be considered when assessing the impacts of the proposed development, along with a close analysis of the cumulative impacts of the proposed development and the bores at 133 Repeater Station Rd.

21b TJ says these are, at best, estimates based on very broad global circulation modelling techniques which have no site specific information relevant to the Springbrook plateau. The Climate Dashboard is one useful tool to consider the potential impacts of climate change. In reality, no-one can state or predict accurately what the future holds in respect of rainfall totals or intensities. On the basis of MC's arguments, no-one should do anything since it might be affected by future climate change. If climate change does impact the ability of this applicant to safely extract groundwater from the Springbrook aquifer, then this will be adequately managed by the imposition and application of suitable conditions of approval including operational monitoring.

22a MC says the full extent of the area impacted by drawdown resulting from pumping at the proposed rate (0.5 L/s) is not known (see SLR, 2020, page 11).

22b TJ says that Peter J Ramsay & Associates reported that the extraction at 133 Repeater Station Road had no impact on lowering water levels in a monitoring well 70 m from the extraction site. TR says that Douglas Partners estimated (very conservatively) that the maximum reduction in water table level after 12 months of pumping with no rainfall recharge was 1.5 m at a distance of 270 m from the extraction point on 263 Repeater Station Road.

TJ further states that he has independently confirmed the predicted drawdown of 1.5 m at a distance of 270 m from the extraction wells, estimated by Douglas Partners, by the use of Dupuits Theory and the Theis equation for transient flow. TJ believes the Douglas Partners analysis was based on the residual water table level which would exist after 12 months of continuous pumping with no rainfall occurring in that period. Based on the minimum recorded rainfall at the BOM Springbrook Road rainfall station (see Points of Agreement 5), TJ considers that the actual drawdown at a distance of 270 m from the bore will be significantly less than 1.5 m even in the worst drought year.

22c MC does not believe that the use of the adopted equation is demonstrated to be appropriate in this setting, as it makes a number of assumptions (e.g. aquifer is isotropic, homogeneous and of uniform thickness, pumping well fully penetrates the aquifer) that are not demonstrated for the site and likely to be incorrect. MC believes that given this, and the lack of geological information to allow for an assessment of the heterogeneity, anisotropy and saturated thickness of the aquifer, an accurate assessment of the extent of drawdown caused by the extraction bores requires further data, such as monitoring of drawdown in monitoring bores located different distances from the extraction bores during pumping. MC also believes that drawdown of 1.5 m at a distance of 270 m from the extraction wells has the potential to cause significant impacts on groundwater dependent ecosystems and other sites of environmental significance, based on an analysis of the site location, elevation contours and location of potential groundwater dependent ecosystems (Figure 1 and Figure 2) – including some closer than 270 m.

22d TM agrees with MC on this matter.

22e TJ considers that both MC and TM seek to overcomplicate this matter. The Springbrook system is an unconfined fractured basalt aquifer which has been the subject of some level of investigation by at least 3 other consulting engineering firms. In each case, the conclusion in respect of extraction has been the same – there will be no adverse impact on the aquifer or systems which rely upon that aquifer. TJ accepts that the aquifer will not be precisely

uniform. However, on the basis that extensive access to this aquifer occurs consistently in the Springbrook plateau, and that reasonably consistent peak flow rates of around 0.35 to 0.50 L/s have been achieved, the assumption that the aquifer is uniform is a reasonable one, especially in the context of the current matter. As engineers, we are taught to use commensurate and appropriate techniques to analyse situations. In TJ's opinion, the level of investigation undertaken and the tools used for that purpose are adequate for the task, and support the conclusions of URS, Peter J Ramsay & Associates and Douglas Partners that extraction will have no adverse impacts on the aquifer.

TJ states that issues relating to ecological impacts are the province of the respective ecological experts, and not the water experts. He also notes that he has shared the Douglas Partners modelling results with Hoffmann's ecological expert, Mr Wayne Moffit, and is comfortable that Mr Moffitt will deal with this information as necessary.

22f MC does not agree and believes that far from over-complicating the matter, the significant data gaps and oversights he has pointed out above (e.g. 7a, 8a, 9a, 12a, 14a, 22d) and cumulative impact assessment with nearby existing bores are routine and fundamental components required in any rigorous study of the sustainability of groundwater extraction, and this is well supported by the extensive literature on the topic (see footnotes 1 and 2).

22g TM agrees with MC on this matter.

Trevor Johnson
BE, MEngSc, PhD, CPEng, FIEAust, RPEQ, GAICD

Tony McAlister
BE, MEngSc, CPEng, FIE Aust. RPEQ, GAICD

Matthew Currell
PhD

23 October 2020