NSW Department of Planning, Industry and Environment
Draft Regional Water Strategy – Far North Coast
Feedback Submission – David Fligelman and Ian Law

Revision	Date	Description	Prepared by
A	[redacted]	For Submission to DPIE	[redacted]

[redacted]

TABLE OF CONTENTS

1 PURPOSE OF THIS SUBMISSION

Best practice in the selection of future bulk water supply options centres on identification and assessment of all viable options such as demand reduction, surface water, groundwater, desalination, potable reuse, and stormwater in the specific context of each catchment or region. The investigations and evaluations need to consider a large number of factors - including water demand, standards of service, environmental impacts, topography, existing infrastructure, climatic, seasonal, cultural, social, community expectations, and of course, costs. Ultimately, these analyses are used to rank and select the preferred water sources on their merits. The long-list of options identified within the Draft Regional Water Strategy for the Far North Coast indicates that DPIE is pursuing this approach.

This submission, prepared by specialists in wastewater treatment and water recycling, is seeking to support DPIE in ensuring that the strategy considers the options associated with potable reuse and purified recycled water on their merits.

In part, this is in the context of Rous County Council's Future Water Project 2060, in which the potable reuse investigations undertaken to date have not accurately represented some key attributes of potable reuse, and further, that these issues in the analysis have prevented potable reuse from being considered on its merits.

2 INTRODUCTION

This submission has been prepared by David Fligelman, with extensive contributions from Ian Law.

David Fligelman is a chemical engineer with more than 20 years' experience in wastewater treatment, biosolids management and advanced water recycling. David's company, Tyr Group, has operated out of Bangalow since 2006. Tyr Group's team of four process engineers provides specialist consulting services in wastewater treatment and recycled water production to municipal water authorities, large international consultancies and contractors throughout Australia's eastern states.

David's specific experience in process design, validation and HACCP for treatment for high quality recycled water extends back to 2005, and includes the following key roles:

- Technology leader for the Pimpama-Coomera WaterFuture Alliance, which included the largest a Class A+ non-potable reuse scheme in Australia, with an ultimate connected population of 150,000. This role extended from 2006-2010, and covered all process aspects of the wastewater treatment and recycled water treatment plant designs, commissioning, performance testing and validation.
- Design and development of an early pilot plant for the Gibson Island Advanced Water Treatment Plant (2007). The early pilot was used to make critical decisions on membrane selection and plant design for the Western Corridor Purified Recycled Water project which is to generate recycled water for power station cooling and water supply replenishment within Wivenhoe Dam.
- Delivered a Technical Feasibility Assessment of Indirect Potable Reuse of recycled water from Merrimac WWTP to Hinze Dam to support Gold Coast Water's Emergency Bulk Water Supply Strategy (2005). This included concept design, costing, analysis and evaluation of a 40 ML/d of a dual-membrane advanced water treatment plant, and transfer of the water to Hinze Dam.
- Technical project advisor to the Robust Water Recycling (Antarctica) project on behalf of the Australian Recycled Water Centre of Excellence (2013-2015). The project centred on research and development of an AWTP for remote potable reuse and associated validation and verification of performance. The plant developed as a part of this project is currently operating at Davis Station.

Ian Law is a Chemical Engineer with a Masters Degree in Public Health Engineering obtained from the University of Cape Town in South Africa, an Adjunct Professor at the University of Queensland and a Fellow of the Singapore Water Academy. Ian has more than 35 years of experience in advanced treatment and reuse projects in Southern Africa, S E Asia and Australia, and is widely recognised both nationally and internationally as a leading specialist in potable reuse. A few highlights of Ian's career in potable reuse include:

- Project Manager for the design and implementation of the 10 ML/d dual membrane demonstration plant in Singapore.
- Project Director for design, construction and commissioning of three Advanced Water Treatment Plants (AWTPs) totalling more than 75 ML/d in Singapore.
- Appointed in 2018 by Sydney Water to overview the design of a 7 ML/d Demonstration Plant that will showcase modern day advanced water reuse technologies and treatment trains,
- Appointed by the ACT Government to an Expert Panel on Health to advised on the implications of implementing Indirect Potable reuse in Canberra including an overview of the technologies in AWTPs.
- Served as a member of the Research Team for the WateReuse Research Foundation's project WRF 11-02: Equivalency of Advanced Treatment Trains for Potable Reuse.
- Appointed by the Water Corporation in Western Australia in 2010 to review, and advise on its 5 ML/day dual membrane water reclamation demonstration plant to be located at the Beenyup WWTP in Perth.
- Appointed by Veolia Water in 2007 to provide technical input and guidance to the firm in its position of Operator for the Western Corridor Project in S E Queensland.
- Project Director for the planning, design and implementation of the NEWater Visitor Centre in Singapore.
- Currently serves on Seqwater's Social Research Advisory Panel that has the aim of overviewing and advising on Seqwater's outreach program on implementing purified recycled water

Ian is also currently assisting in Tweed Shire Council's Water Management Options project, evaluating all options for securing the Council's water supply into the future. Ian's role is specifically to address the Purified Recycled Water (PRW) option.

Tyr Group, together with Ian Law, submitted a proposal to deliver the Investigation of Indirect Potable Reuse for Rous County Council in September 2019. While the proposal was not selected, feedback from the RCC's assessment of the tenders indicated that the Tyr Group proposal was rated highest on a technical basis.

3 RECOMMENDATION 1: TERMINOLOGY - USE "POTABLE REUSE" (RATHER THAN IPR OR DPR)

Option 7 (Indirect Potable Reuse of Purified Recycled Water) and Option 8 (Direct Potable Reuse of Purified Recycled Water) differentiate between potable reuse schemes based on the discharge location of the purified recycled water (i.e. the "indirect" or "direct" aspect of the system. While the Water Industry (including consulting engineers, utilities and regulators) have developed and applied the terms IPR and DPR historically, this delineation has created confusion within the community but placing the focus on the "residence time" of the water in the system, rather than the public health aspects of the end product (i.e. the water), which are much more important to the public. To this end, there is a push within water industry to retire the terms "indirect potable reuse" and "direct potable reuse", and exclusively use the term potable reuse.

Community outreach projects identified the following regarding the terminology applied to potable reuse:

- When presented a range of four IPR and DPR options, the surveyed public was most comfortable with "DPR-based" scheme, and not concerned by where the water came from provided it met standards (Reference: *WRRF-09-01: Effect of Prior Knowledge of Unplanned Potable Reuse on the acceptance of Planned Potable Reuse (February 2012).)*
- Words such as 'environmental' and 'natural', which are generally used in the description of IPR schemes, have a positive affect which can lead to a preference for IPR if emphasised (Reference: *WRRF-13-02: Communication Plans for increasing awareness and fostering acceptance of Direct Potable Reuse (January 2015*), but,
- We also know that communication programs that do not differentiate between IPR and DPR but concentrate on reuse for drinking water, generate different conclusions to those that do (References: *WRRF 09-01 (see dot point 1) & WRRF-12-06: Guidelines for Engineered Storage of Direct Potable Reuse Systems, Task 3 produced an animation: The Ways of Water – Communicating about IPR and DPR without the Acronyms (November 2014)*)
- All waters produced in a potable reuse scheme, no matter what form, must comply with the same microbiological Log Removal Values (12/10/10 in California & 9.5/8/8.1 in Australia). Where the residence time for a scheme is

insufficient (i.e. "direct" rather than "indirect" potable reuse), this must be accommodated by additional barriers or controls within the Advanced Water Treatment Plant to meet the regulatory requirements.

The configuration of any potable reuse scheme (and the AWTP within it) will be influenced by local conditions, regulations and community input, and may or may not include surface water, groundwater augmentation, or discharge direct to the drinking water distribution system. There are now many schemes successfully operating internationally under each of these configurations. However, for the public, the primary for any potable reuse scheme is that the system is designed, controlled and operated to produce a regulated quality of water suitable for the intended end use – where in the system the recycled water is discharged to is peripheral to this. The exclusive use of the term potable reuse (PR), rather than IPR of DPR, is consistent with this focus.

To this end, it is recommended that merging of Option 7 (Indirect Potable Reuse of Purified Recycled Water) and Option 8 (Direct Potable Reuse of Recycled Water) be carefully considered, and the merged option be carried forward using the more general and useful term, "Potable Reuse".

4 RECOMMENDATION 2: CARRY FORWARD AND ASSESS POTABLE REUSE OPTION FOR THE FAR NORTH COAST

In considering a merged option Option 7 and 8, it is essential that DPIE note that the reports released as part of the Rous Future Water Project 2060 are incomplete or inaccurate in relation to potable reuse, and therefore inhibit adequate consideration of the options associated with potable reuse on their merits. To this end, the following sections provide additional information in relation to the technical attributes and potential of potable reuse in the context of Rous County, and highlight the need for further investigation and consideration of potable reuse as a part of the region's future bulk water supply – particularly in light of the environmental, cultural and economic issues presented by the Rous County Councils current preferred option (Dunoon Dam). Please note that this information was provided to Rous County Council in a submission on the Future Water Project 2060 in September 2020.

4.1 SECURE YIELD OF POTABLE REUSE OPTIONS

The Rous County Council IWCM report concludes that "*IPR schemes have a low yield benefit and a potentially high cost. There is also a significant risk that the scheme would not meet public health requirements. Hence IPR has not been considered further.*"

The assessments presented in Water Reuse Investigation, and applied to the IWCM Report, have been based on a number of assumptions which limit the estimated yield to the very minimum which might be expected. Further analysis is required to ascertain the validity of these assumptions, and the secure water yield which can be achieved through potable reuse revised accordingly. Based on the factors outlined in the following sections, and general expectations for conditions in each of the wastewater catchments, it is reasonable to expect that a dramatic increase in the secure yield offered by potable reuse on reconsideration and refinement of these assumptions. Depending on the findings of additional analysis of these factors, potable reuse alone, or in combination with the Alstonville groundwater source, may have the ability to meet the projected demand through to 2060 (and beyond).

4.1.1 Failure to Consider Reuse from Byron and Brunswick Valley STPs

The Water Reuse Investigation Report eliminated Byron Bay or Brunswick Valley STPs as potential sites for potable reuse due based on "their remote location." Further issues were raised regarding the "the areas surrounding these WWTPs is dominated by national parks and conservation areas, further increasing the complexity of delivering treated effluent to nearby raw water sources" and "significant elevation changes, with Rocky Creek Dam, sits at 200 m above sea level, whilst the WWTPs are close to sea level meaning transport of effluent or recycled water would introduce significant hydraulic considerations and operating expense."

The exclusion of these sources ignore that these two plants may represent one of the most valuable sources for purified recycled water in the region as:

- Purified recycled water generated at Byron STP could be readily transferred to the existing Wilson River Intake (for transfer to Nightcap) via:
    - A pipeline along Ewingsdale Road and the adjacent to the M1.
    - Discharge to Byron Creek in the vicinity of Bangalow. The static head for this transfer would be in the order of 60-70m. It may be feasible to utilise the existing road tunnel for the pipeline.
    - Gravity flow to the Wilson River via Byron Creek (through Bangalow).
- With a relatively minor amount of additional pipework (and additional head), the purified recycled water from Byron could be directed to Emigrant Creek. This would provide RCC with the opportunity to control the PRW inflows to either of their major storages as required.
- Effluent from Brunswick Valley STP could be transferred to Byron STP for treatment to purified recycled water to provide an additional source.
- The effluent discharged from the wetlands downstream of Byron STP is currently elevating the water table on local farmland, and creating significant issues. As such, diversion of the effluent to and advanced water treatment plant and effectively "returning to the catchment from which it came", and alleviate the local issues (during dry weather at least).
- During dry periods, the purified recycled water releases to Byron Creek to the Wilson River could be undertaken achieve environmental benefits in that waterway.

Water losses in Byron Creek (or Emigrant Creek) would need to be considered in establishing the secure yield of this scheme, but intermittent discharges, mimicking natural rain events, may assist. Further, as the discharges are upstream of the Eltham gauge, this scheme may require less regulatory adjustments than the Lismore based scheme.

In regard to power consumption, even with the 60-70m lift to Bangalow, followed by the 200m lift from the existing Wilsons River Source to Nightcap, the power consumption for this option would be expected to be lower than desalination.

4.1.2 Non-Potable Reuse

The non-potable reuse targets of a number of shires, as applied in the Rous County Council FWP assessments, are considered ambitious. There is a long history of the planning for non-potable reuse (and third pipe schemes in particular) targeting reuse of a large proportion of the STP effluent stream, but being unable to achieve or maintain that level of performance in practice. Additionally, the cost of constructing, operating and maintaining dual reticulation schemes is very high – especially when considered on a per kL basis.

The history of the Pimpama Recycled Water project on the Gold Coast, which was the largest dual reticulation project in Australia, illustrates this issue. While the planning for the scheme was based on reducing the potable water demand for new houses in the region to just 16% of that for typical residential developments (primarily through non-potable reuse, rainwater tanks, and low flow fittings), this was not achieved in operations. In fact, due to the cost and complexity of operating the recycled water treatment plant and dual reticulation system, the City of Gold Coast shut the scheme down in 2018, leaving the "purple pipes" to be supplied with potable water. Hence, while dual reticulation represents an excellent tool for educating the quality and value of recycled water as a resource, it is often unable to compete with the greater efficiency of other methods of recycled water utilisation (including agricultural, industrial or potable reuse).

Over-estimation of the amount of planned non-potable reuse which can be practically achieved in our local region (rather than reuse already being realised) appears to be limiting the estimated secure yield which can be achieved from purified recycled water. To this end, it is recommended that the secure yield of purified recycled water production be based on a practical view of the projected extent of non-potable reuse which can practically be achieved for each of the sources identified.

4.1.3 Advanced Water Treatment Plant Process Train

The AWTP process trains adopted for potable reuse applications around the world can generally be grouped into:
- 'membrane-based' (incorporating Reverse Osmosis (RO), and,
- 'non-membrane based' (incorporating ozone and activated carbon).

Well known examples of potable reuse schemes with membrane based processes include Orange County (California), Singapore's NEWater scheme, Western Corridor in Brisbane, and Perth's Groundwater Replenishment Scheme. Non-membrane-based schemes are also common, albeit less widely known, and include Windhoek (Namibia), the Montebello Forebay scheme (California), and the UOSA scheme (Virginia)

The Water Reuse Investigation Report considered only membrane based process trains, which, when compared to non-membrane based processes, suffer from:

- A lower water yield (~80% for membrane based vs. ~97% for non-membrane based)
- Generation of a saline (and nutrient rich) brine stream which must be further treated and/or disposed of, and,
- Higher power consumption.

As non-membrane based process trains do not removal salts, they can only be used where the STP effluent is relatively low in salinity or they can be blended into lower salinity surface waters. However, given the low hardness of the water generated from Nightcap STP, there is strong potential that one or more of the potential schemes (Lismore or Byron in particular) could meet these requirements. Should this be the case, the yield from these schemes may be some 15-20% higher than estimated.

4.1.4 Consideration of Growth in Wastewater (and Available effluent) Flows

The secure yield from potable reuse in Rous's FWP (IWCM Report, Figure 17) does not appear to have considered the growth in wastewater flows to sewage treatment plants (and the associated increase in effluent flows) over the project study period. If this is the case, then it underestimates the potential secure water yield from potable reuse by ignoring the scope to progressively increase the volume of water directed to reuse as the water demand in the region increases through to 2060.

4.2 Electricity Consumption and Operating expenses

The FWP 2060 included a Flyover Virtual Landscape Model which listed a power consumption of 6.5 kWh/kL for indirect potable reuse. This is much higher than typically reported for potable reuse schemes. For example:

- An AWTP based on a dual membrane treatment train (UF/RO) generally consumes around 1.5 kWh/kL of produced water.
- If advanced oxidation is added to the end of the process train (to ensure effective removal of contaminants such as 1,4-dioxane and NDMA), this would be expected to add approximately 0.5 kWh/kL at most (depending on log removal of contaminants required).
- Pumping to 80m head would consume around 0.3 kWh/kL, and,
- Lifting to 200m (from the existing Wilson River Source to Rocky Creek Dam) would consume around 0.8 kWh/kL.

Using these typical figures, the power consumption for the potential potable reuse schemes considered would be as follows:

- For a Ballina/Lennox scheme, production and return of purified recycled water to Emigrant Creek Dam would be in the order of 2.3 kWh/kL AWTP production.
- For a Byron scheme, production and return of purified recycled water to Emigrant Creek Dam would be in the order of 2.4 kWh/ kL AWTP production, and in the order of 3.1 kWh/ kL AWTP production for return to Rocky Creek Dam via the Wilson River Source.
- For a Lismore scheme, production and return of purified recycled water to Rocky Creek Dam would be in the order of 2.9 kWh/ kL AWTP production.

To estimate the power consumption per secure yield for these schemes, these figures would need to be divided by the fraction of the secure yield per unit volume produced from the AWTP.

It is also important to note that the power consumption of AWTPs based on non-membrane processes, where possible due to relatively low salinity in the effluent source, will be substantially lower than indicated above.

Regardless, this rudimentary analysis suggests that the reported power consumption of 6.5 kWh/kL is likely to represent a large over-estimate, and misrepresents one of the key attributes of potable reuse as an option.

As with the electricity consumption information, no basis or detail was provided for the operating expenses listed in the Flyover Virtual Landscape model has been provided in the FWP 2060 supporting documents. Given the issues in the electricity consumption estimates, the relatively high operating cost reported for the potable reuse may be preventing proper assessment this supply alternative, and should be revisited in detail.

4.3 Greenhouse Gas Emissions

None of the Rous County Council FWP Reports (including the IWCM Assessment of Augmentation Scenarios, the Water Reuse Investigation Report nor the Flyover Virtual Landscape Model) explore the greenhouse gas emissions which will be generated under each alternative supply option. Under a transition to renewable energy sources for electricity supply, or dedicated renewable energy sources to offset black power consumption from an AWTP, the greenhouse gas emissions generated through potable reuse would be relatively minor compared to a number of alternatives (including a new dam).

4.4 Programme for Implementation

The Flyover Virtual Landscape Model lists an implementation time of approximately nine years for the Dunoon Dam (which is currently the preferred option). This indicates that there is a suitable period of time available for implementation of potable reuse – provided the development of the scheme is not excessively delayed.

A number of potable reuse schemes in Australia, including Toowoomba, Gold Coast and Western Corridor, have suffered from rushed considerations or implementation targets. By contrast, some of the most successful potable reuse projects, including the Scottsdale (Arizona) project, and Perth's Groundwater Replenishment Scheme, have taken 8-10 years from commencement to completion. This underlines the observations that there is sufficient time to implement potable reuse in Rous County under the measured approach required to bring the community on the journey, but that a start of the development of the project should not be delayed by more than a year of two. RCC's proposal in regard to Perradenya is noted in this regard.

If the potable reuse journey is to be commenced, community engagement is critical. Under best practice, the majority of the implementation period for potable reuse is required not for engineering or construction - but rather to engage and educate the community on the potable reuse solution. To this end, it was recommended to Rous County Council that they consider a community engagement program beyond the current "Future Water Project" (if there isn't one in place already). The role of the Perradenya project (or a comparable demonstration project) should be considered in the engagement program. The "Water360' products available through WSAA, which were funded through the Australian Water Recycling Centre of Excellence (AWRCE), may also be a valuable resource for RCC to draw on in community engagement and education.

4.5 Capital Costs

The capital costs of potable reuse alternatives do not appear to have been considered in detail in any of the information presented. For example:

- Water Reuse Investigation Report – Appendix C includes a list of the costs for pipelines only, and presents no costs of the AWTP components of the works. Additionally, no build-up of the pipeline costs has been provided.
- The IWCM Assessment of Augmentation Scenarios report did not assess potable reuse, or present any costings of the potable reuse options.

- The Flyover Virtual Landscape Model indicated that potable reuse had the highest implementation cost of all the options considered (80-110,000 per ML of secure yield) – 4-5 times the cost of the Dunoon Dam options per megalitre of secure yield. This conclusion has not been supported by any costing information in the documents issued, and is at odds with the bulk water supply options assessments in other catchments which generally find potable reuse to be substantially more economical than desalination. IN the absence of additional information, it is not possible to ascertain if this may have been influenced by:
  - under-estimation of the available yield of potable reuse (see Section 3);
  - over-estimation of electricity consumption and other operating costs (see Section 4);
  - over-estimation of the capital cost for the schemes, or,
  - particular challenges (and expense) in implementing potable reuse in this region which have not been explained in the documents provided.

Additionally, unlike the Dunoon Dam option, potable reuse has scope to implemented progressively as demand and effluent flows grow over time. This enables the potable reuse alternative to be staged, thereby minimising upfront capital expenditure and operating costs.

4.6 Regulatory Framework

Media reports have indicated that Rous County Councillors have identified approval of a potable reuse scheme as a key barrier to its adoption. For example: "*Rous CC Chair Keith Williams is a supporter of recycled water in principle but says the NSW state government requires a successful precedent in the state with potable re-use water before a bigger scheme can proceed*" (Byron Shire Echo July 27, 2020). This is not in line with the advice being received from NSW Health by water professionals. Any potable reuse scheme in Australia must have the approval of the relevant state's Department of Health. In each case, the Department will be looking for the potable reuse proponent to show that it complies with the requirements of the *Australian Water Recycling Guidelines – Managing Health and Environmental Risks (Phase 2): Augmentation of Drinking Water Supplies (May 2008)* - particularly the 12-point risk assessment and management framework and the Australian Drinking Water Guidelines 6 (2011). Cognisance is also taken of the World Health Organisation's document, Potable Reuse: Guidance for Producing Safe Drinking- Water (October 2017).

5 RECOMMENDATION 3: AMEND OPTION 16 TO BE BASED ON RECYCLED WATER (RATHER THAN PURIFIED RECYCLED WATER)

The term purified recycled water is generally applied to recycled water which is suitable for any use, including human consumption as potable water. While a number of potable reuse schemes supply purified recycled water to industries which require a particularly high water quality (e.g. computer chip manufacture in Singapore), the quality of purified recycled water would generally exceed that required by industries on the far north coast – particularly agricultural production. As a result, Option 16 would be better to consider the provision of recycled water of all classes to industry and agriculture (rather than just purified recycled water). This will allow the provision of recycled water to industry and agriculture with the level of treatment suitable for the purpose – be it purified recycled water or a lower quality.

6 CONCLUSIONS

As technical professionals in the water industry, we strongly believe that potable reuse should be considered as a water source alternative on its own merits, along with water supply alternatives for the Far North Coast such as surface water, groundwater, demand management, stormwater and desalination. Importantly, review of the Rous County Council Future Water Project documentation provided for public comment, and associated comments in the media, indicate that the assessment of potable reuse to date has not accurately represented the potential of this water supply option for this region, including:

- Failure to consider two significant sources of purified recycled water (Byron and Brunswick Valley STPs), and their potential transfer to Byron Creek (and Nightcap) or Emigrant Creek.

- Likely over-estimation of non-potable reuse which will be achieved by constituent councils.
- Assumption of membrane-based AWTP process trains throughout, where commonly used non-membrane based process trains, if viable, would increase water yield by 15-20% and reduce both power consumption and costs.
- Substantial overestimation of electricity consumption for potable reuse compared to existing schemes.
- Excellent fit of potable reuse to the currently available time for implementation.
- Unsupported and likely overestimated capital and operating costs for potable reuse.
- Identification of regulatory barriers to approval of potable reuse which are not consistent with current advice from NSW Health.

There are multiple potential potable reuse scheme configurations for the region which are worthy of further investigation and analysis, and have potential to out-perform the other alternatives under consideration on cost, efficiency, community, cultural and environmental criteria. To this end, it is strongly recommended that a potable reuse option, combining Options 7 and 8 (and possibly extending to Option 9), be carried forward and considered in detail, and then comprehensively evaluated against the alternatives based on accurate information.

Should you have any queries in relation to this submission or any of its content, please feel free to contact me at [redacted]

Kind Regards,

[redacted]