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Water Research Laboratory

Dear Alana,

Independent Review on Water Quality Assessment regarding the Long Bow Point Golf Course

1. Introduction

This letter provides an independent review of the technical reports prepared in support of the Long Bow Point Golf Course major project application (SSD 8406). Our review is targeted at the surface water, groundwater and water quality aspects of the application.

The review was completed by Dr Francois Flocard, Principal Engineer at the Water Research Laboratory of UNSW Sydney (WRL) and Dr Will Glamore, Associate Professor at UNSW Sydney WRL. Both staff have undertaken multiple expert reviews on similar projects and their CVs are available on request. Over the past 15 years the reviewers have undertaken numerous on-ground projects to study, model, rehabilitate and create large estuarine wetlands across Australia. These projects are extensively documented and have been recognised via multiple awards representing best practice. Associate Professor Glamore also has extensive experience in the Shoalhaven area, having conducted his PhD in the region from 1999-2003 and subsequently undertaken numerous surface and groundwater studies including field based projects.

WRL staff have an on-going role of providing high-level expert advice to the Federal Department of the Environment and the Murray Darling Basin Authority concerning developments near Ramsar Wetlands. WRL's advice has largely been concerned with the hydrological impact to surface and groundwater of large developments near Ramsar Wetlands including nearly every state and territory in Australia. More information on our background expertise or previous review projects can be provided upon request.

2. Documents reviewed

This independent review was based on the information provided below:

- Martens (2011), Integrated Water Management Plan – Proposed Golf Course Development, Culburra Road, West Culburra, NSW (P1103037 JR04V03, June 2011).
- Martens (2012), Integrated Water Management Plan – Proposed Golf Course Development, Culburra Road, West Culburra, NSW (P1103037 JR04V05, November 2011).
- Scanes, P., Ferguson, A. and Potts, J. (2013), Environmental Sensitivity of Lake Wollumboola: Input to Considerations of Development Applications for Long Bow Point, Culburra. NSW Office of Environment and Heritage, Sydney.

- Martens (2013), Integrated Water Management Plan – Proposed Golf Course Development, Culburra Road, West Culburra, NSW (P1103037 JR04V07, October 2013).
- Golf by Design (2014), Draft Plan of Management for Culburra Golf Course. Prepared for the Halloran Trust, March 2014.
- Martens (2015), Integrated Water Management Plan – Proposed Golf Course Development, Culburra Road, West Culburra, NSW (P1103037 JR04V09, June 2015).
- HGEO (2017), West Culburra groundwater assessment – Preliminary report (Stage 1). Prepared for the Shoalhaven City Council.
- Martens (2017), RE: Proposed Culburra Golf Course: Water Quality modelling and OEH Radon Data Review (December 2017).
- Baiada, C., Scanes, P. and Ferguson A. (2018), Detection of Groundwater Inputs to Lake Wollumboola, NSW. Report prepared to OEH Regional Operations Group by OEH Estuary and Catchments Science Team (Revised Version, May 2018).
- NSW Office of Environment and Heritage (2018), RE: Long Bow Point Golf Course, Additional SIS & Water Quality Investigations (SSD 8046) (13 March 2018).
- Lake Wollumboola Protection Association (LWPA), (2018), Objection to Development Application No SSD 8046 Long Bow Point Golf Course at Lots 5 and 6 DP 1065111, Culburra Beach (20 March 2018).
- Santos, I. (2018), Review of OEH and Martens reports on Lake Wollumboola.
- Department of Planning and Environment (2018), State Significant Development Assessment: Long Bow Golf Course SSD 8406 (July, 2018), NSW Department of Planning and Environment.

3. General Comments

3.1 Environmental Setting of Proposed Development

The proposed Long Bow Point Golf Course is located within the catchment of Lake Wollumboola. Lake Wollumboola is classified as a Sensitive Coastal Lake in the 2018 State Environmental Planning Policy (SEPP), is listed as a Wetland of National Importance and forms part of the Jervis Bay National Park. The proposed development area (196 ha) is approximately 60% of the Long Bow Point sub-catchment (330 ha), which flows directly into the lake (HGEO, 2017). Any potential change to the surface water and groundwater dynamics, in terms of quantity or quality, is likely to have a direct impact to Lake Wollumboola, although the extent of impact is difficult to determine.

Lake Wollumboola can be classified as an Intermittently Closed or Open Lake or Lagoon (ICOLL). ICOLLs typically have long residence times as there can be extended periods when the lake entrance to the ocean is closed resulting in limited exchange of lake and ocean waters. As a result of the intermittent entrance opening, ICOLLs can have high flow retention rates resulting in nutrient and phytoplankton levels within the estuary closely associated with catchment development runoff volume and quality. Importantly, calculating the ICOLL water balance and its subsequent influence on water quality can be complex due to the circulation of fresh and saltwater caused by interactions of fresh water runoff, groundwater and coastal waters. The nature of these fresh and salt water exchanges influence lake water quality gradients and sedimentation, and thereby the health of ecological communities.

The proposed development is surrounded by two SEPP Coastal Wetlands on its north and south boundaries. It should be noted that the current proposed golf course layout and associated forest clearing are currently within the "proximity areas" for these two coastal wetlands. In the current pre-development state of the site, surface runoff flows are key irrigation components for these two

wetlands. Wetland environments such as the two wetlands on the study site are highly sensitive to changes in surface water flows and groundwater table elevations, and would be likely impacted by any changes to the wetting/drying cycle within their catchment.

3.2 Groundwater

Groundwater is typically an important component of the water balance for coastal wetlands and ICOLLs. The groundwater contribution can only be verified and quantified through field based data. Based on our review of the limited onsite groundwater data presented by the proponent, and Professor Santos' review of the 2018 Radon study undertaken by OEH, we believe that groundwater discharges to Lake Wollumboola cannot be adequately assessed. Due to the potential importance of the groundwater regime to sensitive receivers, we consider that this is a critical data gap that warrants further consideration.

The proponent has predominantly challenged the contribution (or lack of) of the "deep" groundwater table in the Permian siltstones to Lake Wollumboola. Following our review of Martens (2011, 2015), this assertion is based on two packer tests indicating very low permeability and thereby, slow and limited groundwater flows. These tests do not consider the contribution to the surrounding ecosystems of perched groundwater within the soil profile, nor higher groundwater systems located in the quaternary deposits.

We are aware that Shoalhaven Council has commissioned HGEO to undertake a comprehensive groundwater assessment for the area to the west of Culburra Beach, including the proposed golf course development on Long Bow Point. The HGEO field investigation is planned to have a total of 23 monitoring bores, 16 of which are to be installed on the proposed development site, with ongoing monitoring of groundwater levels and water quality parameters. The proposed field investigation and monitoring program, which we understand will be performed over two years, will provide valuable insight into the groundwater contribution to Lake Wollumboola and we recommend it is commissioned. More importantly, this investigation will offer critical information regarding predevelopment conditions at the site and allow baseline conditions to be measured as a benchmark for assessing any impact of the proposed development on the two neighbouring coastal wetlands and Lake Wollumboola.

4. Review of the Integrated Water Management Plan (IWMP)

A MUSIC model was developed to assess the suitability of the proposed water quality controls for the stormwater discharges into the two neighbouring coastal wetlands and into Lake Wollumboola. The MUSIC software is widely used by industry and is generally suitable for modelling treatment trains of water quality control measures.

The reviewers are familiar with the MUSIC software and have reviewed numerous Storm Water Management Plan models and installations based on modelling results. It is important to note that MUSIC, like any other numerical model, requires calibration based on local flow data as well as treatment performance. Based on our review, it appears that the presented MUSIC model has not been field calibrated or peer-reviewed.

The modelling presented in the reviewed report indicates a decrease in the annual average pollutant loads into the two neighbouring coastal wetlands or into Lake Wollumboola despite the required input of fertiliser in the system. This conclusion has been previously questioned both by OEH and DPE and

appears not to have been further justified by the applicant. Our review further questions this approach and related assumptions used to justify the model.

Based on our review of the model, our concerns regarding the modelling approach and conclusions made by the proponent include:

- New IFD design rainfalls are available since 2016 and are available for use in conjunction with the 2016 edition of Australian Rainfall and Runoff (ARR2016) http://arr.ga.gov.au/arr-guideline.
- Fertiliser input assumptions are non-conservatively based on post establishment application rates. Since the golf course establishment duration is currently planned to last nearly 2 years (Golf by Design, 2014), we recommend the potential impact of higher fertiliser application rates is investigated.
- The modelling notes that all surface water treatment structures will be lined and therefore have infiltration rates of 0 mm/yr. This assumption is non-conservative and based on our experience reviewing existing WSUD infrastructure does not account for the commonly found difference between design and as-built systems.
- It is stated that surface grading will ensure that all surface runoff will be captured in the proposed constructed wetlands. Given the nature of the site topography and size of the proposed golf course, this assumption is likely non-conservative.
- The proposed storm water management plan relies heavily on cross-catchment pumping from the constructed wetlands to the central irrigation dam, resulting in an overall flow reduction of 17%. The impact of this cross-catchment transfer has not been assessed. The flow reduction may have an impact on the perched groundwater and potentially both neighbouring coastal wetlands.
- It appears that the constructed wetlands are to be used as bio-retention basins requiring some unspecified retention duration for treatment before being pumped back to the irrigation dam. This proposed solution has the inherent risk of overflow and release of untreated, nutrient rich run-off into the neighbouring coastal wetlands and Lake Wollumboola. Additional design detail for these ponds is required to assess functionality.
- The modelling appears to focus solely on water quantity and quality during one storm event (100 year ARI). The proposed IWMP should also ensure that long term, runoff volume control for mimicking the natural flow regime pattern and volumes discharging to the coastal wetlands and Lake Wollumboola from the proposed development are unchanged from the pre-development state. As non-flood flows are likely to drive ecosystem services, impacts during moderate to low-flow periods should also be assessed.

Overall, the presented IWMP is not consistent with the standard typically expected for a proposed development adjacent to three (3) highly sensitive ecosystems. In this circumstance a precautionary approach is warranted, especially when limited field data is available. In this regard, it is the reviewers opinion that aspects such as the design of the proposed constructed wetlands, an analysis of WSUD and OSD during more frequent storm events, and the Vegetation Management Plan are necessary at this stage to assess the potential environmental impact of the proposed development.

As stated in the "Draft Plan of Management for Culburra Golf Course" (Golf by Design, 2014), the proposed golf course construction is expected to be conducted in a staged approach over a minimum of 20 months. This period of construction could also be extended due to the construction of the golf course club house. Due to this extended construction period and the potential impact to sensitive receivers, an Erosion and Sediment Control Plan completed to industry standards with a sufficient level of protection to storm water discharges during construction is required. This plan should provide

detailed information on temporary controls proposed to minimise the potential of erosion to disturbed areas and limit the transport of sediments from the development site to the receiving waters during construction. Finally, it is worth noting that the construction details for the club house have not been provided although we believe they should not be judged independently.

Finally, an Operation and Maintenance Plan for the proposed development of the site needs to be completed in accordance with Council's base document, or similar, as the proposed IWMP is highly reliant on cross-pumping between a dozen constructed wetlands and the main irrigation basin.

5. Gateway Determination for the Planning Proposal

In November 2015, the Deputy Secretary, Planning Services, as delegate of the Minister for Planning, issued a Gateway Determination recommending that land in the Lake Wollumboola catchment be zoned for environmental protection, dependent on the outcomes of a biodiversity offset strategy and water quality studies prepared to support the Planning Proposal.

The reviewers understand that The Gateway Determination for the Planning Proposal will be supported by detailed studies, including a two-year groundwater monitoring study presently underway that will assist in defining appropriate development boundaries around Lake Wollumboola and an investigation into alternative locations for a golf course in the locality, though outside of the lake catchment. It is our understanding that the Gateway Determination for the Planning Proposal will take 3 to 4 years to finalise and be available in 2019.

As such, we believe this proposal is reasonable and an appropriate mechanism for determining suitable locations for recreational development and environmental conservation across the Halloran landholdings.

6. Cumulative Impacts and Tipping Point

We understand that the area west of Culburra Beach is also currently the subject of multiple development applications including:

- the proposed golf course development on Long Bow Point (SSD 8406);
- the West Culburra Mixed Use Subdivision (SSD 3846);
- two separate Development Applications for individual houses in the Long Bow Point vicinity (DA 09/2675 and DA 10/1330).

These approved and proposed developments along the foreshore of Lake Wollumboola, as well as the existing pollutant loads from the Culburra Beach residential area, are likely to be associated with a cumulative increase in nutrients and pollutants into the neighbouring coastal wetlands and the lake.

At present, it is difficult to establish an acceptable level of nutrient or pollutant increase to a complex ecosystem such as Lake Wollumboola. Given the accepted highly sensitive ecological nature of Lake Wollumboola, any proposed development impact should be assessed in accordance with a precautionary approach. Several researchers have previously highlighted the importance of avoiding an algal dominated state with lake systems, as once lakes have turned towards an algal dominated state they are more likely to remain in that state. As such, it is highly recommended that unless detailed scientific processes are supported with field data, a precautionary approach is recommended.

7. Summary

In summary, the reviewers find that the previous scientific reviews from OEH, DPE and Dr Santos are justified and technically sound. We recommend that the final decision on the project application awaits the final results of the Gateway Determination for the Planning Proposal associated groundwater investigation. This groundwater investigation will offer critically required information quantifying predevelopment conditions at the site and enable baseline conditions to be quantified and subsequently used to assess any impact of the proposed development on the two neighbouring coastal wetlands and Lake Wollumboola. Further studies are also required to gain a better understanding of trigger points for the Lake Wollumboola ecosystem after which irreversible changes might occur.

Based on the review the technical surface water, groundwater and water quality reports prepared in support of Long Bow Point Golf Course State Significant Development (SSD 8406), as well as the warranted precautionary approach due to the sensitive ecological nature of Lake Wollumboola, the reviewers support DPE's recommendations to the Independent Planning Commission.

Thank you for the opportunity to provide this independent review. Should you require further information please contact Dr Francois Flocard or Associate Professor Will Glamore in the first instance.

Yours sincerely,

Grantley Smith
Manager