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PEER REVIEW STATEMENT (FINAL) – MT PLEASANT FINAL VOID

ATTENTION:	Tegan Cole, NSW Dept of Planning Industry and Environment (DPIE)	
FROM:	Hugh Middlemis, Principal Groundwater Engineer, HydroGeoLogic (HGL)	
REFERENCES:	**8 February 2022**	Mount Pleasant Optimisation Project (SSD 10418)(EPBC 2020/8735)
SUBJECT:	**Mount Pleasant Optimisation Project Rehabilitation and Mine Closure.** **Targeted Peer Review of final void Groundwater Impact Assessment - Final.**	

Dear Tegan

This brief report presents the final stage of the targeted peer review of the post-mining final void groundwater impact assessment elements of the Mount Pleasant Optimisation Project Rehabilitation and Mine Closure.

1. Initial Review

The initial stage outcome was the initial peer review report submitted to the DPE on 7 October 2021 (Middlemis 2021; attached to this report) that:

a) acknowledged the basic fitness for purpose of the groundwater model,

b) concluded that the forecast final void long term groundwater sink is valid,

c) concluded that it is not reasonable to characterise the post-mining final void lake water quality as 'non-polluting' (ie. contrary to the PSEARs), at least in the sense of it forming a source of poor quality water that is a 'window' into the post-mining watertable (although this update concurs that there is a low risk of mobilisation from the final void),

d) identified a range of issues and corrective actions.

The initial review report was discussed at a virtual meeting on 2 December 2021 that was facilitated by DPE and included representatives of MACH Energy and their consultants.

This final peer review statement is based on the initial review, and considers the subsequent response by MACH Energy (23 December 2021), pursuant to a Request for Information (RfI) from the DPE. That MACH (2021c) submission includes (at Attachments A to D) specialist reports from AGE (groundwater modelling), Jacobs (peer review), HEC (final void water and salt balance) and RGS (geochemistry). The initial peer review report (Middlemis 2021) forms part of this final peer review statement because many issues raised in it remain valid, certainly in relation to the groundwater impact assessment documentation put forward in late 2021.

2. Review of MACH response to RfI

This final stage review considered the MACH Energy RfI response (MACH 2021c). The corrective actions recommended in the initial review have been implemented adequately, as discussed in sub-sections below.

Some issues raised have been assessed to a basic level rather than a detailed level, and it is recommended that the DPE consider applying conditions to require further investigation of some matters as part of the ongoing Mining, Rehabilitation and Environmental Management process, such as:

- It is unreasonable to characterise the post-mining final void lake water quality as 'non-polluting', in the sense that it forms a source of very poor quality water that is exposed to the atmosphere, and is effectively a 'window' into the post-mining watertable. While the groundwater assessment has shown that there is no potential for density-driven flow to mobilise poor quality groundwater away from the final void, there has been no assessment of other potential (albeit arguably minor) causal pathways for impacts, such as via surface processes to other parts of the ecosystem. These issues are more relevant to an ecological assessment that should consider the risks associated with the long term poor water quality of the final void lake in relation to physical hazards (eg. to humans, stock, wildlife), potential toxic algal blooms and/or disease vectors (eg. mosquitoes, birds, bats), etc, (eg. see section 4 of McCullough and Linklater 2010), although such issues are not strictly within the scope of this review. It is important to note, however, that the EIS section 7.8.3 (MACH 2020a) notes the MNES guidance that significant impacts would cause "*persistent organic chemicals, heavy metals, **salt** or other potentially harmful substances to accumulate in the environment*" (my emphasis). However, the EIS does not apply the MNES guidance to the assessment of the final void lake, even though it does accumulate salt (the accumulation of other substances has not been assessed).

- The post-mining final void lake water quality was assessed very simply and only in terms of salinity, rather than via a detailed hydrogeochemical analysis. A detailed analysis is warranted in the context of the final void lake forming a local sink that receives inflows from across the mine lease area and the western tailings dam, and the presence of potentially acid forming (PAF) materials, high concentrations of sulfides, metals, and other potential contaminants.
- The 'no void' option has not been fully investigated, in that reduced recharge rates (eg. consistent with those applied to nearby Bengalla and Mt Arthur) should have been applied to Mt Pleasant. That would reduce the post-mining water table mound and thus minimise flows from the eastern out-of-pit emplacement towards the Hunter River. However, the final void lake/sink, which minimises flows towards the River, is consistent with the existing approvals and the current approved MOP. See also section 2.2 below.

2.1 Final Landform Analysis

The MACH Energy response (MACH 2021c) includes information on the final landform analysis at pages 1 to 8, and makes a key point on page 2 that '*The final void has been designed as a long-term groundwater sink to maximise groundwater flows from the Eastern Out-of-Pit Emplacement to the final void.*' That statement also appears on page 16 of the Rehabilitation and Mine Closure Addendum (MACH 2020b), part of the original EIS (MACH 2020a), and a similar statement appears in Table 3 of the later Submissions Report (MACH 2021a), although those points were not clearly highlighted in the initial review. It is a regrettable oversight on my part that my initial review did not identify this fundamental premise for the final landform.

It is important that this fundamental premise of a final void lake/sink has been established within the rehabilitation and final landform design objectives, especially as that has involved extensive consultation (MACH 2020b, Figure 4; MACH 2021a, section 3.2). Important because it implies that the range of options for groundwater assessment can be constrained to those including a final void lake/sink, provided the final landform investigations adopted reasonable assumptions and methods when assessing all options (this remains questionable for the no void option, although that is not necessarily material to the final void premise).

Although I am no authority on the approved MOP, it is also understood that this final landform premise (final void lake/sink) is consistent with the existing approvals and the current approved MOP (Mining Operations Plan and Rehabilitation Management Plan (1 July 2020 – 30 June 2021)). As noted in the initial review, the single final void is an improvement on the previous multiple voids arrangement in terms of a simple but important comparison of the substantially reduced footprint for the void waterbodies and the contributing catchment areas.

It is clear from the information presented, and it was acknowledged at the meeting on 2nd December 2021, that MACH Energy has applied itself very diligently to develop an optimal final landform design in geomorphic and mine planning/scheduling terms, a design that is founded on the assumption of a final void lake/sink. This reviewer characterised the overall landform design efforts and outcomes as better than most closure planning investigations he has encountered. However, as discussed herein, some groundwater-related aspects have not been assessed or optimised to the same level of detail, for example, the 'no void' option as discussed below. The implication is that the decision to discard the 'no void' option and to adopt the final void lake/sink option may have overlooked the benefit of some refinements to optimise the 'no void' option. However, it is again noted that the final landform premise (final void lake/sink) is consistent with the existing approvals and the current approved MOP.

2.2 Final Landform Investigations

Regarding the premise of maximising groundwater flows from the Eastern Out-of-Pit Emplacement to the final void, it has not been made clear why such flows should be maximised, but it is presumed that it would be a quite reasonable mitigation measure to minimise the risk of poor quality flows east towards the Hunter River (ie. a stable final void lake/sink helps protect the River). However, this has implications for the final void lake, in that poor quality flows from the eastern emplacement would impact the lake water quality, although that has not yet been adequately assessed, as noted in the initial review. If the flows through the emplacements are not poor quality, then the documents reviewed do not make the reasoning readily apparent for directing flows towards a (stable) groundwater sink and away from the River (ie. the final void option does not replicate the 2016 gradients towards the river that are shown in Figure 5.8 of AGE 2020a; see Figure 1 below, left frame).

The initial review noted that relatively high recharge rates were applied to the waste rock emplacements, including for the 'no void' scenario (eg. 'spoil' recharge is 6% of annual rainfall, compared to just 3.2% for alluvium and 2.8% for Triassic Sandstone; AGE 2020a, page 32; AGE 2020b). This 6% spoil recharge rate applied to Mt Pleasant is three times higher than the 2% spoil recharge rate reportedly applied to the Bengalla and Mt Arthur mine spoil areas (Table A.2.5 of AGE 2020a); the difference is not justified. The consequent high water table mound post-mining at Mt Pleasant was reportedly the main driver for flows from the eastern out-of-pit emplacement towards the Hunter River (Figure 1, right frame), which was considered unacceptable.

The groundwater assessment remains deficient in terms of the 'no void' option because it still has not investigated whether reduced recharge rates would reduce the water table mound and thus minimise flows towards the Hunter River (eg. consistent with the 2% spoil recharge rate applied to the Bengalla/ and Mt Arthur mines, or possibly lower, such as by land surface treatments to Mt Pleasant emplacements). The groundwater assessment also does not provide details on the quality of these groundwater flow components, or the potential impact on the floodplain or river. The implication is that the 'no void' option may have been unreasonably discarded and that further investigation of the 'no void' option may be warranted. However, the final landform premise adopted (final void lake/sink) is consistent with the existing approvals and the current approved MOP, so further sensitivity/uncertainty scenarios may arguably not be warranted for the no void case, although investigation of the final void scenario recharge sensitivity/uncertainty is warranted.

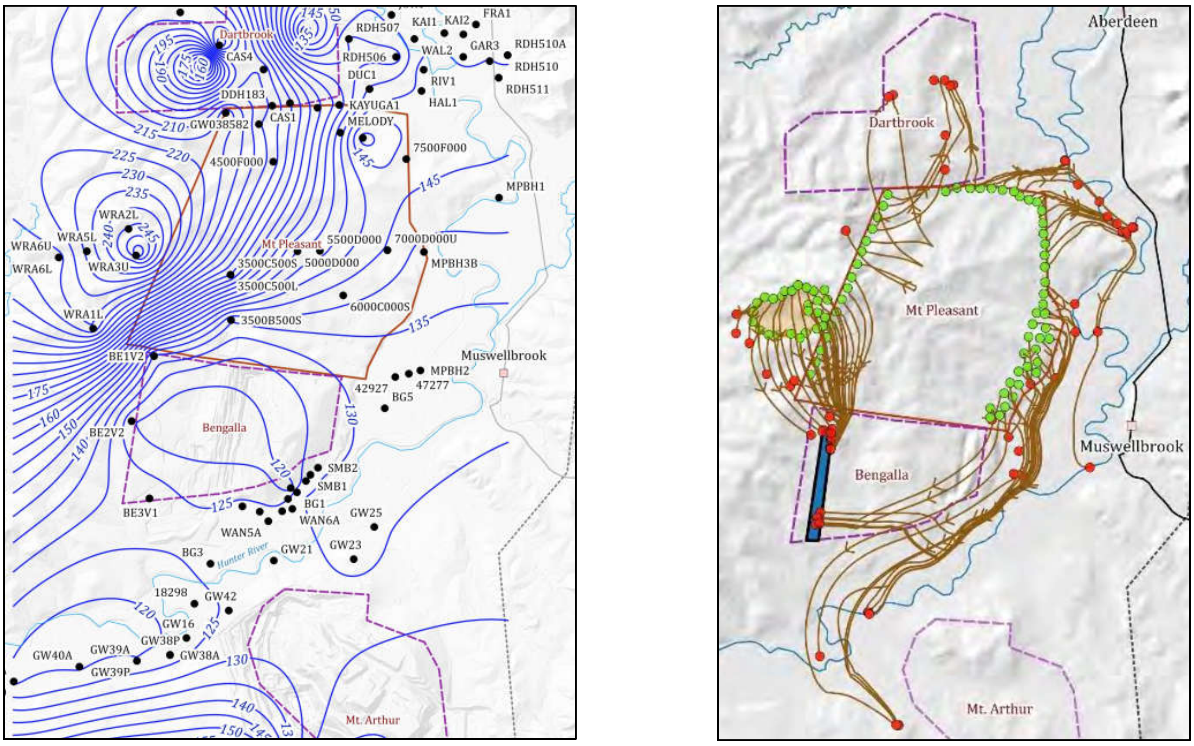

Figure 1 - 2016 water table contours (after AGE 2020a, Figure 5.8) and predicted particle pathlines post-mining for no void scenario (after AGE 202b, Figure 2)

2.3 Final Void Water Level

The MACH (2021c) response has clarified the inconsistency between the valid reporting of the final void lake long term water level in the groundwater assessment (AGE 2020a) and the incorrect reporting in the surface water assessment (HEC 2020, Figure 30). MACH (2021c) states that the surface water assessment was reporting a water level '*80m above the base of the void*' and that '*the two reports are consistent with respect to the equilibrium elevation*'. This reviewer does not agree, in that the HEC (2020) report:

- does not make any reference to the lake water level being 'above the base of the void';
- does not provide any information on the void base level;
- does not make any reference to mAHD, other than on the axis of the preceding Figure 29, which leads the reader to assume (incorrectly) that all levels are specified as mAHD.

The documentation issue is resolved by the MACH (2021c) clarification, but the HEC (2020) report remains inconsistent and incoherent on the lake level.

The post-mining drawdown is predicted to increase due to the lower lake level (Figure 4.1 of Attachment A to MACH 2021c), so the original methodology was not '*conservative*'. However, there is no material change to the water licensing requirements (Table 4.1), the nearby bore drawdown predictions (Table 4.2) and the particle tracking predictions (Figure 4.3).

2.4 Final Void Water Level Versus Groundwater Inflow Relationship

The response report (MACH 2021c) has resolved the issue of the unrealistic void lake stage-inflow curve presented in the EIS, by presenting a revised curve that displays '*a smooth reduction in groundwater inflow as the void water elevation increases and the flow gradient towards the void eases.*' The revised stage-inflow plot (Figure 2.1 of Attachment A to MACH 2021c, presented as Figure 2 below) is aptly described by the Jacobs peer review statement as having '*a much more intuitive shape than the original*' (Attachment B to MACH 2021c).

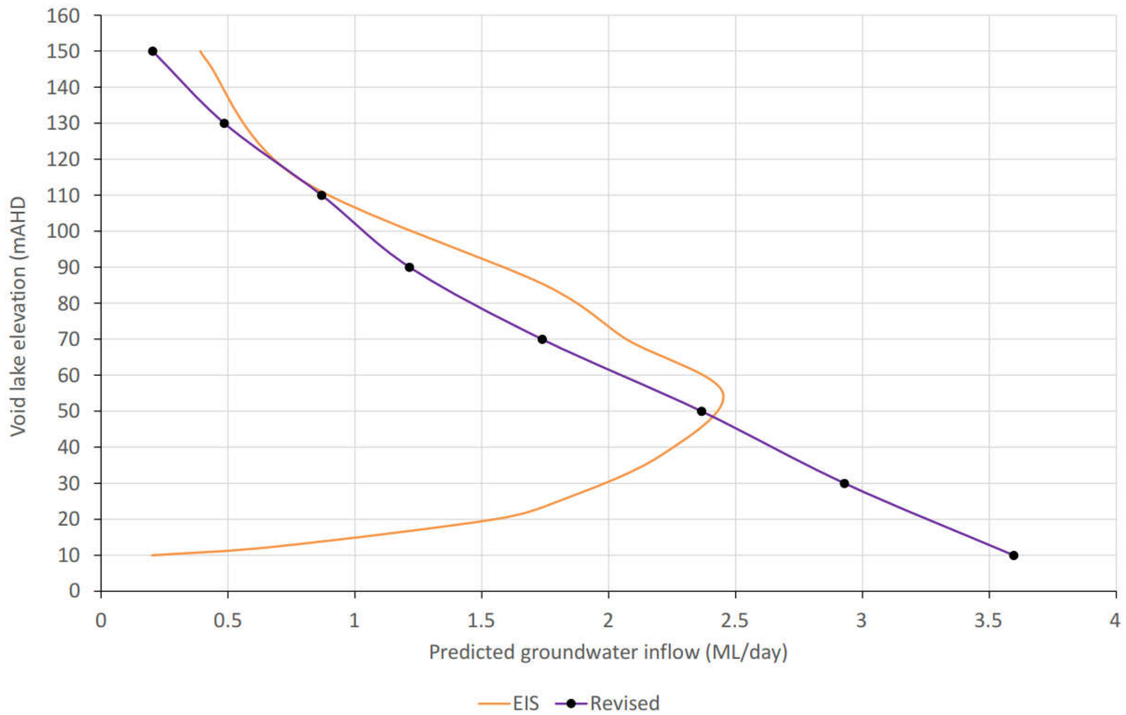

Figure 2.1 Revised MPO Final void stage-inflow relationship

Figure 2 - MPO final void lake stage-inflow curve (after AGE Attachment A to Mach 2021c)

The revised stage-inflow curve is described as being derived via an '*alternative modelling methodology*', but that is yet another example of the many statements with positive spin in the response document (see also previous section and later this section). The Jacobs peer review report notes that original method is '*less relevant*' to the assessment than the revised method, and that it '*cannot be used to indicate equilibrium inflows at various stage elevations*', which essentially confirms that the original method was actually incorrect, as my initial review indicated.

The revised stage-inflow curve was input to the GoldSim water and salt balance modelling (Attachment C to MACH 2021c). Revised results indicate a long term final void lake level of 75mAHD, which is 15m below the original level. This is presumably due to the revised inflows at lake levels of 50-100 mAHD being lower than for the original (incorrect) stage-inflow curve.

2.5 Final Void Water Quality and Stable Groundwater Sink

Revised assumptions were also applied to the final void lake salt balance in terms of the groundwater inflow salinity (900 µS/cm rather than 5522 µS/cm; based on the RGS report at Attachment D to MACH 2021c).

That change resulted in a significant reduction to the predicted pit lake salinity (25,000 µS/cm rather than 70,000 µS/cm) after 1000 years, although the salinity continues to increase at a steady rate with time, indicating that the final void lake will be a saline water body. The final void water quality assessment has predicted effects only in terms of the salinity of the lake, despite recommendations in the initial review for geochemical analysis.

There has been no sensitivity/uncertainty analysis of the final void lake water and salt balance. It could be argued that such analysis is not warranted, given that the latest revisions have reduced the predicted lake level by 15m, which caused some additional drawdown, but little material effect on water licensing, nearby bores and particle tracking. However, significant changes are predicted in terms of the final void lake salinity, and a more comprehensive investigation of sensitivity and uncertainty would be consistent with best practice guidelines (Barnett et al. 2012; Middlemis & Peeters, 2018).

The MACH (2021c) assessment has reasonably demonstrated that there is no potential for density-driven flow to mobilise saline groundwater away from the final void lake, and it has confirmed that any PAF material exposed in the final void wall/floor will be adequately managed to minimise adverse leachate impacts.

2.6 Other Modelling Issues (Addressed)

The western 'no flow' boundary condition has been tested and is not sensitive to alternative arrangements. The effects on Hunter River baseflows have been adequately addressed.

3. Conclusion

This final review statement should be read in conjunction with initial review report (Middlemis 2021), which is attached.

This final review considered the MACH Energy response (MACH 2021c; 23 December 2021). The corrective actions recommended in the initial review have been implemented adequately, but some matters warrant further investigation as part of the ongoing Mining, Rehabilitation and Environmental Management process, notably:

a) It is clear from the information presented that MACH Energy has developed an optimal final landform design in geomorphic and mine planning/scheduling terms, but it is a design that is founded on the adoption of a final void lake/sink. Some groundwater-related aspects have not been assessed or optimised to the same level of detail as the landform design, notably for the 'no void' option and the potential for reduced recharge rates to reduce the post-mining water table and thus minimise flows towards the Hunter River. The implication is that the decision to discard the 'no void' option (and to adopt the final void lake/sink option) may have not adequately considered refinements to optimise the 'no void' option. Having said that, the final landform premise (final void lake/sink) is consistent with the existing approvals and the current approved MOP.

b) The initial review recommended a sensitivity/uncertainty analysis of the final void lake water and salt balance assessment, but this remains unaddressed. The final void scenario sensitivity/uncertainty to 'spoil' recharge should also be investigated, and improved detail should be provided on the uncertainty analysis methods, assumptions, parameter ranges and results (eg. the report mentions 'key parameters' but does not specify them, and plots the range of values only for Kh and Kv in Figures A3.8 and 3.9 of AGE 2020a).

c) The post-mining final void lake water quality is assessed very simply and only in terms of salinity, rather than conducting a detailed hydrogeochemical analysis. Detailed assessment is warranted in the context of the final void lake forming a local sink that receives inflows from across the mine lease area and the western tailings dam, and the presence of potentially acid forming (PAF) materials, high concentrations of sulfides, metals, and other potential contaminants. The assessment should consider MNES guidance in relation to the final void lake water quality, at least in terms of the accumulation of salt, and preferably also on the potential accumulation of other substances.

d) Although there appears to be no established definition for 'non-polluting', this review considers it unreasonable to characterise the post-mining final void lake water quality as 'non-polluting', in the sense that it forms a source of very poor quality water that is exposed to the atmosphere, and is effectively a 'window' into the post-mining watertable. While the groundwater assessment has shown that there is no potential for density-driven flow to mobilise poor quality groundwater away from the final void, there has been no assessment of other potential causal pathways for impacts, such as via surface processes to other parts of the ecosystem (eg. physical hazards to humans, stock or wildlife, water quality hazards such as toxic algal blooms and/or disease vectors via mosquitoes, birds, bats, etc).

The matters summarised above could be characterised as being assessed to a basic level rather than a detailed level at this stage, but they warrant further investigation as part of the ongoing Mining, Rehabilitation and Environmental Management. It is recommended that the DPE consider whether further investigations may be warranted or the application of conditions to the project.

Yours sincerely, HydroGeoLogic

Hugh

Hugh Middlemis

Principal Groundwater Engineer.

References:

AGE (2020a). Mount Pleasant Optimisation Project - Groundwater Impact Assessment (Appendix C to EIS; MACH 2020a).

AGE (2020b). Mount Pleasant Optimisation Project – No Final Void Groundwater Review. Attachment 3 to the Rehabilitation and Mine Closure Addendum (Attachment 8 to EIS; MACH 2020b). 20 November 2020.

HEC (2020). Mount Pleasant Optimisation Project - Surface Water Assessment (Appendix D to EIS; MACH 2020a).

MACH Energy (2020a). Mount Pleasant Optimisation Project – Environmental Impact Statement.

MACH Energy (2020b). Mount Pleasant Optimisation Project – Environmental Impact Statement. Attachment 8. Rehabilitation and Mine Closure Addendum.

MACH Energy (2021a). Mount Pleasant Optimisation Project - Submissions Report.

MACH Energy (2021c). Mount Pleasant Optimisation Project – Request for Information. 23 December 2021. (includes reports from AGE, Jacobs, HEC and RGS as Attachments A-D)

McCullough C. and Lund M. (2010). Mine Voids Management Strategy (IV): Conceptual Models of Collie Basin Pit Lakes. Department of Water Project Report MiWER/Centre for Ecosystem Management Report 2010-12, Edith Cowan University, Perth, Australia. 100pp. www.water.wa.gov.au/__data/assets/pdf_file/0020/4970/96278.pdf