Response to the Snowy 2.0 Mains Works EIS

My main concerns with the proposal pertain to a lack of specific detail, and also (which is a component of the previous issue) the lack of availability of several of the reports prepared for the EIS and appendices. Throughout the proposal, reports, appendices, annexures and other documents, there is an outstanding lack of specific detail in many areas. For example, details of the decision to dismiss fish screens on the Talbingo inlet is not outlined, and no justification for this statement is made in the proposal. The scientific reports prepared for the Aquatic Ecology Assessment (Appendix M.2) were not made publicly available with the Main Works EIS, and as such an informed evaluation of the Aquatic Ecology Assessment or the Main Works EIS is impossible to construct. Other concerns specific to certain components are also raised.

Below I highlight some of the outstanding issues I can see with the proposal.

No mitigation of threats to undescribed galaxiids

Galaxiids were caught at multiple sites on the Murrumbidgee River and Tantangara Creek near the confluence of these two streams, and also downstream of Tantangara Reservoir on the Murrumbidgee River (see Section 5.2.5 Watercourses, Annexure B, Appendix M.2 Aquatic Ecology Assessment). Raadik (2018) suggested that the individuals collected could represent previously unidentified species, and the report highlights that the taxonomy of these unidentified individuals has important implications for the proposal - if these individuals represent a new, unidentified species then the proposal may lead to their extinction. Apparently, this consideration has been made in the impact assessment:

> "Taking a precautionary approach, the impact assessment assumes that there are two undescribed and potentially narrow-range species; one in the Upper Murrumbidgee River and one in the Mid Murrumbidgee River" - *Section 5.2.5 Watercourses, Annexure B, Appendix M.2*

However, Table 6-2 of Annexure B has grouped these unidentified species under the 'Mountain galaxias' banner - hardly what would be considered:

> "a precautionary approach" [that] "assumes there are two undescribed narrow-range species" - *Section 5.2.5 Watercourses, Annexure B, Appendix M.2*

The genetic implications for mixing of Talbingo Mountain galaxias and the unidentified galaxiids is mentioned in Section 7.2.3.3 *Primary catchments, Appendix M.2*, as is the potential for population loss due to Climbing galaxias and/or Redfin perch incursion. However, Table 7-3 in Appendix M.2 outlines the control risks from fish transfer between reservoirs, and the only barrier preventing pest fish passage and invasion upstream of Tantangara Reservoir is the barrier on Tantangara Creek upstream of the Alpine Creek Firetrail. Again in Table 7-4 in Appendix M.2, these unidentified galaxiid species are not mentioned.

The bottom line is: The unidentified galaxiids found elsewhere in the Tantangara/Upper Murrumbidgee catchment upstream of Tantangara Reservoir have been disregarded from threat mitigation measures. This does not reflect:

> "a precautionary approach" [that] "assumes there are two undescribed narrow-range species" [whos taxonomy has] "important implications for impact consideration" - *Section 5.2.5 Watercourses, Annexure B, Appendix M.2*

The statement from Section 5.2.5 *Watercourses, Annexure B, Appendix M.2* which states that these fish have been treated as two undescribed species is false and misleading. It is critically important that these fish be considered and protected as part of this project. The current mitigation measures, or lack thereof, protecting these fish is simply not good enough.

Tantangara Creek barrier: detail, design and location

Specific details are scarce

Details of the proposed barrier to be built on Tantangara Creek to prevent Climbing galaxias incursion are very scarce. Details are limited to a rough location of the construction, which is outlined as upstream of the existing waterfall, upstream of Alpine Creek Firetrail. The map scale and size indicating this location and the area of disturbance associated with its construction are too coarse to show any details of the site (*Figure 2.9 Plateau - project elements, EIS Main Report Part 1*). What may be interpreted from these maps however, is that the disturbance area seems fairly large (~500 m across), which is concerning as even small spatial impacts on stream structure and habitat have potential to cause significant disturbance. The proposed barrier site is:

> "located in a zone in which very few individuals due to the extensive areas of bedrock and fast flows (Raadik 2019)" - *Section 6.4.2 Impacts on Aquatic Habitats and Biota, Appendix M.2*

However as the original report (Raadik 2019) was not made available, the evaluation of the barrier design and/or location is impossible. In some of the bedrock lined areas upstream of the natural waterfall Stocky galaxias is actually found in quite high densities, so understanding the specific location and area of disturbance is essential to provide informed commentary.

Barrier design is not explained

The design of the barrier on Tantangara Creek is not included in the report. This is not ideal. As we know Climbing galaxias is an efficient climber of wet, vertical structures and most fish barriers used in the past - typically to block movement of trout or other jumping species - are unsuitable. The design, construction and temporal effectiveness of such a barrier against Climbing galaxias incursion is not presented in the proposal. This barrier must not be used as an experiment to test the effectiveness of such a barrier - the immediate threats posed by Climbing galaxias are very serious. Before the barrier design is finalised, it must be ensured that this design has been previously tested and is effective.

Again, informed evaluation of the proposed barrier design is impossible without the original report by Raadik containing these details.

Barrier location could be improved

Currently, the details of the design and effectiveness of the proposed barrier are unknown.

The proposed barrier location is upstream of the existing natural waterfall. The issue with this location is that if the barrier fails and/or is breached by Climbing galaxias, then the spatial range of Stocky galaxias will be immediately invaded. In essence, this approach allows no 'second chances'.

Rather, if the barrier was built further downstream in the Tantangara Creek catchment, there would be some geographic separation between the area most likely to be invaded by a barrier breach - immediately upstream of the construction - and the habitat of Stocky galaxias.

The proposed *Weed, Pest and Pathogen Management Plan* suggests future monitoring of pest fish in the future, however details of this 'Plan' are once again scarce. With a barrier further down the Tantangara Creek catchment and adequate ongoing pest fish monitoring up- and downstream of the barrier, the spread of Climbing galaxias (and other pest fish) throughout the upper Murrumbidgee and Tantangara catchments may be more closely understood. Close monitoring would allow the implementation and adaptation of control strategies in the event of a barrier breach (either through damage to the structure or if it turns out the barrier is ineffective), while also reducing the risk of immediate invasion by Climbing galaxias into the range of Stocky galaxias.

A barrier on the lower reaches of Tantangara Creek would be beneficial in several ways:

- It would provide geographic separation between Stocky galaxias and Climbing galaxias in the event of barrier failure or breach. This means a barrier breach and subsequent invasion of Climbing galaxias (and potentially other invasive species) may be observed through regular monitoring programs - before deleterious interactions with Stocky galaxias. Control strategies may be adapted and implemented accordingly, ensuring the protection of Stocky galaxias into the future.
- It could potentially prevent the invasion of Climbing galaxias into the range of the undescribed galaxiids in the Lower Tantangara Creek, and depending on the exact location the galaxiids observed in the Murrumbidgee River near the confluence with Tantangara Creek may also be protected. Given that these individuals are undescribed - and that Appendix M.2 outlines the importance of taking a precautionary approach to their conservation - the protection of these fish is important.
- It would prevent the invasion of a greater proportion of the Tantangara Creek catchment, ensuring minimal disruption to the existing ecological community. In this case, the other small tributaries in the Tantangara Creek catchment could remain free of Climbing galaxias. These tributaries are required as sites for establishment of additional populations of Stocky galaxias for ongoing conservation. If Climbing galaxias invades the catchment, these reintroduction sites will become unsuitable.
- Site access to a barrier on the lower Tantangara Creek would be easier during construction, operation and ongoing maintenance than for a headwater site. There are several road crossings which may be used for access, and potentially incorporated into the barrier design.

There are sites where the stream is confined by steep bedrock in the Lower Tantangara Creek which may be suitable for barrier construction. Further, if a barrier was constructed on the Murrumbidgee River, somewhere between the Tantangara Creek confluence and the high water mark in Tantangara Reservoir, the entire Tantangara Creek and Upper Murrumbidgee catchments would be protected from all pest fish, if transferred to Tantangara Reservoir from Talbingo Reservoir. Admittedly a barrier in this lower part of the catchment may need to be larger than in a headwater environment. However, Snowy Hydro are the experts in barrier construction! They have the equipment, the knowledge and the materials at their disposal. The benefits of constructing a larger barrier would extend to assist with the disposal of some of the 9,000,000 m^3 of material excavated from the tunnel and construction processes.

No ongoing barrier maintenance identified

> "The successful operation of the proposed fish barriers would substantially reduce the potential for the introduction of Climbing galaxias to the Upper Tantangara Creek..."
>
> "A very small residual likelihood would still remain associated with the requirement for ongoing successful operation and maintenance of these barriers..."
>
> *- Section 7.2.3.6 Mitigation Measures and Residual Risks, Appendix M.2*

The ongoing operation and maintenance of fish barriers is **essential** for effective fish exclusion, but no explanation of the ongoing maintenance and monitoring of the Tantangara Creek barrier's integrity is provided. The proposal states:

> "Rehabilitated land [will be] returned to NPWS" - *EIS Main Report - Part 1, Table 2.4*

The construction of the barrier is only the first step in preventing passage of Climbing galaxias - the barrier itself must be monitored and maintained to ensure it remains functional and effective - **FOREVER**. In the event of a large flood or bushfire for example, who is responsible for ensuring the effectiveness of the barrier and providing maintenance and repairs as required?

The persons responsible for the ongoing maintenance and operation of the barrier must be identified before it is constructed. This means maintenance and repairs may be carried out immediately as required, rather than 'finger-pointing' and deciding who is responsible at the time when the barrier may be compromised (e.g. after damage).

This is especially important as once pest fish are established in the Tantangara or upper Murrumbidgee catchments, the threats to Stocky galaxias will remain **FOREVER**. These threats will outlast all of the Snowy Hydro infrastructure and projects. Who is responsible and accountable for barrier maintenance and monitoring in say 100 years time, or 200 years time? These questions need answers before works begin.

The barrier will only protect one existing, threatened site

> "In response to the risks of fish and/or fish disease transfer, Snowy Hydro has incorporated additional secondary controls at outflows of Tantangara Reservoir and above the waterfall on Tantangara Creek. These measures will limit the potential range expansion of any fish that may be transferred to Tantangara Reservoir as a result of the project..." - *Executive Summary, Appendix M.2*

This statement is misleading. The only structure in the Murrumbidgee and Tantangara catchments upstream of Tantangara Reservoir that will "limit the potential range expansion of any fish that may be transferred to Tantangara Reservoir" is the proposed waterfall on the uppermost reaches of Tantangara Creek. This represents roughly ~3 km of the Tantangara Creek catchment which totals well over 40 km of stream. The additional length of stream found in the wider Murrumbidgee catchment upstream of Tantangara Reservoir is well over this amount again. As outlined, the proposed barrier site on Tantangara Creek is only going to prevent Climbing galaxias incursion into a single site. A barrier further downstream could protect a much greater area from the risks of Climbing galaxias, aiding the recovery of Stocky galaxias and potentially protecting additional populations of undescribed galaxiids.

Protecting more than just the *bare minimum* area is particularly important in light of the modelled groundwater changes (Appendix J.1). Nearby headwater streams with similar morphology to the Upper Tantangara Creek are predicted to lose a significant portion of their baseflow and significantly increase in their number of no-flow days. This is bad news for aquatic biota in these systems. Tantangara Creek for example, averages around 1 m wide and 10 cm deep in places, so even a small reduction in flow would be significant. In addition, the conclusions from *Annexure B, Appendix J.4* indicate the situation may actually be worse than predicted:

> "The hydraulic conductivity of the rock to be excavated by the project has been estimated using appropriate hydrogeological techniques and pumping test methods. However, fracture flow is not uniform and local scale and overall tunnel groundwater inflow will only be known once the project commences and groundwater flows into the tunnel are measured. Until that time, the groundwater drawdown and baseflow reduction predictions of the groundwater model will carry a degree of uncertainty. Should the hydraulic conductivity of the rock be higher than modelled (ie there are more fractures encountered

> than anticipated), **then impacts to creeks at the surface may be larger than estimated. This could take the form of more severe impacts within creeks already predicted to be impacted, or it could take the form of impacts to creeks previously estimated to be unaffected by the project**." - *Executive Summary, Modelling Report, Annexure B, Appendix J.4*

This means the real magnitude and impacts of groundwater disruption will not be known until construction begins. The Upper Tantangara Creek - the only known habitat of Stocky galaxias - is nearby to those streams currently predicted to be affected by groundwater loss, so there is a chance that it too may be affected. No mitigation measures or offset strategies are proposed for instances where this situation does occur and baseflow reduction does occur in the Upper Tantangara Creek. Pressures and reliance on groundwater flow is set to increase as climate change drives a drying climate, and the occurrence of extreme climatic events such as bushfire and drought is predicted to increase.

Stocky galaxias requires additional wild populations to be established to increase the resilience of the species to localised population decline, and the headwater streams in the Tantangara catchment are prime candidates for establishing additional populations. Again, if the barrier to Climbing galaxias is constructed further downstream, a larger area will be available for translocation efforts and the impacts of potential stream desiccation due to groundwater loss will be slightly reduced.

Lack of primary measures against fish transfer

> "Given the design features of Snowy 2.0, and based on the findings of the review, flat-panel wedge-wire screens, drum screens and submerged water intake, fish-friendly (SWIFF) screens were considered technically feasible (THA, 2019). These options would all require significant civil works. In the case of drum and SWIFF screens this would include the construction of forebays and screen chambers. These civil works would likely extend the construction footprint of the intake works beyond the existing boundary and require considerable volumes of additional excavation at each of the intakes with associated high construction costs and environmental impacts. Based on preliminary design work, none of these options was considered feasible and they are not proposed as part of the Project" - *Section 7.2.3.2 Preventing Fish Movements, Appendix M.2*

The report by THA (2019) is not publicly available, and therefore the justification behind deeming primary fish screens at Talbingo as 'unfeasible' is unclear. This is not good enough. Fish transfer from Talbingo to Tantangara is a serious issue, and it should be made clear the decision pathway which has led to the dismissal of primary fish control screens in the proposal.

The construction of primary fish control strategies at the Talbingo inlet would mean all the other control strategies such as the Tantangara Creek barrier, and fish screens on the Tantangara outlets would not be required. Not only would this prevent Climbing galaxias invasion into the Upper Murrumbidgee and Tantangara catchments, but also the invasion of these areas by Redfin perch. Redfin perch are widely regarded as a major cause of decline in populations of threatened Macquarie perch, through transfer of EHNV. The population of Macquarie perch in the Murrumbidgee River, downstream of Tantangara Reservoir will be vulnerable to extinction if Redfin passage between the two reservoirs is facilitated.

A vast amount of work is required to implement the secondary controls to fish passage, while effectiveness of some are unknown (Climbing galaxias barrier on Tantangara Creek) and others come with unavoidable risk (Tantangara Reservoir spilling and spreading Redfin perch and EHNV downstream to threatened Macquarie perch populations). And still, no threat mitigation

measures are proposed for the unidentified galaxiids in the Murrumbidgee River and lower Tantangara Creek so they will more than likely decline, or be completely lost with this proposal. One single primary control measure (fish screens at Talbingo) would prevent these threats from reaching Tantangara Reservoir and the catchments upstream of it.

This is the obvious choice.

Few references to some of the scientific reports

Table 4-1, *Appendix M.2* describes a list of reports and works prepared for EMM consulting. Many of these reports are cited very few times throughout the entire 407 page Appendix!

Report	References to report
Lintermans (2019)	6
Cardno (2019)	6
Zukowski & Whiterod (2019)	8
Ning et al. (2019)	10
Hick et al. (2019)	10
EnviroDNA (2017)	0
EnviroDNA (2019a)	11
EnviroDNA (2019b)	4
Raadik (2018)	3
Raadik (2019)	3
Baumgartner et al. (2017)	2
THA Aquatic (2019)	1
Allan & Lintermans (2019)	0

Information from these reports would be used to inform the decisions behind Appendix M.2, however there is very limited reference to some of these works throughout the report. These reports should have been made publicly available so that informed decisions may be made, and evaluative comments may be provided based on the information they contain, rather than the small selection included in Appendix M.2.

For example, Table 5.5.8, *Appendix M.2* describes fish and crayfish distributions in the Upper Tantangara Creek Catchment. The likelihood of occurrence of crayfish *Euastacus* is described as 'Mod (Adj)' indicating no records are present at this site. The presence of this species *is recorded* at this site, and *is provided* in a report listed in Table 4-1, *Appendix M.2* (Allan & Lintermans 2019). The lack of reference to this information suggests the report has not been read - or if it has - the information it provides has been ignored.

The information contained in these reports is critical for the evaluation of the proposal, and the few appearances they make in the text is unsuitable for adequate evaluation. The fact that these reports are not available with the proposal means an informed evaluation can not be constructed.

No details of the proposed "Weed, Pest and Pathogen Management Plan" are provided

A "Weed, Pest and Pathogen Management Plan" is proposed (Table 6.11, *EIS Main Report Part 2*). Given that one of the major ecological impacts of the proposed project is the potential transfer of pest fish and disease, details of this plan are required before the suitability of the proposal may be effectively evaluated.

Without suitable monitoring, the transfer and spread of pest fish and disease throughout the catchment will remain a mystery. This Plan should be prepared before the project begins and made available for comment, to ensure suitable threat mitigation strategies are implemented throughout the entire project and into the future.

Water reticulation

Other issues are also important. The bushfire risk assessment for example, explains that fire mitigation measures include having a tanker on stand by for fire fighting purposes. These tankers will be filled from reticulated water sources, of which:

> "Water supply from Talbingo and Tantangara Reservoirs is considered reticulated"
>
> *- Table 49, Appendix T*

My concern surrounds the fighting of fires near to and within the habitat of Stocky galaxias. Fires may begin from works anywhere in the project, but particularly when works are being carried out near to the Upper Tantangara Creek. Works in this area include the construction of the barrier, and the installation of a communications cable adjacent to the Alpine Creek Firetrail.

According to the current proposal, fish transfer is possible from Talbingo to Tantangara Reservoir, but passage will be blocked upstream of the waterfall on Tantangara Creek. Therefore, all water sources downstream of the barrier on Tantangara Creek (including Tantangara Reservoir) may potentially contain transferred pest fish (Climbing galaxias, Redfin perch, Eastern gambusia and Goldfish), and almost certainly contain existing pest species (Brown trout and Rainbow trout).

If firefighting efforts are required in the Upper Tantangara Creek (upstream of the existing waterfall - where within the range of Stocky galaxias) there is a risk that reticulated water contains pest fish. These pest fish may then be transferred upstream of the waterfall barrier and within the range of Stocky galaxias - which is far from ideal. Trout populations are known to eliminate galaxiid populations within as little as 3 months, so it must be ensured that trout - and other pest species - are not transferred upstream of the barrier. The same risks exist for the transfer of fish (and disease) to areas downstream of Tantangara Reservoir, potentially affecting downstream Macquarie perch and undescribed galaxiid populations.

To mitigate this risk it is essential that water collected from any waterway, for any purpose, be appropriately screened to prevent the uptake of fish or disease present in the waterway. Screening should be fine enough to reduce the risk of transfer of fish and disease through reticulation systems and subsequent firefighting activities.

Conclusion

The key themes throughout these concerns pertain to the lack of specific detail provided in the proposal. Specifically, the scientific reports prepared for the Aquatic Ecology Assessment (Appendix M.2) contain important information which is required to properly evaluated the Assessment. The lack of protection for the unidentified galaxiids is concerning, and parts of the proposal are misleading in saying that a precautionary approach has been adopted in relation to their conservation. I trust that these issues are considered in the final planning stages of this project.

The installation of a primary fish control structure - fish screens - at the Talbingo inlet would mean all other fish controls are not required. These screens are an obvious inclusion in the development. Failing that, the construction of a fish control (including Climbing galaxias) structure in the upper Murrumbidgee or Tantangara Creek catchments near the confluence of these two streams (or downstream) would be far more beneficial than a single small barrier on a existing waterfall in the upper Tantangara Creek. You guys have plenty of rock to dispose of, so why not build a big barrier and keep an entire catchment free from new pest fish?