Alpine Resorts
Victoria

Mount Buller Water Storage Project

Hydrological and Ecological Monitoring and Adaptive Management Program: Impact Year 5

30 August 2024

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EXECUTIVE SUMMARY

Background

From October 2019 to May 2020, the Mount Buller and Mount Stirling Alpine Resort Management Board (the RMB) constructed a 100-megalitre off-stream water storage and ancillary infrastructure (the project) on Mount Buller, within a 10.347-hectare Project Construction Footprint (PCF) between the summit and the Mount Buller Village. As part of the project, Alpine Resorts Victoria (ARV) is implementing an ongoing Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP), with an objective of maintaining the extent and condition of Alpine Bogs that are within the Boggy Creek catchment, downslope of the water storage.

Two years of baseline hydrological and ecological monitoring data (Baseline Years 1 and 2 or BY1 and BY2) were collected as part of the HEMAMP in 2018 and 2019. This was followed by hydrological and ecological monitoring during construction in 2020 (Impact Year 1 or IY1) and post-construction hydrological and ecological monitoring from 2021 to 2024 (Impact Years 2 to 5 or IY2 to IY5). This cover report summarises the results of hydrological and ecological monitoring from Impact Year 5, compares the results with baseline data and provides an assessment of these results against the HEMAMP's performance criteria and triggers for adaptive management.

Performance Criteria

The HEMAMP's performance criteria are as follows:

- The 'extent' criterion – there will be no more than a 10% reduction in the total combined area of the impact sites, determined by on-ground or remote (aerial) monitoring and taking into account natural variation based on extent observations averaged across control sites.
- The 'composition' criterion – there will be no more than a 10% reduction in the total 'bog-dependent' native flora species richness of the impact sites, taking into account natural variation based on species richness observations averaged across control sites.
- The 'encroachment' criteria:
  - Atypical species – there will be no more than a 10% increase in the cover of 'non-bog-dependent' species within the impact sites, taking into account natural variation based on observations averaged across control sites.
  - Weeds – the total cover of weeds (naturalised exotic flora species) within the impact sites will not exceed 5%.
- The 'structure' criterion – there will be no more than a 10% reduction in the average cover of Peat Moss within the impact sites, taking into account natural variation based on Peat Moss cover averaged across control sites.

Performance criteria are expressed in terms of all impact sites collectively, relative to all control sites collectively. All impact sites are at Mount Buller and are at least partially within the catchment area of the water storage. Control sites are split between Mount Buller (outside of the catchment area of the water storage) and Mount Stirling (approximately 6 kilometres north-east of Mount Buller). Mount Buller and Mount Stirling control sites have been analysed collectively and separately to better understand the potential causes of differences between impact sites and control sites.

Adaptive Management Triggers

The HEMAMP's ecological triggers for adaptive management are related to the above performance criteria. Hydrological triggers have been set with reference to hydrological models for the Boggy Creek catchment, which are designed to provide an early warning system for pre-empting ecological change at the impact sites. The adaptive management trigger thresholds follow a 'traffic light' approach, where the level of management intervention is escalated as the risk of adverse impacts on the ecological values of the impact sites increases. Risks of adverse impacts increase as trigger levels move from green, to amber, to red.

Trigger	**Parameter**	**'Green' Threshold**	**'Amber' Threshold**	**'Red' Threshold**
Alpine Bog Extent	Reduction in area of Alpine Bogs at impact sites relative to control sites.	≤5%	>5% but ≤10%	>10%
Alpine Bog Composition	Reduction in bog-dependent species richness at impact sites relative to control sites.	≤5%	>5% but ≤10%	>10%
Encroachment by Atypical Species	Increase in cover of non-bog-dependent native flora at impact sites relative to control sites.	≤5%	>5% but ≤10%	>10%
Encroachment by Weeds	Increase in cover of weeds at impact sites.	≤2.5%	>2.5% but ≤5%	>5%
Alpine Bog Structure	Reduction in cover of Peat Moss at impact sites relative to control sites.	≤5%	>5% but ≤10%	>10%

Trigger	**Parameter**	**'Green' Threshold**	**'Amber' Threshold**	**'Red' Threshold**
Surface Water Flows	Reduction in mean annual surface water flows to Boggy Creek over two consecutive years, relative to model.	≤10%	>10% but ≤50%	>50%
Groundwater Levels	Reduction in mean annual groundwater levels over two consecutive years, relative to model.	≤10%	>10% but ≤50%	>50%
Surface Water Quality	Change in various surface water quality parameters, relative to baseline.	<1.5 x IQR*	≥1.5 x IQR* and ≤3 x IQR*	>3 x IQR*
Groundwater Quality	Change in various groundwater quality parameters, relative to baseline.	<1.5 x IQR*	≥1.5 x IQR* and ≤3 x IQR*	>3 x IQR*

*IQR = Interquartile Range

Results

Alpine Bog Extent

Comparison	IY5 Result	Compliant?	Action Req’d?	Comments
Mount Buller Impact Sites v All Control Sites	-5.5%	Yes	Yes	True relative reduction in area of impact sites is likely to be closer to 0% because various factors are likely to have disproportionately benefitted Mount Stirling control sites. Continued sediment/weed control and revegetation needed at impact sites, particularly Bogs 6 and 11.2.
Mount Buller Impact Sites v Mount Buller Control Sites	+0.7%	Yes	Yes	

Alpine Bog Composition

Comparison	IY5 Result	Compliant?	Action Req’d?	Comments
Mount Buller Impact Sites v All Control Sites	-5.3%	Yes	Yes	Silver Astelia was incidentally observed at impact sites again in IY5, but not along transects or in quadrats. Propagation of Silver Astelia commenced in 2023 (10 pups and approx. 120 seeds) and eight plants were ready for planting in autumn 2024. The plants were planted into areas of dieback along the margins of Bog 4.2, near previous records (but not along monitoring transects).
Mount Buller Impact Sites v Mount Buller Control Sites	-5.3%	Yes	Yes	

Encroachment by Atypical Species

Comparison	IY5 Result	Compliant?	Action Req’d?	Comments
Mount Buller Impact Sites v All Control Sites	+6.7%	Yes	No	The cover of non-bog-dependent flora species has increased by 6.7% at impact sites relative to control sites. However, the absolute cover of non-bog-dependent flora has declined to below baseline levels. No intervention required. Continue monitoring in IY6.
Mount Buller Impact Sites v Mount Buller Control Sites	+1.5%	Yes	No	

Encroachment by Weeds

Comparison	IY5 Result*	Compliant?	Action Req'd?	Comments
Cover of weeds inside and outside of Alpine Bog impact sites (across entire transects)	7.9%	No	Yes	Weed cover along entire transects (inside and outside of Alpine Bogs) was 7.9% in IY5 and has been greater than 5% since monitoring started. Weed cover within impact sites (inside Alpine Bogs only) was 3.6% in IY5 and therefore compliant. However, weed control is still needed, especially in Bog 6.
Cover of weeds across inside Alpine Bog impact sites only	3.6%	Yes	Yes	

*Note: The result for cover of weeds is expressed as an absolute percentage cover. All other results are expressed as a relative change from the Baseline Mean (BM) to Impact Year 5 (IY5).

Alpine Bog Structure

Comparison	IY5 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	+9.9%	Yes	No	Peat Moss cover has increased by 9.9% at impact sites relative to control sites. Overall, Peat Moss cover and health is good, although there was a slight increase in the proportion of Peat Moss recorded as dead in IY5. No intervention required. Continue monitoring in IY6.
Mount Buller Impact Sites v Mount Buller Control Sites	+39.2%	Yes	No	

Surface Water Flows

Comparison*	**IY4 Result**	**IY5 Result**	**Action Req'd?**	**Comments**
Boggy Creek Weir 1 Pickup 2 v Modelled Surface Water Flows	Unknown	+38%	Yes	A complete surface water flow dataset was not available for IY4. Known surface water flows in IY4 were slightly above expected flows, given the climatological conditions that were experienced. A complete dataset was available for Boggy Weir 1 Pickup 2 and an incomplete dataset was available for Boggy Weir 2 in IY5. Mean surface flows were analysed for Boggy Creek Weir 2 for the period December 2023 to April 2024. Results for IY5 were considerably below the model predicted flows at Boggy 2 but above the model predicted flows at Boggy Creek Weir 1 pickup 2.
Boggy Creek Weir 2 v Modelled Surface Water Flows	Unknown	-75%	Yes	

*Note: As outlined in the HEMAMP protocol, no reliable comparison is currently possible between Boggy Creek Weir 1 Pickup 1 and modelled surface water flows, so it has been excluded from this table.

Groundwater Levels

Comparison	**IY4 Result**	**IY5 Result**	**Action Req'd?**	**Comments**
All Boreholes v Modelled Groundwater Levels	-46%	+4%	No	Groundwater levels did not depart considerably from expected levels in IY5 or IY4. Monitoring must continue but no further intervention is needed.

Surface Water Quality

Parameter	IY5 Result	Action Req'd?	Comments
Electrical Conductivity	No outliers detected.	No	Review catchment area for potential sources of TDS and Turbidity, starting with sediment impact from weed control areas. Adjust/add sediment control if necessary to achieve water quality objectives. Other parameters were mostly within the green threshold range of 1.5 x IQR. No intervention required. Continue monitoring in IY6.
Total Dissolved Solids (TDS)	Five 'red' outliers detected in IY5 in February and April, ranging from 42 mg/L (Boggy Weir 1 Pickup 2) to 54 mg/L (Boggy Weir 1 Pickup 1).	Yes	
pH	No outliers detected.	No	
Nutrients (Nitrate)	Minor outliers detected.	No	
Major Ions (Calcium, Magnesium, Potassium, Sodium, Chloride, Sulfate)	Nine 'amber' outliers detected for chloride (5 outliers), calcium (2 outliers) and sulfate (2 outliers).	No	
Turbidity	One 'amber' outlier detected at Boggy Weir 1 Pickup 1. Three 'red' outliers detected at EWS* East.	Yes	
Alkalinity (Bicarbonate)	Three 'amber' outliers detected (one at Boggy Weir 1 Pickup 2 and two at EWS* East)	No	

*EWS = Environmental Watering System

Groundwater Quality

Parameter	IY5 Result	Action Req'd?	Comments
Electrical Conductivity	No outliers detected.	No	Nitrate at BH06 was outside the overall catchment range but within the IQR threshold for BH06 specifically. Other parameters were mostly within the green threshold range of 1.5 x IQR. No intervention required. Continue monitoring in IY6.
Total Dissolved Solids (TDS)	Six 'amber' outliers detected in IY5 in February and April 2024. Two outliers detected at BH17 and one outlier detected at each other bore.	No	
pH	No outliers detected.	No	
Nutrients (Nitrate)	One 'red' outlier and two 'amber' outliers detected at BH06.	No	

Parameter	IY5 Result	Action Req'd?	Comments
Major Ions (Calcium, Magnesium, Potassium, Sodium, Chloride, Sulfate)	Nine 'amber' outliers detected for calcium (3 outliers) and magnesium (6 outliers).	No	
Turbidity	No outliers detected.	No	
Alkalinity (Bicarbonate)	Two 'amber' outliers (BH17 and BH18) detected in IY5.	No	

Conclusions and Recommendations

The benefits of ARV's ongoing implementation of the HEMAMP (including recommendations of annual monitoring reports), Ecological Rehabilitation Plan (ERP) and ERP Addendum are reflected in monitoring results for IY5. However, IY5 monitoring results indicate that certain adaptive management trigger thresholds have been met. Most notably, the bog extent and bog composition performance criteria have been within the 'amber' trigger threshold for at least three consecutive years, meaning that management actions to address these performance criteria will need to be scaled up in IY6.

Suggested actions to address the adaptive management triggers are provided in the recommendations of the monitoring reports (collated below). Most recommendations from IY4 monitoring were implemented in IY5. Two recommendations were not pursued because they were either no longer relevant or rejected after the independent review. Some recommendations from IY4 are ongoing and have been incorporated into the list of recommendations from IY5 monitoring.

Ecological Recommendations

The recommendations of the ecological monitoring report are as follows:

1. Despite positive trends since IY3, the relative decline in extent of impact sites has remained greater than 5% (i.e. at the 'amber' trigger level) for three consecutive years, meaning that management actions and effort at impact sites must be increased in IY6. In particular, weed control and/or revegetation effort should be increased at Bogs 6 and 11.2.
2. Now that artificial watering of Mount Buller's eastern control sites has ceased, ecological monitoring should be alert to a potential decline in the area of these sites and adapt analysis of results accordingly. Analysis of results from Borehole 18 (BH18) may assist.
3. While the area of dieback of non-bog-dependent flora bordering Alpine Bogs at Mount Buller appears to be stabilising, dieback locations must continue to be re-visited in future years to track vegetation recovery or succession and to plan any necessary management interventions e.g. weed control and revegetation.
4. Additional survey effort should be undertaken in IY6 to identify and map any new Alpine Bog vegetation within the Boggy Creek catchment (upslope of Bog 13) and to re-visit Alpine Bogs that were newly identified and mapped in BY2 (so-called 'other sites').

5. ARV must continue to implement the ERP and ERP Addendum to continue to prevent movement of sediment from the PCF into Alpine Bogs.
6. Where possible, ARV should make greater use of jute mat and sediment socks to minimise re-mobilisation of sediment immediately after physical weed removal within and around Alpine Bogs, as was done in IY3 and IY4.
7. The eight Silver Astelia plants that were planted in or near Bog 4.2 in IY5 should be re-visited again in IY6 to monitor their survivorship and to plan follow-up management actions, such as weed control or herbivore management. If any of the eight Silver Astelia plants have died, they should be replaced either at the same location (if conditions for re-introduction are still suitable at this location) or at a new location (if conditions for re-introduction are no longer suitable at the original location or better elsewhere).
8. Bog-dependent species richness at impact sites relative to control sites has remained 5.3% lower than the baseline mean (i.e. at the 'amber' trigger level) for three consecutive years, meaning that efforts to re-introduce Silver Astelia to impact sites must be increased in IY6 e.g. by planting a greater number of Silver Astelia plants than in IY5.
9. As more Silver Astelia plants become available, ARV should consider planting them into Bog 6 and Bog 12, given that the species has been previously recorded at these impact sites.
10. ARV should increase weed control effort within impact sites in IY6 compared with IY5, in anticipation of the 'amber' trigger level being met in IY6 for the third consecutive year.
11. ARV should increase weed control effort in vegetation surrounding impact sites and within the Project Construction Footprint of the water storage, as this will reduce weed propagule loads within the impact sites themselves.
12. As part of its implementation of the ERP, ARV should improve monitoring of weed covers within the Project Construction Footprint to better inform weed control efforts in this area.
13. ARV should investigate potential causes for an increase in the proportion of dead Peat Moss at impact sites if it is again observed in IY6.

Hydrological Recommendations

The recommendations of the hydrological monitoring report are as follows:

1. Investigate TDS and turbidity outliers in surface water:
    a. Areas of weed removal and track grading should be inspected to determine if sediment controls need to be adjusted or added to avoid runoff.
    b. If inspection indicates no or limited sediment runoff, additional sources of TDS could be investigated including the sewage pipeline that traverses the base of the Summit Nature Walk.
    c. Turbidity in the Environmental Watering System (EWS) outlet should be investigated as to its source and whether it is entering the distribution pipeline (as turbidity may be settling in the EWS collection pit).
2. An interim surface flow analysis should be conducted in December 2024 or January 2025 following the collection of six months of flow data from the EWS. As the EWS flows have not yet been characterised, an interim factual letter report or memo is recommended as a proactive measure to address the need to understand the EWS output prior to the next annual Hydrological Report, including enabling an ability to adjust the monitoring infrastructure if required.

3. Groundwater levels should continue to be monitored in accordance with the current HEMAMP program methodology.
4. The HEMAMP Protocol contains adaptive management triggers for underwatering of the Alpine Bogs. It is recommended that either the HEMAMP or a separate monitoring program also considers the prospect of overwatering which may be occurring from the EWS or from changes to the subsurface within the dam footprint. Implications of overwatering may include:
    a. The encroachment of the Alpine Sphagnum Bogs on other vegetation communities (as has been indicated by the ecological monitoring); or,
    b. Potential influences or impact to geotechnical hazards, including slope stability and dam safety.
5. ARV should consider opportunities to utilise the HEMAMP hydrological monitoring to inform ongoing water supply assessments and decisions, including to capture data to assist with water security and demand assessments.
6. BH07 and BH10 should be manually bailed in the next monitoring round to reduce sediment load.

Mount Buller Water Storage Project

Hydrological and Ecological Monitoring and Adaptive Management Program

Impact Year 5 Monitoring

FINAL REPORT

Prepared for Alpine Resorts Victoria

29 August 2024

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Document control

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Biosis staff involved in this project were:

- Michael Goddard, Jane Kenny, Nick Lloyd and Hayley Sime (fieldwork, data analysis and/or reporting)
- Sally Mitchell (mapping)
- Jane Kenny (quality assurance)

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Summary

Background

From October 2019 to May 2020, the Mount Buller and Mount Stirling Alpine Resort Management Board (now Alpine Resorts Victoria or ARV) constructed a 100-megalitre off-stream water storage and ancillary infrastructure (the project) on Mount Buller, within a 10.347-hectare Project Construction Footprint (PCF) between the summit and the Mount Buller Village. As part of the project, ARV is implementing an ongoing Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP), with an objective of maintaining the extent and condition of Alpine Bogs that are downslope of the water storage.

Two years of baseline ecological monitoring data (Baseline Years 1 and 2 or BY1 and BY2) were collected as part of the HEMAMP in 2018 and 2019. This was followed by ecological monitoring during construction in 2020 (Impact Year 1 or IY1) and post-construction ecological monitoring in 2021, 2022, 2023 and 2024 (Impact Years 2, 3, 4 and 5 or IY2, IY3, IY4 and IY5). This report summarises the results of ecological monitoring from Impact Year 5, compares the results with baseline data and provides an assessment of these results against the HEMAMP's performance criteria and ecological triggers for adaptive management.

The HEMAMP's performance criteria are as follows:

- The 'extent' criterion – there will be no more than a 10% reduction in the total combined area of the impact sites, determined by on-ground or remote (aerial) monitoring and taking into account natural variation based on extent observations averaged across control sites.
- The 'composition' criterion – there will be no more than a 10% reduction in the total 'bog-dependent' native flora species richness of the impact sites, taking into account natural variation based on species richness observations averaged across control sites.
- The 'encroachment' criteria:
  - Atypical species – there will be no more than a 10% increase in the cover of 'non-bog-dependent' species within the impact sites, taking into account natural variation based on observations averaged across control sites.
  - Weeds – the total cover of weeds (naturalised exotic flora species) within the impact sites will not exceed 5%.
- The 'structure' criterion – there will be no more than a 10% reduction in the average cover of Peat Moss *Sphagnum* spp. within the impact sites, taking into account natural variation based on Peat Moss cover averaged across control sites.

The HEMAMP's ecological triggers for adaptive management are directly related to the above performance criteria.

Results

Bog extent

Comparison	Threshold	IY5 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	-10.0%	-5.5%	Yes	Yes	True relative reduction in area of impact sites is likely to be closer to 0% because various factors are likely to have disproportionately benefitted Mount Stirling control sites. Continued sediment/weed control and revegetation needed at impact sites, particularly Bogs 6 and 11.2.
Mount Buller Impact Sites v Mount Buller Control Sites	-10.0%	+0.7%	Yes	Yes	

Bog composition

Comparison	Threshold	IY5 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	-10.0%	-5.3%	Yes	Yes	Silver Astelia was incidentally observed at impact sites again in IY5, but not along transects or in quadrats. Propagation of Silver Astelia commenced in 2023 (10 pups and approx. 120 seeds) and eight plants were ready for planting in autumn 2024. The plants were planted into areas of dieback along the margins of Bog 4.2, near previous records (but not along monitoring transects).
Mount Buller Impact Sites v Mount Buller Control Sites	-10.0%	-5.3%	Yes	Yes	

Encroachment by atypical species

Comparison	Threshold	IY5 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	+10.0%	+6.7%	Yes	No	The cover of non-bog-dependent flora species has increased by 6.7% at impact sites relative to control sites. However, the absolute cover of non-bog-dependent flora has declined to below baseline levels. No intervention required. Continue monitoring in IY6.
Mount Buller Impact Sites v Mount Buller Control Sites	+10.0%	+1.5%	Yes	No	

Encroachment by weeds

Parameter	Threshold	IY5 Result *	Compliant?	Action Req'd?	Comments
Cover of weeds inside and outside of Alpine Bog impact sites (across entire transects)	5%	7.9%	No	Yes	Weed cover along entire transects (inside and outside of Alpine Bogs) was 7.9% in IY5 and has been greater than 5% since monitoring started. Weed cover within impact sites (inside Alpine Bogs only) was 3.6% in IY5 and therefore compliant. However, weed control is still needed, especially in Bog 6.
Cover of weeds across inside Alpine Bog impact sites only	5%	3.6%	Yes	Yes	

*Note: The result for cover of weeds is expressed as an absolute percentage cover. All other results are expressed as a relative change from the Baseline Mean (BM) to Impact Year 5 (IY5).

Bog structure

Comparison	Threshold	IY5 Result	Compliant?	Action Req'd?	Comments
Mount Buller Impact Sites v All Control Sites	-10.0%	+9.9%	Yes	No	Peat Moss cover has increased by 9.9% at impact sites relative to control sites. Overall, Peat Moss cover and health is good, although there was a slight increase in the proportion of Peat Moss recorded as dead in IY5. No intervention required. Continue monitoring in IY6.
Mount Buller Impact Sites v Mount Buller Control Sites	-10.0%	+39.2%	Yes	No	

Conclusion and recommendations

The following observations and conclusions were made from Impact Year 5 ecological monitoring:

- ARV undertook the following management actions in IY5 to implement recommendations of previous monitoring reports, the Ecological Rehabilitation Plan Addendum and associated management plans:
  - Installation and maintenance of more than 500 metres of sediment socks and 20 metres of sediment fence.
  - 216 hours of weed control at Mount Buller, 44 hours of weed control at Mount Stirling and removal of over 1.25 tonnes of weed material.
  - Culling of 51 Sambar Deer from the Mount Buller and Mount Stirling resorts.
  - Planting of 875 tubestock in the Alpine Bogs.
  - Planting of eight Silver Astelia plants in and around Bog 4.2.
- Benefits of the above management actions and those undertaken in previous years are reflected in monitoring results and are expected to continue to materialise in future monitoring years.
- However, the bog extent and bog composition performance criteria have been within the 'amber' trigger level for at least three consecutive years, meaning that management actions to address these

performance criteria will need to be scaled up in IY6. This is reflected in the recommendations of this report.

The recommendations of this monitoring report are as follows:

1. Despite positive trends since IY3, the relative decline in extent of impact sites has remained greater than 5% (i.e. at the 'amber' trigger level) for three consecutive years, meaning that management actions and effort at impact sites must be increased in IY6. In particular, weed control and/or revegetation effort should be increased at Bogs 6 and 11.2.
2. Now that artificial watering of Mount Buller's eastern control sites has ceased, ecological monitoring should be alert to a potential decline in the area of these sites and adapt analysis of results accordingly. Analysis of results from Borehole 18 (BH18) may assist.
3. While the area of dieback of non-bog-dependent flora bordering Alpine Bogs at Mount Buller appears to be stabilising, dieback locations must continue to be re-visited in future years to track vegetation recovery or succession and to plan any necessary management interventions e.g. weed control and revegetation.
4. Additional survey effort should be undertaken in IY6 to identify and map any new Alpine Bog vegetation within the Boggy Creek catchment (upslope of Bog 13) and to re-visit Alpine Bogs that were newly identified and mapped in BY2 (so-called 'other sites').
5. ARV must continue to implement the Ecological Rehabilitation Plan (ERP; Biosis 2020a) and its Addendum (Biosis 2022a) to continue to prevent movement of sediment from the PCF into Alpine Bogs.
6. Where possible, ARV should make greater use of jute mat and sediment socks to minimise re-mobilisation of sediment immediately after physical weed removal within and around Alpine Bogs, as was done in IY3 and IY4.
7. The eight Silver Astelia plants that were planted in or near Bog 4.2 in IY5 should be re-visited again in IY6 to monitor their survivorship and to plan follow-up management actions, such as weed control or herbivore management. If any of the eight Silver Astelia plants have died, they should be replaced either at the same location (if conditions for re-introduction are still suitable at this location) or at a new location (if conditions for re-introduction are no longer suitable at the original location or better elsewhere).
8. Bog-dependent species richness at impact sites relative to control sites has remained 5.3% lower than the baseline mean (i.e. at the 'amber' trigger level) for three consecutive years, meaning that efforts to re-introduce Silver Astelia to impact sites must be increased in IY6 e.g. by planting a greater number of Silver Astelia plants than in IY5.
9. As more Silver Astelia plants become available, ARV should consider planting them into Bog 6 and Bog 12, given that the species has been previously recorded at these impact sites.
10. ARV should increase weed control effort within impact sites in IY6 compared with IY5, in anticipation of the 'amber' trigger level being met in IY6 for the third consecutive year.
11. ARV should increase weed control effort in vegetation surrounding impact sites and within the Project Construction Footprint of the water storage, as this will reduce weed propagule loads within the impact sites themselves.
12. As part of its implementation of the ERP, ARV should improve monitoring of weed covers within the Project Construction Footprint to better inform weed control efforts in this area.
13. ARV should investigate potential causes for an increase in the proportion of dead Peat Moss at impact sites if it is again observed in IY6.

1. Introduction

1.1 Project background

Alpine Bogs are groundwater dependent ecosystems with a scattered distribution in alpine, sub-alpine and montane environments across the Australian Alps (DEWHA 2009; FFG Act Scientific Advisory Committee 2013). They are generally characterised by the presence of Peat Moss *Sphagnum* spp. and are particularly susceptible to climate change, given that they have a fragmented distribution and are already at their environmental tolerance limit (DEWHA 2009; Macdonald 2009). Approximately 3 hectares of Alpine Bog are known to exist at Mount Buller.

Alpine Bogs are listed as threatened ecological communities under Commonwealth and State legislation. The Alpine Sphagnum Bogs and Associated Fens (ASBAF) ecological community is listed as endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Alpine Bog Community is listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act). Throughout this document, the term 'Alpine Bogs' refers to both ASBAF and the Alpine Bog Community.

In October 2019, the Mount Buller and Mount Stirling Alpine Resort Management Board (the RMB, now Alpine Resorts Victoria or ARV and hereafter referred to as such) started construction of a 100-megalitre off-stream water storage and ancillary infrastructure (the project) on Mount Buller between the summit and the Mount Buller Village. Construction of the project finished in May 2020, although there is ongoing rehabilitation of the Project Construction Footprint (PCF) and areas of unauthorised disturbance outside the PCF. ARV continues to implement agreed compliance tasks to manage the impacts of the unauthorised disturbance outside the PCF, in consultation with and under supervision of the Victorian Government Department of Energy, Environment and Climate Action (DEECA), Victorian Government Department of Transport and Planning (DTP) and the Australian Government Department of Climate Change, Environment, Energy and Water (DCCEEW). Note that until 2023, the responsibilities of DEECA and DTP came under the former Victorian Government Department of Environment, Land, Water and Planning (DELWP).

Most of the known Alpine Bog community at Mount Buller is located downslope of the PCF and the project has the potential to affect the hydrology of these Alpine Bogs (Biosis and GHD 2016). In accordance with approvals for the project (EPBC Act Approval 2014/7303 and Planning Permit PA1600138), ARV is implementing a Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP), with the objective of maintaining the extent and condition of Alpine Bogs that are downslope of the proposed water storage (Biosis 2019). Those Alpine Bogs with catchment areas affected by the water storage are known as impact sites and are monitored annually as part of the HEMAMP. The annual monitoring also includes control sites, which are Alpine Bogs with catchment areas that are unaffected by the water storage.

The HEMAMP aims to meet the following performance criteria:

- The 'extent' criterion – there will be no more than a 10% reduction in the total combined area of the impact sites, determined by on-ground or remote (aerial) monitoring and taking into account natural variation based on extent observations averaged across control sites.
- The 'composition' criterion – there will be no more than a 10% reduction in the total 'bog-dependent' native flora species richness of the impact sites, taking into account natural variation based on species richness observations averaged across control sites.

- The 'encroachment' criteria:
    - Atypical species – there will be no more than a 10% increase in the cover of 'non-bog-dependent' species within the impact sites, taking into account natural variation based on observations averaged across control sites.
    - Weeds – the total cover of weeds (naturalised exotic flora species) within the impact sites will not exceed 5%.
- The 'structure' criterion – there will be no more than a 10% reduction in the average cover of Peat Moss within the impact sites, taking into account natural variation based on Peat Moss cover averaged across control sites.

1.2 Scope of this report

The HEMAMP is a monitoring and management regime for selected Alpine Bogs on Mount Buller and Mount Stirling (Figure 1). The methods for this monitoring and management regime are outlined in the HEMAMP Protocol (Biosis 2022b). The Protocol is regularly updated and improved in consultation with DEECA and DCCEEW.

Between 2014 and 2018, ARV, assisted by Biosis Pty Ltd (Biosis) and GHD Pty Ltd (GHD), established climatological and hydrological monitoring infrastructure and commenced collecting climate, groundwater and surface water observations as part of the HEMAMP. In January and February 2018, ARV commissioned Biosis to establish the HEMAMP's ecological monitoring components and collect the first year of baseline ecological monitoring data. In total, two years of baseline (pre-construction) monitoring were undertaken (Baseline Years 1 and 2 or BY1 and BY2), one year of monitoring was completed during construction (Impact Year 1 or IY1) and four years of post-construction monitoring have been completed (Impact Years 2, 3, 4 and 5 or IY2, IY3, IY4 and IY5).

This monitoring report:

- Provides a summary of the ecological monitoring data collected in IY5.
- Compares ecological data collected in IY5 with the baseline data collected over BY1 and BY2.
- Provides an assessment of these results against the HEMAMP's performance criteria and ecological triggers for adaptive management.
- Recommends appropriate management actions.

Throughout this report, recommendations are highlighted in text boxes as shown below.

Recommendations
All recommendations arising from IY5 monitoring are highlighted in this fashion throughout this monitoring report.

2. Methods

Monitoring methods followed the HEMAMP Protocol (Biosis 2022b), except where explicitly noted. Mount Buller and Mount Stirling monitoring sites are shown on Figure 2 and Figure 3 respectively.

2.1 Monitoring effort, frequency and timing

HEMAMP monitoring years run from the start of June (winter) to the end of May (autumn) each year. The ecological monitoring components of the HEMAMP were established in January and February 2018 (BY1). Since 2018, Biosis has conducted ecological monitoring, with assistance from ARV, at six impact sites and seven control sites (Table 1). Each year, transect monitoring has been undertaken from late January until mid-February, while mapping has been undertaken from late January until mid-March (Table 2). The timing and completeness of the ecological datasets are further outlines in Appendix 1.

Slight differences in timing of ecological monitoring (particularly the monitoring end date) are generally associated with weather conditions and the need to maintain consistency in the quality of the data (e.g. mapping under clear skies to maximise spatial accuracy). Slight differences in the timing of ecological monitoring from year to year are unlikely to affect an assessment against the performance criteria or ecological triggers for adaptive management.

Table 1 Annual ecological monitoring effort as part of the HEMAMP

Monitoring effort	Impact sites	Control sites (Mt Buller:Mt Stirling)	Total
Number of sites* (Alpine Bogs)	6	7 (4 : 3)	13
Number of transects	24	23 (14 : 9)	47
Average length of transect (m)	18.5	21.6 (22.3 : 20.4)	20
Number of point intersections (20-cm intervals)	2196	2457 (1546 : 911)	4653
Number of quadrats	87	101 (64 : 37)	188
Number of photo points	48	46 (28 : 18)	94

*Note: The data presented in this table relate to the sites at which line and belt transects have been established. Additional sites are mapped but not subject to monitoring with line and belt transects.

Table 2 Timing of ecological monitoring

Monitoring year	Transect monitoring period	Mapping period
Baseline Year 1	26 Jan 2018 to 9 Feb 2018	26 Jan 2018 to 9 Feb 2018
Baseline Year 2	29 Jan 2019 to 14 Feb 2019	29 Jan 2019 to 23 Feb 2019
Impact Year 1	28 Jan 2020 to 20 Feb 2020	30 Jan 2020 to 14 Mar 2020
Impact Year 2	25 Jan 2021 to 4 Feb 2021	2 Feb 2021 to 26 Feb 2021
Impact Year 3	31 Jan 2022 to 9 Feb 2022	2 Feb 2022 to 22 Feb 2022
Impact Year 4	23 Jan 2023 to 2 Feb 2023	20 Feb 2023 to 28 Feb 2023
Impact Year 5	29 Jan 2024 to 8 Feb 2024	30 Jan 2024 to 26 Feb 2024

2.2 Monitoring parameters and data collection

The HEMAMP Protocol (Biosis 2022b) requires that the following ecological parameters are monitored annually:

- Bog extent
- Bog composition
- Encroachment by weeds and other atypical species
- Bog structure.

These parameters allow for the current extent and condition of the Alpine Bogs to be directly assessed against the performance criteria and triggers for adaptive management. Data relating to these ecological parameters are collected using established line transects, belt transects, photo points and on-ground mapping techniques. These data collection methods are outlined in detail in the Standard Operating Procedure (SOP) for ecological monitoring, which is appended to the HEMAMP Protocol (Biosis 2022b).

2.2.1 Bog extent

Bog extent refers to the area of the Alpine Bogs, which is calculated by mapping the boundary of each Alpine Bog on foot using a Differential Global Positioning System (DGPS). Until IY3, boundaries were mapped using a Samsung Galaxy Tab A6, which was paired with a Trimble R1 Global Navigation Satellite System (GNSS) receiver to provide DGPS functionality. From IY3 onwards, boundaries have been mapped using newer DGPS technology, consisting of a tablet or mobile phone paired with an Emlid Reach RS2 or RS+ GNSS receiver.

Ongoing improvements to DGPS technology have allowed for more accurate mapping since monitoring was first undertaken. In BY1 and BY2, mapping was to an accuracy of 3 metres or better in most instances, but accuracy was reduced to up to 5 metres in some areas with an overhanging tree canopy, particularly at Mount Stirling. In IY1 and IY2, improvements to DGPS technology (e.g. satellite availability and satellite-delivered correction services) allowed for sub-2-metre accuracy in most instances (especially at Mount Buller sites) and generally no worse than 3-metre accuracy (e.g. at Mount Stirling sites with overhanging tree canopies). In IY3, IY4 and IY5, use of the Emlid Reach RS2 and RS+ GNSS receivers allowed for access to a greater number of satellites and sub-metre accuracy at all locations. DGPS accuracy was generally at 1 centimetre, but up to 20 centimetres below tree canopies at Mount Buller and up to 70 centimetres below tree canopies at Mount Stirling.

In addition to mapping the boundaries of Alpine Bogs, further analysis of bog extent is undertaken using data collected from the permanent monitoring transects. The dimensions of the Alpine Bogs are estimated by determining the start and end of Alpine Bog vegetation along the transects. The edge of the Alpine Bog vegetation is taken to be the point at which bog-dependent flora species richness is equal to non-bog-dependent flora species richness (similar to the on-ground boundary mapping, which records the boundary of the Alpine Bog at the point where bog-dependent flora transition from at least 50% of vegetative cover to less than 50% of vegetative cover). In addition, the transects allow for the cover and cause of bare ground to be analysed, which informs management actions (e.g. revegetation or pest animal control) that may be required to maintain bog extent.

2.2.2 Bog composition

Bog composition refers to the species richness of bog-dependent flora, which is determined using line transects (point intersection sampling) and belt transects (quadrat sampling) in accordance with the SOP for ecological monitoring (Biosis 2022b). The list of bog-dependent species is provided in Appendix 2 of this report and in the HEMAMP Protocol (Biosis 2022b).

The IY2 monitoring report documented the difficulty in distinguishing between Mountain Baeckea *Baeckea utilis s.s.* and Subalpine Baeckea *Baeckea latifolia*, which are two bog-dependent species that co-occur at Mount Buller and Mount Stirling and that are suspected of hybridising or forming intermediates (Biosis 2021). For this reason and following a recommendation of the IY2 monitoring report, the HEMAMP Protocol was updated in 2022 so that the list of bog-dependent flora species aggregated these two species into one taxon, known as Mountain Baeckea *Baeckea utilis s.l.* (Biosis 2022b). While efforts were still made in the field to distinguish the two species, their records are aggregated for the purposes of assessing bog composition. IY5 is the first year in which this species aggregation has been included in analysis of bog composition.

In addition to bog-dependent species richness, line transects also provide an estimate of the cover of bog-dependent flora. This analysis provides an indication of underlying trends in bog composition and allows for pre-emptive management actions to be taken, if needed.

2.2.3 Encroachment by weeds and other atypical species

Encroachment is assessed by estimating the cover of weeds and other atypical species, using line transects (point intersection sampling) in accordance with the SOP for ecological monitoring (Biosis 2022b).

It is important to note that weed cover is assessed as an absolute cover. This is unlike all other ecological monitoring parameters, which are assessed at impact sites relative to control sites. Since BY1, weed cover is assessed across the entire length of the monitoring transects, not only within the Alpine Bogs themselves. The permanent monitoring transects were set up to pass through the Alpine Bogs, starting and ending 1.5-4 metres outside of the Alpine Bog boundary (when first established in BY1). This means that some weed cover may be attributable to areas immediately outside the Alpine Bogs. In IY5, further analysis was undertaken to estimate weed covers within Alpine Bogs only, given that this is strictly what the performance criteria require and where weed control effort has been concentrated. This further analysis only considers weeds that are encountered at or between the baseline mean start and end points of Alpine Bog vegetation along each transect. The baseline mean start and end points are estimated using the same method used to estimate the dimensions of the Alpine Bogs.

In an effort to scale up weed management, ARV and Biosis conducted some weed control concurrently with monitoring in IY3, IY4 and IY5. Where we encountered isolated occurrences of a weed species, these isolated plants were removed by hand and placed in plastic bags for solarisation and disposal, immediately after recording any required monitoring data (e.g. point intersection or quadrat results). Where relevant, these plants will have contributed to weed cover results in IY3, IY4 and IY5 but will not contribute to results in future years, assuming the immediate weed control actions have been effective. As always, a concerted effort was made to identify and map any novel weed species in the Alpine Bogs, whether encountered during mapping or transect monitoring.

2.2.4 Bog structure

Bog structure refers to the total cover of Peat Moss, whether dead or alive. The proportion of Peat Moss recorded as dead is also analysed to provide an indication of underlying trends in bog structure and pre-empt management actions that may be required (e.g. to avert the future loss of Peat Moss). The cover of Peat Moss, both alive and dead, is estimated using line transects (point intersection sampling) in accordance with the SOP for ecological monitoring (Biosis 2022b).

2.2.5 Other data collection considerations

In accordance with the SOP for ecological monitoring (Biosis 2022b), standardised photos were taken from the permanent photo points at the start and end of transects. These photos provide a visual documentation of gross vegetation changes, when compared with the same photos from previous monitoring years.

In addition, on-ground mapping provided an opportunity to inspect the full extent of the Alpine Bogs and to note any management issues that may not have been detected by transect monitoring (e.g. sedimentation, weed invasion or deer activity). Mapping data and notes from previous years were made available in the field for comparison, so that the cause of any changes could be investigated on the ground and past observations re-visited.

2.3 Data management

The following ecological datasets are being maintained for monitoring consistency and repeatability in future years:

- Herbarium of plant samples.
- An electronic data collection spreadsheet for transect monitoring.
- A spreadsheet of all observations from all transect monitoring conducted to date.
- Spatial dataset of Alpine Bog boundaries from each year, photo point locations and transect locations.
- Database of all photo points taken to date.
- A collection of on-ground observations (e.g. potential management issues) made while walking the Alpine Bog boundaries.

As required by the HEMAMP Protocol (Biosis 2022b), the electronic datasets are stored on ARV's servers and on a third-party cloud-based backup.

2.4 Data analysis

The ecological monitoring program follows a 'Beyond BACI' (Before-After-Control-Impact) design and data analysis has been set up accordingly (Underwood 1992 and 1994). Linear Mixed-effects Models (LMMs) and Analysis of Variance (ANOVA) were used to test the statistical significance of the effect of the period (before/after) and treatment (control/impact) on a given response variable (e.g. area of Alpine Bogs or cover of weeds).

LMMs were fitted using the 'lme4' package in the R statistical and graphical environment (R Development Core Team 2023) using the Restricted Maximum Likelihood (REML) method. The models were in the following form:

*Response ~ Period * Site Class + (1|Year) + (1|Sample)*

The various components of the models are explained as follows:

- Response:
  - The response variable is the ecological monitoring parameter of interest, such as the area of Alpine Bogs or cover of weeds, non-bog-dependent flora, bog-dependent flora or Peat Moss.
  - We are interested in detecting whether or not there has been a statistically significant change in the response variable at impact sites relative to control sites in the period after the impact commenced.
- Period and Site Class:
  - Period refers to the time before (i.e. BY1 and BY2) or after (i.e. IY1 and IY2) the potential impact commenced (i.e. before or after construction of the water storage started).
  - Site Class refers to the 'treatment' that the Alpine Bogs have received. The Alpine Bogs belong to one of two Site Classes – control sites or impact sites.
  - Period and Site Class are the fixed effects in the model. They are the BACI effect that we are monitoring.
  - Where relevant, a third fixed effect is added to the model to investigate differences between responses at Mount Buller and Mount Stirling. This fixed effect is known as Site, as opposed to Site Class.
- 1|Year and 1|Sample:
  - The model also includes Year (BY1, BY2, IY1 etc.) and Sample (Bog 1, Bog 2, Bog 4.1/5/7 etc.) as random effects (i.e. random temporal and spatial variables).
  - The Sample-to-Sample variation represents localised spatial variability within each Site Class (e.g. the variation between Bog 1 and Bog 2 represents some of the random effect within Control sites).
  - The Year-to-Year variation represents temporal variability that applies to all Samples, regardless of Site Class (i.e. the random temporal effect that applies equally to Control and Impact sites, causing the same fluctuations at both Site Classes from year-to-year).

We are interested in determining whether or not there is a statistically significant interaction between Period and Site Class (sometimes called a BA*CI interaction or BACI contrast). If the coefficient for the BA*CI interaction (i.e. the estimate of the BACI contrast) is statistically significant, it suggests that there is a significant difference in the response of control and impact sites to the impact. In other words, there is a statistically significant difference between the control and impact sites after the impact, compared with the control and impact sites before the impact.

The statistical significance of the BA*CI interaction (BACI contrast) was determined by two-way ANOVA using Type III Sums of Squares and the Kenward-Roger approximation for Degrees of Freedom (DF). Estimated Marginal Means (EMMs) provided an estimate of the BACI contrast and an indication of the variability or Standard Error (SE) in the dataset.

Examining SE is important and requires an ecological understanding of the dataset. If ANOVA suggests that the BA*CI interaction is not statistically significant, this may be because construction of the water storage has genuinely had no detectable effect on impact sites or it may be because the datasets are too variable (SE is too high) for an effect to be detectable.

Statistical tests were undertaken in the R statistical and graphical environment (R Development Core Team 2024) with a 5% statistical significance threshold (α = 0.05). LMMs were fitted and ANOVA conducted using the ‘lmerTest’ package, while EMMs were computed and analysed using the ‘emmeans’ package.

3. Results

Where results have reached the HEMAMP Protocol's 'amber' or 'red' thresholds for adaptive management actions (Biosis 2022b), the results are presented here in greater detail by contrasting Mount Buller control sites and Mount Stirling control sites. This allows for more detailed investigation of potential causes and is consistent with the recommendations of previous monitoring reports (e.g. Biosis 2022c) and independent peer reviews (e.g. SE Botanical 2023).

3.1 Bog extent

3.1.1 Area of Alpine Bogs

Alpine Bog areas were mapped using DGPS. The results of this mapping are summarised in Chart 1 and depicted in Figure 4 (raw results for each Alpine Bog are available in Appendix 5). The total combined area of all Alpine Bogs at impact sites was 1.3824 hectares in IY5, which is greater than the baseline mean of 1.3666 hectares (an increase of 0.0158 hectares or 1.2%). The total combined area of all Alpine Bogs at control sites was 2.2193 hectares in IY5, which is greater than the baseline mean of 2.0812 hectares (an increase of 0.1381 hectares or 6.6%, almost entirely at Mount Stirling control sites). The relative change in the area of impact sites in IY5 was therefore a decrease of 5.5%, although this change was not statistically significant (BACI contrast = 0.0150; SE = 0.0076; F-statistic = 3.8551; numerator DF = 1; denominator DF = 71; P = 0.0535).

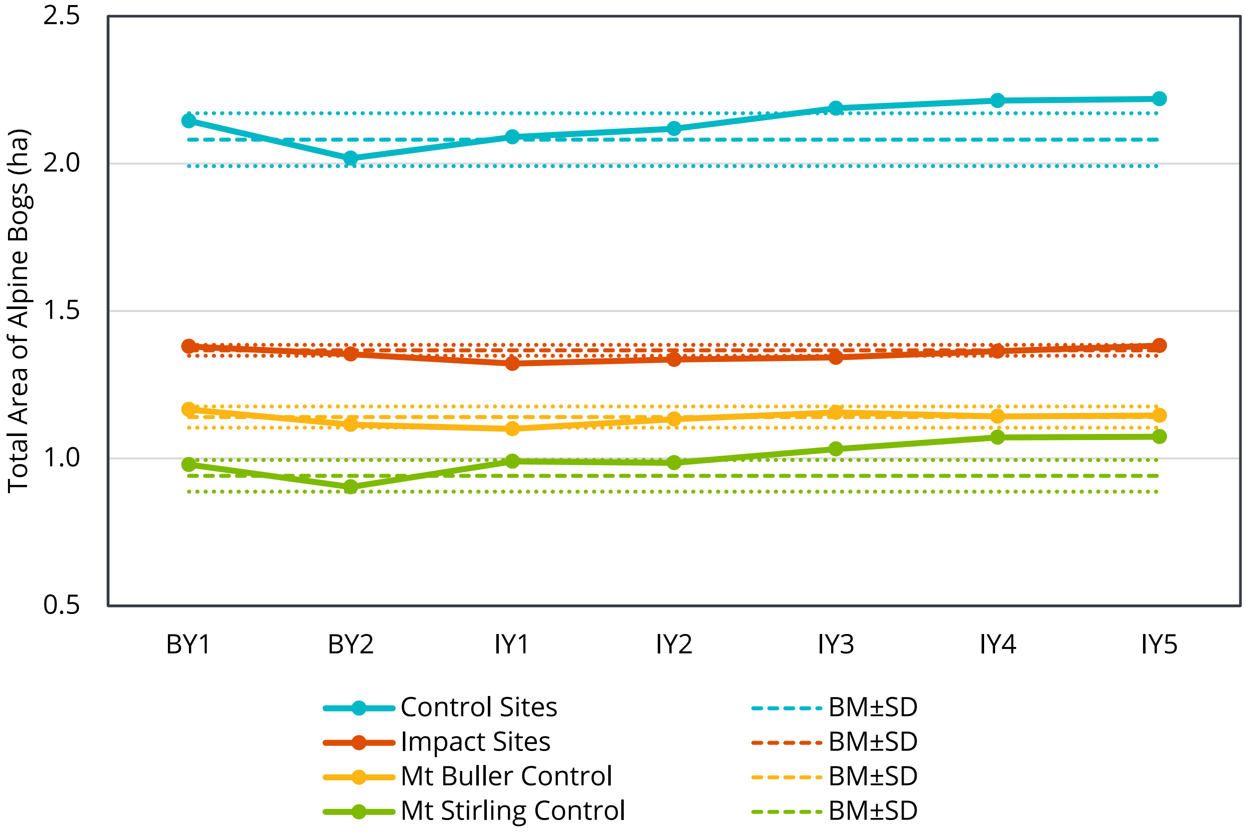

Chart 1 **Total area (hectares) of Alpine Bogs over time relative to the baseline mean ± one standard deviation (BM±SD)**

3.1.2 Dimensions of Alpine Bogs

The dimensions of each Alpine Bog were estimated using line transects and the Diagnostic Key to Alpine Bogs (Appendix 3). The results of these estimates are presented in Chart 2 (raw results for each Alpine Bog are available in Appendix 5). The sum of dimensions at impact sites was 350.8 metres in IY5, which is less than the baseline mean of 354.7 metres (a decrease of 3.9 metres or 1.1%). The sum of dimensions at control sites was 434.8 metres in IY5, which is less than the baseline mean of 438.8 metres (a decrease of 4.0 metres or 0.9%). The relative change in the dimensions of the impact sites was therefore a decrease of 0.2%, although this change was not statistically significant (BACI contrast = 0.547; SE = 0.6290; F-statistic = 0.7566; numerator DF = 1; denominator DF = 71; P = 0.3873).

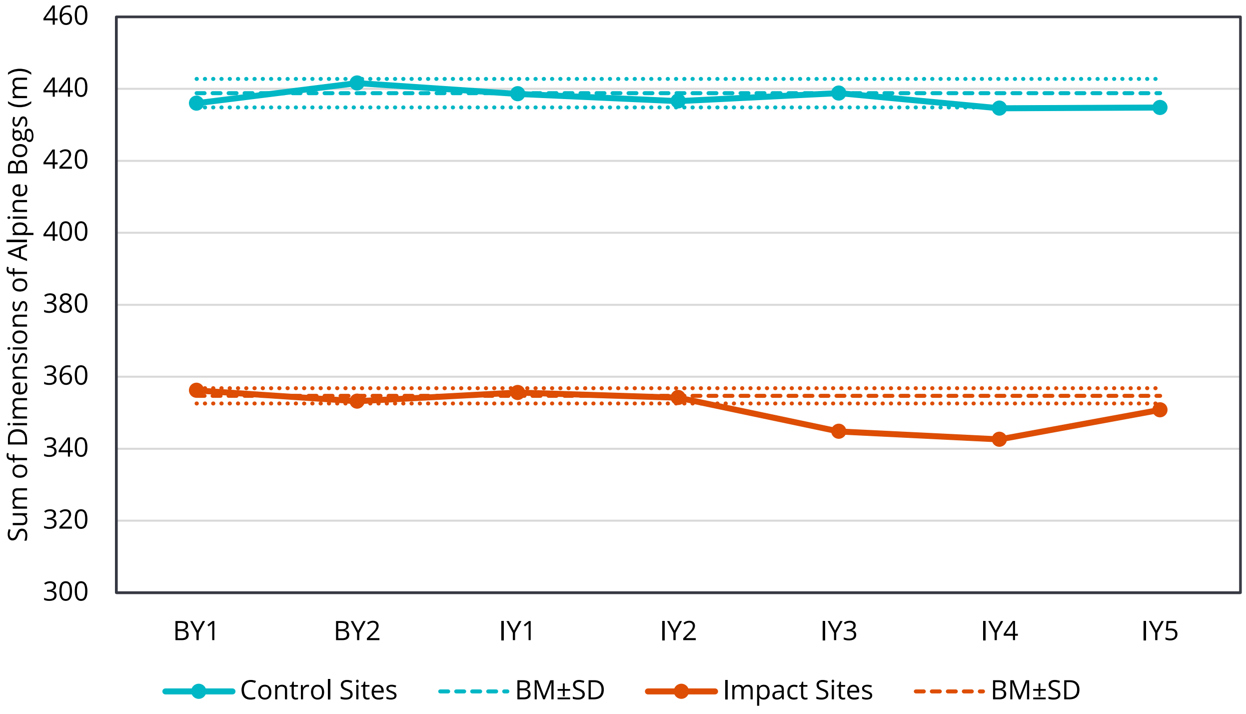

Chart 2 **Sum of dimensions (metres) of Alpine Bogs over time relative to the baseline mean ± one standard deviation (BM±SD)**

3.1.3 Bare ground

Line transects (point intersections) were also used to estimate the cover of bare ground. These estimates are displayed in Chart 3 (raw results for each Alpine Bog are available in Appendix 5). The cover of bare ground increased at impact and control sites from IY4 to IY5 and was greater than baseline levels but less than levels recorded in IY1, IY2 and IY3. In IY5, the cover of bare ground was 1.6% at impact sites and 2.6% at control sites, compared with baseline mean covers of 1.0% and 0.5% respectively. The changes in bare ground at impact sites relative to control sites have not been statistically significant (BACI contrast = 0.0100; SE = 0.0122; F-statistic = 0.6657; numerator DF = 1; denominator DF = 71; P = 0.4173).

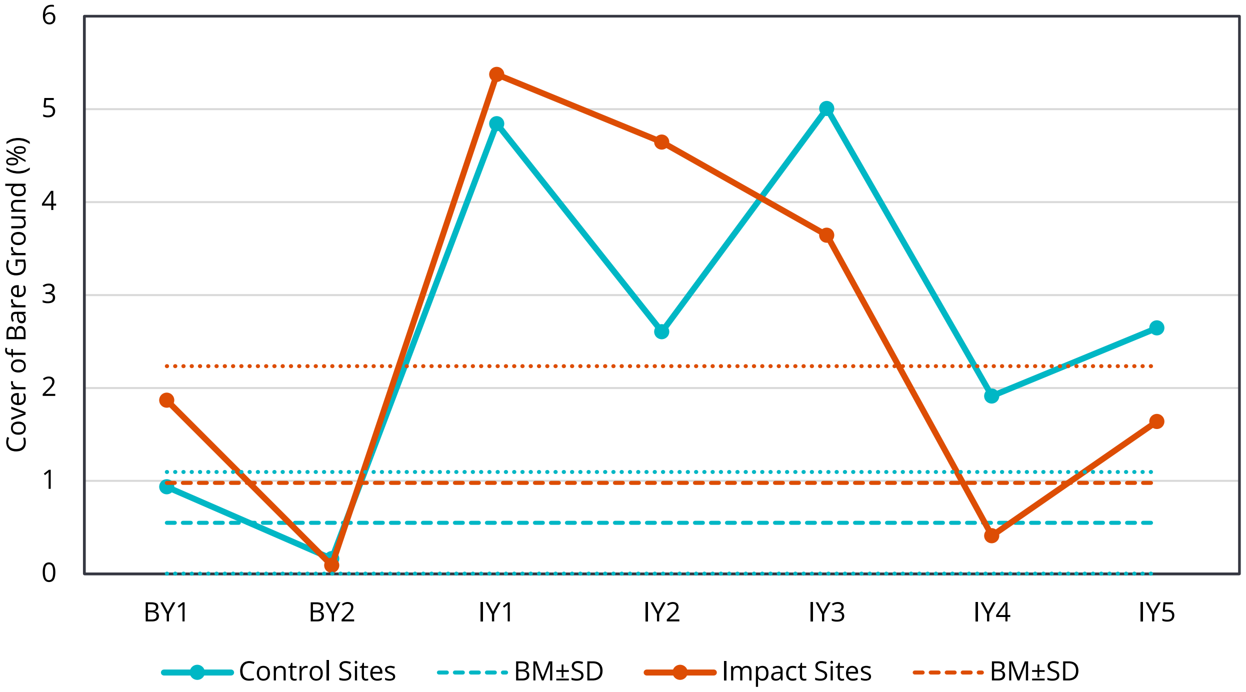

Chart 3 **Percentage cover of total bare ground at Alpine Bogs over time relative to the baseline mean ± one standard deviation (BM±SD)**

The main causes of bare ground differed at impact sites compared with control sites, as shown in Chart 4 (note that the cause or type of bare ground was not recorded prior to IY2). At impact sites in IY5, 55.6% of bare ground was attributed to sedimentation, 5.6% was attributed to deer activity and the remainder was considered natural. This contrasts with IY4, when all bare ground was considered natural. The absolute cover of natural bare ground was 0.4% in IY4 and 0.6% in IY5, meaning that the increased cover of bare ground at impact sites in IY5 was mostly due to sedimentation. At control sites in IY5, 24.6% of bare ground was attributed to deer activity (entirely at Mount Stirling) and the remainder was considered natural. While the absolute cover of bare ground at control sites increased from IY4 to IY5, the absolute cover of bare ground attributable to deer decreased from 0.9% to 0.7%.

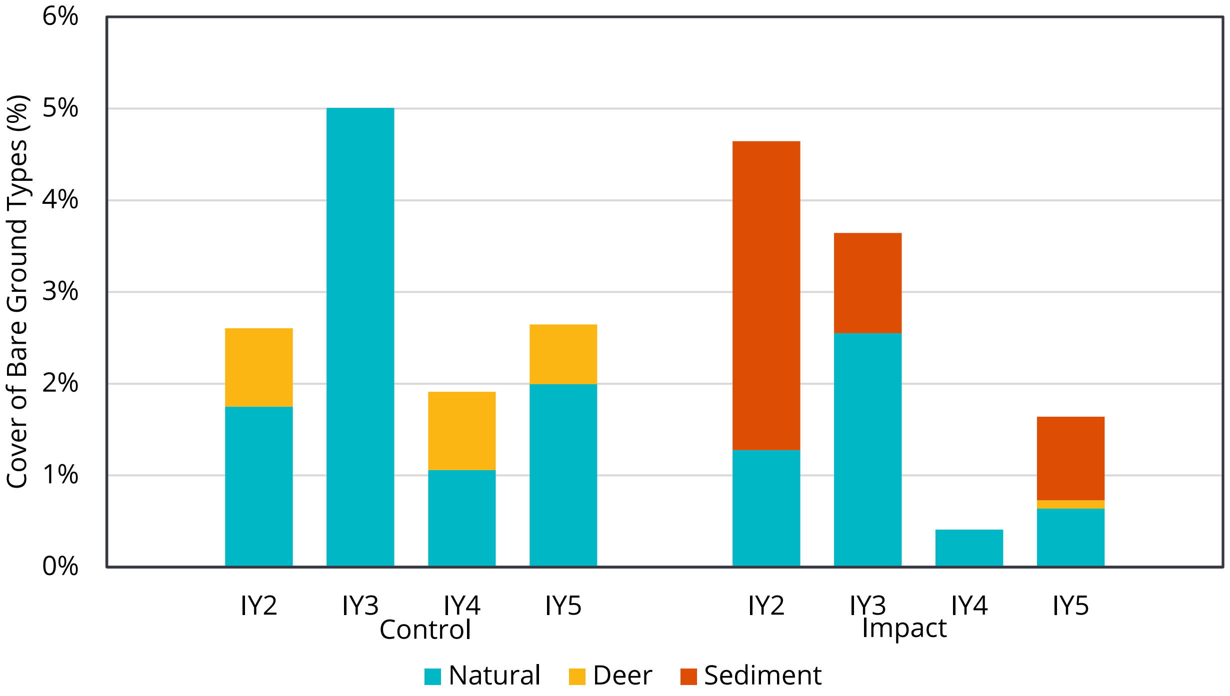

Chart 4 **Percentage cover of bare ground types recorded at control and impact sites**

3.2 Bog composition

3.2.1 Species richness

Using line transects (point intersections) and belt transects (quadrats), a total of 11 distinct bog-dependent flora species have been recorded at impact and control sites since monitoring started (Appendix 2; Appendix 5). In accordance with the HEMAMP Protocol (Biosis 2022b), one of the 11 species is an aggregate of two other species that cannot be reliably distinguished in the field at Mount Buller (Mountain Baeckea *Baeckea utilis s.l.* includes Subalpine Baeckea *Baeckea latifolia* and Mountain Baeckea *Baeckea utilis s.s.*). Baseline monitoring detected 9-10 bog-dependent species across all impact sites and 10 bog-dependent species across all control sites (Chart 5). This means that the baseline mean bog-dependent species richness was 9.5 at impact sites and 10 at control sites. In IY5, 9 bog-dependent flora species were recorded along transects at impact sites (a 5.3% reduction in species richness from the baseline mean) and 10 bog-dependent flora species were recorded along transects at control sites (no change in species richness compared with the baseline mean). The relative decrease in species richness at impact sites compared with control sites in IY5 was therefore 5.3%, although this change was not statistically significant (BACI contrast = 0.1360; SE = 0.3580; F-statistic = 0.1434; numerator DF = 1; denominator DF = 71; P = 0.7061).

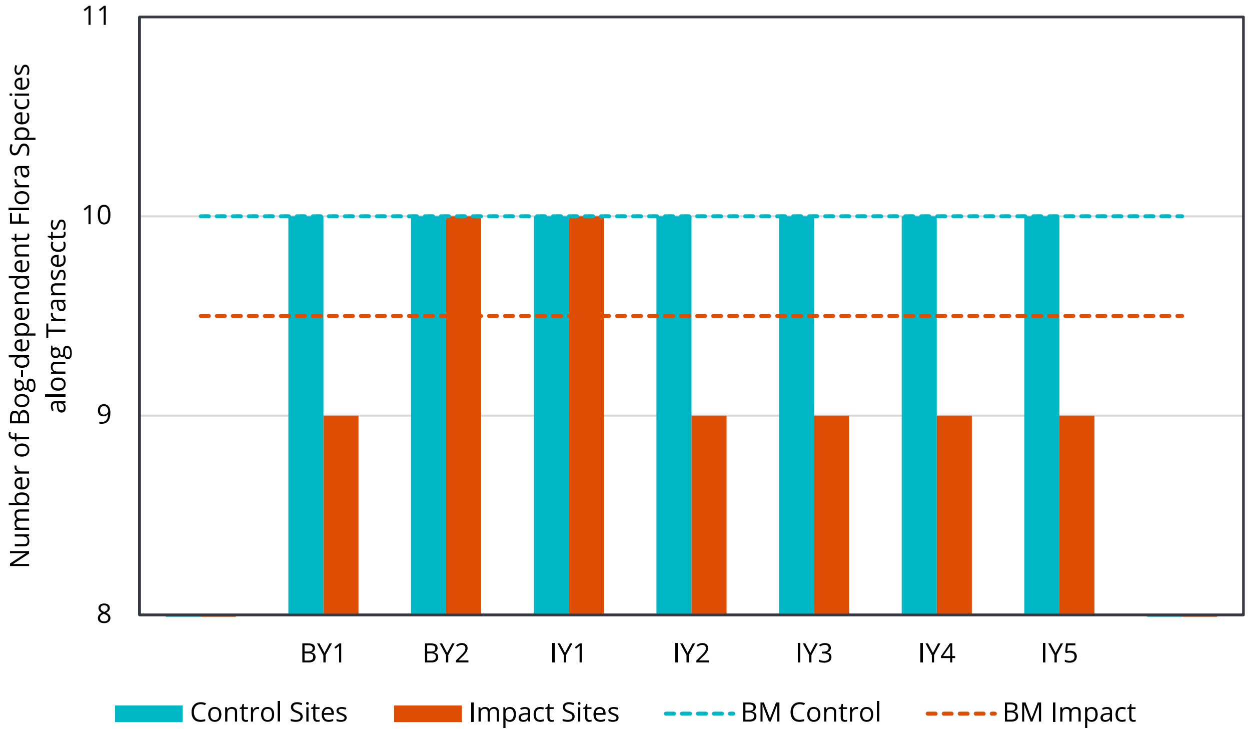

Chart 5 **Bog-dependent flora species richness along transect at control and impact sites relative to the baseline mean**

3.2.2 Cover of bog-dependent flora

Line transects (point intersections) were also used to estimate the cover of bog-dependent flora species. Chart 6 shows these covers (raw results for each Alpine Bog are available in Appendix 5). The cover of bog-dependent flora species has decreased at impact sites from a baseline mean of 78.2% to 77.5% in IY5 (a proportional decrease of 0.9%). The cover of bog-dependent flora species at control sites has decreased from a baseline mean of 87.9% to 87.1% in IY5 (a proportional decrease of 0.9%). The same proportional decrease in cover of bog-dependent species has been observed at impact and control sites, meaning that there has been no change in the relative cover of bog-dependent species at impact sites (relative to control sites) and changes to absolute covers are not statistically significant (BACI contrast = -0.0161; SE = 0.0115; F-statistic = 1.9727; numerator DF = 1; denominator DF = 71; P = 0.1645).

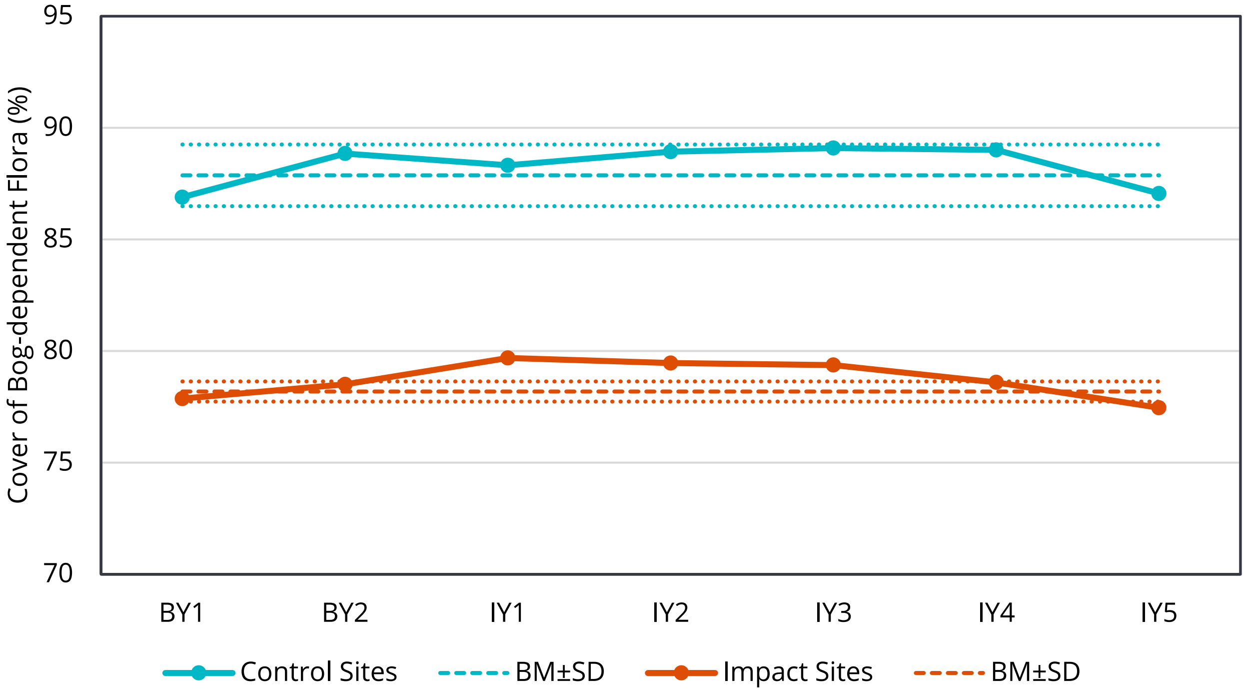

Chart 6 **Percentage cover of bog-dependent flora at Alpine Bogs over time relative to the baseline mean ± one standard deviation (BM±SD)**

3.3 Encroachment by weeds and other atypical species

Line transects (point intersections) were used to estimate the covers of native non-bog-dependent flora species and introduced flora species (weeds) at each Alpine Bog (Appendix 5).

3.3.1 Cover of native non-bog-dependent flora

The cover of native non-bog-dependent flora species is shown in Chart 7. The cover of native non-bog-dependent flora has decreased at impact sites from a baseline mean of 45.2% to 43.1% in IY5 and has decreased at control sites from a baseline mean of 45.1% to 40.0% in IY5. This represents a relative increase of 6.7% in the cover of native non-bog-dependent flora species at impact sites relative to control sites in IY5. However, the relative increase in cover of native non-bog-dependent flora at impact sites relative to control sites since construction of the water storage is not statistically significant (BACI contrast = -0.0263; SE = 0.0141; F-statistic = 3.5099; numerator DF = 1; denominator DF = 71; P = 0.0651).

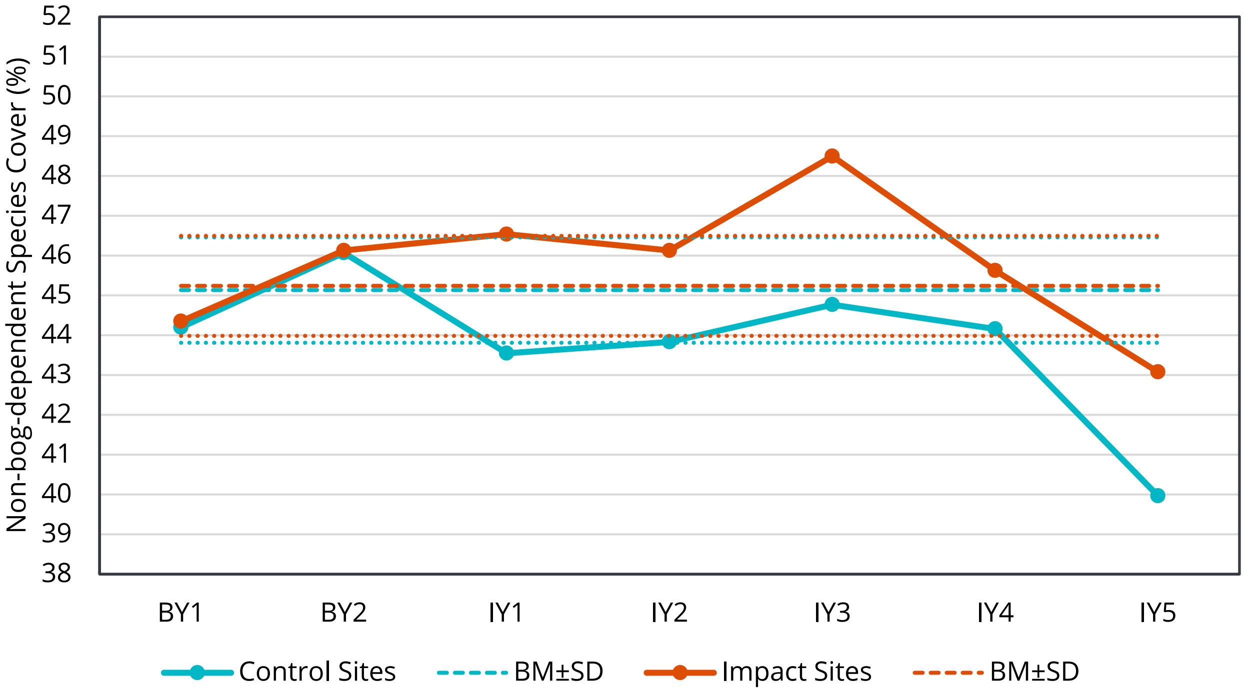

Chart 7 **Percentage cover of native non-bog-dependent flora at Alpine Bogs over time relative to the baseline mean ± one standard deviation (BM±SD)**

3.3.2 Cover of weeds

Weed covers across entire transects (inside and outside of Alpine Bogs) are shown in Chart 8. Weed covers have increased along transects at impact sites from a baseline mean of 5.9% to 7.9% in IY5 and increased along transects at control sites from a baseline mean of 4.3% to 5.2% in IY5. The increase in weed covers along transects at impact sites since baseline monitoring is statistically significant (BACI contrast = -0.0170; SE = 0.0085; F-statistic = 4.0272; numerator DF = 1; denominator DF = 71; P = 0.0486).

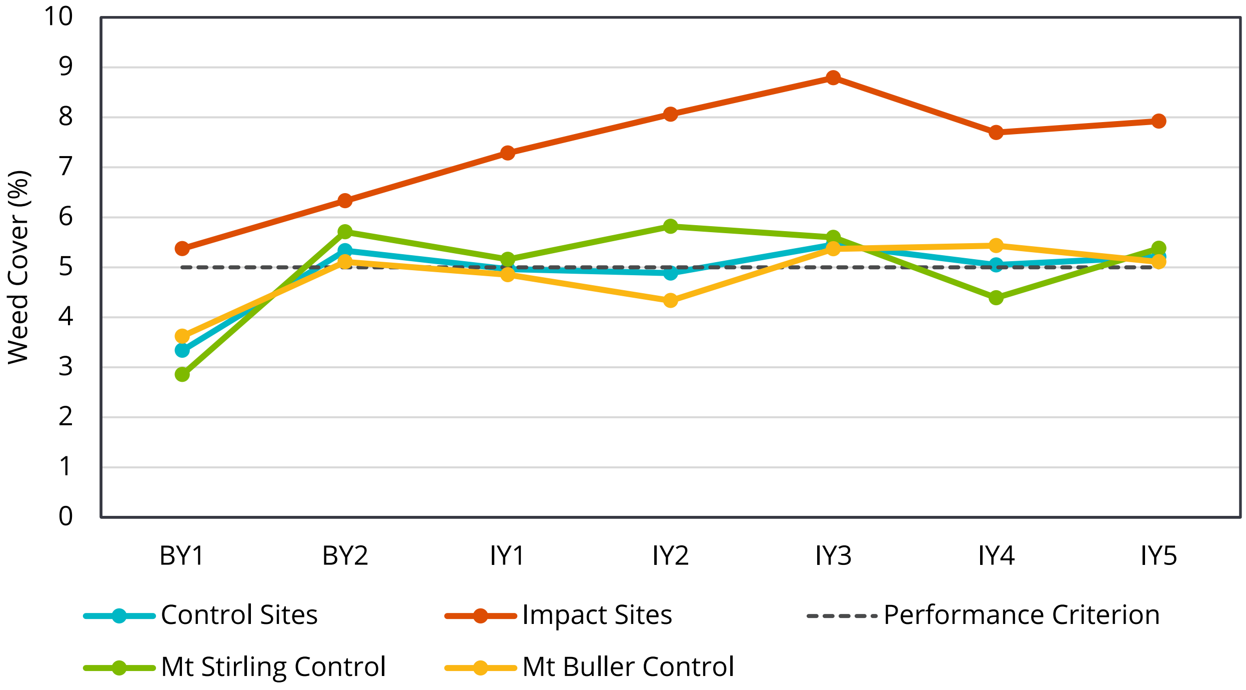

Chart 8 **Percentage weed cover across entire transects inside and outside of Alpine Bogs over time relative to the 5% performance criterion**

Weed covers within Alpine Bogs only (i.e. only along those parts of transects that are within the baseline mean dimensions of the Alpine Bogs) are shown in Chart 9. The baseline mean weed cover within impact sites and control sites was 2.2%. Weed covers within impact sites increased from the baseline mean of 2.2% to 5.1% in IY3, but have since returned to below the 5% performance criterion threshold and were 3.6% in IY5. In contrast, weed covers within control sites have remained below the 5% performance criterion threshold since monitoring commenced and were 3.5% in IY5. The change in weed covers within impact sites since baseline monitoring is not statistically significant (BACI contrast = -0.0086; SE = 0.0101; F-statistic = 0.7186; numerator DF = 1; denominator DF = 71; P = 0.3994).

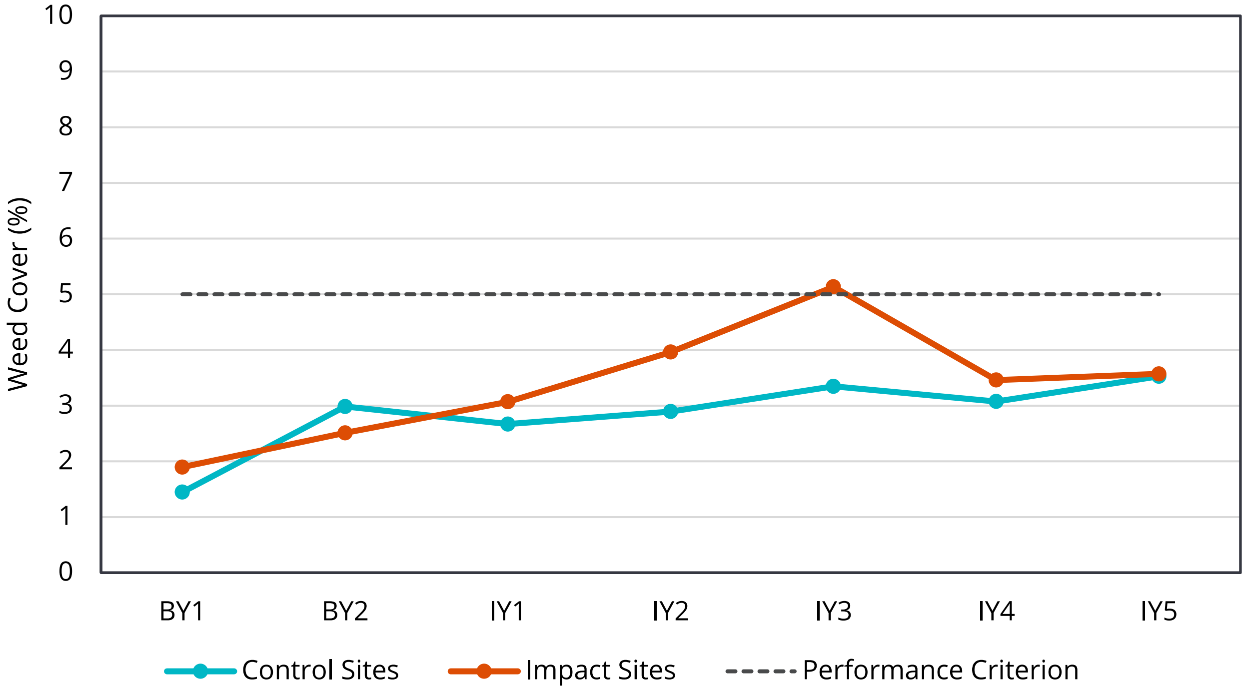

Chart 9 **Percentage weed cover within Alpine Bogs over time relative to the 5% performance criterion**

3.4 Bog structure

3.4.1 Cover of Peat Moss

Line transects (point intersections) were used to estimate the cover of Peat Moss *Sphagnum* spp. at impact sites and control sites. These estimates are displayed in Chart 10 (raw results for each Alpine Bog are available in Appendix 5). At impact sites, the cover of Peat Moss has increased from a baseline mean cover of 5.4% to a cover of 5.8% in IY5, which represents a 7.6% proportional increase. At control sites, the cover of Peat Moss has decreased from a baseline mean cover of 16.4% to a cover of 16.0% in IY5, which represents a 2.2% proportional decrease. In real terms, this means that Peat Moss cover has increased by 9.9% at impact sites relative to control sites. However, the relative increase in Peat Moss cover at impact sites compared with control sites is not statistically significant (BACI contrast = -0.0107; SE = 0.0085; F-statistic = 1.5826; numerator DF = 1; denominator DF = 71; P = 0.2125).

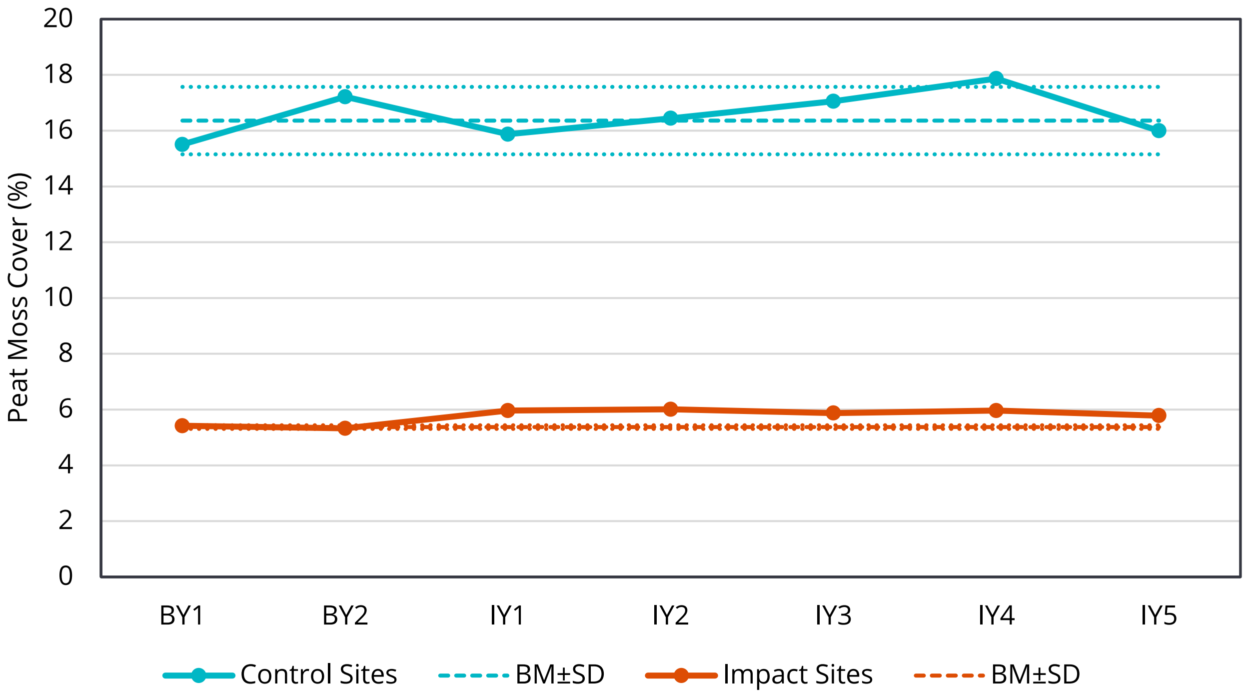

Chart 10 Percentage cover of Peat Moss at Alpine Bogs over time relative to the baseline mean ± one standard deviation (BM±SD)

3.4.2 Dead Peat Moss

The proportion of dead Peat Moss at impact sites and control sites is shown in Chart 11. The baseline mean proportion of dead Peat Moss at impact sites was 0.8%. A substantial (albeit statistically insignificant) increase in dead Peat Moss toa proportion of 8.4% was observed at impact sites in IY1. Such an increase in dead Peat Moss has not been observed since. The proportion of dead Peat Moss returned to baseline levels (or lower) in IY2, IY3 and IY4. At impact sites in IY5, the proportion of dead Peat Moss was 3.1% and therefore again elevated above baseline levels. However, changes in the proportion of dead Peat Moss at impact sites compared with control sites before and after construction have not been statistically significant (BACI contrast = 0.0001; SE = 0.0069; F-statistic = 0.0004; numerator DF = 1; denominator DF = 71; P = 0.9845).

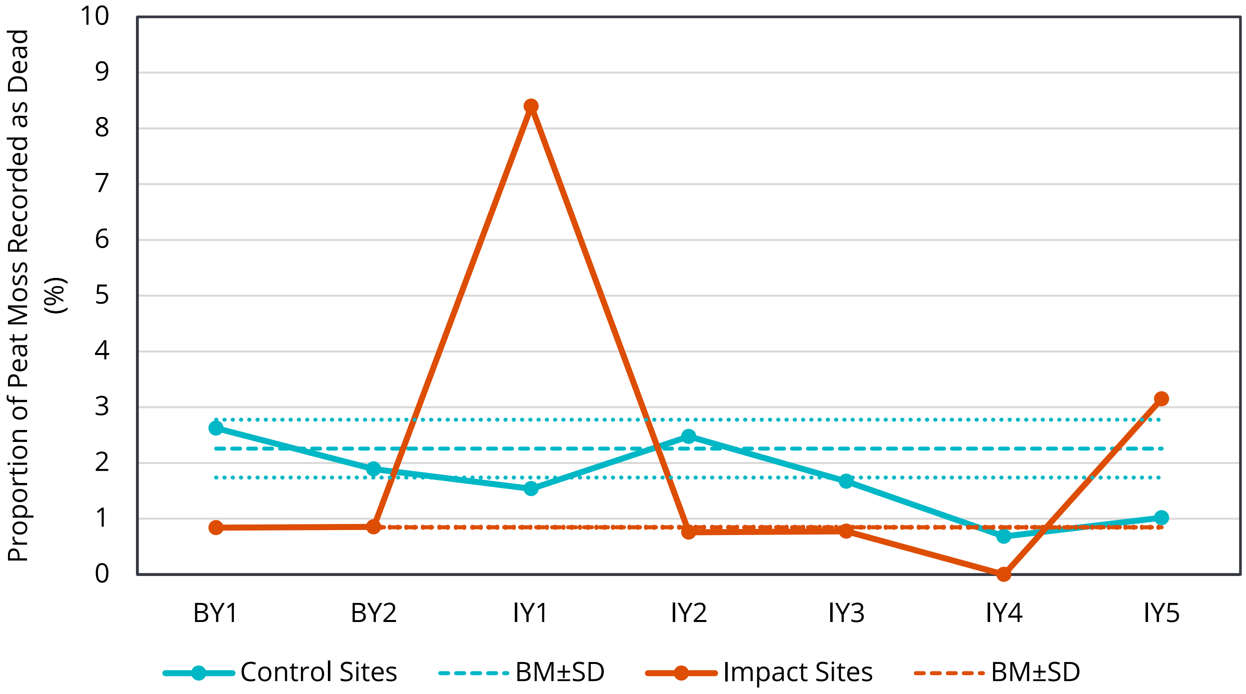

Chart 11 Proportion of Peat Moss recorded as dead relative to the baseline mean ± one standard deviation (BM±SD)

3.5 Summary of ecological monitoring results

Table 3 summarises the results of the HEMAMP IY5 monitoring in terms of the four performance criteria.

Table 3 Summary of ecological monitoring results in Impact Year 5

Parameter	Site	Baseline Mean (BM) ±Standard Deviation	IY5	Change (BM to IY5)	% Change (BM to IY5)
Extent					
Area (ha)	Impact sites	1.3667 ±0.0185	1.3824	+0.0158	+1.2%
	Control sites	2.0812 ±0.0897	2.2193	+0.1381	+6.6%
Sum of dimensions (m)	Impact sites	354.7 ±2.1	350.8	-3.9	-1.1%
	Control sites	438.8 ±4.0	434.8	-4.0	-0.9%
Composition					
Bog-dependent species richness	Impact sites	9.5 ±0.7	9	-0.5	-5.3%
	Control sites	10.0 ±0.0	10	0.0	0.0%
Cover of bog-dependent flora (%)	Impact sites	78.2 ±0.4	77.5	-0.7	-0.9%
	Control sites	87.9 ±1.3	87.1	-0.8	-0.9%
Encroachment					
Cover of non-bog-dependent native flora (%)	Impact sites	45.2 ±1.2	43.1	-2.1	-4.6%
	Control sites	45.1 ±1.3	40.0	-5.1	-11.3%
Cover of weeds across entire transects (%)	Impact sites	5.9 ±0.6	7.9	+2.0	+35.0%
	Control sites	4.3 ±1.4	5.2	+0.9	+20.0%
Cover of weeds within Alpine Bogs (%)	Impact sites	2.5 ±0.6	3.6	+1.0	+40.7%
	Control sites	2.5 ±1.3	3.5	+1.0	+39.3%
Structure					
Cover of Peat Moss (%)	Impact sites	5.4 ±0.1	5.8	+0.4	+7.6%
	Control sites	16.4 ±1.2	16.0	-0.4	-2.2%

4. Discussion

Construction of the water storage project started in October 2019 (midway through IY1) and finished in May 2020 (at the end of IY1). Monitoring in IY1 and IY2 detected that construction of the water storage and ancillary infrastructure had caused noticeable impacts on several downslope Alpine Bogs at Mount Buller, particularly Bogs 4.2, 6, 11.2 and 12 (all impact sites). Impacts on Alpine Bogs were documented in the IY1 and IY2 monitoring reports (Biosis 2020b and Biosis 2021) and included:

- Movement of sediment, large rocks and boulders into and through Alpine Bogs from the Project Construction Footprint (PCF) located upslope.
- Direct removal of approximately 8 square metres of Bog 4.2 along approximately 16 metres of its south-eastern boundary.
- Proliferation of weeds as a result of the above impacts, but particularly in areas affected by sedimentation.

In response to these impacts, ARV prepared an Addendum to the Ecological Rehabilitation Plan (ERP; Biosis 2022a). The ERP Addendum aims to rehabilitate the Alpine Bogs through sediment control, weed management, pest animal control and revegetation. It was officially endorsed by DELWP and DCCEEW in March 2022. However, with consent from DELWP and DCCEEW (and after consultation with both departments), ARV began early implementation of parts of the ERP Addendum in December 2021 (i.e. midway through IY3).

A range of management actions started in IY3 and were documented in the IY3 monitoring report (Biosis 2022c). Most of these same management actions continued in IY4 and again in IY5 as part of the ERP Addendum and/or associated management plans. In IY5, management actions included the following (A. Kirkwood, ARV, pers. comm., 14 May 2024 and 20 August 2024):

- Sediment control, involving:
  - Installation and maintenance of more than 500 metres of sediment socks.
  - Installation and maintenance of more than 20 metres of sediment fence, followed by disassembly before the declared snow season.
- Weed control, involving:
  - 216 hours of weed control at Mount Buller and 44 hours of weed control at Mount Stirling, with at least 15 personnel from various organisations (ARV, Biosis, Graduate Gardeners and Buller Ski Lifts).
  - Mostly manual weed removal, but with isolated herbicide treatment (e.g. for woody weeds).
  - Removal of over 1.25 tonnes of weed material from Mount Buller and Mount Stirling (Photo 1 and Photo 2).
- Pest animal control, including:
  - Authorised deer control (shooting) from late September 2023 to mid-May 2024, involving the culling of 51 Sambar Deer *Cervus unicolor* (Authority to Control or Destroy Game provided by the Game Management Authority under the *Wildlife Act 1975*; Authority Number GMS/2021/05; expiry 20 September 2024).

- Revegetation, involving:
    - Infill planting of 875 tubestock in April and May 2024, concentrating on areas in which weed control was undertaken. This planting occurred specifically within the Alpine Bogs, in addition to the 15,000 tubestock planted within the PCF as part of the ERP (Biosis 2020a) and 275 tubestock planted along Pole Line 6 as part of the ERP Addendum (Biosis 2022a).
    - Successful propagation and planting of eight Silver Astelia *Astelia alpina* var. *novae-hollandiae* plants on 14 May 2024 in and around Bog 4.2 (an impact site in which the species has been previously recorded).

No evidence of European Rabbit *Oryctolagus cuniculus* activity was observed around revegetation sites during IY5, therefore no rabbit control or deterrence was undertaken.

Some of the positive effects of the above management actions are reflected in IY5 monitoring results and are discussed in the following sub-sections of this report.

4.1 Bog extent

4.1.1 Extent of impact sites relative to all control sites

The performance criterion related to bog extent requires that there be no more than a 10% reduction in the total combined area of impact sites, relative to control sites. Further to this, Condition 2b of EPBC Act Approval 2014/7303 requires that there is no more than a 0.0900-hectare reduction in the total combined area of 'indirectly affected areas of Alpine Bog', relative to baseline monitoring and control sites. The approval defines 'indirectly affected areas of Alpine Bog' as Bogs 4.2, 6, 8, 9, 10, 11.2 and 12 (i.e. all impact sites except Bog 13).

As at IY5, neither of the performance thresholds (10% or 0.0900-hectare reduction) have been reached. There has been a 5.5% reduction in the total combined area of impact sites relative to control sites and the total combined area of 'indirectly affected areas of Alpine Bog' is 0.0152 hectares greater than the baseline mean. While these results represent compliance with conditions of approval for the project, the 5.5% relative decline in area of impact sites meets the 'amber' trigger level threshold for adaptive management, as described in the HEMAMP Protocol (Biosis 2022b). The 'amber' threshold is met when there is more than a 5% reduction but less than or equal to a 10% reduction in the area of impact sites relative to control sites (Biosis 2022b).

The 'amber' threshold for bog extent was first reached in IY3, when a 6.9% relative decline in area of impact sites was recorded (Biosis 2022c). In IY4, the relative decline in area of impact sites had improved to 6.6% (Biosis 2023). These results for bog extent were one of several triggers for implementation of the management actions that are listed above and documented in the IY3 and IY4 monitoring reports (Biosis 2022c; Biosis 2023). Results for bog extent in IY5 (a 5.5% relative decline) suggest that these management actions have started to reverse the decline in bog extent at impact sites.

However, the reduction in area of impact sites relative to control sites is still greater than 5%, meaning that the 'amber' threshold has been triggered for a third consecutive year. The HEMAMP Protocol states that if there is no return to the 'green' trigger level (i.e. a relative reduction in extent of less than or equal to 5%) within three years, 'management actions and effort will need to be increased' (Biosis 2022b p. 62). To date, management actions to reverse the decline in the relative extent of impact sites have focussed on weed control and revegetation, particularly in Bog 6, which is known to have experienced some of the greatest construction-related impacts (e.g. sedimentation, followed by weed invasion). Bog 11.2 has also been the focus of sediment control, weed control and revegetation (Photo 3, Photo 4 and Photo 5). Bogs 6 and 11.2 are currently the only two impact sites that have decreased in area since baseline monitoring. Weed control and revegetation efforts in Bogs 6 and 11.2 will need to increase in IY6.

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Despite positive trends since IY3, the relative decline in extent of impact sites has remained greater than 5% (i.e. at the 'amber' trigger level) for three consecutive years, meaning that management actions and effort at impact sites must be increased in IY6. In particular, weed control and/or revegetation effort should be increased at Bogs 6 and 11.2.

4.1.2 Extent of impact sites relative to Mount Buller control sites

The relative decline in area of impact sites has been driven by an increase in the area of control sites, which has occurred almost entirely at Mount Stirling, in Bogs S2 and S3 (Chart 1; Appendix 5). Mount Stirling control sites were 0.1325 hectares (14.1%) larger in IY5 compared with their baseline mean. In contrast, the area of Mount Buller control sites has remained relatively stable, at only 0.0056 hectares (0.5%) greater in IY5 than the baseline mean. Similarly, the absolute area (as opposed to relative area) of impact sites in IY5 was 0.0158 hectares (1.2%) greater than its baseline mean (Table 4).

Table 4 Change in Alpine Bog area from baseline mean to Impact Year 5

Site	Area (ha)		
	Baseline Mean (BM) ±Standard Deviation	Impact Year 5	Change (BM to IY5)
All impact sites	**1.3666 ±0.0184**	**1.3824**	**+0.0158 (+1.2%)**
All control sites	**2.0812 ±0.0896**	**2.2193**	**+0.1381 (+6.6%)**
Mount Buller control sites	1.1403 ±0.0360	1.1458	+0.0056 (+0.5%)
Mount Stirling control sites	0.9410 ±0.0536	1.0735	+0.1325 (+14.1%)

For reasons outlined in the IY3 and IY4 monitoring reports (Biosis 2022c; Biosis 2023), a comparison of impact sites and Mount Buller control sites is likely to be more appropriate for assessing bog extent than a comparison of impact sites with all control sites (Mount Buller and Mount Stirling). When compared with Mount Buller control sites, there has been a 0.7% relative increase in the extent of impact sites as at IY5. This result would be within the 'green' trigger level threshold for adaptive management (Biosis 2022b) and not necessitate the intensive management interventions that are currently occurring at impact sites. However, adaptive management actions should continue at impact sites for the following reasons:

- While effective rehabilitation actions have limited and started to reverse some of the construction-related impacts, the direct and indirect effects of construction (e.g. sedimentation and increased weed cover) are still evident at impact sites. The ERP Addendum requires that these impacts be rehabilitated (Biosis 2022a).
- Construction-related impacts may continue to materialise at impact sites in the coming years. For example, despite there now being effective control of sediment movement into Alpine Bogs, sediment that is already present continues to move through the Alpine Bogs, providing opportunities for weeds to colonise.
- The ecological integrity of impact sites has been compromised in some areas, making them more vulnerable to future impacts (whether construction-related or not). For example, Bog 6 now exists as

multiple fragments (four patches in IY3, eight patches in IY4 and now 20 patches in IY5), rather than the single patch that was mapped in baseline monitoring years. Fragmentation was initially caused by sedimentation and weed invasion, but there was an increase in the number of patches since IY3 because successful weed control and revegetation had 're-established' some of the original areas of Bog 6. This progress towards full rehabilitation must continue.

4.1.3 Further considerations when assessing bog extent

Artificial watering of control sites

In IY3, it was reported that Mount Buller's eastern control sites (Bogs 1, 2 and 11.1) may have benefitted from artificial watering due to accidental but repeated discharge of 20-30 kilolitres of drinking water per week from Baldy Turret tank, located upslope of these control sites. The eastern control sites increased in area in IY3, while the western control site (Bog 4.1/5/7) decreased in area (Biosis 2022c; Table 5). It is unknown when this regular bulk discharge of water from Baldy Turret tank commenced. A visual analysis of the trends in the hydrograph for Borehole 18 (BH18), which is the closest groundwater monitoring bore to the point of discharge (BH18 is approximately 30 metres downslope), suggests that this discharge may have been occurring since IY1 or possibly even BY, although the trends in the hydrograph are inconclusive (GHD 2024). Ultimately, IY3 was the first year in which the areas of eastern and western control sites diverged, which would suggest that the discharge may have commenced relatively recently e.g. during IY1.

The discharge of water from Baldy Turret tank ceased in November 2021, midway through IY3 and two months before IY3 monitoring was undertaken. No artificial watering of Mount Buller's eastern control sites is known to have occurred between November 2021 and April 2023 and therefore no artificial watering of eastern control sites is known to have occurred between IY3 and IY4 ecological monitoring. The reduction in artificial watering of Mount Buller's eastern control sites coincided with a stabilising of their areas in IY4, with only a 0.0047-hectare increase in area observed (Table 5). Nevertheless, a 0.0180-hectare decline in area was observed at the western control site, meaning that there was still a divergence between eastern and western control sites. The continued divergence of eastern and western control sites may have been due to a lagged response in Alpine Bog vegetation.

Following the IY4 monitoring, a constant but unquantified discharge of water from the high level water treatment plant, adjacent to the tank and also upslope of the eastern control sites, was observed during a site visit on 28 April 2023 (near the end of IY4). It is likely to have commenced at around this time, when modifications were made to chlorine and turbidity sensors within the treatment plant. Until this point, the sensors had been part of a closed loop system, which was pressurised and therefore not optimal for the long-term performance of the sensors. This was changed to an open loop system, with constant discharge of freshly treated water, in April 2023 (S. Whitehead, Goulburn Valley Water, pers. comm., 22 August 2024). The discharge was occurring at a constant rate of approximately 2 litres per minute (20 kilolitres per week) when measured on 17 January, 30 January, 2 February and 9 February 2024 (A. Kirkwood, ARV, pers. comm., 17 January 2024; M. Goddard, Biosis, pers. obs., 30 January, 2 February and 9 February 2024). The constant discharge of water ceased in April 2024, when new pipes were installed to direct the water to the Baldy Turret tank nearby (S. Whitehead, Goulburn Valley Water, pers. comm., 22 August 2024).

Table 5 Change in area of Mount Buller control sites from baseline mean to Impact Year 5

Mount Buller control sites	Area (ha)					
	Baseline Mean (BM)	IY1 (change from BM)	IY2 (change from IY1)	IY3 (change from IY2)	IY4 (change from IY3)	IY5 (change from IY4)
Eastern sites (Bogs 1, 2 and 11.1)	0.5893	0.5521 (-0.0372)	0.5735 (+0.0214)	0.6037 (+0.0302)	0.6084 (+0.0047)	0.6110 (+0.0026)
Western site (Bog 4.1/5/7)	0.5509	0.5480 (-0.0029)	0.5597 (+0.0117)	0.5519 (-0.0078)	0.5340 (-0.0180)	0.5348 (+0.0009)

Despite artificial watering of Mount Buller's eastern control sites occurring again in the 9-10 months leading up to IY5 monitoring, the area of these sites remained relatively stable from IY4 to IY5, with only a 0.0026-hectare increase observed (Table 5). The area of the western control sites also remained relatively stable from IY4 to IY5, with a 0.0009-hectare increase observed (Table 5). Again, this observation may be the result of a lagged response in Alpine Bog vegetation to artificial watering. Ultimately, the result means that the divergence in areas of eastern and western control sites, which was first observed in IY3, still persists. The baseline mean area of eastern and western control sites differed by 0.0384 hectares but differed by 0.0762 hectares in IY5 (Table 5).

As a consequence (and as noted in the IY3 and IY4 monitoring reports), Bog 4.1/5/7 appears to be the most reliable control site for comparison with impact sites. This will potentially continue to be the case for several years, while Bogs 1, 2 and 11.1 continue to stabilise after cessation of artificial watering. Bog 4.1/5/7 was 0.0161 hectares (2.9%) smaller in IY5 compared with its baseline mean. If Bog 4.1/5/7 were used as the control against which impact sites were assessed, the relative change in area of impact sites from their baseline mean would be a 4.1% increase as at IY5.

Impact Year 5 – Recommendation 2

Now that artificial watering of Mount Buller's eastern control sites has ceased, ecological monitoring should be alert to a potential decline in the area of these sites and adapt analysis of results accordingly. Analysis of results from Borehole 18 (BH18) may assist.

Localised hydrological changes and dieback

In IY2, small areas of localised dieback of non-bog-dependent species were observed in areas bordering the Alpine Bogs downslope of the PCF (Biosis 2021). In IY3, it was noted that the extent and distribution of this dieback had expanded, so an effort was made to document the locations and estimate the extents of dieback (Biosis 2022c). Most dieback locations were directly downslope of the Environmental Watering System (EWS) and were characterised by waterlogged soils. The IY3 monitoring report therefore recommended that ARV investigate whether the EWS may be contributing to the dieback (Biosis 2022c).

An investigation of the EWS by endoscope in IY4 suggested that the EWS was likely contributing to localised hydrological changes (waterlogging) and therefore dieback in non-bog-dependent species bordering impact sites downslope of the PCF (Biosis 2023). This conclusion is supported by the following additional inferences and observations:

- No areas of dieback have been observed at or near the Mount Stirling control sites. Of the total dieback area observed at Mount Buller, more than 80% borders impact sites, immediately downslope of the EWS.

- Hydrographs for Boreholes 9 and 17 (BH09 and BH17), which are the closest groundwater monitoring bores to the major dieback locations, have shown a distinct lack of seasonality since the EWS was installed, presumably because they are being regularly recharged by the EWS (GHD 2024). In contrast, hydrographs for Boreholes 6 and 16 (BH06 and BH16), which are two of the furthest from the EWS, show similar seasonal trends before and after construction of the EWS (note that BH18, which is also distant from the EWS, is an unreliable comparison because it may have been influenced by regular artificial watering from the Baldy Turret tank and high level water treatment plant, as outlined above).
- The expanding extent and distribution of dieback, in association with waterlogged soils, was first observed in IY3, after 12 months of below-average rainfall and below-average snow depth at Mount Buller (GHD 2024). This would suggest that it is not unusually high precipitation (e.g. due to a La Niña weather pattern) that is the main source of the waterlogged soils and dieback.
- There was a 136.1% increase in the number of points at which water was recorded along transects within impact sites in IY5, compared with the baseline mean. This increase occurred entirely at Bogs 4.2, 6 and 11.2, which are immediately downslope of the EWS. All other impact sites recorded a decline or no change in cover of water in IY5 compared with the baseline mean. In contrast, Mount Buller control sites and Mount Stirling control sites recorded only a 28.0% and 10.0% increase respectively in the number of points at which water was recorded along transects in IY5, compared with the baseline mean.

Areas of dieback were re-visited and mapped in IY4 and IY5. The results of this mapping are summarised in Table 6 and shown in Figure 5. While there was a substantial increase in the area of dieback in IY4, the increase in area of dieback from IY4 to IY5 was small, suggesting that stabilisation of the vegetation response may be occurring (Table 6; Photo 6 and Photo 7). Many areas of dieback are now being colonised by bog-dependent flora, leading to an expansion in the extent of Alpine Bogs at Mount Buller (mostly impact sites). Some areas of dieback are being colonised by introduced flora, which may necessitate weed control in the near future.

Impact Year 5 – Recommendation 3

While the area of dieback of non-bog-dependent flora bordering Alpine Bogs at Mount Buller appears to be stabilising, dieback locations must continue to be re-visited in future years to track vegetation recovery or succession and to plan any necessary management interventions e.g. weed control and revegetation.

Table 6 Observations of dieback of non-bog-dependent species bordering Alpine Bogs

Location	Area of dieback of non-bog-dependent species (sq. m)		
	IY3 (estimated)	IY4 (change from IY3)	IY5 (change from IY4)
Bordering impact sites	115	222.8 (+107.8)	230.3 (+7.5)
Bordering control sites	29	45.7 (+16.7)	48.2 (+2.5)

Regeneration of Alpine Bog vegetation on ski slopes

As noted in the IY4 monitoring report, there appears to have been recent regeneration of Alpine Bog vegetation on the northern mid-slopes of Mount Buller (Biosis 2023). These areas of regeneration are outside of the Alpine Bogs that are subject to annual monitoring and have therefore not been formally assessed or mapped by DGPS. Some of the regeneration is associated with additional Alpine Bogs that were first identified in BY2 (so-called 'other sites'), while other regeneration is in areas where Alpine Bogs have not previously been identified.

This regeneration of Alpine Bog vegetation merits further investigation. It may point to a 'migration' of Alpine Bog vegetation to new areas because of changed hydrological conditions caused by the new water storage, similar to the expansion of Alpine Bog vegetation into areas of dieback. Alternatively, it may be part of a long-term trend of native vegetation regeneration on the northern ski slopes of Mount Buller, ever since Buller Ski Lifts began implementing a vegetation management plan across the Mount Buller ski field in 2011 (Biosis Research 2011).

The IY4 monitoring report therefore recommended further investigation and mapping of Alpine Bog vegetation on the northern mid-slopes of Mount Buller (Biosis 2023). However, due to resource constraints in IY5, the IY5 Alpine Bog mapping exercise was not expanded to investigate Alpine Bog regeneration outside the HEMAMP's defined monitoring sites.

Impact Year 5 – Recommendation 4

Additional survey effort should be undertaken in IY6 to identify and map any new Alpine Bog vegetation within the Boggy Creek catchment (upslope of Bog 13) and to re-visit Alpine Bogs that were newly identified and mapped in BY2 (so-called 'other sites').

Bare ground and sedimentation

Sedimentation is one of the construction-related impacts that contributed to a post-construction reduction in the extent of impact sites, relative to control sites. The IY4 monitoring report observed that the cover of bare ground attributable to sedimentation at impact sites had decreased from 3.4% in IY2 and 1.1% in IY3 to 0.0% in IY4. It was noted that ARV had effectively contained the movement of sediment from the PCF into impact sites and that sediment already present within impact sites was being colonised by vegetation (Biosis 2023). However, the IY4 monitoring report also warned that 'sedimentation detected by transect monitoring may continue to fluctuate over coming years as some sediment that is already present within the impact sites continues to move downstream through the impact sites' (Biosis 2023 p. 27).

The cover of bare ground attributable to sedimentation increased from 0.0% in IY4 to 0.9% in IY5 (Appendix 5). All bare ground attributed to sedimentation was recorded at impact sites. Similarly, monitoring of surface water quality in Boggy Creek, downslope of impact sites, detected elevated total dissolved solids in IY5, which may be the result of soil or sediment run-off (GHD 2024). Of the sediment that was recorded along transects at impact sites in IY5, 50% was recorded in Bog 6, 40% was recorded in Bog 4.2 and 10% was recorded in Bog 12 (Appendix 5). There are various potential causes for the increased incidence of sedimentation at each of these impact sites in IY5, including the following:

- Within Bog 4.2, sediment was recorded at the start of Transects 4.2B and 4.2C, which are near and immediately downslope of dieback of non-bog-dependent flora (Figure 5). These dieback locations were characterised by waterlogged soils and frequent surface water flows in IY5, mostly emanating from groundwater being expressed 10-20 metres downslope of the EWS and near the southern (upslope) boundary of Bog 4.2 (Photo 7). Surface water flows at these locations appeared to be more frequent during IY5 monitoring than in previous years. In addition, locations of sediment within Bog

4.2 were near locations of deer activity recorded in IY5. Dieback of vegetation, deer activity and increased surface water flows in these areas may have mobilised sediment that was deposited in or adjacent to Alpine Bog vegetation during construction.

- Within Bog 6, 90% of sediment was recorded along Transect 6C, which is at or immediately downslope of areas that were subject to intensive weed control in IY3, IY4 and IY5. As documented in previous monitoring reports, weeds proliferated in these areas because they rapidly colonised the sediment that washed down from the PCF during construction. In accordance with the ERP Addendum, weed control has prioritised physical removal of these weeds over herbicide application (Biosis 2022a; Photo 2). It is likely that this physical removal (uprooting) of weeds has re-mobilised the sediment substrate to some extent. Total dissolved solids were elevated in Boggy Creek surface water samples in the latter half of the IY5 monitoring period, which coincides with when the most intensive weed control effort was undertaken.
- Within Bog 12, all bare ground attributable to sedimentation was at Transect 12C, which is immediately downslope of locations where sedimentation was incidentally observed in IY1 and IY2. These incidental observations were within Bog 12 and within 7 to 45 metres of the transect. In addition, impacts of Sambar Deer (trampling and pugging) were observed 15 metres directly upslope of Transect 12C for the first time in IY5 (Photo 8). This deer activity appears to have re-mobilised or re-exposed sediment that was otherwise being incorporated into the peat substrate.

On-ground observations would suggest that the elevated sediment levels detected along transects in IY5 are the result of sediment that has been re-mobilised within impact sites. There was no evidence that this sediment originated from the PCF in IY5. Through installation and maintenance of sediment socks and fences, in accordance with the ERP (Biosis 2020a) and ERP Addendum (Biosis 2022a), it appears that ARV has again been successful at preventing movement of sediment from the PCF into impact sites.

Impact Year 5 – Recommendation 5

ARV must continue to implement the Ecological Rehabilitation Plan (ERP; Biosis 2020a) and its Addendum (Biosis 2022a) to continue to prevent movement of sediment from the PCF into Alpine Bogs.

Impact Year 5 – Recommendation 6

Where possible, ARV should make greater use of jute mat and sediment socks to minimise re-mobilisation of sediment immediately after physical weed removal within and around Alpine Bogs, as was done in IY3 and IY4.

4.2 Bog composition

The performance criterion relating to the composition of the Alpine Bogs is expressed in terms of bog-dependent species richness (i.e. number of bog-dependent species). It requires that there be no more than a 10% reduction in the total bog-dependent native flora species richness of the impact sites, taking into account natural variation based on species richness observations averaged across control sites. If Mountain Baeckea *Baeckea utilis s.l.* is treated as a single bog-dependent taxon (as opposed to two species), the baseline mean bog-dependent species richness was 9.5 (i.e. an average of nine to ten species) at impact sites and 10 at control sites. In practice, this means that there would need to be a net loss of two bog-dependent species from impact sites relative to control sites for there to be greater than a 10% reduction in bog-dependent species richness at impact sites.

In IY5, nine bog-dependent species were recorded along monitoring transects at impact sites and 10 bog-dependent species were recorded along monitoring transects at control sites. While bog-dependent species richness at control sites in IY5 was equal to the baseline mean, bog-dependent species richness at impact sites in IY5 was 0.5 species (or 5.3%) lower than the baseline mean. This is the same result that has been observed since IY2 (Chart 5). The result is attributable to one bog-dependent species, Silver Astelia *Astelia alpina* var. *novae-hollandiae*, not being detected along monitoring transects at impact sites, despite being detected along monitoring transects during one of the two baseline monitoring years.

As explained in previous monitoring reports, Silver Astelia has had a highly localised distribution at impact sites since monitoring began. Its distribution is so localised that it has not been recorded at control sites and has never been recorded at more than two points along transects in any given year. Silver Astelia was recorded by point intercept monitoring along transects at Bog 4.2 in BY2, quadrat monitoring along transects at Bog 6 in IY1 and as incidental observations outside of transects at Bogs 4.2, 6 or 12 in BY1, IY4 and IY5 (Figure 6). The failure of transect monitoring to detect Silver Astelia since IY1 may be due to natural vegetation succession, seasonal conditions or observer error. Alternatively, localised construction-related impacts, such as sedimentation, may have resulted in the loss of this species from along transects.

It should be noted that Silver Astelia has not been lost from impact sites entirely, despite not being recorded along transects since IY1. The species was incidentally observed near Transect 4.2B in IY4 and IY5. Nevertheless, propagation of Silver Astelia commenced in 2023 with the aim of re-introducing the species to impact sites in the general areas where it has previously been recorded. The aim is to re-establish the species more broadly across these impact sites, rather than to re-introduce the species to the specific transects at which it has been previously recorded.

Approximately 120 seeds and 10 vegetative samples of Silver Astelia were collected from Mount Buller in April 2023 for propagation (Biosis 2023). Eight plants were raised in 20-centimetre pots and were ready for planting in autumn 2024, ahead of schedule. These plants were planted on 14 May 2024 in or near dieback locations D11/14, D12, D13 and D13.1, which border Bog 4.2 and are within 1-35 metres of Transect 4.2B, where Silver Astelia was previously recorded (Figure 5; Figure 6). These are locations where non-bog-dependent species have recently died, probably due to waterlogged soils, and where bog-dependent species are currently colonising, resulting in expansion of the extent of Bog 4.2. These locations were selected because they did not require removal of Alpine Bog vegetation to make way for the new Silver Astelia plants and because the locations appear to be currently transitioning to Alpine Bog vegetation. GPS coordinates of the recipient locations have been recorded, which will enable the locations to be re-visited in future years (A. Kirkwood, ARV, pers. comm., 14 May 2024).

Impact Year 5 – Recommendation 7

The eight Silver Astelia plants that were planted in or near Bog 4.2 in IY5 should be re-visited again in IY6 to monitor their survivorship and to plan follow-up management actions, such as weed control or herbivore management. If any of the eight Silver Astelia plants have died, they should be replaced either at the same location (if conditions for re-introduction are still suitable at this location) or at a new location (if conditions for re-introduction are no longer suitable at the original location or better elsewhere).

Impact Year 5 – Recommendation 8

Bog-dependent species richness at impact sites relative to control sites has remained 5.3% lower than the baseline mean (i.e. at the ‘amber’ trigger level) for three consecutive years, meaning that efforts to re-introduce Silver Astelia to impact sites must be increased in IY6 e.g. by planting a greater number of Silver Astelia plants than in IY5.

Impact Year 5 – Recommendation 9

As more Silver Astelia plants become available, ARV should consider planting them into Bog 6 and Bog 12, given that the species has been previously recorded at these impact sites.

4.3 Encroachment by weeds and other atypical species

4.3.1 Encroachment by weeds

Types of weed cover

In 2013/2014, Mount Buller's Alpine Bogs were recorded as having less than 5% weed cover (Biosis and GHD 2016). This was based on visual estimates undertaken within Alpine Bogs during vegetation quality assessments. As a result, the HEMAMP's encroachment performance criteria require that the total cover of weeds within impact sites does not exceed 5% (Biosis 2022b). Note that the requirement is for weed cover to not exceed 5% within the Alpine Bogs, not within the Alpine Bogs and surrounding vegetation. Note also that this is the only performance criterion that references absolute cover, rather than relative cover (impact sites relative to control sites).

Historically, weed cover has been assessed and reported along the entire lengths of monitoring transects. This is not an accurate assessment against the relevant performance criterion because each permanent monitoring transect was established during BY1 such that it started and ended 1.5-4 metres outside of the Alpine Bog monitoring site. This means that each monitoring transect potentially passes through 3-8 metres of vegetation surrounding the Alpine Bog. Surrounding vegetation generally has a higher weed cover than the Alpine Bog itself and, in some cases, surrounding vegetation may not even be native vegetation. An estimate of weed cover along the entire lengths of monitoring transects is therefore not a true representation of weed cover within impact sites or of the weed control effort that ARV has been undertaking within impact sites.

A better assessment of weed cover against the relevant performance criterion would be along only those parts of the transects that are within the Alpine Bogs. This analysis was undertaken for the first time in IY5. However, the Alpine Bog boundaries are dynamic – they fluctuate from year to year and, in a few cases, have expanded beyond the ends of transects since baseline monitoring. Limiting weed cover estimates to those parts of transects within the current Alpine Bog boundaries would therefore introduce an additional layer of temporal variability and complexity. Instead, analysis of weed covers within Alpine Bogs focussed on the baseline mean start and end points of the Alpine Bogs along the transects. This provides a fixed length of transect over which comparisons can be made from year to year (a fixed baseline). A fixed baseline has its own limitations. For example, this method ignores post-construction expansion of Alpine Bogs (although it does capture contraction of Alpine Bogs, which is of greater concern). It is also preferable to have a buffer of high quality native vegetation surrounding the Alpine Bogs, which the fixed baseline method ignores. Ultimately, however, the fixed baseline approach provides a more accurate assessment against the relevant performance criterion i.e. the requirement that weed cover not exceed 5% within Alpine Bog impact sites.

For consistency with past reporting and to provide a holistic assessment of weed covers, we have continued to report weed cover along entire transects in IY5. However, we have also undertaken more detailed analysis and reported weed covers within Alpine Bogs only, which better assesses the performance of weed control and better informs future management efforts.

Summary of weed covers observed to date

A summary of IY5 results for the two types of weed cover is as follows:

- Weed cover along entire transects inside and outside of Alpine Bog impact sites:
    - Based on IY5 results, the weed cover along entire transects at impact sites appears to be stabilising, but remains significantly higher than the weed cover along entire transects at control sites, when compared with the baseline monitoring period.
    - After increasing each year since monitoring began, weed covers along entire transects at impact sites reached a peak of 8.8% in IY3, before declining to 7.7% in IY4 and 7.9% in IY5 (Chart 8). By comparison, weed covers along entire transects at control sites were 5.0% in IY4 and 5.2% in IY5 (Chart 8).
    - The 0.2% increase in weed cover from IY4 to IY5 at impact sites equates to an additional five point intercepts at which weeds were recorded in IY5, out of the 2196 point intercepts sampled at impact sites each year.
    - If the HEMAMP's performance criterion for weed cover were assessed on the basis of weed cover along entire transects at impact sites, the IY5 results would be non-compliant because weed covers along entire transects at impact sites exceed 5%.
    - However, it should be noted that weed covers along entire transects at impact sites have exceeded 5% since monitoring began i.e. even during baseline monitoring. It should also be noted that weed covers along entire transects at control sites have also exceeded 5% in BY2, IY3, IY4 and IY5.
- Weed cover along parts of transects within baseline mean extent of Alpine Bog impact sites:
    - Based on IY5 results, the weed cover within impact sites appears to be stabilising and there is no significant difference between weed cover within impact sites and within control sites, when compared with the baseline monitoring period.
    - After diverging from control sites in IY1 and IY2, weed cover within impacts reached a peak of 5.1% in IY3, before declining to 3.5% in IY4 and 3.6% in IY5 (Chart 9). By comparison, weed cover within control sites was 3.1% in IY4 and 3.5% in IY5, meaning that impact sites and control sites have re-converged (Chart 9).
    - If the HEMAMP's performance criterion for weed cover were assessed on the basis of weed cover within impact sites (as the wording of the criterion would require), the IY5 results would be compliant because weed cover within impact sites does not exceed 5%.
    - So far, IY3 is the only year in which weed cover within impact sites has exceeded the performance criterion threshold of 5%. While intensive weed management and revegetation action started in IY2, these actions were scaled up in IY3 in response to on-ground observations of weed cover that year, which represented the 'red' trigger level for adaptive management, as per the HEMAMP Protocol (Biosis 2022b).
    - Weed cover within impact sites returned to the 'amber' trigger level in IY4. The 'amber' trigger level corresponds with a weed cover that is greater than 2.5% but less than or equal to 5% (Biosis 2022b).
    - Weed cover within impact sites has now been within the 'amber' trigger level for two consecutive years (IY4 and IY5). In accordance with the HEMAMP Protocol, if weed cover within impact sites does not return to the 'green' trigger level (i.e. less than or equal to 2.5%) in IY6, weed control at impact sites will need to be scaled up (Biosis 2022b).

Interpretation of weed cover results

Weed cover results from IY5 reflect the timing, intensity and location of weed control effort that ARV has invested across impact and control sites since IY2. Weed covers across entire transects have remained higher at impact sites relative to control sites throughout the post-construction period, whereas weed covers within the Alpine Bogs have returned to similar levels at impact sites and control sites after a temporary post-construction increase at impact sites. This is likely to be because ARV's weed control effort since IY2 has largely been concentrated within the Alpine Bogs themselves, rather than extending into the vegetation surrounding the Alpine Bogs. Both types of weed cover declined from IY3 to IY4 but remained relatively stable from IY4 to IY5. This is likely to be because the weed control effort was less in IY5 than in IY3 or IY4 and took place comparatively later in the year (mostly after ecological monitoring had taken place). Results from Bog 6 would reflect this. Despite most weed control effort since IY2 being concentrated within Bog 6, weed covers within this impact site decreased from 14.2% in IY3 to 8.7% in IY4 but increased to 9.9% in IY5 (Appendix 5).

The increased post-construction weed cover in vegetation surrounding impact sites may also be partly due to an increased weed cover upslope within the PCF since construction of the water storage. Monitoring of the ERP implementation and visual analysis of photos taken since baseline monitoring would suggest that weed cover has increased across parts of the PCF in recent years (Creative Lines 2024). This increased weed cover, immediately upslope of many of the impact sites, is likely to be a significant source of weed propagules that may colonise any disturbed ground within and around Alpine Bogs. Monitoring of the ERP implementation within the PCF and HEMAMP monitoring at Alpine Bog impact sites has shown similar trends. For example, within the PCF and at impact sites during IY4 and IY5, there was an observed decline in herbaceous weeds, such as Sheep Sorrel *Acetosella vulgaris*, and an increase in graminoid (grass or grass-like) weeds, such as Sweet Vernal-grass *Anthoxanthum odoratum*.

The current species composition of weeds along transects at impact sites can be summarised as follows:

- Graminoid (grass or grass-like) weeds:
    - The dominant weeds at impact sites are graminoids, which made up 69.4% of total weed cover in IY5. By contrast, during baseline monitoring years, an average of 59.8% of total weed cover at impact sites was made up of graminoid weed species.
    - The three most abundant graminoid weeds at impact sites in IY5 were Brown-top Bent *Agrostis capillaris*, Sweet Vernal-grass and Creeping Fescue *Festuca rubra s.s.*, which collectively made up 56.3% of total weed observations along transects. By contrast, these species were the three most abundant graminoid weeds at impact sites during baseline monitoring years, but accounted for 49.2% of total weed observations on average.
    - Soft Rush *Juncus effusus* subsp. *effusus* is the weed species with greatest increase in abundance since baseline monitoring. It made up 0.5% of total weed observations at impact sites during baseline monitoring, but now makes up 6.7% of total weed observations.
- Herbaceous weeds:
    - After an initial increase in the cover of herbaceous weeds, from a baseline mean cover of 3.1% to 4.3-4.4% in IY1, IY2 and IY3, the cover of herbaceous weeds returned to baseline levels in IY4 and IY5.
    - The cover of Sheep Sorrel has declined at impact sites from an average of 2.0% during baseline monitoring years, when it was the most abundant herbaceous weed, to 0.9% in IY5. In contrast, the cover of Monkey Flower *Erythranthe* spp. has increased at impact sites from a baseline mean of 0.3% to 1.1% in IY5, making it now the most abundant herbaceous weed.

Priority weeds for control within the impact sites are documented in the ERP Addendum (Biosis 2022a). These weed species remain a priority and have not changed on the basis of IY5 monitoring results. However, a greater emphasis may need to be placed on the effective control of graminoid weeds that are on this priority list, especially if graminoid weeds continue to become more dominant.

Impact Year 5 – Recommendation 10

ARV should increase weed control effort within impact sites in IY6 compared with IY5, in anticipation of the 'amber' trigger level being met in IY6 for the third consecutive year.

Impact Year 5 – Recommendation 11

ARV should increase weed control effort in vegetation surrounding impact sites and within the Project Construction Footprint of the water storage, as this will reduce weed propagule loads within the impact sites themselves.

Impact Year 5 – Recommendation 12

As part of its implementation of the ERP, ARV should improve monitoring of weed covers within the Project Construction Footprint to better inform weed control efforts in this area.

4.3.2 Encroachment by native non-bog-dependent species

The performance criterion for atypical species requires that there be no more than a 10% increase in the cover of non-bog-dependent species at impact sites, relative to control sites. A divergence of impact sites from control sites with respect to cover of non-bog-dependent species was detected in IY1 and has persisted since. In BY1, the cover of non-bog-dependent flora was 44.4% at impact sites and 44.2% at control sites. In BY2, the cover of non-bog-dependent flora was 46.1% at impact sites and control sites alike. From IY1 to IY5, the cover of non-bog-dependent flora has been consistently 1.4% to 3.7% higher at impact sites relative to control sites (Chart 7).

In IY5, the cover of non-bog-dependent flora was 3.1% higher at impact sites relative to control sites, which represents a relative increase of 6.7% in the cover of non-bog-dependent flora at impact sites. While this result is a return to the 'amber' trigger level for adaptive management (after having been within the 'green' trigger level in IY4), it is not currently cause for concern because the absolute cover of non-bog-dependent species has declined to below baseline mean levels at impact sites for the first time since construction of the water storage (Chart 7). The cover of non-bog-dependent flora at impact sites in IY5 was 4.6% below the baseline mean. Moreover, there was no reduction in the relative cover of bog-dependent flora at impact sites compared with control sites in IY5 and the reduction in absolute cover of bog-dependent flora at impact sites was small at 0.9%. This means that there is no evidence that the impact sites are currently transitioning to non-bog-dependent native vegetation.

4.4 Bog structure

The structure criterion requires that there be no more than a 10% reduction in the average cover of Peat Moss at impact sites, relative to control sites. The cover of Peat Moss has remained relatively stable at impact and control sites across monitoring years. The baseline mean cover of Peat Moss at impact sites and control sites was 5.4% and 16.4% respectively. In IY5, the cover of Peat Moss at impact sites and control sites was

5.8% and 16.0% respectively. While this represents a 9.9% increase in the cover of Peat Moss at impact sites relative to control sites, it is not statistically significant.

After a peak in the proportion of dead Peat Moss recorded along transects at impact sites in IY1, the proportion of dead Peat Moss at impact sites returned to baseline levels or lower in IY2, IY3 and IY4. At 3.1%, the proportion of dead Peat Moss was again elevated above baseline levels at impact sites in IY5 (Chart 11). All dead Peat Moss at impact sites in IY5 was recorded at Bog 4.2, which reflects past results. Bog 4.2 has historically been the only impact site at which dead Peat Moss has been recorded, apart from in IY1 (i.e. during construction of the water storage), when an increase in the proportion of dead Peat Moss was observed and dead Peat Moss was recorded more widely across impact sites (Appendix 5).

Potential causes for the increase in the proportion of dead Peat Moss observed at Bog 4.2 in IY5 include the following:

- Hydrological changes associated with the EWS, which is immediately upslope of Bog 4.2. Some of these hydrological changes (e.g. waterlogging and increased surface water flows) are documented in Section 4.1.3 of this report.
- Increased deer activity at Bog 4.2. IY5 was the first year in which bare ground attributable to deer activity was recorded at impact sites. One of the two records came from Bog 4.2 (Appendix 5).
- Increased sedimentation within Bog 4.2 in IY5. Bare ground attributable to sedimentation declined from 3.0% in IY2 to 0.0% in IY4, but increased again to 1.5% in IY5. Re-mobilisation of sediment due to weed control and/or deer activity is discussed in Section 4.1.3 of this report.
- Natural vegetation succession. As at IY5, there has been a 7.6% proportional increase in the cover of Peat Moss at impact sites when compared with the baseline mean (Chart 10). The increased proportion of dead Peat Moss at impact sites may simply be a product of the increase in absolute cover of Peat Moss at impact sites since baseline monitoring.
- A combination of the above.

Given that there has been an increase in the relative and absolute cover of Peat Moss at impact sites since baseline monitoring, the greater proportion of dead Peat Moss observed in IY5 is not yet cause for concern.

Impact Year 5 – Recommendation 13

ARV should investigate potential causes for an increase in the proportion of dead Peat Moss at impact sites if it is again observed in IY6.

4.5 Triggers for adaptive management

The HEMAMP Protocol uses a 'traffic light' approach to adaptive management triggers, where the level of management intervention is escalated as the risk of adverse impacts on the ecological values of the impact sites increases, from 'green' to 'amber' to 'red' (Biosis 2022b).

The following ecological trigger levels have been reached:

- 'Green' trigger level, on the basis of the following criterion:
  - Bog structure – There has been a 9.9% increase in Peat Moss cover at impact sites, relative to control sites. No management actions are required to address this result, although HEMAMP monitoring, in-depth analysis and reporting must continue. Peat Moss cover would need to

decline by more than 5% at impact sites relative to control sites for the 'amber' trigger level to apply.

- 'Amber' trigger level, on the basis of the following criteria:
    - Bog extent – There has been a 5.5% decrease in the extent of impact sites, relative to control sites. However, for reasons outlined in the IY3 and IY4 monitoring reports (Biosis 2022c; Biosis 2023), a comparison of impact sites and Mount Buller control sites is likely to be more appropriate for assessing bog extent than a comparison of impact sites with all control sites (Mount Buller and Mount Stirling). When compared with Mount Buller control sites, there has been a 0.7% relative increase in the extent of impact sites as at IY5, which would be within the 'green' trigger level threshold. Regardless, management actions to address other criteria are likely to also reverse any decline in bog extent.
    - Bog composition – There has been a 5.3% decrease in bog-dependent species richness at impact sites, relative to control sites, due to Silver Astelia not being observed along monitoring transects at impact sites in IY5. Propagation of this species commenced in IY4 and the first plants were re-introduced to Bog 4.2 in IY5. It is anticipated that even more plants will be introduced through revegetation at impact sites in IY6.
    - Encroachment by atypical species – There has been an 6.7% increase in the cover of non-bog-dependent species at impact sites, relative to control sites. No intervention is required at this stage to address this result, given that the absolute cover of non-bog-dependent species has actually declined to below baseline mean levels. However, this performance criterion must continue to be monitored and analysed in future years.
    - Encroachment by weeds – Weed cover within impact sites was 3.5% in IY4 and 3.6% in IY5. This represents an improvement from IY3, when weed cover within impact sites was 5.1% and therefore within the 'red' trigger level. However, the slight increase in weed cover from IY4 to IY5 suggests that a greater weed control effort will be needed in IY6 than was invested in IY5 in order to continue the downward trend in weed cover within impact sites.

In accordance with the HEMAMP Protocol (Biosis 2022b), if performance criteria that are within the 'amber' trigger level do not return to the 'green' trigger level within three years, management actions and effort will need to be increased. The bog extent and bog composition performance criteria have been within the 'amber' trigger level for at least three consecutive years, meaning that management actions to address these performance criteria will need to be scaled up in IY6. This is reflected in the recommendations of this report. The performance criterion related to encroachment by weeds has been within the 'amber' trigger level for two consecutive years.

4.6 Key observations and required management actions at each monitoring site

Table 7 summarises the key observations made at each monitoring site in IY5 and recommended management actions.

Table 7 Observations made at monitoring sites in IY5 and management priorities

Bog	Observations in IY5	Priority
Impact sites		
Bog 4.2	This impact site is showing signs of recovery and appears to be expanding into areas of surrounding dieback. However, there was increased sedimentation, deer activity, death of Peat Moss and dieback of surrounding non-bog-dependent flora recorded within or near this site in IY5 compared with IY4. Sediment control, weed control, deer control and revegetation must be scaled up at this location in IY6 compared with IY5.	High priority for sediment control, weed control, deer control and revegetation.
Bog 6	This impact site is showing signs of recovery (e.g. increased bog extent), although there was increased sedimentation and weed cover in IY5 compared with IY4. Sediment control, weed control, deer control and revegetation must be scaled up at this location in IY6 compared with IY5.	High priority for sediment control, weed control, deer control and revegetation.
Bog 8/9/10	The area of this impact site has increased as bog-dependent species have filled the void left by the dieback of non-bog-dependent species, which has occurred at three locations. However, weed cover remains relatively high at this site.	Moderate priority for weed control.
Bog 11.2 and 12	These bogs are immediately upslope (Bog 11.2) and downslope (Bog 12) of each other and have similar management issues. Bog 11.2 is showing signs of recovery from the effects of sedimentation, but increased sedimentation and deer activity were recorded at Bog 12 in IY5 (Photo 8).	High priority for sediment control, weed control and deer control.
Bog 13	Weed cover at this Alpine Bog was elevated in IY5 compared with the baseline mean. This is likely to be due to the very small size of the Alpine Bog, its isolation and location (surrounded by introduce vegetation), rather than any impacts from construction. While there were no noticeable impacts on this impact site from earthworks that occurred directly upslope of this bog in IY4, ARV will need to remain vigilant of potential sedimentation.	Moderate priority for weed control. High priority for sediment control.
Control sites		
Bog 1	This impact site has been subject to artificial watering from Baldy Turret tank and the high level water treatment plant near its south-eastern boundary. Artificial watering apparently ceased in April 2024. The site should be monitored for subsequent drying and consequent incursion of weeds and/or non-bog-dependent species. Soft Rush is present on the northern boundary of this site, along the edge of the Summit Nature Walk. These plants need to be removed or killed. Given the proximity of this location to the walking trail and its sensitivity to erosion, herbicide treatment followed by revegetation may be the most appropriate method. Soft Rush is also present near the southern extent of this site.	Moderate priority for weed control.

Bog	Observations in IY5	Priority
Bog 2	The eastern boundary of Bog 2, near Transect 2A, is subject to severe weed pressures due to historic disturbances to the east of this monitoring site. As a result, IY5 saw the highest weed cover at Bog 2 since monitoring began. Targeted weed control along the eastern boundary will be required.	Moderate priority for weed control.
Bog 4.1/5/7	This Alpine Bog complex has been fragmented by weed proliferation along the aqueduct and north of the aqueduct. The main weeds of concern remain Sword Rush, Musk Monkey-flower and Soft Rush. Further weed control will be needed in IY5, particularly downstream of the aqueduct.	High priority for weed control.
Bog 11.1	The north-western branch of this control site remains fragmented due to deer activity and weed proliferation. Dieback of non-bog-dependent flora has also occurred along the north-western branch (dieback locations D5, D6.1, D6.2 and D7). While the dieback appears to have stabilised, weed species, such as Soft Rush and Monkey Musk, are colonising the void.	Moderate priority for weed and deer control.
Bog S1	The north-western end of this Alpine Bog (near Transect S1A) remains dry, perhaps due to water flow becoming channelised by past deer and horse activity. The impact of deer is still evident and impacts from horses are still present near Stirling Trail. Blocking of the main channel (e.g. with rice straw bales) may flood the dominant weeds and allow for recolonisation by bog-dependent species. Further treatment of weeds such as Musk Monkey-flower will be needed. Near the mid-point of this Alpine Bog, the southern boundary remains dynamic as Mountain Tea-tree continue to regenerate following the 2006-2007 fires. Follow-up treatment of woody weeds, such as Grey Sallow, Apple, Blackberry and Prunus, may be required along the north-western boundary of this site after repeated treatments over the last three years.	Moderate priority for weed control, deer control and flow management.
Bog S2	In IY5, weeds were recorded along monitoring transects within Bog S2 for the first time since monitoring commenced. While deer activity has reduced in the Montane Riparian Thicket surrounding the Alpine Bog, deer activity has returned to areas of the Alpine Bog itself.	High priority for weed and deer control.
Bog S3	In IY5, weed cover (11.7%) and bare ground attributed to deer (3.5%) were at their highest levels ever recorded at Bog S3. Most weed cover and deer activity was recorded at Transect S3C, at the southern end of this control site. However, deer activity and associated weed incursions have also returned to the northern end of this site.	High priority for weed and deer control.
Other sites		
Bog 3	This Alpine Bog has contracted to its smallest extent since monitoring began and, for the first time, now exists as two fragments rather than one. Proliferation of weeds, such as Soft Rush and Musk Monkey-flower, are the main cause of the reduced extent and fragmentation. Bog 3 is at the headwaters of a drainage line that ultimately enters Bog 6, which is also why Bog 3 should be prioritised for weed control.	High priority for weed control.

5. Conclusion and recommendations

Seven years of ecological monitoring, including two years of baseline monitoring, have now been completed. The monitoring results allow for an assessment against the HEMAMP's performance criteria. Table 8 presents the results of the compliance assessment as at IY5.

Table 8 Compliance with the HEMAMP performance criteria

Performance criterion	Compliant?	Action required?	Comments
Extent			
No more than a 10% reduction in the total combined area of impact sites, relative to control sites.	Yes	Yes	Potential for future non-compliance. Total combined area of impact sites, relative to control sites, has decreased by 5.5% (although true value is likely to be closer to 0%). Sediment/weed control and revegetation are still needed, especially at Bogs 6 and 11.2.
Composition			
No more than a 10% reduction in the total 'bog-dependent' native flora species richness of impact sites, relative to control sites.	Yes	Yes	Silver Astelia was once again not recorded along transects in IY5, resulting in a 5.3% relative decline in bog-dependent species richness at impact sites. Eight Silver Astelia plants were re-introduced into Bog 4.2 in IY5.
Encroachment			
No more than a 10% increase in the cover of 'non-bog-dependent' species within impact sites, relative to control sites.	Yes	No	The cover of non-bog-dependent flora species has increased by 6.7% at impact sites relative to control sites. However, the absolute cover of non-bog-dependent flora has declined to below baseline levels.
Weed cover not to exceed 5% within impact sites.	No (for entire transects) Yes (for impact sites only)	Yes	Weed cover along entire transects (inside and outside of Alpine Bogs) was 7.9% in IY5 and has been non-compliant since monitoring started. Weed cover along parts of transects within impact sites (inside Alpine Bogs only) was 3.6% in IY5 and compliant. Weed control is still needed, especially in Bog 6.
Structure			
No more than a 10% reduction in the average cover of Peat Moss within impact sites, relative to control sites.	Yes	No	Peat Moss cover has increased by 9.9% at impact sites relative to control sites. Overall, Peat Moss cover and health is good, although there was a slight increase in the proportion of Peat Moss recorded as dead in IY5.

The recommendations of this monitoring report are as follows:

1. Despite positive trends since IY3, the relative decline in extent of impact sites has remained greater than 5% (i.e. at the 'amber' trigger level) for three consecutive years, meaning that management actions and effort at impact sites must be increased in IY6. In particular, weed control and/or revegetation effort should be increased at Bogs 6 and 11.2.
2. Now that artificial watering of Mount Buller's eastern control sites has ceased, ecological monitoring should be alert to a potential decline in the area of these sites and adapt analysis of results accordingly. Analysis of results from Borehole 18 (BH18) may assist.
3. While the area of dieback of non-bog-dependent flora bordering Alpine Bogs at Mount Buller appears to be stabilising, dieback locations must continue to be re-visited in future years to track vegetation recovery or succession and to plan any necessary management interventions e.g. weed control and revegetation.
4. Additional survey effort should be undertaken in IY6 to identify and map any new Alpine Bog vegetation within the Boggy Creek catchment (upslope of Bog 13) and to re-visit Alpine Bogs that were newly identified and mapped in BY2 (so-called 'other sites').
5. ARV must continue to implement the Ecological Rehabilitation Plan (ERP; Biosis 2020a) and its Addendum (Biosis 2022a) to continue to prevent movement of sediment from the PCF into Alpine Bogs.
6. Where possible, ARV should make greater use of jute mat and sediment socks to minimise re-mobilisation of sediment immediately after physical weed removal within and around Alpine Bogs, as was done in IY3 and IY4.
7. The eight Silver Astelia plants that were planted in or near Bog 4.2 in IY5 should be re-visited again in IY6 to monitor their survivorship and to plan follow-up management actions, such as weed control or herbivore management. If any of the eight Silver Astelia plants have died, they should be replaced either at the same location (if conditions for re-introduction are still suitable at this location) or at a new location (if conditions for re-introduction are no longer suitable at the original location or better elsewhere).
8. Bog-dependent species richness at impact sites relative to control sites has remained 5.3% lower than the baseline mean (i.e. at the 'amber' trigger level) for three consecutive years, meaning that efforts to re-introduce Silver Astelia to impact sites must be increased in IY6 e.g. by planting a greater number of Silver Astelia plants than in IY5.
9. As more Silver Astelia plants become available, ARV should consider planting them into Bog 6 and Bog 12, given that the species has been previously recorded at these impact sites.
10. ARV should increase weed control effort within impact sites in IY6 compared with IY5, in anticipation of the 'amber' trigger level being met in IY6 for the third consecutive year.
11. ARV should increase weed control effort in vegetation surrounding impact sites and within the Project Construction Footprint of the water storage, as this will reduce weed propagule loads within the impact sites themselves.
12. As part of its implementation of the ERP, ARV should improve monitoring of weed covers within the Project Construction Footprint to better inform weed control efforts in this area.
13. ARV should investigate potential causes for an increase in the proportion of dead Peat Moss at impact sites if it is again observed in IY6.

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Figures

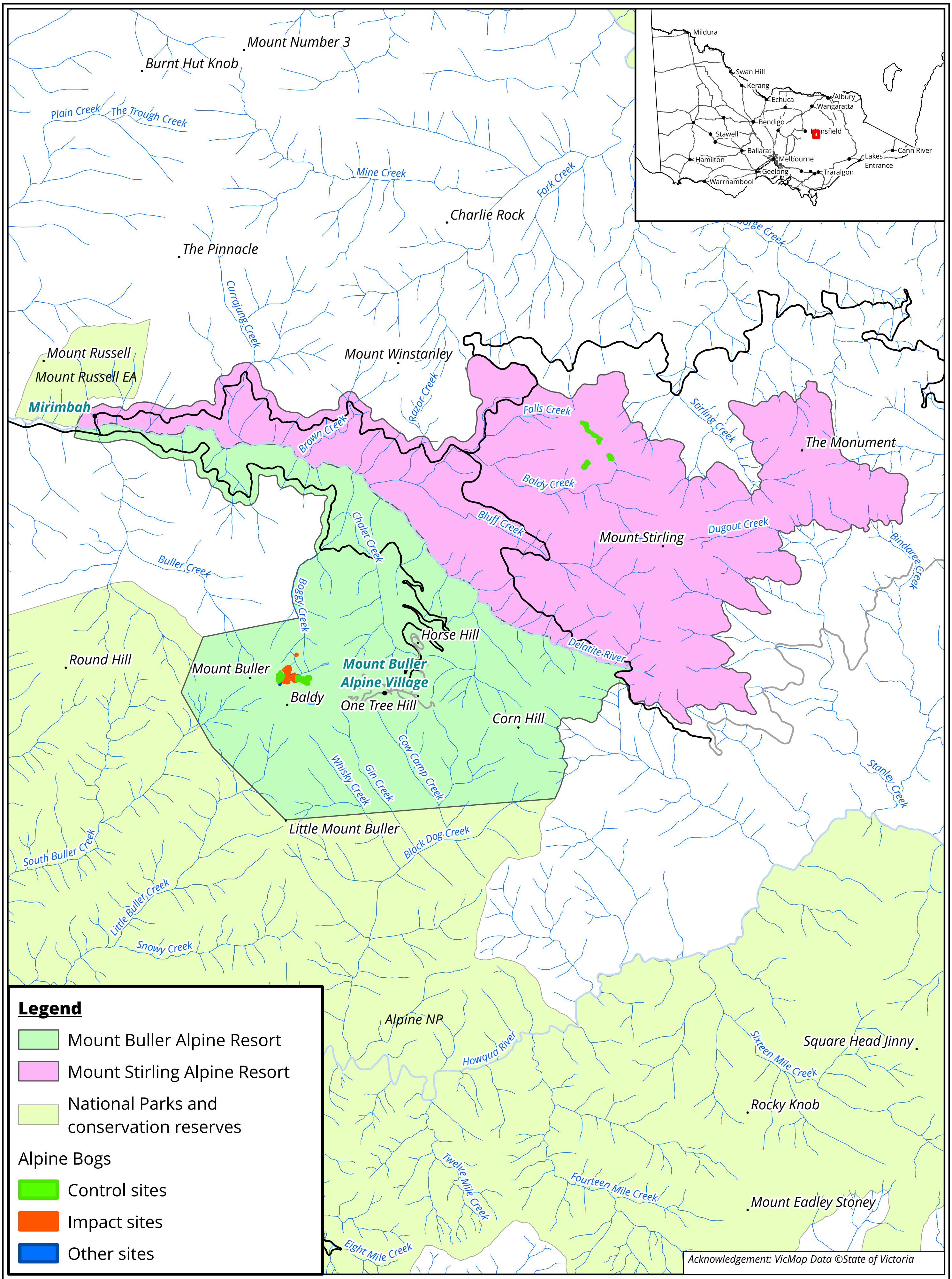

Figure 1 Location of the Mount Buller and Mount Stirling Alpine Resorts, Victoria

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Date: 07 June 2023 ,
Prepared for: MG, Prepared by: SKM, Last edited by: smitchell
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Coordinate System GDA 1994 MGA Zone 55

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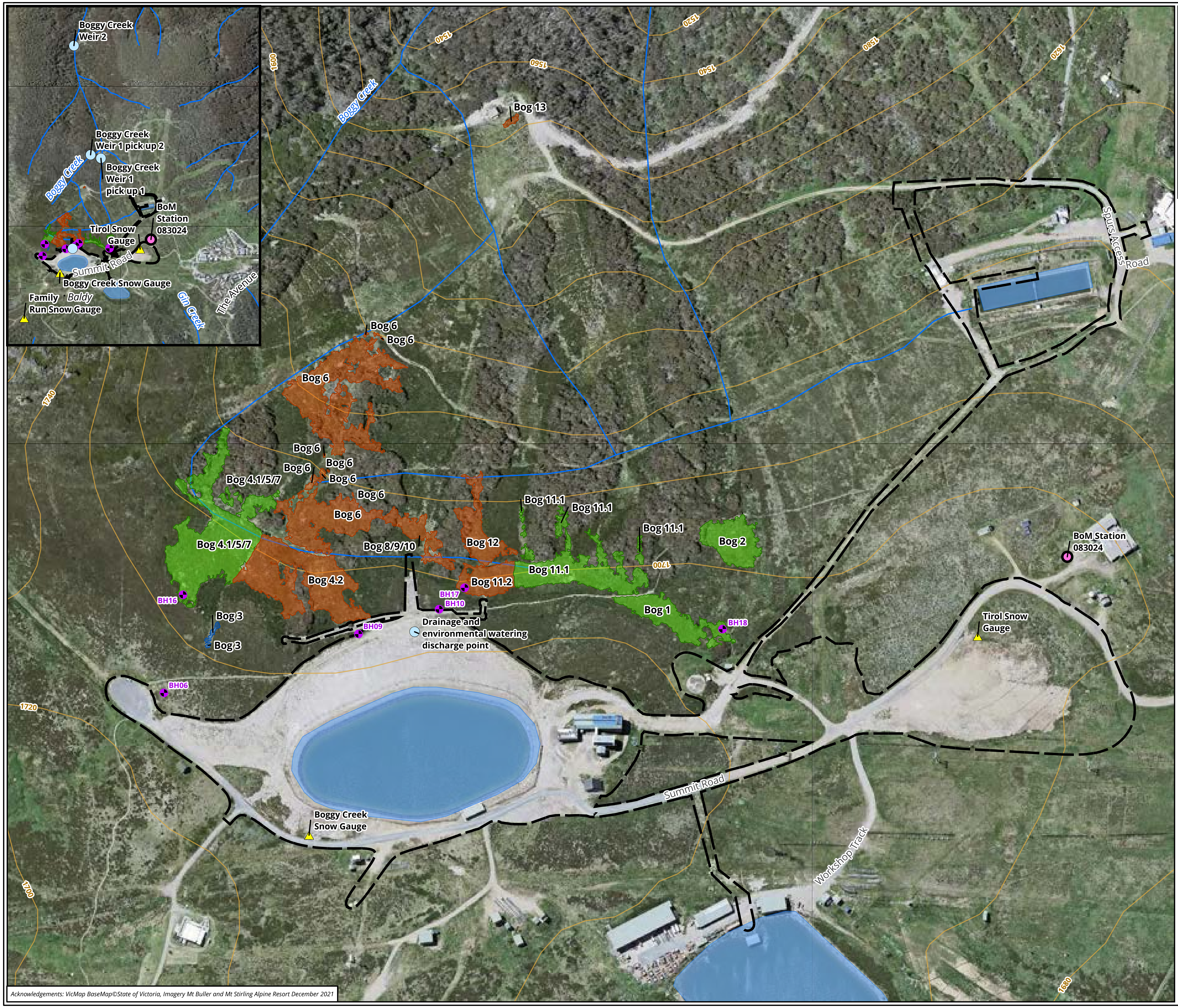
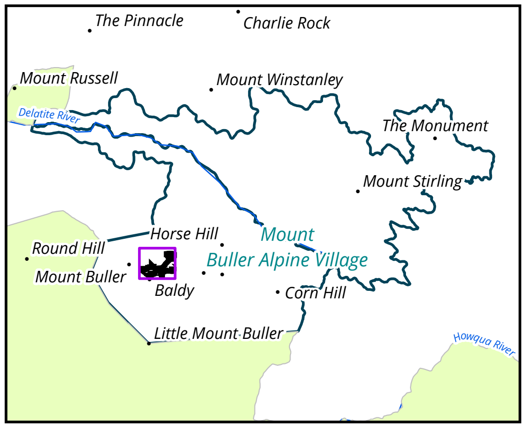


Acknowledgements: VicMap BaseMap©State of Victoria, Imagery Mt Buller and Mt Stirling Alpine Resort December 2021



Legend

- Project Construction Footprint (PCF)

Ecological monitoring (Alpine Bogs)

- 🟩 Control site (2024)
- 🟧 Impact site (2024)
- 🟦 Other site (2024)

Climatological monitoring

- ▲ Snow gauge
- ● Weather station

Hydrological monitoring

- ● Groundwater bore
- ○ Surface water monitoring location

Figure 2 Location of Alpine Bogs subject to monitoring at Mount Buller Alpine Resort

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Metres
Scale: 1:3,000 @ A3
Coordinate System: GDA2020 MGA Zone 55

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Matter: 40264,
Date: 30 August 2024 ,
Prepared for: MG, Prepared by: SKM, Last edited by: jturner
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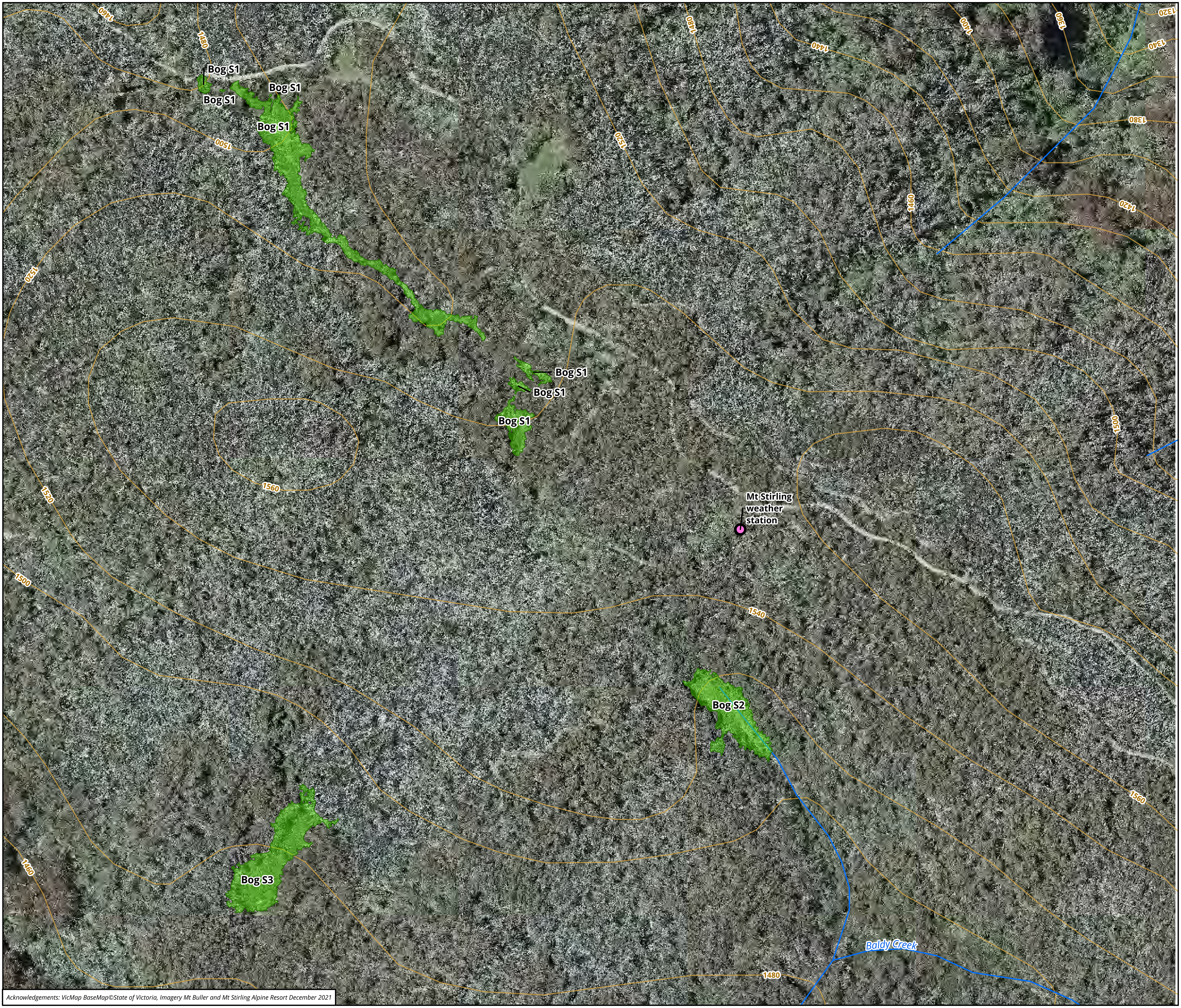

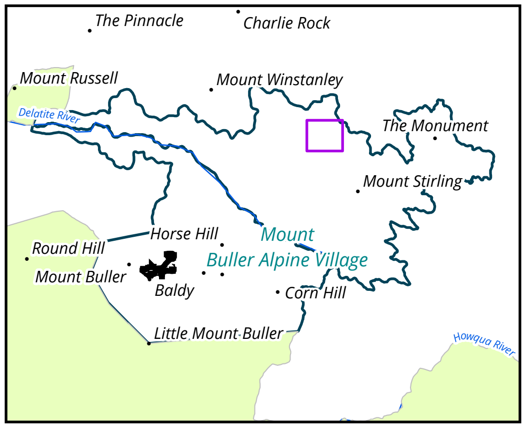

Legend

Alpine Bogs (Biosis 2024)

🟩 Control site (2024)

Climatological monitoring

● Weather station

Figure 3 Location of Alpine Bogs subject to monitoring at Mount Stirling Alpine Resort

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Metres
Scale: 1:3,000 @ A3
Coordinate System: GDA2020 MGA Zone 55

biosis.

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Date: 30 April 2024 ,
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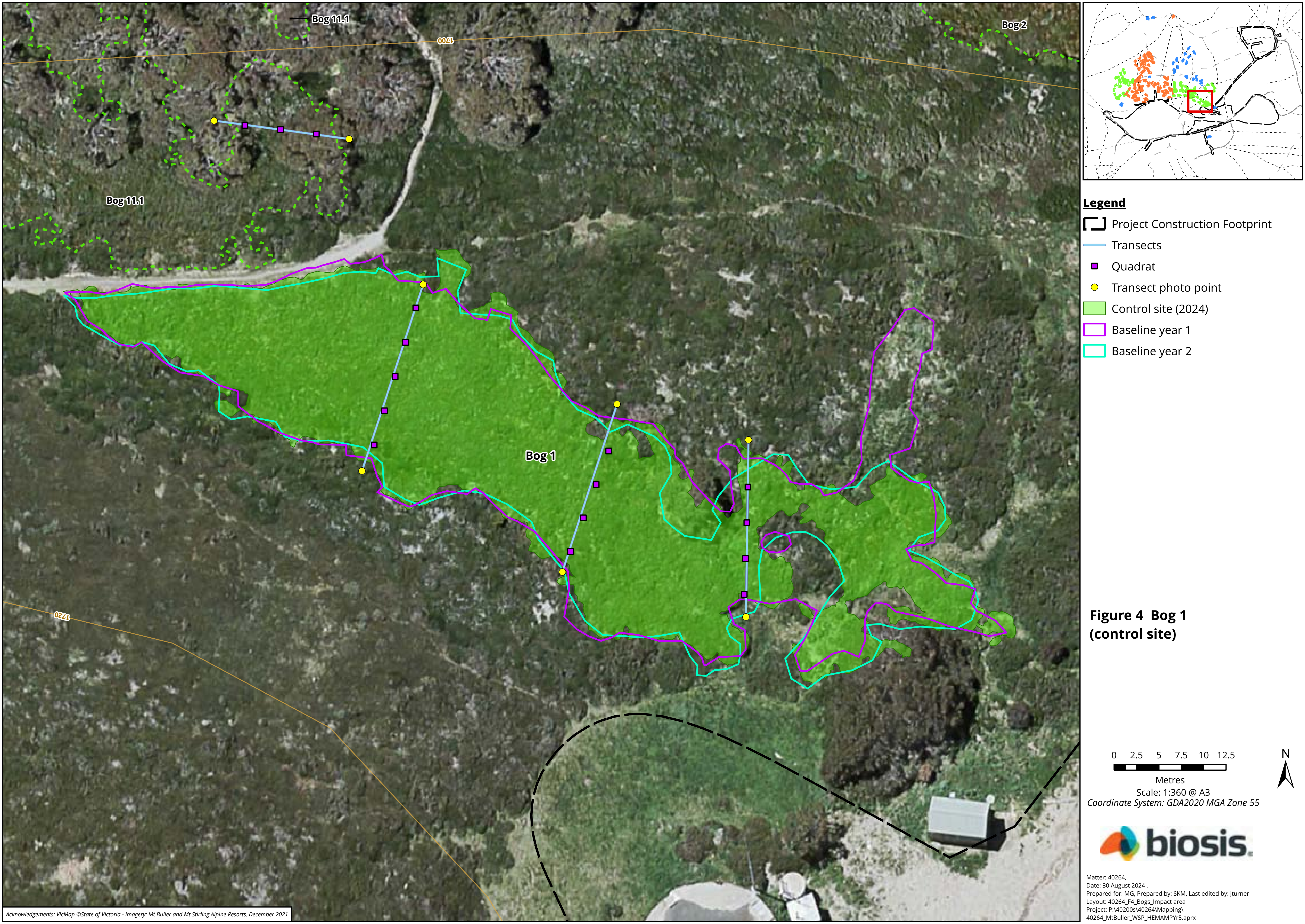

Legend

- ▭ Project Construction Footprint
- ― Transects
- ■ Quadrat
- ● Transect photo point
- 🟩 Control site (2024)
- ▭ Baseline year 1
- ▭ Baseline year 2

Figure 4 Bog 1 (control site)

Scale: 1:360 @ A3
Coordinate System: GDA2020 MGA Zone 55

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biosis

Matter: 40264,
Date: 30 August 2024 ,
Prepared for: MG, Prepared by: SKM, Last edited by: jturner
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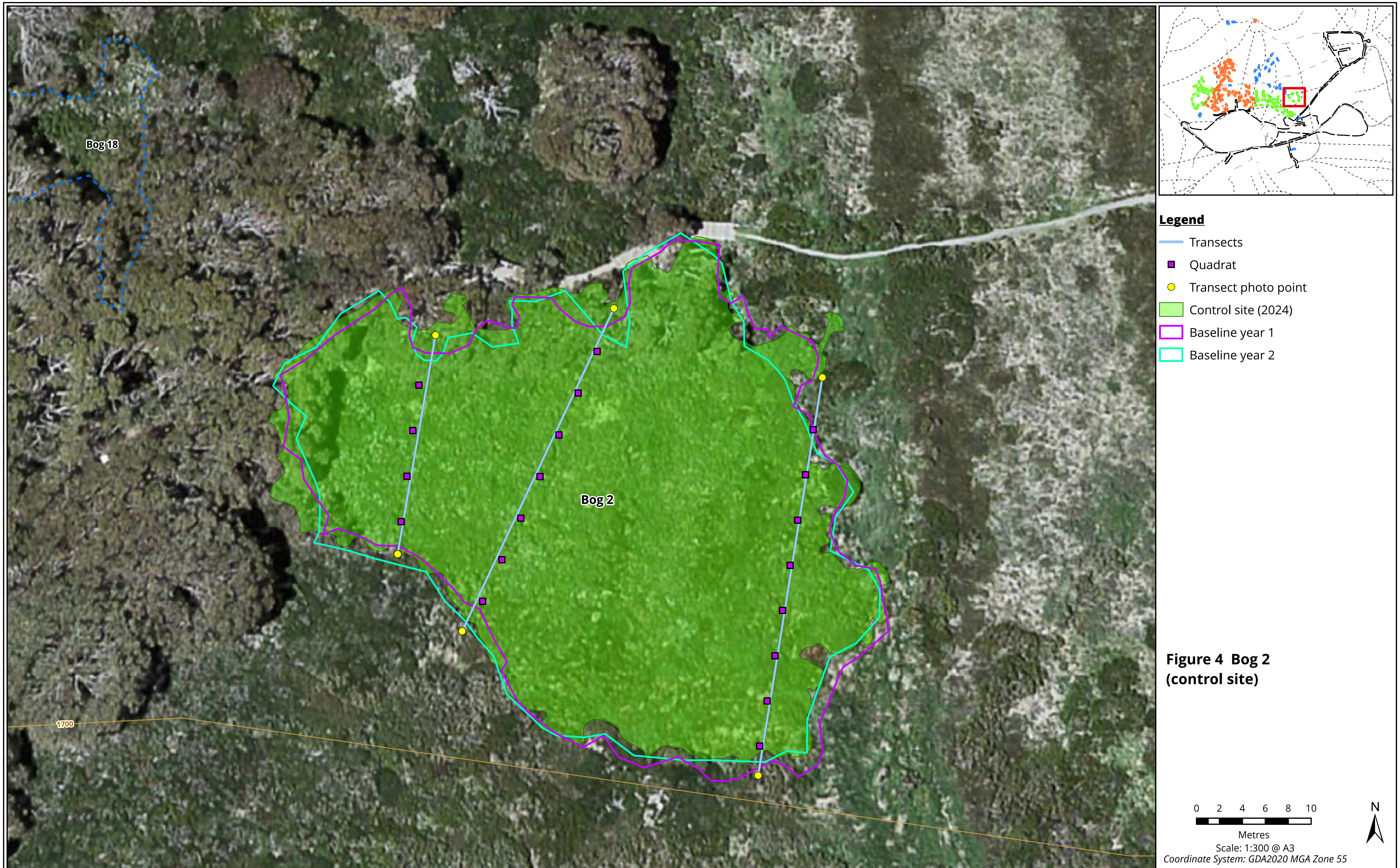

Figure 4 Bog 2 (control site)

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Date: 30 August 2024 ,
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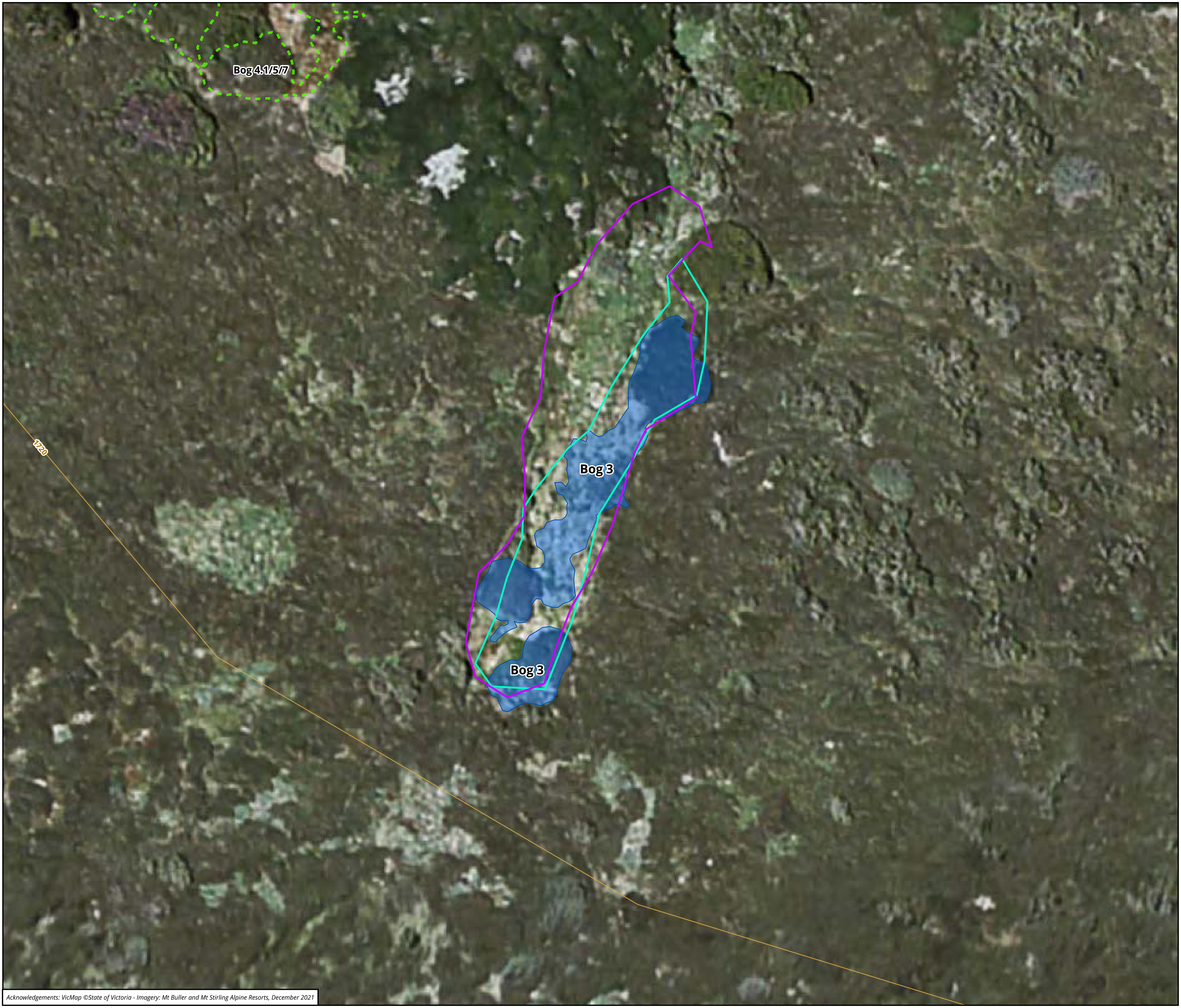

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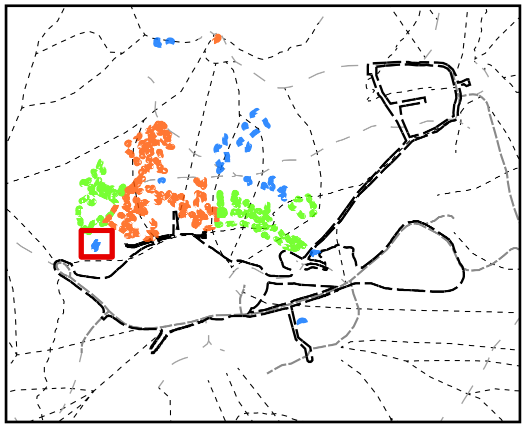

Legend

- 🟦 Other site (2024)
- ▭ Baseline year 1
- ▭ Baseline year 2

Figure 4 Bog 3 (other site)

0 1.5 3 4.5 6 7.5
Metres
Scale: 1:200 @ A3
Coordinate System: GDA2020 MGA Zone 55

N

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Date: 30 August 2024 ,
Prepared for: MG, Prepared by: SKM, Last edited by: jturner
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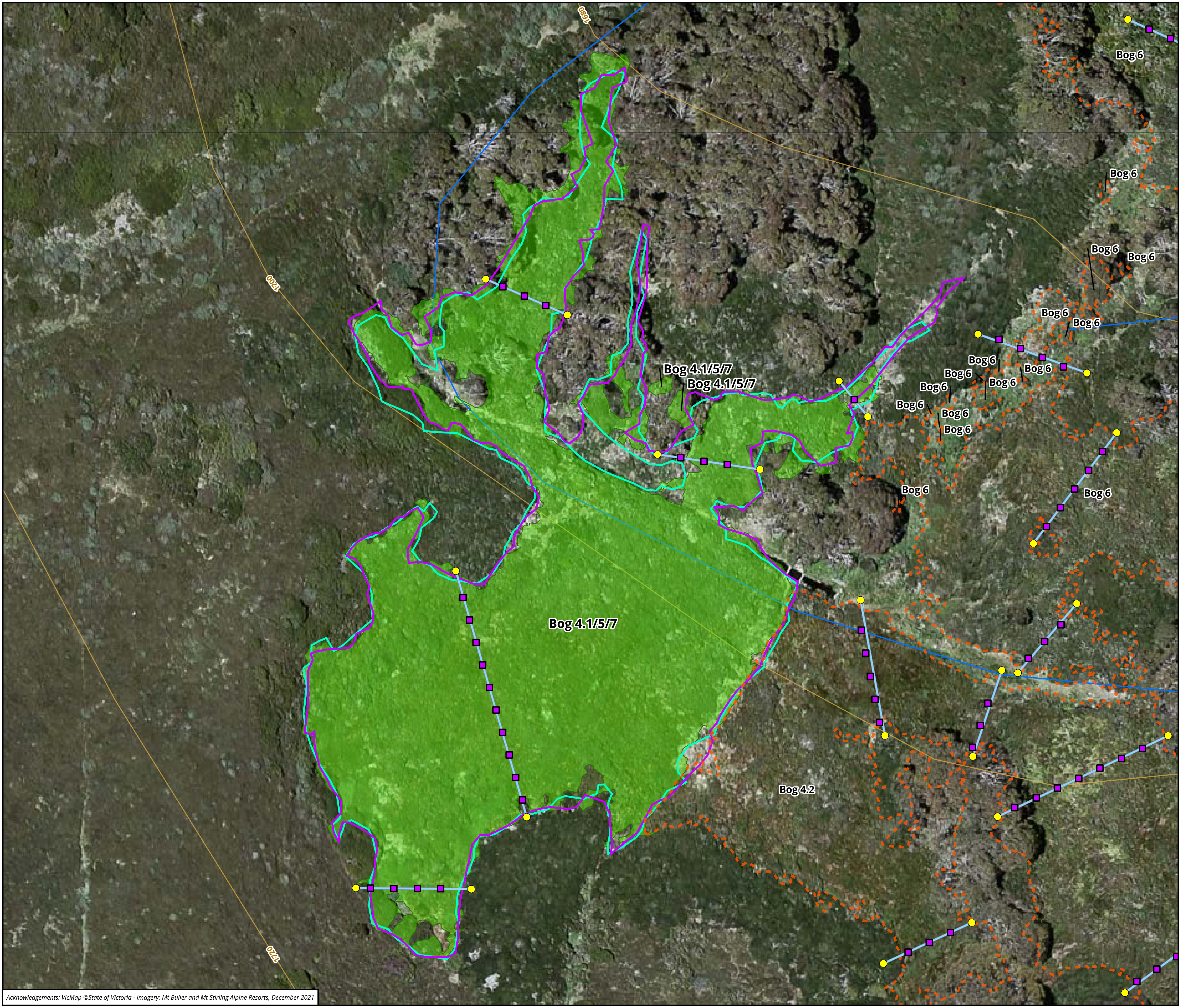

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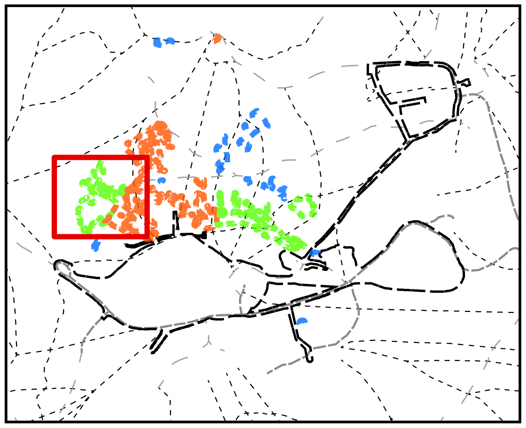

Legend

—	Transects
■	Quadrat
●	Transect photo point
🟩	Control site (2024)
☐	Baseline year 1
☐	Baseline year 2

Figure 4 Bog 4.1/5/7 (control site)

0 4.5 9 13.5 18 22.5

Metres

Scale: 1:600 @ A3

Coordinate System: GDA2020 MGA Zone 55

N

Matter: 40264,
Date: 30 August 2024 ,
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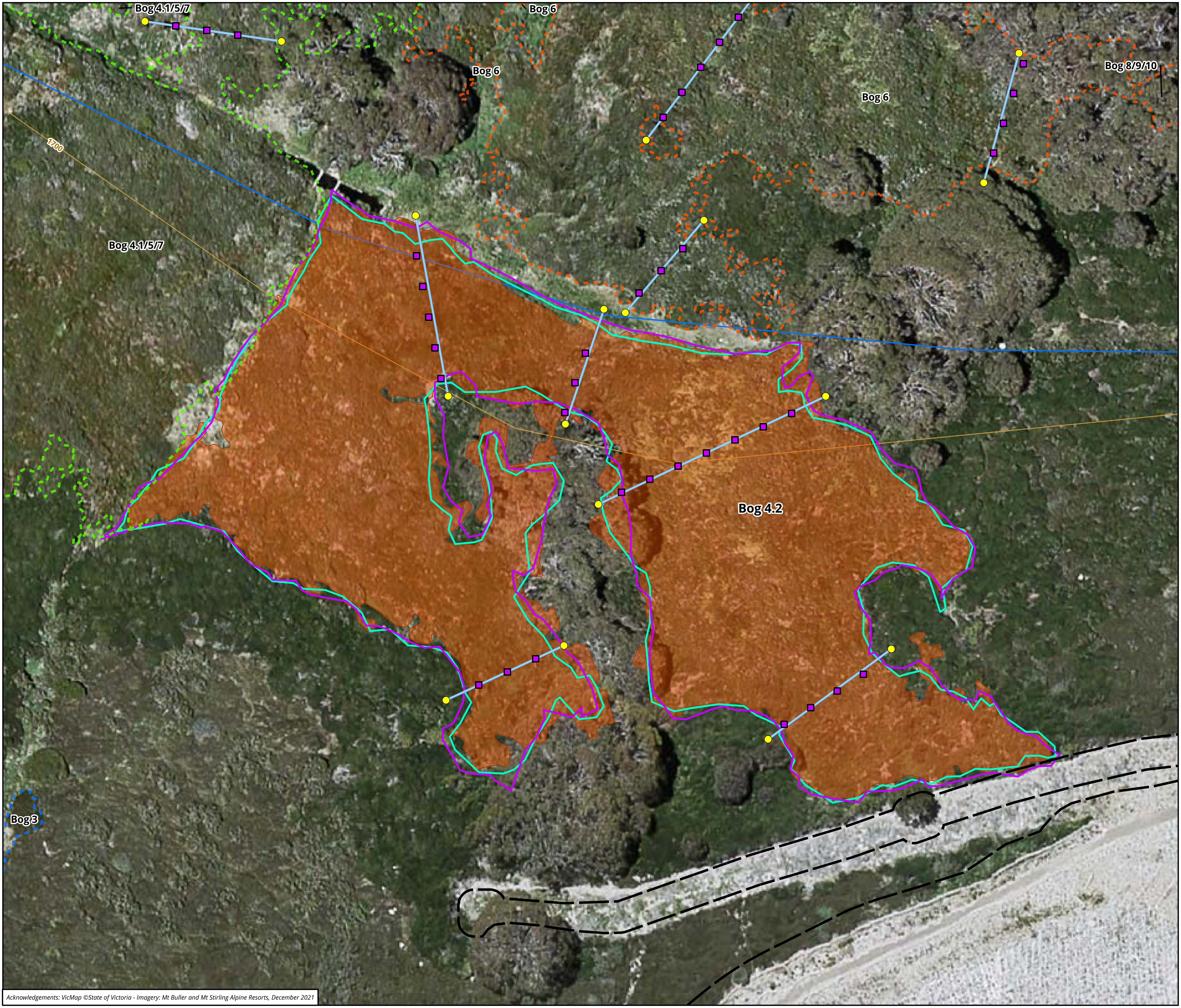

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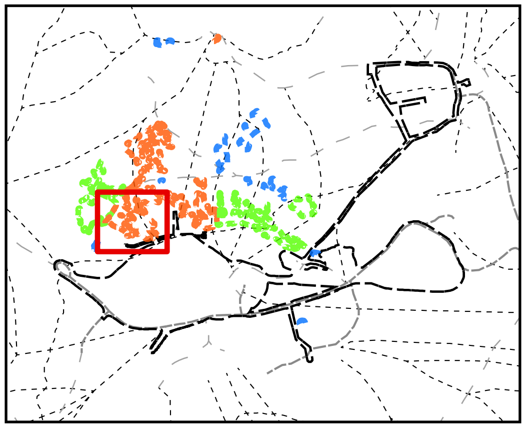

Legend

- Project Construction Footprint
- Transects
- ■ Quadrat
- ● Transect photo point
- 🟧 Impact site (2024)
- ☐ Baseline year 1
- ☐ Baseline year 2

Figure 4 Bog 4.2 (impact site)

0 3.5 7 10.5 14 17.5
Metres
N
Scale: 1:450 @ A3
Coordinate System: GDA2020 MGA Zone 55

Matter: 40264,
Date: 30 August 2024 ,
Prepared for: MG, Prepared by: SKM, Last edited by: jturner
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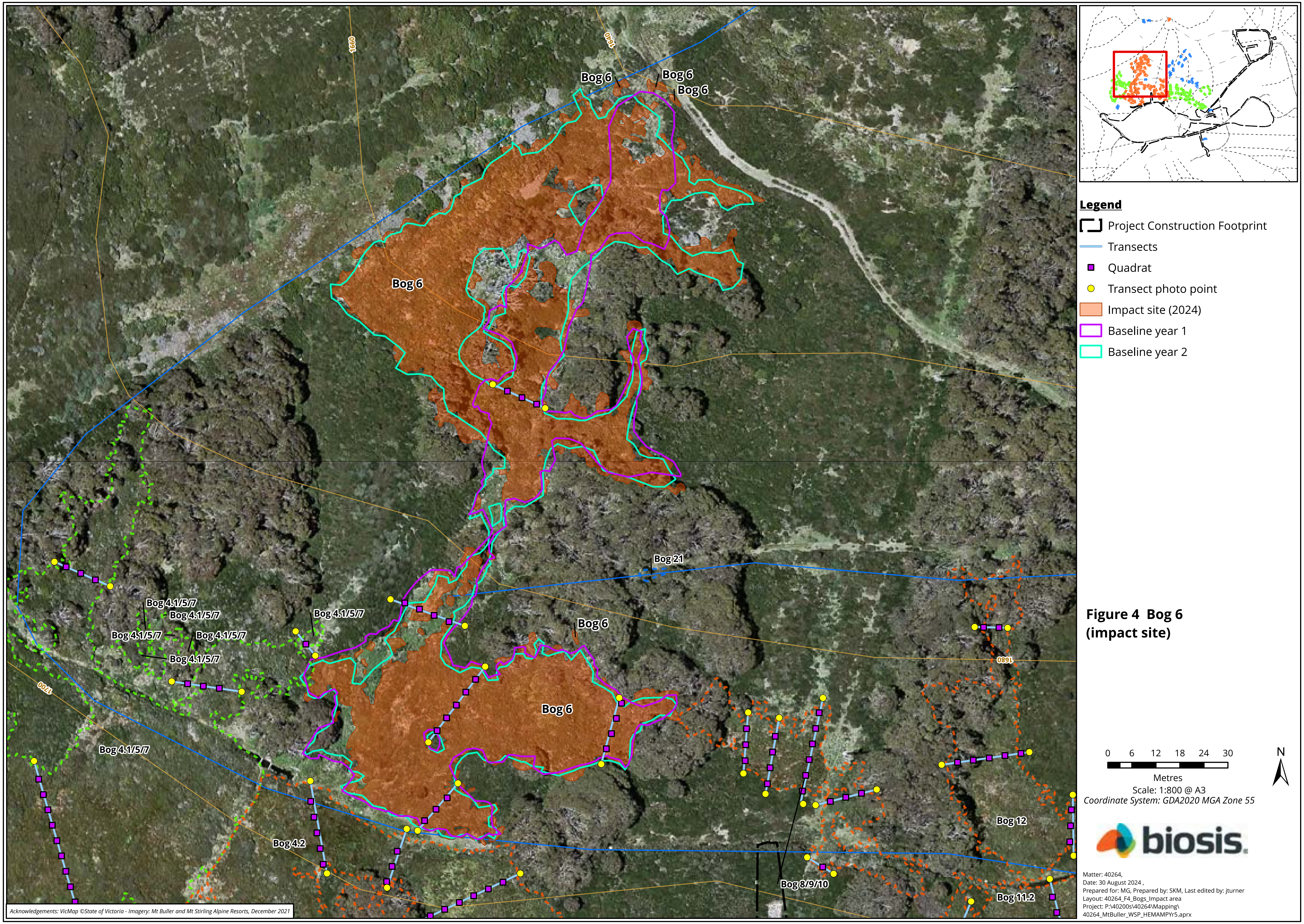

Legend

- ⌜⌟ Project Construction Footprint
- ― Transcts
- ■ Quadrat
- ● Transect photo point
- 🟧 Impact site (2024)
- ▢ Baseline year 1
- ▢ Baseline year 2

Figure 4 Bog 6 (impact site)

Scale: 1:800 @ A3

Coordinate System: GDA2020 MGA Zone 55

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Matter: 40264,
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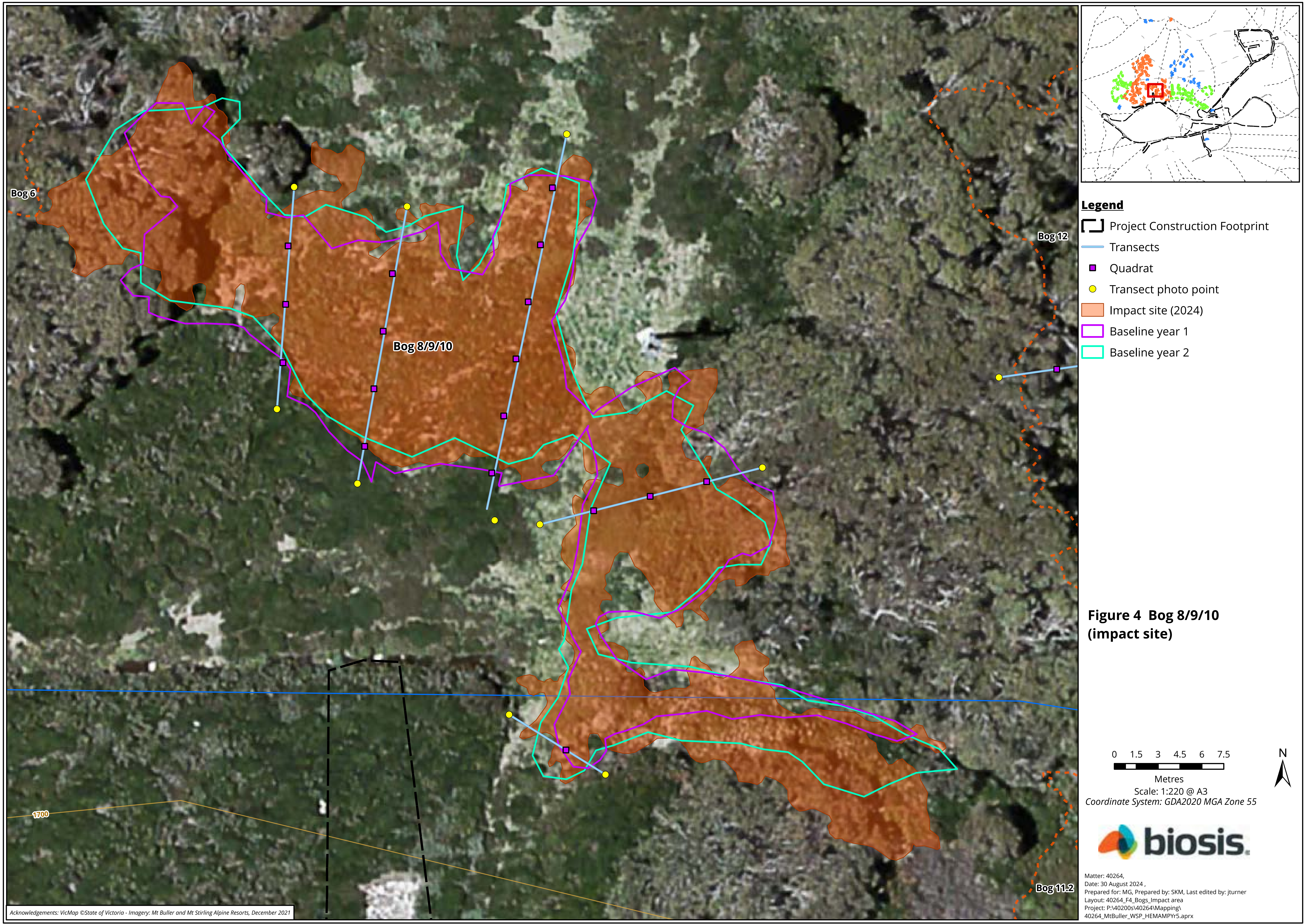

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Figure 4 Bog 8/9/10 (impact site)

Scale: 1:220 @ A3
Coordinate System: GDA2020 MGA Zone 55

Matter: 40264,
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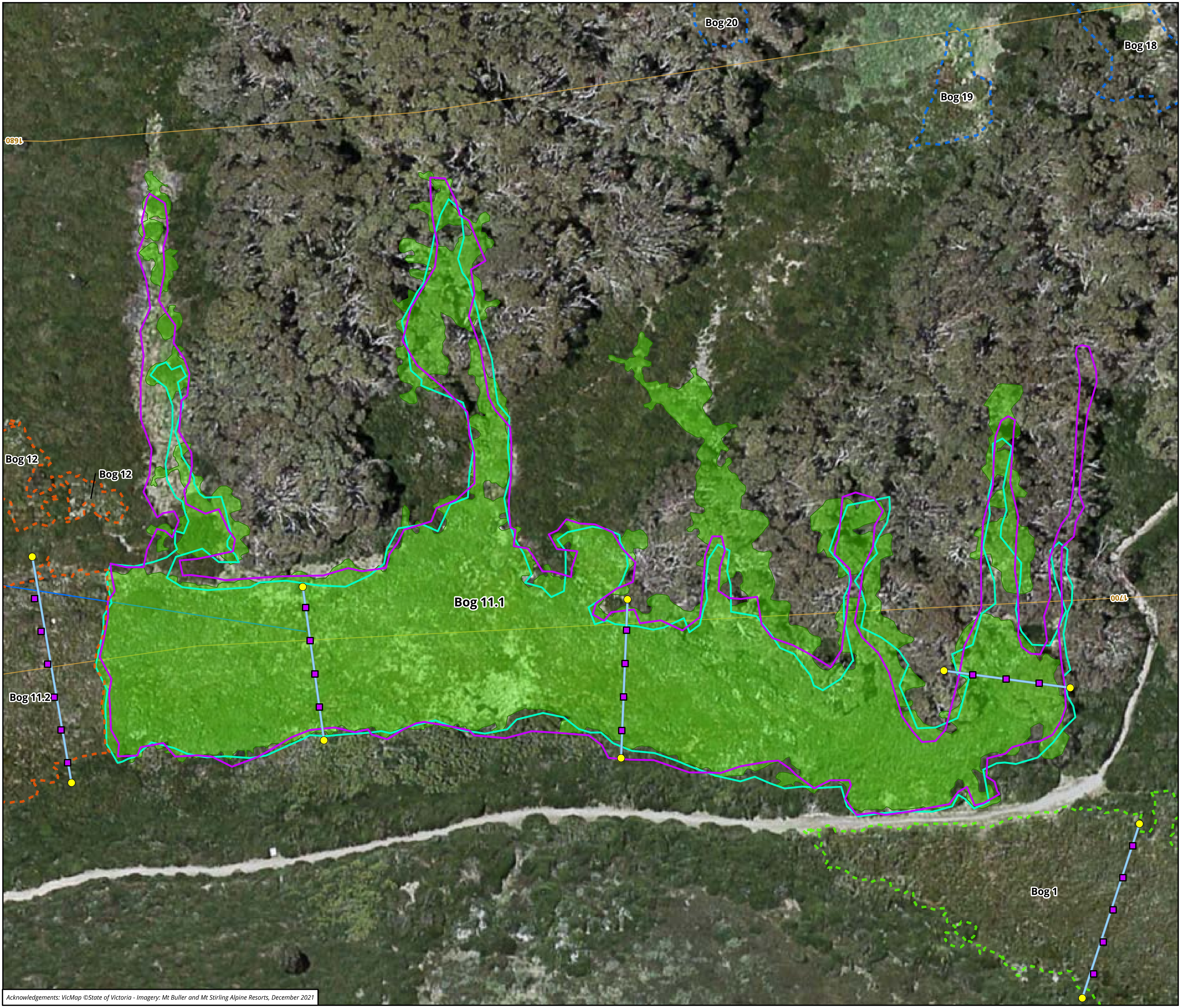

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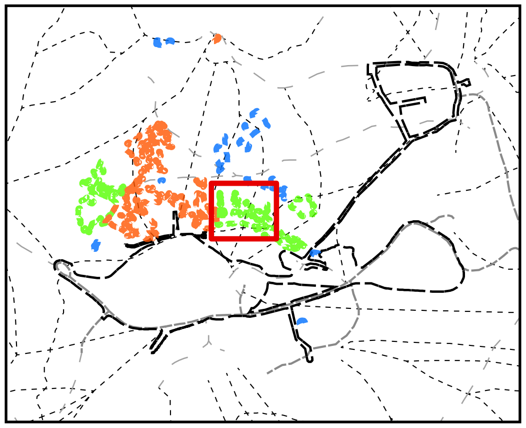

Legend

- ━ Transects
- ■ Quadrat
- ● Transect photo point
- 🟩 Control site (2024)
- ▭ Baseline year 1
- ▭ Baseline year 2

Figure 4 Bog 11.1 (control site)

0 3 6 9 12 15
Metres
Scale: 1:420 @ A3
Coordinate System: GDA2020 MGA Zone 55

N

Matter: 40264,
Date: 30 August 2024 ,
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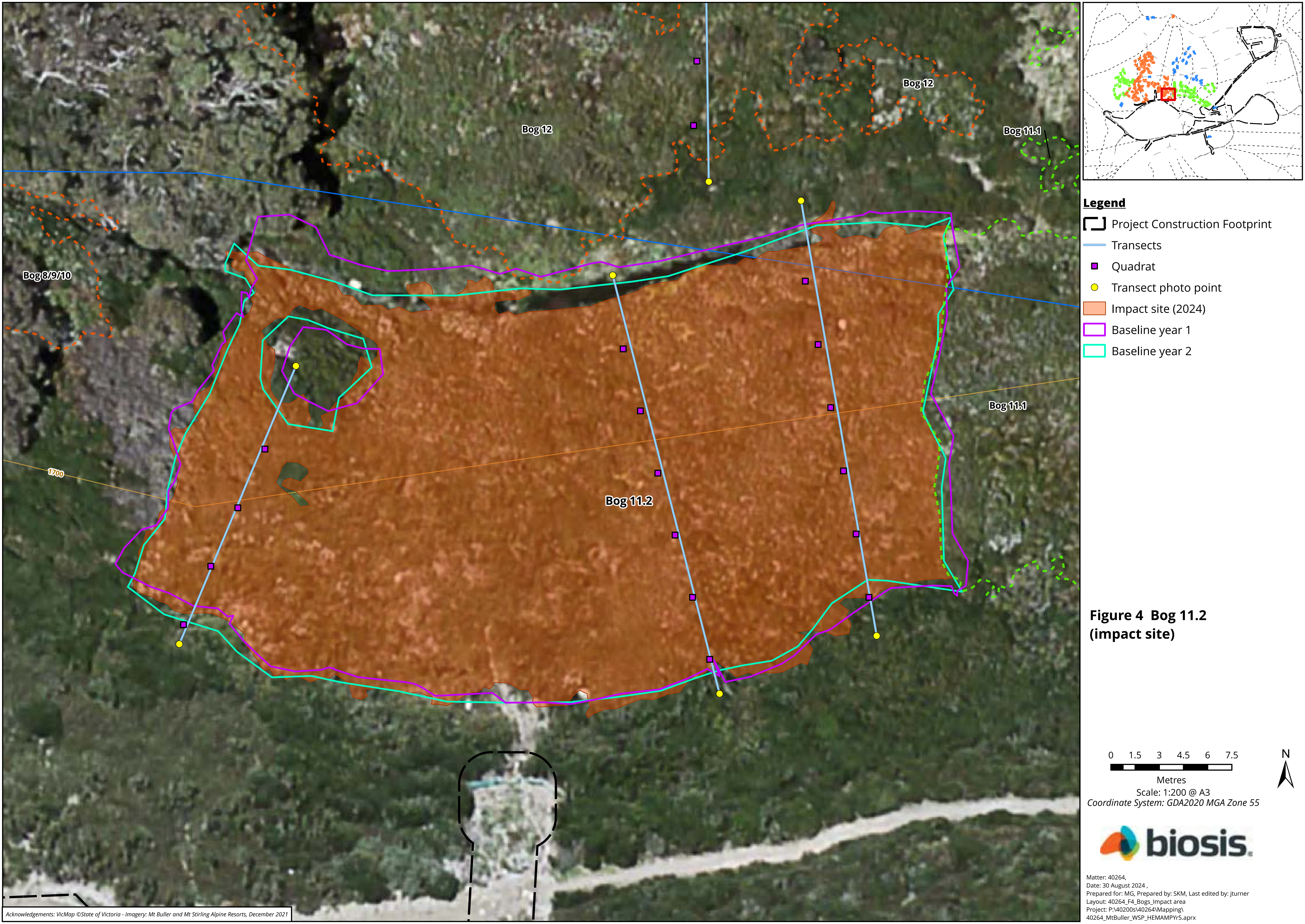

Figure 4 Bog 11.2 (impact site)

Scale: 1:200 @ A3
Coordinate System: GDA2020 MGA Zone 55

Acknowledgements: VicMap ©State of Victoria - Imagery: Mt Buller and Mt Stirling Alpine Resorts, December 2021

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Date: 30 August 2024 ,
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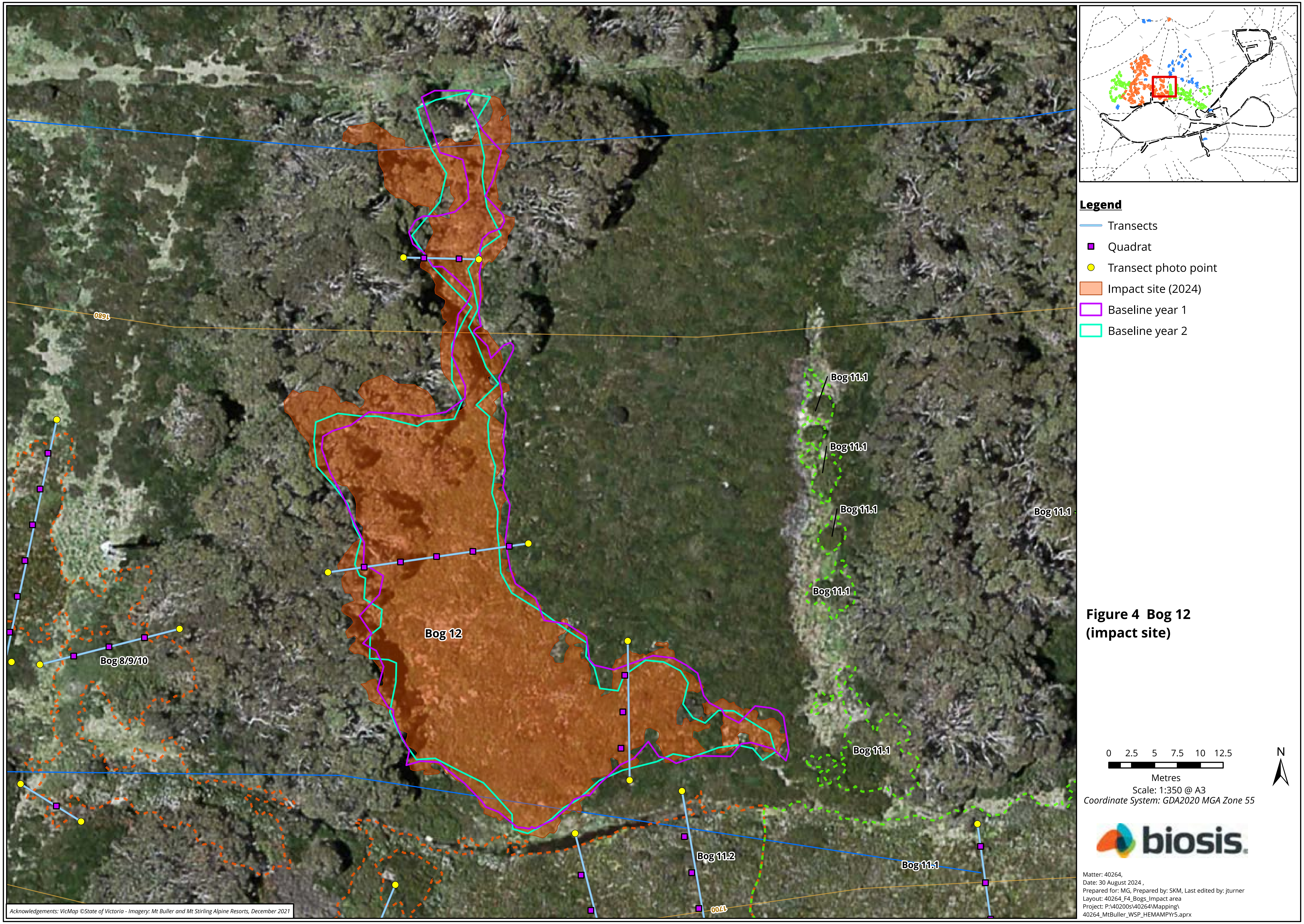

Figure 4 Bog 12 (impact site)

Scale: 1:350 @ A3
Coordinate System: GDA2020 MGA Zone 55

Acknowledgements: VicMap ©State of Victoria - Imagery: Mt Buller and Mt Stirling Alpine Resorts, December 2021

Matter: 40264,
Date: 30 August 2024 ,
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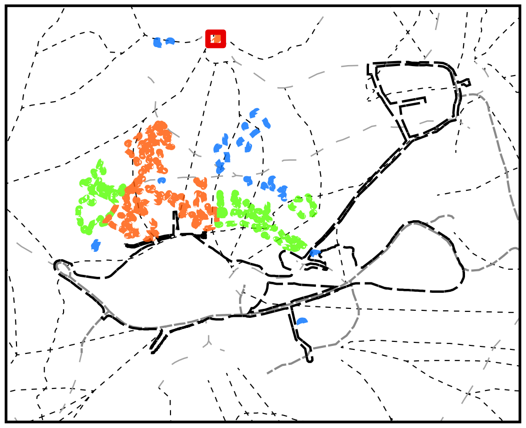
Acknowledgements: VicMap ©State of Victoria - Imagery: Mt Buller and Mt Stirling Alpine Resorts, December 2021



Legend

- ━ Transects
- ■ Quadrat
- ● Transect photo point
- 🟧 Impact site (2024)
- ▭ Baseline year 1
- ▭ Baseline year 2

Figure 4 Bog 13 (impact site)

0 0.8 1.6 2.4 3.2 4
Metres
Scale: 1:100 @ A3
Coordinate System: GDA2020 MGA Zone 55

N

Matter: 40264,
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Legend

- Transects
- ■ Quadrat
- ● Transect photo point
- 🟩 Control site (2024)
- ☐ Baseline year 1
- ☐ Baseline year 2

Figure 4 Bog S1 (control site)

Scale: 1:1,300 @ A3

Coordinate System: GDA2020 MGA Zone 55

Acknowledgements: VicMap ©State of Victoria - Imagery: Mt Buller and Mt Stirling Alpine Resorts, December 2021

Matter: 40264,
Date: 30 April 2024 ,
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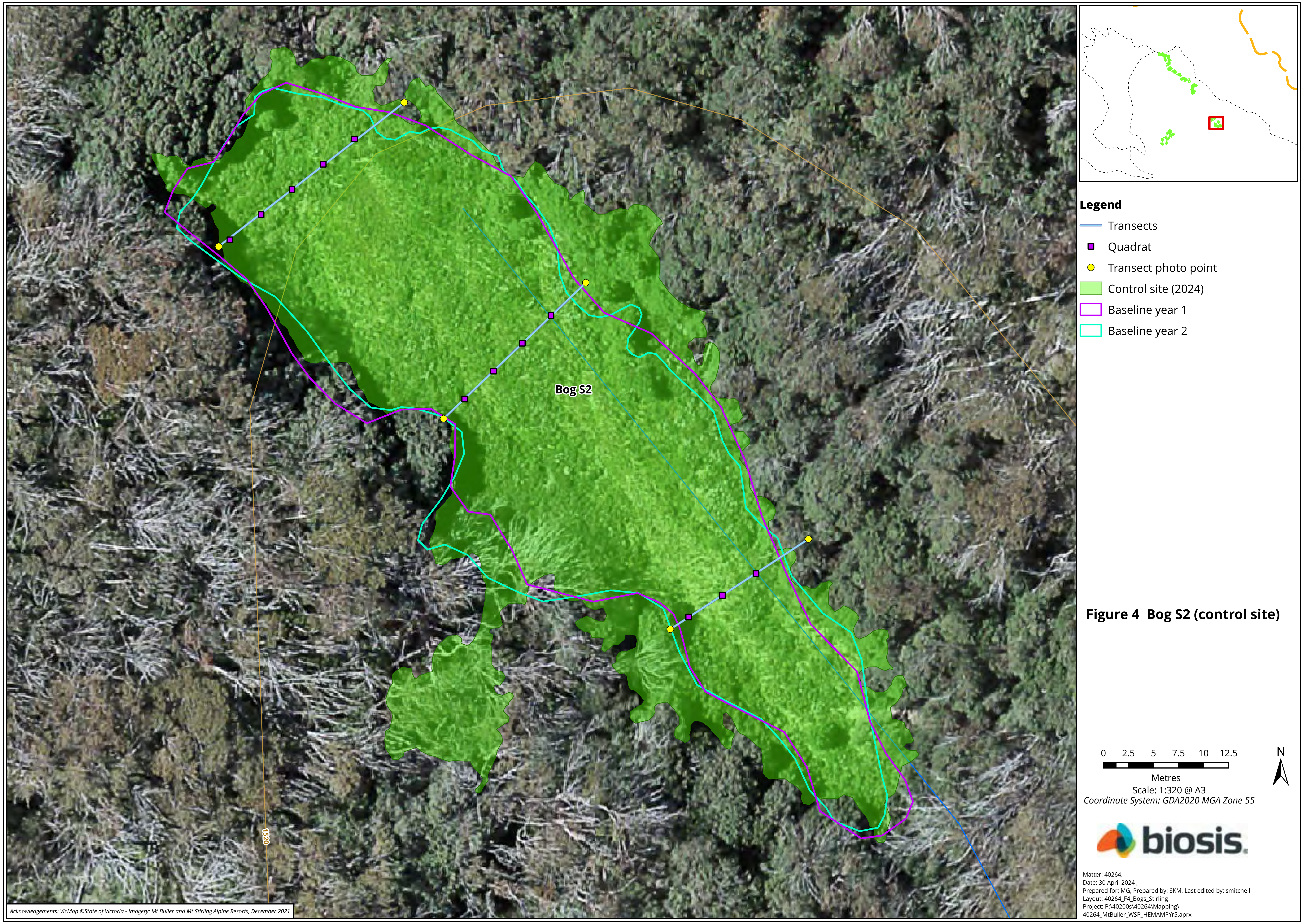

Figure 4 Bog S2 (control site)

Scale: 1:320 @ A3

Coordinate System: GDA2020 MGA Zone 55

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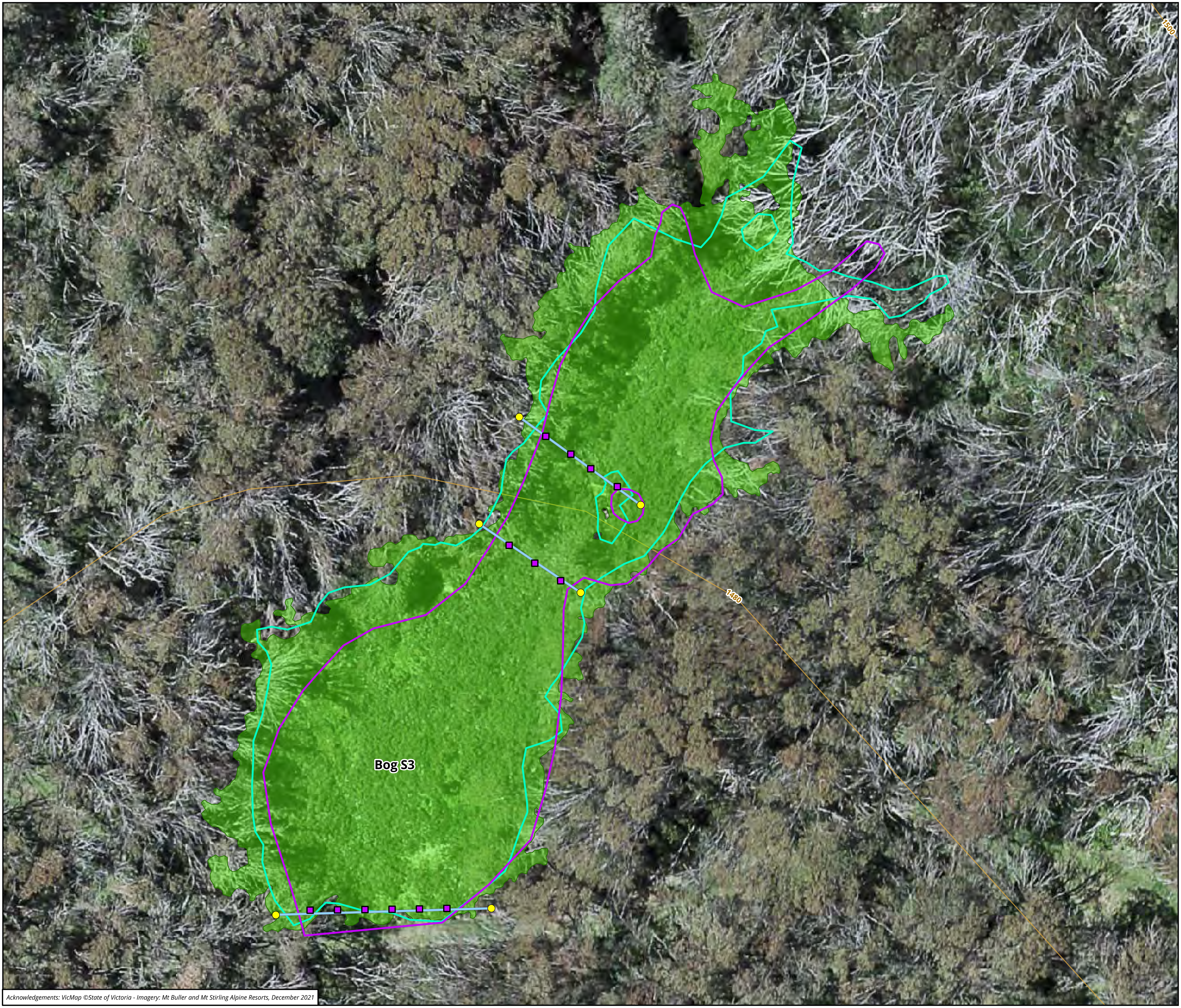
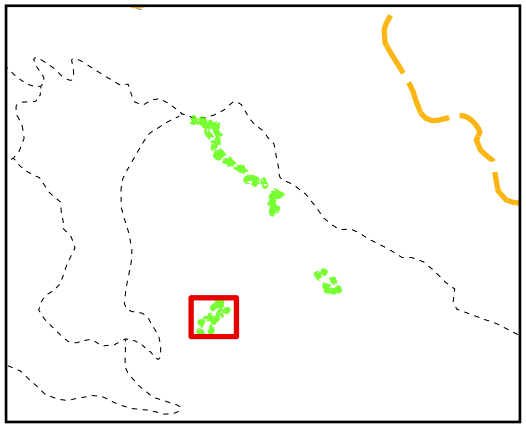
Acknowledgements: VicMap ©State of Victoria - Imagery: Mt Buller and Mt Stirling Alpine Resorts, December 2021





Legend

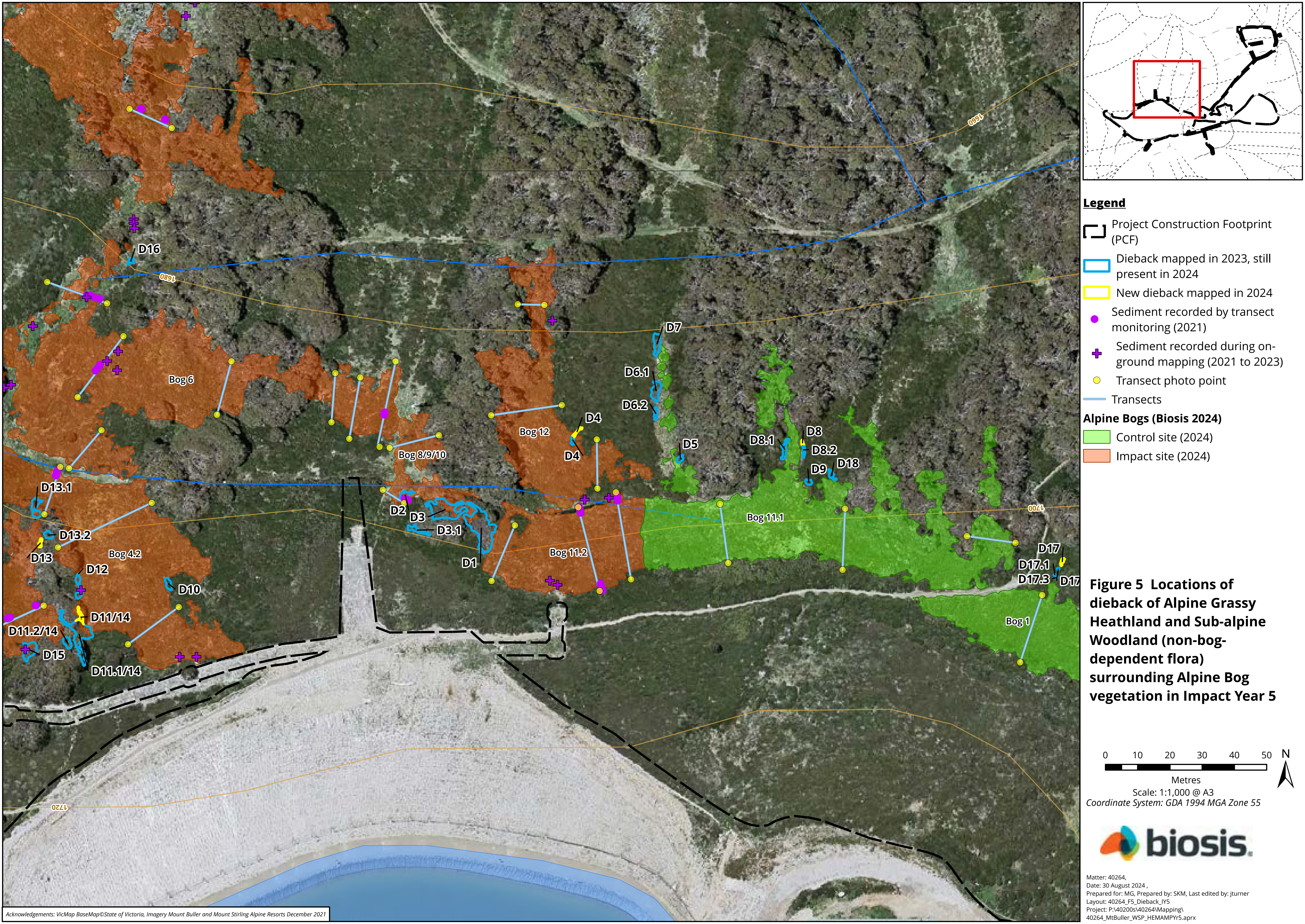
—	Transects
■	Quadrat
●	Transect photo point
🟩	Control site (2024)
▭	Baseline year 1
▭	Baseline year 2

Figure 4 Bog S3 (control site)

Scale: 1:450 @ A3
Coordinate System: GDA2020 MGA Zone 55

Acknowledgements: VicMap ©State of Victoria - Imagery: Mt Buller and Mt Stirling Alpine Resorts, December 2021

Matter: 40264,
Date: 30 April 2024 ,
Prepared for: MG, Prepared by: SKM, Last edited by: smitchell
Layout: 40264_F4_Bogs_Stirling
Project: P:\40200s\40264\Mapping\
40264_MtBuller_WSP_HEMAMPYr5.aprx



Legend

- Project Construction Footprint (PCF)
- ▭ Dieback mapped in 2023, still present in 2024
- ▭ New dieback mapped in 2024
- ● Sediment recorded by transect monitoring (2021)
- ✚ Sediment recorded during on-ground mapping (2021 to 2023)
- ● Transect photo point
- — Transects

Alpine Bogs (Biosis 2024)

- 🟩 Control site (2024)
- 🟧 Impact site (2024)

Figure 5 Locations of dieback of Alpine Grassy Heathland and Sub-alpine Woodland (non-bog-dependent flora) surrounding Alpine Bog vegetation in Impact Year 5

Scale: 1:1,000 @ A3
Coordinate System: GDA 1994 MGA Zone 55

Acknowledgements: VicMap BaseMap©State of Victoria, Imagery Mount Buller and Mount Stirling Alpine Resorts December 2021

Matter: 40264,
Date: 30 August 2024 ,
Prepared for: MG, Prepared by: SKM, Last edited by: jturner
Layout: 40264_F5_Dieback_IY5
Project: P:\40200s\40264\Mapping\
40264_MtBuller_WSP_HEMAMPYr5.aprx

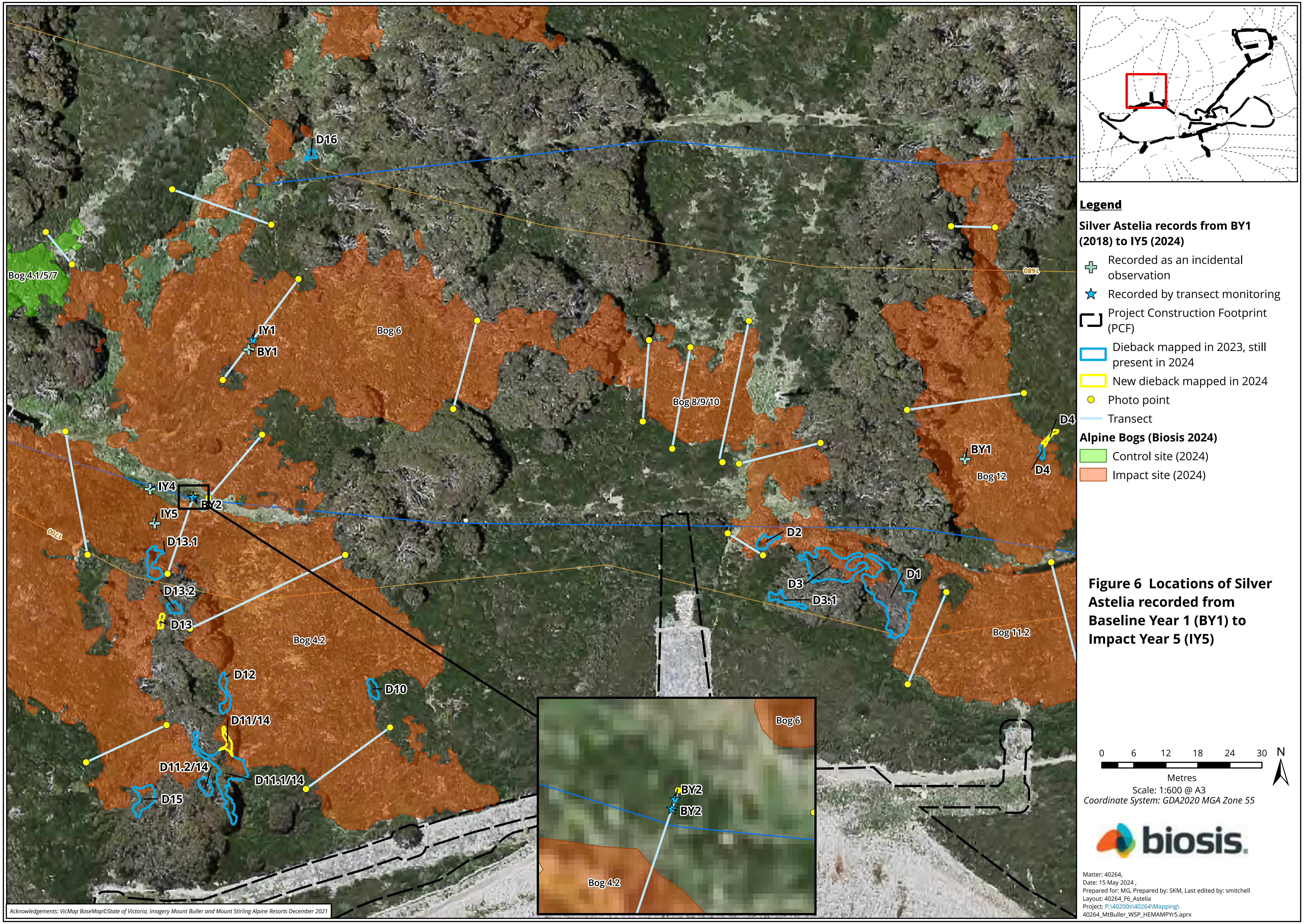


Figure 6 Locations of Silver Astelia recorded from Baseline Year 1 (BY1) to Impact Year 5 (IY5)

Acknowledgements: VicMap BaseMap©State of Victoria, Imagery Mount Buller and Mount Stirling Alpine Resorts December 2021

Matter: 40264,
Date: 15 May 2024 ,
Prepared for: MG, Prepared by: SKM, Last edited by: smitchell
Layout: 40264_F6_Astelia
Project: P:\40200s\40264\Mapping\
40264_MtBuller_WSP_HEMAMPYr5.aprx

Photos

Photo 1 **Area of Bog 6 immediately upslope of Transect 6C before major weed control, dominated by yellow-flowered Monkey Musk (IY5; 1 February 2024)**

Photo 2 **Area of Bog 6 immediately upslope of Transect 6C during major weed control, with reduced cover of Monkey Musk and grassy weeds (IY5; 5 March 2024)**

Photo 3 A rock that entered Bog 11.2 in IY1, with death of surrounding vegetation (IY2; 24 February 2021; compare with Photo 4 and Photo 5)

Photo 4 The rock in Bog 11.2 in IY4, with colonisation by weeds (IY4; 21 February 2023; compare with Photo 3 and Photo 5)

Photo 5 The rock in Bog 11.2 in IY5, with evidence of sediment control, weed control and successful revegetation (IY5; 21 February 2023; compare with Photo 3 and Photo 4)

Photo 6 Dieback of non-bog-dependent flora near southern boundary of Bog 4.2 (Location D11/D14; IY4; 28 February 2023; compare with Photo 7)

Photo 7 Slight increase in extent of dieback near southern boundary of Bog 4.2 (Location D11/D14; IY5; 24 February 2024; compare with Photo 6)

Photo 8 **Pugging caused by deer activity in Bog 12, immediately upslope of Transect 12C, with re-exposure of sediment that was being incorporated into peat substrate (IY5; 8 February 2024)**

Appendices

Appendix 1 HEMAMP monitoring calendar

Table A1.1 summarises the frequency and timing of the ecological monitoring and highlights where datasets may be incomplete. The following codes are used in Table A1.1:

Code	**Meaning**
Yes	Complete dataset for given month
Part	Partially complete dataset for given month
No	Missing dataset for given month

Table A1.1 Timing, frequency and completeness of the HEMAMP's ecological datasets

			Baseline Year 1											
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
			2017							2018				
Ecology	Transect monitoring	Control sites									Yes			
		Impact sites								Yes	Yes			
	Mapping	Control sites								Yes	Yes			
		Impact sites								Yes	Yes			

			Baseline Year 2											
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
			2018							2019				
Ecology	Transect monitoring	Control sites								Yes	Yes			
		Impact sites								Yes	Yes			
	Mapping	Control sites									Yes			
		Impact sites									Yes			

			Impact Year 1											
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
			2019							2020				
Ecology	Transect monitoring	Control sites								Yes	Yes			
		Impact sites									Yes			
	Mapping	Control sites								Yes	Yes	Yes		
		Impact sites								Yes	Yes	Yes		

			Impact Year 2											
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
			2020							2021				
Ecology	Transect monitoring	Control sites								Yes	Yes			
		Impact sites								Yes	Yes			
	Mapping	Control sites									Yes			
		Impact sites									Yes			

			Impact Year 3											
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
			2021							2022				
Ecology	Transect monitoring	Control sites								Yes	Yes			
		Impact sites								Yes	Yes			
	Mapping	Control sites									Yes			
		Impact sites									Yes			

			Impact Year 4											
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
			2022							2023				
Ecology	Transect monitoring	Control sites								Yes	Yes			
		Impact sites								Yes	Yes			
	Mapping	Control sites									Yes			
		Impact sites									Yes			

			Impact Year 5											
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
			2023							2024				
Ecology	**Transect monitoring**	**Control sites**								Yes	Yes			
		Impact sites								Yes	Yes			
	Mapping	**Control sites**								Yes	Yes			
		Impact sites								Yes	Yes			

Appendix 2 Flora species lists

The following status codes are used in this Appendix:

Code	Meaning	Notes
National significance		
CR	Critically endangered	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
EN	Endangered	
VU	Vulnerable	
State significance		
cr	Critically endangered	Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act)
e	Endangered	
v	Vulnerable	
P	Protected species (public land only)	
RU	Restricted use (public land only)	
Noxious weed status		
SP	State prohibited species	Victorian *Catchment and Land Protection Act 1994* (CaLP Act) statuses within the Goulburn Broken/North East catchments
RP	Regionally prohibited species	
RC	Regionally controlled species	
R	Restricted species	
Other		
^	Bog-dependent species	Refer to Diagnostic Key to Alpine Bogs (Appendix 3)

Table A2.1 Flora species list for all Alpine Bogs

Status	Scientific Name	Common Name
Indigenous species		
	Acaena novae-zelandiae	Bidgee-widgee
	Achrophyllum dentatum	Toothed Mitre-moss
e P	*Aciphylla glacialis*	Snow Aciphyll
e P	*Acrothamnus montanus*	Snow Beard-heath
	Agrostis parviflora s.s.	Hair Bent
	Anthosachne scabra s.s.	Common Wheat-grass
e P	*Argyrotegium poliochlorum*	Grey-green Cudweed
	Asperula conferta	Common Woodruff
	Asperula gunnii	Mountain Woodruff
^	*Astelia alpina* var. *novae-hollandiae*	Silver Astelia
RU ^	*Baeckea gunniana*	Alpine Baeckea
e P ^	*Baeckea latifolia* (as *Baeckea utilis s.l.*)	Subalpine Baeckea
RU ^	*Baeckea utilis s.s.* (as *Baeckea utilis s.l.*)	Mountain Baeckea
	Bartramia robusta	Common Apple-moss
RU	*Blechnum penna-marina* subsp. *alpina*	Alpine Water-fern
RU	*Brachyscome scapigera*	Tufted Daisy
RU	*Brachyscome spathulata*	Spoon Daisy
	Brachythecium paradoxum	Feather Moss
	Brachythecium rutabulum	Rough-stalked Feather-moss
	Brachythecium salebrosum	Smooth-stalk Feather-moss
	Brachythecium spp.	Feather Moss
^	*Callistemon pityoides*	Alpine Bottlebrush
	Campylopus introflexus	Heath Star Moss
	Carex appressa	Tall Sedge
	Carex breviculmis	Common Grass-sedge
	Carex flaccida (syn. *Carex austroflaccida*)	Mountain Hook-sedge
	Carex hebes	Mountain Sedge
e P ^	*Carex jackiana*	Carpet Sedge
	Carex spp.	Sedge
	Catagonium nitens subsp. *nitens*	Feather-tail Moss
e P	*Celmisia latifolia*	Victorian Snow-daisy
RU	*Celmisia* spp.	Snow Daisy
v P	*Celmisia tomentella*	Silver Snow-daisy
P	*Chiloglottis cornuta*	Green Bird-orchid
P	*Chiloglottis* spp.	Bird Orchid
	Chiloscyphus semiteres var. *semiteres*	Common Crestwort
	Chiloscyphus trialatus (syn. *Chiloscyphus pallidus*)	Greasy Crestwort
	Clematis aristata	Mountain Clematis
RU	*Coronidium monticola*	Mountain Everlasting
	Cotula alpina	Alpine Cotula
e P	*Craspedia adenophora*	Sticky Billy-buttons
RU	*Craspedia aurantia s.l.*	Orange/Green Billy-buttons

Status	Scientific Name	Common Name
e P	*Craspedia lamicola*	Bog Billy-buttons
RU	*Craspedia spp.*	Billy Buttons
e P	*Craspedia sylvestris*	Mountain Forest Billy-buttons
RU ^	*Dracophyllum continentis* (syn. *Richea continentis*)	Candle Heath
^	*Empodisma minus*	Spreading Rope-rush
RU ^	*Epacris paludosa*	Swamp Heath
	Epilobium billardiereanum subsp. *billardiereanum*	Smooth Willow-herb
	Epilobium billardiereanum subsp. *hydrophilum*	Robust Willow-herb
v P	*Epilobium sarmentaceum*	Mountain Willow-herb
	Epilobium spp.	Willow Herb
	Eucalyptus pauciflora	Snow Gum
	Euchiton involucratus s.s.	Star Cudweed
	Euchiton sphaericus	Annual Cudweed
	Euchiton spp.	Cudweed
	Exocarpos nanus	Alpine Ballart
	Gemmabryum sauteri	Sauter's Thread-moss
	Gentianella cunninghamii subsp. *major*	Tall Snow-gentian
v P	*Gentianella muelleriana* subsp. *willisiana*	Mt Buller Snow-gentian
	Geranium potentilloides var. *1*	Soft Crane's-bill
	Geranium sp. *7*	Alpine Swamp Crane's-bill
	Gonocarpus micranthus	Creeping Raspwort
	Gonocarpus montanus	Mat Raspwort
	Gonocarpus tetragynus	Common Raspwort
	Goodenia hederacea	Ivy Goodenia
RU	*Grevillea australis*	Alpine Grevillea
	Grimmia pulvinata var. *africana*	Blunt-beak Grimmia
^	*Hierochloe redolens*	Sweet Holy-grass
	Hovea montana	Alpine Rusty-pods
e P	*Huperzia australiana*	Fir Clubmoss
	Hydrocotyle hirta	Hairy Pennywort
	Hydrocotyle spp.	Pennywort
	Hygrolembidium acrocladum	Fingerwort
	Hymenodontopsis mnioides (syn. *Pyrrhobryum mnioides*)	Woolly-stem Thyme-moss
	Hypericum japonicum	Matted St John's Wort
	Isolepis aucklandica	New Zealand Club-sedge
	Isolepis habra	Wispy Club-sedge
e P	*Isolepis montivaga*	Fog Club-sedge
	Isolepis spp.	Club Sedge
	Isolepis subtilissima	Mountain Club-sedge
	Lagenophora montana	Mountain Bottle-daisy
	Lagenophora stipitata s.s.	Blue Bottle-daisy
	Leionema phylicifolium	Alpine Leionema
	Leptospermum grandifolium	Mountain Tea-tree

Status	Scientific Name	Common Name
	Leptostigma breviflorum	Mountain Nertera
RU	*Leucopogon gelidus*	Drooping Beard-heath
	Libertia pulchella	Pretty Grass-flag
	Luzula modesta	Southern Woodrush
	Luzula spp.	Woodrush
RU	*Lycopodium fastigiatum*	Mountain Clubmoss
cr P	*Lycopodium scariosum*	Spreading Clubmoss
	Marchantia berteroana	Common Marchantia
	Melicytus sp. aff. *dentatus* (snowfields variant)	Alpine Shrub-violet
	Mentha laxiflora	Forest Mint
RU	*Microseris lanceolata*	Alpine Yam-daisy
RU ^	*Olearia algida*	Mountain Daisy-bush
e P	*Olearia phlogopappa* subsp. *flavescens*	Dusty Daisy-bush
	Oreobolus distichus	Fan Tuft-rush
	Oreomyrrhis eriopoda	Australian Caraway
	Orites lancifolius	Alpine Orites
	Orthodontium lineare	Cape Thread-moss
	Ozothamnus cupressoides	Kerosene Bush
e P	*Phebalium squamulosum* subsp. *alpinum*	Alpine Phebalium
	Picris angustifolia subsp. *merxmuelleri*	Highland Picris
	Pimelea alpina	Alpine Rice-flower
	Pimelea ligustrina	Tall Rice-flower
	Pimelea spp.	Rice Flower
	Plantago euryphylla	Broad Plantain
	Poa costiniana	Bog Snow-grass
	Poa ensiformis	Sword Tussock-grass
	Poa fawcettiae	Horny Snow-grass
	Poa hiemata	Soft Snow-grass
	Poa hothamensis	Ledge Grass
	Poaceae spp.	Grass
	Podocarpus lawrencei	Mountain Plum-pine
RU	*Podolepis robusta*	Alpine Podolepis
RU	*Podolepis* spp.	Podolepis
	Podolobium alpestre	Alpine Shaggy-pea
RU	*Polystichum proliferum*	Mother Shield-fern
	Polytrichum commune	Common Haircap
	Polytrichum spp.	Haircap
P	*Prasophyllum* spp.	Leek Orchid
P	*Prasophyllum suttonii* (syn. *Prasophyllum alpestre*)	Mauve Leek-orchid
	Ptychostomum pseudotriquetrum	Bog Bryum
	Ranunculus graniticola	Granite Buttercup
e P	*Ranunculus gunnianus*	Gunn's Alpine Buttercup
	Ranunculus lappaceus	Australian Buttercup
	Ranunculus pimpinellifolius	Bog Buttercup
	Ranunculus scapiger	Hairy Buttercup

Status	Scientific Name	Common Name
	Ranunculus spp.	Buttercup
	Rhaphidorrhynchium amoenum	Common Signal-moss
	Rosulabryum capillare	Capillary Thread-moss
	Rubus parvifolius	Small-leaf Bramble
	Rumex brownii	Slender Dock
	Rytidosperma nudiflorum	Alpine Wallaby-grass
	Rytidosperma penicillatum	Weeping Wallaby-grass
	Rytidosperma spp.	Wallaby Grass
	Sanionia uncinata	Sickle-leaved Hook-moss
	Schoenus calyptratus	Alpine Bog-sedge
e P	*Scleranthus brockiei*	Brock Knawel
	Senecio gunnii	Mountain Fireweed
e P	*Senecio pinnatifolius* var. *alpinus*	Snowfield Groundsel
	Senecio spp.	Groundsel
RU ^	*Sphagnum cristatum*	Peat Moss
	Stellaria pungens	Prickly Starwort
RU	*Stylidium armeria* subsp. *armeria*	Common Triggerplant
e P	*Stylidium montanum*	Alpine Triggerplant
RU	*Stylidium* spp.	Trigger Plant
	Tasmannia xerophila subsp. *xerophila*	Alpine Pepper
P	*Thelymitra spp.*	Sun Orchid
e P	*Trochocarpa clarkei*	Lilac Berry
	Veronica serpyllifolia	Thyme Speedwell
	Viola betonicifolia	Showy Violet
	Wahlenbergia ceracea	Waxy Bluebell
	Wahlenbergia gloriosa	Royal Bluebell
RU	*Xerochrysum subundulatum*	Orange Everlasting
	Zoopsis leitgebiana	Glass Centipede
Introduced species		
	Acetosella vulgaris	Sheep Sorrel
	Achillea millefolium	Milfoil
	Agrostis capillaris	Brown-top Bent
	Anthoxanthum odoratum	Sweet Vernal-grass
	Cerastium glomeratum s.s.	Sticky Mouse-ear Chickweed
	Cerastium spp.	Mouse-ear Chickweed
	Cerastium vulgare	Common Mouse-ear Chickweed
RC	*Cirsium vulgare*	Spear Thistle
	Dactylis glomerata	Cocksfoot
	Erythranthe guttata	Monkey Musk
	Erythranthe moschata	Musk Monkey-flower
	Festuca rubra s.s.	Creeping Fescue
	Glyceria declinata	Manna Grass
	Holcus lanatus	Yorkshire Fog
	Hypochaeris radicata	Flatweed
	Juncus articulatus subsp. *articulatus*	Jointed Rush

Status	Scientific Name	Common Name
	Juncus effusus subsp. *effusus*	Soft Rush
	Juncus ensifolius	Sword Rush
	Malus pumila	Apple
	Phleum pratense	Timothy Grass
	Ranunculus repens	Creeping Buttercup
RC	*Rubus anglocandicans*	Common Blackberry
	Rumex conglomeratus	Clustered Dock
	Sonchus asper s.s.	Rough Sow-thistle
	Sonchus spp.	Sow Thistle
	Taraxacum officinale spp. agg.	Garden Dandelion
	Trifolium repens var. *repens*	White Clover
	Viola arvensis	Field Pansy

Table A2.2 Bog-dependent flora species list

Status	Scientific Name	Common Name
^	*Astelia alpina* var. *novae-hollandiae*	Silver Astelia
RU ^	*Baeckea gunniana*	Alpine Baeckea
e P ^	*Baeckea utilis s.l.**	Mountain Baeckea*
^	*Callistemon pityoides*	Alpine Bottlebrush
e P ^	*Carex jackiana*	Carpet Sedge
RU ^	*Dracophyllum continentis* (syn. *Richea continentis*)	Candle Heath
^	*Empodisma minus*	Spreading Rope-rush
RU ^	*Epacris paludosa*	Swamp Heath
^	*Hierochloe redolens*	Sweet Holy-grass
RU ^	*Olearia algida*	Mountain Daisy-bush
RU ^	*Sphagnum cristatum*	Peat Moss

Note: Mountain Baeckea *Baeckea utilis s.l.* includes Subalpine Baeckea *Baeckea latifolia*, which is listed as endangered under the FFG Act, and Mountain Baeckea *Baeckea utilis s.s.*, which is not listed as threatened under the FFG Act. These species are aggregated for the purposes of assessing HEMAMP performance criteria because they cannot be reliably distinguished in the field at Mount Buller.

Appendix 3 Diagnostic Key to Alpine Bogs

This diagnostic key has been reproduced from the key to the EPBC Act listed Alpine Sphagnum Bogs and Associated Fens ecological community on the Australian mainland, prepared by the Australian Government Department of the Environment (DoE 2013). The key appeared in early draft versions of the National Recovery Plan but does not appear in the final version, although the final version does make reference to the key (DoE 2015; A. Tolsma, ARI, pers. comm., February 2019).

Key to the listed Alpine *Sphagnum* bogs and Associated Fens ecological community on the Australian mainland

The listed ecological community comprises two main components, *Sphagnum* bogs and their associated fens. Fens, or fen pools, are species-poor communities typically linked to bogs. They are dominated by sedges and frequently inundated. The bogs which surround or link to fens generally display greater species diversity, and it is this diversity which in part guides the following key.

1. Are you above 1000m in elevation and in the Australian Alps bioregion?
Yes – go to 2 No – Unlikely to be the listed community

2. Is live, hummock-forming *Sphagnum* present and abundant, or if burnt[1], can abundant pre-fire *Sphagnum* be inferred from burnt remnants?
Yes – Is the listed community No, *Sphagnum* is minor or absent – go to 3

3. Does the site have a peat substrate evident?
Yes, or unsure – go to 4 No – Unlikely to be the listed community

4. Is *Sphagnum* present?
Yes – go to 5 No – go to 6

5. Is most of the non-*Sphagnum* vegetation cover composed of two or more of the diagnostic species listed below?
Yes – Is the listed community. No – Not the listed community, but may be transitional or a degraded version[2]

6. Is most of the vegetation cover composed of 3 or more of the diagnostic species?
Yes – Is the listed community, possibly degraded. No – Not the listed community, but may be transitional or a degraded version[2]

<u>Diagnostic species other than *Sphagnum*</u>:

- *Empodisma minus*
- *Epacris* spp (usually *E. paludosa, E. glacialis, E. celata or E. breviflora*)
- *Richea* spp (*R. continentis or R. victoriana*)
- *Baeckea* spp (usually *B. gunniana, B. latifolia or B.utilis*)
- *Astelia alpina*
- *Carpha nivicola*
- *Baloskion australe*
- *Carex gaudichaudiana*
- *Callistemon pityoides*
- *Hakea microcarpa*
- *Carex jackiana*[3]
- *Hierochloe redolens*[3]
- *Olearia algida*[3]

---

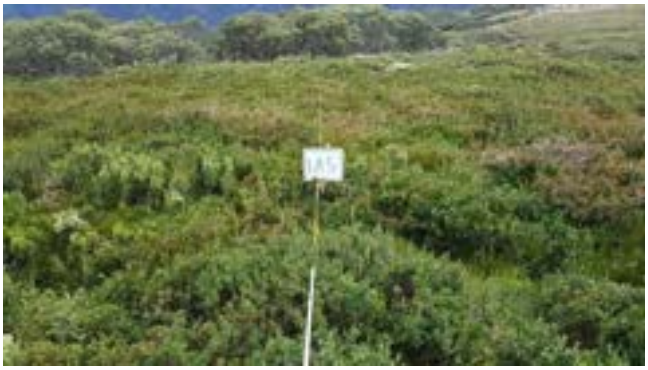
[1] If a site has been recently and severely burnt, *Sphagnum* and other key diagnostic species may be temporarily absent (live hummock-forming *Sphagnum* would normally comprise at least 20-30% cover).In this case, assessment of the site for the listed community should be delayed for at least 24 months. However, the presence of burnt hummocks over peat indicates the community is present.

[2] Clarification: no need to refer.

[3] This key originally appeared in a draft version of the National Recovery Plan for the Alpine Sphagnum Bogs and Associated Fens. The key has been left unchanged except for the addition of these three species and this footnote. These species have been added by Biosis for the purposes of monitoring Alpine Bogs at Mount Buller and Mount Stirling, Victoria. At these locations, Carex jackiana, Hierochloe redolens and Olearia algida are restricted to Alpine Bogs and are therefore amongst the diagnostic species.

Appendix 4 Photo points

Bog 1 (Control Site), Photo Point 1AS

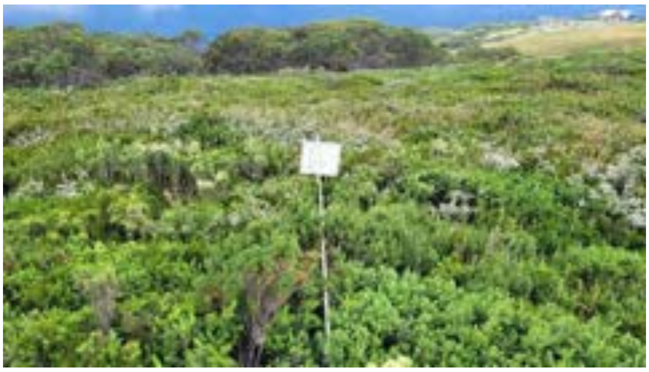


Baseline Year 1, 9 February 2018

Baseline Year 2, 31 January 2019

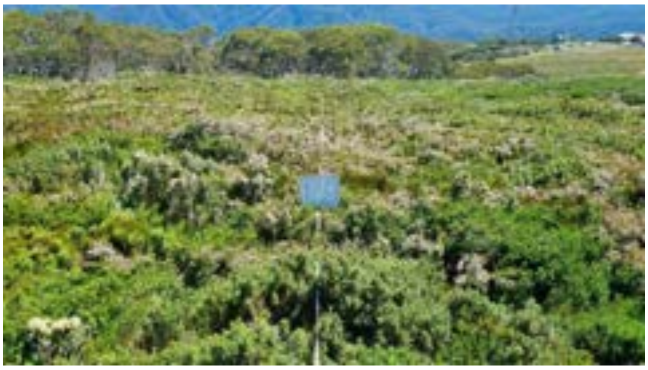
Impact Year 1, 31 January 2020

Impact Year 2, 2 February 2021



Impact Year 3, 31 January 2022

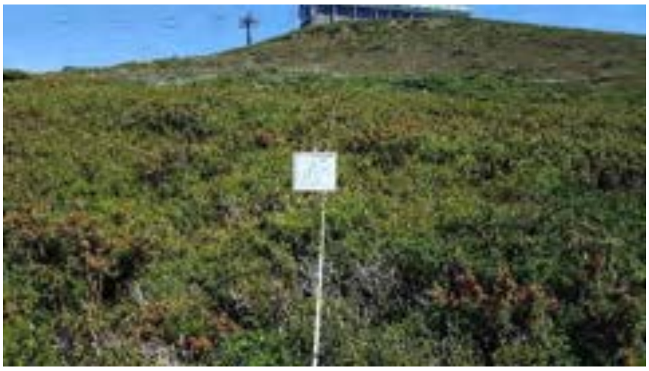
Impact Year 4, 2 February 2023



Impact Year 5, 29 January 2024

Bog 1 (Control Site), Photo Point 1AE

Baseline Year 1, 9 February 2018



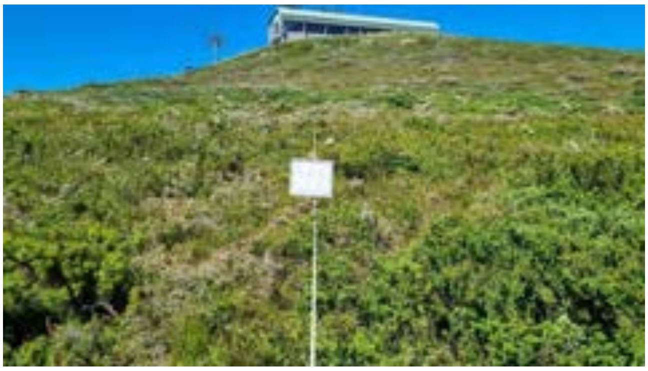
Baseline Year 2, 31 January 2019

Impact Year 1, 31 January 2020

Impact Year 2, 2 February 2021

Impact Year 3, 31 January 2022

Impact Year 4, 2 February 2023

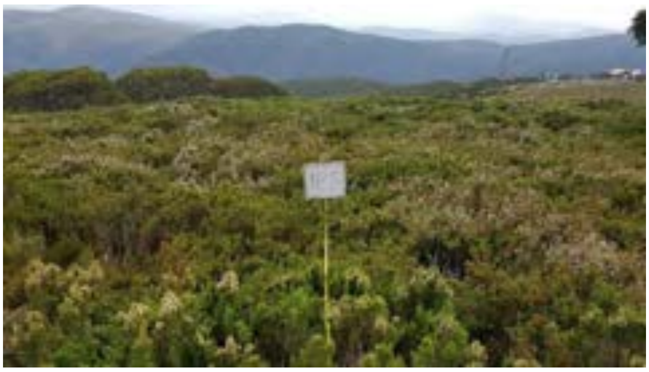


Impact Year 5, 29 January 2024

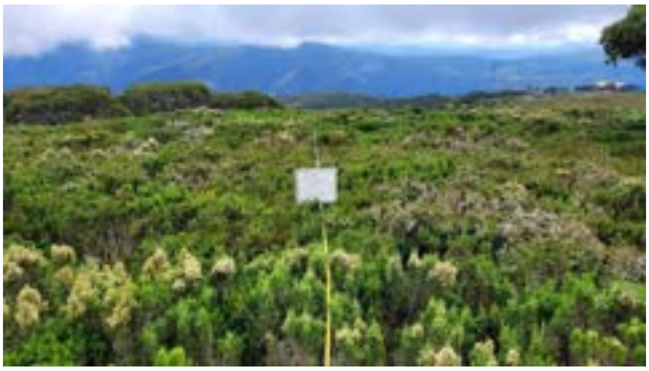
Bog 1 (Control Site), Photo Point 1BS


Baseline Year 1, 9 February 2018


Baseline Year 2, 31 January 2019


Impact Year 1, 31 January 2020

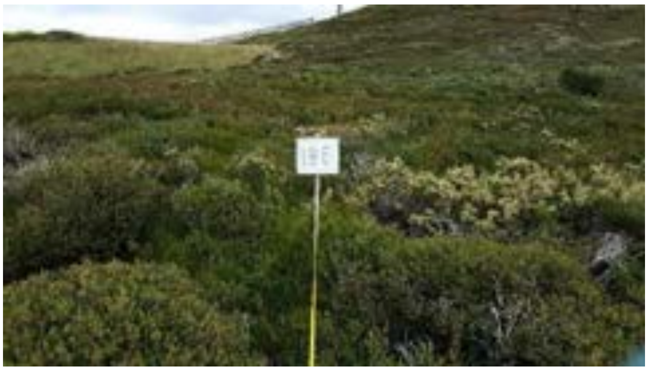

Impact Year 2, 2 February 2021


Impact Year 3, 31 January 2022


Impact Year 4, 23 January 2023


Impact Year 5, 29 January 2024

Bog 1 (Control Site), Photo Point 1BE


Baseline Year 1, 9 February 2018


Baseline Year 2, 31 January 2019


Impact Year 1, 31 January 2020


Impact Year 2, 2 February 2021


Impact Year 3, 31 January 2022


Impact Year 4, 23 January 2023


Impact Year 5, 29 January 2024

Bog 1 (Control Site), Photo Point 1CS

Baseline Year 1, 9 February 2018

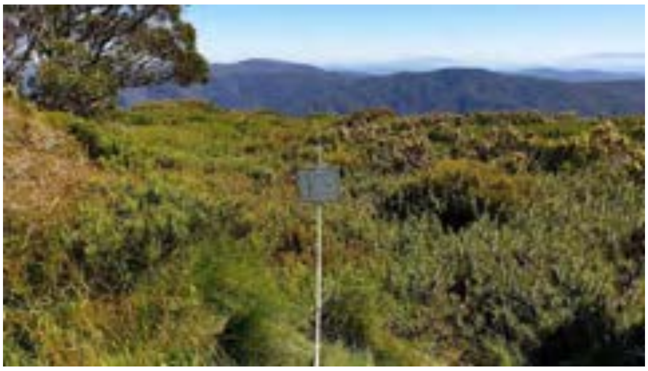
Baseline Year 2, 31 January 2019

Impact Year 1, 31 January 2020

Impact Year 2, 2 February 2021

Impact Year 3, 31 January 2022

Impact Year 4, 23 January 2023



Impact Year 5, 29 January 2024

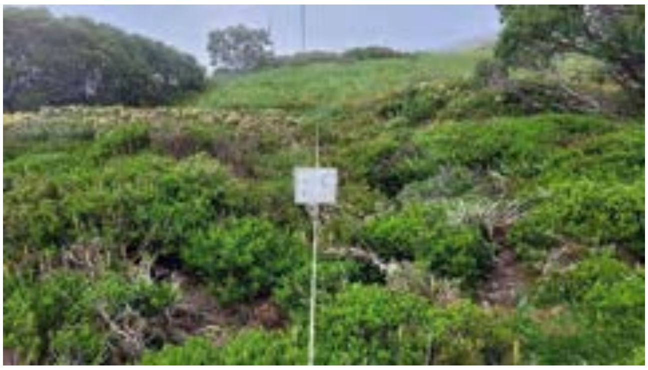
Bog 1 (Control Site), Photo Point 1CE


Baseline Year 1, 9 February 2018


Baseline Year 2, 31 January 2019


Impact Year 1, 31 January 2020

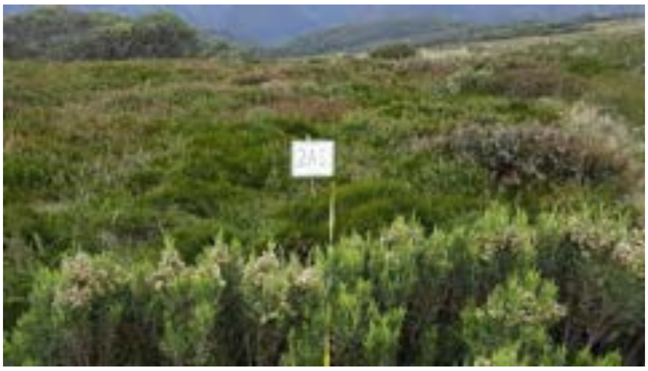

Impact Year 2, 2 February 2021


Impact Year 3, 31 January 2022


Impact Year 4, 23 January 2023


Impact Year 5, 29 January 2024

Bog 2 (Control Site), Photo Point 2AS



Baseline Year 1, 9 February 2018

Baseline Year 2, 31 January 2019

Impact Year 1, 3 February 2020

Impact Year 2, 26 January 2021

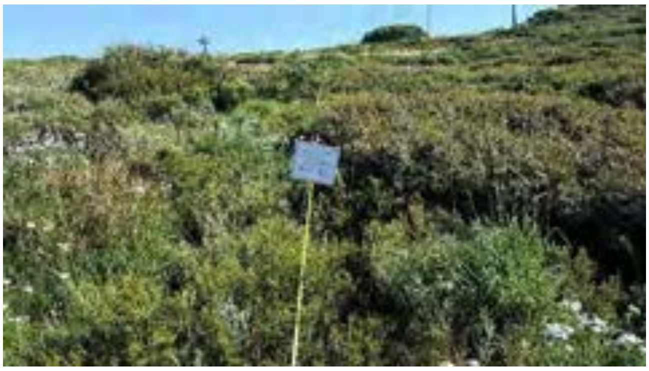
Impact Year 3, 31 January 2022

Impact Year 4, 26 January 2023

Impact Year 5, 8 February 2024

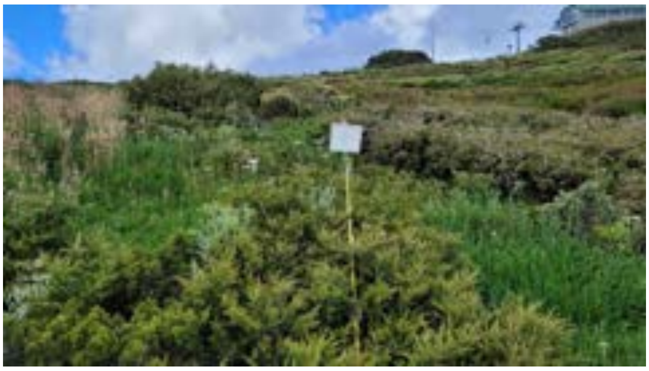
Bog 2 (Control Site), Photo Point 2AE

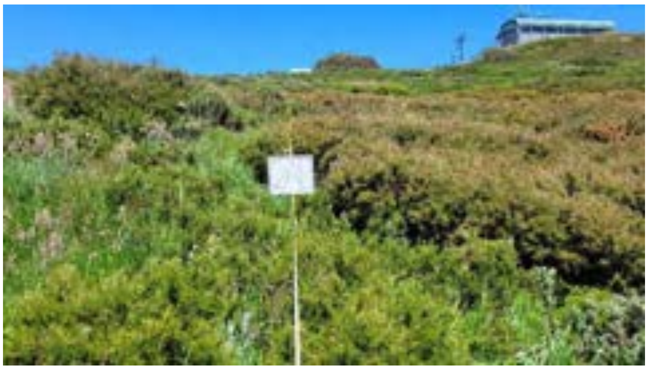

Baseline Year 1, 9 February 2018


Baseline Year 2, 31 January 2019


Impact Year 1, 3 February 2020

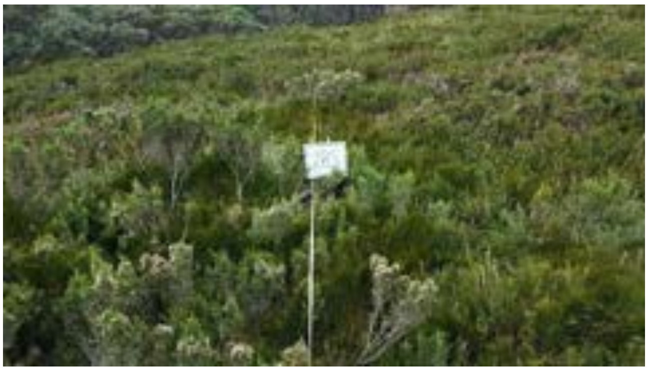

Impact Year 2, 26 January 2021


Impact Year 3, 31 January 2022


Impact Year 4, 26 January 2023


Impact Year 5, 8 February 2024

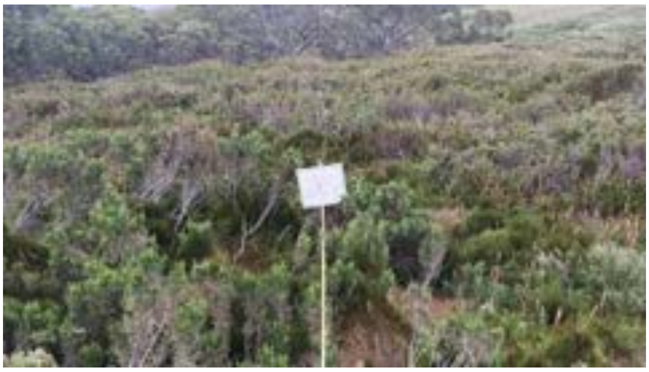
Bog 2 (Control Site), Photo Point 2BS



Baseline Year 1, 9 February 2018

Baseline Year 2, 1 February 2019

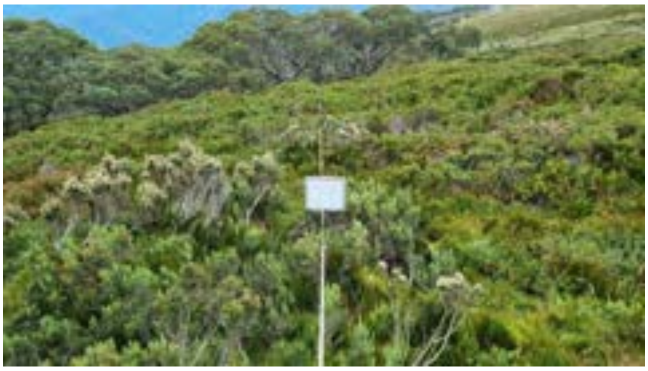
Impact Year 1, 3 February 2020



Impact Year 2, 25 January 2021

Impact Year 3, 31 January 2022

Impact Year 4, 26 January 2023



Impact Year 5, 8 February 2024

Bog 2 (Control Site), Photo Point 2BE

Baseline Year 1, 9 February 2018

Baseline Year 2, 1 February 2019

Impact Year 1, 3 February 2020

Impact Year 2, 25 January 2021

Impact Year 3, 31 January 2022

Impact Year 4, 26 January 2023

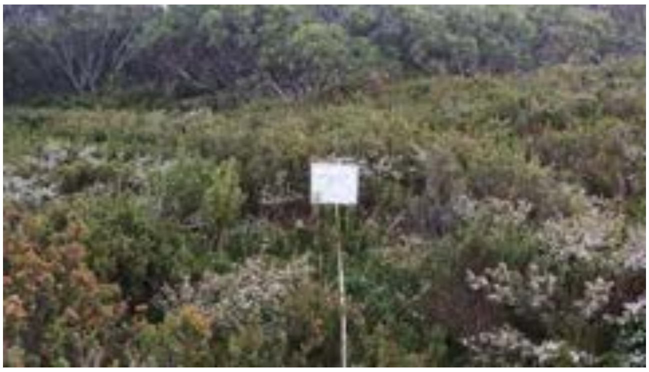
Impact Year 5, 8 February 2024

Bog 2 (Control Site), Photo Point 2CS

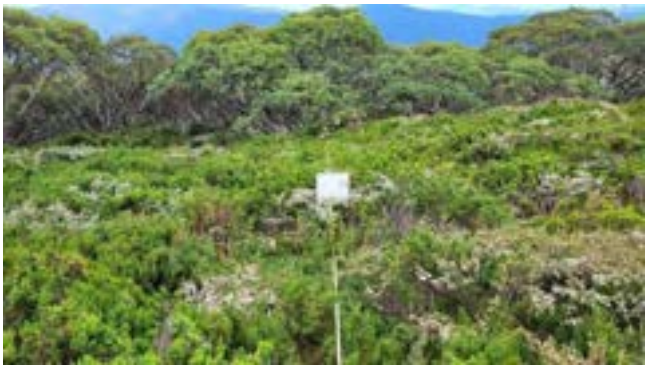
Baseline Year 1, 9 February 2018

Baseline Year 2, 1 February 2019

Impact Year 1, 3 February 2020

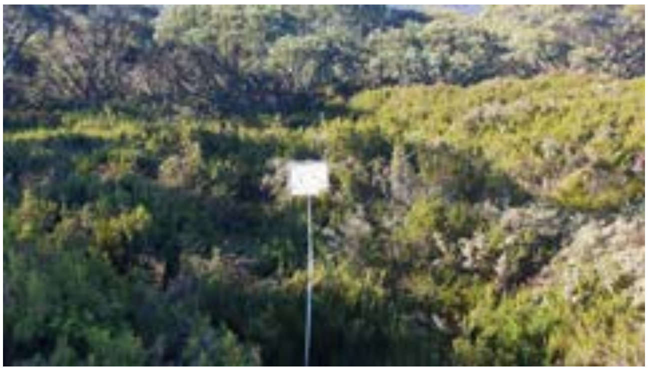


Impact Year 2, 25 January 2021



Impact Year 3, 31 January 2022

Impact Year 4, 2 February 2023



Impact Year 5, 2 February 2024

Bog 2 (Control Site), Photo Point 2CE


Baseline Year 1, 9 February 2018


Baseline Year 2, 1 February 2019


Impact Year 1, 3 February 2020

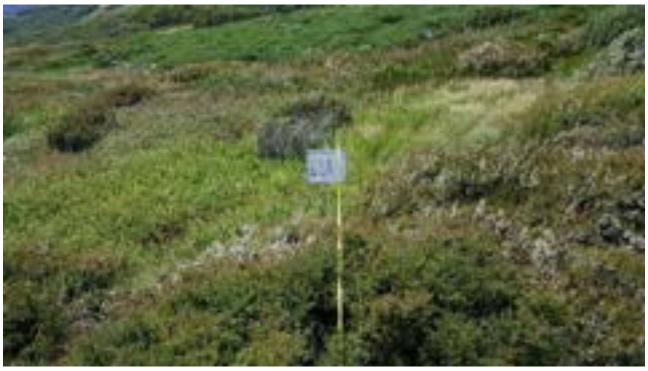

Impact Year 2, 26 January 2021


Impact Year 3, 31 January 2022


Impact Year 4, 2 February 2023


Impact Year 5, 2 February 2024

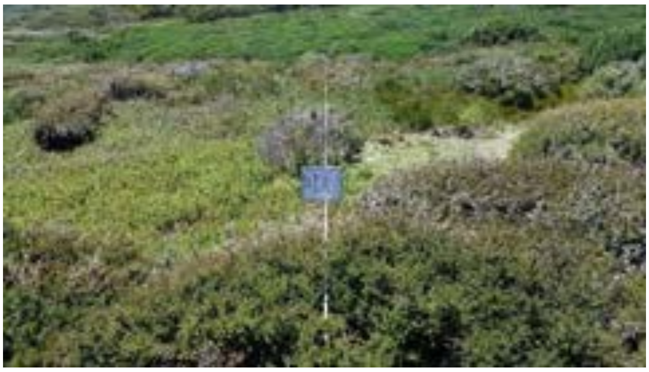
Bog 4.1/5/7 (Control Site), Photo Point 4.1AS



Baseline Year 1, 8 February 2018

Baseline Year 2, 14 February 2019

Impact Year 1, 4 February 2020



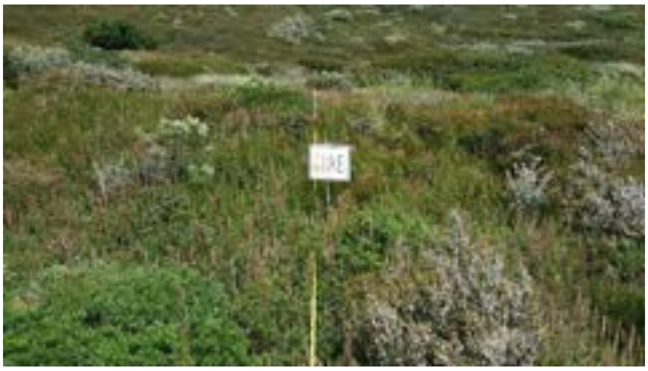
Impact Year 2, 2 February 2021

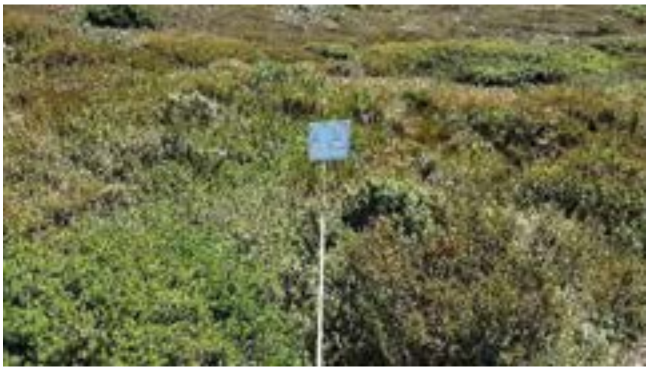
Impact Year 3, 9 February 2022

Impact Year 4, 2 February 2023

Impact Year 5, 5 February 2024

Bog 4.1/5/7 (Control Site), Photo Point 4.1AE


Baseline Year 1, 8 February 2018

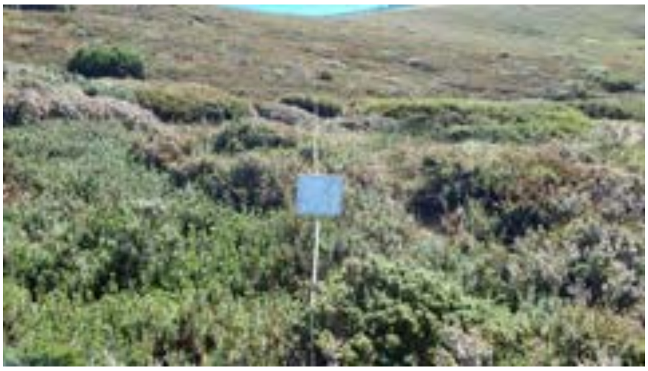

Baseline Year 2, 14 February 2019


Impact Year 1, 4 February 2020

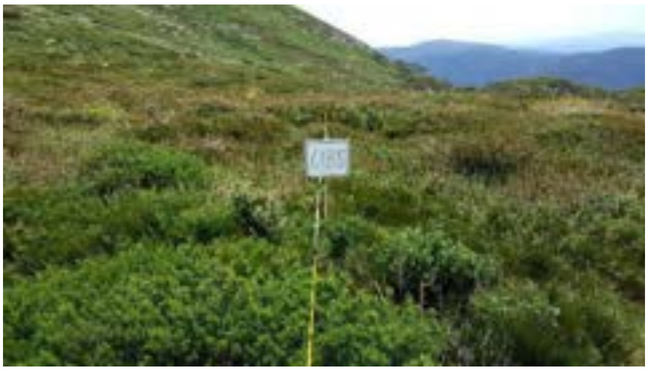

Impact Year 2, 2 February 2021


Impact Year 3, 9 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 31 January 2024

Bog 4.1/5/7 (Control Site), Photo Point 4.1BS


Baseline Year 1, 8 February 2018


Baseline Year 2, 14 February 2019


Impact Year 1, 4 February 2020

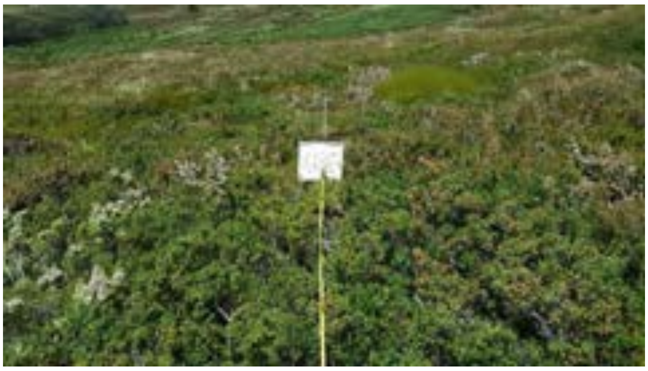

Impact Year 2, 1 February 2021

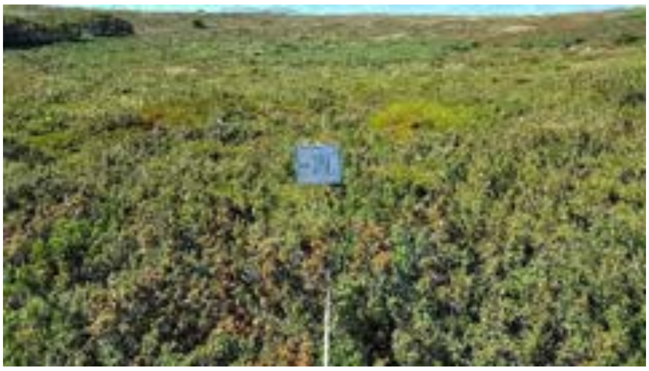

Impact Year 3, 8 February 2022


Impact Year 4, 25 January 2023


Impact Year 5, 31 January 2024

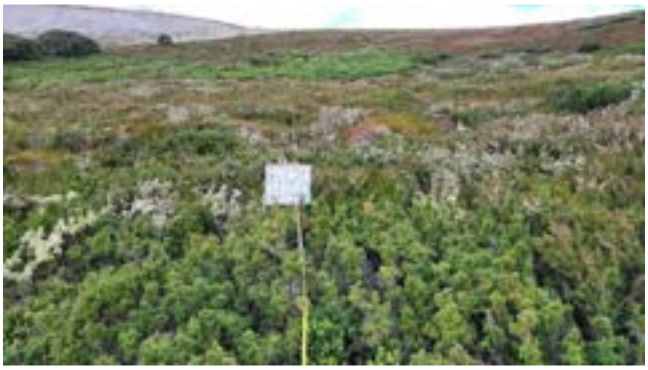
Bog 4.1/5/7 (Control Site), Photo Point 4.1BE

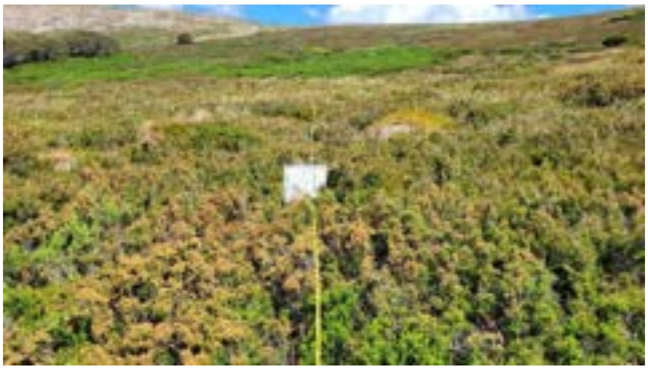

Baseline Year 1, 8 February 2018


Baseline Year 2, 14 February 2019


Impact Year 1, 4 February 2020


Impact Year 2, 1 February 2021


Impact Year 3, 8 February 2022


Impact Year 4, 25 January 2023


Impact Year 5, 31 January 2024

Bog 4.1/5/7 (Control Site), Photo Point 4.1CS


Baseline Year 1, 8 February 2018


Baseline Year 2, 14 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 28 January 2021


Impact Year 3, 8 February 2022


Impact Year 4, 25 January 2023

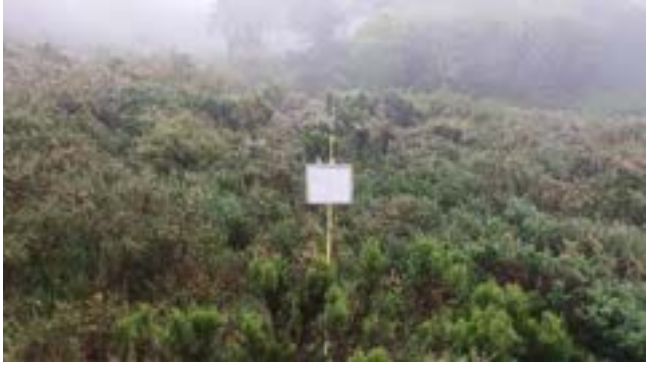

Impact Year 5, 31 January 2024

Bog 4.1/5/7 (Control Site), Photo Point 4.1CE


Baseline Year 1, 8 February 2018


Baseline Year 2, 14 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 28 January 2021


Impact Year 3, 8 February 2022


Impact Year 4, 25 January 2023


Impact Year 5, 31 January 2024

Bog 4.1/5/7 (Control Site), Photo Point 5AS


Baseline Year 1, 8 February 2018


Baseline Year 2, 14 February 2019


Impact Year 1, 6 February 2020


Impact Year 2, 1 February 2021

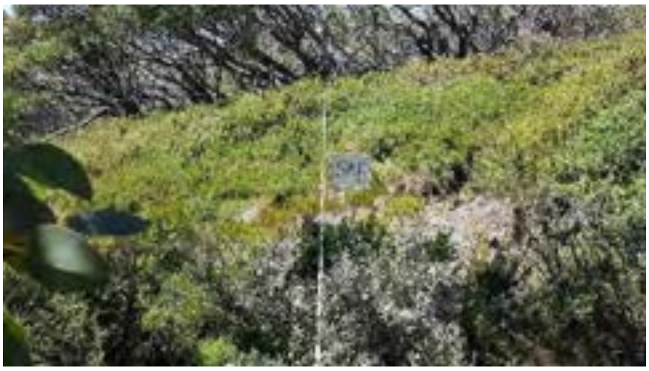

Impact Year 3, 8 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 31 January 2024

Bog 4.1/5/7 (Control Site), Photo Point 5AE


Baseline Year 1, 8 February 2018


Baseline Year 2, 14 February 2019


Impact Year 1, 6 February 2020


Impact Year 2, 1 February 2021


Impact Year 3, 8 February 2022


Impact Year 4, 2 February 2023

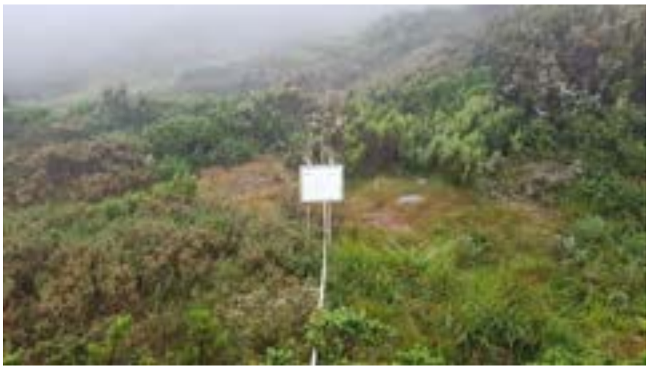

Impact Year 5, 31 January 2024

Bog 4.1/5/7 (Control Site), Photo Point 7AS


Baseline Year 1, 1 February 2018


Baseline Year 2, 11 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 28 January 2021


Impact Year 3, 8 February 2022


Impact Year 4, 25 January 2023


Impact Year 5, 31 January 2024

Bog 4.1/5/7 (Control Site), Photo Point 7AE


Baseline Year 1, 1 February 2018


Baseline Year 2, 11 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 28 January 2021

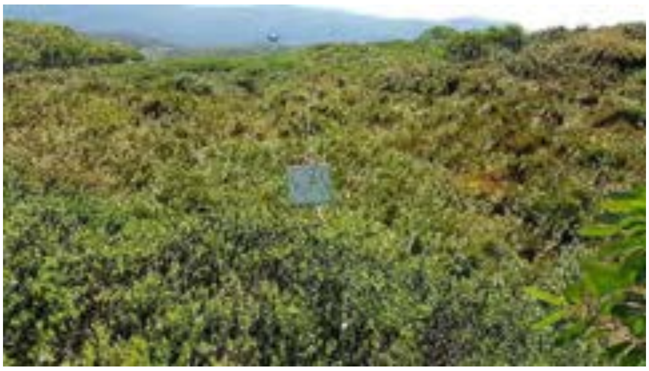

Impact Year 3, 8 February 2022


Impact Year 4, 25 January 2023


Impact Year 5, 31 January 2024

Bog 4.2 (Impact Site), Photo Point 4.2AS


Baseline Year 1, 30 January 2018


Baseline Year 2, 1 February 2019


Impact Year 1, 5 February 2020

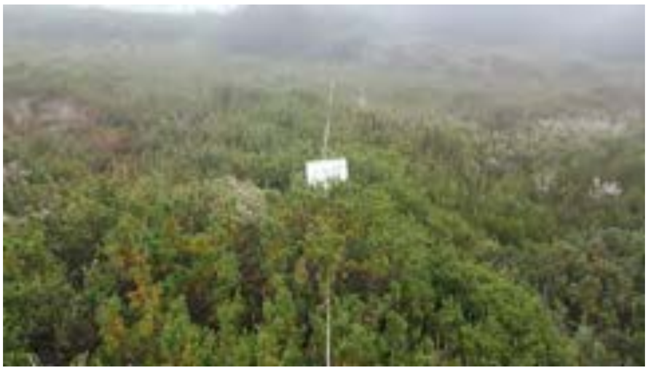

Impact Year 2, 1 February 2021

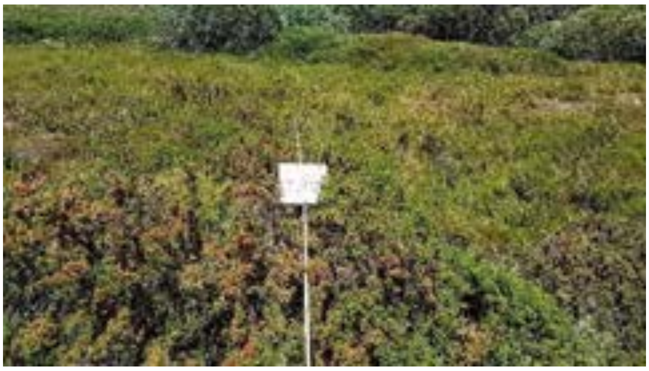

Impact Year 3, 8 February 2022

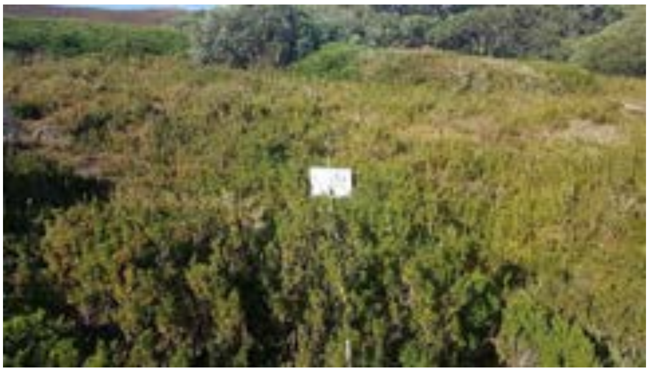

Impact Year 4, 24 January 2023

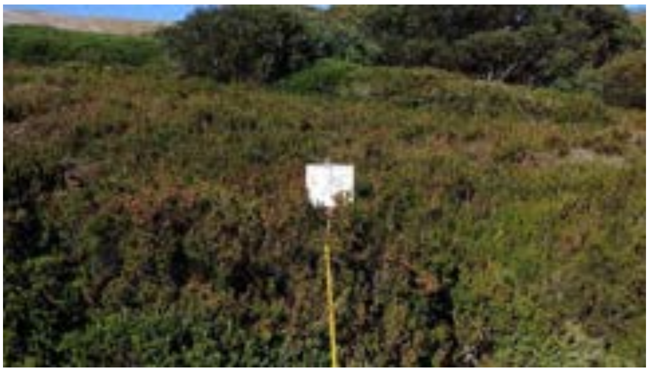

Impact Year 5, 30 January 2024

Bog 4.2 (Impact Site), Photo Point 4.2AE


Baseline Year 1, 30 January 2018

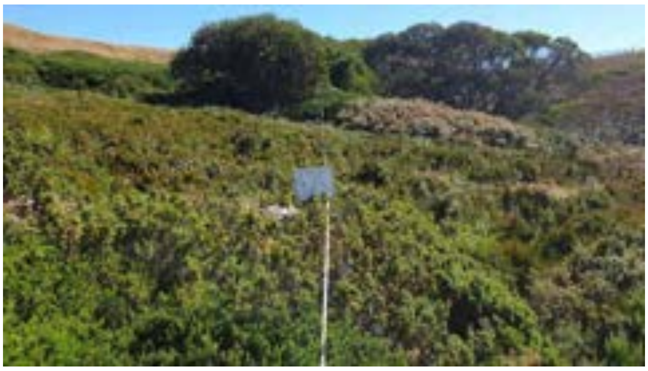

Baseline Year 2, 1 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 1 February 2021


Impact Year 3, 8 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 30 January 2024

Bog 4.2 (Impact Site), Photo Point 4.2BS


Baseline Year 1, 30 January 2018


Baseline Year 2, 1 February 2019


Impact Year 1, 4 February 2020


Impact Year 2, 1 February 2021


Impact Year 3, 8 February 2022


Impact Year 4, 1 February 2023


Impact Year 5, 30 January 2024

Bog 4.2 (Impact Site), Photo Point 4.2BE


Baseline Year 1, 30 January 2018


Baseline Year 2, 1 February 2019


Impact Year 1, 4 February 2020


Impact Year 2, 1 February 2021


Impact Year 3, 8 February 2022


Impact Year 4, 24 January 2023


Impact Year 5, 30 January 2024

Bog 4.2 (Impact Site), Photo Point 4.2CS


Baseline Year 1, 31 January 2018


Baseline Year 2, 1 February 2019


Impact Year 1, 4 February 2020

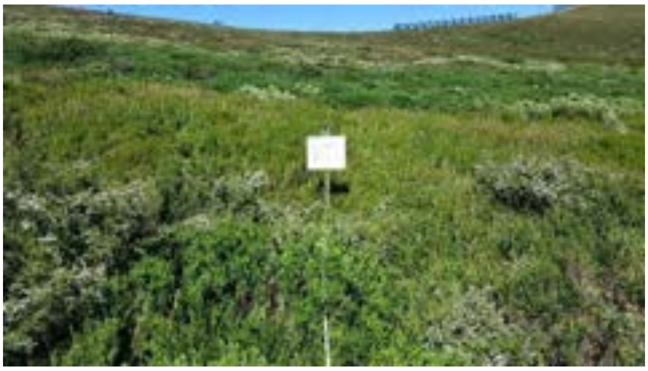

Impact Year 2, 2 February 2021


Impact Year 3, 8 February 2022

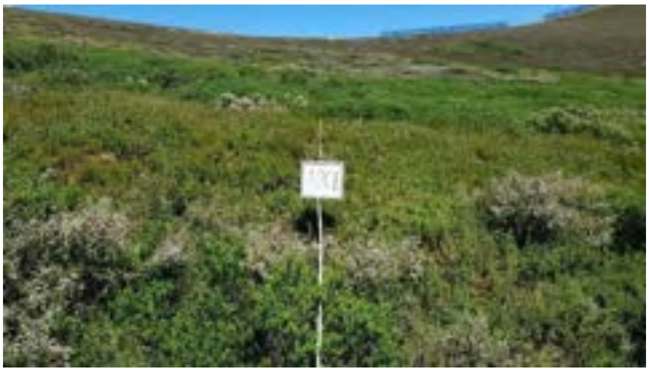

Impact Year 4, 24 January 2023

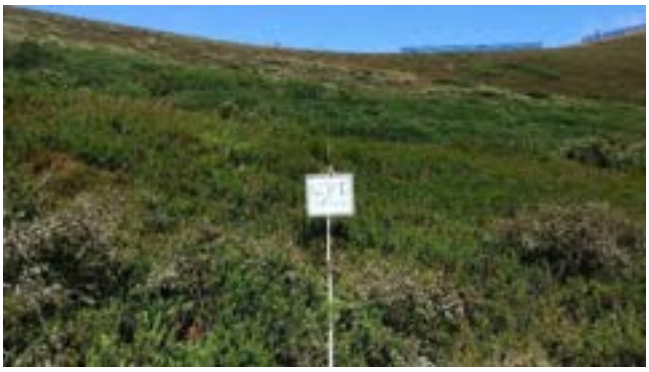

Impact Year 5, 31 January 2024

Bog 4.2 (Impact Site), Photo Point 4.2CE


Baseline Year 1, 31 January 2018


Baseline Year 2, 1 February 2019


Impact Year 1, 4 February 2020


Impact Year 2, 2 February 2021


Impact Year 3, 8 February 2022


Impact Year 4, 24 January 2023


Impact Year 5, 31 January 2024

Bog 4.2 (Impact Site), Photo Point 4.2DS


Baseline Year 1, 31 January 2018


Baseline Year 2, 1 February 2019


Impact Year 1, 4 February 2020


Impact Year 2, 1 February 2021


Impact Year 3, 8 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 30 January 2024

Bog 4.2 (Impact Site), Photo Point 4.2DE


Baseline Year 1, 31 January 2018

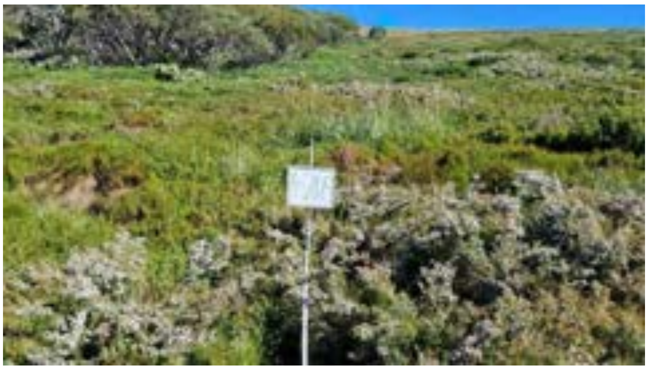

Baseline Year 2, 1 February 2019


Impact Year 1, 4 February 2020


Impact Year 2, 1 February 2021


Impact Year 3, 8 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 30 January 2024

Bog 4.2 (Impact Site), Photo Point 4.2ES


Baseline Year 1, 31 January 2018


Baseline Year 2, 1 February 2019


Impact Year 1, 4 February 2020


Impact Year 2, 2 February 2021


Impact Year 3, 8 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 30 January 2024

Bog 4.2 (Impact Site), Photo Point 4.2EE


Baseline Year 1, 31 January 2018


Baseline Year 2, 1 February 2019


Impact Year 1, 4 February 2020


Impact Year 2, 2 February 2021


Impact Year 3, 8 February 2022

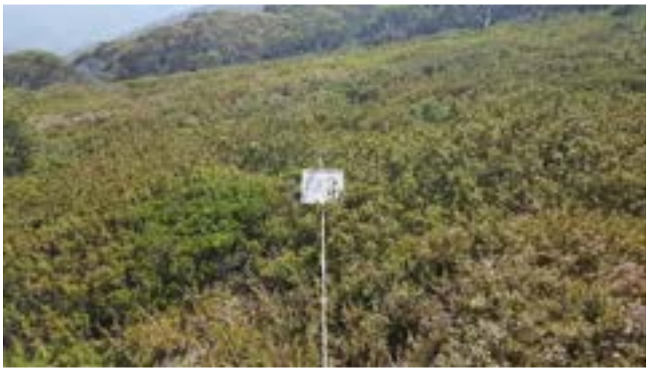

Impact Year 4, 2 February 2023


Impact Year 5, 30 January 2024

Bog 6 (Impact Site), Photo Point 6AS


Baseline Year 1, 31 January 2018


Baseline Year 2, 1 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 28 January 2021

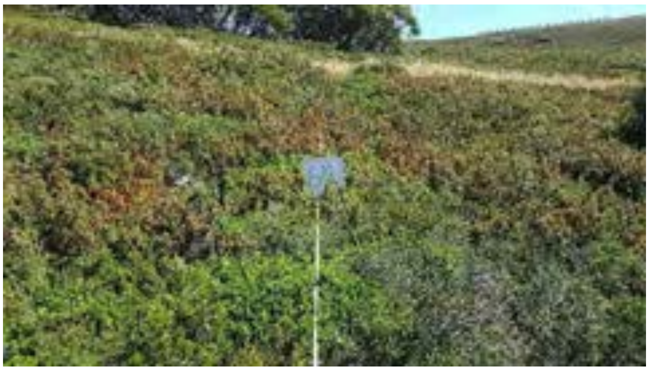

Impact Year 3, 7 February 2022

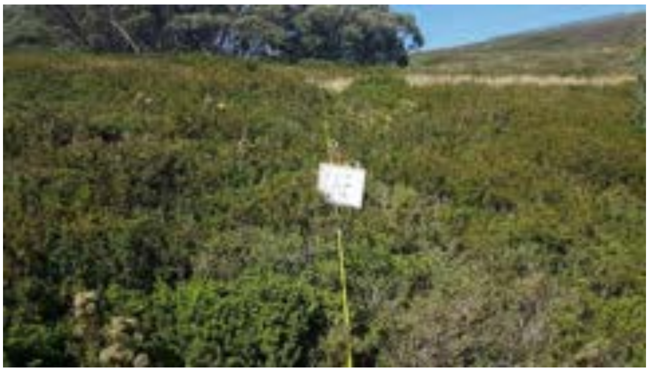

Impact Year 4, 2 February 2023

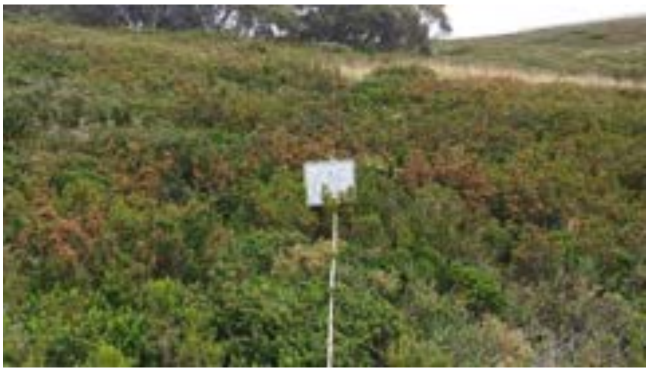

Impact Year 5, 8 February 2024

Bog 6 (Impact Site), Photo Point 6AE


Baseline Year 1, 31 January 2018


Baseline Year 2, 1 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 28 January 2021


Impact Year 3, 7 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 8 February 2024

Bog 6 (Impact Site), Photo Point 6BS


Baseline Year 1, 31 January 2018


Baseline Year 2, 14 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 27 January 2021


Impact Year 3, 7 February 2022


Impact Year 4, 25 January 2023


Impact Year 5, 5 February 2024

Bog 6 (Impact Site), Photo Point 6BE


Baseline Year 1, 31 January 2018


Baseline Year 2, 14 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 27 January 2021


Impact Year 3, 7 February 2022


Impact Year 4, 25 January 2023


Impact Year 5, 30 January 2024

Bog 6 (Impact Site), Photo Point 6CS


Baseline Year 1, 1 February 2018


Baseline Year 2, 11 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 28 January 2021


Impact Year 3, 7 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 8 February 2024

Bog 6 (Impact Site), Photo Point 6CE


Baseline Year 1, 1 February 2018


Baseline Year 2, 11 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 28 January 2021


Impact Year 3, 7 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 1 February 2024

Bog 6 (Impact Site), Photo Point 6DS


Baseline Year 1, 1 February 2018


Baseline Year 2, 11 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 28 January 2021


Impact Year 3, 7 February 2022


Impact Year 4, 25 January 2023


Impact Year 5, 8 February 2024

Bog 6 (Impact Site), Photo Point 6DE


Baseline Year 1, 1 February 2018


Baseline Year 2, 11 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 28 January 2021


Impact Year 3, 7 February 2022


Impact Year 4, 25 January 2023

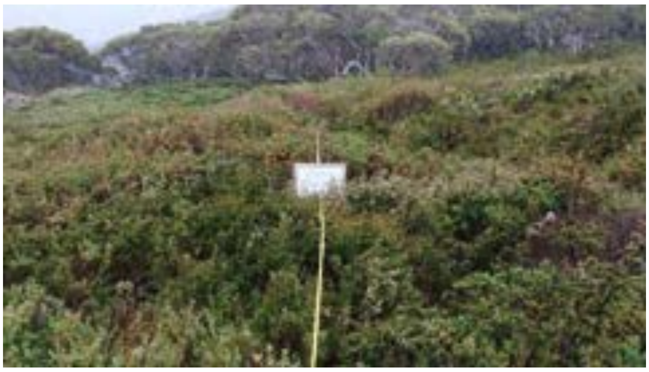

Impact Year 5, 8 February 2024

Bog 6 (Impact Site), Photo Point 6ES


Baseline Year 1, 1 February 2018


Baseline Year 2, 11 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 28 January 2021


Impact Year 3, 7 February 2022

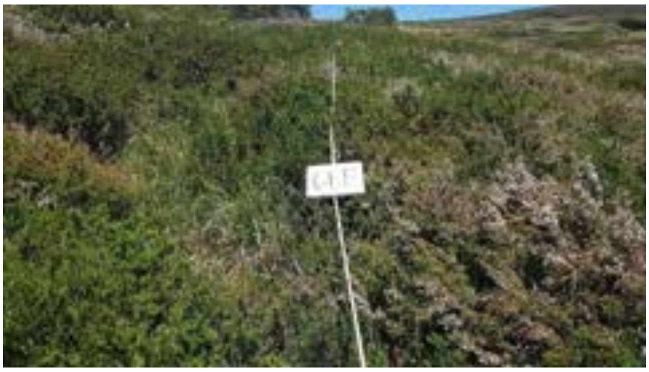

Impact Year 4, 25 January 2023


Impact Year 5, 8 February 2024

Bog 6 (Impact Site), Photo Point 6EE

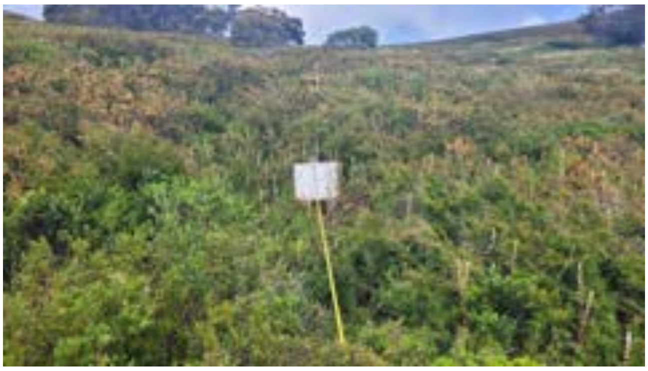

Baseline Year 1, 1 February 2018


Baseline Year 2, 11 February 2019


Impact Year 1, 5 February 2020


Impact Year 2, 28 January 2021

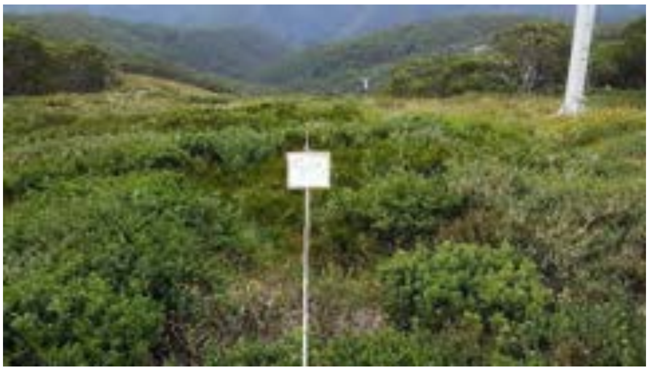

Impact Year 3, 7 February 2022


Impact Year 4, 25 January 2023


Impact Year 5, 8 February 2024

Bog 8/9/10 (Impact Site), Photo Point 8AS

Baseline Year 1, 26 January 2018



Baseline Year 2, 29 January 2019

Impact Year 1, 18 February 2020

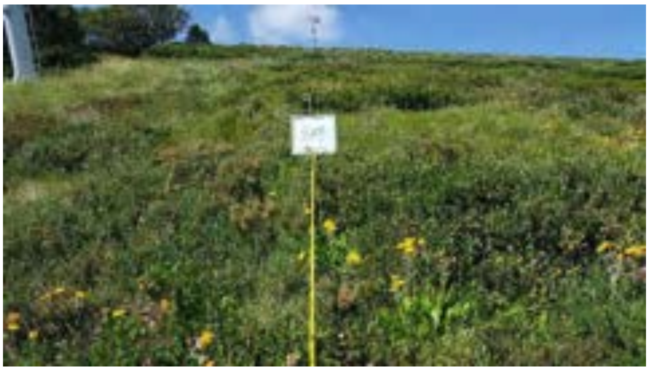
Impact Year 2, 27 January 2021

Impact Year 3, 1 February 2022

Impact Year 4, 24 January 2023

Impact Year 5, 30 January 2024

Bog 8/9/10 (Impact Site), Photo Point 8AE


Baseline Year 1, 26 January 2018

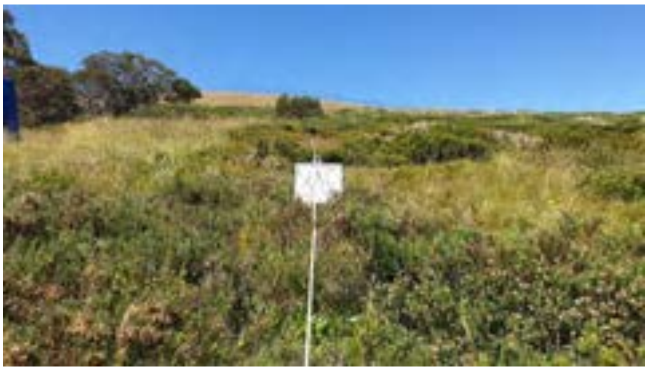

Baseline Year 2, 29 January 2019


Impact Year 1, 18 February 2020


Impact Year 2, 27 January 2021


Impact Year 3, 1 February 2022


Impact Year 4, 24 January 2023


Impact Year 5, 30 January 2024

Bog 8/9/10 (Impact Site), Photo Point 8BS


Baseline Year 1, 26 January 2018


Baseline Year 2, 29 January 2019


Impact Year 1, 18 February 2020


Impact Year 2, 27 January 2021


Impact Year 3, 1 February 2022

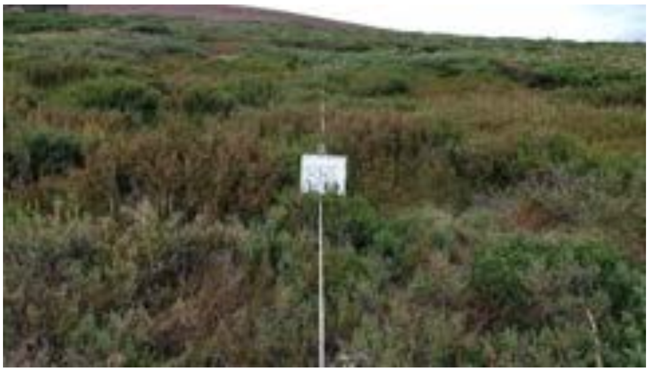

Impact Year 4, 2 February 2023

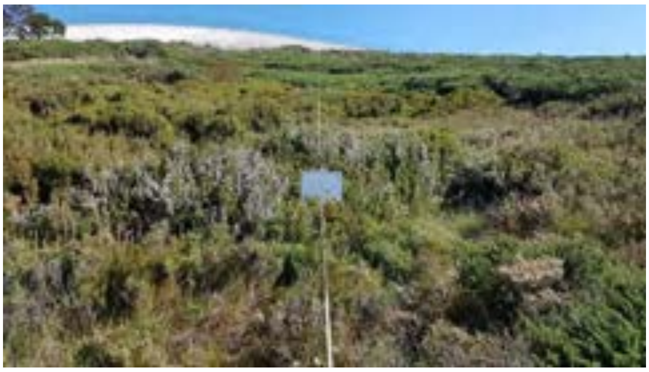

Impact Year 5, 30 January 2024

Bog 8/9/10 (Impact Site), Photo Point 8BE


Baseline Year 1, 26 January 2018

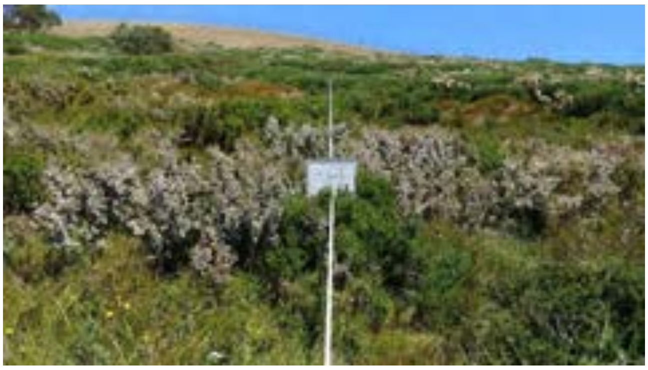

Baseline Year 2, 29 January 2019


Impact Year 1, 18 February 2020


Impact Year 2, 27 January 2021

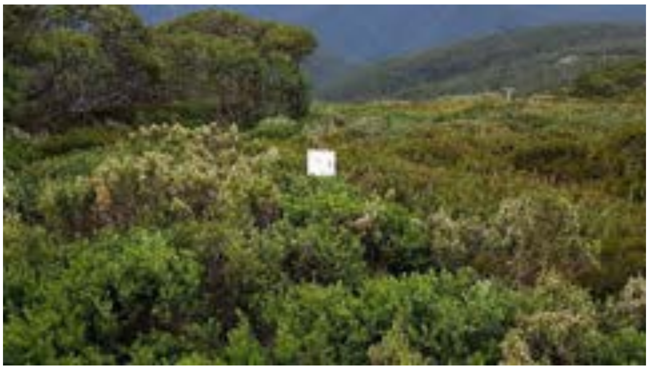

Impact Year 3, 1 February 2022


Impact Year 4, 2 February 2023

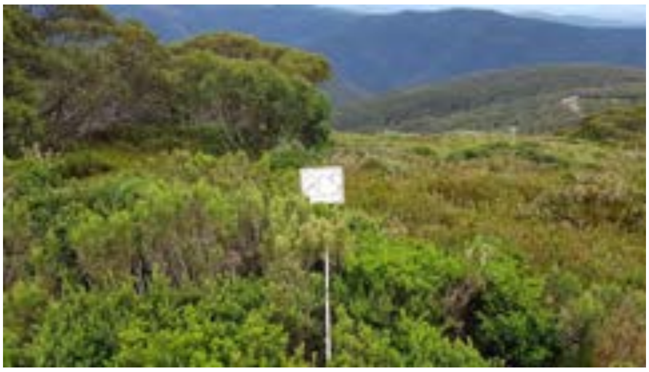

Impact Year 5, 30 January 2024

Bog 8/9/10 (Impact Site), Photo Point 8CS


Baseline Year 1, 26 January 2018


Baseline Year 2, 30 January 2019


Impact Year 1, 20 February 2020

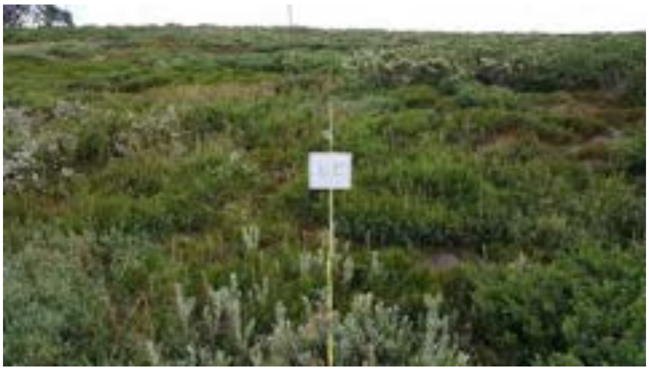

Impact Year 2, 28 January 2021


Impact Year 3, 3 February 2022

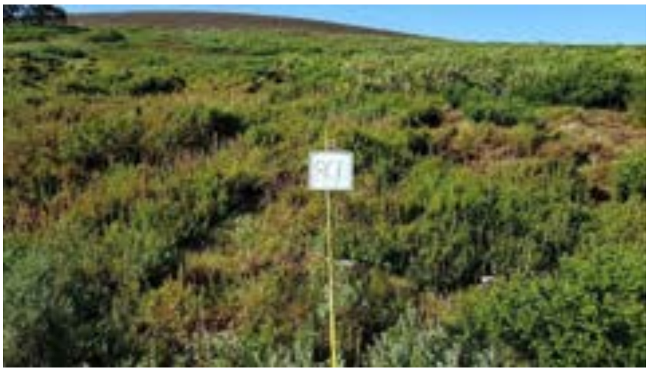

Impact Year 4, 24 January 2023


Impact Year 5, 30 January 2024

Bog 8/9/10 (Impact Site), Photo Point 8CE


Baseline Year 1, 26 January 2018


Baseline Year 2, 30 January 2019


Impact Year 1, 20 February 2020


Impact Year 2, 28 January 2021


Impact Year 3, 3 February 2022


Impact Year 4, 24 January 2023


Impact Year 5, 30 January 2024

Bog 8/9/10 (Impact Site), Photo Point 9AS


Baseline Year 1, 27 January 2018


Baseline Year 2, 30 January 2019


Impact Year 1, 7 February 2020

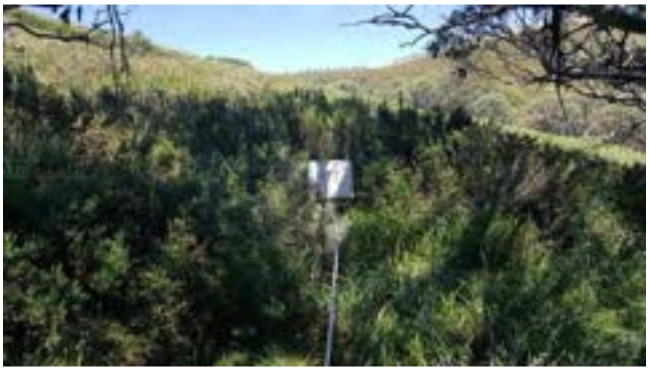

Impact Year 2, 27 January 2021


Impact Year 3, 1 February 2022


Impact Year 4, 24 January 2023


Impact Year 5, 30 January 2024

Bog 8/9/10 (Impact Site), Photo Point 9AE


Baseline Year 1, 27 January 2018


Baseline Year 2, 30 January 2019


Impact Year 1, 7 February 2020


Impact Year 2, 27 January 2021


Impact Year 3, 1 February 2022


Impact Year 4, 24 January 2023


Impact Year 5, 30 January 2024

Bog 8/9/10 (Impact Site), Photo Point 10AS


Baseline Year 1, 27 January 2018


Baseline Year 2, 30 January 2019


Impact Year 1, 7 February 2020


Impact Year 2, 28 January 2021


Impact Year 3, 3 February 2022


Impact Year 4, 24 January 2023


Impact Year 5, 30 January 2024

Bog 8/9/10 (Impact Site), Photo Point 10AE

Baseline Year 1, 27 January 2018

Baseline Year 2, 30 January 2019

Impact Year 1, 7 February 2020

Impact Year 2, 28 January 2021

Impact Year 3, 3 February 2022

Impact Year 4, 24 January 2023

Impact Year 5, 30 January 2024

Bog 11.1 (Control Site), Photo Point 11.1AS


Baseline Year 1, 8 February 2018


Baseline Year 2, 31 January 2019


Impact Year 1, 3 February 2020


Impact Year 2, 25 January 2021


Impact Year 3, 31 January 2022


Impact Year 4, 2 February 2023


Impact Year 5, 29 January 2024

Bog 11.1 (Control Site), Photo Point 11.1AE


Baseline Year 1, 8 February 2018


Baseline Year 2, 31 January 2019


Impact Year 1, 3 February 2020


Impact Year 2, 25 January 2021


Impact Year 3, 31 January 2022


Impact Year 4, 2 February 2023

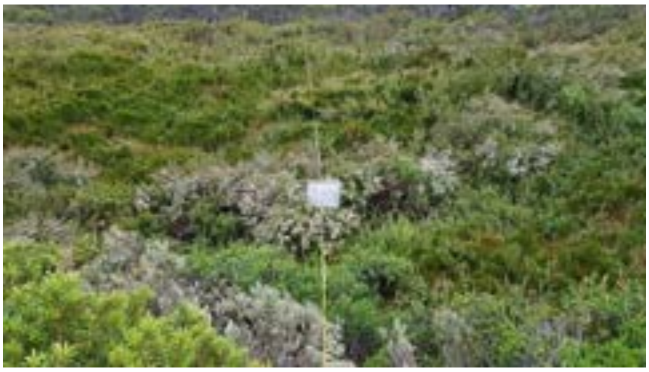

Impact Year 5, 29 January 2024

Bog 11.1 (Control Site), Photo Point 11.1BS


Baseline Year 1, 8 February 2018


Baseline Year 2, 31 January 2019


Impact Year 1, 3 February 2020


Impact Year 2, 25 January 2021


Impact Year 3, 31 January 2022


Impact Year 4, 23 January 2023


Impact Year 5, 29 January 2024

Bog 11.1 (Control Site), Photo Point 11.1BE


Baseline Year 1, 8 February 2018


Baseline Year 2, 31 January 2019


Impact Year 1, 3 February 2020

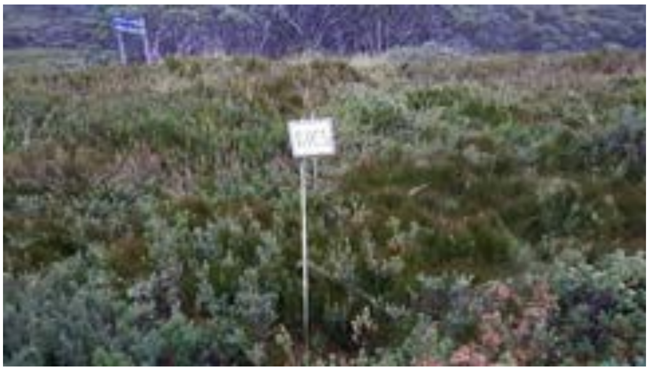

Impact Year 2, 25 January 2021


Impact Year 3, 31 January 2022


Impact Year 4, 23 January 2023

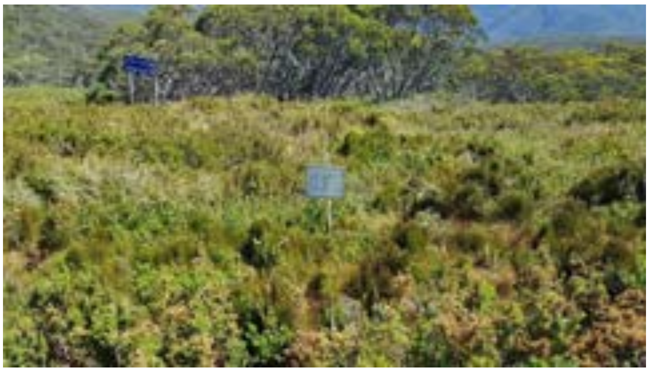

Impact Year 5, 29 January 2024

Bog 11.1 (Control Site), Photo Point 11.1CS


Baseline Year 1, 8 February 2018

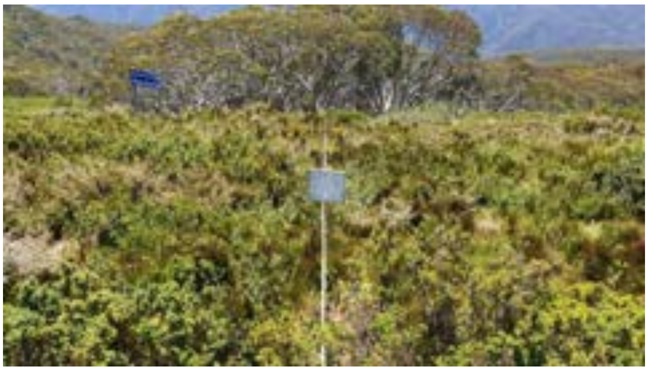

Baseline Year 2, 31 January 2019


Impact Year 1, 4 February 2020


Impact Year 2, 25 January 2021


Impact Year 3, 31 January 2022

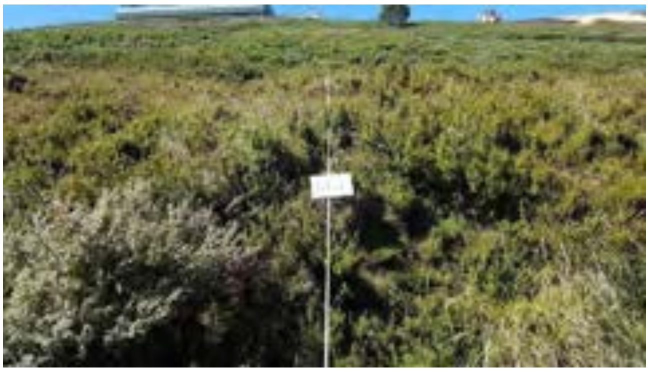

Impact Year 4, 23 January 2023

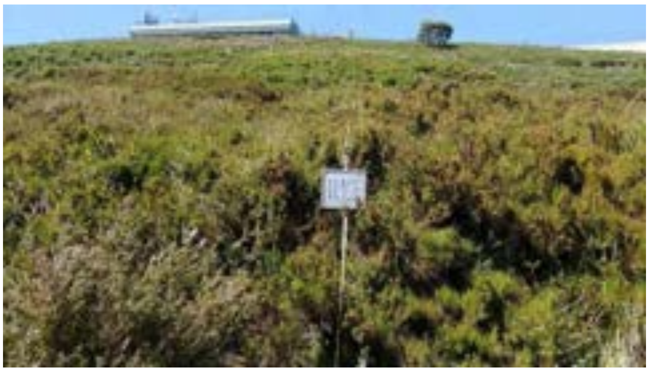

Impact Year 5, 29 January 2024

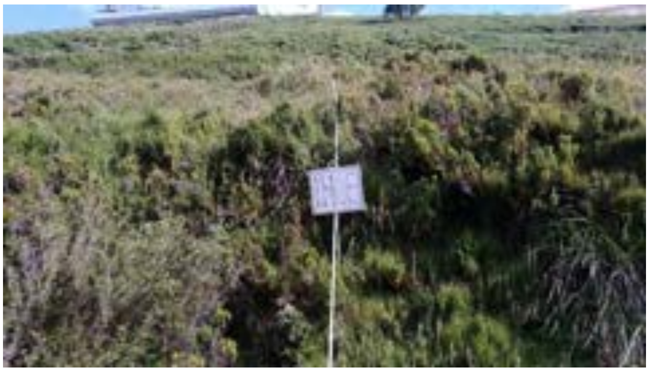
Bog 11.1 (Control Site), Photo Point 11.1CE

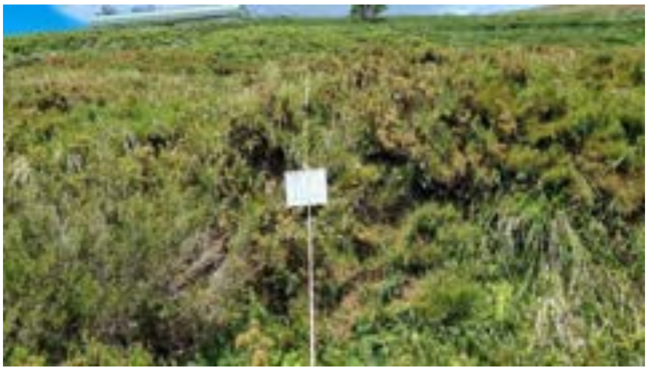

Baseline Year 1, 8 February 2018

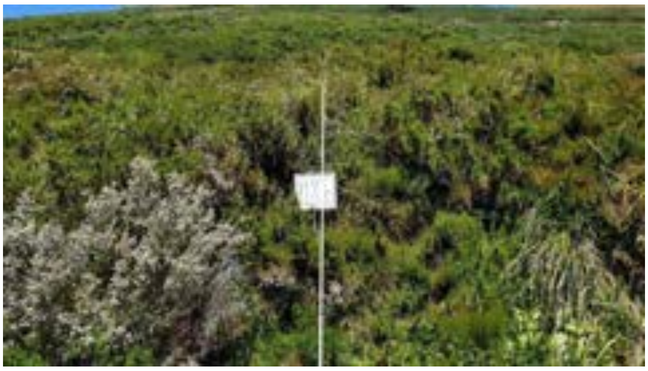

Baseline Year 2, 31 January 2019


Impact Year 1, 4 February 2020


Impact Year 2, 25 January 2021


Impact Year 3, 31 January 2022


Impact Year 4, 23 January 2023


Impact Year 5, 29 January 2024

Bog 11.2 (Impact Site), Photo Point 11.2AS

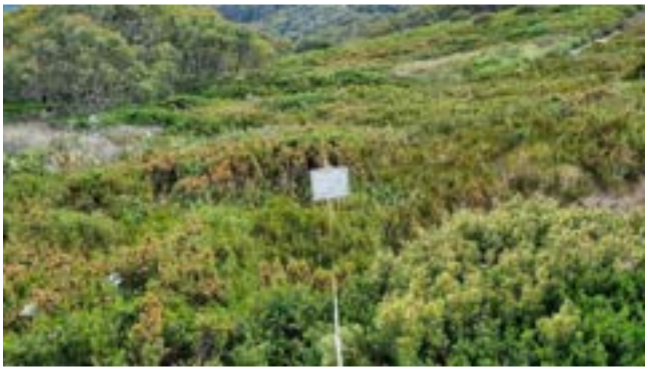

Baseline Year 1, 28 January 2018

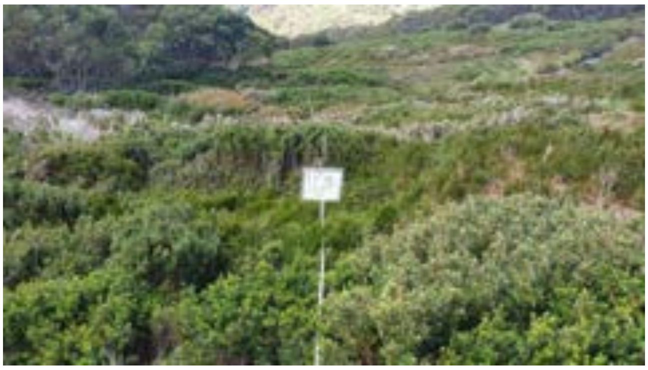

Baseline Year 2, 31 January 2019


Impact Year 1, 7 February 2020

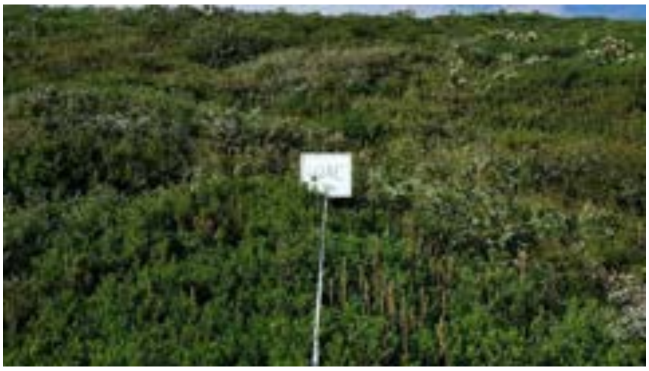

Impact Year 2, 26 January 2021


Impact Year 3, 1 February 2022

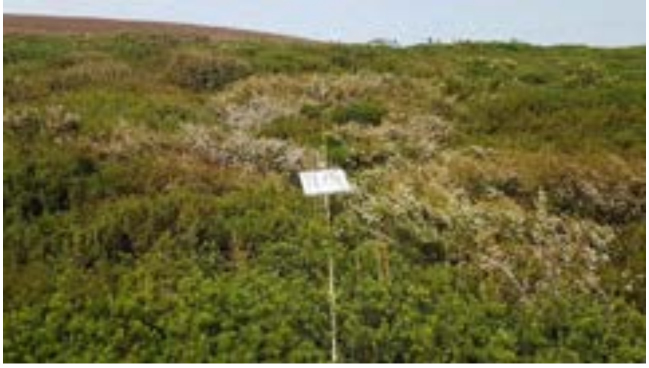

Impact Year 4, 24 January 2023


Impact Year 5, 29 January 2024

Bog 11.2 (Impact Site), Photo Point 11.2AE


Baseline Year 1, 28 January 2018

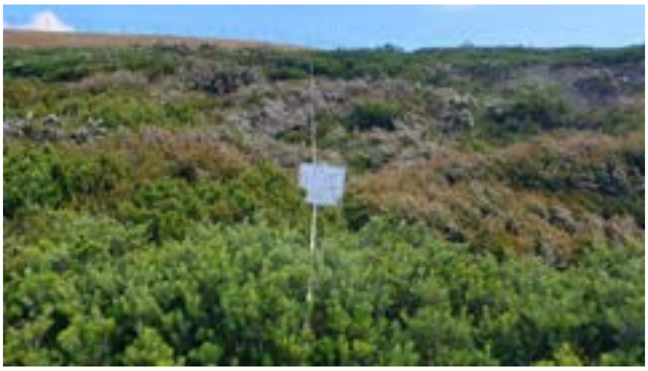

Baseline Year 2, 31 January 2019


Impact Year 1, 7 February 2020

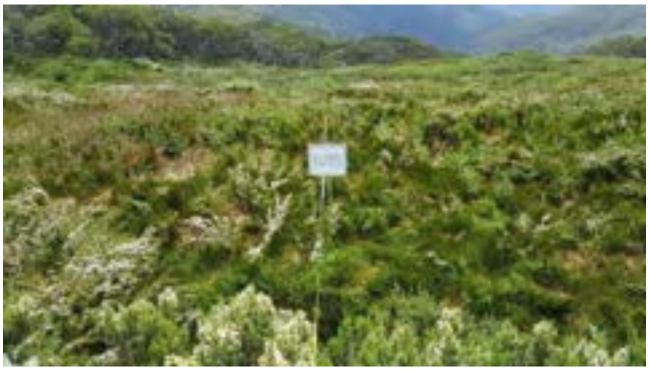

Impact Year 2, 26 January 2021


Impact Year 3, 1 February 2022


Impact Year 4, 2 February 2023

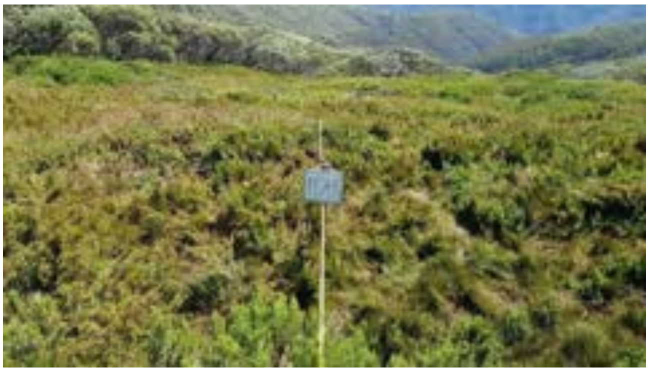

Impact Year 5, 29 January 2024

Bog 11.2 (Impact Site), Photo Point 11.2BS



Baseline Year 1, 28 January 2018

Baseline Year 2, 31 January 2019

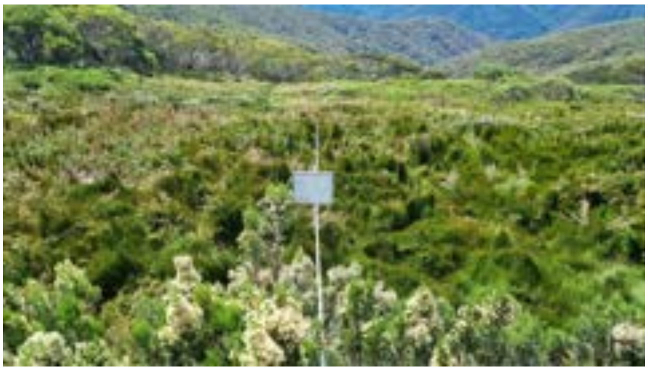


Impact Year 1, 20 February 2020

Impact Year 2, 26 January 2021

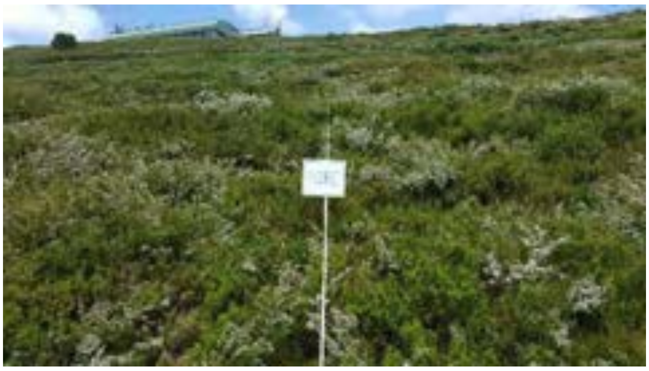
Impact Year 3, 1 February 2022

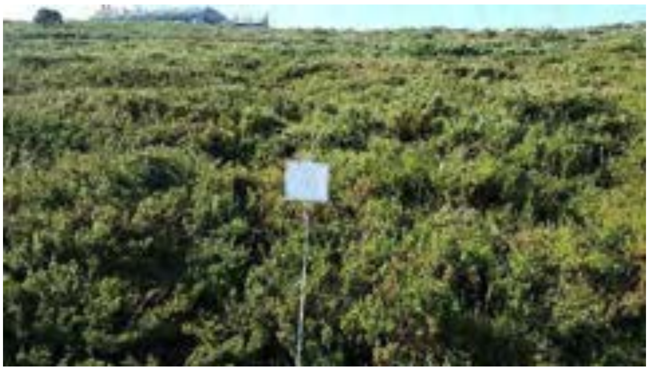
Impact Year 4, 23 January 2023

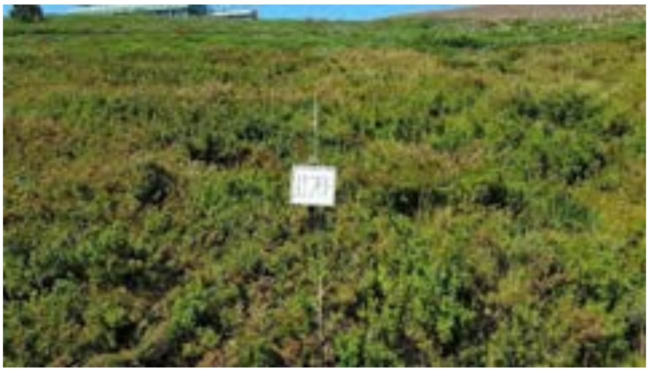


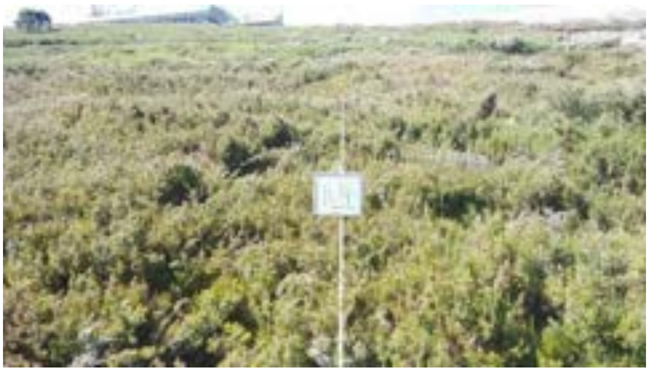
Impact Year 5, 29 January 2024

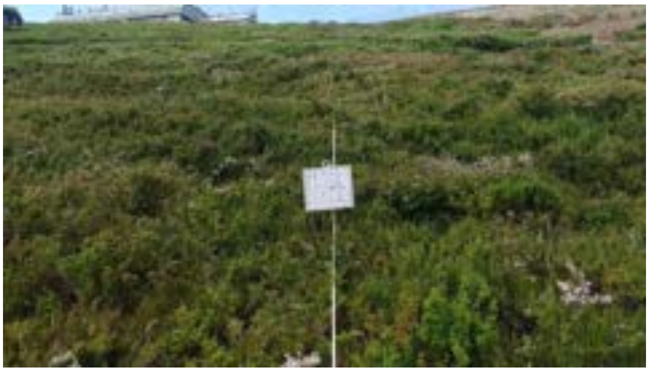
Bog 11.2 (Impact Site), Photo Point 11.2BE

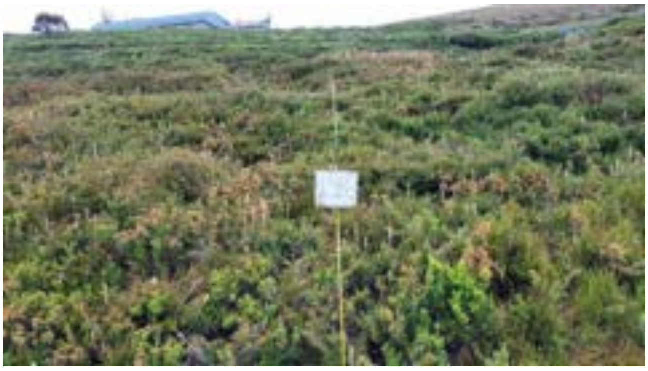

Baseline Year 1, 28 January 2018

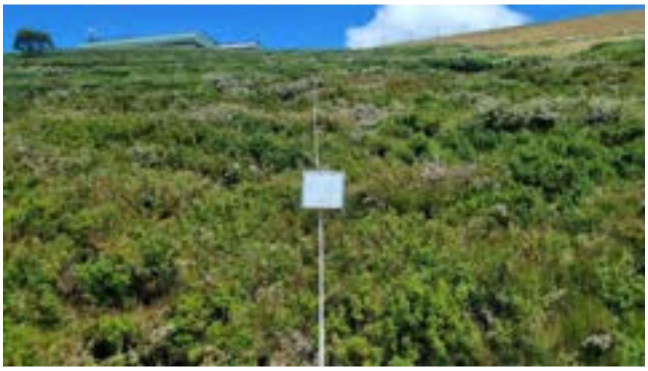

Baseline Year 2, 31 January 2019


Impact Year 1, 20 February 2020

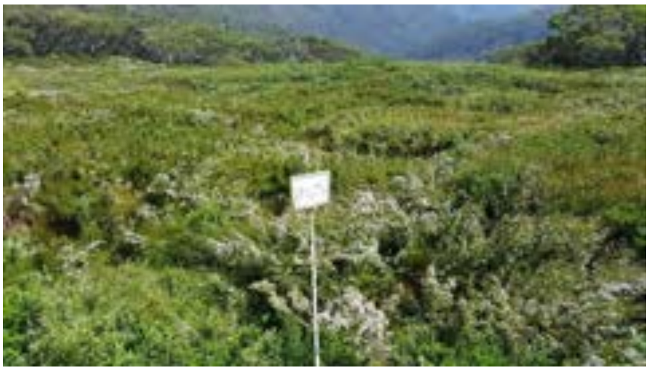

Impact Year 2, 26 January 2021

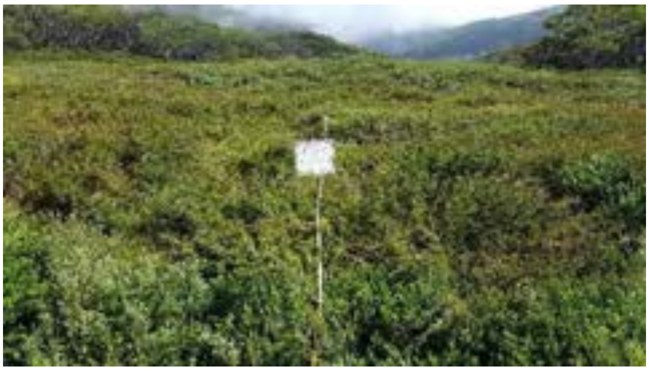

Impact Year 3, 1 February 2022


Impact Year 4, 23 January 2023

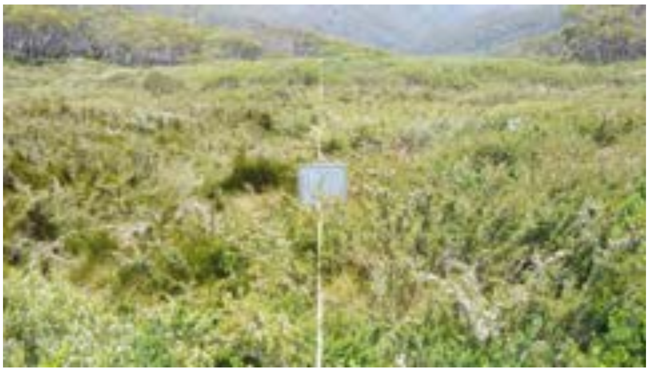

Impact Year 5, 29 January 2024

Bog 11.2 (Impact Site), Photo Point 11.2CS

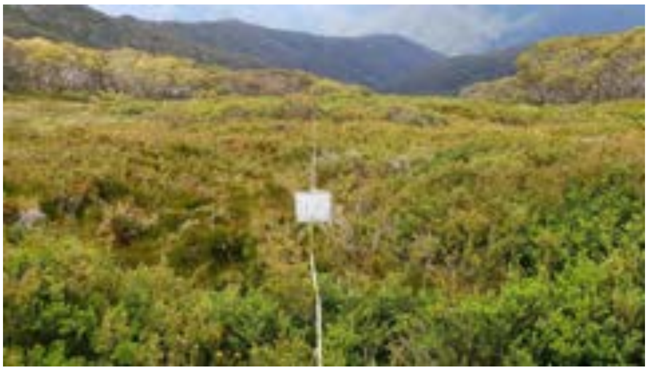

Baseline Year 1, 28 January 2018


Baseline Year 2, 31 January 2019


Impact Year 1, 6 February 2020

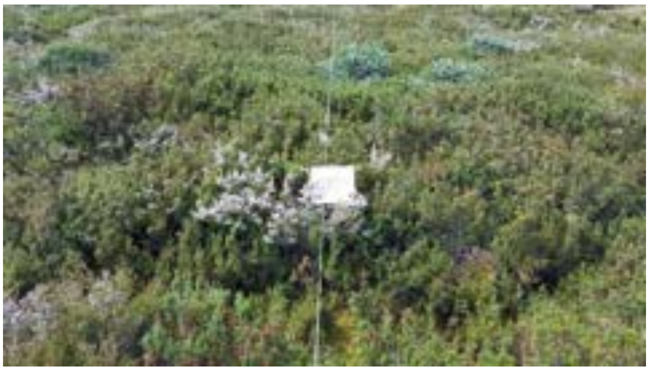

Impact Year 2, 27 January 2021


Impact Year 3, 1 February 2022

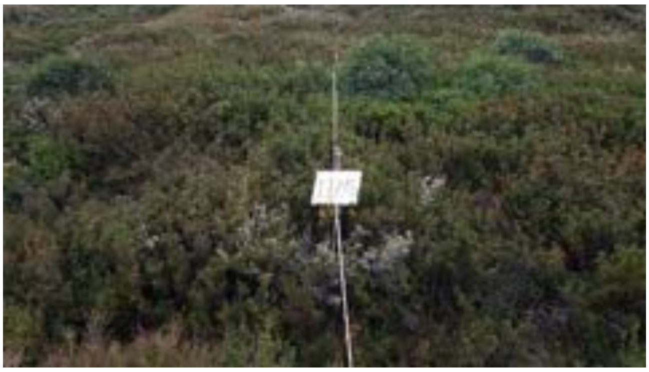

Impact Year 4, 2 February 2023

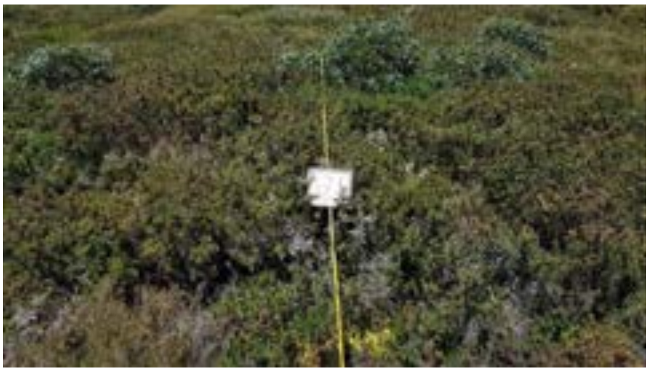

Impact Year 5, 8 February 2024

Bog 11.2 (Impact Site), Photo Point 11.2CE

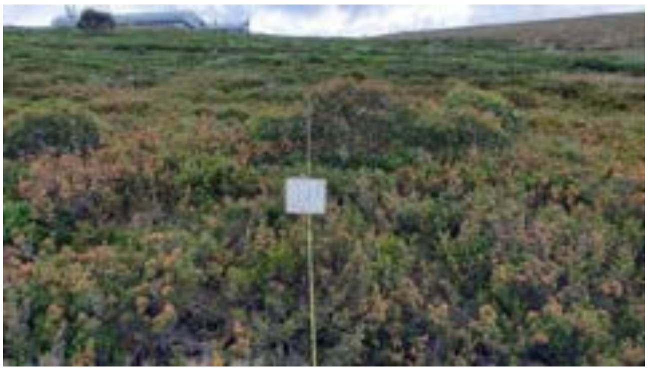

Baseline Year 1, 28 January 2018

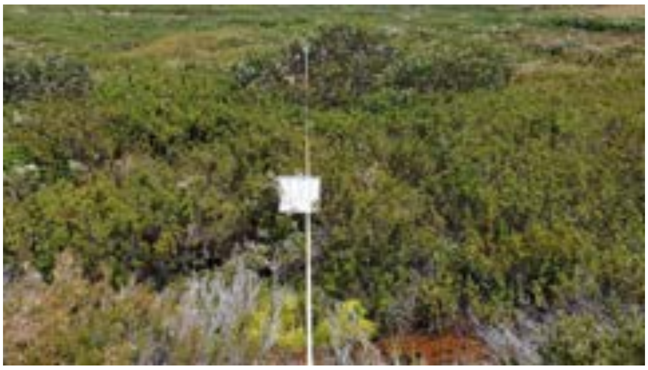

Baseline Year 2, 31 January 2019


Impact Year 1, 6 February 2020


Impact Year 2, 27 January 2021


Impact Year 3, 1 February 2022

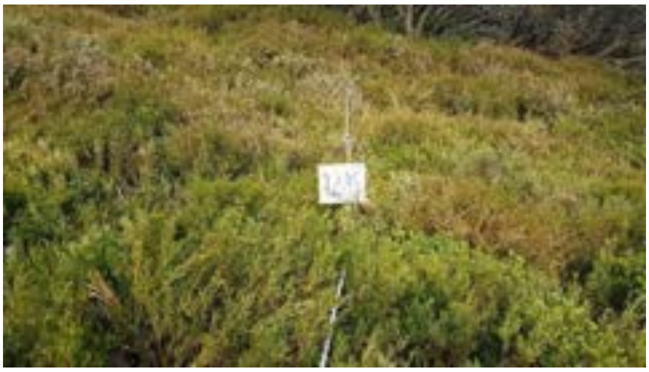

Impact Year 4, 2 February 2023

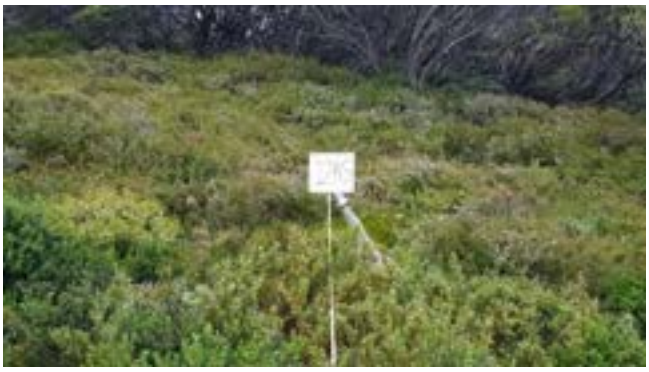

Impact Year 5, 29 January 2024

Bog 12 (Impact Site), Photo Point 12AS


Baseline Year 1, 27 January 2018

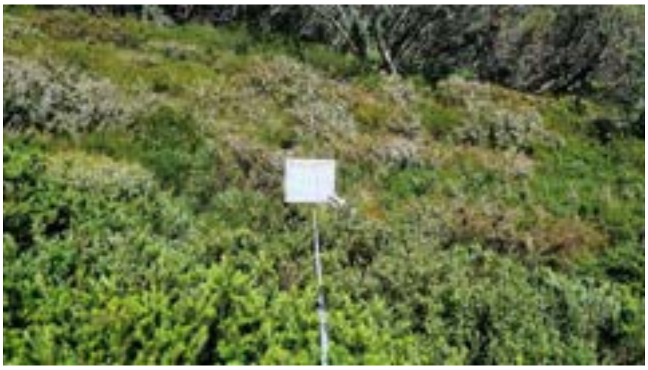

Baseline Year 2, 30 January 2019


Impact Year 1, 7 February 2020


Impact Year 2, 27 January 2021


Impact Year 3, 3 February 2022


Impact Year 4, 24 January 2023


Impact Year 5, 29 January 2024

Bog 12 (Impact Site), Photo Point 12AE


Baseline Year 1, 27 January 2018

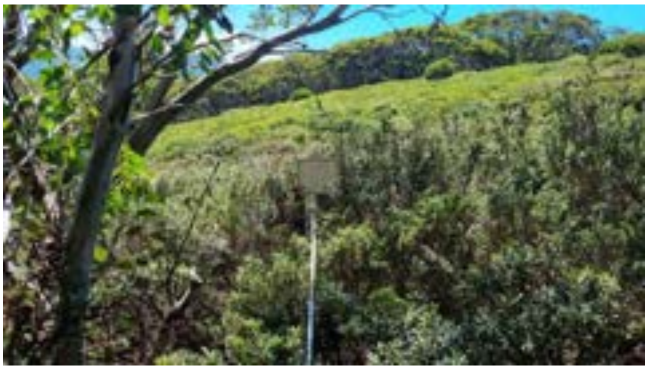

Baseline Year 2, 30 January 2019


Impact Year 1, 7 February 2020


Impact Year 2, 27 January 2021

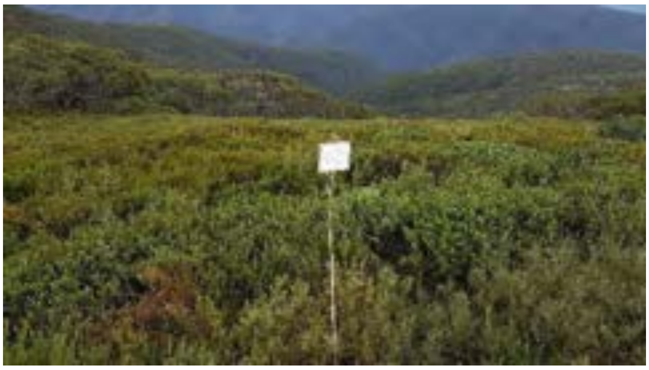

Impact Year 3, 3 February 2022

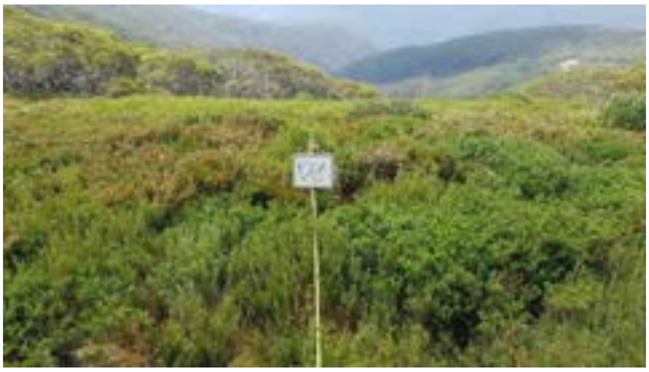

Impact Year 4, 24 January 2023


Impact Year 5, 30 January 2024

Bog 12 (Impact Site), Photo Point 12BS

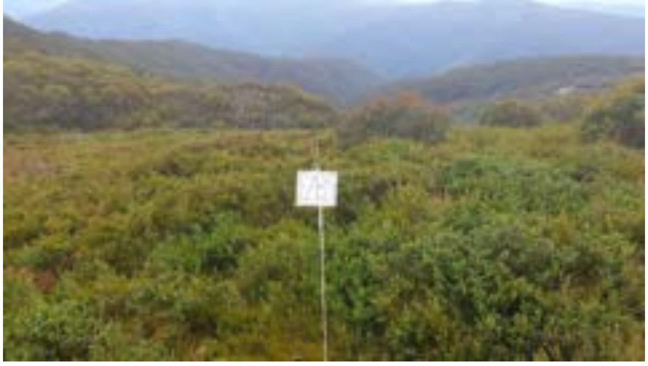

Baseline Year 1, 29 January 2018


Baseline Year 2, 30 January 2019


Impact Year 1, 6 February 2020


Impact Year 2, 27 January 2021


Impact Year 3, 1 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 30 January 2024

Bog 12 (Impact Site), Photo Point 12BE

Baseline Year 1, 29 January 2018

Baseline Year 2, 30 January 2019

Impact Year 1, 6 February 2020

Impact Year 2, 27 January 2021

Impact Year 3, 1 February 2022

Impact Year 4, 2 February 2023

Impact Year 5, 30 January 2024

Bog 12 (Impact Site), Photo Point 12CS


Baseline Year 1, 29 January 2018


Baseline Year 2, 30 January 2019

Impact Year 1, 7 February 2020


Impact Year 2, 27 January 2021


Impact Year 3, 3 February 2022


Impact Year 4, 24 January 2023


Impact Year 5, 30 January 2024

Bog 12 (Impact Site), Photo Point 12CE


Baseline Year 1, 29 January 2018


Baseline Year 2, 30 January 2019


Impact Year 1, 7 February 2020


Impact Year 2, 27 January 2021


Impact Year 3, 3 February 2022


Impact Year 4, 24 January 2023

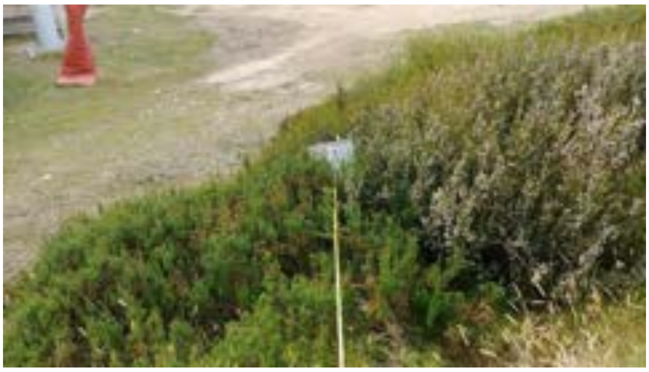

Impact Year 5, 30 January 2024

Bog 13 (Impact Site), Photo Point 13AS

Baseline Year 1, 2 February 2018

Baseline Year 2, 14 February 2019

Impact Year 1, 31 January 2020



Impact Year 2, 4 February 2021

Impact Year 3, 9 February 2022

Impact Year 4, 30 January 2023

Impact Year 5, 5 February 2024

Bog 13 (Impact Site), Photo Point 13AE


Baseline Year 1, 2 February 2018


Baseline Year 2, 14 February 2019


Impact Year 1, 31 January 2020


Impact Year 2, 4 February 2021


Impact Year 3, 9 February 2022


Impact Year 4, 30 January 2023


Impact Year 5, 5 February 2024

Bog 13 (Impact Site), Photo Point 13BS


Baseline Year 1, 2 February 2018


Baseline Year 2, 14 February 2019


Impact Year 1, 31 January 2020


Impact Year 2, 4 February 2021


Impact Year 3, 9 February 2022


Impact Year 4, 30 January 2023


Impact Year 5, 5 February 2024

Bog 13 (Impact Site), Photo Point 13BE

Baseline Year 1, 2 February 2018

Baseline Year 2, 14 February 2019

Impact Year 1, 31 January 2020

Impact Year 2, 4 February 2021

Impact Year 3, 9 February 2022

Impact Year 4, 30 January 2023

Impact Year 5, 5 February 2024

Bog 13 (Impact Site), Photo Point 13CS


Baseline Year 1, 2 February 2018

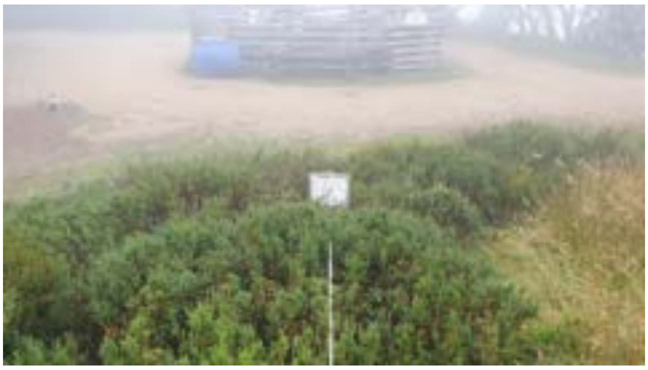

Baseline Year 2, 14 February 2019


Impact Year 1, 31 January 2020


Impact Year 2, 4 February 2021


Impact Year 3, 9 February 2022


Impact Year 4, 30 January 2023


Impact Year 5, 5 February 2024

Bog 13 (Impact Site), Photo Point 13CE


Baseline Year 1, 2 February 2018

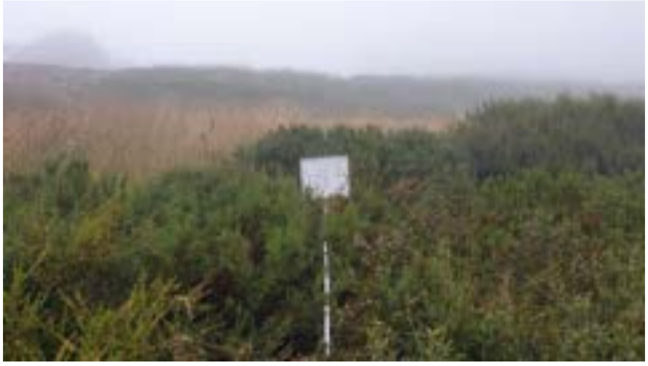

Baseline Year 2, 14 February 2019


Impact Year 1, 31 January 2020


Impact Year 2, 4 February 2021


Impact Year 3, 9 February 2022


Impact Year 4, 30 January 2023


Impact Year 5, 5 February 2024

Bog S1 (Control Site), Photo Point S1AS


Baseline Year 1, 6 February 2018


Baseline Year 2, 13 February 2019


Impact Year 1, 28 January 2020


Impact Year 2, 4 February 2021


Impact Year 3, 2 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 6 February 2024

Bog S1 (Control Site), Photo Point S1AE


Baseline Year 1, 6 February 2018


Baseline Year 2, 13 February 2019


Impact Year 1, 28 January 2020


Impact Year 2, 4 February 2021


Impact Year 3, 2 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 6 February 2024

Bog S1 (Control Site), Photo Point S1BS


Baseline Year 1, 6 February 2018


Baseline Year 2, 13 February 2019


Impact Year 1, 28 January 2020


Impact Year 2, 4 February 2021


Impact Year 3, 2 February 2022


Impact Year 4, 31 January 2023


Impact Year 5, 6 February 2024

Bog S1 (Control Site), Photo Point S1BE

Baseline Year 1, 6 February 2018

Baseline Year 2, 13 February 2019

Impact Year 1, 28 January 2020

Impact Year 2, 4 February 2021

Impact Year 3, 2 February 2022

Impact Year 4, 31 January 2023

Impact Year 5, 6 February 2024

Bog S1 (Control Site), Photo Point S1CS

Baseline Year 1, 6 February 2018

Baseline Year 2, 13 February 2019

Impact Year 1, 28 January 2020

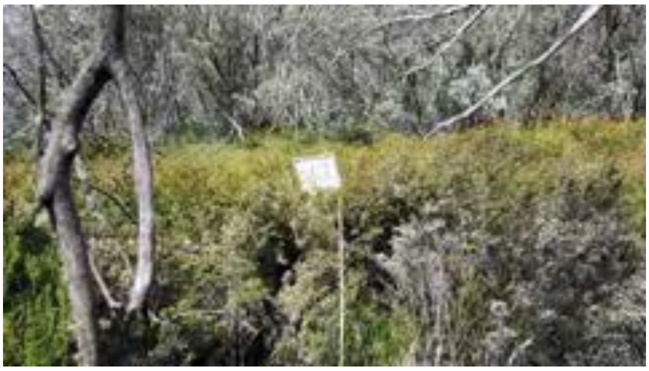
Impact Year 2, 4 February 2021

Impact Year 3, 2 February 2022

Impact Year 4, 31 January 2023

Impact Year 5, 6 February 2024

Bog S1 (Control Site), Photo Point S1CE


Baseline Year 1, 6 February 2018


Baseline Year 2, 13 February 2019


Impact Year 1, 28 January 2020


Impact Year 2, 4 February 2021


Impact Year 3, 2 February 2022


Impact Year 4, 31 January 2023


Impact Year 5, 6 February 2024

Bog S2 (Control Site), Photo Point S2AS

Baseline Year 1, 6 February 2018

Baseline Year 2, 13 February 2019

Impact Year 1, 29 January 2020

Impact Year 2, 3 February 2021

Impact Year 3, 3 February 2022

Impact Year 4, 31 January 2023

Impact Year 5, 7 February 2024

Bog S2 (Control Site), Photo Point S2AE


Baseline Year 1, 6 February 2018


Baseline Year 2, 13 February 2019


Impact Year 1, 29 January 2020


Impact Year 2, 3 February 2021


Impact Year 3, 3 February 2022


Impact Year 4, 31 January 2023


Impact Year 5, 7 February 2024

Bog S2 (Control Site), Photo Point S2BS


Baseline Year 1, 7 February 2018


Baseline Year 2, 13 February 2019


Impact Year 1, 29 January 2020


Impact Year 2, 3 February 2021


Impact Year 3, 3 February 2022


Impact Year 4, 31 January 2023


Impact Year 5, 7 February 2024

Bog S2 (Control Site), Photo Point S2BE

Baseline Year 1, 7 February 2018

Baseline Year 2, 13 February 2019

Impact Year 1, 29 January 2020

Impact Year 2, 3 February 2021

Impact Year 3, 3 February 2022

Impact Year 4, 31 January 2023

Impact Year 5, 7 February 2024

Bog S2 (Control Site), Photo Point S2CS


Baseline Year 1, 7 February 2018


Baseline Year 2, 13 February 2019


Impact Year 1, 30 January 2020


Impact Year 2, 3 February 2021


Impact Year 3, 3 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 7 February 2024

Bog S2 (Control Site), Photo Point S2CE

Baseline Year 1, 7 February 2018

Baseline Year 2, 13 February 2019

Impact Year 1, 30 January 2020

Impact Year 2, 3 February 2021

Impact Year 3, 3 February 2022

Impact Year 4, 2 February 2023

Impact Year 5, 7 February 2024

Bog S3 (Control Site), Photo Point S3AS


Baseline Year 1, 7 February 2018


Baseline Year 2, 12 February 2019


Impact Year 1, 29 January 2020


Impact Year 2, 3 February 2021


Impact Year 3, 3 February 2022


Impact Year 4, 31 January 2023


Impact Year 5, 6 February 2024

Bog S3 (Control Site), Photo Point S3AE

Baseline Year 1, 7 February 2018

Baseline Year 2, 12 February 2019

Impact Year 1, 29 January 2020

Impact Year 2, 3 February 2021

Impact Year 3, 3 February 2022

Impact Year 4, 31 January 2023

Impact Year 5, 6 February 2024

Bog S3 (Control Site), Photo Point S3BS


Baseline Year 1, 7 February 2018


Baseline Year 2, 12 February 2019


Impact Year 1, 29 January 2020


Impact Year 2, 3 February 2021


Impact Year 3, 3 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 7 February 2024

Bog S3 (Control Site), Photo Point S3BE


Baseline Year 1, 7 February 2018


Baseline Year 2, 12 February 2019


Impact Year 1, 29 January 2020


Impact Year 2, 3 February 2021


Impact Year 3, 3 February 2022


Impact Year 4, 2 February 2023


Impact Year 5, 7 February 2024

Bog S3 (Control Site), Photo Point S3CS


Baseline Year 1, 7 February 2018


Baseline Year 2, 12 February 2019


Impact Year 1, 29 January 2020


Impact Year 2, 3 February 2021


Impact Year 3, 2 February 2022


Impact Year 4, 31 January 2023


Impact Year 5, 6 February 2024

Bog S3 (Control Site), Photo Point S3CE


Baseline Year 1, 7 February 2018


Baseline Year 2, 12 February 2019


Impact Year 1, 29 January 2020


Impact Year 2, 3 February 2021


Impact Year 3, 2 February 2022


Impact Year 4, 31 January 2023


Impact Year 5, 6 February 2024

Appendix 5 Ecology data

Table A5.1 Area of Alpine Bogs as determined by DGPS mapping

Site	Area (ha)										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
All impact sites	**1.3797***	**1.3536**	**1.3666**	**1.3217**	**1.3353**	**1.3423**	**1.3636**	**1.3824**			
Bog 4.2	0.4014	0.3842	0.3928	0.3912	0.3823	0.3866	0.3882	0.3957			
Bog 6	0.4914*	0.6723	0.6723*	0.6380	0.6473	0.6359	0.6492	0.6584			
Bog 8/9/10	0.0667	0.0718	0.0692	0.0704	0.0762	0.0798	0.0838	0.0839			
Bog 11.2	0.1195	0.1120	0.1157	0.1094	0.1083	0.1094	0.1089	0.1099			
Bog 12	0.1145	0.1071	0.1108	0.1076	0.1157	0.1249	0.1275	0.1282			
Bog 13	0.0051	0.0063	0.0057	0.0051	0.0055	0.0058	0.0060	0.0063			
All control	**2.1446**	**2.0178**	**2.0812**	**2.0902**	**2.1183**	**2.1875**	**2.2136**	**2.2193**			
Bog 1	0.1781	0.1620	0.1700	0.1491	0.1595	0.1626	0.1641	0.1652			
Bog 2	0.1516	0.1481	0.1499	0.1459	0.1464	0.1521	0.1519	0.1530			
Bog 4.1/5/7	0.5562	0.5457	0.5509	0.5480	0.5597	0.5519	0.5340	0.5348			
Bog 11.1	0.2798	0.2590	0.2694	0.2571	0.2676	0.2890	0.2923	0.2928			
Bog S1	0.5712	0.4584	0.5148	0.5126	0.4992	0.5009	0.5145	0.5111			
Bog S2	0.1805	0.1778	0.1791	0.1785	0.1846	0.2108	0.2306	0.2340			
Bog S3	0.2271	0.2669	0.2470	0.2989	0.3013	0.3201	0.3261	0.3284			

*Note: As discussed in the IY1 monitoring report, mapping of Bog 6 in BY1 is unlikely to have captured the full extent of the Bog 6 entity as recognised in subsequent years and is therefore unreliable. The BY2 area for Bog 6 has therefore been used as the baseline mean and BY1 total for all impact sites.

Table A5.2 Dimensions of Alpine Bogs as estimated by line transects

Site	Sum of dimensions (m)										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
All impact sites	**356.2**	**353.2**	**354.7**	**355.6**	**354.2**	**344.8**	**342.6**	**350.8**			
Bog 4.2	92.2	92.6	92.4	92.2	92.6	89.8	93	92.2			
Bog 6	79.6	75.8	77.7	77.4	78.2	74.2	69.8	75			
Bog 8/9/10	66.4	67.8	67.1	65.2	65	61.4	60.8	64.2			
Bog 11.2	67.2	66.4	66.8	66.8	67.2	67.2	66	67			
Bog 12	40.6	41.0	40.8	41.4	40.6	40.6	40.4	40			
Bog 13	10.2	9.6	9.9	12.6	10.6	11.6	12.6	12.4			
All control	**436.0**	**441.6**	**438.8**	**438.6**	**436.6**	**438.8**	**434.6**	**434.8**			
Bog 1	55.8	57.2	56.5	57.0	56.6	55.8	55	57			
Bog 2	78.8	79.6	79.2	77.2	79	79.4	79.2	78			
Bog 4.1/5/7	81.6	84.2	82.9	85.2	83.8	86	83.4	83.4			
Bog 11.1	48.6	48.4	48.5	48.0	47.4	47.6	48	47			
Bog S1	52.6	52.4	52.5	52.0	51.2	50.8	51.2	50.6			
Bog S2	57.4	58.2	57.8	58.2	57	57	57.8	58.4			
Bog S3	61.2	61.6	61.4	61.0	61.6	62.2	60	60.4			

Table A5.3 Cover of all bare ground as estimated by line transects

Site	Cover of all bare ground										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
All impact sites	**1.9%**	**0.1%**	**1.0%**	**5.4%**	**4.6%***	**3.6%***	**0.4%***	**1.6%***			
Bog 4.2	3.4%	0.0%	1.7%	5.8%	5.2%	1.9%	0.0%	1.9%			
Bog 6	3.8%	0.0%	1.9%	8.2%	5.3%	4.0%	1.5%	3.2%			
Bog 8/9/10	0.7%	0.0%	0.3%	6.0%	3.7%	2.8%	0.5%	0.5%			
Bog 11.2	0.0%	0.0%	0.0%	3.7%	8.0%	5.6%	0.0%	0.0%			
Bog 12	0.8%	0.8%	0.8%	3.1%	0.4%	5.4%	0.0%	2.7%			
Bog 13	0.0%	0.0%	0.0%	0.0%	1.7%	3.4%	0.0%	1.7%			
All control	**0.9%**	**0.2%**	**0.5%**	**4.8%**	**2.6%***	**5.0%***	**1.9%***	**2.6%***			
Bog 1	0.6%	0.0%	0.3%	3.5%	0.3%	1.9%	0.0%	0.6%			
Bog 2	1.1%	0.0%	0.6%	10.3%	0.7%	2.7%	0.0%	0.2%			
Bog 4.1/5/7	0.4%	0.0%	0.2%	0.8%	0.6%	0.6%	0.4%	0.6%			
Bog 11.1	0.7%	0.4%	0.5%	3.6%	0.0%	3.2%	0.4%	0.7%			
Bog S1	3.0%	0.3%	1.7%	2.4%	7.1%	4.7%	6.4%	6.4%			
Bog S2	0.0%	0.0%	0.0%	5.7%	0.7%	1.0%	1.3%	3.7%			
Bog S3	0.9%	0.9%	0.8%	7.9%	10.7%	24.0%	6.6%	8.5%			

*Note: From IY2 onwards, the type of bare ground was also recorded. Results presented here are for all bare ground, regardless of type.

Table A5.4 Cover of bare ground attributed to natural causes as estimated by line transects

Site	Cover of bare ground attributed to natural causes										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
All impact sites	**-**	**-**	**-**	**-**	**1.3%**	**2.6%**	**0.4%**	**0.6%**			
Bog 4.2	-	-	-	-	2.2%	1.7%	0.0%	0.2%			
Bog 6	-	-	-	-	1.1%	3.4%	1.5%	1.1%			
Bog 8/9/10	-	-	-	-	1.1%	2.3%	0.5%	0.5%			
Bog 11.2	-	-	-	-	0.8%	0.8%	0.0%	0.0%			
Bog 12	-	-	-	-	0.4%	5.4%	0.0%	1.6%			
Bog 13	-	-	-	-	1.7%	3.4%	0.0%	1.7%			
All control	**-**	**-**	**-**	**-**	**1.8%**	**5.0%**	**1.1%**	**2.0%**			
Bog 1	-	-	-	-	0.3%	1.9%	0.0%	0.6%			
Bog 2	-	-	-	-	0.7%	2.7%	0.0%	0.2%			
Bog 4.1/5/7	-	-	-	-	0.0%	0.6%	0.4%	0.6%			
Bog 11.1	-	-	-	-	0.0%	3.2%	0.4%	0.7%			
Bog S1	-	-	-	-	3.4%	4.7%	1.3%	4.7%			
Bog S2	-	-	-	-	0.7%	1.0%	1.3%	3.7%			
Bog S3	-	-	-	-	8.5%	24.0%	4.7%	5.0%			

Table A5.5 Cover of bare ground attributed to deer activity as estimated by line transects

Site	Cover of bare ground attributed to deer activity										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
All impact sites	**-**	**-**	**-**	**-**	**0.0%**	**0.0%**	**0.0%**	**0.1%**			
Bog 4.2	-	-	-	-	0.0%	0.0%	0.0%	0.2%			
Bog 6	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog 8/9/10	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog 11.2	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog 12	-	-	-	-	0.0%	0.0%	0.0%	0.4%			
Bog 13	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
All control	**-**	**-**	**-**	**-**	**0.9%**	**0.0%**	**0.9%**	**0.7%**			
Bog 1	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog 2	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog 4.1/5/7	-	-	-	-	0.6%	0.0%	0.0%	0.0%			
Bog 11.1	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog S1	-	-	-	-	3.7%	0.0%	5.1%	1.7%			
Bog S2	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog S3	-	-	-	-	2.2%	0.0%	1.9%	3.5%			

Table A5.6 Cover of bare ground attributed to sedimentation as estimated by line transects

Site	Cover of bare ground attributed to sedimentation										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
All impact sites	**-**	**-**	**-**	**-**	**3.4%**	**1.1%**	**0.0%**	**0.9%**			
Bog 4.2	-	-	-	-	3.0%	0.2%	0.0%	1.5%			
Bog 6	-	-	-	-	4.2%	0.6%	0.0%	2.1%			
Bog 8/9/10	-	-	-	-	2.5%	0.5%	0.0%	0.0%			
Bog 11.2	-	-	-	-	7.2%	4.8%	0.0%	0.0%			
Bog 12	-	-	-	-	0.0%	0.0%	0.0%	0.8%			
Bog 13	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
All control	**-**	**-**	**-**	**-**	**0.0%**	**0.0%**	**0.0%**	**0.0%**			
Bog 1	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog 2	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog 4.1/5/7	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog 11.1	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog S1	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog S2	-	-	-	-	0.0%	0.0%	0.0%	0.0%			
Bog S3	-	-	-	-	0.0%	0.0%	0.0%	0.0%			

Table A5.7 Bog-dependent flora species richness as determined by line and belt transects

Site	**Number of bog-dependent flora species***										
	BY1	**BY2**	**BM**	**IY1**	**IY2**	**IY3**	**IY4**	**IY5**	**IY6**	**IY7**	**IY8**
All impact sites	**9**	**10**	**9.5**	**10**	**9**	**9**	**9***	**9***			
Bog 4.2	8	9	8.5	8	8	8	8*	8*			
Bog 6	8	8	8	9	8	8	8	8			
Bog 8/9/10	8	5	6.5	8	6	7	7	7			
Bog 11.2	6	6	6	6	5	6	5	5			
Bog 12	7	7	7	6	6	6	6	7			
Bog 13	3	5	4	6	3	4	3	4			
All control	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**			
Bog 1	5	5	5	5	6	6	5	6			
Bog 2	6	6	6	5	5	6	6	6			
Bog 4.1/5/7	8	8	8	7	8	7	8	8			
Bog 11.1	8	7	7.5	8	8	7	7	8			
Bog S1	6	6	6	7	7	6	7	7			
Bog S2	6	6	6	6	7	5	6	5			
Bog S3	6	8	7	8	7	8	8	7			

*Note: Subalpine Baeckea *Baeckea latifolia* and Mountain Baeckea *Baeckea utilis s.s.* have been aggregated into one taxon (Mountain Baeckea *Baeckea utilis s.l.*) for the purposes of this table and analysis of bog-dependent species richness. While Silver Astelia was not recorded along line and belt transects at impact sites in IY4 or IY5, it was incidentally recorded beside Transect 4.2B in Bog 4.2. The results presented in this table do not include incidental observations.

Table A5.8 Cover of bog-dependent flora species as estimated by line transects

Site	Cover of bog-dependent flora species										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
All impact sites	**77.9%**	**78.5%**	**78.2%**	**79.7%**	**79.5%**	**79.4%**	**78.6%**	**77.5%**			
Bog 4.2	87.5%	87.3%	87.4%	87.3%	87.7%	86.0%	87.9%	86.7%			
Bog 6	72.2%	72.4%	72.3%	72.6%	74.1%	74.3%	70.7%	69.1%			
Bog 8/9/10	75.6%	75.6%	75.6%	77.5%	74.9%	77.5%	74.5%	73.8%			
Bog 11.2	88.1%	90.5%	89.3%	91.0%	91.0%	88.9%	89.4%	87.8%			
Bog 12	72.8%	72.4%	72.6%	73.5%	75.1%	73.9%	73.2%	70.0%			
Bog 13	43.6%	48.7%	46.2%	59.0%	53.0%	58.1%	60.7%	65.8%			
All control	**86.9%**	**88.8%**	**87.9%**	**88.3%**	**88.9%**	**89.1%**	**89.0%**	**87.1%**			
Bog 1	88.0%	90.5%	89.3%	90.2%	90.2%	88.6%	89.0%	89.9%			
Bog 2	89.0%	91.1%	90.0%	91.3%	90.4%	91.5%	91.5%	89.2%			
Bog 4.1/5/7	81.2%	83.9%	82.5%	83.7%	83.7%	81.7%	81.6%	81.7%			
Bog 11.1	87.4%	87.7%	87.5%	88.1%	88.4%	88.4%	89.9%	87.4%			
Bog S1	84.8%	86.9%	85.9%	86.9%	89.2%	88.2%	89.2%	84.5%			
Bog S2	97.0%	99.3%	98.1%	98.0%	98.7%	98.3%	97.6%	96.3%			
Bog S3	84.2%	85.2%	84.7%	82.3%	85.2%	90.9%	88.6%	83.3%			

Table A5.9 Cover of native non-bog-dependent flora species as estimated by line transects

Site	Cover of native non-bog-dependent flora species										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
All impact sites	**44.4%**	**46.1%**	**45.2%**	**46.5%**	**46.1%**	**48.5%**	**45.6%**	**43.1%**			
Bog 4.2	24.7%	26.9%	25.8%	27.1%	29.5%	27.5%	26.4%	23.9%			
Bog 6	62.5%	65.7%	64.1%	61.5%	65.7%	66.9%	66.7%	63.4%			
Bog 8/9/10	49.4%	51.7%	50.6%	53.3%	50.6%	56.1%	50.1%	49.7%			
Bog 11.2	24.9%	23.6%	24.3%	25.7%	24.7%	27.6%	25.7%	23.6%			
Bog 12	61.5%	61.5%	61.5%	63.4%	56.4%	62.6%	56.4%	57.6%			
Bog 13	66.7%	72.6%	69.7%	79.5%	72.6%	77.8%	71.8%	54.7%			
All control	**44.2%**	**46.1%**	**45.1%**	**43.5%**	**43.8%**	**44.8%**	**44.2%**	**40.0%**			
Bog 1	42.9%	44.2%	43.5%	45.4%	44.8%	49.2%	51.1%	43.8%			
Bog 2	41.6%	41.4%	41.5%	41.2%	40.5%	42.1%	38.7%	34.6%			
Bog 4.1/5/7	39.2%	42.3%	40.8%	39.8%	39.0%	40.2%	41.4%	39.6%			
Bog 11.1	41.2%	44.4%	42.8%	40.4%	43.0%	44.0%	44.0%	40.8%			
Bog S1	54.5%	57.9%	56.2%	46.8%	47.1%	44.4%	46.8%	42.8%			
Bog S2	32.3%	32.3%	32.3%	33.0%	34.7%	34.3%	33.3%	29.3%			
Bog S3	61.2%	63.7%	62.5%	60.6%	61.5%	62.1%	57.1%	50.8%			

Table A5.10 Cover of weed species as estimated by entire line transects inside and outside of Alpine Bogs

Site	Cover of weed species inside and outside of Alpine Bogs										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
All impact sites	**5.4%**	**6.3%**	**5.9%**	**7.3%**	**8.1%**	**8.8%**	**7.7%**	**7.9%**			
Bog 4.2	4.5%	4.7%	4.6%	4.3%	4.5%	4.3%	4.7%	4.7%			
Bog 6	4.4%	6.9%	5.7%	7.8%	9.7%	14.5%	9.7%	10.5%			
Bog 8/9/10	6.0%	9.0%	7.5%	11.0%	11.5%	10.3%	12.4%	10.1%			
Bog 11.2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%			
Bog 12	0.0%	0.4%	0.2%	0.8%	0.8%	1.6%	0.0%	0.4%			
Bog 13	40.2%	35.0%	37.6%	42.7%	47.0%	44.4%	37.6%	43.6%			
All control	**3.3%**	**5.3%**	**4.3%**	**5.0%**	**4.9%**	**5.5%**	**5.0%**	**5.2%**			
Bog 1	3.2%	3.5%	3.3%	3.5%	3.8%	3.8%	3.8%	1.3%			
Bog 2	3.9%	4.6%	4.2%	5.5%	4.8%	7.8%	6.9%	8.7%			
Bog 4.1/5/7	4.9%	7.6%	6.2%	5.4%	5.0%	6.0%	7.4%	6.8%			
Bog 11.1	1.4%	3.2%	2.3%	4.3%	2.9%	2.2%	1.4%	0.7%			
Bog S1	6.4%	7.4%	6.9%	6.7%	9.8%	6.7%	5.1%	3.7%			
Bog S2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%			
Bog S3	2.2%	9.5%	5.8%	8.5%	7.6%	9.8%	7.9%	11.7%			

Table A5.11 Cover of weed species as estimated by the parts of line transects within the baseline dimensions of Alpine Bogs

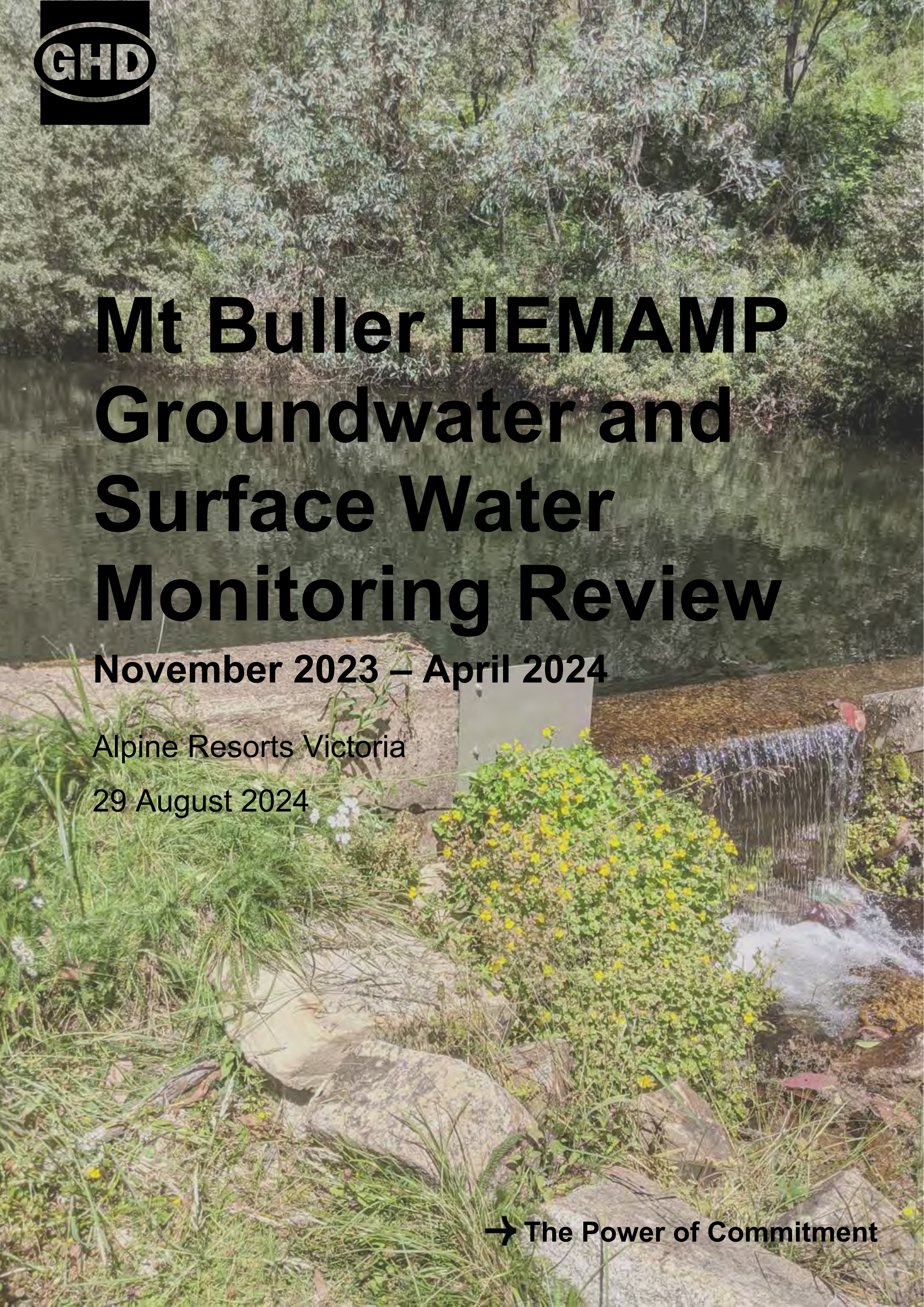
Site	Cover of weed species within Alpine Bogs										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
All impact sites	**1.9%**	**2.5%**	**2.2%**	**3.1%**	**4.0%**	**5.1%**	**3.5%**	**3.6%**			
Bog 4.2	1.1%	0.4%	0.8%	0.9%	1.1%	1.3%	1.5%	1.3%			
Bog 6	3.6%	5.9%	4.7%	6.4%	8.7%	14.2%	8.7%	9.9%			
Bog 8/9/10	1.5%	3.8%	2.6%	4.1%	5.0%	4.1%	4.7%	3.5%			
Bog 11.2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Bog 12	0.0%	0.5%	0.2%	1.0%	0.5%	1.9%	0.0%	0.0%			
Bog 13	19.2%	11.5%	15.4%	19.2%	26.9%	23.1%	9.6%	13.5%			
All control	**1.4%**	**3.0%**	**2.2%**	**2.7%**	**2.9%**	**3.3%**	**3.1%**	**3.5%**			
Bog 1	0.0%	0.4%	0.2%	0.4%	0.4%	0.7%	0.7%	0.0%			
Bog 2	0.8%	2.3%	1.5%	1.5%	1.5%	1.8%	1.8%	4.3%			
Bog 4.1/5/7	3.1%	4.3%	3.7%	3.3%	3.6%	4.8%	5.7%	4.1%			
Bog 11.1	0.4%	0.4%	0.4%	1.2%	2.0%	2.0%	1.2%	0.0%			
Bog S1	3.0%	2.6%	2.8%	3.0%	4.9%	3.4%	2.6%	2.3%			
Bog S2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%			
Bog S3	2.3%	9.7%	6.0%	8.7%	7.8%	10.0%	8.1%	12.0%			

Table A5.12 Cover of Peat Moss *Sphagnum* spp. as estimated by line transects

Site	Cover of Peat Moss *Sphagnum* spp.										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
All impact sites	**5.4%**	**5.3%**	**5.4%**	**6.0%**	**6.0%**	**5.9%**	**6.0%**	**5.8%**			
Bog 4.2	15.9%	15.1%	15.5%	15.1%	16.8%	16.8%	15.3%	14.8%			
Bog 6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Bog 8/9/10	0.0%	0.0%	0.0%	2.1%	0.0%	0.0%	0.0%	0.0%			
Bog 11.2	3.2%	2.7%	2.9%	2.1%	2.9%	2.1%	4.0%	3.2%			
Bog 12	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Bog 13	18.8%	22.2%	20.5%	28.2%	26.5%	26.5%	29.1%	30.8%			
All control	**15.5%**	**17.2%**	**16.4%**	**15.9%**	**16.4%**	**17.1%**	**17.9%**	**16.0%**			
Bog 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Bog 2	3.4%	3.0%	3.2%	2.1%	3.4%	2.5%	3.7%	1.8%			
Bog 4.1/5/7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Bog 11.1	5.4%	11.9%	8.7%	7.6%	6.1%	4.7%	6.5%	6.5%			
Bog S1	33.7%	39.4%	36.5%	38.7%	37.7%	40.7%	43.4%	35.4%			
Bog S2	62.0%	65.0%	63.5%	59.3%	61.6%	65.0%	64.6%	60.6%			
Bog S3	21.1%	21.1%	21.1%	21.8%	24.3%	25.6%	26.5%	25.9%			

Table A5.13 Proportion of Peat Moss *Sphagnum* spp. recorded as dead along line transects

Site	Proportion of Peat Moss *Sphagnum* spp. recorded as dead										
	BY1	BY2	BM	IY1	IY2	IY3	IY4	IY5	IY6	IY7	IY8
All impact sites	**0.8%**	**0.9%**	**0.8%**	**8.4%**	**0.8%**	**0.8%**	**0.0%**	**3.1%**			
Bog 4.2	1.2%	1.2%	1.2%	2.5%	1.1%	1.1%	0.0%	5.1%			
Bog 6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Bog 8/9/10	0.0%	0.0%	0.0%	66.7%	0.0%	0.0%	0.0%	0.0%			
Bog 11.2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Bog 12	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Bog 13	0.0%	0.0%	0.0%	9.1%	0.0%	0.0%	0.0%	0.0%			
All control	**2.6%**	**1.9%**	**2.2%**	**1.5%**	**2.5%**	**1.7%**	**0.7%**	**1.0%**			
Bog 1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Bog 2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Bog 4.1/5/7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			
Bog 11.1	0.0%	15.2%	10.4%	0.0%	0.0%	0.0%	0.0%	11.1%			
Bog S1	7.0%	0.0%	3.2%	1.7%	5.4%	0.8%	0.0%	0.0%			
Bog S2	1.6%	1.6%	1.6%	2.3%	0.5%	0.5%	1.6%	0.6%			
Bog S3	0.0%	0.0%	0.0%	0.0%	3.9%	6.2%	0.0%	1.2%			



Mt Buller HEMAMP Groundwater and Surface Water Monitoring Review

November 2023 – April 2024

Alpine Resorts Victoria

29 August 2024

→ The Power of Commitment

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→ The Power of Commitment

Acknowledgement of Country

GHD acknowledges Aboriginal and Torres Strait Islander peoples as the Traditional Custodians of the land, water and sky throughout Australia on which we do business. We recognise their strength, diversity, resilience and deep connections to Country. We pay our respects to Elders of the past, present and future, as they hold the memories, knowledges and spirit of Australia. GHD is committed to learning from Aboriginal and Torres Strait Islander peoples in the work we do.

Executive summary

A 100 ML water storage dam was constructed on the Mt Buller summit, between October 2019 and May 2020, as part of the Mt Buller Sustainable Water Security Project. A Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP) was developed to enable monitoring of the condition of Alpine Sphagnum Bogs which are hydraulically down-gradient of the dam construction footprint. The hydrological component of the HEMAMP involves tri-annual groundwater and surface water monitoring and sampling, undertaken by Alpine Resorts Victoria (ARV). The annual monitoring period includes one monitoring event in spring (typically November), one in late summer (typically February) and autumn (typically April). Monitoring has been undertaken prior to dam construction (Baseline monitoring) and after dam construction (Impact monitoring).

Based upon the monitoring completed in late 2023 and early 2024 (Impact Year 5), the following conclusions are made regarding the construction of the water storage dam:

- No obvious hydrochemical differences in the surface water and groundwater have been identified between the Baseline and Impact periods
- No major exceedances of the ANZG (2018) water quality objectives are identified. The water quality objectives are met at all locations with the exception of minor exceedances of nitrate (as N) at bore BH06
- Surface water flows from Boggy Creek Weir 1 pickup 1 and Weir 2 indicate that flows are highly responsive to rainfall all year-round and may be increased by snowmelt for several weeks in late spring
- Flow metres were installed in the Environmental Watering System in early 2024 and flow data will be analysed in the next annual monitoring report
- There is no obvious influence upon groundwater levels at most locations. However, two bores (BH09 and BH17), directly down-gradient of the water storage have shown a change in water level behaviour. The strong seasonal water level trend identified historically has been replaced with a more stable water level, albeit with a slight reduction in water level highs

This change in water level response is in part due to changes in the upgradient groundwater catchment due to the footprint of the water storage and associated earthworks. It is noted, however, that groundwater seepage beneath the storage is captured via a drainage blanket, then concentrated and redirected to Alpine bogs further downslope (north) via the EWS.

This report recommends:

- Adaptive management responses are recommended to investigate TDS and turbidity outliers in surface water (see Section 8.2.1.2):
  - Areas of weed removal and track grading should be inspected to determine if sediment controls need to be adjusted or added to avoid runoff
  - If inspection indicates no or limited sediment runoff, additional sources of TDS could be investigated including the sewage pipeline that traverses the base of the Summit Nature Walk
  - Turbidity in the EWS outlet should be investigated as to its source and whether it is entering the distribution pipeline (as turbidity may be settling in the EWS collection pit)
- An interim surface flow analysis to be conducted in December or January following the collection of six months of flow data from the EWS. As the EWS flows have not yet been characterised, an interim factual letter report or memo is recommended as a proactive measure to address the need to understand the EWS output prior to the next annual Hydrological Report
- Groundwater levels should continue to be monitored in accordance with the current HEMAMP program methodology
- The HEMAMP protocol contains adaptive management triggers for underwatering of the Alpine Sphagnum Bogs. It is recommended that either the HEMAMP or a separate monitoring program also considers the prospect of overwatering which may be occurring from the EWS or from changes to the subsurface in the dam footprint. Implications of overwatering may include:

    - The encroachment of the Alpine Sphagnum Bogs on other vegetation communities (as has been indicated by the ecological monitoring), or
    - Potential influences or impact to geotechnical hazards, including slope stability and dam safety
- We recommend that ARV should consider opportunities to utilise the HEMAMP hydrological monitoring to inform ongoing water supply assessments and decisions, including to capture data to assist with water security and demand assessments
- BH07 and BH10 should be manually bailed in the next monitoring round to reduce sediment load

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.3 and the assumptions and qualifications contained throughout the Report.

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Appendices

1. Introduction

Mt Buller and Mt Stirling Resort Management Board, now incorporated into Alpine Resorts Victoria (ARV) determined the need for a 100 ML water storage as part of the Mt Buller Sustainable Water Security Project. This project aims to provide a reliable water supply to the resort, capable of meeting future demand. The water storage was constructed between October 2019 and May 2020 and had a 10.3 ha construction footprint. The footprint of the storage is adjacent to sensitive alpine ecosystems, particularly native vegetation and habitat for significant species, that are immediately down-gradient of the storage construction footprint.

A Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP) was developed to monitor the condition of the ecosystems, notably Alpine Sphagnum Bogs. The HEMAMP was implemented prior to the commencement of construction to obtain a baseline of information on surface water, groundwater and ecological conditions. Monitoring has continued post-construction. These pre-construction and post-construction monitoring periods have been referred to as baseline and impact periods in data reporting.

The hydrological component of the HEMAMP has involved bi-annual groundwater and surface water monitoring and sampling, undertaken by ARV. The annual monitoring period has included one monitoring event in spring (typically November) and one in late summer (typically February). In 2023, an additional monitoring round was added in April. This was added in response to a peer review of the monitoring program by Monash University as well as recommendations from the former Department of Environment, Land, Water and Planning (DELWP)[1].

This Impact Year 5 report presents the findings of the 2023-2024 monitoring events. The data analysis in this report incorporates changes to the adaptive management triggers in the HEMAMP Version 5 (Biosis 2022).

1.1 Impact Year 4 report recommendations

The impact year 4 (IY4) assessment recommended further investigations and infrastructure improvements as summarised in Table 1. The recommendations have largely been addressed.

Table 1 Key recommendations from IY4

Recommendation	Works completed	Resolved?
Consider a review of dam safety and associated geotechnical hazards associated with the change in groundwater behaviour and the design and operational arrangements of the EWS.	An intermediate dam safety inspection was conducted on 14 December 2023 in accordance with ANCOLD Guidelines on Dam Safety Management (2003). The dam was observed to be in fair to satisfactory condition and some surveillance and documentation recommendations were made in the report (GHD 2024).	Yes
Repair Bore 10 headworks and decommission bores BH04 and BH04A.	A permit to decommission Bore BH04 and BH04A has been obtained and a drilling contractor has been engaged for these works.	Partially
Incorporate surface flow analysis from the Boggy Creek catchment in the next annual monitoring period.	Surface flow gauges have been reviewed and data downloaded	Yes
Incorporate flow monitoring of the EWS. Flow meters were installed in IY4 but automatic monitoring was not available due to connectivity issues.	GHD produced a flow monitoring options assessment in December 2023. Following the options assessment, new flow meters have been obtained and installation was underway at the end of the IY5 monitoring period.	Partially
Note: EWS = Environmental Watering System		

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[1] Now the Department of Energy, Environment and Climate Action (DEECA)

1.2 Purpose of this report

The purpose of this report is to present the data obtained from the annual groundwater and surface water monitoring at Mt Buller in the Impact Year 5 (IY5) 2023-2024 hydrological monitoring period (i.e. November 2023, February 2024 and April 2024 monitoring events).

1.3 Scope and limitations

This report: has been prepared by GHD Pty Ltd (GHD) for Alpine Resorts Victoria and may only be used and relied on by Alpine Resorts Victoria for the purpose agreed between GHD and Alpine Resorts Victoria as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Alpine Resorts Victoria arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Alpine Resorts Victoria and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

1.4 Assumptions

The following assumptions have been used to prepare this report:

- GHD has relied upon data collected by the ARV, including climate and water flow data. This is assumed to be accurate. GHD has not completed any independent verification of the data
- A climatological model was produced by Biosis as part of the endorsed HEMAMP for the purpose of reviewing data against the HEMAMP adaptive management triggers. GHD has input surface flow data and groundwater flow data into the HEMAMP model and included the model outputs in this report. GHD has not undertaken an independent review or verification of the HEMAMP climatological model and assumes that the model is accurate and fit-for-purpose

2. Overview of monitoring program

2.1 Objectives

The objectives of the water monitoring program are to measure results of water quality and flow monitoring against the adaptive management triggers of the HEMAMP, to identify potential implications on surface water and groundwater levels and quality caused by the construction and operation of the water storage.

2.2 Monitoring network

2.2.1 Surface water

2.2.1.1 Boggy Creek

Prior to 2018, there were two surface water sampling locations at weirs referred to as Boggy Creek 1 and Boggy Creek 2. Following a site inspection and sampling event in February 2018, a third location was added, at a weir downstream of the existing sampling locations.

The surface water sampling locations since 2018 include:

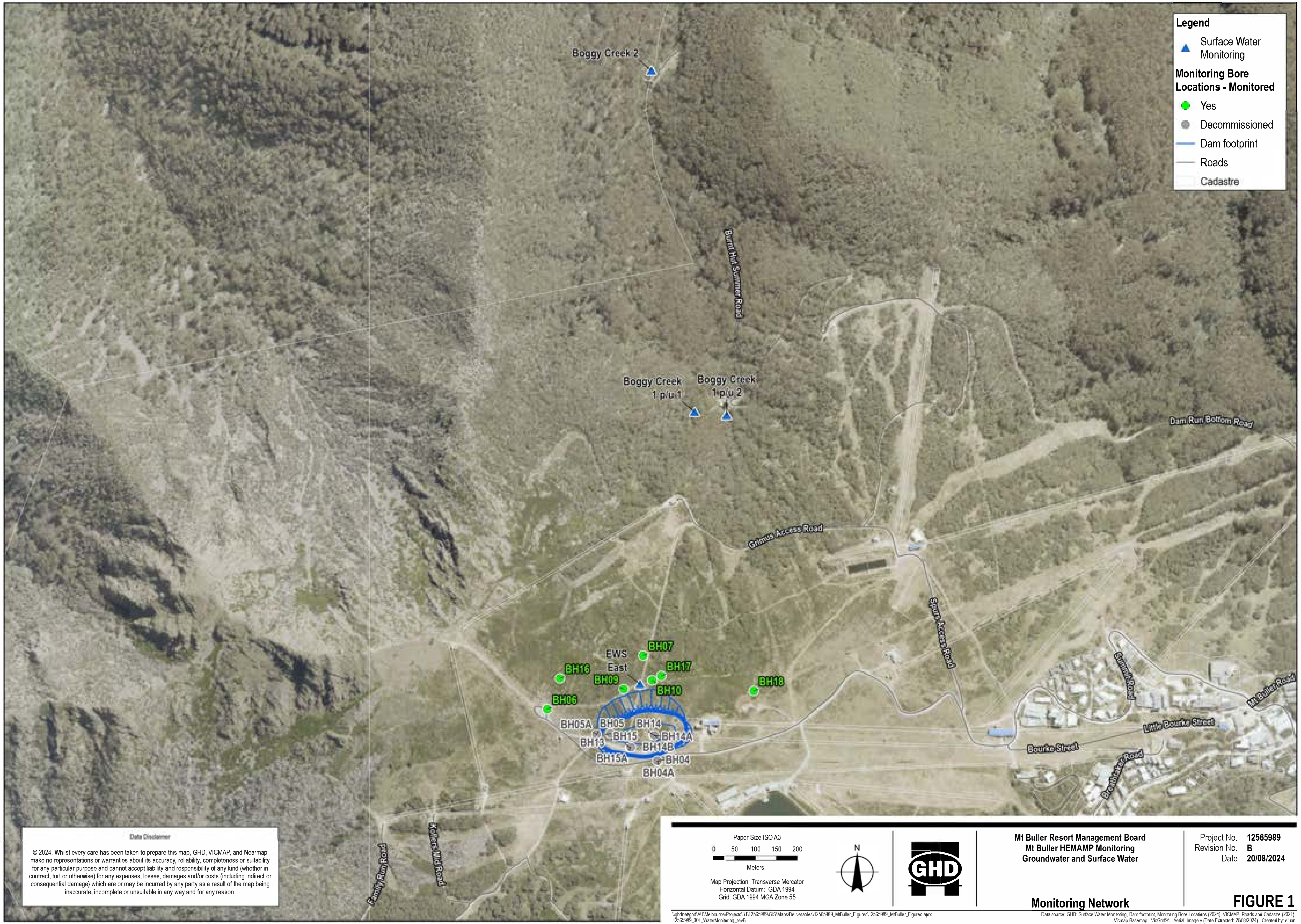
- Boggy Creek 1
  - Pick up Location 1 west of the shed and tank
  - Pick up Location 2, south of the shed and tank
- Boggy Creek 2
  - At a weir downstream of the two Boggy Creek 1 sites.
- Environmental watering system (EWS)

These sampling sites are shown in Figure 1 and are summarised in Table 2.

Table 2 Surface water monitoring network

Location Name	UTM Zone 55 Coordinates		Location
	Easting	Northing	
Boggy Creek 1 p/u 1	449,781	5,889,496	Collection point is behind the shed off to the right up the hill, away from the tank pick up 1
Boggy Creek 1 p/u 2	449,857	5,889,488	Collection point is by the weir located on this hill behind the shed called Boggy Creek 1, pick up 2
Boggy Creek 2	449,677.79	5,890,310.05	Collection point is by the weir at Boggy Creek 2
EWS East	449,656	5,888,881	Collection point is the eastern pipe of the EWS distribution pit, located on the northern wall of the dam. (western pipe is the groundwater collection drain, eastern pipe is the leakage collection drain)
Note: Coordinates presented above are handheld GPS coordinates			

It is noted that limited flow data has been provided for surface water. Therefore, surface water flow analysis is limited in this report. ARV installed new flow gauges at Boggy Creek weir 1 pickup 1 and pickup 2 in January and May 2022 and Boggy Weir 2 in December 2023.



Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

Mt Buller Resort Management Board
Mt Buller HEMAMP Monitoring
Groundwater and Surface Water

Monitoring Network

Project No.	12565989
Revision No.	B
Date	20/08/2024

FIGURE 1

\\ghdnet\ghd\AU\Melbourne\Projects\31\12565989\GIS\Maps\Deliverables\12565989_MtBuller_Figures\12565989_MtBuller_Figures.aprx - 12565989_001_WaterMonitoring_revB
Printdate: 20Aug 2024 - 13:39

Data source: GHD: Surface Water Monitoring, Dam footprint, Monitoring Bore Locations (2024). VICMAP: Roads and Cadastre (2021). Vicmap Basemap - VicGrid94 - Aerial: Imagery (Date Extracted: 20/08/2024). Created by: ejuan

2.2.1.2 Environmental watering system

In addition to the Boggy Creek sampling locations, a fourth sampling location was added to the monitoring program in 2022-2023 following recommendation from DELWP. The fourth sampling location is the Leakage Collection Pipeline, which is the eastern pipeline feeding into the EWS located at the toe of the storage embankment.

To prevent excessive hydrostatic pressures on the storage lining system, the storage was constructed with an under-drainage system. The design drawings in Appendix A show the drainage system as comprising bedding sand with a network of DN100 collection pipes. The pipes terminate at central point beneath the storage, and then gravity feed to a 'distribution pit' located at the toe of the northern embankment. Groundwater collecting beneath the storage can then be directed to the north and discharged over the landscape.

Two pipelines feed into the EWS pit:

- Leakage Collection Pipeline (referred to as EWS East), which captures leakage of surface water from the dam
- Groundwater Collection Pipeline (referred to as EWS West), which is intended to capture groundwater build-up beneath the dam which would naturally flow to the sphagnum bogs

From the EWS pit, here are two (0.6 m deep) soakage trenches extending to the east (~58 m) and west (~107 m) of the distribution pit which spread the discharge across the northern slopes of Mount Buller. The pipe comprises both slotted and non-slotted intervals so that EWS water is mostly redirected to the Alpine Bog areas and avoids discharge at snow-gum stands.

Sampling of the EWS is completed using the same methodology as that applied to the Boggy Creek locations. The distribution pit is metered, however, at the time of assessment, no data was available. Flow gauges with automatic logging have since been installed as described in Section 1.1.

2.2.2 Groundwater

2.2.2.1 Bore locations

The groundwater monitoring network originally comprised 14 bores which were installed as part of the initial geotechnical investigations. The original monitoring network is shown Figure 1 and these bores were gauged multiple times during the preconstruction period to establish baseline conditions.

Additional bores were installed to target Alpine Bog areas e.g. BH16, BH17 and BH18. A review of the program by GHD (2018) recommended that water quality sampling continue at bores BH06, BH09, BH16, BH17 and BH18 during the construction period. The remaining bores (BH07 and BH10) are to be manually gauged for the standing water level during sampling rounds (refer Table 3).

Table 3 Groundwater monitoring network

Bore ID	Automatic Standing Water Level (SWL) data logger	Manual gauging	Groundwater Sampling
BH04	Scheduled for decommission		
BH04A	Scheduled for decommission		
BH06	✓	✓	✓
BH07		✓	✓
BH09	✓	✓	✓
BH10		✓	
BH16	✓	✓	✓
BH17	✓	✓	✓
BH18	✓	✓	✓
Environmental Watering System – collected from beneath the dam and discharged at EWS pit			

Bore ID	Automatic Standing Water Level (SWL) data logger	Manual gauging	Groundwater Sampling
EWS West	Flow meter installed for IY6	NA	✓

Many of the original bores were located within the storage construction footprint and were destroyed in-situ during the construction program. During a site inspection by GHD in late 2021, bore BH09 could not be identified and was suspected as being hidden by fill material. Bore BH10 was sampled in place of the ‘missing’ bore BH09.

Bore BH09 was subsequently identified using a metal detector in March 2022. The bore condition was reviewed and as it appeared to be sound and operational, it was re-incorporated into the monitoring program.

2.2.2.2 Monitoring bore construction

The construction details for each groundwater monitoring bore are given in Table 4. The bores which are no longer operational have been shaded grey.

Table 4 Groundwater monitoring bores construction details

Bore ID	Zone 55 Coordinates		Total Depth (m bgl)	Screen (m bgl)		
	Easting	Northing		Top	Bottom	Screened Lithology
BH04	449,692.8	5,888,663	15.68	8.68	14.68	Carbonaceous Mudstone
BH04A	449,692.6	5,888,663	2.56	1.56	2.56	Basalt
BH05	449,547.4	5,888,727	19.8	14	19.8	Granitic Soils
BH05A	449,546.6	5,888,727	2.5	1.5	2.5	Colluvium
BH06	449,429.0	5,888,787	9	6	9	Granite
BH07	449,658.3	5,888,915	1	0	1	Bog/Granitic Soil
BH09	449,611.8	5,888,835	6	3	6	Granite
BH10	449,679.9	5,888,856	9	6	9	Granite
BH13	449,580.0	5,888,729	9	6	9	Colluvium
BH14	449,683.5	5,888,724	19.5	16.5	19.5	Granite
BH14A	449,683.9	5,888,725	15	12	15	Granite
BH14B	449,684.4	5,888,725	9.5	6.5	9.5	Granitic Soils
BH15	449,626.7	5,888,695	23	20	23	Granitic Soils
BH15A	449,629.6	5,888,696	6	3	6	Colluvium
BH16	449,459	5,888,860	2.1	1.1	2.1	Granitic Soils
BH17	449,701	5,888,866	2.2	1	2.2	Granitic Soils
BH18	449,922	5,888,830	2.15	1.15	2.15	Granitic Soils
Note: grey shading denotes bores which are no longer operational						

2.3 Sampling and analytical program

The monitoring is conducted tri-annually (previously bi-annually), in the months of February, November and April each year. The April monitoring round was introduced in 2023 and was recommended to continue for two years. The reporting period follows the financial year, i.e. this report documents results of the monitoring period November 2023 – April 2024.

2.3.1 Surface water

2.3.1.1 Sampling method

A Standard Operating Procedure (SOP) has been prepared for the hydrological monitoring program to help to maintain consistency in the instance that a change in ARV staff should take place. Sampling for the 2023-2024 monitoring events was undertaken in accordance with this procedure.

Photographs of the sampling points are taken at each site and are attached in Appendix B. Samples are taken on the inside of the weir wall from the nearest access point at each weir:

- the western corner at Boggy Creek 1 p/u 1 and Boggy Creek 2, and
- the eastern corner at Boggy Creek 1 p/u 2
- the eastern pipe within the EWS distribution pit

One duplicate and one split sample is required for each surface water monitoring event, as summarised in Table 5. This can be taken at either of the primary sample locations, making sure that the location of the duplicate sample is noted on the field sheet.

Table 5 Number of surface water samples required per monitoring event

Sample Type	Number
Primary sample	4
Primary laboratory duplicate (Duplicate) sample	1
Inter-laboratory duplicate (Split) sample	1

2.3.1.2 Analytical program

Table 6 lists the analytes requested for each surface water sample. Prior to taking a sample, a calibrated field water quality meter was used to measure in-field water quality parameters. The field and laboratory parameters are summarised in Table 6. In addition to the analytes in Table 6, a suite of metals were also analysed in November 2023 for comparison with metal results obtained in 2015. Incorporating metal results in April 2023 evens this to one impact year and one baseline year.

Table 6 Surface water analytes

Suite	Locations	Analytes
In-situ field measurements	Boggy Creek p/u 1 Boggy Creek p/u 2 Boggy Creek 2 EWS East	Temperature pH Dissolved oxygen Oxidation – Reduction Potential (Redox) Electrical Conductivity (µS/cm)
SW1 (laboratory analysis)	Boggy Creek p/u 1 Boggy Creek p/u 2 Boggy Creek 2 EWS East	Electrical conductivity (EC) Total Dissolved Solids (TDS) pH (field) Nutrients (Total P, N), Total Kjeldahl Nitrogen (TKN) Major ions (Ca, Mg, Na, K, Cl, SO4, HCO3, CO3 and NO3) Turbidity Suspended Solids

2.3.2 Groundwater

2.3.2.1 Sampling method

Samples are collected from the five groundwater monitoring bores and the western outlet pipe of the EWS pit.

Samples were collected in accordance with the SOP described in Section 2.3.1.1.

Groundwater sampling is consistent with EPA Publication 669.1 (2022).

One duplicate and one split sample is required for each groundwater monitoring event, as shown in Table 7. This can be taken at either of the primary sample locations, making sure that the location of the duplicate sample is noted on the field sheet.

Table 7 Number of groundwater samples required per monitoring event

Sample Type	Number
Primary sample	6
Primary laboratory duplicate (Duplicate) sample	1
Inter-laboratory duplicate (Split) sample	1

Monitoring bores are purged of standing water (minimum three casing volumes, where possible) prior to sampling using a dedicated, disposable bailer to eliminate cross contamination. Field parameters are monitored throughout the purging process using a calibrated field water quality meter. The bore is considered ready for sampling when the field indicators stabilise, in accordance with EPA Victoria (2022). Some bores are sampled without purging when there is insufficient recharge to purge three casing volumes of water or where recharge rates are very low.

The volume of water purged, and comments on observed characteristics of the water, are recorded on the field sheet for each bore (refer Appendix B).

2.3.2.2 Analytical program

Table 8 summarises the analytes requested for each groundwater sample, and the field measured water quality parameters.

Table 8 Groundwater analytes

Suite	Bore ID/Locations	Analytes
In-situ field measurements	BH06, BH09 (BH10*), BH16, BH17, BH18, EWS West *BH10 was monitored in place of BH09 in the 2021-2022 period	Temperature pH Dissolved oxygen Oxidation – Reduction Potential (Redox) Electrical Conductivity (µS/cm)
GW1 (Laboratory analysis)	BH06, BH09 (BH10*), BH16, BH17, BH18, EWS West *BH10 was monitored in place of BH09 in the 2021-2022 period	Electrical conductivity, Total Dissolved Solids and pH Nitrate (as N), Nitrite (as N), Nitrogen (Total Oxidised) and Phosphorus (Total) Alkalinity (total) as CaCO3, Alkalinity (Bicarbonate as CaCO3), Alkalinity (Carbonate as CaCO3) Calcium, Magnesium, Potassium, Sodium, Chloride, sulphate

2.3.3 Laboratory

Samples are placed in an esky and chilled during the field sampling. Samples are refrigerated until they are ready for dispatch to the analytical laboratory in chilled eskies.

The samples are submitted to ALS Environmental Laboratories Pty Ltd (ALS) as the primary laboratory and Eurofins Scientific (Eurofins) as the independent, secondary laboratory for QA/QC analysis.

A completed chain of custody form is submitted with the samples. Eurofins and ALS are both registered with NATA[2] for the nominated analyses.

2.4 Water quality objectives

The *Environment Protection Act 2017* commenced on 1 July 2021 and specifies new objectives of the EPA and consequential amendments to the former act *Environment Protection Act 1970*. The Act changes Victoria's focus to a prevention based approach, rather than preventing waste and pollution impacts and managing these after they have occurred. Central to the Act is the General Environmental Duty (GED) which requires Victorians to reduce the risk of their activities potentially harming the environment or human health through waste and pollution.

The Act introduces two subordinate instruments:

- Environment Protection Regulations (EPR)
- Environment Reference Standard (ERS)

Under section 93 of the new Environment Protection Act 2017, an Environmental Reference Standard (ERS) is used to assess and report on the environmental conditions throughout Victoria. The ERS:

- Identifies environmental values (human health and the environment) to be achieved or maintained in Victoria
- Specifies indicators and objectives used to measure, determine or assess whether those environmental values are being achieved, maintained, or threatened

The ERS is not meant to represent a compliance standard, but rather has a primary function to provide an environmental assessment and reporting benchmark. The ERS contains environmental values for each element of the environment in separate parts, i.e. air, land, water (surface and groundwater), however, the different elements of the environment can impact each other and the interactions between them need to be considered.

The ERS classifies the waters of Victoria (surface water and groundwater) into segments, with each segment having particular identified environmental values. For the surface and groundwater at the water storage, the protection of water dependent ecosystems and species is most relevant.

The ERS also sets indicators and objectives for the environmental value of the water, which for water dependent ecosystem and species are the Australian and New Zealand Guidelines for Fresh and Marine Water quality (ANZG 2018, updated July 2021). The ANZG (2018) guideline allows for water quality objectives to be selected based on different levels of species protection sought.

The results of the 2023-2024 monitoring program have been compared to the criteria of ANZG (2018, updated July 2021) for 95% Freshwater species protection. Of the analytes included in the laboratory program, a water quality objective criterion exists for nitrate (2.4 mg/L as N).

A discussion of the surface and groundwater quality against relevant water quality objectives has been included in Section 8.3.

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[2] NATA – National Association of Testing Authorities

3. Monitoring results - Climate

3.1 Rainfall

The Bureau of Meteorology (BOM) maintains an active climate station at Mt Buller (Station No. 083024). The automated station is located approximately 500 m from the water storage dam at Tirol flat and monitors temperature (highs and lows) and rainfall (amongst other climate parameters) twice daily (am and pm). The monthly rainfall for the 2023 – 2024 monitoring period has been summarised in Table 9.

Table 9 Monthly rainfall over the 2023-24 monitoring period

Month	2023-2024 Monitoring period rainfall (mm)
April 2023	110
May 2023	159.8
June 2023	284
July 2023	181.2
August 2023	119.6
September 2023	88.4
October 2023	258.2
November 2023	86.4
December 2023	130.8
January 2024	253.2
February 2024	20.2
March 2024	33.8
Year Total (Apr 23 – Mar 24)	**1725.6**

Table 10 presents the monthly rainfall for the previous three years as well as the mean monthly rainfall during the baseline years and 1889 to 2018. From the table it can be seen that total rainfall over the recent years is higher than the historical range. The annual total for 2023 was 422.5 mm above the long-term average, and 47.8 mm above the mean recorded during the baseline years 2012-2018.

Rainfall trends are shown in Figure 2 for the years 2014 to 2023. To assess the variability of the climate, a rainfall deviation graph has also been included in Figure 2. This has been prepared to identify long term rainfall trends for the period 1990 to 2023 to characterise the influence of climate on groundwater levels. The absolute value of the residual mass curve is not important, but rather the slope:

- A positive slope indicates a wetter than average period
- A negative slope indicates a drier than average period
- A section of both negative and positive indicates a period of generally average rainfall
- The grade of the slope indicates how much wetter or drier than average the climate is

Note that the cumulative deviation from mean monthly rainfall has been calculated from 1990 to present, and so on the graph starts at a negative value based on previous years of rainfall. The residual mass curve indicates that rainfall has been close to average between 2018 and the present, except for a short period of above average rainfall in 2022.

Table 10 Monthly rainfall during impact years and historical mean rainfall

Month	Mean monthly rainfall (mm)		Monthly rainfall (mm)		
	1990 - 2018	2012 - 2018	2021	2022	2023
January	75.7	101.5	122	136.6	35.2
February	75.1	84.6	76.6	19.4	63.8
March	76.9	107.8	134.4	100.8	185.4
April	97.1	100.7	51.8	165.6	110
May	125.1	184.6	142.4	122.0	159.8
June	146.1	166.3	180.0	202.0	284
July	163.6	213.0	148.4	96.4	181.2
August	167.0	215.7	98.0	260.4	119.6
September	148.5	143.9	0.0	231.4	88.4
October	108.4	111.2	92.0	490.0	258.2
November	109.1	91.2	136.8	290.0	86.4
December	95.1	134.6	75.2	126.6	130.8
Year Total	**1280.3**	**1,655**	**1,257.6**	**2,241.2**	**1702.8**

3.2 Snow depth

As the water storage and the associated groundwater monitoring bore network are above the snow line, they become inundated with snow during the winter period. Snow is another form of precipitation that can recharge the aquifers underlying the summit.

Mt Buller Ski Lifts (Ski Patrol) undertakes snow gauging at three (3) locations across the resort:

- Tirol flat
- Boggy Creek
- Family Run

These sites have been in use continuously since 1987 and are considered to be reasonably close to the study site to provide an indication of snow depths. Of the three sites, the Tirol and Boggy Creek gauges are considered most reflective of the conditions at the water storage site and are described below based on historical records:

- **Tirol flat**
  The gauge is located near BoM automated weather station 083024. The monitoring site is located above the tree line and generally receives the least amount of snow, has sunlight all day, is prone to scouring from wind effect and in spring will lose all its snow first, in line with the north side of the mountain. It is not unusual during a significant snowfall for the Tirol Gauge to have nothing on it due to wind. Although the Tirol Gauge has the least amount of snow due to exposure, all the gauges are well above the lowest skiable point of 1,375 m AHD, therefore average depths are recorded and helps reflect snow across the whole resort.
- **Boggy Creek**
  The gauge is located at the top of the Boggy Creek T-Bar. The gauge is above the tree line and receives sunlight all day and has little or no wind affect. It receives considerably more snow than the Tirol Gauge.

The snow depths, averaged across the three gauges, have been shown in Figure 3. The graph has two snow depths reflecting the natural snow depth and that resulting from snow making activities. Snow depths were lower in IY5 than in IY4.

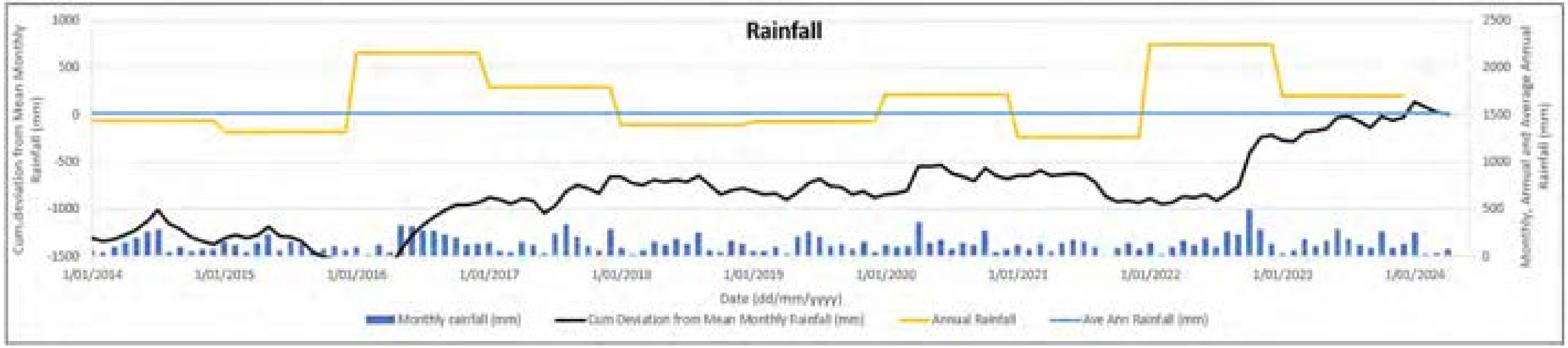

Figure 2 *Rainfall trends January 2014 - April 2024*

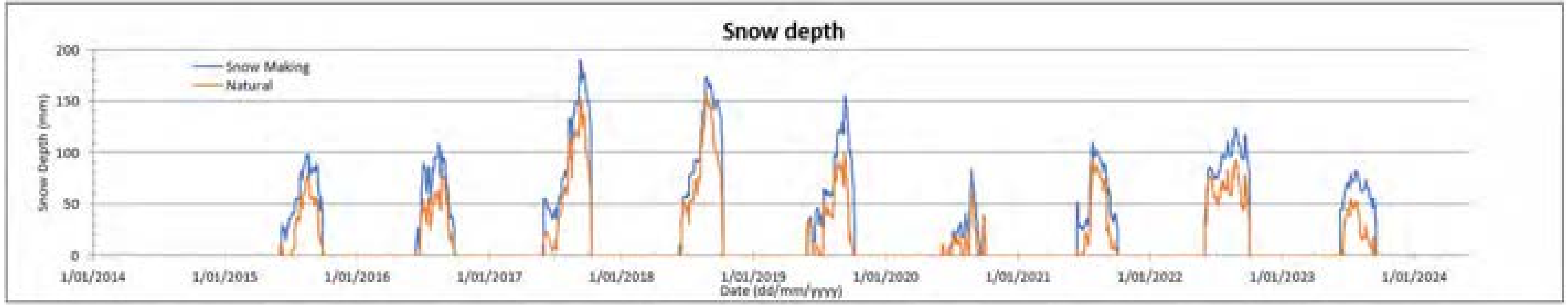

Figure 3 *Rainfall and snow depth data January 2014 – April 2024*

4. Monitoring results – network condition

4.1 Surface water

The surface water monitoring sites remain easily accessible for sampling. The weirs at each sampling site appeared to be in a similar condition to previous monitoring rounds.

4.2 Groundwater

All but two of the groundwater monitoring bores are in a sound condition i.e. there was no obvious damage to the casing or headworks, they were secure and operational. Bore BH10 was not open over its full depth, however, access into the screen interval was possible.

All of the monitoring bores designated for sampling (bores BH06, BH07, BH09, BH16, BH17 and BH18) are in operable condition. Minor differences in bore depths were measured in all bores compared to original depths, potentially indicating minor sediment build up in the bores. This was most notable in bores BH07 and BH10 which are not sampled. These bores should be manually bailed in the next monitoring round to reduce sediment load.

A summary of the groundwater monitoring network condition is presented in Table 11.

Table 11 Summary of monitoring bore condition

Bore ID	HEMAMP Water Quality Site	Status	Datalogger installed? (Y/N)	Condition
BH06	Yes	Identified	Y	Operational and secure
BH07	Yes	Identified	N	Bore depth has reduced to 0.88 m from an original depth of 1.77 m. Bentonite is protruding at the top of the well around the J plug. Headworks are operational and secure.
BH09	Yes	Identified	Y	Operational and secure
BH10	No	Identified	N	Headwork has been damaged and positioned loosely atop the well opening. Bore depth has reduced to 8.69 from an original depth of 9 m.
BH16	Yes	Identified	Y	Operational and secure
BH17	Yes	Identified	Y	Operational and secure
BH18	Yes	Identified	Y	Operational and secure
Note: Monitoring bore network condition as of 10/04/2024				

5. Monitoring results – surface flows

Flow meters were installed by ARV at Boggy Creek 1 and Boggy Creek 2 in January 2022, May 2022 (Boggy 1 p/u2) and December 2023 (Boggy Creek 2). There is no flow gauging data for earlier impact periods.

Surface flow timeseries have been plotted against rainfall and snow depth in Figure 4 and Figure 5. The timeseries shows a high level of responsiveness to rainfall at both Boggy 1 and Boggy 2. Surface flows appear to respond to rainfall immediately (i.e. surface flows increase on the day that rainfall occurs).

Snowmelt may also contribute to higher baseline surface flows in November-December. For example, in November 2022 the minimum surface flow rates at Boggy 1 remain higher than other periods of the year, suggesting another source may be topping up surface flows between rain events (noting that there were 10 days in November with < 1 mm of rain).

This is similarly exhibited in December 2023 when there were 19 days of < 1 mm rainfall. Minimum surface flows remained higher throughout December 2023 compared January 2024, despite December 2023 receiving less rainfall compared to January 2024. Figure 4 suggests that unlike the influence of rainfall, surface flows may have a delayed and longer lasting response to snowmelt.

A data gap in the surface flow analysis is the influence of continuous watering from the EWS. Flow rate data from the EWS should be incorporated in the next surface flow analysis to identify potential capture of EWS flows at the Boggy Creek weirs.

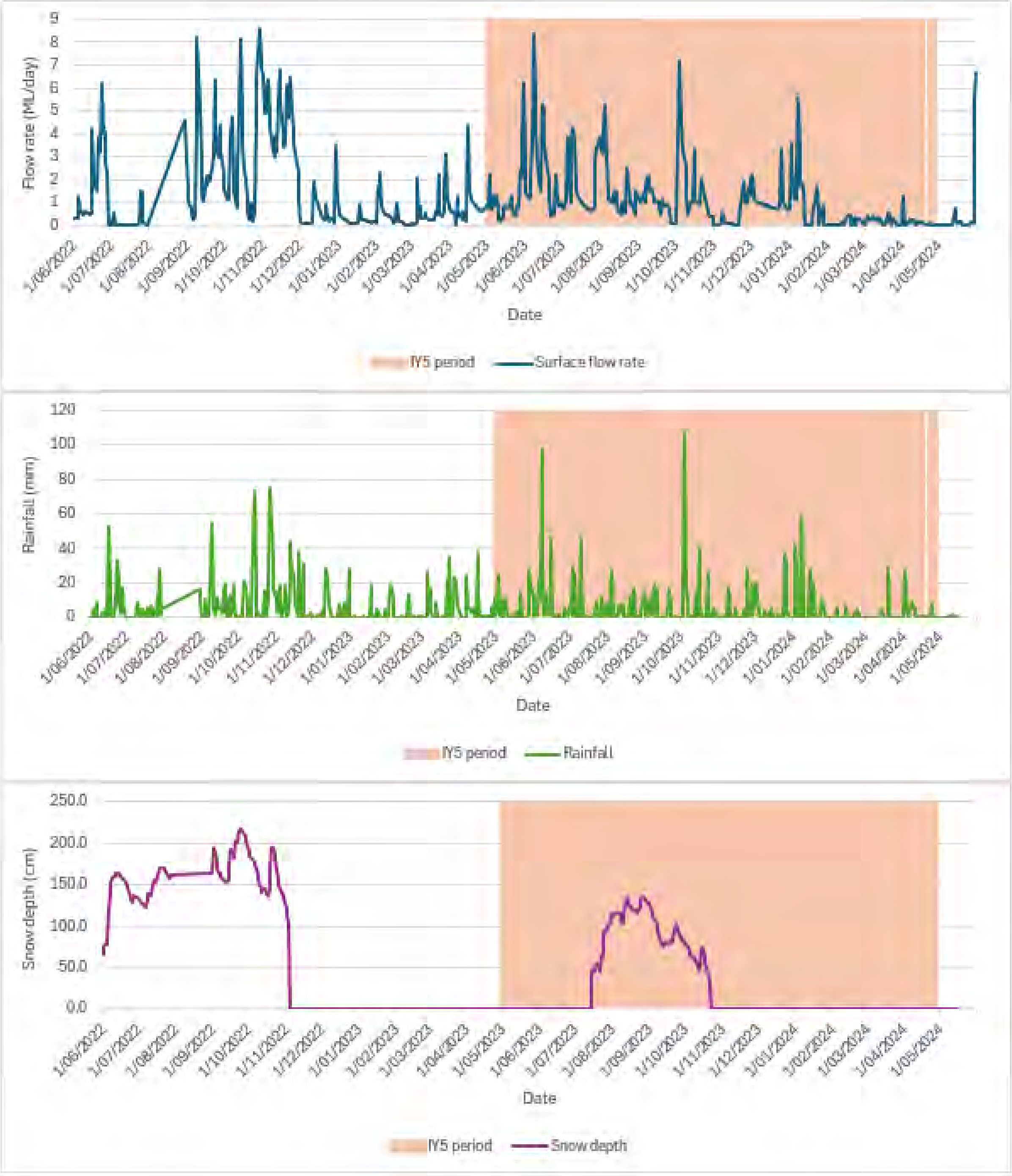

Figure 4 *Boggy 1 p/u 2 surface flows*

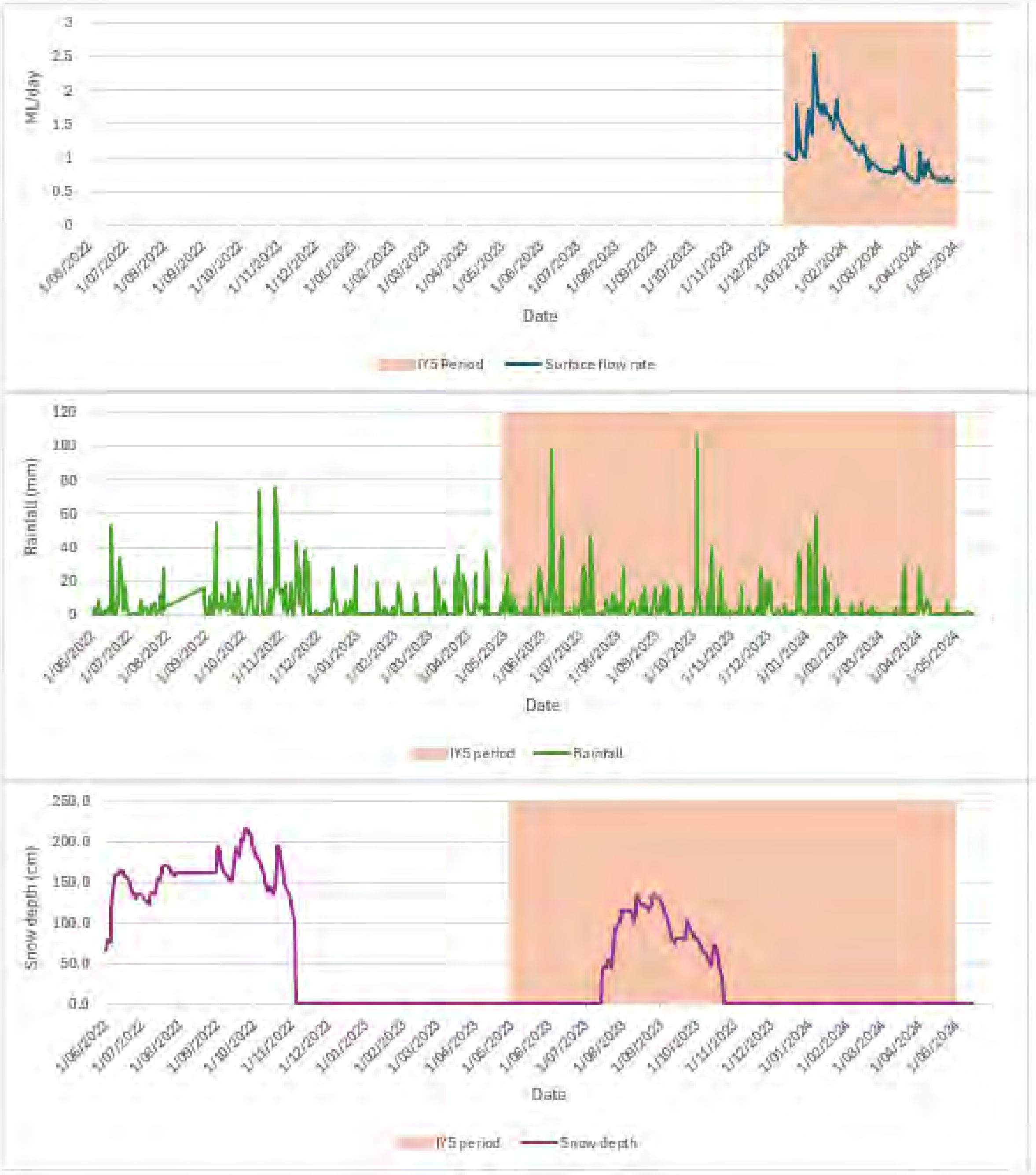

Figure 5 *Boggy 2 surface flows*

6. Monitoring results – groundwater level

6.1 Groundwater data collection

Automated water level dataloggers were installed in bores BH06, BH09, BH16, BH17 and BH18. The dataloggers (Insitu® LevelTROLL™) were non vented units and therefore barometric pressure datalogging was completed by installing an Insitu® BaroTROLL™ in bore BH06. The barometric logging enabled water level correction in the non-vented units. The dataloggers were removed, inspected, and downloaded during each monitoring round.

A manual measurement of the standing water level (SWL) is also taken for all monitoring bores (refer Appendix B for field notes) during each sampling round. For bores containing dataloggers, the SWL is manually taken before and after removing the datalogger. Standing water levels were manually measured using a hand held electronic water level probe. Manual SWL data is added to the hydrographs in Appendix C as a way of quality checking and "calibrating" the logger data.

There have been some issues identified with the water level logging data in terms of reference datums being incorrectly set and loggers moved. These included an incorrect logger setting when the loggers were re-installed after dam construction in June 2018 (recording "Depth" with no reference, instead of depth to water), and a swap of the Leveltroll and Barrotroll in BH06 in February 2023.

This has required GHD to undertake some post processing of data, and the manual correction of barometric response for one annual period. In some cases, there are data gaps in the time series monitoring record (e.g. during dam construction). No corrections have been required for the logger data since June 2023, with the exception of a standard correction using manual readings.

6.2 Hydrographs

The Hydrographs for each monitoring bore are presented in Appendix C. The following is noted regarding the format of the hydrographs:

- The approximate construction period of the water storage has been indicated on the SWL graph
- Snow depth and rainfall has been appended to each graph
- A rainfall cumulative deviation has been included in the rainfall chart. It is based upon rainfall data since 1990

6.2.1 Evidence of bore failure

Anomalous water levels can be taken as circumstantial evidence of bore failure. Anomalous water levels were not identified in any of the monitoring bores.

6.2.2 Summary

Interpretations of the hydrographs for each monitoring bore are included in Table 12. Bores which are manually gauged have also been included in this table.

The water level response in most monitoring bores is strongly dependent upon the prevailing climate. From the review of the hydrographs, bores BH06 and BH18 exhibit similar responses to rainfall during the water storage construction period compared to the preconstruction or baseline monitoring period. These bores are situated cross-gradient from the water storage and are not expected to be impacted by the water storage construction or operation. Conversely, bores BH09, BH17 and to a lesser extent BH16 exhibit some change in SWL patterns after the construction of the water storage.

Interpretation of the water level response in the manually monitored bores is more uncertain owing to the limited frequency of the water level gauging.

Table 12 Summary of hydrograph and other water level data responses

Bore ID	Aquifer	Monitoring method	Comment
BH06	Granite (weathered)	Datalogger + Manual	Bore BH06 is upgradient of mapped bogs near BH16. The hydrograph suggests that this bore is responsive to rainfall. A notable seasonality in this bore is evident during both the baseline and impact periods, suggesting that the bore is behaving in the same way as it was prior to the water storage construction. Water levels are generally greater than 5 m below the surface, however during the snow season and spring, water can be within 2 m of the surface during years with higher rainfall. After recharge during the Winter and Spring periods, water levels exhibit a slow decline over the Summer. Declines in some cases have continued below the base of the bore (9 m), i.e. there have been periods when the bore is dry. Water levels recover relatively rapidly, with the most rapid rises occurring during the onset of the snow season. The significant variation in water levels potentially suggests that storage in the weathered granites may form a significant contribution to down-gradient seeps and spring flows.
BH07	Granitic soil (bog)	Manual only (Datalogger prior to 2018)	This is a shallow bore (1.0 m depth) with water levels responding to rainfall events. It is located within a mapped bog area immediately north of the water storage dam. In late summer, water levels fall below the base of the monitoring bore. The bore indicates that for the majority of the year, water levels are within 1 m of the surface or shallower, however, there are small periods in the late Summer through Autumn where water levels become deeper than 1 m.
BH09	Granite (sandy clay/clayey sands)	Datalogger + Manual	There is an obvious change in the water level response in this monitoring bore since the construction of the storage. During the baseline period, the hydrograph exhibits a strong season response, with water level lows typically between 2.5 m and 3 m bgl and water levels becoming artesian, i.e. water levels above current ground surface, in late Winter and Spring. Prior to storage construction, water levels would fall over the summer period, resulting in a pronounced seasonal response. Towards the end of the construction period the water level response changed, noting that this bore is directly down-gradient of the storage. Water levels no longer become artesian, and the seasonal drainage has stopped, with rapid water levels frequently responding between 1 m and 2.5 m bgl. The groundwater catchment supplying water to the zone monitored by this bore has been disturbed by the storage construction. There is additional storage of infiltrating rainfall into the embankment materials (immediately north of the bore), and changes in recharge due to the storage itself. The bore is located marginally up-gradient of the western arm of the EWS, which is understood to have been flowing continuously since installation. In summary the bore is indicating that the water table is getting more frequent recharge events, but the total volume of recharge is not as much.
BH10	Granite (extremely weathered – moderately weathered)	Manual only	The response of monitoring bore BH10 was similar to bore BH09 in the baseline period monitoring. Manual gauging results indicate that the SWL is continuing to respond to seasonal trends and remains within the baseline range. The hydrograph exhibits a strong season response, with water levels typically deeper than 2 m bgl, but become within 0.5 m of the ground surface in the peak of the snow season. Water levels exhibit a steady decline over the summer period and fall to around 6 m below the surface. Water level recovery is rapid, rising over 5 m with rainfall and the commencement of the snow season. Smaller rainfall events in early Autumn do not seem to have a significant influence in terms of arresting the rate of water decline during the Summer/Autumn period. The significant variation in water levels, and slow drainage from the Winter/Spring highs potentially suggests that storage in the granites may form a significant contribution to down-gradient seeps and spring flows.

Bore ID	Aquifer	Monitoring method	Comment
BH16	Clayey gravelly SAND and Silty GRAVEL	Datalogger + Manual	Bore BH16 is located cross slope from the storage, and within the margins of a bog. Water levels typically exhibit a strong season response and fall during the Summer and late Autumn periods. At times during Winter, water levels can become artesian. As per other monitoring bores, there is a gradual decline in water levels following winter as groundwater drains from storage, however, water level recovery can be rapid. Larger rainfall events are, however, evident in the water level monitoring response. In this bog, there seems to be tendency for water levels to remain more stable (generally within 1 m variation between seasons), with groundwater storage taking more time to deplete, and recharge. The hydrograph shows less seasonality in BH16 during IY4 and IY5. The variation in water levels is not as great as previous years, with only an ~0.5 m difference across the monitoring period.
BH17	Clayey SAND	Datalogger + Manual	BH17 is a shallow bore located within the margins of a bog. In the baseline years the bore shows similar features to that of bore BH16, i.e. an obvious seasonal response. At times the groundwater level has been artesian, and in some cases water levels remained artesian throughout the year. Since the construction of the storage the seasonal response of the water level has not been as pronounced. This bore is located directly down-gradient of the storage, and it would seem that the construction of the storage has modified aquifer recharge in this area. The bog in this area is receiving water from the EWS. It is noted that groundwater levels are tending to remain more stable (generally within 0.5 m of the ground surface, and 0.5 m variation between seasons), with groundwater storage taking more time to deplete, and recharge. Groundwater levels have frequently been artesian or very close to surface in IY5.
BH18	Clayey SAND	Datalogger + Manual	This bore is located further to the east of the water storage. Bore BH18 appears to be experiencing similar trends and ranges in SWL in the impact years and baseline years. This indicates that the bore is not being impacted by the water storage. Water levels exhibit a strong season response and fall during the Summer and late Autumn periods. Water levels are reactive to rainfall events. At times during late Summer/Autumn water levels can fall below the base of the bore, however, they can quickly respond following a rainfall event.

7. Monitoring results – water quality

7.1 Surface water

7.1.1 Field parameters

Field monitoring sheets have been attached as Appendix B. Measurements were taken in the field using a Water Quality Meter (WQM) prior to sampling for each site. The final measurements (taken immediately prior to sampling) are displayed in both graphical and tabulated format alongside previous years in Appendix D, to allow comparison between baseline and construction periods.

From Appendix D, the field parameters appear to remain within the same range between the baseline and water storage construction periods at each location. No obvious change in the water quality has been identified from the field water quality parameter monitoring.

Typically, the field parameter results demonstrate:

- Temperature averages are approximately 8°C to 9°C at each location
- At all locations, pH ranges from slightly acidic to neutral, with the exception of October 2015 at Boggy Creek 1 with a pH of 9 to 10
- Dissolved Oxygen values range between 7 mg/L and 13 mg/L with the exception of a low reading of 0.5 mg/L in January 2014 at Boggy Creek 1 p/u 1
- The average oxidation potential during the impact period is between 52 % to 63 % of that of the baseline period at all locations. The lowest ORP results have been reported for November in both IY4 and IY5 monitoring periods. Negative ORP results indicated reducing conditions in the November 2022 monitoring round at all locations. This was an anomaly to the previous and subsequent monitoring rounds and have not been observed in IY5
- Electrical conductivity (EC) has reduced at Boggy 1 P/U 2 during both the IY4 and IY5 monitoring periods, to approximately half of the baseline average

7.1.2 Analytical results

Analytical results are presented in summary tables in Appendix E. The certified laboratory reports are attached in Appendix F. The discussion below focuses on differences between the baseline and water storage construction periods.

Inorganics

For all monitoring locations, laboratory measurements of pH, and EC are typically within the same range during both the baseline and post construction impact monitoring periods. These parameters are typically within the same range as the field measurements.

New TDS maximums were recorded for all locations in IY5, similarly to IY4 increases. The EWS East reported inorganics within the range of all Boggy Creek monitoring locations.

Acidity and Alkalinity

Bicarbonate concentrations were slightly lower overall in IY5 but close to the range of previous monitoring rounds. EWS East was similar to Boggy 1 p/u 2. At all locations, the carbonate alkalinity has not been above laboratory Limits of Reporting (LOR).

Major Ions

At all locations, major ions such as calcium, magnesium and potassium ions are all within a similar range across the monitoring record, i.e. sodium and calcium <2.5 mg/L, magnesium and potassium <1 mg/L and chloride approximately 1 mg/L.

Nutrients

Nitrate ranges are similar in all wells and showed a mild decrease in the start of the impact period, before increasing in the IY4 and IY5 monitoring periods. Concentrations of phosphorus (Total) are low and are also below the limit of reporting in many instances.

7.1.3 Summary Tables

Results for key analytes are summarised in Table 13. Table 14 summarises any notable differences in surface water quality between the construction and baseline monitoring periods.

Table 13 Key analyte results for surface water

Key analyte	Boggy Creek 1 p/u 1	Boggy Creek 1 p/u 2	Boggy Creek 2
pH	Appears to be consistent between baseline and impact periods. Typically slightly acidic to neutral.	Appears to be consistent between baseline and impact periods. Typically slightly acidic to neutral.	Appears to be consistent between baseline and impact periods. Typically slightly acidic to neutral.
Electrical conductivity	Apart from low results in November 2023, appears to be consistent between baseline and impact periods. Concentration ranges from 19 µS to 28 µS/cm	Apart from low results in November 2023, appears to be consistent between baseline and impact periods. Concentration ranges from 16 µS to 51 µS/cm	Apart from low results in November 2023, appears to be consistent between baseline and impact periods. Concentration ranges from 21 µS to 29 µS/cm
Turbidity	Appears to be consistent between baseline and impact periods. Typically < 2 NTU	Appears to be consistent between baseline and impact periods. Typically < 1 NTU	Appears to be consistent between baseline and impact periods. Typically < 1 NTU
Bicarbonate	Appears to be consistent between baseline and impact periods albeit slightly lower results in IY5. Concentrations range from 7 mg/L to 15 mg/L except for Feb 2022 at 37 mg/L.	Appears to be consistent between baseline and impact periods albeit slightly lower results in IY5. Concentrations range from 6 mg/L to 24 mg/L.	Appears to be consistent between baseline and impact periods albeit slightly lower results in IY5. Concentrations range from 13 mg/L to 16 mg/L.
Carbonate	Consistent between baseline and impact periods. Concentration below detection limit.	Consistent between baseline and impact periods. Concentration below detection limit.	Consistent between baseline and impact periods. Concentration below detection limit.
Calcium, Magnesium, Potassium, Sodium Chloride	Appears to be consistent between baseline and impact periods. Ion concentrations typically < 3 mg/L.	Appears to be consistent between baseline and impact periods. Ion concentrations typically < 3 mg/L	Appears to be consistent between baseline and impact periods. Ion concentrations typically < 3 mg/L
Nitrogen and nitrate	Appears to be consistent between baseline and impact periods. Typically < 1 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 1 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 1 mg/L.
Phosphorus and phosphate	Appears to be consistent between baseline and impact periods. Typically < 1 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 1 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 1 mg/L.

Table 14 Summary of surface water differences

Key analyte	Notable difference in construction period compared to baseline years?		
	Boggy Creek 1 p/u 1	Boggy Creek 1 p/u 1	Boggy Creek 2
pH	No	No	No
Electrical conductivity	No	No	No
Turbidity	No	No	No
Bicarbonate	No	No	No
Carbonate	No	No	No
Calcium, Magnesium, Potassium, Sodium Chloride	No	No	No
Nitrogen and nitrate	No	No	No
Phosphorus and phosphate	No	No	No

7.2 Groundwater

7.2.1 Field parameters

Measurements were taken in the field using a calibrated WQM prior to sampling for each site. The final measurements (taken immediately prior to sampling) are displayed in both graph and table form alongside previous years in Appendix D, to allow comparison between baseline and construction periods.

From Appendix D, the field parameters appear to remain within the same range between baseline and construction periods at each groundwater monitoring location. This indicates that water quality has not obviously changed. Typically, the field parameter results demonstrate:

– Temperature averages between approximately 6°C to 10°C at each location, with bore BH18 exhibiting the widest variation in temperature

– At all locations, pH ranges from acidic to neutral. Bore BH16 shows the widest range and a slight drop in average pH from 6.26 in the baseline period to 5.15 during construction

– Dissolved Oxygen (DO) values are generally similar among all bores, with the exception of a low measurement taken at bore BH16, 3.79 mg/L, during the February 2024 monitoring event. Note that DO measurements are less reliable than other parameters due to the sampling method (bailer)

– Oxidation Reduction Potential (ORP), which has been averaging lower (less oxidising) values in the impact years, increased slightly in the IY5 period to be closer to the historical maximums in all bores except BH18

– In IY4, EC results in BH16 and BH17 were approximately half of the baseline period average. This trend toward lower EC is first apparent in the November 2021 monitoring round and may be related to increased rainfall infiltration due to high annual rainfall. In IY5, EC in bores BH16 and BH17 has increased marginally from IY4 but remains close to half of the baseline period

7.2.2 Analytical results

Analytical results are included in Appendix E. The following summary relates to the monitoring bores BH06, BH10, BH16, BH17 and BH18 as well as EWS West.

Inorganics

The electrical conductivity (EC) remains low, typically < 50 µS/cm. Bore BH06 is typically highest in EC, recording a maximum of 58 µS/cm in Apr 2024. The EWS West EC is similar to bores BH09 and BH16.

The salinity remains low at all locations (< 100 mg/L TDS), however TDS values have remained markedly higher in all bores since April 2023 compared to previous records, with the exception of two outliers in bores BH09 and BH16 in November 2023.

Acidity and Alkalinity

Bicarbonate concentrations remain similar between the baseline and impact period. Bores BH17 and BH18 have the highest concentrations of bicarbonate (maximums of 26 mg/L and 20 mg/L respectively). The remaining bores typically have concentrations of bicarbonate <10 mg/L. EWS West TDS was within the historical range of bores BH06, BH09 and BH16.

At all locations, the carbonate alkalinity has not been above the laboratory LOR.

Major Ions

Major ions (unfiltered calcium, magnesium. potassium and sodium) are generally within a similar range between the baseline and impact periods for all bores. Bores BH06, BH10, BH16 and BH17 all typically average < 3 mg/L for calcium, magnesium and potassium. Chloride and sulfate are relatively consistent for all bores in both baseline and construction periods, at typically < 2 mg/L.

Nutrients

Nutrient concentrations are reasonably consistent across all locations, during both baseline and impact periods.

Nitrate concentrations in bore BH18 are typically an order of magnitude lower than the other monitoring wells. BH06 continues to record the highest nitrate by an order of magnitude. EWS West reported the lowest levels of Nitrate in IY5.

Phosphate and phosphorus are typically below the LOR or very low (< 1 mg/L) at all locations in both baseline and impact periods, with the exception of bore BH16 in 2022 which has a total phosphorus concentration of 3.6 mg/L.

7.2.3 Summary table

Results are summarised in Table 15.

Table 15 Key analyte results for groundwater

Key analyte	BH06	BH10	BH16	BH17	BH18
pH	Appears to be consistent between baseline and impact periods. Typically slightly acidic to neutral.	Appears to be consistent between baseline and impact periods. Typically slightly acidic to neutral.	Appears to be consistent between baseline and impact periods. Typically slightly acidic to neutral.	Appears to be consistent between baseline and impact periods. Typically slightly acidic to neutral.	Appears to be consistent between baseline and impact periods. Typically slightly acidic to neutral.
Electrical conductivity	Appears to be consistent between baseline and impact periods. Typically < 50 µS/cm.	Appears to be consistent between baseline and impact periods. Typically < 50 µS/cm.	Appears to be consistent between baseline and impact periods. Typically < 50 µS/cm.	Appears to be consistent between baseline and impact periods. Typically < 50 µS/cm.	Appears to be consistent between baseline and impact periods. Typically < 50 µS/cm.
Bicarbonate	Appears to be consistent between baseline and impact periods. Range typically < 10 mg/L.	Appears to be consistent between baseline and impact periods. Range typically < 10 mg/L.	Appears to be consistent between baseline and impact periods. Range typically < 10 mg/L.	Appears to be consistent between baseline and impact periods. Range from 10-20 mg/L.	Appears to be consistent between baseline and impact periods. Range from 10-20 mg/L.

Key analyte	BH06	BH10	BH16	BH17	BH18
Carbonate	Appears to be consistent between baseline and impact periods. Concentrations below detection limit.	Appears to be consistent between baseline and impact periods. Concentrations below detection limit.	Appears to be consistent between baseline and impact periods. Concentrations below detection limit.	Appears to be consistent between baseline and impact periods. Concentrations below detection limit.	Appears to be consistent between baseline and impact periods. Concentrations below detection limit.
Calcium, Magnesium, Potassium, Sodium, Chloride	Appears to be consistent between baseline and impact periods. Typically < 3 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 3 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 3 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 3 mg/L.	Increases in calcium, magnesium, potassium. Concentrations < 10 mg/L.
Nitrogen and nitrate	Appears to be consistent between baseline and impact periods. Typically < 2 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 2 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 10 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 2 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 2 mg/L.
Phosphorus and phosphate	Appears to be consistent between baseline and impact periods. Typically < 1 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 1 mg/L.	One higher total phosphorus result in 2022 (3.6 mg/L).	Appears to be consistent between baseline and impact periods. Typically < 1 mg/L.	Appears to be consistent between baseline and impact periods. Typically < 1 mg/L.

Salinity remains low throughout baseline and impact years, indicating an ongoing strong connection with infiltrating rainfall and snow melt. The low salinity also suggests short residence times of water in each aquifer throughout baseline and construction periods. A summary of the key differences is provided in Table 16.

Table 16 Groundwater: Differences in key analytes between baseline and impact monitoring periods

Key analyte	Notable difference in impact period compared to baseline years?				
	BH06	BH10	BH16	BH17	BH18
pH	No	No	No	No	No
Electrical conductivity	No	No	No	No	No
Bicarbonate	No	No	No	No	No
Carbonate	No	No	No	No	No
Calcium, Magnesium, Potassium, Sodium Chloride	No	No	No	No	No
Nitrogen and nitrate	No	No	No	No	No
Phosphorus and phosphate	No	No	No **One higher result in 2022**	No	No

7.3 QAQC Program

An assessment of the QAQC program is presented in Appendix G. Based on the completion and results of the QAQC program, there is an acceptable level of confidence in the field and analytical results for IY5.

8. Discussion

8.1 Independent review recommendations

An independent review is conducted of the HEMAMP Hydrological and Ecological Monitoring Reports each year. In August 2023, Southeast Botanical Consulting (SE Botanical) provided an independent review of the IY4 reports. The following recommendations were made in relation to the hydrological monitoring and reporting:

- "Mean annual groundwater changes should be provided as a percentage in the hydrological monitoring reports and the results should be assessed against the reduction management actions trigger"
- "Inter-Quartile Range (IQR) should be calculated for all surface water and groundwater quality parameters, assessed against the quality management action triggers and these data, and the trigger results should be provided in the annual hydrological monitoring report. Alternatively, the quality management action trigger could be modified in the HEMAMP, with 'green' 'amber' and 'red' triggers linked to the Mann-Kendall statistical analysis for surface water and groundwater that is provided in the Y4 hydrological monitoring report (GHD, 2022)"
- Continue surface water flow monitoring until there is sufficient data to determine the appropriate management need

In IY4, Mann Kendall analysis was included in the reporting in response to the previous year's independent review. Based on discussions with Biosis and ARV, and the recommendations in the most recent independent review, Mann Kendall analysis has been omitted from the IY5 assessment for the following reasons:

- Concentrations of the analytes in the monitoring program are typically close to or below the LOR, which increases the sensitivity of Mann Kendall analysis and creates a tendency to identify false or negligible trends which do not materially impact the HEMAMP objectives
- Mann Kendall is analysed on a continuous time series and does not analyse individual results against a standard range. It therefore does not meet the HEMAMP objective to respond to recent changes in water quality against the baseline range

8.2 HEMAMP adaptive management triggers

Hydrological triggers have been set with reference to hydrological models for the Boggy Creek catchment, which are designed to provide an early warning system for pre-empting ecological change at the impact sites (Table 17). The adaptive management trigger thresholds follow a 'traffic light' approach, where the level of management intervention is escalated as the risk of adverse impacts on the ecological values of the impact sites increases. Risks of adverse impacts increase as trigger levels move from green, to amber, to red.

Inter-Quartile Range (IQR) methodology

The concentrations of most parameters are very low, particularly for major ions (i.e. typically < LOR or < 2 mg/L). Some parameters are therefore particularly sensitive to the IQR as a measure for adaptive management. An acceptable 'green' range was determined by applying 1.5 times the baseline IQR to either side of the baseline first quartile (Q1) and third quartile (Q3); i.e. below baseline Q1 and above baseline Q3. This produced a range for each analyte which was representative of the baseline period.

The adaptive management triggers for water quality are based on comparison of individual impact year results against a baseline period IQR statistic. It is noted that there are two distinct groundwater catchments apparent in the monitoring data with slightly different chemical compositions. Alpine bogs are located among each of these catchments, indicating these ecosystems are capable of existing within the water quality range of each. A combined baseline IQR (i.e. for groundwater, a bicarbonate IQR calculated from all monitoring bores) allows for a 'big picture' analysis. This method minimises the risk of creating a sensitive trigger whereby a value for one monitoring bore may be outside of the typical range for that bore yet within the range of the alpine bog habitat as a whole.

Table 17 HEMAMP adaptive management triggers

Trigger	Parameter	'Green' Threshold	'Amber' Threshold	'Red' Threshold
Surface Water Flows	Reduction in mean annual surface water flows to Boggy Creek over two consecutive years, relative to model	≤10%	>10% but ≤50%	>50%
Groundwater Levels	Reduction in mean annual groundwater levels over two consecutive years, relative to model	≤10%	>10% but ≤50%	>50%
Surface Water Quality	Change in various surface water quality parameters, relative to baseline.	<1.5 x IQR*	≥1.5 x IQR* and ≤3 x IQR*	>3 x IQR*
Groundwater Quality	Change in various groundwater quality parameters, relative to baseline.	<1.5 x IQR*	≥1.5 x IQR* and ≤3 x IQR*	>3 x IQR*

* The Inter-quartile range (IQR) has been calculated for surface water and groundwater for each analyte using the baseline range for all monitoring locations. This gives a representative IQR which accounts for variability in the catchments across which the alpine bogs occur.

8.2.1 Surface water

8.2.1.1 Surface water flow

Surface water flow data capture was amended for Boggy Creek Weir 2 in December 2023, therefore only half of IY5 is available for this weir. A full year of flow data was available for Boggy Creek Weir 1 Pickup 2.

A hydrological model was created for comparison to record surface water flow as described in the HEMAMP Version 5 (Biosis, 2022). GHD did not contribute to the development of the hydrological model and has not reviewed or verified the model.

The actual surface water flow rates differed from the model predictions at both locations. Actual mean daily flow rates at Boggy 1 pickup 1 were 38% higher than predicted flow rates in IY5. Conversely, actual mean daily flow rates at Boggy 2 were 75% below predicted values for IY5 as a whole.

Results of the surface flow analysis are presented in Table 18.

Table 18 Results of Surface flow analysis

Comparison*	IY4 Result	IY5 Result	Action Req'd?	Comments
Boggy Creek Weir 1 Pickup 2 v Modelled Surface Water Flows	Unknown	+ 38%	Yes	A complete surface water flow dataset was not available for IY4. Known surface water flows in IY4 were slightly above expected flows, given the climatological conditions that were experienced. A complete dataset was available for Boggy Weir 1 Pickup 2 and an incomplete dataset was available for Boggy Weir 2 in IY5. Mean surface flows were analysed for Boggy Creek Weir 2 for the period December 2023 to April 2024. Results for IY5 were considerably below the model predicted flows at Boggy 2 but above the model predicted flows at Boggy Creek Weir 1 pickup 2.
Boggy Creek Weir 2 v Modelled Surface Water Flows	Unknown	- 75%	Yes	

8.2.1.2 Surface water quality

Most analytical results were within the ‘green’ threshold of 1.5 times the IQR as shown in Table 19. The concentrations of most parameters are very low, particularly for major ions (i.e. typically < LOR or < 2 mg/L). Some parameters are therefore particularly sensitive to the IQR as a measure for adaptive management.

Five extreme/red outliers were identified for total dissolved solids (TDS) across the surface water monitoring locations in IY5. This consisted of two outliers at Boggy 1 p/u 1 and one outlier at each other location. Three of the outliers occurred in April 2024.

TDS could be impacted by a range of sources containing inorganic or organic constituents, such as sewage, water treatment, soil, rock, algal and plant decomposition. It is possible that the TDS results are related to weed control works which occurred during IY5 upstream of Boggy Creek, which largely involved the up-rooting of weeds to avoid herbicide spraying. Track grading along the road to Boggy Creek Weir 2 also occurred during the summer of IY5. Soil/sediment runoff from these locations to Boggy Creek could increase TDS concentrations in surface water by adding additional dissolved minerals, metals or salts.

It is noted however that turbidity concentrations did not increase in the Boggy Creek monitoring locations during IY5. In contrast to TDS, increased turbidity would indicate impact from non-dissolved solids in water such as suspended sediment runoff. The absence of increased turbidity could indicate that sediment is settling below the surface at the weir monitoring locations, or that the source of increased TDS may be from another source.

Three extreme/red outliers for turbidity were identified at EWS East however these were not reflected in the Boggy Creek locations. Turbidity at the three Boggy Creek locations was within the green threshold with the exception of one amber value at Boggy 1 p/u 1.

Management actions

The HEMAMP Version 5 specifies the requirement for management action when one or more parameters report extreme (red) outliers. The management action is dependent on the parameter(s) exceeding the threshold. Where one or more parameters report mild (amber) outliers, further investigation is required to determine pre-emptive management actions. Responses for water quality are described in section 8.3.6 of the HEMAMP Version 5.

The following adaptive management responses are recommended for TDS and turbidity:

- Areas of weed removal and track grading should be inspected to determine if sediment controls need to be adjusted or added to avoid runoff
- If inspection indicates no or limited sediment runoff, additional sources of TDS could be investigated including the sewage pipeline that traverses the base of the Summit Nature Walk
- Turbidity in the EWS outlet should be investigated as to its source and whether it is entering the distribution pipeline (as turbidity may be settling in the EWS collection pit)

Table 19 Results of IQR analysis – Surface water quality

Parameter	IY5 Result	Action Required	Comments
Electrical Conductivity	No outliers detected.	No	Review catchment area for potential sources of TDS and Turbidity, starting with sediment impact from weed control areas. Adjust/add sediment control if necessary to achieve water quality objectives. Other parameters were mostly within the green threshold range of 1.5 x IQR. No intervention required. Continue monitoring in IY6.
Total Dissolved Solids	Five ‘red’ outliers detected in IY5 in February and April, ranging from 42 mg/L (Boggy 1 p/u 2) to 54 mg/L (Boggy 1 p/u 1).	Yes	
pH	No outliers detected.	No	
Nutrients (Nitrate)	Minor outliers detected.	No	
Major Ions (Calcium, Magnesium, Potassium, Sodium, Chloride, Sulfate)	Nine ‘amber’ outliers detected for chloride (5 outliers), calcium (2 outliers), and sulfate (2 outliers).	No	

Parameter	IY5 Result	Action Required	Comments
Turbidity	One ‘amber’ outlier detected at Boggy 1 p/u 1. Three ‘red’ outliers detected at EWS East.	Yes	
Alkalinity (Bicarbonate)	Three ‘amber’ outliers detected (one at Boggy 1 p/u 2 and two at EWS East)	No	

8.2.2 Groundwater

8.2.2.1 Groundwater flow

A hydrological model was created for comparison to record groundwater levels as described in the HEMAMP Version 5 (Biosis, 2022). GHD did not contribute to the development of the hydrological model and has not reviewed or verified the model.

The recorded mean annual groundwater level for all bores in IY5 was approximately 4% higher than the annual mean predicted by the model. In contrast, the recorded mean annual groundwater level for all bores in IY4 was approximately 46% lower than the annual mean predicted by the model. A possible explanation for these differences is that the model may be over-predicting the influence of rainfall or snow depth, given total rainfall and mean snow depth in IY4 were higher than IY5.

Table 20 Results of Groundwater Level analysis

Comparison	IY4 Result	IY5 Result	Action Req’d?	Comments
All boreholes v Modelled Groundwater Levels	- 46%	+ 4%	No	Groundwater levels did not depart considerably from expected levels in IY5 or IY4. Monitoring must continue but no further intervention is needed.

8.2.2.2 Groundwater quality

Most analytical results were within the ‘green’ threshold of 1.5 times the IQR. The concentrations of most parameters are very low, particularly for major ions (i.e. typically < LOR or < 2 mg/L). Some parameters are therefore particularly sensitive to the IQR as a measure for adaptive management.

The HEMAMP Version 5 specifies the requirement for management action when one or more parameters report extreme (red) outliers. The exact management action is dependent on the parameter(s) exceeding the threshold. Where one or more parameters report mild (amber) outliers, further investigation is required to determine pre-emptive management actions.

One extreme/red outlier was identified for nitrate at the ‘control’ bore BH06 in IY5 (refer Table 21). Two amber outliers also occurred at BH16. All other values were within the ‘green’ threshold. It is noted that BH06 has consistently reported nitrate above the range of the other bores, including during the baseline period. When calculating an IQR for BH06 specifically, the results are within the ‘green’ threshold for this bore. Based on this, it is recommended that the red exceedance should not trigger an adaptive management response in this scenario, as downgradient bores are not indicating impacts.

Table 21 Results of IRQ analysis – Groundwater quality

Parameter	IY5 Result	Action Req’d?	Comments
Electrical Conductivity	No outliers detected.	No	Nitrate at BH06 was outside the overall catchment range but within the IQR threshold for BH06 specifically.
Total Dissolved Solids	Six ‘amber’ outliers detected in IY5 in February and April 2024. Two outliers detected	No	

Parameter	IY5 Result	Action Req'd?	Comments
	at BH17 and one outlier detected at each other bore.		Other parameters were mostly within the green threshold range of 1.5 x IQR. No intervention required. Continue monitoring in IY5.
pH	No outliers detected.	No	
Nutrients (Nitrate)	One 'red' outlier and two 'amber' outliers detected at BH06.	No	
Major Ions (Calcium, Magnesium, Potassium, Sodium, Chloride, Sulfate)	Nine 'amber' outliers detected for calcium (3 outliers) and magnesium (6 outliers).	No	
Turbidity	No outliers detected.	No	
Alkalinity (Bicarbonate)	Two 'amber' outliers (BH17 and BH18) detected in IY5.	No	

8.3 Comparison with water quality objectives

Of the analytes included in the laboratory program, a water quality objective exists for nitrate (1 mg/L as N).

Bore BH06 recorded three exceedances of the nitrate (as N) criteria during IY5. The maximum nitrate concentration in IY5 (4.91 mg/L) was similar to the baseline period (maximum of 4.9 mg/L). Three exceedances of the nitrate as N criteria occurred for bore BH06 during the baseline period.

Bore BH16 and BH17 exceeded the nitrate as N criteria during the baseline period (bores BH16 in 2015 and BH17 in 2015 and 2018), but not during the impact period (maximum concentration of 0.22 mg/L and 0.25 mg/L, respectively).

The results suggest that the water quality objectives are met at all locations with the exception of minor exceedances at bore BH06 with regard to nitrate (as N). Bore BH06 appears to have naturally high background concentrations of nitrate (as N), which have fallen slightly during the impact period but remain above the criteria. Bores BH16 and BH17 also showed falls in nitrate concentration from the baseline to impact period. Concentrations were marginally above the criteria (1.1 mg/L to 1.2 mg/L) in the baseline period and were below the criteria in the impact period.

9. Conclusion and recommendations

9.1 Conclusions

9.1.1 Surface flow

The surface flow analysis indicates a strong influence from rainfall on the flow rates at Boggy Creek 1 and Boggy Creek 2. Snowmelt may also contribute to higher baseline flow rates in the late spring to early summer (November to December).

Flow rate data from the EWS had not been captured during Impact Year 5, therefore the EWS flows remain a data gap in the Boggy Creek catchment. Flow data is now being captured and will be used in the next hydrological report.

9.1.2 Groundwater levels

Bores BH06 and BH18 exhibit similar responses to rainfall during the water storage construction period compared to the preconstruction or baseline monitoring period. These bores are situated cross-gradient from the water storage and are expected to not be impacted by the water storage construction or operation.

Conversely, bores BH09, BH17 and to a lesser extent bore BH16 exhibit some change in SWL patterns after the construction of the water storage. Bores BH09 and BH17 are adjacent to the EWS, which is understood to be flowing continuously (i.e. not manually controlled) since the water storage construction. These bores exhibit less seasonality in the impact years and do not decline to the depths observed in the baseline monitoring period.

9.1.3 Water quality

Baseline water quality data is limited, making it difficult to draw robust conclusions. However, there does not appear to be any obvious, significant change to water quality (surface and groundwater) as a result of the water storage construction based upon the analytical program undertaken to date.

9.1.4 QA/QC program

The frequency of field duplicate and field split samples is deemed sufficient for the adopted monitoring program.

9.2 Recommendations

The following recommendations are made:

- Adaptive management responses are recommended to investigate TDS and turbidity outliers in surface water (see Section 8.2.1.2):
    - Areas of weed removal and track grading should be inspected to determine if sediment controls need to be adjusted or added to avoid runoff
    - If inspection indicates no or limited sediment runoff, additional sources of TDS could be investigated including the sewage pipeline that traverses the base of the Summit Nature Walk
    - Turbidity in the EWS outlet should be investigated as to its source and whether it is entering the distribution pipeline (as turbidity may be settling in the EWS collection pit)
- An interim surface flow analysis should be conducted in December 2024 or January 2025 following the collection of six months of flow data from the EWS. As the EWS flows have not yet been characterised, an interim factual letter report or memo is recommended as a proactive measure to address the need to understand the EWS output prior to the next annual Hydrological Report, including enabling an ability to adjust the monitoring infrastructure if required
- Groundwater levels should continue to be monitored in accordance with the current HEMAMP program methodology

- The HEMAMP protocol contains adaptive management triggers for underwatering of the Alpine Sphagnum Bogs. It is recommended that either the HEMAMP or a separate monitoring program also considers the prospect of overwatering which may be occurring from the EWS or from changes to the subsurface within the dam footprint. Implications of overwatering may include:
  - The encroachment of the Alpine Sphagnum Bogs on other vegetation communities (as has been indicated by the ecological monitoring), or
  - Potential influences or impact to geotechnical hazards, including slope stability and dam safety
- We recommend that ARV should consider opportunities to utilise the HEMAMP hydrological monitoring to inform ongoing water supply assessments and decisions, including to capture data to assist with water security and demand assessments
- BH07 and BH10 should be manually bailed in the next monitoring round to reduce sediment load

10. References

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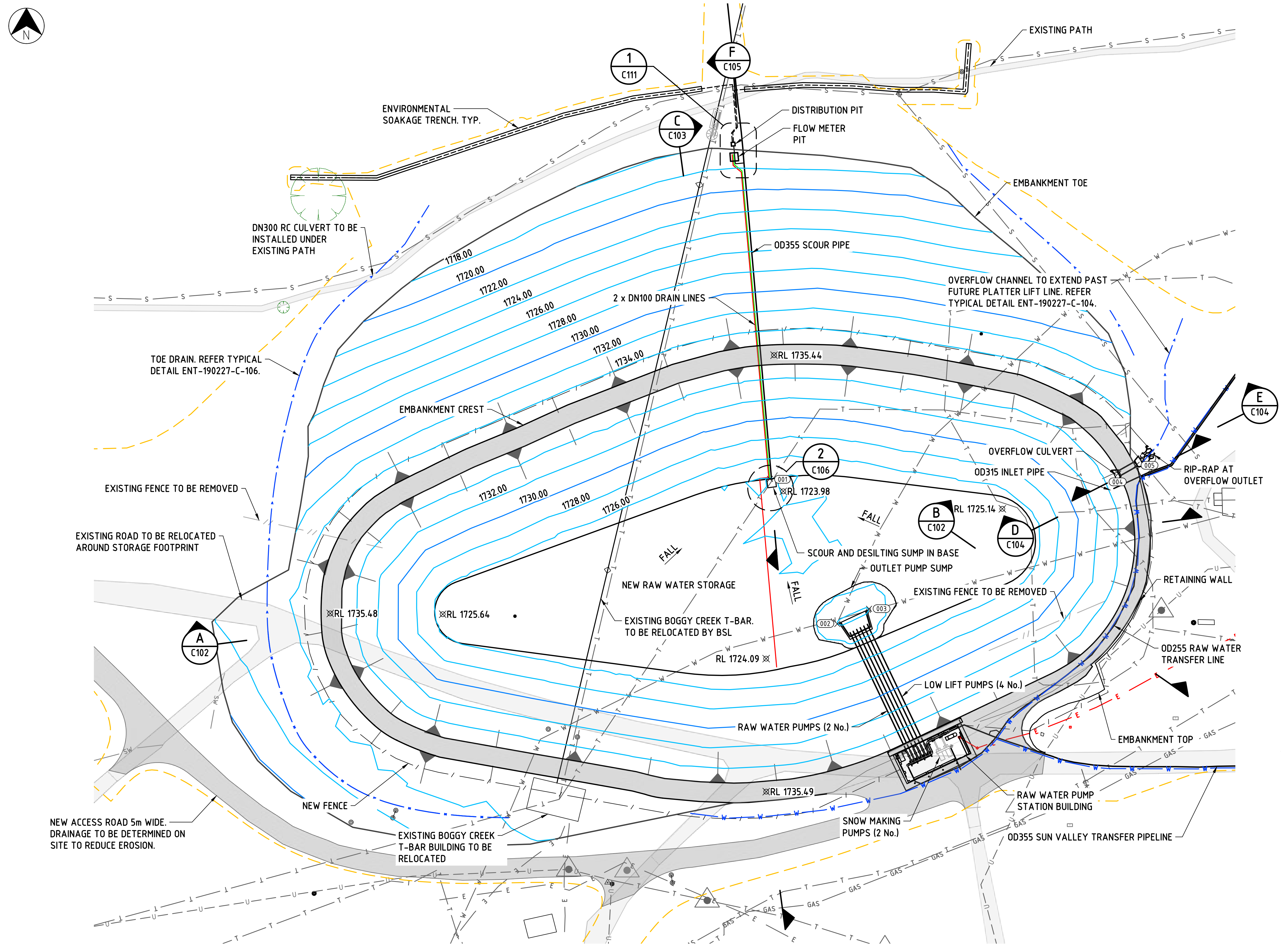
- Southeast Botanical Consulting, 2023. *Mt Buller Water Security Off-Stream Storage Project: Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP) Year 4 Planning Permit Condition 8 Independent Review.* 11 August 2023. Reference number: MBMSRMB0623

Appendices

Appendix A

Dam design drawings



0 5 10 15 20 25m
SCALE IN METRES (1:500 AT A1)

RAW WATER STORAGE PLAN

SCALE 1:500

AS CONSTRUCTED DETAILS BASED ON INFORMATION PROVIDED BY ENTRACON PTY LTD

WATER STORAGE VOLUME VS DEPTH:

WATER LEVEL (mRL)	VOLUME (ML)
1724.4	0.2
1724.8	0.7
1725.0	0.8
1726.0	6.2
1727.0	12.8
1728.0	20.2
1729.0	28.6
1730.0	37.9
1731.0	48.2
1732.0	59.6
1733.0	72.1
1734.0	85.8
1735.0	102.7

WATER STORAGE KEY DETAILS:

LINER EXTENT OF COVERAGE	16978.31m^2
(TWL) TOP WATER LEVEL	1735mRL
(BWL) BOTTOM WATER LEVEL	1724.8 mRL
MINIMUM CREST LEVEL	1735.55mRL
APPROXIMATE USABLE VOLUME	102ML
FREEBOARD	500mm

NOTES ON LINER EXTENT:

1. LINER EXTENT IS APPROXIMATE ONLY AND DOES NOT ALLOW FOR OVERLAPS, FIXING DETAILS, PENETRATIONS OR ADDITIONAL LENGTH REQUIRED FOR ANCHOR TRENCH

NOTES:

1. ALL COORDINATES ARE TO MGA.
2. ALL LEVELS IN METRES TO AHD.
3. ALL DIMENSIONS IN mm UNLESS NOTED OTHERWISE.
4. REFER TO ENT-190227-C-002 FOR LEGEND.
5. REFER TO ENT-190227-C-107 FOR CUT FILL VOLUMES.
6. REFER TO ENT-190227-C-006 FOR SET OUT POINTS.

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WARNING
ALL SERVICES SHOWN ON THE DRAWINGS ARE APPROXIMATE ONLY. EXACT LOCATION IS TO BE CONFIRMED ON SITE BY CONTRACTOR PRIOR TO COMMENCEMENT OF ANY WORKS.

AS CONSTRUCTED

REV.	ZONE	REVISION	DATE	CHK'D	APP'D
1		AS CONSTRUCTED	6/05/20	SMM	SMM
0		ISSUED FOR CONSTRUCTION	3/10/19	JL	SMM

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DESIGN CHECK J. LOUW Oct-19	DRAFT CHECK P. WOJCIECHOWSKI Oct-19	ASSET/ENG. MANAGER K. ALEXANDER
APPROVED S.MORRIS Oct-19		

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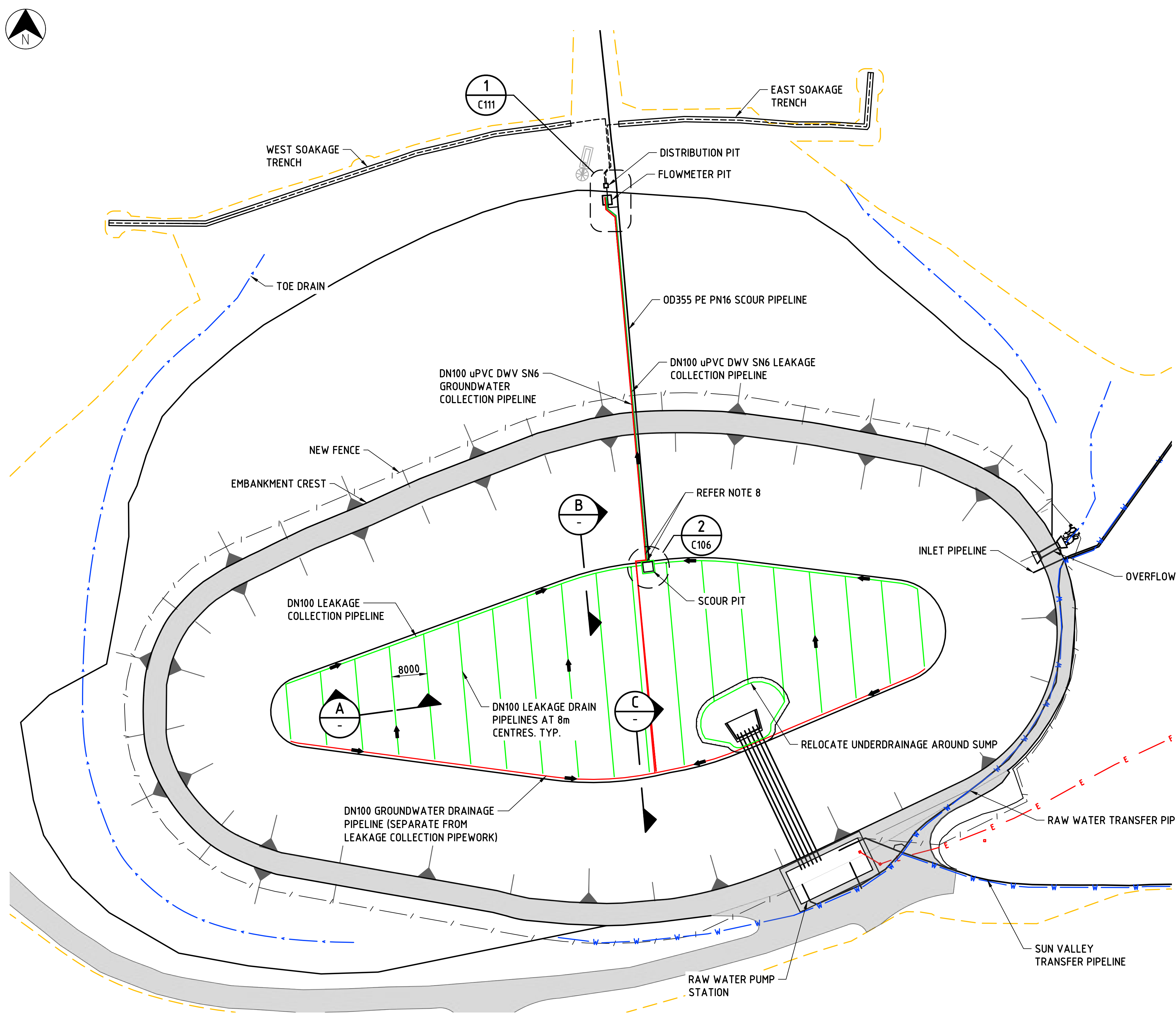
MT BULLER AND MT STIRLING RESORT MANAGEMENT
MT BULLER WATER STORAGE UPGRADE
RAW WATER STORAGE
GENERAL ARRANGEMENT - PLAN

DO NOT SCALE
SCALE: AS SHOWN
DRAWING NUMBER
ENT-190227-C-100
NUMERAL
REV 1

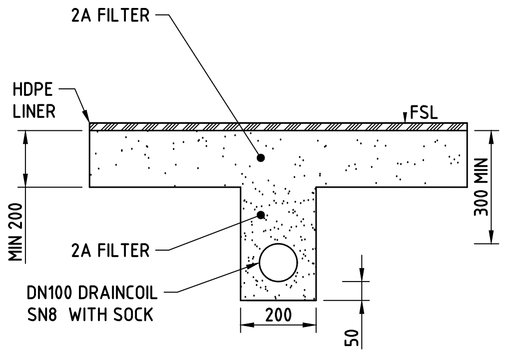
A1

DATE PLOTTED: 6 May 2020 8:40 AM BY: WILL DARLING
S:\Projects\ENT-190227 - Mt Buller Water Storage\6 CAD\6.1 Working Drawings\ent-190227-c-100.dwg

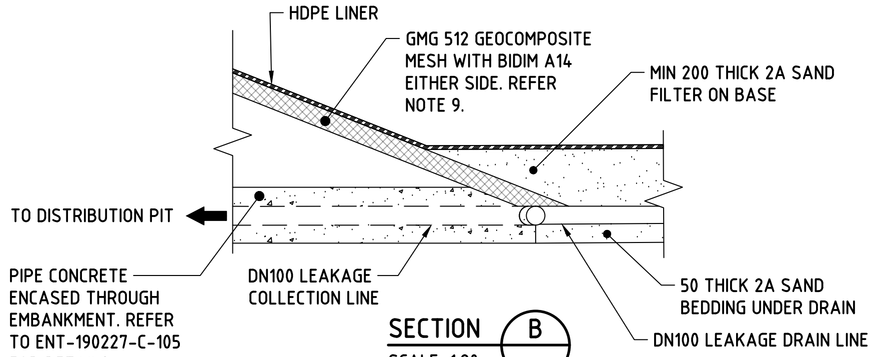


RAW WATER STORAGE PLAN

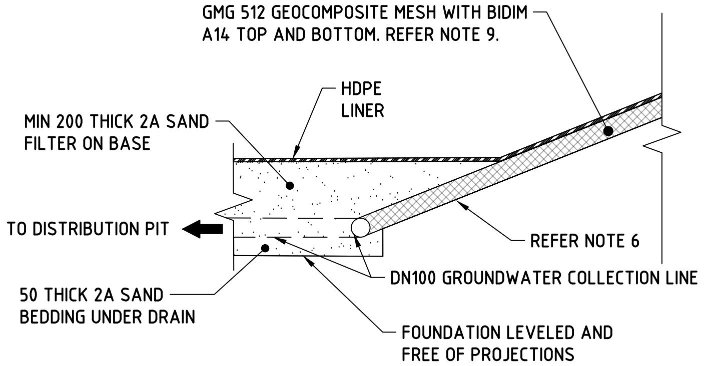
SCALE 1:500



SECTION A -
SCALE 1:10



SECTION B -
SCALE 1:20



SECTION C -
SCALE 1:20

NOTES:

1. ALL COORDINATES ARE TO MGA.
2. ALL LEVELS IN METRES TO AHD.
3. ALL DIMENSIONS IN mm UNLESS NOTED OTHERWISE.
4. ENSURE DRAINAGE PIPE IS PROTECTED DURING COMPACTION WORKS.
5. IF REQUIRED OVER-EXCAVATION REPLACE WITH 2A IN CUT FACE AND FLOOR AS PER ENGINEERS DIRECTION.
6. IF REQUIRED 2A TO REPLACE GEOCOMPOSITE AS PER ENGINEERS DIRECTION TO INTERCEPT SEEPAGE BELOW GEODRAIN ON CUT FACE ONLY.
7. REFER TO ENT-190227-C-002 FOR LEGEND.
8. GROUNDWATER AND LEAKAGE COLLECTION PIPELINES TO BE RELOCATED AROUND SCOUR SUMP AND SCOUR PIPELINE ON SITE. ENSURE PIPELINES ARE CONTINUOUSLY GRADED TOWARDS OUTLET.
9. DURING EXCAVATION WORKS DAM ENGINEER TO ADVISE ON SUITABILITY OF BOTTOM BIDIM LAYER PRIOR TO ORDERING MATERIALS.

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WARNING

ALL SERVICES SHOWN ON THE DRAWINGS ARE APPROXIMATE ONLY. EXACT LOCATION IS TO BE CONFIRMED ON SITE BY CONTRACTOR PRIOR TO COMMENCEMENT OF ANY WORKS.

0 5 10 15 20 25m
SCALE IN METRES (1:500 AT A1)

AS CONSTRUCTED DETAILS BASED ON INFORMATION PROVIDED BY ENTRACON PTY LTD

AS CONSTRUCTED

REV.	ZONE	REVISION	DATE	CHK'D	APP'D
1		AS CONSTRUCTED	6/05/20	SMM	SMM
0		ISSUED FOR CONSTRUCTION	4/10/19	JL	SMM

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DESIGN CHECK J. LOUW Oct-19	DRAFT CHECK P. WOJCIECHOWSKI Oct-19	ASSET/ENG. MANAGER K. ALEXANDER
APPROVED S.MORRIS Oct-19		

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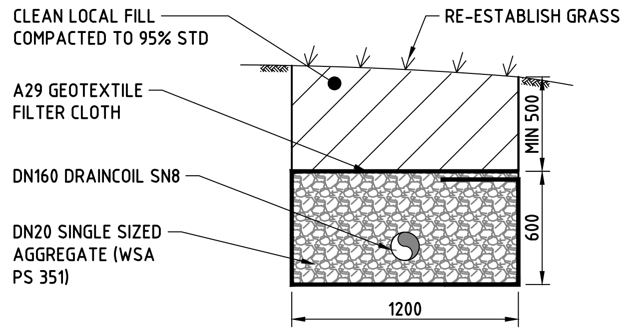
MT BULLER AND MT STIRLING RESORT MANAGEMENT
MT BULLER WATER STORAGE UPGRADE
RAW WATER STORAGE
UNDER DRAINAGE - PLAN

DO NOT SCALE
SCALE: AS SHOWN
DRAWING NUMBER
ENT-190227-C-101
NUMERAL
1
REV

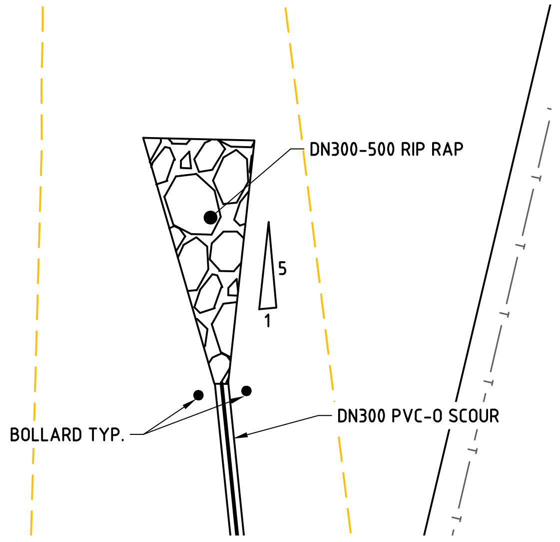
A1

DATE PLOTTED: 5 May 2020 5:52 PM BY: WILL DARLING
S:\Projects\ENT-190227 - Mt Buller Water Storage\6 CAD\6.1 Working Drawings\ENT-190227-C-101.dwg



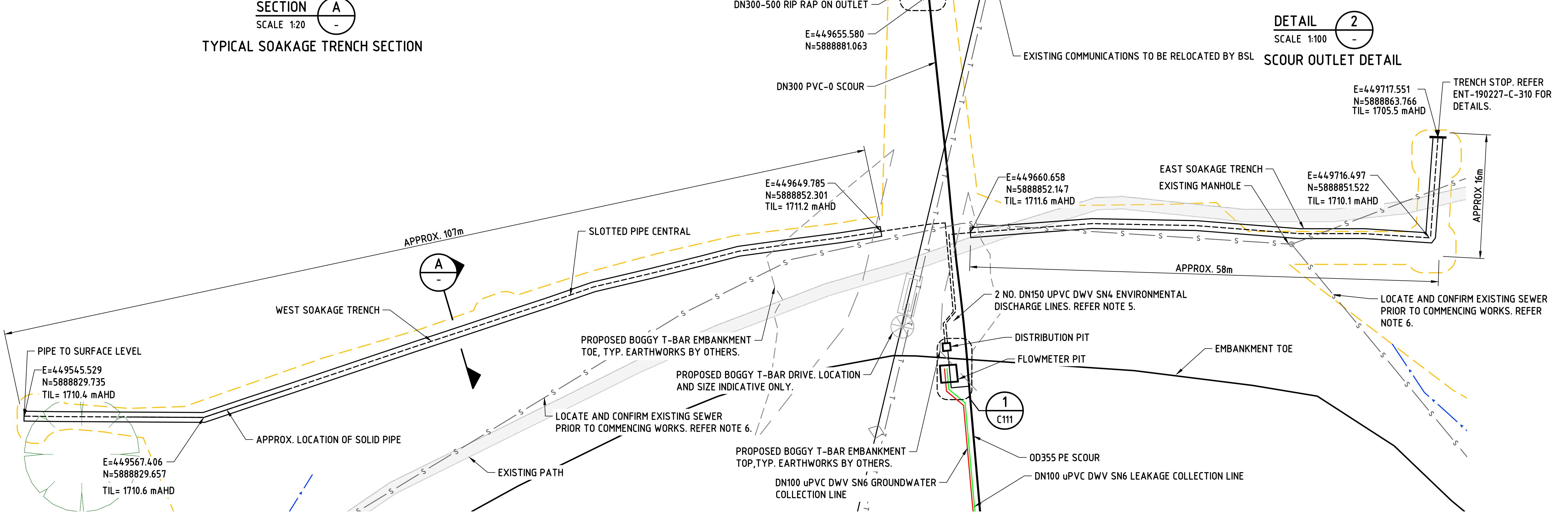
SECTION A
SCALE 1:20 -

TYPICAL SOAKAGE TRENCH SECTION



DETAIL 2
SCALE 1:100 -

SCOUR OUTLET DETAIL



ENVIRONMENTAL DISCHARGE SYSTEM PLAN
SCALE 1:250

NOTES:

1. ALL COORDINATES ARE TO MGA.
2. ALL LEVELS IN METRES TO AHD.
3. ALL DIMENSIONS IN mm UNLESS NOTED OTHERWISE.
4. TRENCH SURFACE TO BE MOUNDED TO ALLOW FOR SETTLEMENT
5. ENVIRONMENTAL DISCHARGE LINES TO BE RUN IN THE SAME TRENCH AS THE SCOUR LINE. REFER ENT-190227-C-105 FOR TRENCH DETAILS. PIPE EMBEDMENT TO HAVE A MINIMUM MODULUS OF 5 MPa.
6. EXISTING SEWER TO BE PROTECTED DURING WORKS.
7. TIL-REFERS TO THE APPROX. TRENCH INVERT LEVEL.

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WARNING
ALL SERVICES SHOWN ON THE DRAWINGS ARE APPROXIMATE ONLY. EXACT LOCATION IS TO BE CONFIRMED ON SITE BY CONTRACTOR PRIOR TO COMMENCEMENT OF ANY WORKS.

0 0.2 0.4 0.6 0.8 1m
SCALE IN METERS (1:20 AT A1)

0 2.5 5 7.5 10 12.5m
SCALE IN METRES (1:250 AT A1)

AS CONSTRUCTED DETAILS BASED ON INFORMATION PROVIDED BY ENTRACON PTY LTD

AS CONSTRUCTED

REV.	ZONE	REVISION	DATE	CHK'D	APP'D
1		AS CONSTRUCTED	6/05/20	SMM	SMM
C		FOR PLANNING ENDORSEMENT-ENV. DISCHARGE AREA	21/02/20	SMM	WD
0		ISSUED FOR CONSTRUCTION	4/10/19	JL	SMM

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DESIGN CHECK J. LOUW Oct-19	DRAFT CHECK P. WOJCIECHOWSKI Oct-19	ASSET/ENG. MANAGER K. ALEXANDER
APPROVED S.MORRIS Oct-19		

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MT BULLER AND MT STIRLING RESORT MANAGEMENT
MT BULLER WATER STORAGE UPGRADE
RAW WATER STORAGE
ENVIRONMENTAL DISCHARGE - PLAN

DO NOT SCALE
SCALE: AS SHOWN
DRAWING NUMBER
ENT-190227-C-110
NUMERAL
REV 1

A1

DATE PLOTTED: 5 May 2020 5:10 PM BY: WILL DARLING
S:\Projects\ENT-190227 - Mt Buller Water Storage\6 CAD\6.1 Working Drawings\ENT-190227-C-110.dwg

Appendix B

Photolog and field sheets

Bore Id	Date	Time	SWL (m)	Bore depth (m)	Comment	Construction Depth (m)
BH04	15/11/23	1.45			one filled with soil, one	15.68
BH04A	15/11/23	" "			open - SWL 0.09. Need formal decommissioning	2.56
BH06	15/11/23	10.21	6.685	9.2		9
BH07	15/11/23	2.58	0.532	0.87	bentonite covering well cap (~~+ plug~~) removed some for clean access	1
BH09	15/11/23	3.10	2.277	5.92		6
BH10	15/11/23	1.54	2.545	8.58	Dipper catching at 2.53 headworks damaged	9
BH16	15/11/23	8:50	0.0	2.02		2.1
BH17	15/11/23	2.05	0.07	2.04	slow to recharge	2.2
BH18	15/11/23	11.36	0.972	2.03		2.15
					bentonite likely to keep expanding up into riser cap	
					bring equipment in Feb to try	
					to tidy it up a little. GROUT	

Purging and Sampling Record

Bore ID: EWS

Job Information

Client: ARV
Project: Mt Buller
Proj. No.: 12565989
Sampler: MT
Date: 14/11/23
Round: Nov 23

Sampling Information

Purge Method: —
Sample Method: —
WQ Meter Type: YSI 21D101~~3~~751
~~Flow Cell: Y / N~~ ~~Pump Depth:~~ ....m
~~WLevel Meter Type:~~ ~~Dip / Fox / Int.Fce~~ / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): .... m
Logic Check: ....
Screen: From..........to.......... m
Stick Up: .... m
NAPL Check: ....
Bore Diam.: .... mm
Ref.datum: ....
Well Cap Secure? ....
Bore Depth: .... m

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (uS/cm)	Dis.Oxygen (mg/L)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..............)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
11:00	—	6.7	9.09	16.8	10.4	-66.8	—	—	EWS WEST
									Redox rapidly decreasing
									clear, low turbidity
11:30	—	6.8	7.65	14.7	9.04	34.1	—	—	EWS EAST
									Clear, low turbidity

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? Y / N
Was sampling equipment pre-cleaned? Y / N
COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: Boggy l p/u 2

Job Information

Client: ARV
Project: MT Buller
Proj. No.: 12565989
Sampler: MT
Date: 14/11/23
Round: Nov 23

Sampling Information

Purge Method: —
Sample Method: —
WQ Meter Type: YSI 21D101751
~~Flow Cell: Y / N~~ ~~Pump Depth:~~ ....m
WLevel ~~Meter Type:~~ ~~Dip / Fox / Int.Fce~~ / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): .... m
Screen: From..........to.......... m
NAPL Check: ....
Ref.datum: ....
Bore Depth: .... m
Logic Check: ....
Stick Up: .... m
Bore Diam.: .... mm
Well Cap Secure? ....

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (uS/cm)	Dis.Oxygen (mg/L)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..........)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
14:23	—	6.9	7.41	13.4	11.88	33.3	—	—	Clear, odourless, low turbidity, weir full and flowing
									Dup + Split

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? Y / N
Was sampling equipment pre-cleaned? Y / N
COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Dup + Split

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: Boggy 1 p/a 1

Job Information

Client: ARV
Project: Mt Buller
Proj. No.: 12565989
Sampler: MT
Date: 14/11/23
Round: Nov 23

Sampling Information

Purge Method: —
Sample Method: —
WQ Meter Type: YSI 21D101751
~~Flow Cell~~: Y / N ~~Pump Depth~~: ....m
~~WLevel Meter Type~~: Dip ~~/ Fox / Int.Fce / Gge~~
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): .... m
Screen: From: ....to.......... m
NAPL Check: ....
Ref.datum: ....
Bore Depth: .... m
Logic Check: ....
Stick Up: .... m
Bore Diam.: .... mm
Well Cap Secure? ....

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (uS/cm)	Dis.Oxygen (mg/L)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..............)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	*+/- 0.05 pH*	*+/- 3%*	*+/- 10%*	*+/- 10 mV*	*stable*		
14:11	—	7.6	7.80	16.2	11.79	1.3	—	—	Clear, odourless, low turbidity,
									weir full and flowing

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? Y / N
Was sampling equipment pre-cleaned? Y / N
COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: Boggy 2

Job Information

Client: ARV
Project: Mt Buller
Proj. No.: 12565989
Sampler: MT
Date: 14/11/23
Round Nov 23

Sampling Information

Purge Method: —
Sample Method: —
WQ Meter Type: YSI 21D101751
~~**Flow Cell: Y / N**~~ ~~**Pump Depth:..........m**~~
~~**WLevel Meter Type:**~~ **Dip / Fox / Int.Fce / Gge**
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): .... m **Logic Check:** ....
Screen: From..........**to**.......... **m** **Stick Up:** .... **m**
NAPL Check: .... **Bore Diam.:** .... **mm**
Ref.datum: .... **Well Cap Secure?**..........
Bore Depth: .... **m**

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (uS/cm)	Dis.Oxygen (mg/L)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..............)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	*+/- 0.05 pH*	*+/- 3%*	*+/- 10%*	*+/- 10 mV*	*stable*		
13:51	—	8.0	7.33	16.8	12.94	36.7	—	—	Clear, odourless, low turbidity.
									Weir full and flowing.

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? Y / N
Was sampling equipment pre-cleaned? Y / N
COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Diol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

2m : 4L × 3 = 12L

Purging and Sampling Record

Bore ID: BH16

Job Information

Client: ARV
Project:
Proj. No.: 12565989
Sampler: MT
Date: 15/11/23
Round Nov 23

Sampling Information

Purge Method: Bailer
Sample Method: "
WQ Meter Type: YSI 21010[illegible]751
Flow Cell: Y / N
Pump Depth: ....m
WLevel Meter Type: Dip / Fox / Int.Fce / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): 0.0 m
Screen: From: ....to........... m
NAPL Check:
Ref.datum:
Bore Depth: 2.02 m
Logic Check:
Stick Up: .... m
Bore Diam.: .... mm
Well Cap Secure? Y

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (..............)	Dis.Oxygen (..............)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..............)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		*-*	*+/- 0.05 pH*	*+/- 3%*	*+/- 10%*	*+/- 10 mV*	*stable*		
[illegible]	8:54								Logger out - In at 10:09
3	9 00	5·7	6·64	14·6	11·85	-6·1			slight turbidity? otherwise colourless no smell
6	9.03	5·3	5·42	13·9	10·35	25·7			low turbidity, no colour, odourless
9	9.07	5·2	4·94	13·4	9.52	71·5			as above
12	9·10	5·3	5·60	13·5	9·63	58·3			as above
									good recharge
									Logger -
									Battery 26% used
									Memory 15% used

Field QA Checks:

~~Air bubbles in vials? Y / N Any violent reactions? Y / N~~
Decontamination as per GHD procedure? [✓ Y] / N
Was sampling equipment pre-cleaned? [✓ Y] / N
COC updated? [✓ Y] / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Dup + Split

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

2.4m = 5L

Purging and Sampling Record

Bore ID: BH06

Job Information		*Sampling Information*		*Bore Information*	
Client: ARV		Purge Method: Bailer		SWL(mbTOC): Logger in 6.685 | 6.685 Logger out m	Logic Check:
Project:		Sample Method: ''		Screen: From: to: m	Stick Up: m
Proj. No.: 12565989		WQ Meter Type: YSI 21D101751		NAPL Check:	Bore Diam.: mm
Sampler: MT		Flow Cell: Y / N	Pump Depth: m	Ref.datum:	Well Cap Secure? Y
Date: 15/11/23		WLevel Meter Type:	Dip / Fox / Int.Fce / Gge	Bore Depth: 9.2 m	
Round: Nov 23		Field Filtered? Y / N (filter vessel, disposable filter/syringe)			

Time (.........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (.........)	Dis.Oxygen (.........)	Ox-Red Pt. (± mV)	SWL (m TOC)	(.........)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
								10:21	Logger out – In 11:25
10:37	3	6.3	4.65	17.7	9.96	182.3	6.71		clear, no odour
10:44	6	6.2	5.00	21.0	9.27	163.9	6.72		clear, no odour, low turbidity
10:59	9	6.5	5.22	22.2	9.49	161.9	6.73		" "
11:03	12	5.6	5.12	20.7	9.64	167.6	6.73		
11:10	15	5.8	5.90	20.9	9.47	111.5	6.75		Parameters fairly stable, sample @
									15L
									Barro – 25% memory used
									29% battery used
									Logger – 15% memory used
									26% battery used

3% [illegible]

Field QA Checks:

~~Air bubbles in vials? Y / N Any violent reactions? Y / N~~

Decontamination as per GHD procedure? [✓ Y] / N

Was sampling equipment pre-cleaned? [✓ Y] / N

COC updated? [✓ Y] / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Diol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: BH18

Job Information	*Sampling Information*	*Bore Information*
Client: ARV	**Purge Method:** Bailer	**SWL(mbTOC):** 0.965 (logger in) 0.972 (logger out) m — **Logic Check:**
Project:	**Sample Method:** "	**Screen: From:** …… **to** …… m — **Stick Up:** …… m
Proj. No.: 12565989	**WQ Meter Type:** YSI 21D101751	**NAPL Check:** — **Bore Diam.:** …… mm
Sampler: MTT	**Flow Cell:** Y / N — **Pump Depth:** ……m	**Ref.datum:** — **Well Cap Secure?** Y
Date: 15/11/23	**WLevel Meter Type:** Dip / Fox / Int.Fce / Gge	**Bore Depth:** 2.03 m
Round Nov 23	**Field Filtered? Y / N** (filter vessel, disposable filter/syringe)	

Time (……….)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (……….)	Dis.Oxygen (……….)	Ox-Red Pt. (± mV)	SWL (m TOC)	(……….)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
~~11:49~~	~~2~~	~~8.6~~					~~0.98~~	11:35	Logger out – In
11.49	2	8.6	5.91	38.1	2.69	80.7	0.98		temp may be ↑; 1L sat in bucket for some time
									clear no odour, no sediment
11.54	4	7.3	5.83	35.1	2.18	93.2	0.98		mod turbidity with fine brown
11.57							1.08		sediment, no odour
12.00							1.045	/	
12.03	6	7.7	5.48	32.3	1.76	124.7			clear, no odour, low/negligible
12.06							1.085		sediment
12.15	8	7.6	5.81	31.8	1.82	26.8			as above, some fine sediment
									Logger – 29% battery used 24 April
									18% memory used same as April
									Time – 2 mins out; monitor.

Field QA Checks:

~~Air bubbles in vials? Y / N Any violent reactions? Y / N~~

Decontamination as per GHD procedure? [✓ Y] / N

Was sampling equipment pre-cleaned? [✓ Y] / N

COC updated? [✓ Y] / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

2×4=8

Purging and Sampling Record

Bore ID: BH09

Job Information

Client: ARV
Project:
Proj. No.: 12565989
Sampler: MT
Date: 15/11/23
Round: Nov 23

Sampling Information

Purge Method: Bailer
Sample Method: 〃
WQ Meter Type: YSI 21D101751
Flow Cell: Y / N
Pump Depth: m
WLevel Meter Type: Dip / Fox / Int.Fce / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): logger in 2:254 logger out 2.277 m
Logic Check:
Screen: From: to m
Stick Up: m
NAPL Check:
Bore Diam.: mm
Ref.datum:
Well Cap Secure?
Bore Depth: 5.92 m

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (..........)	Dis.Oxygen (..........)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..........)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		*-*	*+/- 0.05 pH*	*+/- 3%*	*+/- 10%*	*+/- 10 mV*	*stable*		
								15:08	Logger out
3.15	3	5.8	5.95	15.3	9.84	91.6	2.346		v. low turbidity, odourless, colourless
3.20	6	5.5	5.36	14.2	8.94	133.5	2.42		as above
3.25	9	5.8	5.53	14.6	9.06	136.1	2.425		as above
3.30	12	5.4	5.31	13.9	8.20	153.4	2.46		as above
3.36	15	5.5	5.41	13.8	8.01	150.6	2.464		as above
3.43	18	5.8	5.53	14.1	8.49	105.1	2.46		
								15.50	logger in
									Logger 15% memory used
									29% battery used

Field QA Checks:

~~Air bubbles in vials? Y / N Any violent reactions? Y / N~~
Decontamination as per GHD procedure? [✓ Y] / N
Was sampling equipment pre-cleaned? [✓ Y] / N
COC updated? [✓ Y] / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: 17

Job Information

Client: ARV
Project:
Proj. No.: 12565989
Sampler: MT
Date: 15/11/23
Round Nov 23

Sampling Information

Purge Method: Bailer
Sample Method: " "
WQ Meter Type: YSI 21010175
Flow Cell: Y / N   **Pump Depth:** ……m
WLevel Meter Type: Dip / Fox / Int.Fce / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): logger in 0.03 0.07 logger out m   **Logic Check:**
Screen: From: ……**to**…… m   **Stick Up:** …… m
NAPL Check: **Bore Diam.:** …… mm
Ref.datum: **Well Cap Secure?** Y
Bore Depth: 2.04 m

Time (……)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (……)	Dis.Oxygen (……)	Ox-Red Pt. (± mV)	SWL (m TOC)	(……)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
2.05									logger out - back in 16:02
2.12	3	6.9	5.99	29.9	7.46	100.2	1.433		clear, no turbidity, colourless, odourless
2.23							1.526		
2.30							1.35		VERY SLOW TO RECHARGE
2.34	5	9.3	5.92	31.8	8.22	145.8			low turbidity, no odour, grey tinge.
3.57							0.391		
									logger - 15% memory used
									29% battery used
									Time is 7 mins behind actual

Field QA Checks:

~~Air bubbles in vials? Y / N Any violent reactions? Y / N~~
Decontamination as per GHD procedure? [✓ Y] / N
Was sampling equipment pre-cleaned? [✓ Y] / N
COC updated? [✓ Y] / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Bore Id	Date	Time	SWL (m)	Bore depth (m)	Comment	Construction Depth (m)
BH06	6/2/24	16:00	7.068	9.0		9
BH07	7/2/24	13:45	0·46	0·87	bentonite around well plug	1
BH09	6/2/24	14:40	2.406	6.0		6
☆ BH10	7/2/24	15:20	2.85	8.66	Slight blockage at 2.5m	9
BH16	7/2/24	11:20	0.185	2.02		2.1
BH17	7/2/24	14:10	0.04	2.04	Slow Recharge	2.2
BH18	7/2/24	15:40	1.455	2.04	Slow Recharge	2.15
BH10	7/2/24	sampled	3·25 full	bail - water	clear, odourless, no sediment	

☆ BH10 → Solid tone at SWL

Purging and Sampling Record

Bore ID: 6

Job Information

Client: ARV
Project: Mt Buller Ongoing Water Monitoring Program
Proj. No.: 12565989
Sampler: MT
Date: 6/2/24
Round Feb-24

Sampling Information

Purge Method: Bailer
Sample Method: Bailer
WQ Meter Type: YSI 18L101817
Flow Cell: Y / N **Pump Depth:**……….m
WLevel Meter Type: Dip / Fox / Int.Fce / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): 7.068 m **Logic Check:** …………
Screen: From:…………**to**………. m **Stick Up:** ………… m
NAPL Check:……………………
Bore Diam.: 50 mm
Ref.datum: …………………… **Well Cap Secure?** Yes
Bore Depth: 9 m

Time (……….)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (uS/cm)	Dis.Oxygen (%)	Ox-Red Pt. (± mV)	SWL (m TOC)	(……….)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	*+/- 0.05 pH*	*+/- 3%*	*+/- 10%*	*+/- 10 mV*	*stable*		
16.00							7.065		loggers in ~~out~~, water in well ~~cap~~
16.04							7.068		loggers out
16.19	3	6.8	4.84	17.9	74.3	248.4	7.110		colourless, odourless, no sediment
16:30	6	6.3	4.80	20.2	81.4	259.9	7.11		colourless, odourless, no sediment,
16.39	9	5.8	4.52	20.4	78.8	281.9	7.131		turbidity very low
16:45	12	5.7	4.67	20.4	75.1	284.5	7.13		" "

Field QA Checks:

Air bubbles in vials? Y / [✓ N] Any violent reactions? Y / [✓ N]
Decontamination as per GHD procedure? [✓ Y] / N
Was sampling equipment pre-cleaned? [✓ Y] / N
COC updated? [✓ Y] / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Logger used memory -> 15%, used battery -> 30%
Baro " " 25% " " 30%

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

5.6 × 2 = 1.2L × 3 = [illegible]

Purging and Sampling Record

Bore ID: BH09

Job Information		*Sampling Information*		*Bore Information*	
Client: ARV		Purge Method: Bailer		SWL(mbTOC): 2.406 m	Logic Check:
Project: Mt Buller Ongoing Water Monitoring Program		Sample Method: Bailer		Screen: From: ... to ... m	Stick Up: ... m
Proj. No.: 12565989		WQ Meter Type: YSI 18L101817		NAPL Check:	Bore Diam.: ... mm
Sampler: MT		Flow Cell: Y / N	Pump Depth: ... m	Ref.datum:	Well Cap Secure? Yes
Date: 6/2/24		WLevel Meter Type:	Dip / Fox / Int.Fce / Gge	Bore Depth: 6 m	
Round Feb-24		Field Filtered? Y / N (filter vessel, disposable filter/syringe)			

Time (.........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (.........)	Dis.Oxygen (.........)	Ox-Red Pt. (± mV)	SWL (m TOC)	(.........)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
14:40							2.404		Remove logger -> 14:40
14.47							2.406		logger out
15.08	5	10.0	5.18	15.9	67.8	233.3	2.531		Colourless, odourless, no sediment
15.14	10	9.8	4.80	16.1	68.5	244.2	2.621		" " "
15.22	15	9.8	4.77	16.2	64.9	251.9	2.632		" " "
15.27	20	9.5	5.19	15.3	68.4	236.6	2.732		" " "
15.31	23	9.5	4.81	15.2	72.3	257.6	2.668		" " "
15.46									logger back in; BH lid on.
									SWL taken from black marker
									line (PVC pipe cut on an angle)

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N

Decontamination as per GHD procedure? [✓ Y] / N

Was sampling equipment pre-cleaned? [✓ Y] / N

COC updated? [✓ Y] / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Logger -> 15% memory used, used battery -> 30%

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

12 L to bale

Purging and Sampling Record

Bore ID: BH16

Job Information

Client: ARV
Project: Mt Buller Ongoing Water Monitoring Program
Proj. No.: 12565989
Sampler: MT
Date: 7/2/24
Round Feb-24

Sampling Information

Purge Method: Bailer
Sample Method: Bailer
WQ Meter Type: YSI 18L101817
Flow Cell: Y / N
Pump Depth:..........m
WLevel Meter Type: Dip / Fox / Int.Fce / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): 0.185 m
Screen: From:..........**to**.......... m
NAPL Check:..........
Ref.datum:..........
Bore Depth: 2.02 m
Logic Check:..........
Stick Up:.......... m
Bore Diam.:.......... mm
Well Cap Secure? Yes

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (uS/cm)	Dis.Oxygen (%......)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..........)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	*+/- 0.05 pH*	*+/- 3%*	*+/- 10%*	*+/- 10 mV*	*stable*		
11.24							0.18		Logger in.
11.25							0.185		Logger out.
11.30	3L	7.7	5.62	14.2	89.3	246.9	0.48		Low Turb, odourless, no sed, colourless
11.34	6L	7.2	4.97	13.8	80.4	272.0	0.34		As above, increased sed.
11.45	9L	7.3	5.23	14.3	66.9	250.7	0.19		Yellow tinge.
11.51	12L	7.2	5.33	13.5	29.6	244.3			Less sed,
12.07									logger back in

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? Y / N
Was sampling equipment pre-cleaned? Y / N
COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

GW-FD02, ~~GW-F[illegible]~~ GW-FS02

- Logger Out 11.17am.
- Logger in 12.07

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

12L. bail

Purging and Sampling Record

Bore ID: 18

Job Information

Client: ARV
Project: Mt Buller Ongoing Water Monitoring Program
Proj. No.: 12565989
Sampler: MT
Date: 7/2/24
Round Feb-24

Sampling Information

Purge Method: Bailer
Sample Method: Bailer
WQ Meter Type: YSI 18L101817
Flow Cell: Y / N
Pump Depth: ....m
WLevel Meter Type: Dip / Fox / Int.Fce / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): 1.455 m
Logic Check: ....
Screen: From: ....to............ m
Stick Up: .... m
NAPL Check: ....
Bore Diam.: .... mm
Ref.datum: ....
Well Cap Secure? Yes
Bore Depth: 2.04 m

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (uS/cm)	Dis.Oxygen (%)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..........)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
15:43							1.436		Logger in
15.45							1.455		Logger out
15.49	750 ml						1.6		slow recharge?
15.50	1250 ml								
	[illegible]								
15.53	1.75L	11.7	5.66	48.0	20.5	118.8	1.58		moderate turbidity, fine sediment,
16.00	2.75L								odourless, brown tinge
16.02	3L	16.6	5.46	39.3	21.9	142.8	1.75		low turbidity, fine sed, odourless,
									brown tinge
16.14							1.55		
16.26							1.51		
16.30									logger back in

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? [✓ Y] / N
Was sampling equipment pre-cleaned? [✓ Y] / N
COC updated? [✓ Y] / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc Data logger 3 mins out. (time).
logger memory 18% used logger battery 30% used

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

12L

Bore ID: 17

Job Information		Sampling Information		Bore Information	
Client:	ARV	Purge Method:	Bailer	SWL(mbTOC): 0.04 m	Logic Check:
Project:	Mt Buller Ongoing Water Monitoring Program	Sample Method:	Bailer	Screen: From: to: m	Stick Up: m
Proj. No.:	12565989	WQ Meter Type:	YSI 18L101817	NAPL Check:	Bore Diam.: 50 mm
Sampler:	MT	Flow Cell: Y / N	Pump Depth: – m	Ref.datum:	Well Cap Secure? Y
Date:	7/2/24	WLevel Meter Type:	Dip / Fox / Int.Fce / Gge	Bore Depth: 2.04 m	
Round	Feb-24	Field Filtered? Y / N (filter vessel, disposable filter/syringe)			

Time (……)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (µS/cm)	Dis.Oxygen (%)	Ox-Red Pt. (± mV)	SWL (m TOC)	(……)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	*+/- 0.05 pH*	*+/- 3%*	*+/- 10%*	*+/- 10 mV*	*stable*		
14.13							0.02		
14.16							0.04		
14.19	3	8.0	5.95	28.8	69.4	221.0	1.48		clear, low turbidity, no sediment
14.30							1.622		colourless, odourless
14.41							1.26		
14.52	6	9.6	5.96	29.1	61.3	202.6	1.845		temp up a little (sitting in bucket
							└ solid tone no smell.		while waiting for recharge).
15.02							1.52		

Field QA Checks:

Air bubbles in vials? Y [✓ N] Any violent reactions? Y [✓ N]

Decontamination as per GHD procedure? [✓ Y] / N

Was sampling equipment pre-cleaned? [✓ Y] / N

COC updated? [✓ Y] / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

used battery 30% used memory 15%

Logger out 14.15
Logger in 15.10

time 10 mins out

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: EWS

Job Information

Client: ARV
Project: Mt Buller Ongoing Water Monitoring Program
Proj. No.: 12565989
Sampler: MT
Date: 6/2/24
Round: Feb-24

Sampling Information

Purge Method: Bailer
Sample Method: Bailer
WQ Meter Type: YSI 18L101817
Flow Cell: Y / N
Pump Depth: ....m
WLevel Meter Type: Dip / Fox / Int.Fce / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): .... m
Logic Check: ....
Screen: From: ....to.......... m
Stick Up: .... m
NAPL Check: ....
Bore Diam.: .... mm
Ref.datum: ....
Well Cap Secure? ....
Bore Depth: .... m

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (µS/cm)	Dis.Oxygen (%)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..........)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):	-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable			
14:00									EWS East
14.10		14.7	6.40	22.1	45.3	114.2			~~13290~~ 132290
									clear, no sediment, colourless, odorless
14.21		12.5	6.04	18.2	51.1	135.3			EWS West
									316.5
									clear, no sediment, colourless odourless

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? Y [✓ N]
Was sampling equipment pre-cleaned? Y [✓ N]
COC updated? Y [✓ N]

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Samples taken from bucket

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: Boggy 1 Weir 1

Job Information

Client: ARV
Project: Mt Buller Ongoing Water Monitoring Program
Proj. No.: 12565989
Sampler: MT
Date: 6/2/24
Round Feb-24

Sampling Information

Purge Method: Bailer
Sample Method: Bailer
WQ Meter Type: YSI 18L101817
Flow Cell: Y / N **Pump Depth:** ....m
WLevel Meter Type: Dip / Fox / Int.Fce / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): .... m **Logic Check:** ....
Screen: From:............**to**.......... m **Stick Up:** .... m
NAPL Check:..............................
Bore Diam.: .... mm
Ref.datum: ....
Well Cap Secure?............
Bore Depth: .... m

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (µS/cm)	Dis.Oxygen (%)	Ox-Red Pt. (± mV)	SWL (m TOC)	(............)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	*+/- 0.05 pH*	*+/- 3%*	*+/- 10%*	*+/- 10 mV*	*stable*		
12.21		11.1	6.86	18.3	90.2	102.2			colourless, odorless no turbidity
									mosquitoes on the surface

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? [✓ Y] / N
Was sampling equipment pre-cleaned? [✓ Y] / N
COC updated? [✓ Y] / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: Boggy L Weir 2

Job Information

Client: ARV
Project: Mt Buller Ongoing Water Monitoring Program
Proj. No.: 12565989
Sampler: MT
Date: 6/2/24
Round Feb-24

Sampling Information

Purge Method: Bailer
Sample Method: Bailer
WQ Meter Type: YSI 18L101817
Flow Cell: Y / N **Pump Depth:** ....m
WLevel Meter Type: Dip / Fox / Int.Fce / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): .... m **Logic Check:** ....
Screen: From:............**to**........... m **Stick Up:** .... m
NAPL Check:.............................. **Bore Diam.:** .... mm
Ref.datum: .... **Well Cap Secure?**............
Bore Depth: .... m

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (µS/cm)	Dis.Oxygen (%.......)	Ox-Red Pt. (± mV)	SWL (m TOC)	(.............)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		*-*	*+/- 0.05 pH*	*+/- 3%*	*+/- 10%*	*+/- 10 mV*	*stable*		
12.3		9.5	6.65	13.6	91.2	126.4			colourless odorless no turbidity or
									sediment, mosquitoes on surface

Field QA Checks:

Air bubbles in vials? Y / [✓ N] Any violent reactions? Y / N
Decontamination as per GHD procedure? [✓ Y] / N
Was sampling equipment pre-cleaned? [✓ Y] / N
COC updated? [✓ Y] / N

Parameters	DTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: Boggy2

Job Information

Client: ARV
Project: Mt Buller Ongoing Water Monitoring Program
Proj. No.: 12565989
Sampler: MT
Date: 6/2/24
Round Feb-24

Sampling Information

Purge Method: Bailer
Sample Method: Bailer
WQ Meter Type: YSI 18L101817
Flow Cell: Y / N **Pump Depth:** ....m
WLevel Meter Type: Dip / Fox / Int.Fce / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): .... m **Logic Check:** ....
Screen: From:............**to**.......... m **Stick Up:** .... m
NAPL Check:.............................. **Bore Diam.:** .... mm
Ref.datum: .... **Well Cap Secure?**............
Bore Depth: .... m

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (uS/cm)	Dis.Oxygen (...%...)	Ox-Red Pt. (± mV)	SWL (m TOC)	(.............)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
11:48		10.6	6.65	18.2	90.3	140.4			very clear, no turbidity, odorless
									colourless

Field QA Checks:

Air bubbles in vials? Y [✓ N] Any violent reactions? Y [✓ N]
Decontamination as per GHD procedure? [✓ Y] / N
Was sampling equipment pre-cleaned? [✓ Y] / N
COC updated? [✓ Y] / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

SW-FD02 and SW-FS02

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

GHD

www.ghd.com.au
Tel. (03) 8687 8000 Fax. (03) 8687 8111
180 Lonsdale Street Melbourne Vic 3000

Bore Id	Date	Time	mbtoc SWL (m)	mbtoc Bore depth (m)	Comment	Construction Depth (m)
BH04					Decomissioning	15.68
BH04A					"	2.56
BH06	10/4/24	2:15pm	8.663	9.20	Slow recharge	9
BH07	10/4/24	10.42 am.	0.60	0.88	Bento needs sealing.	1
BH09	10/4/24	8:55am	2.82	5.95		6
BH10	10/4/24.	10.30 am.	4.395	8.69	Headworks still damaged.	9
BH16	10/4/24	1:15 pm	0.452	2.03	Good recharge	2.1
BH17	10/4/24	10:05am	0.125	2.05	Slow Recharge, ground dry	2.2
BH18	9/4/24	2pm	0.34	2.04	Good Recharge	2.15

Purging and Sampling Record

Bore ID: BH09

Job Information

Client: ARV
Project: HEMAMP Monitoring
Proj. No.: 12565989
Sampler: MT
Date: 10/4/24
Round: April 2024

Sampling Information

Purge Method: Bailer
Sample Method: Bailer
WQ Meter Type: YSI 21D101751
Flow Cell: Y / N
Pump Depth: ....m
WLevel Meter Type: Dip / Fox / [✓ Int.Fce] / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): 2.81/2.82 m
Logic Check: ....
Screen: From: 3 to 6 m
Stick Up: .... m
NAPL Check: ....
Bore Diam.: 50 mm
Ref.datum: ....
Well Cap Secure? Y
Bore Depth: 5.95 m

Time (..AM..)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (..............)	Dis.Oxygen (..............)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..............)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
8:59	3L	8.2	5.57	15.1	7.17	103.9	2.88		Odourless. Very low turb. No colour.
									Some sed.
9.04	6L	8.3	5.49	14.6	6.7	129.7	3.0		As above ".
9.08	9L	8.4	5.43	14.3	6.81	144.1	3.15		As above "
9.13	12L	7.9	5.38	14.2	7.28	156.3	3.26		Becoming more turbid.
9.17	15L	8.3	5.47	14.0	6.51	155.9	3.33		As above "
9.21	18L	7.9	~~5.35~~	14.0	7.38	166.0	3.33		As above, beautiful c
			5.43						
									Sample at 9.25am

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? Y / N
Was sampling equipment pre-cleaned? Y / N
COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Logger out 8.45am. / in 9.45

15% Memory Used, 31% battery used

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

2×2 = 4L
×3 = 12L

Purging and Sampling Record

Bore ID: BH17

Job Information	Sampling Information	Bore Information
Client: ARV	**Purge Method:** Bailer	**SWL(mbTOC):** 0.125 m
Project: HEMAMP Monitoring	**Sample Method:** Bailer	**Logic Check:**
Proj. No.: 12565989	**WQ Meter Type:** YSI 21D101751	**Screen: From:** 1 **to** 2.2 m
Sampler: MT	**Flow Cell:** Y / N	**Stick Up:** m
Date: 10/4/24	**Pump Depth:** m	**NAPL Check:**
Round April 2024	**WLevel Meter Type:** Dip / Fox / [✓ Int.Fce] / Gge	**Bore Diam.:** 50 mm
	Field Filtered? Y / N (filter vessel, disposable filter/syringe)	**Ref.datum:**
		Well Cap Secure? Y
		Bore Depth: 2.05 m

Time (.........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (.........)	Dis.Oxygen (.........)	Ox-Red Pt. (± mV)	SWL (m TOC)	(.........)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
10.05	3L	7.6	6.20	28.4	4.55	133.3	1.462		Low turb, no sediment odourless. No odour.
10.13							1.22		Bailed dry 10.18am @ 5L.
10.53							0.83		
10.57	6L	8.9	6.37	29.0	5.05	85.4	1.155		Minor fine sed, low turb. Odourless, colourless.
11.15	8L	7.9	6.06	28.1	4.34	140.6	1.84		As above.
									Sampled 11.20.
									Slow recharge.

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? Y / N
Was sampling equipment pre-cleaned? Y / N
COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Used memory 15%, used battery 31%.

Logger out 9:57
Logger in 11:24

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

0.5 × 2 = 1 × 2 = 2L

Purging and Sampling Record

Bore ID: #6

Job Information	Sampling Information	Bore Information
Client: ARV	Purge Method: Bailer	SWL(mbTOC): 8.662 / 8.663 m · Logic Check:
Project: HEMAMP Monitoring	Sample Method: Bailer	Screen: From: 6 to 9 m · Stick Up: m
Proj. No.: 12565989	WQ Meter Type: YSI 21D101751	NAPL Check: · Bore Diam.: 50 mm
Sampler: MT	Flow Cell: Y / N · Pump Depth: m	Ref.datum: · Well Cap Secure? Y
Date: 10/4/24	WLevel Meter Type: Dip / Fox / [✓ Int.Fce] / Gge	Bore Depth: 9.20 m
Round April 2024	Field Filtered? Y / N (filter vessel, disposable filter/syringe)	

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (..........)	Dis.Oxygen (..........)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..........)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
2.19	1.5 L	7.4	4.97	39.4	7.48	180.6	8.813		Colourless, no sediment, low turb, odourless.
2.34									Borehole purged dry - 2L
2.57							8.75		
3.06	3.5L	7.3	4.77	39.7	8.36	204.5	8.892		As above "
3:17							8.775		
3:29									
									Sampled at 3:30

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N

Decontamination as per GHD procedure? Y / N

Was sampling equipment pre-cleaned? Y / N

COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Level Troll: Batt used 35% / Memory 15% | Barro Troll: Battery used 31%, Memory used 25% - Logger Out at 2.06 pm, ☆ GW-FS01.1

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: Boggy 2

Job Information

Client: ARV
Project: HEMAMP Monitoring
Proj. No.: 12565989
Sampler: MT
Date: 9/4/24
Round April 2024

Sampling Information

Purge Method: ~~Bailer~~ Grab Sample
Sample Method: ~~Bailer~~ " "
WQ Meter Type: YSI 21D1018751
Flow Cell: Y [✓ N]
Pump Depth:..........m
WLevel Meter Type: Dip / Fox / [✓ Int.Fce] / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): .... m
Logic Check: ....
Screen: From:..........to.......... m
Stick Up: .... m
NAPL Check:....................
Bore Diam.: .... mm
Ref.datum: ....
Well Cap Secure? –
Bore Depth: – m

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (uS/cm)	Dis.Oxygen (mg/L)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..........)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	*+/- 0.05 pH*	*+/- 3%*	*+/- 10%*	*+/- 10 mV*	*stable*		
10:36		7.6	6.46	18.5	10.39	95.0			Clear, no odour, flowing

Field QA Checks:

Air bubbles in vials? Y / N   Any violent reactions? Y / N
Decontamination as per GHD procedure? Y / N
Was sampling equipment pre-cleaned? Y / N
COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

SW-FS03
SW-F003.

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: Boggy 1 p/up 2.

Job Information

Client: ARV
Project: Mt Buller Ongoing Water Monitoring Program
Proj. No.: 12565989
Sampler: MT
Date: 9/4/24
Round ~~Feb-24~~ APRIL '24

Sampling Information

Purge Method: ~~Bailer~~ Grab Sample
Sample Method: ~~Bailer~~
WQ Meter Type: YSI 21O1O1751
Flow Cell: Y / [✓ N]
Pump Depth: ....m
WLevel Meter Type: Dip / Fox / [✓ Int.Fce] / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): .... m
Screen: From: .... to .... m
NAPL Check: ....
Ref.datum: —
Bore Depth: .... m
Logic Check: ....
Stick Up: .... m
Bore Diam.: .... mm
Well Cap Secure? —

Time (AM)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (mS/cm)	Dis.Oxygen (mg/L)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..........)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
11.29		6.8	6.76	14.7	10.36	60.2			Odourless, yellow tinge, low turbidity.
									Flowing.
									EWS East
12:16		10.0	6.13	16.5	5.69	25.5	—	—	Clear, no sediment, odourless
									EWS West
									Not flowing, no water to
									sample

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? Y / N
Was sampling equipment pre-cleaned? Y / N
COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: Boggy 1 P/up1

Job Information

Client: ARV
Project: Mt Buller Ongoing Water Monitoring Program
Proj. No.: 12565989
Sampler: MT
Date: 9/4/24
Round ~~Feb 24~~ APRIL '24

Sampling Information

Purge Method: Bailer
Sample Method: Bailer
WQ Meter Type: YSI 21D101751
Flow Cell: Y / N
Pump Depth: ....m
WLevel Meter Type: Dip / Fox / [✓ Int.Fce] / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): .... m
Logic Check: ....
Screen: From: .... to .... m
Stick Up: .... m
NAPL Check: ....
Bore Diam.: .... mm
Ref.datum: ....
Well Cap Secure? ~ —
Bore Depth: — m

Time (..AM..)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (uS/cm)	Dis.Oxygen (mg/L)	Ox-Red Pt. (± mV)	SWL (m TOC)	(............)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	*+/- 0.05 pH*	*+/- 3%*	*+/- 10%*	*+/- 10 mV*	*stable*		
11.14		6.8	6.78	17.4	10.64	72.4			Low turbidity, odourless, yellow tinge

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N
Decontamination as per GHD procedure? Y / N
Was sampling equipment pre-cleaned? Y / N
COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc SW-FS01

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: #18

Job Information

Client: ARV
Project: HEMAMP Monitoring
Proj. No.: 12565989
Sampler: MT
Date: 9/4/24
Round April 2024

Sampling Information

Purge Method: Bailer
Sample Method: Bailer
WQ Meter Type: YSI 21D101751
Flow Cell: Y / [✓ N]   Pump Depth: — m
WLevel Meter Type: Dip / Fox / [✓ Int.Fce] / Gge
Field Filtered? Y / N (filter vessel, disposable filter/syringe)

Bore Information

SWL(mbTOC): 0.32/0.34 m   Logic Check:
Screen: From: 1.15 to 2.15 m   Stick Up: m
NAPL Check: Bore Diam.: 50 mm
Ref.datum: Well Cap Secure? Y
Bore Depth: 2.04 m

Time (PM)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (µS/cm)	Dis.Oxygen (mg/L)	Ox-Red Pt. (± mV)	SWL (m TOC)	(............)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
1:54		9.0	5.68	20.8	6.63	64.1	–		Mod turb. Odourless. Brown tinge.
1:59		9.1	5.52	22.3	6.92	106.6	1.0		Some fine sed. / High turbidity
2:10		9.1	5.61	22.4	5.93	131.4	0.97		~ "

Field QA Checks:

Air bubbles in vials? Y / N   Any violent reactions? Y / N
Decontamination as per GHD procedure? Y / N
Was sampling equipment pre-cleaned? Y / N
COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc Logger out 1.40pm.

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Purging and Sampling Record

Bore ID: #16

Job Information	Sampling Information	Bore Information	
Client: ARV	**Purge Method:** Bailer	**SWL(mbTOC):** 0.445 ~~1.395~~ / 0.452 m	**Logic Check:**
Project: HEMAMP Monitoring	**Sample Method:** Bailer	**Screen: From:** 1.1 **to** 2.1 m	**Stick Up:** m
Proj. No.: 12565989	**WQ Meter Type:** YSI 21D101751	**NAPL Check:**	**Bore Diam.:** 50 mm
Sampler: MT	**Flow Cell:** Y / N **Pump Depth:** m	**Ref.datum:**	**Well Cap Secure?** Y
Date: 10/4/24	**WLevel Meter Type:** Dip / Fox / [✓ Int.Fce] / Gge	**Bore Depth:** 2.03 m	
Round April 2024	**Field Filtered?** Y / N (filter vessel, disposable filter/syringe)		

Time (..........)	Volume (L)	Temp (°C)	pH (pH units)	Elec.Cond (..........)	Dis.Oxygen (..........)	Ox-Red Pt. (± mV)	SWL (m TOC)	(..........)	Comment: Colour, turbidity, sediment load, sheen, odour, flow rate, purged dry?
Stable when (3 consecutive readings):		-	+/- 0.05 pH	+/- 3%	+/- 10%	+/- 10 mV	stable		
1.19	3L	8.2	5.53	14.7	7.39	140.8	0.45		Mod turb, orange sediment, brown tinge, odourless.
1.27	6L	7.8	5.21	13.9	7.70	175.8	0.47		As above, increasing sediment.
1.34	9L	7.8	5.12	13.9	7.53	186.5	0.47		As above
									Sample taken at 1.45pm.

Field QA Checks:

Air bubbles in vials? Y / N Any violent reactions? Y / N

Decontamination as per GHD procedure? Y / N

Was sampling equipment pre-cleaned? Y / N

COC updated? Y / N

Parameters	BTEX	TPH	PAH	CHC	PCB	OCP	OPP	Tot. Metal	Biol.				
Preservatives													

Comment: Duplicate samples collected, bottles used, access, condition of headworks etc

Used memory 15% / Used battery 31%.

- Logger out 1.10pm.
- Logger returned 1.45pm.

GW-FD03

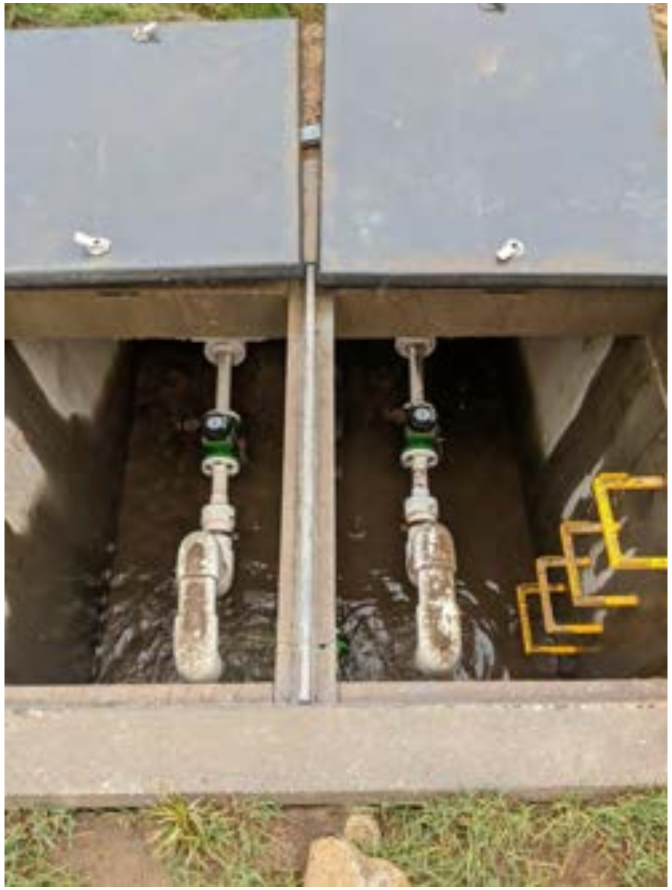
GW-FS03

Purge Volumes

Casing Int. Dia (mm)	50	100	150
Vol (L/m of casing)	2.0	7.9	17.7

*Double for gravel pack

Photographic Log

Location	Description (Within bog/ Outside bog)	Collection point / Headworks	Site location
EWS – Environmental Watering System	Outside bog **Coordinates (UTM, Zone 55)**		

→ **The Power of Commitment**

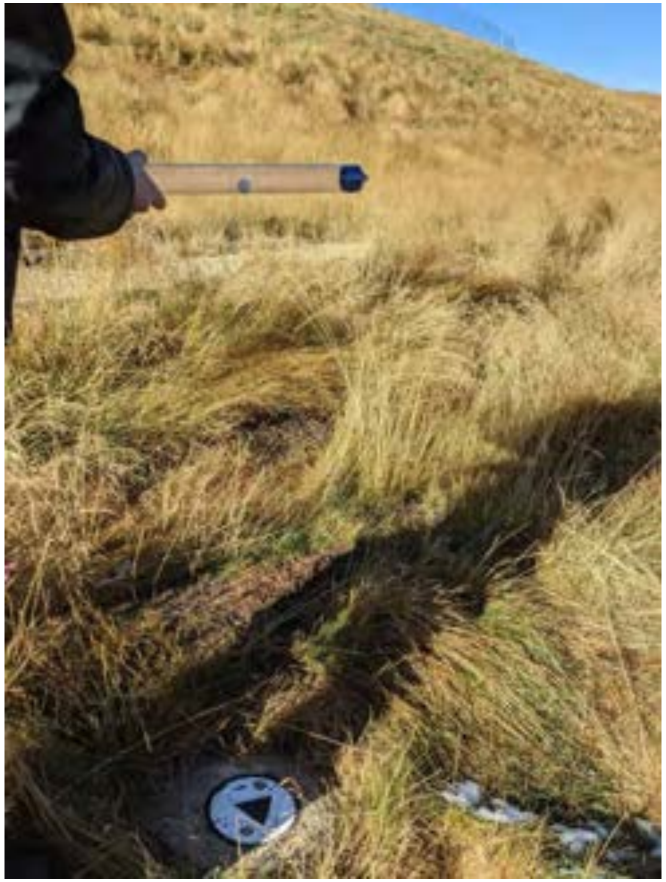
Location	Description (Within bog/ Outside bog)	Collection point / Headworks	Site location
Boggy Creek 1 Pickup Weir 1	Outside bog		

Location	Description (Within bog/ Outside bog)	Collection point / Headworks	Site location
Boggy Creek 1 Pickup Weir 2	Outside bog		

Location	Description (Within bog/ Outside bog)	Collection point / Headworks	Site location
Boggy Creek 2	Outside bog		

Location	Description (Within bog/ Outside bog)	Collection point / Headworks	Site location
BH06	**Coordinates (UTM, Zone 55)** 449,429.0 5,888,787		Bore BH06 is upgradient of mapped bogs near BH16. 

Location	Description (Within bog/ Outside bog)	Collection point / Headworks	Site location
BH07	Within bog **Coordinates (UTM, Zone 55)** 449,658.3 5,888,915		BH07 is located within a mapped bog area north of the water storage dam 

Location	Description (Within bog/ Outside bog)	Collection point / Headworks	Site location
BH09	**Coordinates (UTM, Zone 55)** 449,611.8 5,888,835		BH09 is directly down-gradient of the storage and marginally up-gradient of the western arm of the EWS. 

Location	Description (Within bog/ Outside bog)	Collection point / Headworks	Site location
BH10	**Coordinates (UTM, Zone 55)** 449,679.9 5,888,856		BH10 is directly downgradient of the water storage, located on the northern side of the summit nature trail footpath. 

Location	Description (Within bog/ Outside bog)	Collection point / Headworks	Site location
BH16	Within bog **Coordinates (UTM, Zone 55)** 449,459 – 5,888,860		BH16 is located cross slope from the storage, and within the margins of a bog. 

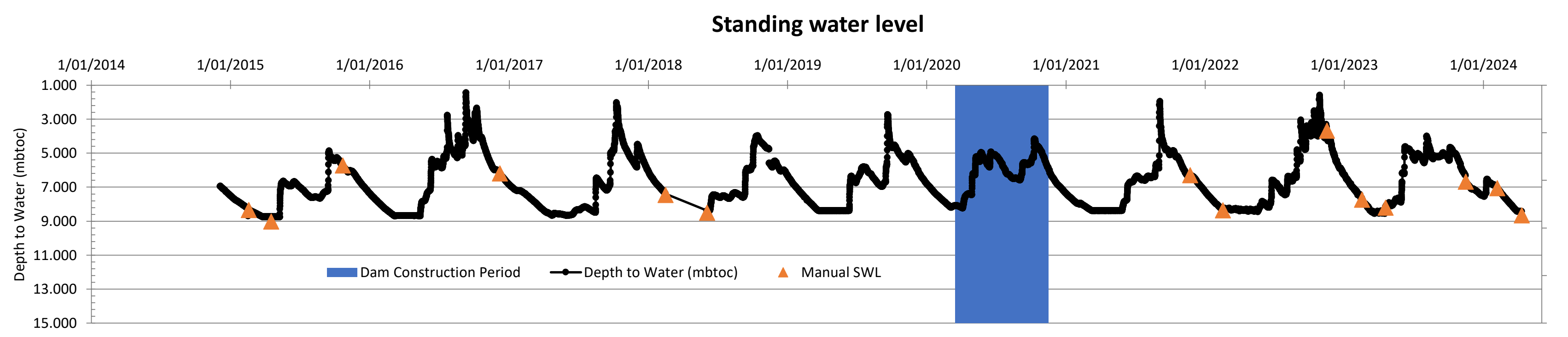
Location	Description (Within bog/ Outside bog)	Collection point / Headworks	Site location
BH17	Within bog **Coordinates (UTM, Zone 55)** 449,701 5,888,866		BH17 is a shallow bore located within the margins of a bog 

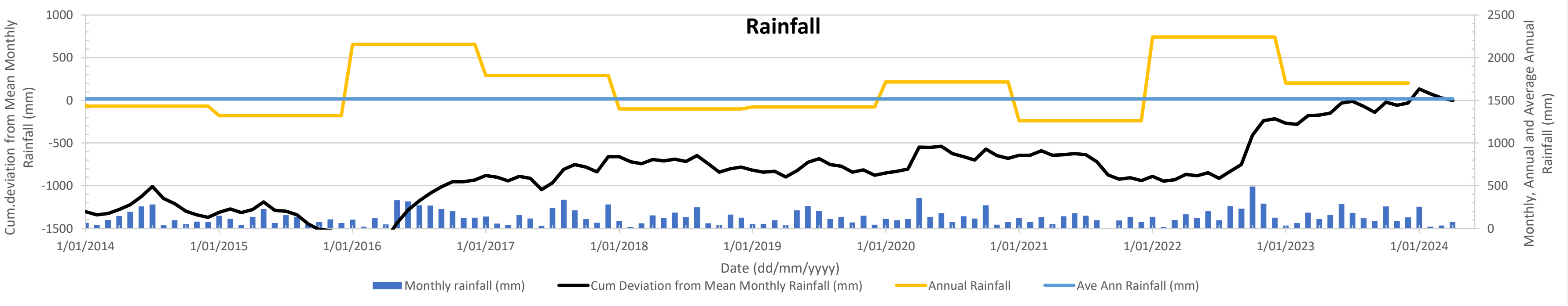
Location	Description (Within bog/ Outside bog)	Collection point / Headworks	Site location
BH18	**Coordinates (UTM, Zone 55)** 449,922 5,888,830		This bore is located further to the east of the water storage. 

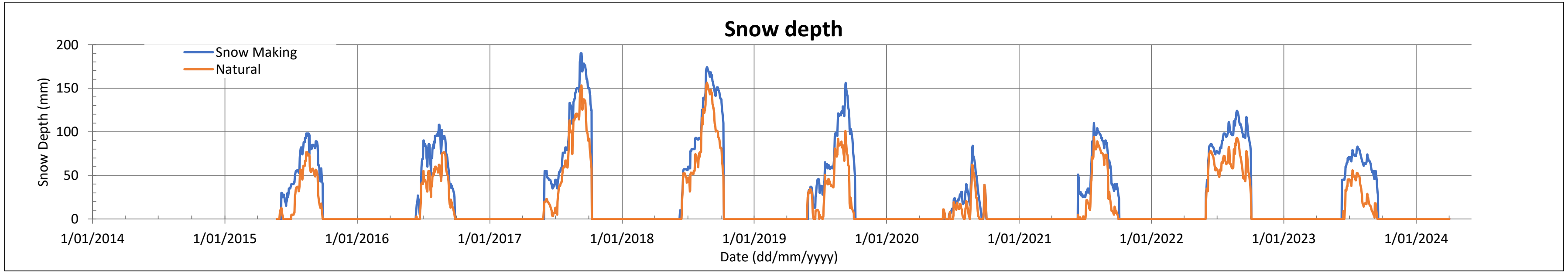
Appendix C

Hydrographs

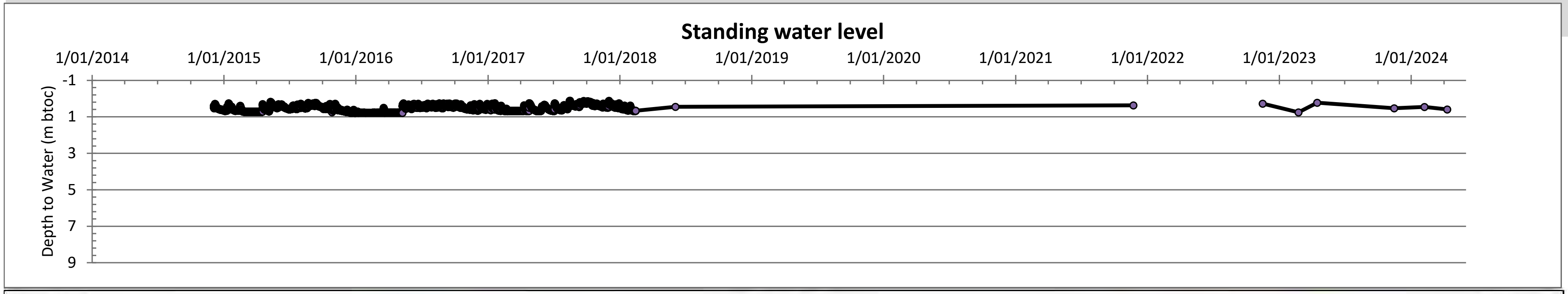
Monitoring Bore BH06

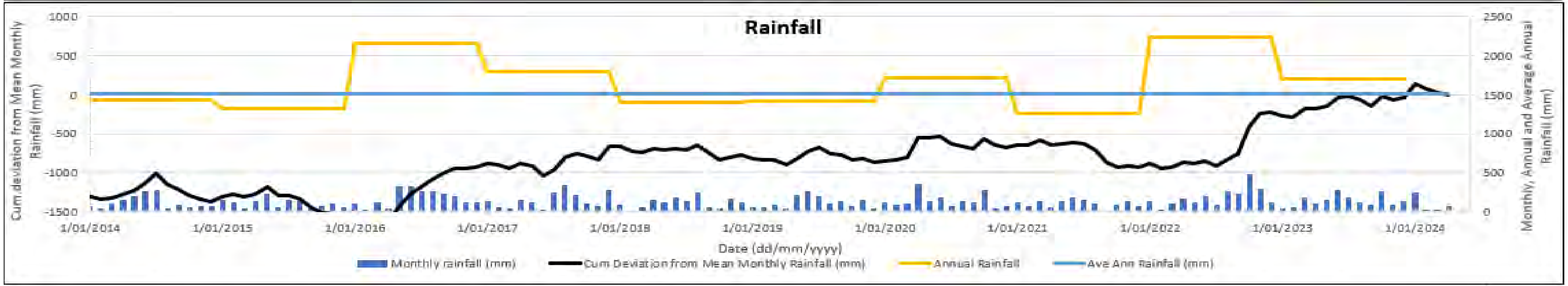


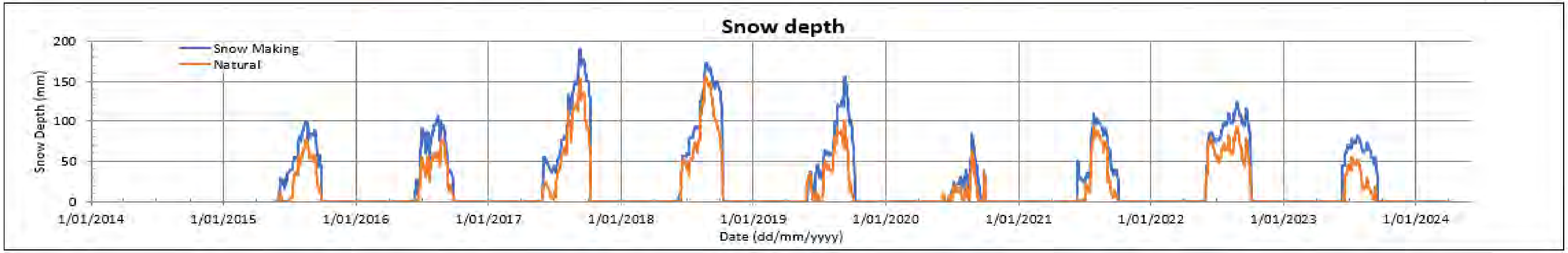




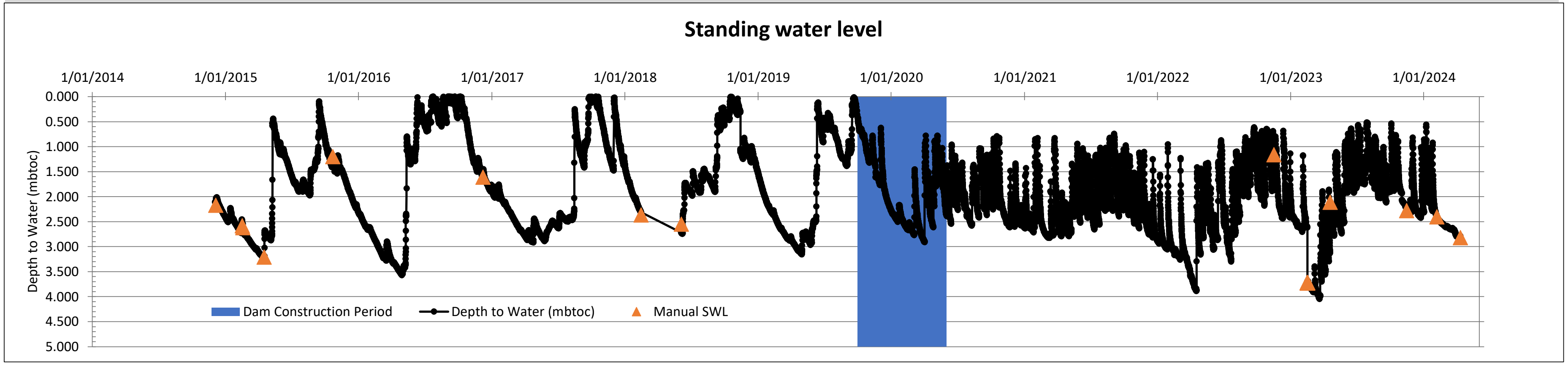
Monitoring Bore BH07

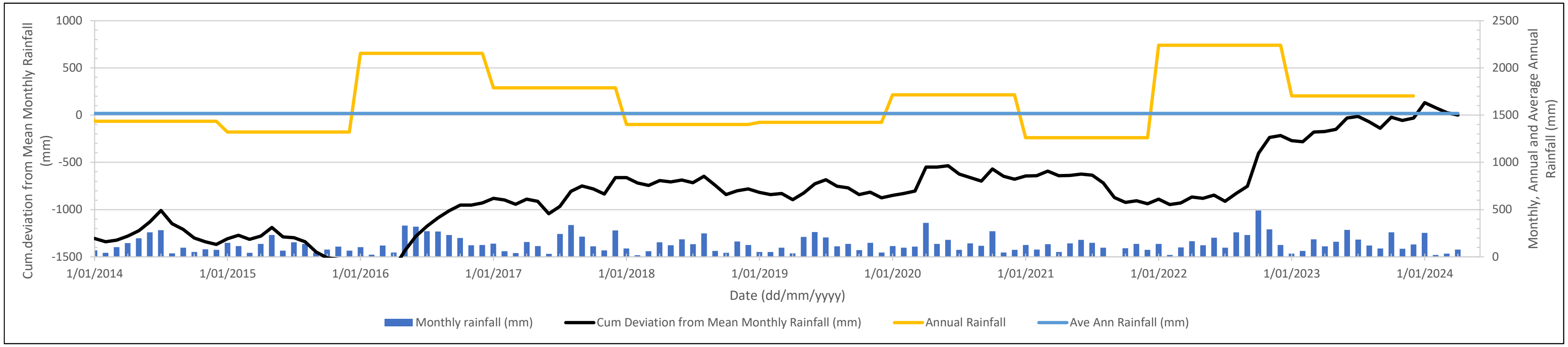

Standing water level

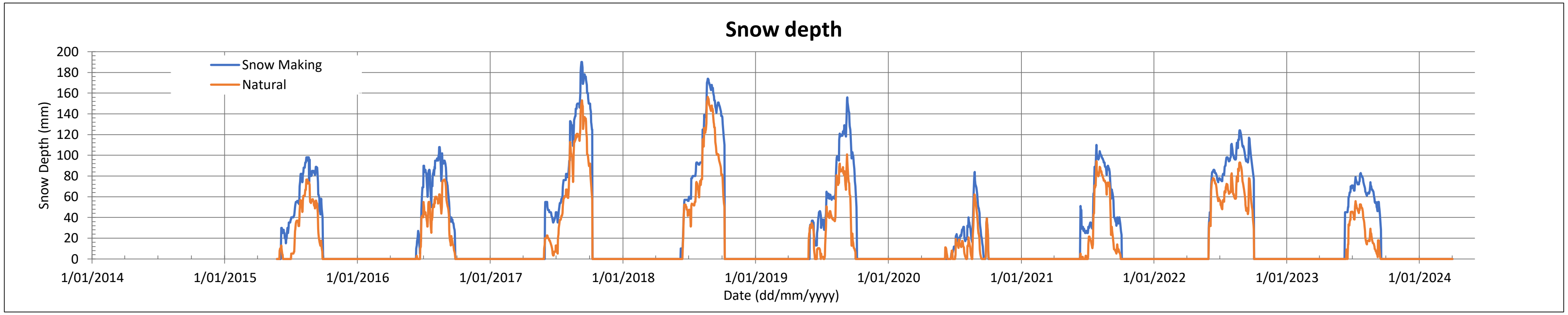

Rainfall


Snow depth

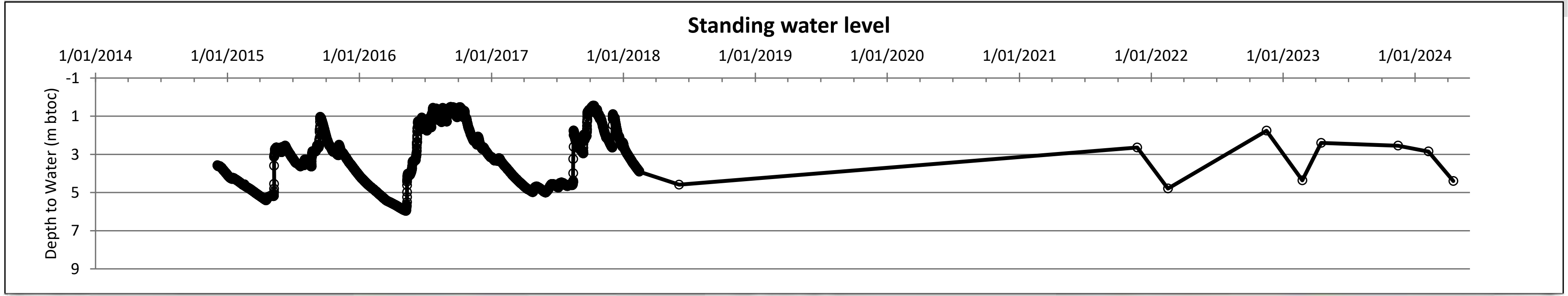
Monitoring Bore BH09



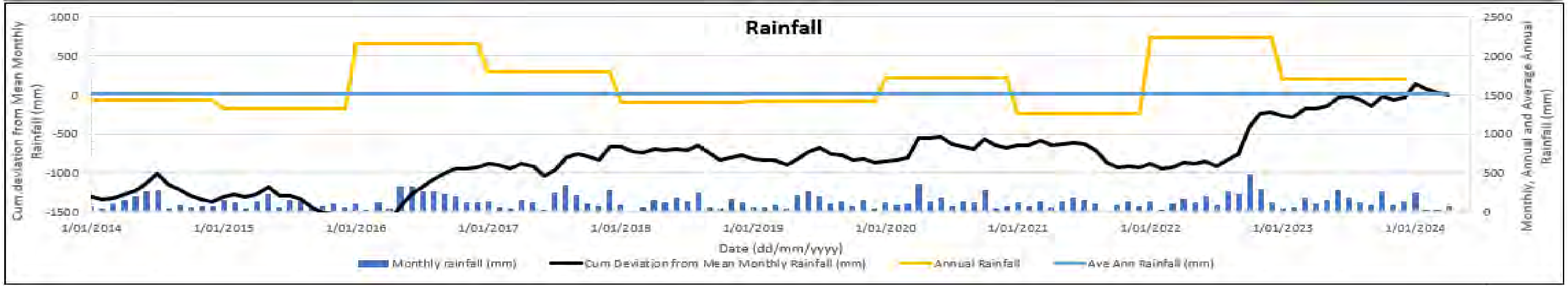




Monitoring Bore BH10



Standing water level



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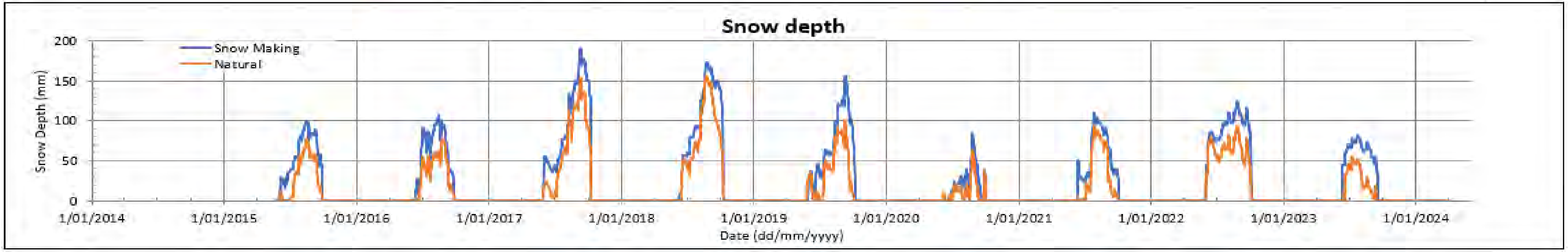
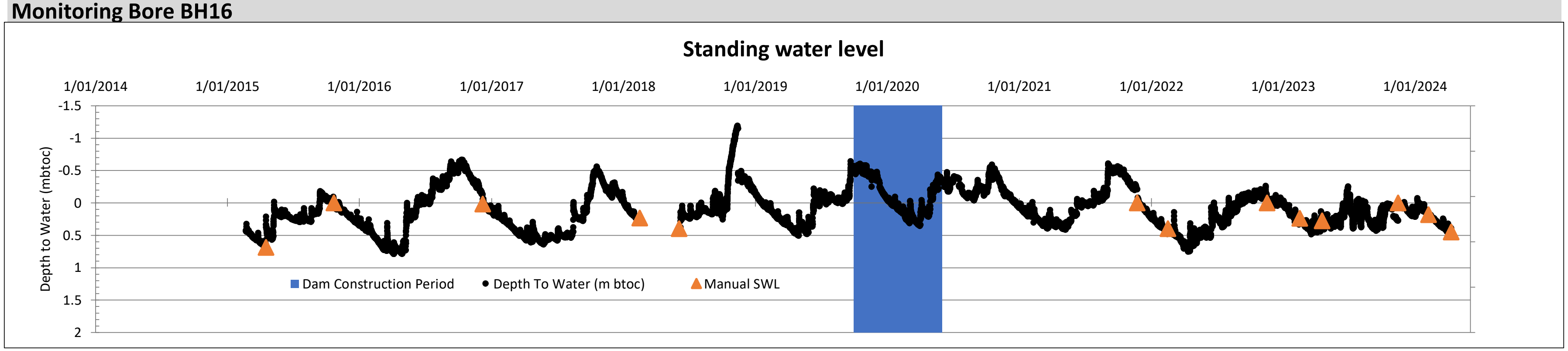
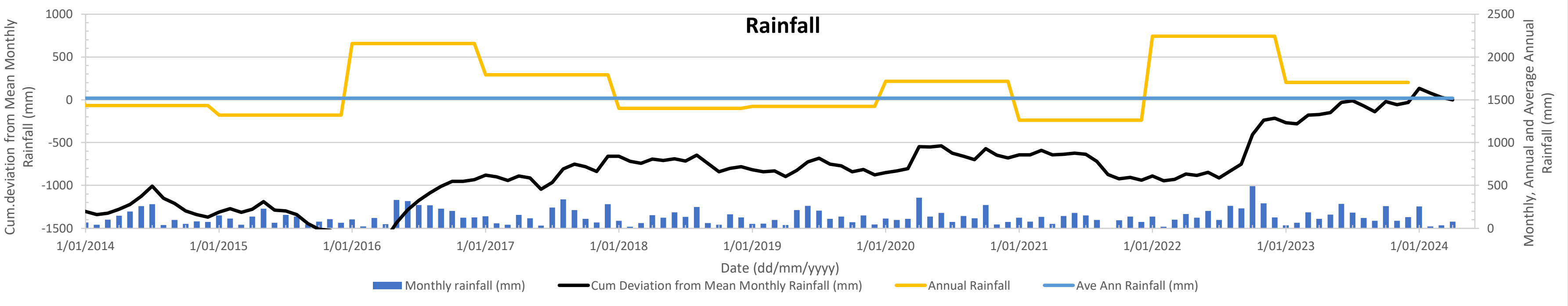


Snow depth

Monitoring Bore BH16



Standing water level



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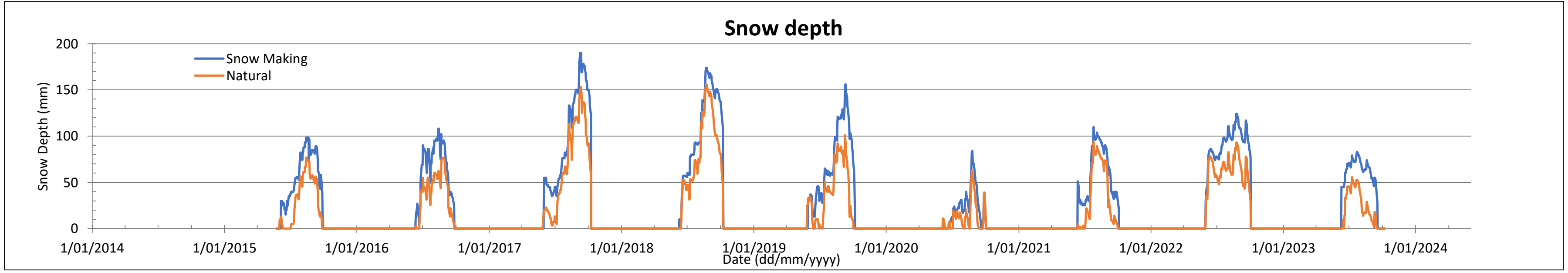
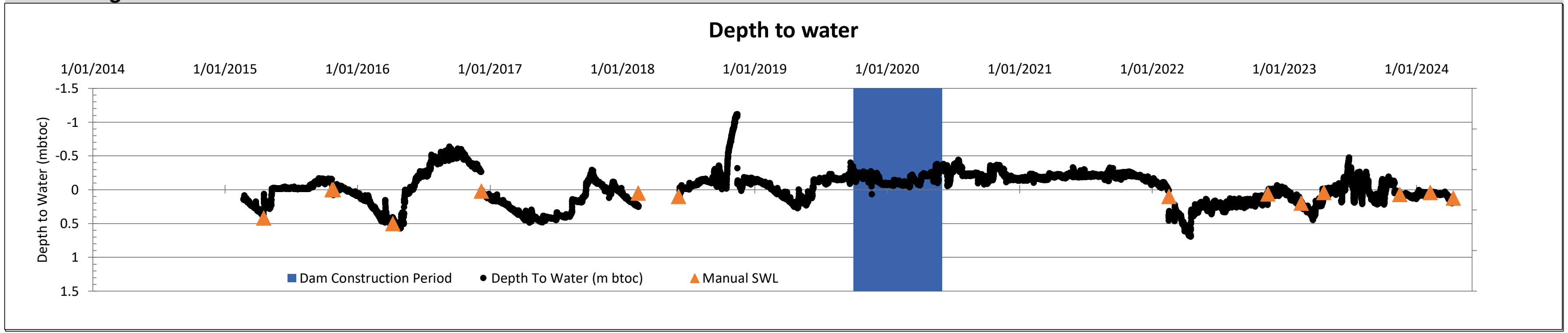
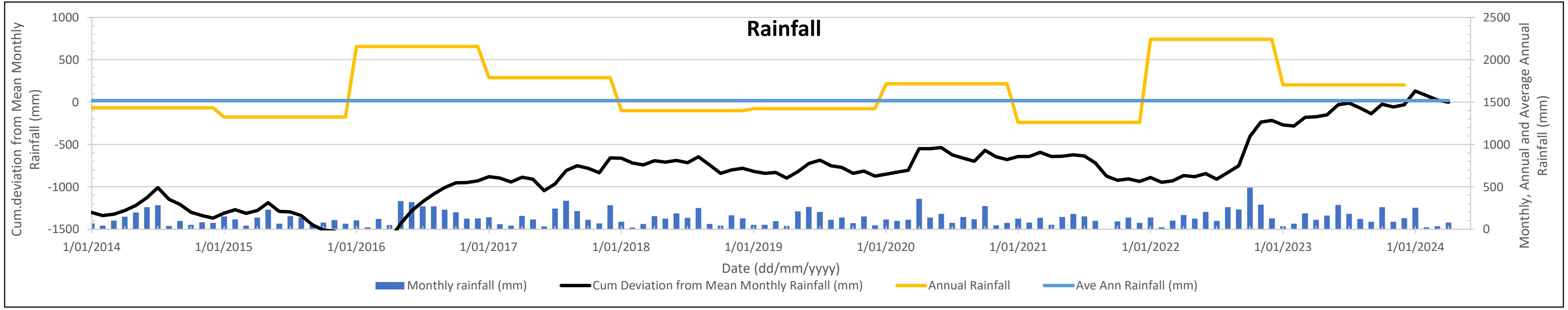
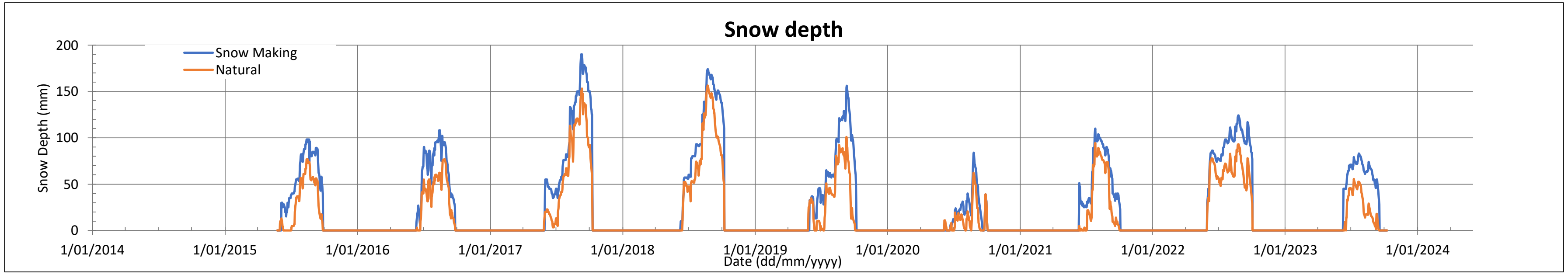


Snow depth

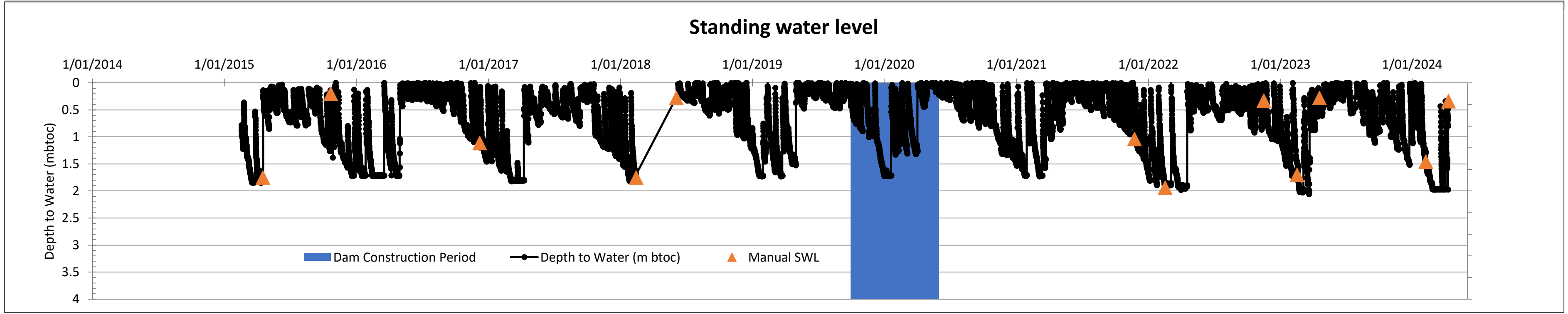
Monitoring Bore BH17

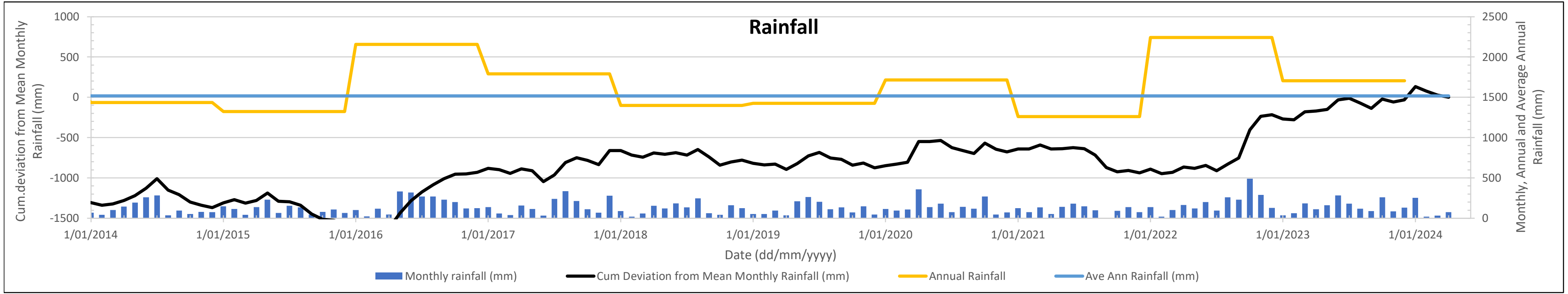


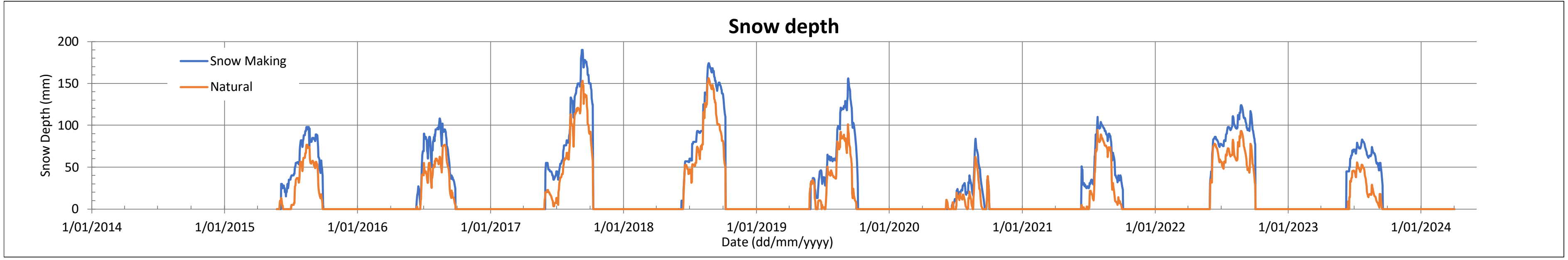




Monitoring Bore BH18







Alpine Resorts Victoria

Mount Buller HEMAMP
Manual Water Level Gaugings

Bore	Geology Sequence	RL NS (LiDAR)	Measured Bore Depth (m btoc)	Stick up (m bgl)	Feb-14		May-14		4/12/2014		5/12/2014		16/02/2015		17/02/2015	
					SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT
BH04	Carbonaceous Mudstone	1735	15.58	-0.1	6.97	1728	5.48	1729	6.57	1728	6.58	1728	6.68	1728	6.66	1728
BH04A	Basalt (sandy clays, cobbles)	1735	2.38	-0.07	DRY	DRY	1.71	1733	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
BH05	Granitic Soils	1733	19.67	-0.1	17.99	1715	13.8	1719	14.35	1719	14.35	1719	15.52	1717	15.53	1717
BH05A	Colluvium (clayey sand, cobbles)	1733	2.33	-0.12	DRY	DRY	0.3	1733	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
BH06	Granite, weathered with clay bands	1727	9.02	-0.1	7.67	1719	-	-	6.99	1720	7.01	1720	8.33	1718	8.34	1718
BH07	Bog/Granitic Soil	1695	1.77	-0.09	DRY	DRY	0	1695	0.05	1695	0.57	1695	0.56	1695	0.6	1695
BH09	Granite (sandy clay / clayey sands)	1714	5.82	-0.1	2.72	1711	0.57	1713	1.98	1712	2.17	1712	2.58	1711	2.62	1711
BH10	Granite (EW-MW)	1712	8.825	-0.09	4.15	1708	2.61	1709	3.61	1708	3.63	1708	4.63	1707	4.64	1707
BH13	Colluvium (sand, cobbles)	1733	8.87	-0.09	5.32	1727	2.18	1730	4.52	1728	4.56	1728	3.98	1729	3.97	1729
BH14	Granite (EW-MW)	1733	19.35	-0.11	12.52	1720	13.17	1720	11.9	1721	11.91	1721	13.87	1719	13.9	1719
BH14A	Granite (EW) to soils	1733	14.98	-0.09	12.61	1720	13.6	1719	11.47	1721	11.51	1721	13.65	1719	13.69	1719
BH14B	Granitic Soils	1733	9.44	-0.09	9.03	1724	8.38	1725	7.42	1726	7.46	1726	8.56	1724	8.45	1725
BH15	Granitic Soils	1734	18.29	-0.11	13.06	1721	13.45	1721	12.85	1721	12.86	1721	13.45	1721	13.45	1721
BH15A	Colluvium	1734	5.5	-0.12	4.03	1730	1.75	1732	3.71	1730	3.74	1730	3.18	1731	3.2	1731
BH16	Clayey gravelly SAND and Silty GRAVEL	1715	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BH17	Clayey SAND	1707	-	-	-	-	-	-	-	-	-	-	-	-	3.97	1703
BH18	Clayey SAND	1711	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Alpine Resorts Victoria

Mount Buller HEMAMP
Manual Water Level Gaugings

Bore	Geology Sequence	RL NS (LiDAR)	Measured Bore Depth (m btoc)	Stick up (m bgl)	21/02/2015		17/04/2015		17/04/2015		22/10/2015		26/10/2015		7/04/2016	
					SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT
BH04	Carbonaceous Mudstone	1735	15.58	-0.1	-	-	7.42	1727	5.74	1729	5.74	1729	5.72	1729	8.05	1727
BH04A	Basalt (sandy clays, cobbles)	1735	2.38	-0.07	-	-	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
BH05	Granitic Soils	1733	19.67	-0.1	-	-	16.13	1717	13.05	1720	13.05	1720	13.83	1719	16.58	1716
BH05A	Colluvium (clayey sand, cobbles)	1733	2.33	-0.12	-	-	2.34	1731	0.55	1732	0.55	1732		0	2.23	1731
BH06	Granite, weathered with clay bands	1727	9.02	-0.1	8.38	1718	DRY	DRY	5.73	1721	5.73	1721	6.0 (est)	1721	DRY	DRY
BH07	Bog/Granitic Soil	1695	1.77	-0.09	0.678	1695	0.7	1695	0.4	1695	0.4	1695	0.56	1695	DRY	DRY
BH09	Granite (sandy clay / clayey sands)	1714	5.82	-0.1	2.725	1711	3.21	1711	1.2	1713	1.2	1713	1.75 (est)	1712	3.32	1711
BH10	Granite (EW-MW)	1712	8.825	-0.09	4.68	1707	5.37	1707	2.69	1709	2.69	1709	3.27 (est)	1709	5.63	1706
BH13	Colluvium (sand, cobbles)	1733	8.87	-0.09	-	-	5.65	1727	3.08	1730	3.08	1730	8.49	1724	6.93	1726
BH14	Granite (EW-MW)	1733	19.35	-0.11		1733	14.98	1718	10.34	1722	10.38	1722	10.66	1722	15.18	1718
BH14A	Granite (EW) to soils	1733	14.98	-0.09	-	-	14.83	1718	9.88	1723	9.88	1723	10.13	1723	DRY	DRY
BH14B	Granitic Soils	1733	9.44	-0.09	-	-	DRY	DRY	6.06	1727	6.06	1727	6.16	1727	DRY	DRY
BH15	Granitic Soils	1734	18.29	-0.11	-	-	14.15	1720	12.26	1722	12.26	1722	12.32	1722	14.57	1719
BH15A	Colluvium	1734	5.5	-0.12	-	-	4.08	1730	2.7	1731	2.7	1731	2.25	1732	3.85	1730
BH16	Clayey gravelly SAND and Silty GRAVEL	1715	-	-	0.44	1715	0.69	1714	+0.01	1715	0.00	1715	+0.02 (est) - artesian	1715	0.71	1714
BH17	Clayey SAND	1707	-	-	0.15	1707	0.42	1707	+0.08	1707	+0.08	1707	+0.02 (est) - artesian	1707	0.5	1707
BH18	Clayey SAND	1711	-	-	1.119	1710	1.75	1709	0.2	1711	0.2	1711	1.19	1710	0.53	1710

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Alpine Resorts Victoria

Mount Buller HEMAMP
Manual Water Level Gaugings

Bore	Geology Sequence	RL NS (LiDAR)	Measured Bore Depth (m btoc)	Stick up (m bgl)	7/12/2016		13/02/2018		4/06/2018		23/11/2021		16/02/2022		16/11/2022	
					SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT
BH04	Carbonaceous Mudstone	1735	15.58	-0.1	5.76	1729	7.11	1728	6.04	1729	NA	-	NA	-	6.21	
BH04A	Basalt (sandy clays, cobbles)	1735	2.38	-0.07	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	Inaccessible	-	1.96	
BH05	Granitic Soils	1733	19.67	-0.1	13.37	1720	15.92	1717	15.6	1717	N/A	-	NA	-	-	
BH05A	Colluvium (clayey sand, cobbles)	1733	2.33	-0.12	1.32	1732	DRY	DRY	0.5	1733	N/A	-	NA	-	-	
BH06	Granite, weathered with clay bands	1727	9.02	-0.1	6.19	1721	7.46	1719	8.5	1718	6.3	1720	8.36	1718	3.671	1723
BH07	Bog/Granitic Soil	1695	1.77	-0.09	0.55	DRY	0.76	DRY	0.45	1714	0.37	1695	NA	-	0.28	1695
BH09	Granite (sandy clay / clayey sands)	1714	5.82	-0.1	1.61	1712	2.36	1712	2.55	1712	Not found	-	NA	-	1.16	1713
BH10	Granite (EW-MW)	1712	8.825	-0.09	2.71	1709	3.99	1708	4.59	1707	2.64	1709	4.79	1707	1.76	1710
BH13	Colluvium (sand, cobbles)	1733	8.87	-0.09	3.53	1729	5.72	1727	2.9	1730	N/A	-	NA	-	N/A	
BH14	Granite (EW-MW)	1733	19.35	-0.11	10.3	1723	12.41	1720	14.66	1718	N/A	-	NA	-	N/A	
BH14A	Granite (EW) to soils	1733	14.98	-0.09	9.84	1723	11.9	1721	DRY	DRY	N/A	-	NA	-	N/A	
BH14B	Granitic Soils	1733	9.44	-0.09	6.18	1727	8.105	1725	DRY	DRY	N/A	-	NA	-	N/A	
BH15	Granitic Soils	1734	18.29	-0.11	11.53	1722	12.56	1721	13.49	1720	N/A	-	NA	-	N/A	
BH15A	Colluvium	1734	5.5	-0.12	2.98	1731	4.04	1730	2.72	1731	N/A	-	NA	-	N/A	
BH16	Clayey gravelly SAND and Silty GRAVEL	1715	-	-	0.02	1715	0.23	1715	0.4	1715	0	1715	0.4	1715	0	1715
BH17	Clayey SAND	1707	-	-	0.02	1707	0.05	1707	0.1	1707	Not found	-	0.1	1707	0.06	1707
BH18	Clayey SAND	1711	-	-	1.11	1710	1.75	1709	0.28	1711	2.02	1709	1.94	1709	0.33	1711

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Alpine Resorts Victoria

Mount Buller HEMAMP
Manual Water Level Gaugings

Bore	Geology Sequence	RL NS (LiDAR)	Measured Bore Depth (m btoc)	Stick up (m bgl)	16/02/2023		19/04/2023		15/11/2023		7/02/2024		10/04/2024	
					SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT	SWL (m btoc)	RLWT
BH04	Carbonaceous Mudstone	1735	15.58	-0.1	Inaccessible		Inaccessible	-	N/A	-	N/A	-	N/A	-
BH04A	Basalt (sandy clays, cobbles)	1735	2.38	-0.07	Inaccessible		Inaccessible	-	N/A	-	N/A	-	N/A	-
BH05	Granitic Soils	1733	19.67	-0.1	N/A		N/A	-	N/A	-	N/A	-	N/A	-
BH05A	Colluvium (clayey sand, cobbles)	1733	2.33	-0.12	N/A		N/A	-	N/A	-	N/A	-	N/A	-
BH06	Granite, weathered with clay bands	1727	9.02	-0.1	7.743	1719	8.205	1719	6.685	1720	7.068	1720	8.663	1718
BH07	Bog/Granitic Soil	1695	1.77	-0.09	0.76	1695	0.23	1695	0.532	1695	0.46	1695	0.6	1695
BH09	Granite (sandy clay / clayey sands)	1714	5.82	-0.1	3.723	1710	2.11	1712	2.277	1712	2.406	1712	2.82	1711
BH10	Granite (EW-MW)	1712	8.825	-0.09	4.362	1708	2.4	1710	2.545	1709	2.85	1709	4.395	1708
BH13	Colluvium (sand, cobbles)	1733	8.87	-0.09	N/A		N/A	-	N/A	-	N/A	-	N/A	-
BH14	Granite (EW-MW)	1733	19.35	-0.11	N/A		N/A	-	N/A	-	N/A	-	N/A	-
BH14A	Granite (EW) to soils	1733	14.98	-0.09	N/A		N/A	-	N/A	-	N/A	-	N/A	-
BH14B	Granitic Soils	1733	9.44	-0.09	N/A		N/A	-	N/A	-	N/A	-	N/A	-
BH15	Granitic Soils	1734	18.29	-0.11	N/A		N/A	-	N/A	-	N/A	-	N/A	-
BH15A	Colluvium	1734	5.5	-0.12	N/A		N/A	-	N/A	-	N/A	-	N/A	-
BH16	Clayey gravelly SAND and Silty GRAVEL	1715	-	-	0.24	1715	0.28	1715	0	1715	0.185	1715	0.452	1715
BH17	Clayey SAND	1707	-	-	0.2	1707	0.04	1707	0.07	1707	0.04	1707	0.125	1707
BH18	Clayey SAND	1711	-	-	1.705	1709	0.44	1711	0.972	1710	1.455	1710	0.34	1711

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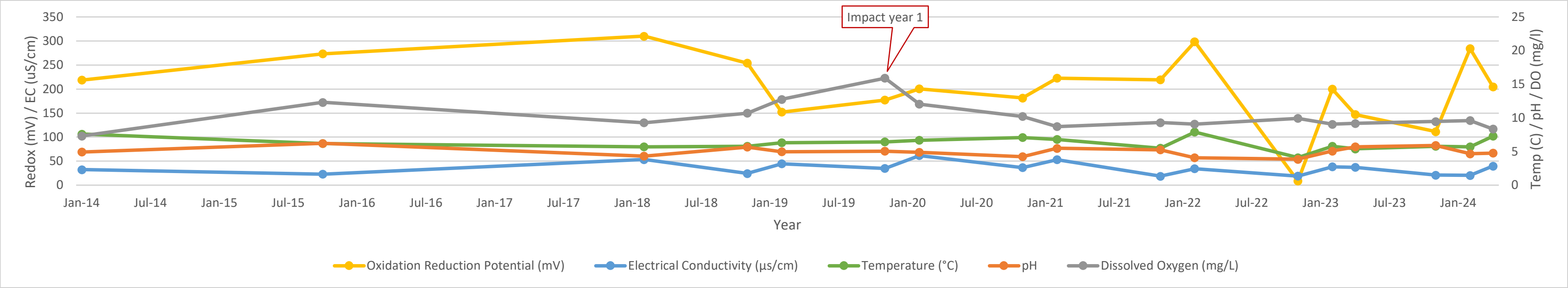
Appendix D

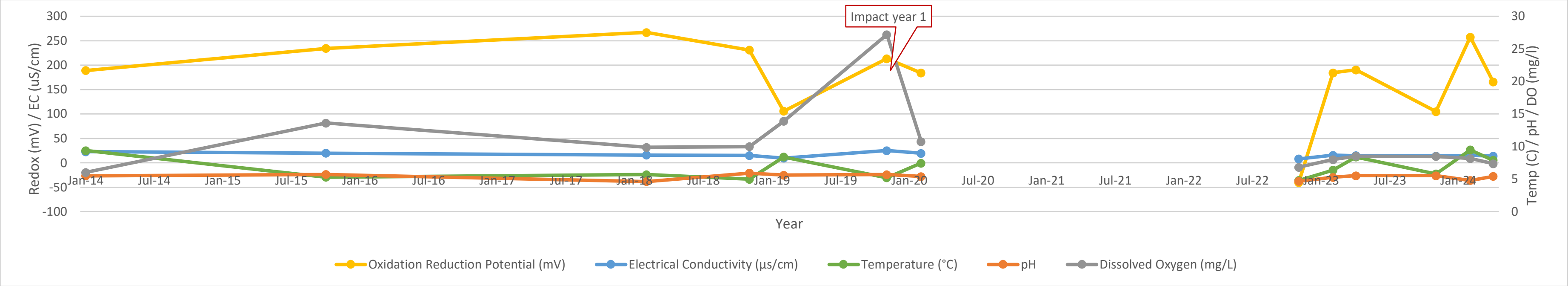
Field parameter data

Appendix D
Purging Field Parameters

	Baseline					Impact											
	Jan-14	Oct-15	Feb-18	Nov-18	Feb-19	Nov-19	Feb-20	Nov-20	Feb-21	Nov-21	Feb-22	Nov-22	Feb-23	Apr-23	Nov-23	Feb-24	Apr-24
BH06																	
Temperature (°C)	7.6	6.2	5.7	5.8	6.3	6.43	6.67	7.1	6.8	5.5	7.9	4.1	5.8	5.4	5.8	5.7	7.3
pH	4.92	6.2	4.32	5.65	4.97	5.04	4.9	4.24	5.48	5.26	4.09	3.85	5.07	5.7	5.9	4.67	4.77
Dissolved Oxygen (mg/L)	7.31	12.31	9.29	10.7	**12.76**	**15.9**	**12.05**	10.21	8.71	9.3	9.09	9.92	9.06	9.18	9.47	**9.6128**	8.36
Oxidation Reduction Potential (mV)	219	273.4	310	254	152	177.37	200.67	181.5	222.73	219.5	298.4	8.7	199.9	146.9	111.5	284.5	204.5
Electrical Conductivity (µs/cm)	32.3	23	53.3	24.4	44.4	34.97	61.63	36.53	53.23	18.5	34.2	19.1	38.2	37.2	20.9	20.4	39.7



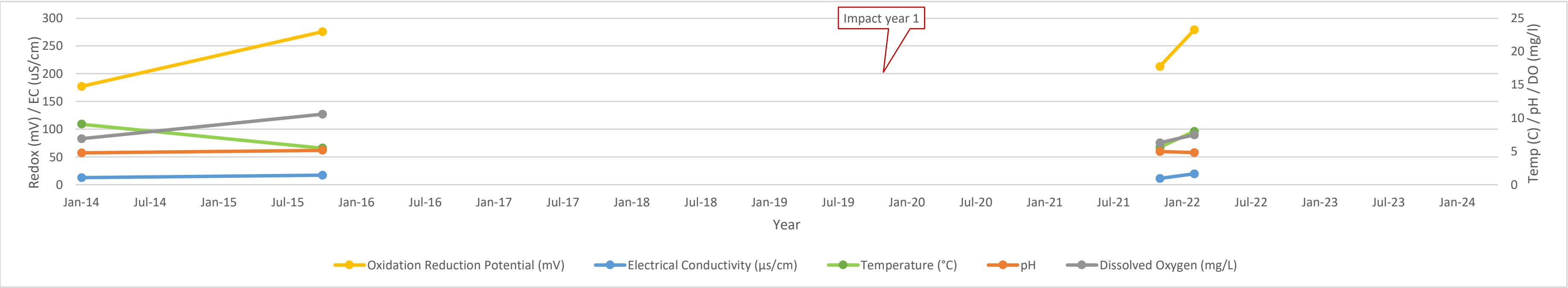
BH09																	
Temperature (°C)	9.4	5.3	5.7	5	8.4	5.23	7.47					4.8	6.4	8.4	5.8	9.5	7.9
pH	5.52	5.72	4.63	5.94	5.61	5.71	5.42					4.68	5.28	5.54	5.53	4.81	5.43
Dissolved Oxygen (mg/L)	6.03	13.62	9.89	10	**13.9**	**27.2**	10.78					6.83	8	8.53	8.49	**8.1699**	7.38
Oxidation Reduction Potential (mV)	189	234.3	267	231	106	213.33	184.2					-40.4	184.5	190.5	105.1	257.6	166
Electrical Conductivity (µs/cm)	23	20	16.1	15	9.8	25.07	19.47					8.2	15.8	14.8	14.1	15.2	14



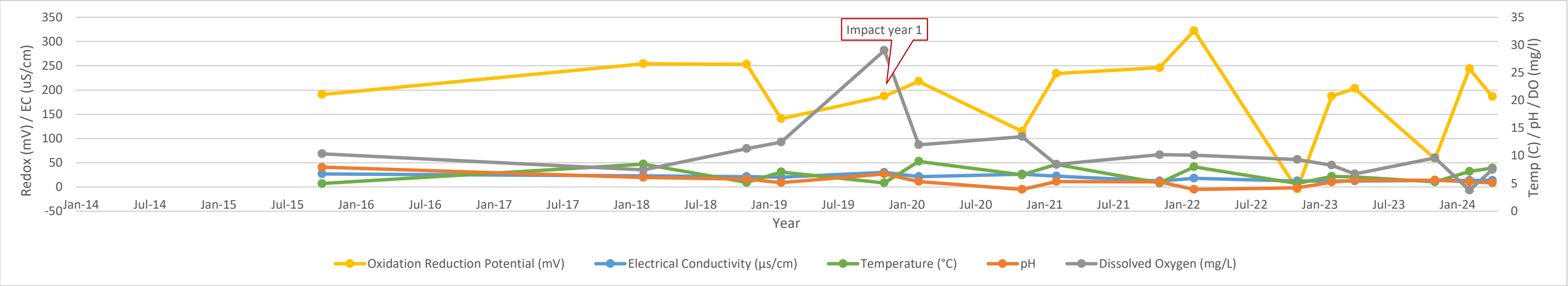
Note - Bold indicates value converted from ppm to mg/L

Appendix D
Purging Field Parameters

	Baseline					Impact											
	Jan-14	Oct-15	Feb-18	Nov-18	Feb-19	Nov-19	Feb-20	Nov-20	Feb-21	Nov-21	Feb-22	Nov-22	Feb-23	Apr-23	Nov-23	Feb-24	Apr-24
BH10																	
Temperature (°C)	9.1	5.5								5.6	8						
pH	4.79	5.18								5	4.81						
Dissolved Oxygen (mg/L)	6.91	10.59								6.3	7.48						
Oxidation Reduction Potential (mV)	177	275.5								212.7	278.9						
Electrical Conductivity (µs/cm)	12.6	17								11.5	19.6						



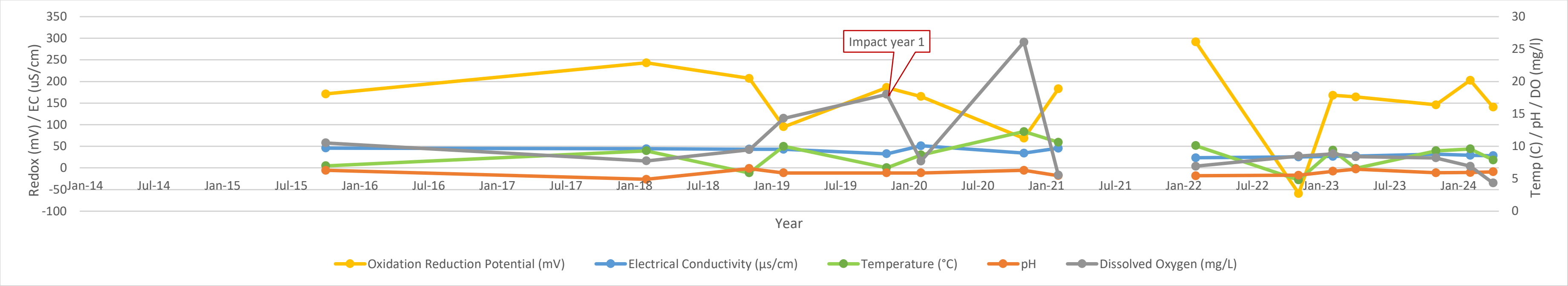
	Jan-14	Oct-15	Feb-18	Nov-18	Feb-19	Nov-19	Feb-20	Nov-20	Feb-21	Nov-21	Feb-22	Nov-22	Feb-23	Apr-23	Nov-23	Feb-24	Apr-24
BH16																	
Temperature (°C)		5	8.5	5.2	7.1	5.13	9	6.57	8.46	5.1	8	5	6.3	6.2	5.3	7.2	7.8
pH		7.93	6.09	5.83	5.19	6.73	5.38	3.95	5.37	5.3	3.96	4.24	5.26	5.63	5.6	5.33	5.12
Dissolved Oxygen (mg/L)		10.38	7.5	11.3	**12.5**	**29**	**12**	13.45	8.44	10.2	10.11	9.34	8.3	6.76	9.63	**3.7888**	7.53
Oxidation Reduction Potential (mV)		191	254	253	141	187.67	217.6	114.97	234.13	246	322.1	-4.5	187.5	203.1	58.3	244.3	186.5
Electrical Conductivity (µs/cm)		27	23.1	21.6	20.1	29.97	21.5	26.67	22.56	12.4	18.1	12.4	12.7	12.4	13.5	13.5	13.9



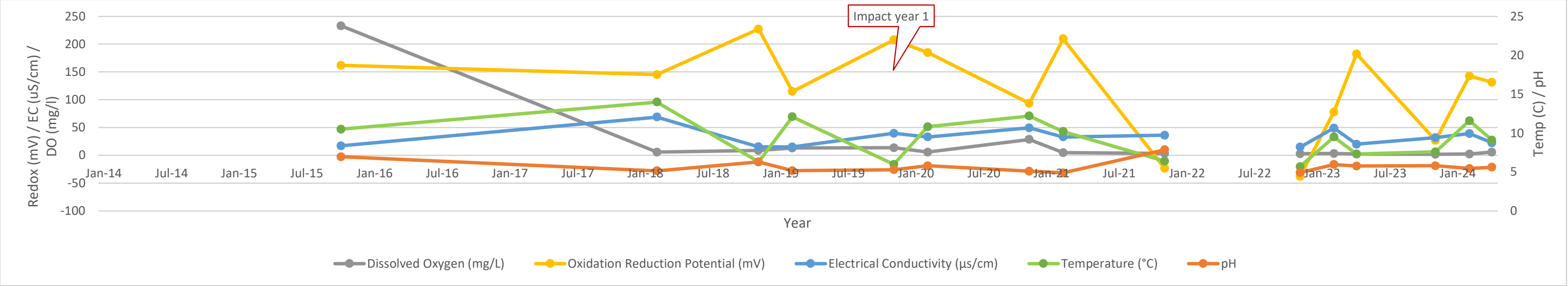
Note - Bold indicates value converted from ppm to mg/L

Appendix D
Purging Field Parameters

	Baseline					Impact											
	Jan-14	Oct-15	Feb-18	Nov-18	Feb-19	Nov-19	Feb-20	Nov-20	Feb-21	Nov-21	Feb-22	Nov-22	Feb-23	Apr-23	Nov-23	Feb-24	Apr-24
BH17																	
Temperature (°C)		7	9.3	5.9	10	6.7	8.67	12.27	10.63		10.1	4.8	9.4	6.6	9.3	9.6	7.9
pH		6.3	4.91	6.57	5.89	5.9	5.9	6.3	5.48		5.46	5.54	6.16	6.49	5.92	5.96	6.06
Dissolved Oxygen (mg/L)		10.52	7.76	9.47	**14.3**	**18**	7.73	26.06	5.58		6.93	8.5	8.85	8.41	8.22	**6.9269**	4.34
Oxidation Reduction Potential (mV)		171	243	207	95	186	165.07	68.67	182.86		291.5	-59	168.1	164.3	145.8	202.6	140.6
Electrical Conductivity (µs/cm)		46	44.4	43.3	43.1	32.7	51.3	34.23	45.46		23.6	25.3	26.8	27.6	31.8	29.1	28.1



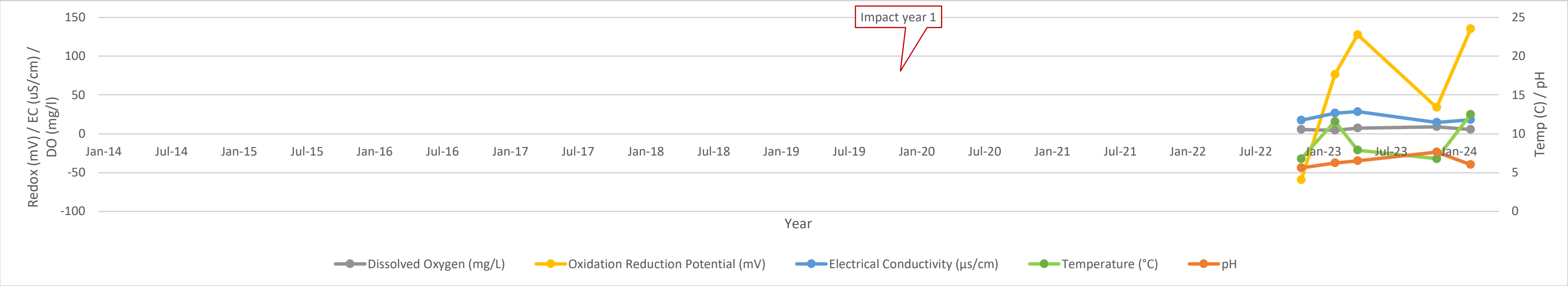
BH18																	
Temperature (°C)		10.5	14	6.3	12.1	5.97	10.83	12.2	10.2	6.4		5.7	9.5	7.3	7.6	11.6	9.1
pH		6.97	5.16	6.3	5.18	5.3	5.81	5.1	4.9	7.86		4.94	5.96	5.78	5.81	5.46	5.61
Dissolved Oxygen (mg/L)		233.1	5.99	**8.6**	**13.1**	**13.6**	5.76	28.6	4.97	3.51		2.7	3.32	2.38	1.82	**2.4747**	5.93
Oxidation Reduction Potential (mV)		161.9	145	227	115	207.67	184.9	93.7	209.7	-23.1		-37.8	77.9	182.6	26.8	142.8	131.4
Electrical Conductivity (µs/cm)		17	68.8	15.4	15.3	39.67	33.07	49.3	33	36.4		14.95	49	20.1	31.8	39.3	22.4



Note - Bold indicates value converted from ppm to mg/L

Appendix D
Purging Field Parameters

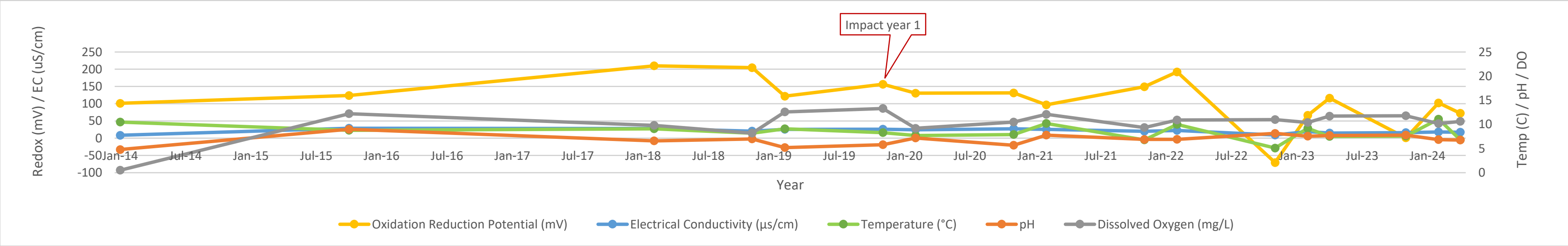
	Baseline					Impact											
	Jan-14	Oct-15	Feb-18	Nov-18	Feb-19	Nov-19	Feb-20	Nov-20	Feb-21	Nov-21	Feb-22	Nov-22	Feb-23	Apr-23	Nov-23	Feb-24	Apr-24
EWS West																	
Temperature (°C)												6.8	11.6	7.9	6.8	12.5	
pH												5.61	6.27	6.55	7.65	6.04	
Dissolved Oxygen (mg/L)												5.59	4.45	7.45	9.04	**5.7743**	
Oxidation Reduction Potential (mV)												-59.2	76.4	127.5	34.1	135.3	
Electrical Conductivity (µs/cm)												17.5	26.6	28.6	14.7	18.2	



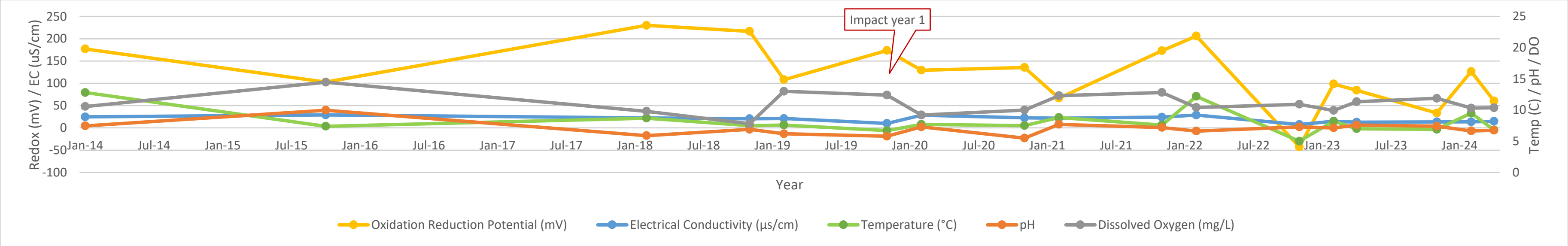
Note - Bold indicates value converted from ppm to mg/L

Appendix D
Surface Water
Field Parameters

	Baseline					Impact											
	Jan-14	Oct-15	Feb-18	Nov-18	Feb-19	Nov-19	Feb-20	Nov-20	Feb-21	Nov-21	Feb-22	Nov-22	Feb-23	Apr-23	Nov-23	Feb-24	Apr-24
Boggy Creek 1 p/u 1																	
Temperature (°C)	10.5	8.8	9.1	8.2	9.1	8.3	7.7	7.9	10.2	6.8	10	5.1	9.2	7.5	7.6	11.1	6.8
pH	4.79	9	6.6	7	5.2	5.8	7.2	5.7	7.8	6.9	6.92	8.15	7.57	7.7	7.8	6.86	6.78
Dissolved Oxygen (mg/L)	0.51	12.24	9.8	8.2	**12.6**	**13.3**	9.2	10.5	12.1	9.37	10.93	11	10.4	11.73	11.79	**10.1926**	10.64
Oxidation Reduction Potential (mV)	101	123.8	210	204.5	121.8	156.3	130.5	131.2	96.7	149	192	-70.8	66.3	116.2	1.3	102.2	72.4
Electrical Conductivity (µs/cm)	8.5	29	28.3	20.6	25.8	26.3	24.6	27.5	25.9	20.2	22.8	9.3	19.5	15.2	16.2	18.3	17.4



	Jan-14	Oct-15	Feb-18	Nov-18	Feb-19	Nov-19	Feb-20	Nov-20	Feb-21	Nov-21	Feb-22	Nov-22	Feb-23	Apr-23	Nov-23	Feb-24	Apr-24
Boggy Creek 1 p/u 2																	
Temperature (°C)	12.8	7.4	8.7	7.5	7.6	6.7	7.7	7.5	8.8	7.6	12.2	5	8.2	7	6.9	9.5	6.8
pH	7.47	9.97	5.9	6.9	6.2	5.8	7.3	5.5	7.7	7.2	6.62	7.3	7.14	7.59	7.41	6.65	6.76
Dissolved Oxygen (mg/L)	10.57	14.45	9.8	7.8	**13**	**12.4**	9.2	10	12.3	12.81	10.42	10.92	9.93	11.34	11.88	**10.3169**	10.36
Oxidation Reduction Potential (mV)	177	102.8	230	216.6	108.1	173.7	129.4	135.4	66.8	173	206	-42.6	98.6	84.4	33.3	126.4	60.2
Electrical Conductivity (µs/cm)	24.7	29	22.4	20.5	21	10.1	28.6	22.5	21.7	24.1	28.7	7.6	15	12.8	13.4	13.6	14.7

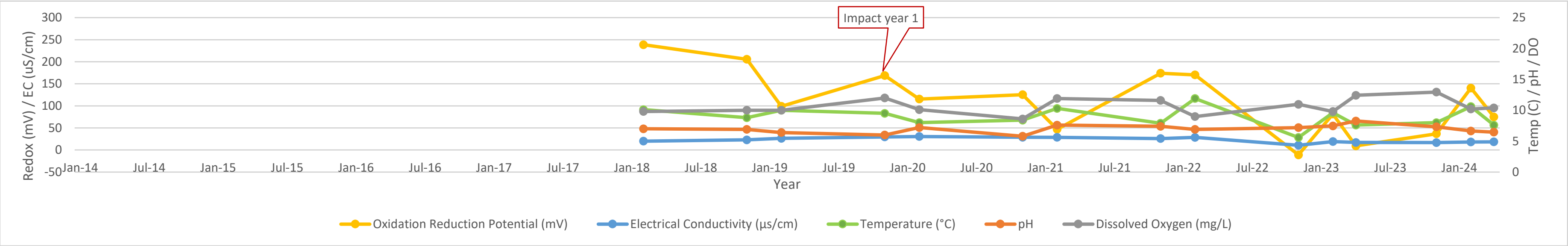


Note - Bold indicates value converted from ppm to mg/L

Appendix D
Surface Water
Field Parameters

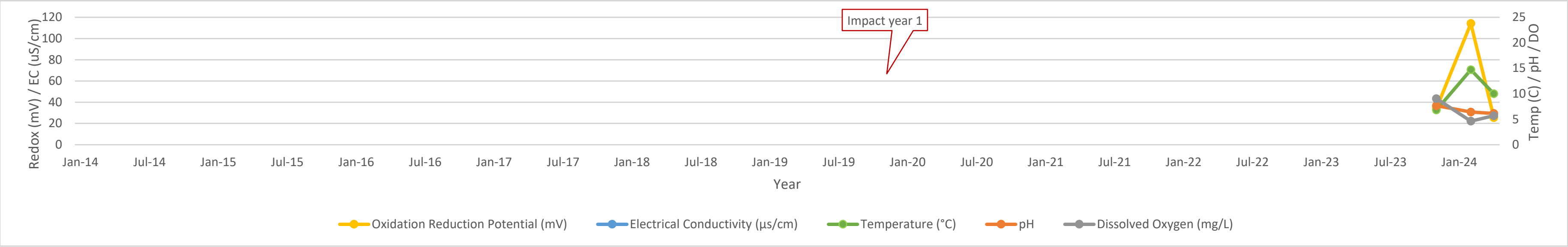
Boggy Creek 2

	Baseline					Impact											
	Jan-14	Oct-15	Feb-18	Nov-18	Feb-19	Nov-19	Feb-20	Nov-20	Feb-21	Nov-21	Feb-22	Nov-22	Feb-23	Apr-23	Nov-23	Feb-24	Apr-24
Temperature (°C)			10.1	8.8	10	9.5	8	8.4	10.3	7.9	11.9	5.6	9.6	7.6	8	10.6	7.6
pH			7	6.9	6.4	6	7.2	5.8	7.6	7.4	6.9	7.19	7.47	8.27	7.33	6.65	6.46
Dissolved Oxygen (mg/L)			9.8	10	**10**	**12**	10.1	8.6	11.9	11.6	8.99	10.97	9.8	12.43	12.94	**10.2039**	10.39
Oxidation Reduction Potential (mV)			238.6	205.5	99.1	168.7	115.4	125.4	47	174	170.2	-11.1	81.4	9.3	36.7	140.4	75
Electrical Conductivity (µs/cm)			20	23	26.4	29.6	30.6	28.9	28.7	25.9	28.5	10.8	19.1	17.1	16.8	18.2	18.5



EWS East

	Baseline					Impact											
	Jan-14	Oct-15	Feb-18	Nov-18	Feb-19	Nov-19	Feb-20	Nov-20	Feb-21	Nov-21	Feb-22	Nov-22	Feb-23	Apr-23	Nov-23	Feb-24	Apr-24
Temperature (°C)															6.8	14.7	10
pH															7.65	6.4	6.13
Dissolved Oxygen (mg/L)															9.04	**4.6206**	5.69
Oxidation Reduction Potential (mV)															34.1	114.2	25.5
Electrical Conductivity (µs/cm)															14.7	22.1	16.5



Note - Bold indicates value converted from ppm to mg/L

Appendix E

Laboratory results

Field ID				BH06												
Baseline/Impact Period				Baseline			Impact									
Date /Time				12 Feb 2014 03:00PM	27 Oct 2015	15 Feb 2018	25 Nov 2020	09 Feb 2021	23 Nov 2021	15 Feb 2022	17 Nov 2022 03:00PM	16 Feb 2023	19 Apr 2023 03:00PM	15 Nov 2023 03:00PM	06 Feb 2024 03:00PM	10 Apr 2024 03:00PM
Lab Report Number				EM1401293	477470	18-09444	870256	893814	933545	956224	EM2222893	23-14906	EM2306987	EM2320487	EM2401890	EM2405745
Sample Code				EM1401293004	M15-Oc20501	18-09444_5546157	6787594	6877651	7249146	7353389	EM2222893005	23-14906_8321066	EM2306987006	EM2320487001	EM2401890005	EM2405745009
	Unit	EQL	ANZG (2018) - FW - 99% (updated 26 July 2021)													
Field Parameters																
pH (Field)	pH units			-	-	4.980	-	-	-	-	-	-	-	-	-	-
NA																
Dissolved Oxygen	mg/L	0.1		-	-	-	-	-	-	-	10.4	-	-	-	-	-
Phosphorus reactive (as P)	mg/L	0.01		-	-	-	-	-	-	-	-	-	0.02	-	-	-
Inorganics																
pH (Lab)	pH units	0.01		7.05	5.6	-	4.1	6	5.26	4.09	6.02	-	5.07	5.78	-	-
pH Redox	pH units	0.01		-	-	-	-	-	-	-	5.79	-	-	-	-	-
Electrical conductivity (lab)	µS/cm	1		45	24	51	36.5	53.2	18.5	34.2	32	57	53	31	29	58
Dissolved Oxygen (Lab) (filtered)	mg/L			-	-	-	10.25	8.72	9.3	9.09	-	-	-	-	-	-
Redox (Lab)	mV	0.1		-	-	-	-	225.1	219.5	298.4	256	-	-	-	-	-
Temperature	°C			-	-	-	7.1	6.8	5.5	7.9	-	-	-	-	-	-
Turbidity	NTU	0.1		-	650	-	-	-	160	210	7.9	29	-	19.4	40.5	4.8
Total Dissolved Solids	mg/L	5		33	16	42	-	-	-	-	27	35	80	15	45	53
Total Dissolved Solids (filtered)	mg/L	5		-	-	-	12	36	15	38	-	-	-	-	-	-
Total Suspended Solids	mg/L	1		-	700	-	-	-	-	-	-	-		-	-	-
Acidity & Alkalinity																
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		4		2	-	-	-	-	2			3	3	2
Alkalinity (Bicarbonate)	mg/L	2		-	-	-	5	3	4		-	-	-	-	-	-
Alkalinity (total as CaCO3)	mg/L	1		4		-	-	-	-	-	2			3	3	2
Hardness as CaCO3	mg/L	1		-	-	-	-	-	-	-	-	-	14	-	-	-
Major Ions																
Calcium	mg/L	0.1		-	1.5	3.0	2.2	3.5	1.3	3.2	-	2.1	-	-	-	-
Calcium (filtered)	mg/L	0.1		1	-	-	-	-	-	-	2	-	4	2	2	3
Magnesium	mg/L	0.1		-	0.6	1.2	2.2	5.4	0.5	1.3	-	0.8	-	-	-	-
Magnesium (filtered)	mg/L	0.1			-	-	-	-	-	-		-	1			1
Potassium	mg/L	0.1		-	0.5	0.4	1.8	3.8	0.3	0.5	-	0.4	-	-	-	-
Sodium	mg/L	0.1		-	2.1	2.1	2.3	2.8	1.5	2.1	-	1.5	-	-	-	-
Sodium (filtered)	mg/L	0.1		4	-	-	-	-	-	-	2	-	2	2	2	2
Chloride	mg/L	1		2	1.3	2	1	2		2	1	2	2	1	1	2
Sulfate	mg/L	1		-	-		-	-	-	-	-		-	-	-	-
Sulfate (filtered)	mg/L	1			-	-	-	-	-	-		-	7			
Cations Total	meq/L	0.01		0.22	-	-	-	-	-	-	0.19	-	0.37	0.19	0.19	0.32
Anions Total	meq/L	0.01		0.14	-	-	-	-	-	-	0.07	-	0.20	0.09	0.09	0.10
Ionic Balance	%	0.01		-	-	-	-	-	-	-	-	-	-	-	-	-
Nutrients																
Ammonia as N	mg/L	0.01	0.32[#1]	-	-	-	-	-	-	-	-	-	0.04	-		0.28
Nitrate (as N)	mg/L	0.01	1[#2]	3.12	1.2	4.9	-	-	-	-	2.13	5.1	4.69	2.55	2.26	4.91
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		3.12	1.2	4.9	1.9	5.1	1.2	5.6	2.13	5.1	4.69	2.55	2.26	4.91
Nitrogen (Total)	mg/L	0.1		-	1.4	5.3	2.3	5.4	1.4	6.2	2.9	5.7	5.3	2.8	2.5	5.3
Kjeldahl Nitrogen Total	mg/L	0.1		-		0.5	0.4	0.3	0.2	0.6	0.8	0.6	0.6	0.2	0.2	0.4
Nitrate (as NO3-)	mg/L			-	-	-	1.9	5.1	1.2	5.6	-	-	-	-	-	-
Phosphate total (P)	mg/L	0.05		-	0.49	-	-	-	-	-	-	-	-	-	-	-
Phosphorus (Total)	mg/L	0.01		-	-					0.2			0.03	0.02	0.08	
Metals																
Copper (filtered)	mg/L	0.001	0.001	-		-	-	-	-	-	-	-	0.013	-	-	-
Iron (filtered)	mg/L	0.05			-	-	-	-	-	-	-	-	-	-	-	-
Nickel (filtered)	mg/L	0.001	0.008	-	0.001	-	-	-	-	-	-	-		-	-	-
Zinc (filtered)	mg/L	0.001	0.0024	-	0.003	-	-	-	-	-	-	-	0.010	-	-	-

Comments
#1 Measured as NH3-N at pH 8
#2 Values taken from "Updating nitrate toxicity effects on freshwater aquatic species, 2013"
#3 Trigger corrected Sep 2002 - https://www.mfe.govt.nz/sites/default/files/anzecc-nitrate-correction-sep02.pdf

Environmental Standards
Department of Agriculture and Water Resources, 2018 updated July 2021, ANZG (2018) - FW - 95% (updated 26 July 2021)
Department of Agriculture and Water Resources, 2018 updated July 2021, ANZG (2018) - FW - 99% (updated 26 July 2021)

Statistics
*** A Non Detect Multiplier of 0.5 has been applied.**

Appendix E Table 1 Analytical Results

Field ID				BH09									
Baseline/Impact Period				Baseline				Impact					
Date /Time				12 Feb 2014 03:00PM	27 Oct 2015	27 Oct 2015	14 Feb 2018	16 Nov 2022 03:00PM	16 Feb 2023	19 Apr 2023 03:00PM	15 Nov 2023 03:00PM	06 Feb 2024 03:00PM	10 Apr 2024 03:00PM
Lab Report Number				EM1401293	477470	479595	18-09453	EM2222893	23-14906	EM2306987	EM2320487	EM2401890	EM2405745
Sample Code				EM1401293005	M15-Oc20500	M15-No11471	18-09453_5546205	EM2222893006	23-14906_8321067	EM2306987007	EM2320487002	EM2401890006	EM2405745007
	Unit	EQL	ANZG (2018) - FW - 99% (updated 26 July 2021)										
Field Parameters													
pH (Field)	pH units			-	-	-	5.693	-	-	-	-	-	-
NA													
Dissolved Oxygen	mg/L	0.1		-	-	-	-	10.1	-	-	-	-	-
Phosphorus reactive (as P)	mg/L	0.01		-	-	-	-	-	-	0.01	-	-	-
Inorganics													
pH (Lab)	pH units	0.01		7.15	6	-	-	6.22	-	5.94	5.58	-	-
pH Redox	pH units	0.01		-	-	-	-	5.90	-	-	-	-	-
Electrical conductivity (lab)	µS/cm	1		34	-	19	16	14	23	20	18	19	21
Dissolved Oxygen (Lab) (filtered)	mg/L			-	-	-	-	-	-	-	-	-	-
Redox (Lab)	mV	0.1		-	-	-	-	2,600	-	-	-	-	-
Temperature	°C			-	-	-	-	-	-	-	-	-	-
Turbidity	NTU	0.1		-	-	-	-	4.8	53	-	5.3	12.0	39.5
Total Dissolved Solids	mg/L	5		30	-	12	12	11	12	44		72	27
Total Dissolved Solids (filtered)	mg/L	5		-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	mg/L	1		-	-	-	-	-	-	39	-	-	-
Acidity & Alkalinity													
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		11	-		4	3	4	3	2	5	6
Alkalinity (Bicarbonate)	mg/L	2		-	-	-	-	-	-	-	-	-	-
Alkalinity (total as CaCO3)	mg/L	1		11			-	3	4	3	2	5	6
Hardness as CaCO3	mg/L	1		-	-	-	-	-	-	2	-	-	-
Major Ions													
Calcium	mg/L	0.1		-	-	1.3	0.7	-	0.9	-	-	-	-
Calcium (filtered)	mg/L	0.1		1	-	-	-		-	1	1	1	1
Magnesium	mg/L	0.1		-	-		0.3	-	0.4	-	-	-	-
Magnesium (filtered)	mg/L	0.1			-	-	-		-				
Potassium	mg/L	0.1		-	-		0.1	-	0.1	-	-	-	-
Sodium	mg/L	0.1		-	-	1.4	1.2	-	0.8	-	-	-	-
Sodium (filtered)	mg/L	0.1		5	-	-	-		-	1	1	1	1
Chloride	mg/L	1		2	-		1		1	1	1	1	1
Sulfate	mg/L	1		-	-	-		-		-	-	-	-
Sulfate (filtered)	mg/L	1		1	-	-	-	1	-		1		
Cations Total	meq/L	0.01		0.27	-	-	-		-	0.09	0.09	0.09	0.09
Anions Total	meq/L	0.01		0.3	-	-	-	0.08	-	0.09	0.09	0.13	0.15
Ionic Balance	%	0.01		-	-	-	-	-	-	-	-	-	-
Nutrients													
Ammonia as N	mg/L	0.01	0.32[#1]	-	-	-	-	-	-		-		0.04
Nitrate (as N)	mg/L	0.01	1[#2]	0.27	-	0.57	0.50	0.23	0.84	0.84	0.65	0.54	0.56
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		0.27	-	0.57	0.51	0.23	0.84	0.84	0.65	0.54	0.56
Nitrogen (Total)	mg/L	0.1		-	-	-	0.7	0.4	1.0	0.9	0.8	0.5	0.6
Kjeldahl Nitrogen Total	mg/L	0.1		-	-	-	0.2	0.2	0.2	0.1	0.1		
Nitrate (as NO3-)	mg/L			-	-	-	-	-	-	-	-	-	-
Phosphate total (P)	mg/L	0.05		-	-		-	-	-	-	-	-	-
Phosphorus (Total)	mg/L	0.01		-	-	-	0.07		0.05	0.04	0.02		0.03
Metals													
Copper (filtered)	mg/L	0.001	0.001	-	0.001	-	-	-	-		-	-	-
Iron (filtered)	mg/L	0.05		0.43	-		-	-	-	-	-	-	-
Nickel (filtered)	mg/L	0.001	0.008	-		-	-	-	-		-	-	-
Zinc (filtered)	mg/L	0.001	0.0024	-	0.005	-	-	-	-		-	-	-

Appendix E Table 1 Analytical Results

			Field ID	BH16											
			Baseline/Impact Period	Baseline		Impact									
			Date /Time	27 Oct 2015	15 Feb 2018	25 Nov 2020	09 Feb 2021	23 Nov 2021	15 Feb 2022	17 Nov 2022 03:00PM	16 Feb 2023	19 Apr 2023 03:00PM	15 Nov 2023 03:00PM	07 Feb 2024 03:00PM	10 Apr 2024 03:00PM
			Lab Report Number	477470	18-09455	870535	893780	933560	956224	EM2222893	23-14906	EM2306987	EM2320487	EM2401890	EM2405745
			Sample Code	M15-Oc20497	18-09455_5546208	6787665	6877669	7249186	7353388	EM2222893007	23-14906_8321068	EM2306987008	EM2320487003	EM2401890007	EM2405745010
	Unit	EQL	ANZG (2018) - FW - 99% (updated 26 July 2021)												
Field Parameters															
pH (Field)	pH units			-	6.09	-	-	-	-	-	-	-	-	-	-
NA															
Dissolved Oxygen	mg/L	0.1		-	-	-	-	-	-	10.2	-	-	-	-	-
Phosphorus reactive (as P)	mg/L	0.01		-	-	-	-	-	-	-	-	0.01	-	-	-
Inorganics															
pH (Lab)	pH units	0.01		5.8	-	3.9	5.4	5.3	3.96	6.48	-	6.00	5.78	-	-
pH Redox	pH units	0.01		-	-	-	-	-	-	5.83	-	-	-	-	-
Electrical conductivity (lab)	µS/cm	1		21	21	26.6	22.6	24.6	18.1	22	18	17	17	17	19
Dissolved Oxygen (Lab) (filtered)	mg/L			-	-	13.54	8.4	10.2	10.11	-	-	-	-	-	-
Redox (Lab)	mV	0.1		-	-	-	232.2	246	322.1	270	-	-	-	-	-
Temperature	°C			-	-	6.4	8.5	5.1	8	-	-	-	-	-	-
Turbidity	NTU	0.1		5.8	-	-	-	130	1,200	20.1	36	-	23.7	158	89.8
Total Dissolved Solids	mg/L	5		14	15	-	-	-	-	26	10	42		66	25
Total Dissolved Solids (filtered)	mg/L	5		-	-	15	11	12	12	-	-	-	-	-	-
Total Suspended Solids	mg/L	1		2.7	-	-	-	-	-	-	-	61	-	-	-
Acidity & Alkalinity															
Alkalinity (Bicarbonate as CaCO3)	mg/L	1			5	-	-	-	-	6	3	3	2	4	4
Alkalinity (Bicarbonate)	mg/L	2		-	-	6	6	4	4	-	-	-	-	-	-
Alkalinity (total as CaCO3)	mg/L	1			-	-	-	-	-	6	3	3	2	4	4
Hardness as CaCO3	mg/L	1		-	-	-	-	-	-	-	-		-	-	-
Major Ions															
Calcium	mg/L	0.1		1.4	0.8	3.1	1.9	0.9	0.8	-	0.5	-	-	-	-
Calcium (filtered)	mg/L	0.1		-	-	-	-	-	-	1	-		1		
Magnesium	mg/L	0.1			0.3	9.3	4.8	0.2	0.2	-	0.2	-	-	-	-
Magnesium (filtered)	mg/L	0.1		-	-	-	-	-	-		-				
Potassium	mg/L	0.1			0.1	2.6	1.5	0.2	0.1	-		-	-	-	-
Sodium	mg/L	0.1		1.9	1.6	2.8	2.2	2.1	1.6	-	1.3	-	-	-	-
Sodium (filtered)	mg/L	0.1		-	-	-	-	-	-	2	-	2	2	2	2
Chloride	mg/L	1		1.1	1	1	2	1	1	1	1	1	1	1	1
Sulfate	mg/L	1		-		-	-	-	-	-		-	-	-	-
Sulfate (filtered)	mg/L	1		-	-	-	-	-	-		-				
Cations Total	meq/L	0.01		-	-	-	-	-	-	0.14	-	0.09	0.14	0.09	0.09
Anions Total	meq/L	0.01		-	-	-	-	-	-	0.15	-	0.09	0.07	0.11	0.11
Ionic Balance	%	0.01		-	-	-	-	-	-	-	-	0.66	-	-	-
Nutrients															
Ammonia as N	mg/L	0.01	0.32$^{\#1}$	-	-	-	-	-	-	-	-	0.10	-		
Nitrate (as N)	mg/L	0.01	1$^{\#2}$	1.1	0.83	-	-	-	-	0.84	0.72	0.74	0.92	0.89	0.92
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		1.1	0.84	0.98	0.81	0.84	0.7	0.84	0.73	0.74	0.92	0.89	0.92
Nitrogen (Total)	mg/L	0.1		1.2	1.1	1.5	1.2	0.8	2.1	1.1	0.7	0.9	0.9	1.5	1.1
Kjeldahl Nitrogen Total	mg/L	0.1			0.3	0.5	0.3		1.5	0.3		0.2		0.6	0.2
Nitrate (as NO3-)	mg/L			-	-	0.97	0.8	0.83	0.7	-	-	-	-	-	-
Phosphate total (P)	mg/L	0.05			-	-	-	-	-	-	-	-	-	-	-
Phosphorus (Total)	mg/L	0.01		-			0.06		3.6		0.07	0.08	0.03	0.38	0.19
Metals															
Copper (filtered)	mg/L	0.001	0.001		-	-	-	-	-	-	-	0.010	-	-	-
Iron (filtered)	mg/L	0.05		-	-	-	-	-	-	-	-	-	-	-	-
Nickel (filtered)	mg/L	0.001	0.008		-	-	-	-	-	-	-		-	-	-
Zinc (filtered)	mg/L	0.001	0.0024	0.006	-	-	-	-	-	-	-	0.005	-	-	-

Appendix E Table 1 Analytical Results

			Field ID	BH17											
			Baseline/Impact Period	Baseline			Impact								
			Date /Time	27 Oct 2015	27 Oct 2015	14 Feb 2018	25 Nov 2020	09 Feb 2021	15 Feb 2022	16 Nov 2022 03:00PM	16 Feb 2023	19 Apr 2023 03:00PM	15 Nov 2023 03:00PM	07 Feb 2024 03:00PM	10 Apr 2024 03:00PM
			Lab Report Number	477470	479595	18-09454	870535	893780	956224	EM2222893	23-14906	EM2306987	EM2320487	EM2401890	EM2405745
			Sample Code	M15-Oc20499	M15-No11470	18-09454_5546207	6787666	6877670	7353387	EM2222893008	23-14906_8321069	EM2306987009	EM2320487004	EM2401890008	EM2405745008
	Unit	EQL	ANZG (2018) - FW - 99% (updated 26 July 2021)												
Field Parameters															
pH (Field)	pH units			-	-	4.91	-	-	-	-	-	-	-	-	-
NA															
Dissolved Oxygen	mg/L	0.1		-	-	-	-	-	-	9.7	-	-	-	-	-
Phosphorus reactive (as P)	mg/L	0.01		-	-	-	-	-	-	-	-	0.02	-	-	-
Inorganics															
pH (Lab)	pH units	0.01		6.4	-	-	7.64	5.48	5.46	6.79	-	6.36	6.13	-	-
pH Redox	pH units	0.01		-	-	-	-	-	-	6.70	-	-	-	-	-
Electrical conductivity (lab)	µS/cm	1		-	46	43	33.3	45.5	23.6	45	44	40	38	38	42
Dissolved Oxygen (Lab) (filtered)	mg/L			-	-	-	25.78	5.56	6.93	-	-	-	-	-	-
Redox (Lab)	mV	0.1		-	-	-	-	181.7	291.5	272	-	-	-	-	-
Temperature	°C			-	-	-	12.2	10.6	10.1	-	-	-	-	-	-
Turbidity	NTU	0.1		-	-	-	-	-	340	140	21	-	3.0	16.3	33.5
Total Dissolved Solids	mg/L	5		-	30	30	-	-	-	44	22	52	20	59	55
Total Dissolved Solids (filtered)	mg/L	5		-	-	-	30	34	32	-	-	-	-	-	-
Total Suspended Solids	mg/L	1		-	-	-	-	-	-	-	-	88	-	-	-
Acidity & Alkalinity															
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		-		15	-	-	-	15	16	26	13	16	18
Alkalinity (Bicarbonate)	mg/L	2		-	-	-	20	20	21	-	-	-	-	-	-
Alkalinity (total as CaCO3)	mg/L	1				-	-	-	-	15	16	26	13	16	18
Hardness as CaCO3	mg/L	1		-	-	-	-	-	-	-	-	7	-	-	-
Major Ions															
Calcium	mg/L	0.1		-	3.2	2.3	3.8	3	2.5	-	3.1	-	-	-	-
Calcium (filtered)	mg/L	0.1		-	-	-	-	-	-	3	-	3	3	4	3
Magnesium	mg/L	0.1		-	0.9	0.8	1.7	1.3	0.9	-	1.1	-	-	-	-
Magnesium (filtered)	mg/L	0.1		-	-	-	-	-	-	1	-		1	1	1
Potassium	mg/L	0.1		-		0.3	1.3	0.8	0.3	-	0.5	-	-	-	-
Sodium	mg/L	0.1		-	3.2	2.8	4.3	3.6	3.1	-	3.8	-	-	-	-
Sodium (filtered)	mg/L	0.1		-	-	-	-	-	-	4	-	4	4	4	4
Chloride	mg/L	1		-	1.0	1	2	1	1	1	2	1	1	1	2
Sulfate	mg/L	1		-	-		-	-	-	-		-	-	-	-
Sulfate (filtered)	mg/L	1		-	-	-	-	-	-		-				
Cations Total	meq/L	0.01		-	-	-	-	-	-	0.40	-	0.32	0.40	0.46	0.40
Anions Total	meq/L	0.01		-	-	-	-	-	-	0.33	-	0.55	0.29	0.35	0.42
Ionic Balance	%	0.01		-	-	-	-	-	-	-	-	-	-	-	-
Nutrients															
Ammonia as N	mg/L	0.01	0.32$^{\#1}$	-	-	-	-	-	-	-	-	0.16	-		0.03
Nitrate (as N)	mg/L	0.01	1$^{\#2}$	-	1.1	1.2	-	-	-	1.11	0.64	0.55		0.52	0.32
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		-	1.1	1.2	1.1	0.9	0.46	1.11	0.65	0.55		0.52	0.32
Nitrogen (Total)	mg/L	0.1		-	-	1.5	2	1.1	1	1.4	0.8	0.8		0.8	0.3
Kjeldahl Nitrogen Total	mg/L	0.1		-	-	0.3	0.8	0.2	0.5	0.3	0.1	0.2		0.3	
Nitrate (as NO3-)	mg/L			-	-	-	1.1	0.9	0.46	-	-	-	-	-	-
Phosphate total (P)	mg/L	0.05		-		-	-	-	-	-	-	-	-	-	-
Phosphorus (Total)	mg/L	0.01		-	-	0.05		0.06	0.51	0.05	0.10	0.13	0.03	0.10	0.02
Metals															
Copper (filtered)	mg/L	0.001	0.001		-	-	-	-	-	-	-	0.003	-	-	-
Iron (filtered)	mg/L	0.05		-		-	-	-	-	-	-	-	-	-	-
Nickel (filtered)	mg/L	0.001	0.008	0.001	-	-	-	-	-	-	-		-	-	-
Zinc (filtered)	mg/L	0.001	0.0024	0.004	-	-	-	-	-	-	-	0.006	-	-	-

Field ID				BH18											
Baseline/Impact Period				Basline			Impact								
Date /Time				27 Oct 2015	27 Oct 2015	15 Feb 2018	25 Nov 2020	09 Feb 2021	23 Nov 2021	16 Nov 2022 03:00PM	16 Feb 2023	19 Apr 2023 03:00PM	15 Nov 2023 03:00PM	07 Feb 2024 03:00PM	09 Apr 2024 03:00PM
Lab Report Number				477470	479595	18-09462	870535	893780	933560	EM2222893	23-14906	EM2306987	EM2320487	EM2401890	EM2405745
Sample Code				M15-Oc20513	M15-No11484	18-09462_5546351	6787667	6877671	7249188	EM2222893009	23-14906_8321070	EM2306987010	EM2320487005	EM2401890009	EM2405745006
	Unit	EQL	ANZG (2018) - FW - 99% (updated 26 July 2021)												
Field Parameters															
pH (Field)	pH units			-	-	-	-	-	-	-	-	-	-	-	-
NA															
Dissolved Oxygen	mg/L	0.1		-	-	-	-	-	-	9.3	-	-	-	-	-
Phosphorus reactive (as P)	mg/L	0.01		-	-	-	-	-	-	-	-	0.02	-	-	-
Inorganics															
pH (Lab)	pH units	0.01		5.9	-	-	5.1	4.85	7.86	6.49	-	6.22	6.15	-	-
pH Redox	pH units	0.01		-	-	-	-	-	-	5.95	-	-	-	-	-
Electrical conductivity (lab)	µS/cm	1		29	-	25	49.3	33.3	36.4	25	38	29	41	46	33
Dissolved Oxygen (Lab) (filtered)	mg/L			-	-	-	28.32	5.12	3.51	-	-	-	-	-	-
Redox (Lab)	mV	0.1		-	-	-	-	211.5	-23.1	279	-	-	-	-	-
Temperature	°C			-	-	-	12.1	10.2	6.4	-	-	-	-	-	-
Turbidity	NTU	0.1		120	-	-	-	-	2,500	36.3	190	-	55.8	51.7	476
Total Dissolved Solids	mg/L	5		19	-	18	-	-	-	25	22	42	25	50	70
Total Dissolved Solids (filtered)	mg/L	5		-	-	-	20	21	20	-	-	-	-	-	-
Total Suspended Solids	mg/L	1		120	-	-	-	-	-	-	-	119	-	-	-
Acidity & Alkalinity															
Alkalinity (Bicarbonate as CaCO3)	mg/L	1			-	12	-	-	-	9	16	13	14	20	12
Alkalinity (Bicarbonate)	mg/L	2		-	-	-	18	15	13	-	-	-	-	-	-
Alkalinity (total as CaCO3)	mg/L	1			-	-	-	-	-	9	16	13	14	20	12
Hardness as CaCO3	mg/L	1		-	-	-	-	-	-	-	-	5	-	-	-
Major Ions															
Calcium	mg/L	0.1		1.8	-	1.5	7	3.6	5.3	-	1.6	-	-	-	-
Calcium (filtered)	mg/L	0.1		-	-	-	-	-	-	2	-	2	4	4	2
Magnesium	mg/L	0.1		0.6	-	0.5	10	3.6	9.6	-	0.6	-	-	-	-
Magnesium (filtered)	mg/L	0.1		-	-	-	-	-	-		-		1	1	
Potassium	mg/L	0.1			-	0.1	4.8	2.2	3.6	-	0.2	-	-	-	-
Sodium	mg/L	0.1		3.9	-	3.2	4.8	3.3	3.4	-	2.4	-	-	-	-
Sodium (filtered)	mg/L	0.1		-	-	-	-	-	-	2	-	2	4	4	3
Chloride	mg/L	1		1.9	-	1	2	2	2	1	2	1	2	1	2
Sulfate	mg/L	1		-	-	1	-	-	-	-		-	-	-	-
Sulfate (filtered)	mg/L	1		-	-	-	-	-	-		-				
Cations Total	meq/L	0.01		-	-	-	-	-	-	0.19	-	0.19	0.46	0.46	0.23
Anions Total	meq/L	0.01		-	-	-	-	-	-	0.21	-	0.29	0.34	0.43	0.30
Ionic Balance	%	0.01		-	-	-	-	-	-	-	-	-	-	-	-
Nutrients															
Ammonia as N	mg/L	0.01	0.32#1	-	-	-	-	-	-	-	-	0.19	-	0.01	
Nitrate (as N)	mg/L	0.01	1#2		-	0.06	-	-	-		0.01		0.84		0.06
Nitrogen (Total Oxidised) (as N)	mg/L	0.01			-	0.06	0.02	0.01			0.02		0.84		0.06
Nitrogen (Total)	mg/L	0.1			-	1.1	0.8	0.3	0.5	0.3	0.2	0.3	1.0	0.4	1.0
Kjeldahl Nitrogen Total	mg/L	0.1			-	1.1	0.8	0.3	0.5	0.3	0.2	0.3	0.2	0.4	0.9
Nitrate (as NO3-)	mg/L			-	-	-		0.01		-	-	-	-	-	-
Phosphate total (P)	mg/L	0.05		0.1	-	-	-	-	-	-	-	-	-	-	-
Phosphorus (Total)	mg/L	0.01		-	-	0.63	0.15	0.07	0.1	0.02	0.06	0.16	0.04	0.25	0.51
Metals															
Copper (filtered)	mg/L	0.001	0.001	0.12	-	-	-	-	-	-	-	0.012	-	-	-
Iron (filtered)	mg/L	0.05		-	0.08	-	-	-	-	-	-	-	-	-	-
Nickel (filtered)	mg/L	0.001	0.008	0.005	-	-	-	-	-	-	-		-	-	-
Zinc (filtered)	mg/L	0.001	0.0024	0.003	-	-	-	-	-	-	-		-	-	-

			Field ID	Boggy 1 p/u 1										
			Baseline/Impact Period	Baseline				Impact						
			Date /Time	15 Feb 2023	13 Feb 2014 03:00PM	26 Oct 2015	14 Feb 2018	25 Nov 2020	09 Feb 2021	23 Nov 2021	15 Feb 2022	14 Nov 2023 03:00PM	06 Feb 2024 03:00PM	09 Apr 2024 03:00PM
			Lab Report Number	23-14906	EM1401293	477470	18-09219	870279	893808	933587	956223	EM2320487	EM2401890	EM2405745
			Sample Code	23-14906_8320917	EM1401293015	M15-Oc20494	18-09219_5544481	6787599	6877707	7252501	7353374	EM2320487009	EM2401890001	EM2405745001
	Unit	EQL	ANZG (2018) - FW - 99% (updated 26 July 2021)											
Field Parameters														
pH (Field)	pH units			-	-	-	7.184	-	-	-	-	-	-	-
NA														
Dissolved Oxygen	mg/L	0.1		-	-	-	-	-	-	-	-	-	-	-
Phosphorus reactive (as P)	mg/L	0.01		-	-	-	-	-	-	-	-	-	-	-
Inorganics														
pH (Lab)	pH units	0.01		-	6.42	6.8	-	5.74	7.78	6.9	6.92	6.12	-	-
pH Redox	pH units	0.01		-	-	-	-	-	-	-	-	-	-	-
Electrical conductivity (lab)	µS/cm	1		27	28	21	26	27.5	25.9	20.2	22.8	19	22	30
Dissolved Oxygen (Lab) (filtered)	mg/L			-	-	-	-	10.51	12.05	9.37	10.93	-	-	-
Redox (Lab)	mV	0.1		-	-	-	-	-	97.5	149	192	-	-	-
Temperature	°C			-	-	-	-	7.9	10.2	6.8	10	-	-	-
Turbidity	NTU	0.1		0.3	-	1.8	0.8	0.5	0.4	0.2	0.3	1.7	1.6	2.0
Total Dissolved Solids	mg/L	5		15	15	14	22	-	-	-	-	23	54	44
Total Dissolved Solids (filtered)	mg/L	5		-	-	-	-	12	14	12	8	-	-	-
Total Suspended Solids	mg/L	1		-	-	4.7						-	-	-
Acidity & Alkalinity														
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		9	12		-	-	-	-	-	7	11	13
Alkalinity (Bicarbonate)	mg/L	2		-	-	-	15	13	13	12	37	-	-	-
Alkalinity (total as CaCO3)	mg/L	1		9	12		-	-	-	-	-	7	11	13
Hardness as CaCO3	mg/L	1		-	-	-	-	-	-	-	-	-	-	-
Major Ions														
Calcium	mg/L	0.1		1.9	-	1.4	2.0	1.6	1.8	0.9	1.4	-	-	-
Calcium (filtered)	mg/L	0.1		-	2	-	-	-	-	-	-	1	2	2
Magnesium	mg/L	0.1		0.6	-	0.6	0.6	0.5	0.6	0.4	0.5	-	-	-
Magnesium (filtered)	mg/L	0.1		-		-	-	-	-	-	-			
Potassium	mg/L	0.1		0.2	-		0.2	0.2	0.2	0.1	0.1	-	-	-
Sodium	mg/L	0.1		2.7	-	2.4	2.6	2.1	2.4	1.5	2	-	-	-
Sodium (filtered)	mg/L	0.1		-	2	-	-	-	-	-	-	2	2	3
Chloride	mg/L	1		1		1.1	1		1	1	1		1	2
Sulfate	mg/L	1			-	-		-	-	-	-	-	-	-
Sulfate (filtered)	mg/L	1		-		-	-	-	-	-	-			
Cations Total	meq/L	0.01		-	0.19	-	-	-	-	-	-	0.14	0.19	0.23
Anions Total	meq/L	0.01		-	0.24	-	-	-	-	-	-	0.14	0.25	0.32
Ionic Balance	%	0.01		-	-	-	-	-	-	-	-	-	-	-
Nutrients														
Ammonia as N	mg/L	0.01	$0.32^{\#1}$	-	-	-	-	-	-	-	-	-		
Nitrate (as N)	mg/L	0.01	$1^{\#2}$	0.18	0.03	0.14	0.16	-	-	-	-	0.14	0.14	0.12
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		0.19	0.03	0.14	0.16	0.16	0.14	0.09	0.15	0.14	0.14	0.12
Nitrogen (Total)	mg/L	0.1		0.2	-	0.7	0.3	0.2	0.1	0.2	0.2	0.1	0.1	0.3
Kjeldahl Nitrogen Total	mg/L	0.1			-	0.5	0.2			0.2				0.2
Nitrate (as NO3-)	mg/L			-	-	-	-	0.15	0.13	0.09	0.15	-	-	-
Phosphate total (P)	mg/L	0.05		-	-	0.06	-	-	-	-	-	-	-	-
Phosphorus (Total)	mg/L	0.01			-	-			0.06	0.08		0.04	0.04	
Metals														
Copper (filtered)	mg/L	0.001	0.001	-	-	-	-	-	-	-	-	-	-	-
Iron (filtered)	mg/L	0.05		-	0.28	-	-	-	-	-	-	-	-	-
Nickel (filtered)	mg/L	0.001	0.008	-	-	-	-	-	-	-	-	-	-	-
Zinc (filtered)	mg/L	0.001	0.0024	-	-	-	-	-	-	-	-	-	-	-

Field ID				Boggy 1 p/u 2										
Baseline/Impact Period				Basline			Impact							
Date /Time				13 Feb 2014 03:00PM	26 Oct 2015	14 Feb 2018	25 Nov 2020	09 Feb 2021	23 Nov 2021	15 Feb 2022	15 Feb 2023	14 Nov 2023 03:00PM	06 Feb 2024 03:00PM	09 Apr 2024 03:00PM
Lab Report Number				EM1401293	477470	18-09219	870279	893808	933587	956223	23-14906	EM2320487	EM2401890	EM2405745
Sample Code				EM1401293016	M15-Oc20495	18-09219_5544482	6787600	6877708	7252502	7353375	23-14906_8320918	EM2320487010	EM2401890002	EM2405745002
	Unit	EQL	ANZG (2018) - FW - 99% (updated 26 July 2021)											
Field Parameters														
pH (Field)	pH units			-	-	7.03	-	-	-	-	-	-	-	-
NA														
Dissolved Oxygen	mg/L	0.1		-	-	-	-	-	-	-	-	-	-	-
Phosphorus reactive (as P)	mg/L	0.01		-	-	-	-	-	-	-	-	-	-	-
Inorganics														
pH (Lab)	pH units	0.01		6.16	6.9	-	5.52	7.72	7.2	6.62	-	6.09	-	-
pH Redox	pH units	0.01		-	-	-	-	-	-	-	-	-	-	-
Electrical conductivity (lab)	µS/cm	1		51	22	20	22.5	22.2	24.1	28.7	21	16	18	22
Dissolved Oxygen (Lab) (filtered)	mg/L			-	-	-	9.91	12.19	12.81	10.42	-	-	-	-
Redox (Lab)	mV	0.1		-	-	-	-	66.7	173	206	-	-	-	-
Temperature	°C			-	-	-	7.5	8.8	7.6	12.2	-	-	-	-
Turbidity	NTU	0.1		-		0.2	0.1	0.1	0.6	0.5		0.6	1.2	0.9
Total Dissolved Solids	mg/L	5		29	14	18	-	-	-	-	12	15	42	27
Total Dissolved Solids (filtered)	mg/L	5		-	-	-	10	14	10	12	-	-	-	-
Total Suspended Solids	mg/L	1		-	9.3					4	-	-	-	-
Acidity & Alkalinity														
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		24		-	-	-	-	-	7	6	7	8
Alkalinity (Bicarbonate)	mg/L	2		-	-	11	10	11	13	15	-	-	-	-
Alkalinity (total as CaCO3)	mg/L	1		24		-	-	-	-	-	7	6	7	8
Hardness as CaCO3	mg/L	1		-	-	-	-	-	-	-	-	-	-	-
Major Ions														
Calcium	mg/L	0.1		-	1.9	1.5	1.2	1.4	1.2	1.8	0.9	-	-	-
Calcium (filtered)	mg/L	0.1		4	-	-	-	-	-	-	-	1	1	2
Magnesium	mg/L	0.1		-	0.7	0.5	0.5	0.5	0.4	0.6	0.3	-	-	-
Magnesium (filtered)	mg/L	0.1		2	-	-	-	-	-	-	-			
Potassium	mg/L	0.1		-		0.1	0.1	0.2	0.2	0.2		-	-	-
Sodium	mg/L	0.1		-	2.3	2.0	1.6	1.8	2	2.6	1.3	-	-	-
Sodium (filtered)	mg/L	0.1		3	-	-	-	-	-	-	-	2	2	2
Chloride	mg/L	1			1.2	1		1	1	1	1		1	1
Sulfate	mg/L	1		-	-		-	-	-	-		-	-	-
Sulfate (filtered)	mg/L	1			-	-	-	-	-	-	-			
Cations Total	meq/L	0.01		0.49	-	-	-	-	-	-	-	0.14	0.14	0.19
Anions Total	meq/L	0.01		0.48	-	-	-	-	-	-	-	0.12	0.17	0.19
Ionic Balance	%	0.01		1.54	-	-	-	-	-	-	-	-	-	-
Nutrients														
Ammonia as N	mg/L	0.01	$0.32^{\#1}$	-	-	-	-	-	-	-	-	-		
Nitrate (as N)	mg/L	0.01	$1^{\#2}$	0.14	0.12	0.12	-	-	-	-	0.13	0.11	0.10	0.12
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		0.14	0.12	0.12	0.09	0.09	0.18	0.46	0.13	0.11	0.10	0.12
Nitrogen (Total)	mg/L	0.1		-	0.4	0.1		0.3	0.4	0.5	0.1	0.1	0.1	0.2
Kjeldahl Nitrogen Total	mg/L	0.1		-	0.3			0.2	0.2					0.1
Nitrate (as NO3-)	mg/L			-	-	-	0.08	0.09	0.17	0.46	-	-	-	-
Phosphate total (P)	mg/L	0.05		-		-	-	-	-	-	-	-	-	-
Phosphorus (Total)	mg/L	0.01		-	-				0.07		0.06	0.03	0.03	
Metals														
Copper (filtered)	mg/L	0.001	0.001	-	-	-	-	-	-	-	-	-	-	-
Iron (filtered)	mg/L	0.05		0.34	-	-	-	-	-	-	-	-	-	-
Nickel (filtered)	mg/L	0.001	0.008	-	-	-	-	-	-	-	-	-	-	-
Zinc (filtered)	mg/L	0.001	0.0024	-	-	-	-	-	-	-	-	-	-	-

Appendix E Table 1 Analytical Results

Field ID				Boggy 2									EWS East		
Baseline/Impact Period				Baseline	Impact								Impact		
Date /Time				14 Feb 2018	25 Nov 2020	09 Feb 2021	23 Nov 2021	15 Feb 2022	14 Nov 2023 03:00PM	15 Feb 2023	06 Feb 2024 03:00PM	09 Apr 2024 03:00PM	14 Nov 2023 03:00PM	06 Feb 2024 03:00PM	09 Apr 2024 03:00PM
Lab Report Number				18-09131	870279	893808	933587	956223	EM2320487	23-14906	EM2401890	EM2405745	EM2320487	EM2401890	EM2405745
Sample Code				18-09131_5543403	6787601	6877709	7252503	7353376	EM2320487011	23-14906_8320919	EM2401890003	EM2405745003	EM2320487013	EM2401890012	EM2405745005
	Unit	EQL	ANZG (2018) - FW - 99% (updated 26 July 2021)												
Field Parameters															
pH (Field)	pH units			6.69	-	-	-	-	-	-	-	-	-	-	-
NA															
Dissolved Oxygen	mg/L	0.1		-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus reactive (as P)	mg/L	0.01		-	-	-	-	-	-	-	-	-	-	-	-
Inorganics															
pH (Lab)	pH units	0.01		-	5.79	7.58	7.4	6.9	6.14	-	-	-	6.06	-	-
pH Redox	pH units	0.01		-	-	-	-	-	-	-	-	-	-	-	-
Electrical conductivity (lab)	µS/cm	1		27	29	28.7	25.9	28.5	21	26	23	28	18	19	24
Dissolved Oxygen (Lab) (filtered)	mg/L			-	8.52	11.91	11.6	8.99	-	-	-	-	-	-	-
Redox (Lab)	mV	0.1		-	-	47.1	174	170.2	-	-	-	-	-	-	-
Temperature	°C			-	8.4	10.3	7.9	11.9	-	-	-	-	-	-	-
Turbidity	NTU	0.1		0.1	0.1	0.1	0.3	0.1	0.1		0.5	0.6	4.6	7.7	3.8
Total Dissolved Solids	mg/L	5		20	-	-	-	-	20	12	30	49	15	26	43
Total Dissolved Solids (filtered)	mg/L	5		-	12	16	10	12	-	-	-	-	-	-	-
Total Suspended Solids	mg/L	1							-	-	-	-	-	-	-
Acidity & Alkalinity															
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		-	-	-	-	-	8	10	9	10	6	6	8
Alkalinity (Bicarbonate)	mg/L	2		15	13	14	16	13	-	-	-	-	-	-	-
Alkalinity (total as CaCO3)	mg/L	1		-	-	-	-	-	8	10	9	10	6	6	8
Hardness as CaCO3	mg/L	1		-	-	-	-	-	-	-	-	-	-	-	-
Major Ions															
Calcium	mg/L	0.1		2.0	1.9	2.2	1.4	1.9	-	1.3	-	-	-	-	-
Calcium (filtered)	mg/L	0.1		-	-	-	-	-	2	-	2	2	1	1	2
Magnesium	mg/L	0.1		0.6	0.7	0.7	0.5	0.6	-	0.4	-	-	-	-	-
Magnesium (filtered)	mg/L	0.1		-	-	-	-	-		-					
Potassium	mg/L	0.1		0.2	0.2	0.2	0.2	0.2	-	0.1	-	-	-	-	-
Sodium	mg/L	0.1		2.3	2	2.2	1.8	2.3	-	1.5	-	-	-	-	-
Sodium (filtered)	mg/L	0.1		-	-	-	-	-	2	-	2	2	2	2	2
Chloride	mg/L	1		1		1	1	1	1	2		2	1	1	1
Sulfate	mg/L	1			-	-	-	-	-		-	-	-	-	-
Sulfate (filtered)	mg/L	1		-	-	-	-	-		-			3		2
Cations Total	meq/L	0.01		-	-	-	-	-	0.19	-	0.19	0.19	0.14	0.14	0.19
Anions Total	meq/L	0.01		-	-	-	-	-	0.19	-	0.18	0.26	0.21	0.15	0.23
Ionic Balance	%	0.01		-	-	-	-	-	-	-	-	-	-	-	-
Nutrients															
Ammonia as N	mg/L	0.01	0.32[#1]	-	-	-	-	-	-	-			-		
Nitrate (as N)	mg/L	0.01	1[#2]	0.09	-	-	-	-	0.10	0.09	0.09	0.10	0.14	0.11	0.03
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		0.09	0.08	0.07	0.1	0.09	0.10	0.10	0.09	0.10	0.14	0.11	0.03
Nitrogen (Total)	mg/L	0.1		0.2		0.2	0.3		0.1		0.4	0.2	0.1	0.1	0.1
Kjeldahl Nitrogen Total	mg/L	0.1		0.1		0.2	0.2				0.3	0.1			0.1
Nitrate (as NO3-)	mg/L			-	0.07	0.07	0.1	0.09	-	-	-	-	-	-	-
Phosphate total (P)	mg/L	0.05		-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus (Total)	mg/L	0.01				0.05	0.05		0.03	0.08	0.02		0.02	0.02	
Metals															
Copper (filtered)	mg/L	0.001	0.001	-	-	-	-	-	-	-	-	-	-	-	-
Iron (filtered)	mg/L	0.05		-	-	-	-	-	-	-	-	-	-	-	-
Nickel (filtered)	mg/L	0.001	0.008	-	-	-	-	-	-	-	-	-	-	-	-
Zinc (filtered)	mg/L	0.001	0.0024	-	-	-	-	-	-	-	-	-	-	-	-

Appendix E Table 1 Analytical Results

			Field ID	EWS West											
			Baseline/Impact Period	Impact											
			Date /Time	15 Feb 2023	14 Nov 2023 03:00PM	06 Feb 2024 03:00PM									
			Lab Report Number	23-14906	EM2320487	EM2401890									
			Sample Code	23-14906_8320922	EM2320487012	EM2401890013									
	Unit	EQL	ANZG (2018) - FW - 99% (updated 26 July 2021)				Number of Results	Number of Detects	Minimum Concentration	Minimum Detect	Maximum Concentration	Average Concentration *	Standard Deviation *	% of Detects	% of Non-Detects
Field Parameters															
pH (Field)	pH units			-	-	-	7	7	4.91	4.91	7.184	6.1	0.93	100	0
NA															
Dissolved Oxygen	mg/L	0.1		-	-	-	5	5	9.3	9.3	10.4	9.9	0.44	100	0
Phosphorus reactive (as P)	mg/L	0.01		-	-	-	5	5	0.01	0.01	0.02	0.016	0.0055	100	0
Inorganics															
pH (Lab)	pH units	0.01		-	6.09	-	57	57	3.9	3.9	7.86	6.1	0.92	100	0
pH Redox	pH units	0.01		-	-	-	5	5	5.79	5.79	6.7	6	0.38	100	0
Electrical conductivity (lab)	µS/cm	1		34	19	21	93	93	14	14	58	29	11	100	0
Dissolved Oxygen (Lab) (filtered)	mg/L			-	-	-	26	26	3.51	3.51	28.32	11	5.3	100	0
Redox (Lab)	mV	0.1		-	-	-	24	24	-23.1	-23.1	2,600	298	497	100	0
Temperature	°C			-	-	-	26	26	5.1	5.1	12.2	8.7	2.1	100	0
Turbidity	NTU	0.1		2.3	4.6	8.9	69	66	0.1	0.1	2,500	100	342	96	4
Total Dissolved Solids	mg/L	5		18	16	34	67	65	10	10	80	30	17	97	3
Total Dissolved Solids (filtered)	mg/L	5		-	-	-	26	26	8	8	38	17	9	100	0
Total Suspended Solids	mg/L	1		-	-	-	25	10	<2	2.7	700	47	141	40	60
Acidity & Alkalinity															
Alkalinity (Bicarbonate as CaCO3)	mg/L	1		11	6	8	64	55	<1	2	26	8.6	5.5	86	14
Alkalinity (Bicarbonate)	mg/L	2		-	-	-	29	28	<2	3	37	12	7.2	97	3
Alkalinity (total as CaCO3)	mg/L	1		11	6	8	61	50	<1	2	26	8.8	5.4	82	18
Hardness as CaCO3	mg/L	1		-	-	-	5	4	<1	2	14	5.7	5.3	80	20
Major Ions															
Calcium	mg/L	0.1		1.8	-	-	50	50	0.5	0.5	7	2	1.2	100	0
Calcium (filtered)	mg/L	0.1		-	1	2	43	39	1	1	4	1.9	1.1	91	9
Magnesium	mg/L	0.1		0.6	-	-	50	48	0.2	0.2	10	1.4	2.3	96	4
Magnesium (filtered)	mg/L	0.1		-			43	9	1	1	2	0.63	0.29	21	79
Potassium	mg/L	0.1		0.4	-	-	50	42	0.1	0.1	4.8	0.63	1	84	16
Sodium	mg/L	0.1		1.0	-	-	50	50	0.8	0.8	4.8	2.3	0.85	100	0
Sodium (filtered)	mg/L	0.1		-	2	2	43	42	1	1	5	2.4	1	98	2
Chloride	mg/L	1		1	1		93	81	1	1	2	1.2	0.49	87	13
Sulfate	mg/L	1		1	-	-	17	2	1	1	1	0.56	0.17	12	88
Sulfate (filtered)	mg/L	1		-			43	6	1	1	7	0.78	1.1	14	86
Cations Total	meq/L	0.01		-	0.14	0.19	43	42	<0.01	0.09	0.49	0.22	0.12	98	2
Anions Total	meq/L	0.01		-	0.15	0.16	43	43	0.07	0.07	0.55	0.21	0.12	100	0
Ionic Balance	%	0.01		-	-	-	2	2	0.66	0.66	1.54	1.1	0.62	100	0
Nutrients															
Ammonia as N	mg/L	0.01	$0.32^{\#1}$	-	-		24	8	0.01	0.01	0.28	0.039	0.072	33	67
Nitrate (as N)	mg/L	0.01	$1^{\#2}$	0.23	0.13	0.14	67	62	0.01	0.01	5.1	0.78	1.2	93	7
Nitrogen (Total Oxidised) (as N)	mg/L	0.01		0.23	0.13	0.14	93	87	0.01	0.01	5.6	0.79	1.3	94	6
Nitrogen (Total)	mg/L	0.1		0.2	0.1	0.1	87	81	0.1	0.1	6.2	1	1.4	93	7
Kjeldahl Nitrogen Total	mg/L	0.1					87	56	0.1	0.1	1.5	0.25	0.26	64	36
Nitrate (as NO3-)	mg/L			-	-	-	26	24	0.01	0.01	5.6	0.82	1.4	92	8
Phosphate total (P)	mg/L	0.05		-	-	-	7	3	<0.05	0.06	0.49	0.11	0.17	43	57
Phosphorus (Total)	mg/L	0.01			0.04	0.02	82	52	<0.01	0.02	3.6	0.11	0.41	63	37
Metals															
Copper (filtered)	mg/L	0.001	0.001	-	-	-	10	6	0.001	0.001	0.12	0.016	0.037	60	40
Iron (filtered)	mg/L	0.05		-	-	-	9	4	<0.05	0.08	0.43	0.14	0.16	44	56
Nickel (filtered)	mg/L	0.001	0.008	-	-	-	10	3	0.001	0.001	0.005	0.0011	0.0014	30	70
Zinc (filtered)	mg/L	0.001	0.0024	-	-	-	10	8	0.003	0.003	0.01	0.0047	0.0023	80	20

Appendix F

Laboratory reports

CHAIN OF CUSTODY RECORD

GHD Melbourne Office Address
180 Lonsdale Street, Melbourne 3000
Telephone: 613 8687 8000
Fax: 613 8687 8111

Completion Date / Turnaround
FREIGHT
5 Day TAT

Quote #
Page 1 of 1
Quote: **ALS**

Project Number
12565989

Project Name
Mount Buller Water Storage Ongoing Monitoring Program

GHD Project Manager
Meg Turner

GHD Contact
Meg Turner

GHD PM email
Meg.Turner@ghd.com

GHD Contact email
meg.turner@ghd.com

Laboratory
ALS

Laboratory Address
2 - 4 Westall Road, Springvale 3171

Laboratory Contact
Shirley Le Cornu

COURIER AND LABORATORY INSTRUCTIONS
- Sign chain of custody document on receipt and release of samples, between each party
- Samples are to be delivered to the laboratory address shown
- Laboratory contact should sign the COC and send a copy (via email) to the GHD Project Manager and GHD Contact, along with a sample receipt notice, within 24 hours of receipt
- A signed copy of the COC should be returned to the GHD Project Manager and GHD Contact with the results via email at the completion of analysis as requested.
- All results should reference the Job Number and Project Name
- All results should be provided in NATA accredited pdf format and ESDAT format

Samples sent to lab for
Micro Nitrate BOD pH
Colour Turbidity RP
Other
Date 12/4 SU

						Containers			Analyses Required															
	Sample I.D.	Date and Time	Composite Sample	Sample Matrix S: Soil, SL: Sludge, W: Water, A: Air, OIL	Preservative	Type J: soil jar, B: bag, V: vial, G: glass bottle, P: plastic bottle	Number	Volume (ml)	Major Cations (Ca, Mg, Na, K)	Major Anions (Cl, SO4, Alkalinity, Total)	Nutrients: Nitrogen as N, nitrate as N, Total N, TKN, Total P	EC, TDS, Turbidity										Forward to Eurofins	SAMPLE COMMENTS
1	Boggy 1 P/U 1	9/4/24		W		P	3		X	X	X	X											
2	Boggy 1 P/U 2	↓		↓		↓	↓		↓	↓	↓	↓											
3	Boggy 2																						
4	SW-FD03																						
↓	SW-FS03																					X	Send to Eurofins
↓	SW-FS01.1																					X	" " "
5	EWS East			GW																			
6	BH18			GW																			
7	BH09	10/4/24																					
8	BH17	↓		↓																			
9	BH06																						
10	BH16																						
11	GW-FD03																						
↓	GW-FS03																					X	Send to Eurofins
↓	GW-FS01.1																					X	Send to Eurofins
12	R3			W																			

Environmental Division
Melbourne
Work Order Reference
EM2405745
Telephone : + 61-3-8549 9600
15.4, BL

TOTAL NUMBER OF SAMPLES	16
TOTAL NUMBER OF ESKIES	2

CUSTODY DETAILS

SAMPLER:	M. Turner	Date/Time	10/4/24	Relinquished by:	M. Turner	Date/Time	11/4/24
COURIER:		Date/Time		Relinquished by:		Date/Time	
LABORATORY:		Date/Time					
COMMENTS:	Samples stored on ice in esky						

(M) 12/4, 11-20

CERTIFICATE OF ANALYSIS

Work Order	: **EM2405745**	Page	: 1 of 8
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: Meg Turner	Contact	: Peter Ravlic
Address	: LEVEL 8, 180 LONSDALE ST MELBOURNE VIC, AUSTRALIA 3001	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: ----	Telephone	: +6138549 9645
Project	: 12565989	Date Samples Received	: 12-Apr-2024 11:20
Order number	: ----	Date Analysis Commenced	: 12-Apr-2024
C-O-C number	: ----	Issue Date	: 22-Apr-2024 16:54
Sampler	: ----		
Site	:		
Quote number	: EN/000		
No. of samples received	: 12		
No. of samples analysed	: 12		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Eric Chau	Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EK055G: EM2405745 #12 Result for Ammonia has been confirmed by re-preparation and re-analysis.
- EK061G: EM2405745 #12 Result for TKN has been confirmed by re-extraction and re-analysis.
- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- EA015H: EM2405745 #1-6 TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- EA015H: EM2405745 #7-10TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**Boggy 1 P/U 1**	**Boggy 1 P/U 2**	**Boggy 2**	**SW-FD03**	**EWS East**
			Sampling date / time	09-Apr-2024 00:00	09-Apr-2024 00:00	09-Apr-2024 00:00	09-Apr-2024 00:00	09-Apr-2024 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EM2405745-001**	**EM2405745-002**	**EM2405745-003**	**EM2405745-004**	**EM2405745-005**
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**30**	**22**	**28**	**29**	**24**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**44**	**27**	**49**	**79**	**43**
EA045: Turbidity								
Turbidity	----	0.1	NTU	**2.0**	**0.9**	**0.6**	**0.7**	**3.8**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**13**	**8**	**10**	**10**	**8**
Total Alkalinity as CaCO3	----	1	mg/L	**13**	**8**	**10**	**10**	**8**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	<1	**2**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**2**	**1**	**2**	**1**	**1**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**2**	**2**	**2**	**2**	**2**
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L	**3**	**2**	**2**	**2**	**2**
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	<1
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.12**	**0.12**	**0.10**	**0.10**	**0.03**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.12**	**0.12**	**0.10**	**0.10**	**0.03**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Sample ID	**Boggy 1 P/U 1**	**Boggy 1 P/U 2**	**Boggy 2**	**SW-FD03**	**EWS East**
			Sampling date / time	09-Apr-2024 00:00	09-Apr-2024 00:00	09-Apr-2024 00:00	09-Apr-2024 00:00	09-Apr-2024 00:00
Compound	CAS Number	LOR	Unit	**EM2405745-001**	**EM2405745-002**	**EM2405745-003**	**EM2405745-004**	**EM2405745-005**
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.1**	**0.1**	**0.1**	**0.1**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.3**	**0.2**	**0.2**	**0.2**	**0.1**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**0.32**	**0.19**	**0.26**	**0.23**	**0.23**
ø Total Cations	----	0.01	meq/L	**0.23**	**0.19**	**0.19**	**0.19**	**0.19**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			*Sample ID*	BH18	BH09	BH17	BH06	BH16
			Sampling date / time	09-Apr-2024 00:00	10-Apr-2024 00:00	10-Apr-2024 00:00	10-Apr-2024 00:00	10-Apr-2024 00:00
Compound	*CAS Number*	*LOR*	*Unit*	EM2405745-006	EM2405745-007	EM2405745-008	EM2405745-009	EM2405745-010
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**33**	**21**	**42**	**58**	**19**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**70**	**27**	**55**	**53**	**25**
EA045: Turbidity								
Turbidity	----	0.1	NTU	**476**	**39.5**	**33.5**	**4.8**	**89.8**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**12**	**6**	**18**	**2**	**4**
Total Alkalinity as CaCO3	----	1	mg/L	**12**	**6**	**18**	**2**	**4**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	<1	<1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**2**	**1**	**2**	**2**	**1**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**2**	**1**	**3**	**3**	<1
Magnesium	7439-95-4	1	mg/L	<1	<1	**1**	**1**	<1
Sodium	7440-23-5	1	mg/L	**3**	**1**	**4**	**2**	**2**
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	<1
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	**0.04**	**0.03**	**0.28**	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.06**	**0.56**	**0.32**	**4.91**	**0.92**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.06**	**0.56**	**0.32**	**4.91**	**0.92**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Sample ID	**BH18**	**BH09**	**BH17**	**BH06**	**BH16**
			Sampling date / time	09-Apr-2024 00:00	10-Apr-2024 00:00	10-Apr-2024 00:00	10-Apr-2024 00:00	10-Apr-2024 00:00
Compound	CAS Number	LOR	Unit	**EM2405745-006**	**EM2405745-007**	**EM2405745-008**	**EM2405745-009**	**EM2405745-010**
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.9**	<0.1	<0.1	**0.4**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**1.0**	**0.6**	**0.3**	**5.3**	**1.1**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.51**	**0.03**	**0.02**	<0.01	**0.19**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**0.30**	**0.15**	**0.42**	**0.10**	**0.11**
ø Total Cations	----	0.01	meq/L	**0.23**	**0.09**	**0.40**	**0.32**	**0.09**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**GW-FD03**	**R3**	----	----	----
			Sampling date / time	10-Apr-2024 00:00	10-Apr-2024 00:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EM2405745-011**	**EM2405745-012**	--------	--------	--------
				Result	Result	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**18**	<1	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**16**	<10	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**144**	**4.8**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**3**	<1	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**3**	<1	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**1**	<1	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	<1	----	----	----
Magnesium	7439-95-4	1	mg/L	<1	<1	----	----	----
Sodium	7440-23-5	1	mg/L	**2**	<1	----	----	----
Potassium	7440-09-7	1	mg/L	<1	<1	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.02**	**0.05**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.91**	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.91**	<0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Sample ID	**GW-FD03**	**R3**	**----**	**----**	**----**
			Sampling date / time	10-Apr-2024 00:00	10-Apr-2024 00:00	----	----	----
Compound	CAS Number	LOR	Unit	**EM2405745-011**	**EM2405745-012**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.3**	**0.1**	**----**	**----**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**1.2**	**0.1**	**----**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.42**	<0.01	**----**	**----**	**----**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**0.09**	<0.01	**----**	**----**	**----**
ø Total Cations	----	0.01	meq/L	**0.09**	<0.01	**----**	**----**	**----**

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM2405745**	Page	: 1 of 10
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: Meg Turner	Telephone	: +6138549 9645
Project	: 12565989	Date Samples Received	: 12-Apr-2024
Site	:	Issue Date	: 22-Apr-2024
Sampler	: ----	No. of samples received	: 12
Order number	: ----	No. of samples analysed	: 12

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EK055G: Ammonia as N by Discrete Analyser	EM2405740--017	Anonymous	**Ammonia as N**	7664-41-7	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
EA045: Turbidity						
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	----	----	----	16-Apr-2024	11-Apr-2024	**5**
Clear Plastic Bottle - Natural BH09, BH17, BH06, BH16, GW-FD03, R3	----	----	----	16-Apr-2024	12-Apr-2024	**4**
ED093F: Dissolved Major Cations						
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	----	----	----	17-Apr-2024	16-Apr-2024	**1**
EK055G: Ammonia as N by Discrete Analyser						
Clear Plastic Bottle - Natural Boggy 2, SW-FD03, EWS East, BH18	----	----	----	18-Apr-2024	10-Apr-2024	**8**
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2	----	----	----	19-Apr-2024	10-Apr-2024	**9**
Clear Plastic Bottle - Natural BH09, BH17, BH06, BH16, GW-FD03, R3	----	----	----	19-Apr-2024	11-Apr-2024	**8**
EK057G: Nitrite as N by Discrete Analyser						
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	----	----	----	16-Apr-2024	11-Apr-2024	**5**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser						

Matrix: **WATER**

Method **Container** / Client Sample ID(s)	*Extraction / Preparation* *Date extracted*	*Due for extraction*	***Days overdue***	*Analysis* *Date analysed*	*Due for analysis*	***Days overdue***
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Analysis Holding Time						
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	----	----	----	19-Apr-2024	11-Apr-2024	**8**
Clear Plastic Bottle - Natural BH09, BH17, BH06, BH16, GW-FD03, R3	----	----	----	19-Apr-2024	12-Apr-2024	**7**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser						
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	18-Apr-2024	10-Apr-2024	**8**	----	----	----
Clear Plastic Bottle - Natural BH09, BH17, BH06, BH16, GW-FD03, R3	18-Apr-2024	11-Apr-2024	**7**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser						
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	18-Apr-2024	11-Apr-2024	**7**	----	----	----
Clear Plastic Bottle - Natural BH09, BH17, BH06, BH16, GW-FD03, R3	18-Apr-2024	12-Apr-2024	**6**	----	----	----

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method ***Container / Client Sample ID(s)***	***Sample Date***	*Extraction / Preparation* ***Date extracted***	*Due for extraction*	*Evaluation*	*Analysis* ***Date analysed***	*Due for analysis*	*Evaluation*

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method ***Container*** */ Client Sample ID(s)*	***Sample Date***	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	**09-Apr-2024**	**----**	----	----	**17-Apr-2024**	07-May-2024	✓
Clear Plastic Bottle - Natural (EA010-P) BH09, BH17, BH06, BH16, GW-FD03, R3	**10-Apr-2024**	**----**	----	----	**17-Apr-2024**	08-May-2024	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	**09-Apr-2024**	**----**	----	----	**16-Apr-2024**	16-Apr-2024	✓
Clear Plastic Bottle - Natural (EA015H) BH09, BH17, BH06, BH16, GW-FD03, R3	**10-Apr-2024**	**----**	----	----	**16-Apr-2024**	17-Apr-2024	✓
EA045: Turbidity							
Clear Plastic Bottle - Natural (EA045) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	**09-Apr-2024**	**----**	----	----	**16-Apr-2024**	11-Apr-2024	×
Clear Plastic Bottle - Natural (EA045) BH09, BH17, BH06, BH16, GW-FD03, R3	**10-Apr-2024**	**----**	----	----	**16-Apr-2024**	12-Apr-2024	×
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	**09-Apr-2024**	**----**	----	----	**17-Apr-2024**	23-Apr-2024	✓
Clear Plastic Bottle - Natural (ED037-P) BH09, BH17, BH06, BH16, GW-FD03, R3	**10-Apr-2024**	**----**	----	----	**17-Apr-2024**	24-Apr-2024	✓

Matrix: **WATER**

Evaluation: ✗ = Holding time breach ; ✓ = Within holding time.

Method	*Sample Date*	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	**09-Apr-2024**	**----**	----	----	**16-Apr-2024**	07-May-2024	✓
Clear Plastic Bottle - Natural (ED041G) BH09, BH17, BH06, BH16, GW-FD03, R3	**10-Apr-2024**	**----**	----	----	**12-Apr-2024**	08-May-2024	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	**09-Apr-2024**	**----**	----	----	**16-Apr-2024**	07-May-2024	✓
Clear Plastic Bottle - Natural (ED045G) BH09, BH17, BH06, BH16, GW-FD03, R3	**10-Apr-2024**	**----**	----	----	**12-Apr-2024**	08-May-2024	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD03, EWS East, BH18	**09-Apr-2024**	**----**	----	----	**17-Apr-2024**	16-Apr-2024	✗
Clear Plastic Bottle - Natural (ED093F) BH09, BH17, BH06, BH16, GW-FD03, R3	**10-Apr-2024**	**----**	----	----	**17-Apr-2024**	17-Apr-2024	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK055G) Boggy 2, SW-FD03, EWS East, BH18	**09-Apr-2024**	**----**	----	----	**18-Apr-2024**	10-Apr-2024	✗
Clear Plastic Bottle - Natural (EK055G) Boggy 1 P/U 1, Boggy 1 P/U 2	**09-Apr-2024**	**----**	----	----	**19-Apr-2024**	10-Apr-2024	✗
Clear Plastic Bottle - Natural (EK055G) BH09, BH17, BH06, BH16, GW-FD03, R3	**10-Apr-2024**	**----**	----	----	**19-Apr-2024**	11-Apr-2024	✗

Matrix: **WATER**

Evaluation: ✗ = Holding time breach ; ✓ = Within holding time.

Method ***Container** / Client Sample ID(s)*		***Sample Date***	*Extraction / Preparation*			*Analysis*		
			Date extracted	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural (EK057G) Boggy 1 P/U 1, Boggy 2, EWS East,	Boggy 1 P/U 2, SW-FD03, BH18	**09-Apr-2024**	**----**	----	----	**16-Apr-2024**	11-Apr-2024	✗
Clear Plastic Bottle - Natural (EK057G) BH09, BH06, GW-FD03,	BH17, BH16, R3	**10-Apr-2024**	**----**	----	----	**12-Apr-2024**	12-Apr-2024	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Natural (EK059G) Boggy 1 P/U 1, Boggy 2, EWS East,	Boggy 1 P/U 2, SW-FD03, BH18	**09-Apr-2024**	**----**	----	----	**19-Apr-2024**	11-Apr-2024	✗
Clear Plastic Bottle - Natural (EK059G) BH09, BH06, GW-FD03,	BH17, BH16, R3	**10-Apr-2024**	**----**	----	----	**19-Apr-2024**	12-Apr-2024	✗
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Clear Plastic Bottle - Natural (EK061G) Boggy 1 P/U 1, Boggy 2, EWS East,	Boggy 1 P/U 2, SW-FD03, BH18	**09-Apr-2024**	**18-Apr-2024**	10-Apr-2024	✗	**19-Apr-2024**	16-May-2024	✓
Clear Plastic Bottle - Natural (EK061G) BH09, BH06, GW-FD03,	BH17, BH16, R3	**10-Apr-2024**	**18-Apr-2024**	11-Apr-2024	✗	**19-Apr-2024**	16-May-2024	✓
EK067G: Total Phosphorus as P by Discrete Analyser								
Clear Plastic Bottle - Natural (EK067G) Boggy 1 P/U 1, Boggy 2, EWS East,	Boggy 1 P/U 2, SW-FD03, BH18	**09-Apr-2024**	**18-Apr-2024**	11-Apr-2024	✗	**19-Apr-2024**	16-May-2024	✓
Clear Plastic Bottle - Natural (EK067G) BH09, BH06, GW-FD03,	BH17, BH16, R3	**10-Apr-2024**	**18-Apr-2024**	12-Apr-2024	✗	**19-Apr-2024**	16-May-2024	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by Auto Titrator	ED037-P	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by Auto Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	7	63	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by Auto Titrator	ED037-P	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	4	12	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by Auto Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	12	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	4	12	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	6	63	**9.52**	**7.50**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	12	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by Auto Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	12	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	12	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	4	63	**6.35**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Reqular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Turbidity	EA045	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	12	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	12	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	12	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Conductivity by Auto Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM Schedule B(3)
Turbidity	EA045	WATER	In house: Referenced to APHA 2130 B. This method is compliant with NEPM Schedule B(3)
Alkalinity by Auto Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) on a settled supernatant aliquot of the sample using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocynate forms highly-coloured ferric thiocyanate which is measured at 480 nm.
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM Schedule B(3)

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al, Zhang et al. This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	* EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM Schedule B(3)

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM Schedule B(3)

FREIGHT

GHD

CHAIN OF CUSTODY RECORD

GHD Melbourne Office Address
180 Lonsdale Street, Melbourne 3000
Telephone: 613 8687 8000
Fax: 613 8687 8111

Completion Date / Turnaround
5 Day TAT

Quote #
Page 1 of 1
Quote: ALS

Project Number
12565989

Project Name
Mount Buller Water Storage Ongoing Monitoring Program

GHD Project Manager
Meg Turner

GHD Contact
Meg Turner

GHD PM email
Meg.Turner@ghd.com

GHD Contact email
meg.turner@ghd.com

Laboratory
ALS

Laboratory Address
2 - 4 Westall Road, Springvale 3171

Laboratory Contact
Shirley Le Cornu

COURIER AND LABORATORY INSTRUCTIONS

- Sign chain of custody document on receipt and release of samples, between each party
- Samples are to be delivered to the laboratory address shown
- Laboratory contact should sign the COC and send a copy (via email) to the GHD Project Manager and GHD Contact, along with a sample receipt notice, within 24 hours of receipt
- A signed copy of the COC should be returned to the GHD Project Manager and GHD Contact with the results via email at the completion of analysis as requested
- All results should reference the Job Number and Project Name
- All results should be provided in NATA accredited pdf format and ESDAT format.

						Containers			Analyses Required														
	Sample I.D.	Date and Time	Composite Sample	Sample Matrix S: Soil SL: Sludge W: Water A: Air U: Unk	Preservative	Type J: Jar B: Bag V: Vial G: glass bottle P: plastic bottle	Number	Volume (ml)	Major Cations (Ca, Mg, Na, K)	Major Anions (Cl, SO4, Alkalinity, Total)	Nutrients: Nitrogen as N, nitrate as N, Total N, TKN, Total P	EC, TDS, Turbidity										Forward to Eurofins	SAMPLE COMMENTS
1	Boggy 1 P/U 1	6/2/24		W		P	3		X	X	X	X											
2	Boggy 1 P/U 2																						
3	Boggy 2																						
4	SW-FD01																						
→	~~SW-FD02~~ SW-FS01																					X	Send to Eurofins (COC provided)
5	BH06																						
6	BH09																						
7	BH16	7/2/24																					
8	BH17																						
9	BH18																						
10	GW-FD02																						
→	GW-FS02																					X	Send to Eurofins (Seperate COC)
11	~~Rinsate~~ R2																						
	Extra:																						
12	EWS East	6/2/24																					
13	EWS West.																						

Environmental Division
Melbourne
Work Order Reference
EM2401890
Telephone : +61-3-8549 9600

Forwarded to
Secondary Lab
Initials SH Date 9/2

TOTAL NUMBER OF SAMPLES	13
TOTAL NUMBER OF ESKIES	3

CUSTODY DETAILS							
SAMPLER:	M. Turner	Date/Time	7/2/24	Relinquished by:	M. Turner	Date/Time	7/2/24
COURIER:	A. SAMMUTT	Date/Time	8/2/24	Relinquished by:		Date/Time	
LABORATORY:		Date/Time					
COMMENTS:	Samples stored on ice in esky						

(An) 9/2, 11-00

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EM2401890**

Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: Meg Turner	Contact	: Peter Ravlic
Address	: LEVEL 8, 180 LONSDALE ST MELBOURNE VIC, AUSTRALIA 3001	Address	: 4 Westall Rd Springvale VIC Australia 3171
E-mail	: meg.turner@ghd.com	E-mail	: peter.ravlic@alsglobal.com
Telephone	: ----	Telephone	: +6138549 9645
Facsimile	: ----	Facsimile	: +61-3-8549 9626
Project	: 12565989	Page	: 1 of 3
Order number	: ----	Quote number	: EB2020GHDSER0038 (EN/000)
C-O-C number	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Site	:		
Sampler	: Meg Turner		

Dates

Date Samples Received	: 09-Feb-2024 11:00	Issue Date	: 09-Feb-2024
Client Requested Due Date	: 16-Feb-2024	Scheduled Reporting Date	: **16-Feb-2024**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Intact.
No. of coolers/boxes	: 3	Temperature	: 4.6°C - Ice present
Receipt Detail	:	No. of samples received / analysed	: 13 / 11

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- **Extra sample received:**
  EWS East (sample 012)
  EWS West (sample 013)
- **Please direct any queries related to sample condition / numbering / breakages to Client Services.**
- Sample Disposal - Aqueous (3 weeks), Solid (2 months) from receipt of samples.
- **Analytical work for this work order will be conducted at ALS Springvale.**
- **Please refer to the Proactive Holding Time Report table below which summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory. The laboratory will process these samples unless instructions are received from you indicating you do not wish to proceed. The absence of this summary table indicates that all samples have been received within the recommended holding times for the analysis requested.**
- Please be aware that APHA/NEPM recommends water and soil samples be chilled to less than or equal to 6°C for chemical analysis, and less than or equal to 10°C but unfrozen for Microbiological analysis. Where samples are received above this temperature, it should be taken into consideration when interpreting results. Refer to ALS EnviroMail 85 for ALS recommendations of the best practice for chilling samples after sampling and for maintaining a cool temperature during transit.

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

If no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component

Matrix: **WATER**

Laboratory sample ID	*Sampling date / time*	*Sample ID*	(On Hold) WATER No analysis requested	WATER - EA010P Electrical Conductivity (Auto Titrator)	WATER - EA015H Total Dissolved Solids - Standard Level	WATER - EA045 Turbidity	WATER - NT-01 & 02 Ca, Mg, Na, K, Cl, SO4, Alkalinity	WATER - NT-08 Total Nitrogen + NO2 + NO3 + NH3 + Total P
EM2401890-001	06-Feb-2024 00:00	Boggy 1 P/U 1		✓	✓	✓	✓	✓
EM2401890-002	06-Feb-2024 00:00	Boggy 1 P/U 2		✓	✓	✓	✓	✓
EM2401890-003	06-Feb-2024 00:00	Boggy 2		✓	✓	✓	✓	✓
EM2401890-004	06-Feb-2024 00:00	SW-FD01		✓	✓	✓	✓	✓
EM2401890-005	06-Feb-2024 00:00	BH06		✓	✓	✓	✓	✓
EM2401890-006	06-Feb-2024 00:00	BH09		✓	✓	✓	✓	✓
EM2401890-007	07-Feb-2024 00:00	BH16		✓	✓	✓	✓	✓
EM2401890-008	07-Feb-2024 00:00	BH17		✓	✓	✓	✓	✓
EM2401890-009	07-Feb-2024 00:00	BH18		✓	✓	✓	✓	✓
EM2401890-010	07-Feb-2024 00:00	GW-FD02		✓	✓	✓	✓	✓
EM2401890-011	07-Feb-2024 00:00	R2		✓	✓	✓	✓	✓
EM2401890-012	06-Feb-2024 00:00	EWS East	✓					
EM2401890-013	06-Feb-2024 00:00	EWS West	✓					

Proactive Holding Time Report

The following table summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Client Sample ID(s)	Container	Due for extraction	Due for analysis	Samples Received Date	Samples Received Evaluation	Instructions Received Date	Instructions Received Evaluation
EA045: Turbidity							
BH06	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	×	----	----
BH09	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	×	----	----
Boggy 1 P/U 1	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	×	----	----
Boggy 1 P/U 2	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	×	----	----
Boggy 2	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	×	----	----
SW-FD01	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	×	----	----
EK055G: Ammonia as N by Discrete analyser							
BH06	Clear Plastic Bottle - Natural	----	07-Feb-2024	09-Feb-2024	×	----	----
BH09	Clear Plastic Bottle - Natural	----	07-Feb-2024	09-Feb-2024	×	----	----
BH16	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	×	----	----
BH17	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	×	----	----
BH18	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	×	----	----
Boggy 1 P/U 1	Clear Plastic Bottle - Natural	----	07-Feb-2024	09-Feb-2024	×	----	----
Boggy 1 P/U 2	Clear Plastic Bottle - Natural	----	07-Feb-2024	09-Feb-2024	×	----	----
Boggy 2	Clear Plastic Bottle - Natural	----	07-Feb-2024	09-Feb-2024	×	----	----
GW-FD02	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	×	----	----
R2	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	×	----	----
SW-FD01	Clear Plastic Bottle - Natural	----	07-Feb-2024	09-Feb-2024	×	----	----

EK057G: Nitrite as N by Discrete Analyser							
BH06	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	✗	----	----
BH09	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	✗	----	----
Boggy 1 P/U 1	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	✗	----	----
Boggy 1 P/U 2	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	✗	----	----
Boggy 2	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	✗	----	----
SW-FD01	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	✗	----	----
EK059G: Nitrite and Nitrate as N (NOx) by Discrete Analyser							
BH06	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	✗	----	----
BH09	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	✗	----	----
Boggy 1 P/U 1	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	✗	----	----
Boggy 1 P/U 2	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	✗	----	----
Boggy 2	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	✗	----	----
SW-FD01	Clear Plastic Bottle - Natural	----	08-Feb-2024	09-Feb-2024	✗	----	----
EK061G: Total Kjeldahl Nitrogen as N By Discrete Analyser							
BH06	Clear Plastic Bottle - Natural	07-Feb-2024	06-Mar-2024	09-Feb-2024	✗	----	----
BH09	Clear Plastic Bottle - Natural	07-Feb-2024	06-Mar-2024	09-Feb-2024	✗	----	----
BH16	Clear Plastic Bottle - Natural	08-Feb-2024	07-Mar-2024	09-Feb-2024	✗	----	----
BH17	Clear Plastic Bottle - Natural	08-Feb-2024	07-Mar-2024	09-Feb-2024	✗	----	----
BH18	Clear Plastic Bottle - Natural	08-Feb-2024	07-Mar-2024	09-Feb-2024	✗	----	----
Boggy 1 P/U 1	Clear Plastic Bottle - Natural	07-Feb-2024	06-Mar-2024	09-Feb-2024	✗	----	----
Boggy 1 P/U 2	Clear Plastic Bottle - Natural	07-Feb-2024	06-Mar-2024	09-Feb-2024	✗	----	----
Boggy 2	Clear Plastic Bottle - Natural	07-Feb-2024	06-Mar-2024	09-Feb-2024	✗	----	----
GW-FD02	Clear Plastic Bottle - Natural	08-Feb-2024	07-Mar-2024	09-Feb-2024	✗	----	----
R2	Clear Plastic Bottle - Natural	08-Feb-2024	07-Mar-2024	09-Feb-2024	✗	----	----
SW-FD01	Clear Plastic Bottle - Natural	07-Feb-2024	06-Mar-2024	09-Feb-2024	✗	----	----
EK067G: Total Phosphorus as P By Discrete Analyser							
BH06	Clear Plastic Bottle - Natural	08-Feb-2024	07-Mar-2024	09-Feb-2024	✗	----	----
BH09	Clear Plastic Bottle - Natural	08-Feb-2024	07-Mar-2024	09-Feb-2024	✗	----	----
Boggy 1 P/U 1	Clear Plastic Bottle - Natural	08-Feb-2024	07-Mar-2024	09-Feb-2024	✗	----	----
Boggy 1 P/U 2	Clear Plastic Bottle - Natural	08-Feb-2024	07-Mar-2024	09-Feb-2024	✗	----	----
Boggy 2	Clear Plastic Bottle - Natural	08-Feb-2024	07-Mar-2024	09-Feb-2024	✗	----	----
SW-FD01	Clear Plastic Bottle - Natural	08-Feb-2024	07-Mar-2024	09-Feb-2024	✗	----	----

Requested Deliverables

ACCOUNTS PAYABLE		
- A4 - AU Tax Invoice (INV)	Email	accountspayableAU@ghd.com
GHD LAB REPORTS		
- *AU Certificate of Analysis - NATA (COA)	Email	ghdlabreports@ghd.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	ghdlabreports@ghd.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	ghdlabreports@ghd.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	ghdlabreports@ghd.com
- EDI Format - ESDAT (ESDAT)	Email	ghdlabreports@ghd.com
- Electronic SRN for ESdat (ESRN_ESDAT)	Email	ghdlabreports@ghd.com
Meg Turner		
- *AU Certificate of Analysis - NATA (COA)	Email	meg.turner@ghd.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	meg.turner@ghd.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	meg.turner@ghd.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	meg.turner@ghd.com
- A4 - AU Tax Invoice (INV)	Email	meg.turner@ghd.com
- Chain of Custody (CoC) (COC)	Email	meg.turner@ghd.com
- EDI Format - ESDAT (ESDAT)	Email	meg.turner@ghd.com
- EDI Format - XTab (XTAB)	Email	meg.turner@ghd.com
- Electronic SRN for ESdat (ESRN_ESDAT)	Email	meg.turner@ghd.com

CERTIFICATE OF ANALYSIS

Work Order : **EM2401890**
Client : **GHD PTY LTD**
Contact : Meg Turner
Address : LEVEL 8, 180 LONSDALE ST
MELBOURNE VIC, AUSTRALIA 3001
Telephone : ----
Project : 12565989
Order number : ----
C-O-C number : ----
Sampler : Meg Turner
Site :
Quote number : EN/000
No. of samples received : 13
No. of samples analysed : 13

Page : 1 of 8
Laboratory : Environmental Division Melbourne
Contact : Peter Ravlic
Address : 4 Westall Rd Springvale VIC Australia 3171
Telephone : +6138549 9645
Date Samples Received : 09-Feb-2024 11:00
Date Analysis Commenced : 09-Feb-2024
Issue Date : 16-Feb-2024 17:26

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Arenie Vijayaratnam	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Eric Chau	Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Scott Beddoes	Senior Chemist - Inorganics	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- EA015H: EM2401890 #1,2,4,5,8-10,12,13 TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- EP045: EM2401890 #11, turbidity result has been confirmed by re-preparation and re-analysis.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Sample ID	**Boggy 1 P/U 1**	**Boggy 1 P/U 2**	**Boggy 2**	**SW-FD02**	**BH06**
			Sampling date / time	06-Feb-2024 00:00	06-Feb-2024 00:00	06-Feb-2024 00:00	06-Feb-2024 00:00	06-Feb-2024 00:00
Compound	CAS Number	LOR	Unit	**EM2401890-001**	**EM2401890-002**	**EM2401890-003**	**EM2401890-004**	**EM2401890-005**
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**22**	**18**	**23**	**23**	**29**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**54**	**42**	**30**	**28**	**45**
EA045: Turbidity								
Turbidity	----	0.1	NTU	**1.6**	**1.2**	**0.5**	**0.5**	**40.5**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**11**	**7**	**9**	**9**	**3**
Total Alkalinity as CaCO3	----	1	mg/L	**11**	**7**	**9**	**9**	**3**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	<1	<1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**1**	**1**	<1	**1**	**1**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**2**	**1**	**2**	**2**	**2**
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L	**2**	**2**	**2**	**2**	**2**
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	<1
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.14**	**0.10**	**0.09**	**0.09**	**2.26**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.14**	**0.10**	**0.09**	**0.09**	**2.26**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Sample ID	**Boggy 1 P/U 1**	**Boggy 1 P/U 2**	**Boggy 2**	**SW-FD02**	**BH06**
			Sampling date / time	06-Feb-2024 00:00	06-Feb-2024 00:00	06-Feb-2024 00:00	06-Feb-2024 00:00	06-Feb-2024 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EM2401890-001**	**EM2401890-002**	**EM2401890-003**	**EM2401890-004**	**EM2401890-005**
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	**0.3**	<0.1	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.1**	**0.1**	**0.4**	<0.1	**2.5**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.04**	**0.03**	**0.02**	**0.01**	**0.08**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**0.25**	**0.17**	**0.18**	**0.21**	**0.09**
ø Total Cations	----	0.01	meq/L	**0.19**	**0.14**	**0.19**	**0.19**	**0.19**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**BH09**	**BH16**	**BH17**	**BH18**	**GW-FD02**
			Sampling date / time	06-Feb-2024 00:00	07-Feb-2024 00:00	07-Feb-2024 00:00	07-Feb-2024 00:00	07-Feb-2024 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EM2401890-006**	**EM2401890-007**	**EM2401890-008**	**EM2401890-009**	**EM2401890-010**
				Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**19**	**17**	**38**	**46**	**17**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**72**	**66**	**59**	**50**	**41**
EA045: Turbidity								
Turbidity	----	0.1	NTU	**12.0**	**158**	**16.3**	**51.7**	**151**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**5**	**4**	**16**	**20**	**3**
Total Alkalinity as CaCO3	----	1	mg/L	**5**	**4**	**16**	**20**	**3**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	<1	<1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**1**	**1**	**1**	**1**	<1
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**1**	<1	**4**	**4**	**1**
Magnesium	7439-95-4	1	mg/L	<1	<1	**1**	**1**	<1
Sodium	7440-23-5	1	mg/L	**1**	**2**	**4**	**4**	**2**
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	<1
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	<0.01	**0.01**	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.54**	**0.89**	**0.52**	<0.01	**0.89**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.54**	**0.89**	**0.52**	<0.01	**0.89**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**BH09**	**BH16**	**BH17**	**BH18**	**GW-FD02**
			Sampling date / time	06-Feb-2024 00:00	07-Feb-2024 00:00	07-Feb-2024 00:00	07-Feb-2024 00:00	07-Feb-2024 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EM2401890-006**	**EM2401890-007**	**EM2401890-008**	**EM2401890-009**	**EM2401890-010**
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	**0.6**	**0.3**	**0.4**	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.5**	**1.5**	**0.8**	**0.4**	**1.1**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.38**	**0.10**	**0.25**	**0.41**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**0.13**	**0.11**	**0.35**	**0.43**	**0.06**
ø Total Cations	----	0.01	meq/L	**0.09**	**0.09**	**0.46**	**0.46**	**0.14**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**R2**	**EWS East**	**EWS West**	**----**	**----**
			Sampling date / time	07-Feb-2024 00:00	06-Feb-2024 00:00	06-Feb-2024 00:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EM2401890-011**	**EM2401890-012**	**EM2401890-013**	**--------**	**--------**
				Result	Result	Result	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	**19**	**21**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	<10	**26**	**34**	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**2.0**	**7.7**	**8.9**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**1**	**6**	**8**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**1**	**6**	**8**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	**1**	<1	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	**1**	**2**	----	----
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	----	----
Sodium	7440-23-5	1	mg/L	<1	**2**	**2**	----	----
Potassium	7440-09-7	1	mg/L	<1	<1	<1	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**0.11**	**0.14**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**0.11**	**0.14**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**R2**	**EWS East**	**EWS West**	**----**	**----**
			Sampling date / time	07-Feb-2024 00:00	06-Feb-2024 00:00	06-Feb-2024 00:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EM2401890-011**	**EM2401890-012**	**EM2401890-013**	**--------**	**--------**
				Result	Result	Result	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	**0.1**	**0.1**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	**0.02**	**0.02**	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**0.02**	**0.15**	**0.16**	----	----
ø Total Cations	----	0.01	meq/L	<0.01	**0.14**	**0.19**	----	----

QUALITY CONTROL REPORT

Work Order : **EM2401890**

Client : **GHD PTY LTD**
Contact : Meg Turner
Address : LEVEL 8, 180 LONSDALE ST
MELBOURNE VIC, AUSTRALIA 3001
Telephone : ----
Project : 12565989
Order number : ----
C-O-C number : ----
Sampler : Meg Turner
Site :
Quote number : EN/000
No. of samples received : 13
No. of samples analysed : 13

Page : 1 of 7

Laboratory : Environmental Division Melbourne
Contact : Peter Ravlic
Address : 4 Westall Rd Springvale VIC Australia 3171
Telephone : +6138549 9645
Date Samples Received : 09-Feb-2024
Date Analysis Commenced : 09-Feb-2024
Issue Date : 16-Feb-2024

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Arenie Vijayaratnam	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Eric Chau	Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Scott Beddoes	Senior Chemist - Inorganics	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC
* = The final LOR has been raised due to dilution or other sample specific cause; adjusted LOR is shown in brackets. The duplicate ranges for Acceptable RPD% are applied to the final LOR where applicable.

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EA010P: Conductivity by PC Titrator (QC Lot: 5603281)									
EM2401890-001	Boggy 1 P/U 1	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	22	22	0.0	0% - 20%
EM2401890-011	R2	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	<1	0.0	No Limit
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 5595010)									
EM2401890-008	BH17	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	59	50	16.1	No Limit
EM2401924-004	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	4530	4250	6.3	0% - 20%
EM2401749-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	8130	8300	2.0	0% - 20%
EA045: Turbidity (QC Lot: 5592679)									
EM2401816-001	Anonymous	EA045: Turbidity	----	0.1	NTU	7.7	7.6	0.0	0% - 20%
EM2401890-003	Boggy 2	EA045: Turbidity	----	0.1	NTU	0.5	0.5	0.0	No Limit
EA045: Turbidity (QC Lot: 5593522)									
EM2401890-012	EWS East	EA045: Turbidity	----	0.1	NTU	7.7	8.0	4.1	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 5603279)									
EM2401890-001	Boggy 1 P/U 1	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	11	9	17.0	0% - 50%
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	11	9	17.0	0% - 50%
EM2401890-011	R2	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	1	1	0.0	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	1	1	0.0	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 5593293)									
EM2401890-001	Boggy 1 P/U 1	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.0	No Limit
EM2401890-012	EWS East	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.0	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 5593294)									
EM2401890-001	Boggy 1 P/U 1	ED045G: Chloride	16887-00-6	1	mg/L	1	<1	0.0	No Limit
EM2401890-012	EWS East	ED045G: Chloride	16887-00-6	1	mg/L	1	1	0.0	No Limit
ED093F: Dissolved Major Cations (QC Lot: 5601057)									
EM2401836-008	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	27	26	0.0	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	10	10	0.0	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	37	37	0.0	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	17	17	0.0	0% - 50%
EM2401882-007	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	74	74	0.0	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	139	140	1.0	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	1180	1200	1.0	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	34	34	0.0	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 5601058)									
EM2401890-012	EWS East	ED093F: Calcium	7440-70-2	1	mg/L	1	1	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	<1	<1	0.0	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	2	2	0.0	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	<1	<1	0.0	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 5594293)									
EM2401808-003	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01 (0.20)*	mg/L	12.9	12.9	0.3	0% - 20%
EM2401890-008	BH17	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 5593291)									
EM2401861-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM2401890-001	Boggy 1 P/U 1	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 5593295)									
EM2401890-012	EWS East	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM2401909-007	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 5594292)									
EM2401723-006	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.12	0.12	0.0	0% - 50%
EM2401890-003	Boggy 2	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.09	0.09	0.0	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 5595020)									
EM2401890-004	SW-FD02	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.0	No Limit
EM2401890-013	EWS West	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 5595019)									
EM2401697-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.06	0.10	53.8	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
				Laboratory Duplicate (DUP) Report					
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 5595019) - continued									
EM2401808-003	Anonymous	EK067G: Total Phosphorus as P	----	0.01 (0.02)*	mg/L	130	122	6.2	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 5595021)									
EM2401890-004	SW-FD02	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.01	0.04	92.5	No Limit
EM2401890-013	EWS West	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.02	0.01	0.0	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA010P: Conductivity by PC Titrator (QCLot: 5603281)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	1412 µS/cm	102	85.0	119
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 5595010)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	102	91.0	110
				<10	2340 mg/L	113	80.8	119
				<10	293 mg/L	96.9	91.0	110
EA045: Turbidity (QCLot: 5592679)								
EA045: Turbidity	----	0.1	NTU	<0.1	40 NTU	103	88.1	110
EA045: Turbidity (QCLot: 5593522)								
EA045: Turbidity	----	0.1	NTU	<0.1	40 NTU	103	88.1	110
ED037P: Alkalinity by PC Titrator (QCLot: 5603279)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	94.3	85.0	116
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 5593293)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	500 mg/L	108	90.0	110
				<1	25 mg/L	104	90.0	110
ED045G: Chloride by Discrete Analyser (QCLot: 5593294)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	1000 mg/L	102	90.0	110
				<1	10 mg/L	100	90.0	110
ED093F: Dissolved Major Cations (QCLot: 5601057)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	102	80.0	120
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	103	80.0	120
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	100	80.0	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	96.3	80.0	120
ED093F: Dissolved Major Cations (QCLot: 5601058)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	103	80.0	120
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	103	80.0	120
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	101	80.0	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	96.4	80.0	120
EK055G: Ammonia as N by Discrete Analyser (QCLot: 5594293)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	96.1	90.0	110
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5593291)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Acceptable Limits (%) Low	High
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5593291) - continued								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	99.0	90.0	110
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5593295)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	98.2	90.0	110
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 5594292)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	98.1	90.0	110
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 5595020)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	5 mg/L	95.1	70.0	117
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5595019)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	2.21 mg/L	93.1	71.9	114
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5595021)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	2.21 mg/L	93.4	71.9	114

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Acceptable Limits (%) Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 5593293)							
EM2401890-013	EWS West	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	100 mg/L	108	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 5593294)							
EM2401890-013	EWS West	ED045G: Chloride	16887-00-6	400 mg/L	107	70.0	142
EK055G: Ammonia as N by Discrete Analyser (QCLot: 5594293)							
EM2401818-008	Anonymous	EK055G: Ammonia as N	7664-41-7	1 mg/L	105	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5593291)							
EM2401861-002	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	89.5	80.0	114
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5593295)							
EM2401890-013	EWS West	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	90.6	80.0	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 5594292)							
EM2401723-007	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	95.2	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 5595020)							
EM2401890-005	BH06	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	93.2	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5595019)							

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5595019) - continued							
EM2401697-002	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	89.0	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5595021)							
EM2401890-005	BH06	EK067G: Total Phosphorus as P	----	1 mg/L	92.7	70.0	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM2401890**	Page	: 1 of 11
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: Meg Turner	Telephone	: +6138549 9645
Project	: 12565989	Date Samples Received	: 09-Feb-2024
Site	:	Issue Date	: 16-Feb-2024
Sampler	: Meg Turner	No. of samples received	: 13
Order number	: ----	No. of samples analysed	: 13

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
EA045: Turbidity						
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	----	----	----	09-Feb-2024	08-Feb-2024	**1**
EK055G: Ammonia as N by Discrete Analyser						
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS West	----	----	----	12-Feb-2024	07-Feb-2024	**5**
Clear Plastic Bottle - Natural EWS East	----	----	----	13-Feb-2024	07-Feb-2024	**6**
Clear Plastic Bottle - Natural BH16, GW-FD02	----	----	----	12-Feb-2024	08-Feb-2024	**4**
Clear Plastic Bottle - Natural BH17, BH18, R2	----	----	----	13-Feb-2024	08-Feb-2024	**5**
EK057G: Nitrite as N by Discrete Analyser						
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	----	----	----	09-Feb-2024	08-Feb-2024	**1**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser						
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	----	----	----	13-Feb-2024	08-Feb-2024	**5**
Clear Plastic Bottle - Natural BH16, BH17, BH18, GW-FD02, R2	----	----	----	13-Feb-2024	09-Feb-2024	**4**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser						

Matrix: **WATER**

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	Date extracted	Due for extraction	**Days overdue**	Date analysed	Due for analysis	**Days overdue**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Analysis Holding Time Compliance						
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	13-Feb-2024	07-Feb-2024	**6**	----	----	----
Clear Plastic Bottle - Natural BH16, BH17, BH18, GW-FD02, R2	13-Feb-2024	08-Feb-2024	**5**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser						
Clear Plastic Bottle - Natural Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	13-Feb-2024	08-Feb-2024	**5**	----	----	----
Clear Plastic Bottle - Natural BH16, BH17, BH18, GW-FD02, R2	13-Feb-2024	09-Feb-2024	**4**	----	----	----

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
Container */ Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*

Matrix: **WATER**

Evaluation: ✗ = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	**06-Feb-2024**	**----**	----	----	**15-Feb-2024**	05-Mar-2024	✓
Clear Plastic Bottle - Natural (EA010-P) BH16, BH17, BH18, GW-FD02, R2	**07-Feb-2024**	**----**	----	----	**15-Feb-2024**	06-Mar-2024	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	**06-Feb-2024**	**----**	----	----	**12-Feb-2024**	13-Feb-2024	✓
Clear Plastic Bottle - Natural (EA015H) BH16, BH17, BH18, GW-FD02, R2	**07-Feb-2024**	**----**	----	----	**12-Feb-2024**	14-Feb-2024	✓
EA045: Turbidity							
Clear Plastic Bottle - Natural (EA045) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	**06-Feb-2024**	**----**	----	----	**09-Feb-2024**	08-Feb-2024	✗
Clear Plastic Bottle - Natural (EA045) BH16, BH17, BH18, GW-FD02, R2	**07-Feb-2024**	**----**	----	----	**09-Feb-2024**	09-Feb-2024	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	**06-Feb-2024**	**----**	----	----	**15-Feb-2024**	20-Feb-2024	✓
Clear Plastic Bottle - Natural (ED037-P) BH16, BH17, BH18, GW-FD02, R2	**07-Feb-2024**	**----**	----	----	**15-Feb-2024**	21-Feb-2024	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method *Container / Client Sample ID(s)*	*Sample Date*	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	**06-Feb-2024**	**----**	----	----	**09-Feb-2024**	05-Mar-2024	✓
Clear Plastic Bottle - Natural (ED041G) BH16, BH17, BH18, GW-FD02, R2	**07-Feb-2024**	**----**	----	----	**09-Feb-2024**	06-Mar-2024	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	**06-Feb-2024**	**----**	----	----	**09-Feb-2024**	05-Mar-2024	✓
Clear Plastic Bottle - Natural (ED045G) BH16, BH17, BH18, GW-FD02, R2	**07-Feb-2024**	**----**	----	----	**09-Feb-2024**	06-Mar-2024	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F) R2	**07-Feb-2024**	**----**	----	----	**14-Feb-2024**	14-Feb-2024	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	**06-Feb-2024**	**----**	----	----	**14-Feb-2024**	05-Mar-2024	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) BH16, BH17, BH18, GW-FD02	**07-Feb-2024**	**----**	----	----	**14-Feb-2024**	06-Mar-2024	✓

Matrix: **WATER**

Evaluation: ✘ = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
Container */ Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK055G) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS West	**06-Feb-2024**	**----**	----	----	**12-Feb-2024**	07-Feb-2024	✘
Clear Plastic Bottle - Natural (EK055G) EWS East	**06-Feb-2024**	**----**	----	----	**13-Feb-2024**	07-Feb-2024	✘
Clear Plastic Bottle - Natural (EK055G) BH16, GW-FD02	**07-Feb-2024**	**----**	----	----	**12-Feb-2024**	08-Feb-2024	✘
Clear Plastic Bottle - Natural (EK055G) BH17, BH18, R2	**07-Feb-2024**	**----**	----	----	**13-Feb-2024**	08-Feb-2024	✘
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	**06-Feb-2024**	**----**	----	----	**09-Feb-2024**	08-Feb-2024	✘
Clear Plastic Bottle - Natural (EK057G) BH16, BH17, BH18, GW-FD02, R2	**07-Feb-2024**	**----**	----	----	**09-Feb-2024**	09-Feb-2024	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Natural (EK059G) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	**06-Feb-2024**	**----**	----	----	**13-Feb-2024**	08-Feb-2024	✘
Clear Plastic Bottle - Natural (EK059G) BH16, BH17, BH18, GW-FD02, R2	**07-Feb-2024**	**----**	----	----	**13-Feb-2024**	09-Feb-2024	✘
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Natural (EK061G) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	**06-Feb-2024**	**13-Feb-2024**	07-Feb-2024	✘	**13-Feb-2024**	12-Mar-2024	✓
Clear Plastic Bottle - Natural (EK061G) BH16, BH17, BH18, GW-FD02, R2	**07-Feb-2024**	**13-Feb-2024**	08-Feb-2024	✘	**13-Feb-2024**	12-Mar-2024	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
Container */ Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Natural (EK067G) Boggy 1 P/U 1, Boggy 1 P/U 2, Boggy 2, SW-FD02, BH06, BH09, EWS East, EWS West	**06-Feb-2024**	**13-Feb-2024**	08-Feb-2024	×	**13-Feb-2024**	12-Mar-2024	✓
Clear Plastic Bottle - Natural (EK067G) BH16, BH17, BH18, GW-FD02, R2	**07-Feb-2024**	**13-Feb-2024**	09-Feb-2024	×	**13-Feb-2024**	12-Mar-2024	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		*Count*		*Rate (%)*			*Quality Control Specification*
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by Auto Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by Auto Titrator	EA010-P	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	3	22	**13.64**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	4	38	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	3	29	**10.34**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	4	36	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	3	22	**13.64**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by Auto Titrator	ED037-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by Auto Titrator	EA010-P	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	38	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	3	29	**10.34**	**7.50**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by Auto Titrator	EA010-P	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	38	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Turbidity	EA045	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	38	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Conductivity by Auto Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM Schedule B(3)
Turbidity	EA045	WATER	In house: Referenced to APHA 2130 B. This method is compliant with NEPM Schedule B(3)
Alkalinity by Auto Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) on a settled supernatant aliquot of the sample using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm.
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM Schedule B(3)

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al, Zhang et al. This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	* EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM Schedule B(3)

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM Schedule B(3)

CHAIN OF CUSTODY
Water Resources Group

ABN: 94 105 060 320

Page.........of.........

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FREIGHT

Client:	GHD		
Contact:	(results) Meg Turner		
	(invoice) Meg Turner		
Address:	105 Hume St Wodonga, 3690		
Phone:	+61 3 8787 8862	**Fax:**	
Email:	Meg.Turner@ghd.com		
P/O No.:	12565989	**Quote No.:**	
T/A Time:		**Sampler:**	MT
Job/Proj Ref:	12565989		

Office use only

Lab Work Order No:

LIMS Program Code:

TESTS REQUIRED

Environmental Division
Melbourne
Work Order Reference
EM2320487

Telephone : + 61-3-8549 9600

Lab Sample ID	Sample Description	No of Containers	Date Sampled	Time sampled	Matrix	Cations/Anions	Nutrients	Cond, turb, TDS	Field Parameters
1 BH06		3	15/11/23		GW	X	X	X	X
2 BH09		↓	↓		↓	↓	↓	↓	↓
3 BH16									
4 BH17									
5 BH18									
6 GW-Dup									
7 GW-Split					W				
8 Rinsate					W				

Special Instructions: Cations / Anions = ALS Suite NT-1, NT-2
Nutrients = ALS Suite NT-11, EK059GV

Conductivity, TDS, turbidity = ALS suite WA010, WA015, WA045
Field parameters = DO, EC, pH, Redox, Temp (ALS Suite EN67.2)

Relinquished By:	Company:	Date:	Time:	Received By:	Company:	Date:	Time:
				RICHARD B	ALS	17/11/23	10:40

This form is for recording of sample data after prior consultation with an analyst regarding sampling procedures and does not over-ride pricing agreements, OHS requirements and our terms and conditions.

As an Occupational Health and Safety consideration, it is a requirement of ALS Water Resources Group that all samples received be undamaged and prior advice given in writing of any potential health risks.

LAB USE ONLY

Sample conditions:
Samples received undamaged [Yes/No]
Samples adequately preserved [Yes/No]
Samples within recommended holding times: [Yes/No]
Samples transported at appropriate temperature [Yes/No]

CHAIN OF CUSTODY
Water Resources Group

ABN: 94 105 060 320

Page........of.........

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Client: GHD

Contact: (results) Meg Turner

(invoice) Meg Turner

Address: 105 Hume St Wodonga, 3690

Phone: +61 3 8787 8862 **Fax:**

Email: Meg.Turner@ghd.com

P/O No.: 12565989 **Quote No.:**

T/A Time: **Sampler:** MT

Job/Proj Ref: 12565989

Office use only

Lab Work Order No: ~~12565989~~

LIMS Program Code:

TESTS REQUIRED (see detail below)

	Lab Sample ID	Sample Description	No of Containers	Date Sampled	Time sampled	Matrix	Cations/Anions	Nutrients	Conductivity	Field Parameters	TDS, Turbidity
9	Boggy 1p/u 1		3	14/11/23		W	X	X	X	X	X
10	Boggy 1 p/u 2		3	↓		W	↓	↓	↓	↓	↓
11	Boggy 2		3	↓		W	↓	↓	↓	↓	↓
12	EWS		3	↓		W	↓	↓	↓	↓	↓
13	EWS East		3	↓		GW	↓	↓	↓	↓	↓
14	SW-Dup		3	↓		W	↓	↓	↓	↓	↓
15	SW-Split		3	↓		W	↓	↓	↓	↓	↓

Special Instructions: Cations / Anions = ALS Suite NT-1, NT-2
Nutrients = ALS Suite NT-11, EK059GV

Conductivity, TDS, turbidity = ALS suite WA010, WA015, WA045
Field parameters = DO, EC, pH, Redox, Temp (ALS Suite EN67.2)

Relinquished By:	Company:	Date:	Time:	Received By:	Company:	Date:	Time:
Meg T	GHD	16/11/23		RICHARD B	ALS	17/11/23	10:40

This form is for recording of sample data after prior consultation with an analyst regarding sampling procedures and does not over-ride pricing agreements, OHS requirements and our terms and conditions.

As an Occupational Health and Safety consideration, it is a requirement of ALS Water Resources Group that all samples received be undamaged and prior advice given in writing of any potential health risks.

LAB USE ONLY

Sample conditions:
Samples received undamaged [Yes/No]
Samples adequately preserved [Yes/No]
Samples within recommended holding times: [Yes/No]
Samples transported at appropriate temperature [Yes/No]

CERTIFICATE OF ANALYSIS

Work Order : **EM2320487**
Amendment : **1**
Client : **GHD PTY LTD**
Contact : Meg Turner
Address : SUITE 5, 105 HUME ST
WODONGA VIC, AUSTRALIA 3690
Telephone : ----
Project : 12565989
Order number : 12565989
C-O-C number : ----
Sampler : MT
Site :
Quote number : EN/000
No. of samples received : 15
No. of samples analysed : 15

Page : 1 of 10
Laboratory : Environmental Division Melbourne
Contact : Peter Ravlic
Address : 4 Westall Rd Springvale VIC Australia 3171
Telephone : +6138549 9645
Date Samples Received : 17-Nov-2023 10:40
Date Analysis Commenced : 17-Nov-2023
Issue Date : 30-Nov-2023 21:00

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Nikki Stepniewski	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA015-H (TDS) conducted by ALS Scoresby, NATA accreditation no. 992, site no. 989.
- As per QWI – EN55-3 Data Interpreting Procedures, Ionic balances are typically calculated using Major Anions - Chloride, Alkalinity and Sulfate; and Major Cations - Calcium, Magnesium, Potassium and Sodium. Where applicable and dependent upon sample matrix, the Ionic Balance may also include the additional contribution of Ammonia, Dissolved Metals by ICPMS and H+ to the Cations and Nitrate, SiO2 and Fluoride to the Anions.
- Amendment (28/11/2023): This report has been amended to add NT-4 suite to sample #1 to #15. A request from Meg Turner received on 28/11/2023 at 5:16 pm via an email. All analysis results are as per the report.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.
- ED045G: The presence of Thiocyanate, Thiosulfate and Sulfite can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.

Analytical Results

Sub-Matrix: **GROUNDWATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	BH06	BH09	BH16	BH17	BH18
			Sample ID	**BH06**	**BH09**	**BH16**	**BH17**	**BH18**
			Sampling date / time	15-Nov-2023 00:00	15-Nov-2023 00:00	15-Nov-2023 00:00	15-Nov-2023 00:00	15-Nov-2023 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EM2320487-001**	**EM2320487-002**	**EM2320487-003**	**EM2320487-004**	**EM2320487-005**
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**5.78**	**5.58**	**5.78**	**6.13**	**6.15**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**31**	**18**	**17**	**38**	**41**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**15**	<10	<10	**20**	**25**
EA045: Turbidity								
Turbidity	----	0.1	NTU	**19.4**	**5.3**	**23.7**	**3.0**	**55.8**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**3**	**2**	**2**	**13**	**14**
Total Alkalinity as CaCO3	----	1	mg/L	**3**	**2**	**2**	**13**	**14**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	**1**	<1	<1	<1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**1**	**1**	**1**	**1**	**2**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**2**	**1**	**1**	**3**	**4**
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	**1**	**1**
Sodium	7440-23-5	1	mg/L	**2**	**1**	**2**	**4**	**4**
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	<1
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**2.55**	**0.65**	**0.92**	<0.01	**0.84**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**2.55**	**0.65**	**0.92**	<0.01	**0.84**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: **GROUNDWATER** (Matrix: **WATER**)			Sample ID	**BH06**	**BH09**	**BH16**	**BH17**	**BH18**
			Sampling date / time	15-Nov-2023 00:00	15-Nov-2023 00:00	15-Nov-2023 00:00	15-Nov-2023 00:00	15-Nov-2023 00:00
Compound	CAS Number	LOR	Unit	**EM2320487-001**	**EM2320487-002**	**EM2320487-003**	**EM2320487-004**	**EM2320487-005**
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.1**	<0.1	<0.1	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**2.8**	**0.8**	**0.9**	<0.1	**1.0**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.02**	**0.03**	**0.03**	**0.04**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**0.09**	**0.09**	**0.07**	**0.29**	**0.34**
ø Total Cations	----	0.01	meq/L	**0.19**	**0.09**	**0.14**	**0.40**	**0.46**

Analytical Results

Sub-Matrix: **GROUNDWATER** (Matrix: **WATER**)			*Sample ID*	**GW-Dup**	**GW-Split**	**EWS East**	**----**	**----**
			Sampling date / time	15-Nov-2023 00:00	15-Nov-2023 00:00	14-Nov-2023 00:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EM2320487-006**	**EM2320487-007**	**EM2320487-013**	**--------**	**--------**
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**5.84**	**5.87**	**6.06**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**17**	**17**	**18**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	<10	<10	----	----	----
Total Dissolved Solids @180°C	----	10	mg/L	----	----	**15**	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**21.7**	**3.7**	**4.6**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**3**	**3**	**6**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**3**	**3**	**6**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	**3**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	**1**	**1**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**1**	**1**	**1**	----	----
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	----	----
Sodium	7440-23-5	1	mg/L	**2**	**2**	**2**	----	----
Potassium	7440-09-7	1	mg/L	<1	<1	<1	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.71**	**0.98**	**0.14**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.71**	**0.98**	**0.14**	----	----

Analytical Results

Sub-Matrix: **GROUNDWATER** (Matrix: **WATER**)			Sample ID	**GW-Dup**	**GW-Split**	**EWS East**	**----**	**----**
			Sampling date / time	15-Nov-2023 00:00	15-Nov-2023 00:00	14-Nov-2023 00:00	----	----
Compound	CAS Number	LOR	Unit	**EM2320487-006**	**EM2320487-007**	**EM2320487-013**	**--------**	**--------**
				Result	Result	Result	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.7**	**1.0**	**0.1**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	**0.04**	**0.02**	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**0.06**	**0.09**	**0.21**	----	----
ø Total Cations	----	0.01	meq/L	**0.14**	**0.14**	**0.14**	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**Rinsate**	**Boggy 1 p/u 1**	**Boggy 1 p/u 2**	**Boggy 2**	**EWS**
			Sampling date / time	15-Nov-2023 00:00	14-Nov-2023 00:00	14-Nov-2023 00:00	14-Nov-2023 00:00	14-Nov-2023 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EM2320487-008**	**EM2320487-009**	**EM2320487-010**	**EM2320487-011**	**EM2320487-012**
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**5.64**	**6.12**	**6.09**	**6.14**	**6.09**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	<1	**19**	**16**	**21**	**19**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	<10	**----**	**----**	**----**	**----**
Total Dissolved Solids @180°C	----	10	mg/L	**----**	**23**	**15**	**20**	**16**
EA045: Turbidity								
Turbidity	----	0.1	NTU	<0.1	**1.7**	**0.6**	**0.1**	**4.6**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	<1	**7**	**6**	**8**	**6**
Total Alkalinity as CaCO3	----	1	mg/L	<1	**7**	**6**	**8**	**6**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	<1	<1	<1
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	<1	<1	**1**	**1**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	<1	**1**	**1**	**2**	**1**
Magnesium	7439-95-4	1	mg/L	<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L	<1	**2**	**2**	**2**	**2**
Potassium	7440-09-7	1	mg/L	<1	<1	<1	<1	<1
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**0.14**	**0.11**	**0.10**	**0.13**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**0.14**	**0.11**	**0.10**	**0.13**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**Rinsate**	**Boggy 1 p/u 1**	**Boggy 1 p/u 2**	**Boggy 2**	**EWS**
			Sampling date / time	15-Nov-2023 00:00	14-Nov-2023 00:00	14-Nov-2023 00:00	14-Nov-2023 00:00	14-Nov-2023 00:00
Compound	*CAS Number*	*LOR*	*Unit*	**EM2320487-008**	**EM2320487-009**	**EM2320487-010**	**EM2320487-011**	**EM2320487-012**
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	**0.1**	**0.1**	**0.1**	**0.1**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.03**	**0.04**	**0.03**	**0.03**	**0.04**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	<0.01	**0.14**	**0.12**	**0.19**	**0.15**
ø Total Cations	----	0.01	meq/L	<0.01	**0.14**	**0.14**	**0.19**	**0.14**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Sample ID*	**SW - Dup**	**SW - Split**	**----**	**----**	**----**
			Sampling date / time	14-Nov-2023 00:00	14-Nov-2023 00:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EM2320487-014**	**EM2320487-015**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.09**	**6.07**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**18**	**17**	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**10**	<10	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**0.8**	**0.5**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**9**	**7**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**9**	**7**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	<1	<1	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**1**	**1**	----	----	----
Magnesium	7439-95-4	1	mg/L	<1	<1	----	----	----
Sodium	7440-23-5	1	mg/L	**2**	**2**	----	----	----
Potassium	7440-09-7	1	mg/L	<1	<1	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.11**	**0.11**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.11**	**0.11**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Sample ID	**SW - Dup**	**SW - Split**	**----**	**----**	**----**
			Sampling date / time	14-Nov-2023 00:00	14-Nov-2023 00:00	----	----	----
Compound	CAS Number	LOR	Unit	**EM2320487-014**	**EM2320487-015**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Continued								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	**----**	**----**	**----**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.1**	**0.1**	**----**	**----**	**----**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.01**	**0.01**	**----**	**----**	**----**
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**0.18**	**0.14**	**----**	**----**	**----**
ø Total Cations	----	0.01	meq/L	**0.14**	**0.14**	**----**	**----**	**----**

QUALITY CONTROL REPORT

Work Order	: **EM2320487**	Page	: 1 of 7
Amendment	: **1**		
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: Meg Turner	Contact	: Peter Ravlic
Address	: SUITE 5, 105 HUME ST WODONGA VIC, AUSTRALIA 3690	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: ----	Telephone	: +6138549 9645
Project	: 12565989	Date Samples Received	: 17-Nov-2023
Order number	: 12565989	Date Analysis Commenced	: 17-Nov-2023
C-O-C number	: ----	Issue Date	: 30-Nov-2023
Sampler	: MT		
Site	:		
Quote number	: EN/000		
No. of samples received	: 15		
No. of samples analysed	: 15		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Dilani Fernando	Laboratory Coordinator	Melbourne Inorganics, Springvale, VIC
Jarwis Nheu	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Nikki Stepniewski	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC
* = The final LOR has been raised due to dilution or other sample specific cause; adjusted LOR is shown in brackets. The duplicate ranges for Acceptable RPD% are applied to the final LOR where applicable.

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EA005P: pH by PC Titrator (QC Lot: 5437610)									
EM2320467-002	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	6.66	6.66	0.0	0% - 20%
EM2320487-006	GW-Dup	EA005-P: pH Value	----	0.01	pH Unit	5.84	5.86	0.3	0% - 20%
EA005P: pH by PC Titrator (QC Lot: 5437613)									
EM2320487-015	SW - Split	EA005-P: pH Value	----	0.01	pH Unit	6.07	6.08	0.2	0% - 20%
EM2320489-011	Anonymous	EA005-P: pH Value	----	0.01	pH Unit	6.88	6.88	0.0	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 5437606)									
EM2320453-006	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	11400	11400	0.0	0% - 20%
EM2320457-002	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	5620	5540	1.5	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 5437612)									
EM2320487-006	GW-Dup	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	17	17	0.0	0% - 50%
EM2320487-015	SW - Split	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	17	17	0.0	0% - 50%
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 5436039)									
EM2320382-003	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	2950	2990	1.3	0% - 20%
EM2320391-008	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	3250	3290	1.2	0% - 20%
EM2320436-016	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	3860	3880	0.5	0% - 20%
EM2320487-002	BH09	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	<10	0.0	No Limit
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 5437356)									
EM2320272-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	3440	3410	1.0	0% - 20%
EM2320428-012	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	1260	1340	6.0	0% - 20%
EM2320436-009	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	2170	2090	3.6	0% - 20%

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 5437356) - continued									
EM2320573-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	6730	6920	2.9	0% - 20%
EA045: Turbidity (QC Lot: 5433219)									
EM2320454-001	Anonymous	EA045: Turbidity	----	0.1	NTU	<0.1	<0.1	0.0	No Limit
EM2320487-008	Rinsate	EA045: Turbidity	----	0.1	NTU	<0.1	<0.1	0.0	No Limit
ED037P: Alkalinity by PC Titrator (QC Lot: 5437611)									
EM2320487-006	GW-Dup	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	3	3	0.0	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	3	3	0.0	No Limit
EM2320487-015	SW - Split	ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.0	No Limit
		ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	7	6	0.0	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	7	6	0.0	No Limit
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 5442715)									
EM2320427-020	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.0	No Limit
EM2320463-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.0	No Limit
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 5442721)									
EM2320487-013	EWS East	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	3	1	93.1	No Limit
EM2320542-008	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	8580	8610	0.3	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 5442716)									
EM2320427-020	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	<1	<1	0.0	No Limit
EM2320463-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	<1	<1	0.0	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 5442724)									
EM2320487-013	EWS East	ED045G: Chloride	16887-00-6	1	mg/L	1	<1	0.0	No Limit
EM2320542-008	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	22400	22800	1.8	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 5440844)									
EM2320237-002	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	51	51	0.0	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	467	465	0.3	0% - 20%
		ED093F: Sodium	7440-23-5	1	mg/L	2720	2710	0.2	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	150	149	0.9	0% - 20%
EM2320238-004	Anonymous	ED093F: Calcium	7440-70-2	1 (2)*	mg/L	283	294	3.8	0% - 20%
		ED093F: Magnesium	7439-95-4	1 (2)*	mg/L	517	529	2.4	0% - 20%
		ED093F: Sodium	7440-23-5	1 (2)*	mg/L	4600	4700	2.2	0% - 20%
		ED093F: Potassium	7440-09-7	1 (2)*	mg/L	52	53	0.0	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 5440846)									
EM2320487-003	BH16	ED093F: Calcium	7440-70-2	1	mg/L	1	<1	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
ED093F: Dissolved Major Cations (QC Lot: 5440846) - continued									
EM2320487-003	BH16	ED093F: Magnesium	7439-95-4	1	mg/L	<1	<1	0.0	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	2	2	0.0	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	<1	<1	0.0	No Limit
EM2320487-011	Boggy 2	ED093F: Calcium	7440-70-2	1	mg/L	2	2	0.0	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	<1	<1	0.0	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	2	2	0.0	No Limit
		ED093F: Potassium	7440-09-7	1	mg/L	<1	<1	0.0	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 5458576)									
EM2320487-001	BH06	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EM2320487-010	Boggy 1 p/u 2	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 5442844)									
EM2320487-001	BH06	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	2.55	2.57	0.7	0% - 20%
EM2320487-010	Boggy 1 p/u 2	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.11	0.10	15.5	0% - 50%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 5440913)									
EM2320427-017	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.7	1.0	49.7	0% - 50%
EM2320487-003	BH16	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 5440912)									
EM2320365-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01 (0.02)*	mg/L	0.46	0.43	6.6	0% - 20%
EM2320487-003	BH16	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.03	0.03	0.0	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 5440914)									
EM2320487-014	SW - Dup	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.01	<0.01	0.0	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Acceptable Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EA005P: pH by PC Titrator (QCLot: 5437610)								
EA005-P: pH Value	----	----	pH Unit	----	4 pH Unit	99.8	98.8	101
				----	7 pH Unit	100	99.3	101
EA005P: pH by PC Titrator (QCLot: 5437613)								
EA005-P: pH Value	----	----	pH Unit	----	7 pH Unit	100	98.8	101
				----	9 pH Unit	100	99.3	101
EA010P: Conductivity by PC Titrator (QCLot: 5437606)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	1412 µS/cm	93.6	85.0	119
EA010P: Conductivity by PC Titrator (QCLot: 5437612)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	1412 µS/cm	95.9	85.0	119
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 5436039)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	200 mg/L	100	91.0	110
				<10	1000 mg/L	100	80.8	119
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 5437356)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	101	91.0	110
				<10	2340 mg/L	99.8	80.8	119
				<10	293 mg/L	95.9	91.0	110
EA045: Turbidity (QCLot: 5433219)								
EA045: Turbidity	----	0.1	NTU	<0.1	40 NTU	100	88.1	110
ED037P: Alkalinity by PC Titrator (QCLot: 5437611)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	95.0	85.0	116
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 5442715)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	500 mg/L	104	90.0	110
				<1	25 mg/L	107	90.0	110
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 5442721)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	500 mg/L	104	90.0	110
				<1	25 mg/L	106	90.0	110
ED045G: Chloride by Discrete Analyser (QCLot: 5442716)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	1000 mg/L	99.3	90.0	110
				<1	10 mg/L	98.0	90.0	110
ED045G: Chloride by Discrete Analyser (QCLot: 5442724)								

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 5442724) - continued								
ED045G: Chloride	16887-00-6	1	mg/L	<1	1000 mg/L	101	90.0	110
				<1	10 mg/L	99.2	90.0	110
ED093F: Dissolved Major Cations (QCLot: 5440844)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	102	80.0	120
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	102	80.0	120
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	98.5	80.0	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	98.1	80.0	120
ED093F: Dissolved Major Cations (QCLot: 5440846)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	100	80.0	120
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	100	80.0	120
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	96.3	80.0	120
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	96.7	80.0	120
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5458576)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	103	90.0	110
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 5442844)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	103	90.0	110
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 5440913)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	5 mg/L	86.7	70.0	117
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5440912)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	2.21 mg/L	93.0	71.9	114
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5440914)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	2.21 mg/L	88.7	71.9	114

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 5442715)							
EM2320427-021	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	100 mg/L	97.4	70.0	130
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 5442721)							
EM2320487-014	SW - Dup	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	100 mg/L	98.1	70.0	130
ED045G: Chloride by Discrete Analyser (QCLot: 5442716)							

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED045G: Chloride by Discrete Analyser (QCLot: 5442716) - continued							
EM2320427-021	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	106	70.0	142
ED045G: Chloride by Discrete Analyser (QCLot: 5442724)							
EM2320487-014	SW - Dup	ED045G: Chloride	16887-00-6	400 mg/L	99.5	70.0	142
EK057G: Nitrite as N by Discrete Analyser (QCLot: 5458576)							
EM2320487-002	BH09	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	102	80.0	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 5442844)							
EM2320487-002	BH09	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	107	70.0	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 5440913)							
EM2320427-018	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	101	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5440912)							
EM2320365-005	Anonymous	EK067G: Total Phosphorus as P	----	2 mg/L	116	70.0	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 5440914)							
EM2320487-015	SW - Split	EK067G: Total Phosphorus as P	----	1 mg/L	98.4	70.0	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM2320487**	Page	: 1 of 11
Amendment	: **1**		
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Melbourne
Contact	: Meg Turner	Telephone	: +6138549 9645
Project	: 12565989	Date Samples Received	: 17-Nov-2023
Site	:	Issue Date	: 30-Nov-2023
Sampler	: MT	No. of samples received	: 15
Order number	: 12565989	No. of samples analysed	: 15

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method		*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)		*Date extracted*	*Due for extraction*	**Days overdue**	*Date analysed*	*Due for analysis*	**Days overdue**
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
Boggy 1 p/u 1,	Boggy 1 p/u 2,	----	----	----	23-Nov-2023	14-Nov-2023	**9**
Boggy 2,	EWS,						
EWS East,	SW - Dup,						
SW - Split							
Clear Plastic Bottle - Natural							
BH06,	BH09,	----	----	----	23-Nov-2023	15-Nov-2023	**8**
BH16,	BH17,						
BH18,	GW-Dup,						
GW-Split,	Rinsate						
EA045: Turbidity							
Clear Plastic Bottle - Natural							
Boggy 1 p/u 1,	Boggy 1 p/u 2,	----	----	----	17-Nov-2023	16-Nov-2023	**1**
Boggy 2,	EWS,						
EWS East,	SW - Dup,						
SW - Split							
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural							
Boggy 1 p/u 1,	Boggy 1 p/u 2,	----	----	----	29-Nov-2023	16-Nov-2023	**13**
Boggy 2,	EWS,						
EWS East,	SW - Dup,						
SW - Split							
Clear Plastic Bottle - Natural							
BH06,	BH09,	----	----	----	29-Nov-2023	17-Nov-2023	**12**
BH16,	BH17,						
BH18,	GW-Dup,						
GW-Split,	Rinsate						
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Natural							
Boggy 1 p/u 1,	Boggy 1 p/u 2,	----	----	----	22-Nov-2023	16-Nov-2023	**6**
Boggy 2,	EWS,						
EWS East,	SW - Dup,						
SW - Split							
Clear Plastic Bottle - Natural							
BH06,	BH09,	----	----	----	22-Nov-2023	17-Nov-2023	**5**
BH16,	BH17,						
BH18,	GW-Dup,						
GW-Split,	Rinsate						
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							

Matrix: **WATER**

Method	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser - Analysis Holding Time Compliance						
Clear Plastic Bottle - Natural Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	23-Nov-2023	15-Nov-2023	**8**	----	----	----
Clear Plastic Bottle - Natural BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	23-Nov-2023	16-Nov-2023	**7**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser						
Clear Plastic Bottle - Natural Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	23-Nov-2023	16-Nov-2023	**7**	----	----	----
Clear Plastic Bottle - Natural BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	23-Nov-2023	17-Nov-2023	**6**	----	----	----

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
Container */ Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*

Matrix: **WATER**

Evaluation: ✘ = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P) Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	**14-Nov-2023**	**----**	----	----	**23-Nov-2023**	14-Nov-2023	✘
Clear Plastic Bottle - Natural (EA005-P) BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	**15-Nov-2023**	**----**	----	----	**23-Nov-2023**	15-Nov-2023	✘
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P) Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	**14-Nov-2023**	**----**	----	----	**23-Nov-2023**	12-Dec-2023	✓
Clear Plastic Bottle - Natural (EA010-P) BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	**15-Nov-2023**	**----**	----	----	**23-Nov-2023**	13-Dec-2023	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H) Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	**14-Nov-2023**	**----**	----	----	**21-Nov-2023**	21-Nov-2023	✓
Clear Plastic Bottle - Natural (EA015H) BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	**15-Nov-2023**	**----**	----	----	**20-Nov-2023**	22-Nov-2023	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA045: Turbidity							
Clear Plastic Bottle - Natural (EA045) Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	**14-Nov-2023**	**----**	----	----	**17-Nov-2023**	16-Nov-2023	×
Clear Plastic Bottle - Natural (EA045) BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	**15-Nov-2023**	**----**	----	----	**17-Nov-2023**	17-Nov-2023	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	**14-Nov-2023**	**----**	----	----	**23-Nov-2023**	28-Nov-2023	✓
Clear Plastic Bottle - Natural (ED037-P) BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	**15-Nov-2023**	**----**	----	----	**23-Nov-2023**	29-Nov-2023	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	**14-Nov-2023**	**----**	----	----	**22-Nov-2023**	12-Dec-2023	✓
Clear Plastic Bottle - Natural (ED041G) BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	**15-Nov-2023**	**----**	----	----	**22-Nov-2023**	13-Dec-2023	✓

Matrix: **WATER**

Evaluation: ✘ = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	**14-Nov-2023**	**----**	----	----	**22-Nov-2023**	12-Dec-2023	✓
Clear Plastic Bottle - Natural (ED045G) BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	**15-Nov-2023**	**----**	----	----	**22-Nov-2023**	13-Dec-2023	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	**14-Nov-2023**	**----**	----	----	**22-Nov-2023**	12-Dec-2023	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	**15-Nov-2023**	**----**	----	----	**22-Nov-2023**	13-Dec-2023	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	**14-Nov-2023**	**----**	----	----	**29-Nov-2023**	16-Nov-2023	✘
Clear Plastic Bottle - Natural (EK057G) BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	**15-Nov-2023**	**----**	----	----	**29-Nov-2023**	17-Nov-2023	✘

Matrix: **WATER**

Evaluation: ✘ = Holding time breach ; ✓ = Within holding time.

Method ***Container** / Client Sample ID(s)*	***Sample Date***	*Extraction / Preparation* ***Date extracted***	 *Due for extraction*	 *Evaluation*	*Analysis* ***Date analysed***	 *Due for analysis*	 *Evaluation*
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Natural (EK059G) Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	**14-Nov-2023**	**----**	----	----	**22-Nov-2023**	16-Nov-2023	✘
Clear Plastic Bottle - Natural (EK059G) BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	**15-Nov-2023**	**----**	----	----	**22-Nov-2023**	17-Nov-2023	✘
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Natural (EK061G) Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	**14-Nov-2023**	**23-Nov-2023**	15-Nov-2023	✘	**24-Nov-2023**	21-Dec-2023	✓
Clear Plastic Bottle - Natural (EK061G) BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	**15-Nov-2023**	**23-Nov-2023**	16-Nov-2023	✘	**24-Nov-2023**	21-Dec-2023	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Natural (EK067G) Boggy 1 p/u 1, Boggy 1 p/u 2, Boggy 2, EWS, EWS East, SW - Dup, SW - Split	**14-Nov-2023**	**23-Nov-2023**	16-Nov-2023	✘	**24-Nov-2023**	21-Dec-2023	✓
Clear Plastic Bottle - Natural (EK067G) BH06, BH09, BH16, BH17, BH18, GW-Dup, GW-Split, Rinsate	**15-Nov-2023**	**23-Nov-2023**	17-Nov-2023	✘	**24-Nov-2023**	21-Dec-2023	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		*Count*		*Rate (%)*			*Quality Control Specification*
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by Auto Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	4	36	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by Auto Titrator	EA010-P	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	4	38	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by Auto Titrator	EA005-P	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	4	37	**10.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	8	80	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	3	22	**13.64**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by Auto Titrator	ED037-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	4	36	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by Auto Titrator	EA010-P	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	38	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by Auto Titrator	EA005-P	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	4	37	**10.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	6	80	**7.50**	**7.50**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by Auto Titrator	EA010-P	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	38	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	4	80	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Turbidity	EA045	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS)							
Chloride by Discrete Analyser	ED045G	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
pH by Auto Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM Schedule B(3)
Conductivity by Auto Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM Schedule B(3)
Turbidity	EA045	WATER	In house: Referenced to APHA 2130 B. This method is compliant with NEPM Schedule B(3)
Alkalinity by Auto Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) on a settled supernatant aliquot of the sample using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride. In the presence of ferric ions the liberated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm.
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM Schedule B(3)

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al, Zhang et al. This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	* EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM Schedule B(3)

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM Schedule B(3)

DATE: 15/4/24
TIME: 17:05
COURIER: –
TEMPERATURE 5.9 °C
ATTEMP TO CHILL : [✓ YES] NO

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GHD

CHAIN OF CUSTODY RECORD

Project Number	12565989
Project Name	Mount Buller Water Storage Ongoing Monitoring Program
GHD Project Manager	Meg Turner
GHD Contact	Meg Turner
GHD PM email	Meg.Turner@ghd.com
GHD Contact email	meg.turner@ghd.com

GHD Melbourne Office Address
180 Lonsdale Street Melbourne 3000
Telephone 613 8687 8000
Fax 613 8687 8111

Completion Date / Turnaround FREIGHT 5 Day TAT

Quote # Page 1 of 1
Quote ALS

Laboratory
ALS

Laboratory Address
2 - 4 Westall Road, Springvale 3171

Laboratory Contact
Shirley Le Cornu

COURIER AND LABORATORY INSTRUCTIONS:

- Sign chain of custody document on reciept and release of samples between each party
- Samples are to be delivered to the laboratory address shown
- Laboratory contact should sign the COC and send a copy (via email) to the GHD Project Manager and GHD Contact, along with a sample receipt notice, within 24 hours of receipt
- A signed copy of the COC should be returned to the GHD Project Manager and GHD Contact with the results via email at the completion of analysis as requested
- All results should reference the Job Number and Project Name
- All results should be provided in NATA accredited pdf format and ESDAT format

#1087789

Micro Nitrate BOD pH
Colour Turbidity RP
Other
Date 12/4 SM

	Sample I.D.	Date and Time	Composite Sample	Sample Matrix S: Soil SL: Sludg W: Water A: Air GW:	Preservative	Type J: soil jar B: bag V: vial G: glass bottle P: plastic bottle	Number	Volume (ml)	Major Cations (Ca, Mg, Na, K)	Major Anions (Cl, SO4 Alkalinity, Total)	ds N	EC, TDS, T	Forward to Eurofins	SAMPLE COMMENTS
1	Boggy 1 P/U 1	9/4/24		W		P	3		X	X	X	X		
2	Boggy 1 P/U 2													
3	Boggy 2													
4	SW-FD03													
→	SW-FS03												X	Send to Eurofins
→	SW-FS01.1												X	" " "
5	EWS East			GW										
6	BH18			GW										
7	BH09	10/4/24												
8	BH17													
9	BH06													
10	BH16													
11	GW-FD03													
→	GW-FS03												X	Send to Eurofins
→	GW-FS01.1												X	Send to Eurofins
12	R3			W										

Environmental Division
Melbourne
Work Order Reference
EM2405745
Telephone : +61-3-8549 9600
15/4, BL

TOTAL NUMBER OF SAMPLES	16
TOTAL NUMBER OF ESKIES	2

CUSTODY DETAILS

SAMPLER:	M. Turner	Date/Time	10/4/24	Relinquished by	M. Turner	Date/Time 11/4/24
COURIER:		Date/Time		Relinquished by		Date/Time
LABORATORY:		Date/Time				
COMMENTS:	Samples stored on ice in esky					

Mona (M) 12/4, 11-20

Company Name: GHD Pty Ltd VIC
Address: Level 8, 180 Lonsdale St
Melbourne
VIC 3000

Project Name: Mount Buller Water Storage Ongoing Monitoring Program
Project ID: 12565989

Order No.:
Report #: 1087789
Phone: 8687 8000
Fax: 8687 8111

Received: Apr 15, 2024 5:05 PM
Due: Apr 22, 2024
Priority: 5 Day
Contact Name: Meg Turner

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail						Conductivity (at 25 °C)	Phosphate total (as P)	Turbidity	Total Nitrogen Set (as N)	Major Anions	Major Cations	Total Dissolved Solids Dried at 180 °C ± 2 °C
Melbourne Laboratory - NATA # 1261 Site # 1254						X	X	X	X	X	X	X
External Laboratory												
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**							
1	SW_FS03	Apr 09, 2024		Water	M24-Ap0037659	X	X	X	X	X	X	X
2	SW_FS01.1	Apr 09, 2024		Water	M24-Ap0037660	X	X	X	X	X	X	X
3	GW_FS03	Apr 09, 2024		Water	M24-Ap0037661	X	X	X	X	X	X	X
4	GW_FS01.1	Apr 09, 2024		Water	M24-Ap0037662	X	X	X	X	X	X	X
Test Counts						4	4	4	4	4	4	4

Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates.

GHD Melbourne
Level 8, 180 Lonsdale St
Melbourne
VIC 3000

Attention: **Meg Turner**

Report **1087789-W**
Project name Mount Buller Water Storage Ongoing Monitoring Program
Project ID 12565989
Received Date Apr 15, 2024

Client Sample ID			**SW_FS03**	**SW_FS01.1**	**GW_FS03**	**GW_FS01.1**
Sample Matrix			**Water**	**Water**	**Water**	**Water**
Eurofins Sample No.			**M24-Ap0037659**	**M24-Ap0037660**	**M24-Ap0037661**	**M24-Ap0037662**
Date Sampled			**Apr 09, 2024**	**Apr 09, 2024**	**Apr 09, 2024**	**Apr 09, 2024**
Test/Reference	LOR	Unit				
Ammonia (as N)	0.01	mg/L	0.02	< 0.01	0.02	0.02
Chloride	1	mg/L	1.4	1.6	1.2	3.0
Conductivity (at 25 °C)	10	uS/cm	33	28	20	50
Nitrate & Nitrite (as N)	0.05	mg/L	0.10	0.13	0.96	5.9
Nitrate (as N)	0.02	mg/L	0.10	0.13	0.96	5.9
Nitrite (as N)	0.02	mg/L	< 0.02	< 0.02	< 0.02	< 0.02
Sulphate (as SO4)	5	mg/L	20	< 5	< 5	< 5
Total Dissolved Solids Dried at 180 °C ± 2 °C	10	mg/L	59	39	47	83
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	1.0	0.7	1.3	2.2
Total Nitrogen (as N)*	0.2	mg/L	1.1	0.8	2.3	8.1
Turbidity	1	NTU	< 1	1.6	130	15
Phosphate total (as P)	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01
Alkalinity (speciated)						
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	240	260	33	< 20
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10	< 10	< 10
Alkali Metals						
Calcium	0.5	mg/L	1.7	1.5	0.5	3.4
Magnesium	0.5	mg/L	0.6	< 0.5	< 0.5	1.3
Potassium	0.5	mg/L	< 0.5	< 0.5	< 0.5	< 0.5
Sodium	0.5	mg/L	2.0	2.3	1.7	2.1

Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Major Cations			
Ammonia (as N)	Melbourne	Apr 17, 2024	28 Days
- Method: LTM-INO-4450 Determination of Nitrogen Species by Discrete Analyser			
Alkali Metals	Melbourne	Apr 17, 2024	180 Days
- Method: LTM-MET-3010 Alkali Metals Sulfur Silicon Phosphorus by ICP-AES			
Major Anions			
Chloride	Melbourne	Apr 17, 2024	28 Days
- Method: LTM-INO-4270 Anions by Ion Chromatography			
Nitrate (as N)	Melbourne	Apr 17, 2024	28 Days
- Method: LTM-INO-4450 Determination of Nitrogen Species by Discrete Analyser			
Sulphate (as SO4)	Melbourne	Apr 17, 2024	28 Days
- Method: LTM-INO-4270 Anions by Ion Chromatography			
Alkalinity (speciated)	Melbourne	Apr 17, 2024	14 Days
- Method: LTM-INO-4250 Alkalinity by Electrometric Titration			
Conductivity (at 25 °C)	Melbourne	Apr 17, 2024	28 Days
- Method: LTM-INO-4030 Conductivity			
Turbidity	Melbourne	Apr 17, 2024	28 Days
- Method: Turbidity by classical using APHA 2130B (LTM-INO-4140)			
Phosphate total (as P)	Melbourne	Apr 17, 2024	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Total Nitrogen Set (as N)			
Nitrate & Nitrite (as N)	Melbourne	Apr 17, 2024	28 Days
- Method: LTM-INO-4450 Determination of Nitrogen Species by Discrete Analyser			
Nitrite (as N)	Melbourne	Apr 17, 2024	2 Days
- Method: LTM-INO-4450 Determination of Nitrogen Species by Discrete Analyser			
Total Kjeldahl Nitrogen (as N)	Melbourne	Apr 17, 2024	28 Days
- Method: APHA 4500-Norg B,D Total Kjeldahl Nitrogen by FIA			
Total Dissolved Solids Dried at 180 °C ± 2 °C	Melbourne	Apr 17, 2024	28 Days
- Method: LTM-INO-4170 Total Dissolved Solids in Water			

Company Name: GHD Pty Ltd VIC
Address: Level 8, 180 Lonsdale St
Melbourne
VIC 3000

Order No.:
Report #: 1087789
Phone: 8687 8000
Fax: 8687 8111

Received: Apr 15, 2024 5:05 PM
Due: Apr 22, 2024
Priority: 5 Day
Contact Name: Meg Turner

Project Name: Mount Buller Water Storage Ongoing Monitoring Program
Project ID: 12565989

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail						Conductivity (at 25 °C)	Phosphate total (as P)	Turbidity	Total Nitrogen Set (as N)	Major Anions	Major Cations	Total Dissolved Solids Dried at 180 °C ± 2 °C
Melbourne Laboratory - NATA # 1261 Site # 1254						X	X	X	X	X	X	X
External Laboratory												
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**							
1	SW_FS03	Apr 09, 2024		Water	M24-Ap0037659	X	X	X	X	X	X	X
2	SW_FS01.1	Apr 09, 2024		Water	M24-Ap0037660	X	X	X	X	X	X	X
3	GW_FS03	Apr 09, 2024		Water	M24-Ap0037661	X	X	X	X	X	X	X
4	GW_FS01.1	Apr 09, 2024		Water	M24-Ap0037662	X	X	X	X	X	X	X
Test Counts						4	4	4	4	4	4	4

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follow guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013. They are included in this QC report where applicable. Additional QC data may be available on request.
2. Unless otherwise stated, all soil/sediment/solid results are reported on a dry weight basis.
3. Unless otherwise stated, all biota/food results are reported on a wet weight basis on the edible portion.
4. For CEC results where the sample's origin is unknown or environmentally contaminated, the results should be used advisedly.
5. Actual LORs are matrix dependent. Quoted LORs may be raised where sample extracts are diluted due to interferences.
6. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds where annotated.
7. SVOC analysis on waters is performed on homogenised, unfiltered samples unless noted otherwise.
8. Samples were analysed on an 'as received' basis.
9. Information identified in this report with blue colour indicates data provided by customers that may have an impact on the results.
10. This report replaces any interim results previously issued.

Holding Times

Please refer to the 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours before sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and despite any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the sampling date; therefore, compliance with these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether, the holding time is seven days; however, for all other VOCs, such as BTEX or C6-10 TRH, the holding time is 14 days.

Units

mg/kg: milligrams per kilogram

mg/L: milligrams per litre

ppm: parts per million

µg/L: micrograms per litre

ppb: parts per billion

%: Percentage

org/100 mL: Organisms per 100 millilitres

NTU: Nephelometric Turbidity Units

MPN/100 mL: Most Probable Number of organisms per 100 millilitres

CFU: Colony Forming Unit

Colour: Pt-Co Units (CU)

Terms

APHA	American Public Health Association
CEC	Cation Exchange Capacity
COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where moisture has been determined on a solid sample, the result is expressed on a dry weight basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples, these are performed on laboratory-certified clean sands and in the case of water samples, these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC represents the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a similar compound to the analyte target is reported as percentage recovery. See below for acceptance criteria.
TBTO	Tributyltin oxide (*bis*-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment; however, free tributyltin was measured, and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 6.0
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should only be used as a guide and may be different when site-specific Sampling Analysis and Quality Plan (SAQP) have been implemented.

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is ≤30%; however, the following acceptance guidelines are equally applicable:

Results <10 times the LOR:	No Limit
Results between 10-20 times the LOR:	RPD must lie between 0-50%
Results >20 times the LOR:	RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range, not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS. SVOCs recoveries 20 – 150%, VOC recoveries 50 – 150%

PFAS field samples containing surrogate recoveries above the QC limit designated in QSM 6.0, where no positive PFAS results have been reported or reviewed, and no data was affected.

QC Data General Comments

1. Where a result is reported as less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown are not data from your samples.
3. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time.Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery, the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results, a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data; thus, it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Ammonia (as N)	mg/L	< 0.01			0.01	Pass	
Chloride	mg/L	< 1			1	Pass	
Conductivity (at 25 °C)	uS/cm	10			10	Pass	
Nitrate & Nitrite (as N)	mg/L	< 0.05			0.05	Pass	
Nitrate (as N)	mg/L	< 0.02			0.02	Pass	
Nitrite (as N)	mg/L	< 0.02			0.02	Pass	
Sulphate (as SO4)	mg/L	< 5			5	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	mg/L	< 10			10	Pass	
Total Kjeldahl Nitrogen (as N)	mg/L	< 0.2			0.2	Pass	
Turbidity	NTU	< 1			1	Pass	
Method Blank							
Alkali Metals							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
Method Blank							
Nitrite (as N)	mg/L	< 0.02			0.02	Pass	
Sulphate (as SO4)	mg/L	< 5			5	Pass	
Phosphate total (as P)	mg/L	< 0.01			0.01	Pass	
Method Blank							
Nitrite (as N)	mg/L	< 0.02			0.02	Pass	
Method Blank							
Alkali Metals							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
Method Blank							
Nitrite (as N)	mg/L	< 0.02			0.02	Pass	
Method Blank							
Alkali Metals							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							
Ammonia (as N)	%	105			70-130	Pass	
Chloride	%	126			70-130	Pass	
Conductivity (at 25 °C)	%	97			70-130	Pass	
Nitrate & Nitrite (as N)	%	116			70-130	Pass	
Sulphate (as SO4)	%	113			70-130	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	%	97			70-130	Pass	
Total Kjeldahl Nitrogen (as N)	%	101			70-130	Pass	
Turbidity	%	93			70-130	Pass	
LCS - % Recovery							
Alkalinity (speciated)							
Carbonate Alkalinity (as CaCO3)	%	107			70-130	Pass	
LCS - % Recovery							
Alkali Metals							
Calcium	%	93			80-120	Pass	

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Magnesium			%	92			80-120	Pass	
Potassium			%	93			80-120	Pass	
Sodium			%	91			80-120	Pass	
LCS - % Recovery									
Nitrate & Nitrite (as N)			%	114			70-130	Pass	
Phosphate total (as P)			%	98			70-130	Pass	
LCS - % Recovery									
Nitrite (as N)			%	101			70-130	Pass	
LCS - % Recovery									
Alkali Metals									
Calcium			%	89			80-120	Pass	
Magnesium			%	91			80-120	Pass	
Potassium			%	88			80-120	Pass	
Sodium			%	91			80-120	Pass	
LCS - % Recovery									
Nitrate & Nitrite (as N)			%	114			70-130	Pass	
LCS - % Recovery									
Alkali Metals									
Calcium			%	93			80-120	Pass	
Magnesium			%	88			80-120	Pass	
Potassium			%	88			80-120	Pass	
Sodium			%	88			80-120	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
				Result 1					
Chloride	M24-Ap0038956	NCP	%	85			70-130	Pass	
Nitrate & Nitrite (as N)	B24-Ap0034963	NCP	%	107			70-130	Pass	
Nitrite (as N)	B24-Ap0034963	NCP	%	99			70-130	Pass	
Sulphate (as SO4)	M24-Ap0038967	NCP	%	103			70-130	Pass	
Total Kjeldahl Nitrogen (as N)	M24-Ap0038990	NCP	%	106			70-130	Pass	
Phosphate total (as P)	B24-Ap0027787	NCP	%	99			70-130	Pass	
Spike - % Recovery									
Alkali Metals				Result 1					
Calcium	M24-Ap0039585	NCP	%	94			75-125	Pass	
Magnesium	M24-Ap0039585	NCP	%	98			75-125	Pass	
Potassium	M24-Ap0039585	NCP	%	93			75-125	Pass	
Sodium	M24-Ap0043956	NCP	%	92			75-125	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Chloride	M24-Ap0038955	NCP	mg/L	6.2	6.1	1.5	30%	Pass	
Sulphate (as SO4)	M24-Ap0038955	NCP	mg/L	7.5	8.6	15	30%	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	M24-Ap0038955	NCP	mg/L	140	130	8.8	30%	Pass	
Total Kjeldahl Nitrogen (as N)	B24-Ap0030454	NCP	mg/L	1.4	1.5	8.1	30%	Pass	
Turbidity	M24-Ap0043777	NCP	NTU	2.1	2.1	<1	30%	Pass	
Duplicate									
Alkali Metals				Result 1	Result 2	RPD			
Calcium	M24-Ap0037659	CP	mg/L	1.7	1.6	4.2	30%	Pass	
Magnesium	M24-Ap0037659	CP	mg/L	0.6	0.5	5.4	30%	Pass	
Potassium	M24-Ap0037659	CP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
Sodium	M24-Ap0037659	CP	mg/L	2.0	2.0	1.1	30%	Pass	

Duplicate									
				Result 1	Result 2	RPD			
Phosphate total (as P)	M24-Ap0037660	CP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
Ammonia (as N)	M24-Ap0037661	CP	mg/L	0.02	0.02	4.4	30%	Pass	
Nitrate & Nitrite (as N)	M24-Ap0037661	CP	mg/L	0.96	0.98	1.5	30%	Pass	
Nitrite (as N)	M24-Ap0037661	CP	mg/L	< 0.02	< 0.02	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised by:

Savini Suduweli	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal
Mary Makarios	Senior Analyst-Inorganic
Mary Makarios	Senior Analyst-Metal

Glenn Jackson
Managing Director

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

For Eurofins

91

CHAIN OF CUSTODY RECORD

GHD Melbourne Office Address
180 Lonsdale Street, Melbourne 3000
Telephone: 613 8687 8000
Fax: 613 8687 8111

Completion Date / Turnaround
5 Day TAT

Report: 1067359
9/2 BF

Project Number
12565989

Project Name
Mount Buller Water Storage Ongoing Monitoring Program

GHD Project Manager
Meg Turner

GHD Contact
Meg Turner

GHD PM email
Meg.Turner@ghd.com

GHD Contact email
meg.turner@ghd.com

Laboratory
ALS

Laboratory Address
2 - 4 Westall Road, Springvale 3171

Laboratory Contact
Shirley Le Cornu

Sample I.D.	Date and Time	Composite Sample	S: Soil SL: Sludg W: Water A: Air GW:	Preservative	Containers Type J: soil jar B: bag V: vial G: glass bottle P: plastic bottle	Containers Number	Containers Volume (ml)	Analyses Required Major Cations (Ca, Mg, Na, K)	Major Anions (Cl, SO4, Alkalinity, Total)	Nutrients: Nitrogen as N, nitrate as N, Total N, TKN, Total P	EC, TDS, Turbidity										Forward to Eurofins
SW-FS01	6/2/24		W		P	3		X	X	X	X										
GW-FS02	7/2/24		W		P	3		X	X	X	X										

TOTAL NUMBER OF SAMPLES	2
TOTAL NUMBER OF ESKIES	1

CUSTODY DETAILS

SAMPLER:	M. Turner	Date/Time	7/2/24	Relinquished by:	M. Turner 7/2/24
COURIER:		Date/Time		Relinquished by:	

9/2 11:00

DATE: 9/2
TIME: 17:22
COURIER:
TEMPERATURE 4.1
ATTEMP TO CHILL : YES / NO
BF

Scott Huett

From: Meg Turner <Meg.Turner@ghd.com>
Sent: Friday, 9 February 2024 4:03 PM
To: Peter Ravlic
Subject: [EXTERNAL] - RE: EM2401890 - GHDSER - 12565989

Hi Peter,

Thank you for the notice, please analyse the EWS samples as per the rest of the samples.

Could the following sample names please be changed also:

Original name	New name
SW-FD01	SW-FD02
SW-FS01	SW-FS02

Kind regards,

Meg Turner (she/her)
B. Env Sci
Environmental Scientist – Victoria Environmental Management
GHD
Proudly employee-owned | ghd.com
105 Hume Street, Wodonga, Victoria, 3690, Australia
D +61 3 8687 8862 **(primary phone)** M +61 477 513 431 **(if work phone is unattended)** E meg.turner@ghd.com

➔ **The Power of Commitment**

Connect

From: Peter Ravlic <peter.ravlic@alsglobal.com>
Sent: Friday, February 9, 2024 12:38 PM
To: Meg Turner <Meg.Turner@ghd.com>
Subject: EM2401890 - GHDSER - 12565989

Hi Meg

For the attached COC:

Extra sample received:
EWS East (sample 012)
EWS West (sample 013)

Thanks

Kind Regards

eurofins

web: www.eurofins.com.au
email: EnviroSales@eurofins.com

Eurofins Environment Testing Australia Pty Ltd
ABN: 50 005 085 521

Melbourne	Geelong	Sydney	Canberra	Brisbane	Newcastle
6 Monterey Road	19/8 Lewalan Street	179 Magowar Road	Unit 1,2 Dacre Street	1/21 Smallwood Place	1/2 Frost Drive
Dandenong South	Grovedale	Girraween	Mitchell	Murarrie	Mayfield West
VIC 3175	VIC 3216	NSW 2145	ACT 2911	QLD 4172	NSW 2304
+61 3 8564 5000	+61 3 8564 5000	+61 2 9900 8400	+61 2 6113 8091	T: +61 7 3902 4600	+61 2 4968 8448
NATA# 1261	NATA# 1261	NATA# 1261	NATA# 1261	NATA# 1261	NATA# 1261
Site# 1254	Site# 25403	Site# 18217	Site# 25466	Site# 20794	Site# 25079 & 25289

Eurofins ARL Pty Ltd
ABN: 91 05 0159 898

Perth
46-48 Banksia Road
Welshpool
WA 6106
+61 8 6253 4444
NATA# 2377
Site# 2370

Eurofins Environment Testing NZ Ltd
NZBN: 9429046024954

Auckland	Auckland (Asb)	Christchurch	Tauranga
35 O'Rorke Road	Unit C1/4 Pacific Rise,	43 Detroit Drive	1277 Cameron Road,
Penrose,	Mount Wellington,	Rolleston,	Gate Pa,
Auckland 1061	Auckland 1061	Christchurch 7675	Tauranga 3112
+64 9 526 4551	+64 9 525 0568	+64 3 343 5201	+64 9 525 0568
IANZ# 1327	IANZ# 1308	IANZ# 1290	IANZ# 1402

Company Name: GHD Pty Ltd VIC
Address: Level 8, 180 Lonsdale St
Melbourne
VIC 3000

Order No.:
Report #: 1067359
Phone: 8687 8000
Fax: 8687 8111

Received: Feb 9, 2024 5:22 PM
Due: Feb 16, 2024
Priority: 5 Day
Contact Name: Meg Turner

Project Name: MOUNT BULLER WATER STORAGE ONGOING MONITORING PROGRAM
Project ID: 12565989

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail						Conductivity (at 25 °C)	Phosphate total (as P)	Turbidity	Total Nitrogen Set (as N)	Eurofins Suite B11E: Cl/SO4/Alkalinity	Eurofins Suite B11C: Na/K/Ca/Mg	Total Dissolved Solids Dried at 180 °C ± 2 °C
Melbourne Laboratory - NATA # 1261 Site # 1254						X	X	X	X	X	X	X
External Laboratory												
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**							
1	SW-FS02	Feb 06, 2024		Water	M24-Fe0025606	X	X	X	X	X	X	X
2	GW-FS02	Feb 07, 2024		Water	M24-Fe0025607	X	X	X	X	X	X	X
Test Counts						2	2	2	2	2	2	2

Certificate of Analysis

GHD Melbourne
Level 8, 180 Lonsdale St
Melbourne
VIC 3000

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates.

Attention:	**Meg Turner**
Report	**1067359-W**
Project name	MOUNT BULLER WATER STORAGE ONGOING MONITORING PROGRAM
Project ID	12565989
Received Date	Feb 09, 2024

Client Sample ID **Sample Matrix** **Eurofins Sample No.** **Date Sampled** Test/Reference	LOR	Unit	**SW-FS02** **Water** **M24-Fe0025606** **Feb 06, 2024**	**GW-FS02** **Water** **M24-Fe0025607** **Feb 07, 2024**
Chloride	1	mg/L	1.1	1.3
Conductivity (at 25 °C)	10	uS/cm	73	56
Nitrate & Nitrite (as N)	0.05	mg/L	0.10	0.97
Nitrate (as N)	0.02	mg/L	0.10	0.97
Nitrite (as N)	0.02	mg/L	< 0.02	< 0.02
Sulphate (as SO4)	5	mg/L	< 5	< 5
Total Dissolved Solids Dried at 180 °C ± 2 °C	10	mg/L	3200	4600
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	0.3	0.3
Total Nitrogen (as N)*	0.2	mg/L	0.4	1.3
Turbidity	1	NTU	< 1	33
Phosphate total (as P)	0.01	mg/L	< 0.01	< 0.01
Alkalinity (speciated)				
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	39	< 20
Carbonate Alkalinity (as CaCO3)	10	mg/L	< 10	< 10
Hydroxide Alkalinity (as CaCO3)	20	mg/L	< 20	< 20
Total Alkalinity (as CaCO3)	20	mg/L	39	< 20
Alkali Metals				
Calcium	0.5	mg/L	1.8	1.0
Magnesium	0.5	mg/L	0.7	< 0.5
Potassium	0.5	mg/L	< 0.5	< 0.5
Sodium	0.5	mg/L	2.3	2.0

Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Eurofins Suite B11E: Cl/SO4/Alkalinity			
Chloride	Melbourne	Feb 10, 2024	28 Days
- Method: LTM-INO-4270 Anions by Ion Chromatography			
Sulphate (as SO4)	Melbourne	Feb 10, 2024	28 Days
- Method: LTM-INO-4270 Anions by Ion Chromatography			
Alkalinity (speciated)	Melbourne	Feb 10, 2024	14 Days
- Method: LTM-INO-4250 Alkalinity by Electrometric Titration			
Conductivity (at 25 °C)	Melbourne	Feb 10, 2024	28 Days
- Method: LTM-INO-4030 Conductivity			
Turbidity	Melbourne	Feb 13, 2024	28 Days
- Method: Turbidity by classical using APHA 2130B (LTM-INO-4140)			
Phosphate total (as P)	Melbourne	Feb 10, 2024	28 Days
- Method: LTM-MET-3040 Metals in Waters, Soils & Sediments by ICP-MS			
Eurofins Suite B11C: Na/K/Ca/Mg	Melbourne	Feb 10, 2024	180 Days
- Method: LTM-MET-3040 METALS IN WATERS, SOLIDS,			
Total Nitrogen Set (as N)			
Nitrate & Nitrite (as N)	Melbourne	Feb 10, 2024	28 Days
- Method: LTM-INO-4450 Determination of Nitrogen Species by Discrete Analyser			
Nitrate (as N)	Melbourne	Feb 10, 2024	28 Days
- Method: LTM-INO-4450 Determination of Nitrogen Species by Discrete Analyser			
Nitrite (as N)	Melbourne	Feb 10, 2024	2 Days
- Method: LTM-INO-4450 Determination of Nitrogen Species by Discrete Analyser			
Total Kjeldahl Nitrogen (as N)	Melbourne	Feb 10, 2024	28 Days
- Method: APHA 4500-Norg B,D Total Kjeldahl Nitrogen by FIA			
Total Dissolved Solids Dried at 180 °C ± 2 °C	Melbourne	Feb 10, 2024	28 Days
- Method: LTM-INO-4170 Total Dissolved Solids in Water			

Company Name: GHD Pty Ltd VIC
Address: Level 8, 180 Lonsdale St
Melbourne
VIC 3000

Order No.:
Report #: 1067359
Phone: 8687 8000
Fax: 8687 8111

Received: Feb 9, 2024 5:22 PM
Due: Feb 16, 2024
Priority: 5 Day
Contact Name: Meg Turner

Project Name: MOUNT BULLER WATER STORAGE ONGOING MONITORING PROGRAM
Project ID: 12565989

Eurofins Analytical Services Manager : Savini Suduweli

Sample Detail						Conductivity (at 25 °C)	Phosphate total (as P)	Turbidity	Total Nitrogen Set (as N)	Eurofins Suite B11E: Cl/SO4/Alkalinity	Eurofins Suite B11C: Na/K/Ca/Mg	Total Dissolved Solids Dried at 180 °C ± 2 °C
Melbourne Laboratory - NATA # 1261 Site # 1254						X	X	X	X	X	X	X
External Laboratory												
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**							
1	SW-FS02	Feb 06, 2024		Water	M24-Fe0025606	X	X	X	X	X	X	X
2	GW-FS02	Feb 07, 2024		Water	M24-Fe0025607	X	X	X	X	X	X	X
Test Counts						2	2	2	2	2	2	2

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follow guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013. They are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry weight basis unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion unless otherwise stated.
4. For CEC results where the sample's origin is unknown or environmentally contaminated, the results should be used advisedly.
5. Actual LORs are matrix dependent. Quoted LORs may be raised where sample extracts are diluted due to interferences.
6. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
7. SVOC analysis on waters is performed on homogenised, unfiltered samples unless noted otherwise.
8. Samples were analysed on an 'as received' basis.
9. Information identified in this report with blue colour indicates data provided by customers that may have an impact on the results.
10. This report replaces any interim results previously issued.

Holding Times

Please refer to the 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours before sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and despite any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling; therefore, compliance with these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether, the holding time is 7 days; however, for all other VOCs, such as BTEX or C6-10 TRH, the holding time is 14 days.

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ppm:** parts per million
µg/L: micrograms per litre	**ppb:** parts per billion	**%:** Percentage
org/100 mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100 mL:** Most Probable Number of organisms per 100 millilitres
CFU: Colony forming unit	**Colour:** Pt-Co Units	

Terms

APHA	American Public Health Association
CEC	Cation Exchange Capacity
COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where moisture has been determined on a solid sample, the result is expressed on a dry weight basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples, these are performed on laboratory-certified clean sands and in the case of water samples, these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC represents the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a similar compound to the analyte target is reported as percentage recovery. See below for acceptance criteria.
TBTO	Tributyltin oxide (*bis*-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment; however, free tributyltin was measured, and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 5.4
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should only be used as a guide and may be different when site-specific Sampling Analysis and Quality Plan (SAQP) have been implemented.

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is ≤30%; however, the following acceptance guidelines are equally applicable:

Results <10 times the LOR:	No Limit
Results between 10-20 times the LOR:	RPD must lie between 0-50%
Results >20 times the LOR:	RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range, not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS. SVOCs recoveries 20 – 150%, VOC recoveries 70 – 130%

PFAS field samples containing surrogate recoveries above the QC limit designated in QSM 5.4, where no positive PFAS results have been reported or reviewed, and no data was affected.

QC Data General Comments

1. Where a result is reported as less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown are not data from your samples.
3. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time.Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery, the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results, a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data; thus, it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Chloride	mg/L	< 1			1	Pass	
Conductivity (at 25 °C)	uS/cm	< 10			10	Pass	
Nitrate & Nitrite (as N)	mg/L	< 0.05			0.05	Pass	
Nitrate (as N)	mg/L	< 0.02			0.02	Pass	
Nitrite (as N)	mg/L	< 0.02			0.02	Pass	
Sulphate (as SO4)	mg/L	< 5			5	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	mg/L	< 10			10	Pass	
Total Kjeldahl Nitrogen (as N)	mg/L	< 0.2			0.2	Pass	
Phosphate total (as P)	mg/L	< 0.01			0.01	Pass	
Method Blank							
Alkali Metals							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							
Chloride	%	108			70-130	Pass	
Conductivity (at 25 °C)	%	90			70-130	Pass	
Nitrate & Nitrite (as N)	%	103			70-130	Pass	
Nitrite (as N)	%	98			70-130	Pass	
Sulphate (as SO4)	%	95			70-130	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	%	99			70-130	Pass	
Total Kjeldahl Nitrogen (as N)	%	119			70-130	Pass	
Turbidity	%	101			70-130	Pass	
Phosphate total (as P)	%	97			70-130	Pass	
LCS - % Recovery							
Alkalinity (speciated)							
Carbonate Alkalinity (as CaCO3)	%	116			70-130	Pass	
Total Alkalinity (as CaCO3)	%	119			70-130	Pass	
LCS - % Recovery							
Alkali Metals							
Calcium	%	90			80-120	Pass	
Magnesium	%	103			80-120	Pass	
Potassium	%	98			80-120	Pass	
Sodium	%	106			80-120	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
				Result 1					
Total Kjeldahl Nitrogen (as N)	M24-Fe0029262	NCP	%	111			70-130	Pass	
Phosphate total (as P)	M24-Fe0015564	NCP	%	111			70-130	Pass	
Spike - % Recovery									
Alkali Metals				Result 1					
Calcium	B24-Fe0020155	NCP	%	98			75-125	Pass	
Potassium	M24-Fe0025101	NCP	%	106			75-125	Pass	
Sodium	B24-Fe0020155	NCP	%	106			75-125	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
Chloride	M24-Fe0026103	NCP	mg/L	7600	6900	11	30%	Pass	
Conductivity (at 25 °C)	M24-Fe0028586	NCP	uS/cm	2800	2800	2.0	30%	Pass	
Nitrate & Nitrite (as N)	M24-Fe0024949	NCP	mg/L	0.35	0.31	11	30%	Pass	
Nitrite (as N)	M24-Fe0024949	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Sulphate (as SO4)	M24-Fe0026103	NCP	mg/L	560	560	1.4	30%	Pass	
Total Dissolved Solids Dried at 180 °C ± 2 °C	M24-Fe0024089	NCP	mg/L	2500	2400	2.8	30%	Pass	
Total Kjeldahl Nitrogen (as N)	M24-Fe0024383	NCP	mg/L	0.9	1.0	12	30%	Pass	
Turbidity	M24-Fe0024928	NCP	NTU	< 1	< 1	<1	30%	Pass	
Phosphate total (as P)	M24-Fe0025606	CP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	M24-Fe0025167	NCP	mg/L	290	290	<1	30%	Pass	
Carbonate Alkalinity (as CaCO3)	M24-Fe0025167	NCP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	M24-Fe0025167	NCP	mg/L	< 20	< 20	<1	30%	Pass	
Total Alkalinity (as CaCO3)	M24-Fe0025167	NCP	mg/L	290	290	<1	30%	Pass	
Duplicate									
Alkali Metals				Result 1	Result 2	RPD			
Calcium	M24-Fe0025606	CP	mg/L	1.8	1.8	1.3	30%	Pass	
Magnesium	M24-Fe0025606	CP	mg/L	0.7	0.7	<1	30%	Pass	
Potassium	M24-Fe0025606	CP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
Sodium	M24-Fe0025606	CP	mg/L	2.3	2.3	<1	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised by:

Savini Suduweli	Analytical Services Manager
Caitlin Breeze	Senior Analyst-Inorganic
Mary Makarios	Senior Analyst-Inorganic
Mary Makarios	Senior Analyst-Metal

Glenn Jackson
Managing Director

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

Appendix G

QAQC report

Quality Assurance and Quality Control Assessment Report

1. Background

Quality assurance and quality control (QA/QC) practices were applied to all stages of data gathering and subsequent sample handling procedures and were designed to provide control over both field and laboratory operations. Additionally, the analytical laboratory completed their own internal QA procedures, as required by NATA registration, during the analysis of samples.

The QA/QC program undertaken as part of the assessment by GHD included the following:

- Use of appropriately qualified and trained staff
- Calibration of field instruments
- Preservation of samples with ice during transport from the field to the laboratory
- Transportation of samples with accompanying chain-of-custody (COC) documentation
- Compliance with sample holding times
- Review of results of field quality assurance samples
- Review of results of internal laboratory quality control procedures which included analysis of method blanks, laboratory duplicate samples, laboratory control samples, matrix spike samples and surrogates

Field quality assurance samples provide information that discounts or potentially identifies any errors due to possible sources of cross contamination, inconsistencies in sampling and analytical techniques used. The quality assurance samples collected during the field program included:

- **Field duplicates:** Coded duplicate samples submitted to the primary laboratory for analysis as individual samples without any indication to the laboratory that they have been duplicated.
- **Field splits:** Duplicate samples with one sample being sent to a secondary laboratory for analysis. The same parameters are analysed utilising similar analytical techniques.
- **Rinsate blank:** A sample of deionised water collected from equipment used during sampling to indicate whether cross contamination occurred from equipment.

Field methodologies for sample collection, sample tracking, preservation and storage are summarised in Section 2 in the report.

2. Laboratories and sample batches

Samples were submitted to ALS Environmental (ALS) and Eurofins, both of which are National Association of Testing Authorities (NATA) accredited laboratories, accredited to perform the required analysis.

Sample batches issued during the surface water and groundwater sampling program are summarised in Table 1.

Table 1 Laboratory report summary

Laboratory	Report number	Sample date
Surface water and groundwater samples		
ALS (Primary)	EM2405745	09/04/2023 – 10/04/2024

Laboratory	Report number	Sample date
	EM2401890	06/02/2024 – 07/02/2024
	EM2320487	14/11/2023 - 15/11/2023
Eurofins (Secondary)	1087789	09/04/2023 – 10/04/2024
	1067359	06/02/2024 – 07/02/2024

3. GHD QA/QC

3.1 Calibration of field instruments

Calibrated field instruments were supplied for the field works undertaken. The calibration certificate is provided at the end of the QAQC report.

3.2 Sample holding time

All analytes were extracted and analysed within both ALS' and Eurofins' technical holding times, with the exception of those detailed in Table 2.

Table 2 Summary of QA/QC compliance – sample holding time

Matrix	Laboratory Report	Analyte	Extraction / Preparation overdue (days)	Analysis overdue (days)
Surface water	EM2320487	pH		9
	EM2320487	Turbidity		1
	EM2320487	Nitrite as N		13
	EM2320487	Nitrite plus nitrate as N (NO_x)		6
	EM2320487	Total Kjeldahl Nitrogen	8	
	EM2320487	Total Phosphorus	7	
	EM2405745	Turbidity		5
	EM2405745	Dissolved Major Cations		1
	EM2405745	Ammonia as N		8-9
	EM2405745	Total Kjeldahl Nitrogen	8	
	EM2405745	Total Phosphorus as P	7	
	EM2401890	Turbidity		1
	EM2401890	Ammonia as N		5-6
	EM2401890	Nitrite as N		1
	EM2401890	Total Kjeldahl Nitrogen	6	
	EM2401890	Total Phosphorus as P	5	
Groundwater	EM2320487	pH		8
	EM2320487	Nitrite as N		12
	EM2320487	Nitrite plus nitrate as N (NO_x)		5

Matrix	Laboratory Report	Analyte	Extraction / Preparation overdue (days)	Analysis overdue (days)
	EM2320487	Total Kjeldahl Nitrogen	7	
	EM2320487	Total Phosphorus	6	
	EM2405745	Turbidity		4
	EM2405745	Ammonia as N		7-8
	EM2405745	Total Kjeldahl Nitrogen	7-8	
	EM2405745	Total Phosphorus as P	6-7	
	EM2401890	Turbidity		1
	EM2401890	Ammonia as N		4-6
	EM2401890	Nitrite as N		1
	EM2401890	Total Kjeldahl Nitrogen	5-6	
	EM2401890	Total Phosphorus as P	4-5	

3.3 Field duplicate and split duplicate frequency

Table 3 summaries the total number of primary, field and split duplicate samples collected and analysed for contaminants of potential concern in the groundwater and surface water investigation. The required frequency is one field duplicate and one split duplicate (i.e.. one duplicate pair) sample per twenty (20) primary samples (i.e. 5% frequency). The frequency of duplicate samples for the IY5 monitoring period is above the minimum requirement.

Table 3 Field and split duplicate sampling and analysis frequency

Matrix	No. of primary samples	No. of field duplicate pairs	Frequency (%)
Surface water	12	3	25
Groundwater	18	3	17

3.4 Field duplicate and split duplicate RPD results

3.4.1 Relative percentage difference

A quantitative measure of the duplicate sample results was made using calculated relative percentage difference (RPD) values for each chemical. The RPD values were calculated using the following equation.

$$RPD(\%) = \frac{(C_o - C_s)}{\left(\frac{C_o + C_s}{2}\right)} \times 100$$

where C_o = reported concentration of the chemical of interest from the original parent sample

Cs = reported concentration of the chemical of interest from the duplicate sample

All RPD values were within the acceptable range of 0% to 30% with exceptions summarised in Table 6. RPD values are displayed in Attachment 2. Several RPD exceedances occurred for concentrations at or close to the limit of reporting (LOR), noting that RPD exceedances are typically considered only where a concentration is greater than 10 times the LOR.

Table 4 ***Field duplicate and spilt duplicate RPD exceedance summary***

Primary Sample	Duplicate Sample	Report Number	Analyte	RPD (%)
Surface Water				
Boggy 2	SW-FS02	EM2401890 1067359	Dissolved Oxygen Lab (filtered)	104
Boggy 2	SW-FS02	EM2401890 1067359	TDS	196
Boggy 2	SW-FS02	EM2401890 1067359	Alkalinity (Bicarbonate as CaCO3)	125
Boggy 2	SW-FS02	EM2401890 1067359	Alkalinity (Total as CaCO3)	125
Boggy 1 p/u 2	SW - Dup	EM2320487	Anions Total	40
Boggy 1 p/u 1	SW_FS01.1	EM2405745 1087789	Alkalinity (Bicarbonate as CaCO3)	181
Boggy 2	SW–FD03	EM2405745	TDS	47
Boggy 2	SW–FS03	EM2405745 1087789	Alkalinity (Bicarbonate as CaCO3)	184
Boggy 2	SW–FS03	EM2405745 1087789	Nitrogen Total	138
Boggy 2	SW–FS03	EM2405745 1087789	Kjeldahl Nitrogen Total	164
Groundwater				
BH16	GW-FS02	EM2401890 1067359	Dissolved Oxygen Lab (filtered)	107
BH16	GW-FD02	EM2401890	TDS (filtered)	47
BH16	GW-FS02	EM2401890 1067359	TDS	131
BH16	GW-FS02	EM2401890 1067359	TDS (filtered)	194
BH16	GW-FD02	EM2401890	Cations (total)	43
BH16	GW-FD02	EM2401890	Anions (total)	59
BH16	GW-FD02	EM2401890	Kjeldahl Nitrogen Total	31
BH16	GW-FD02	EM2401890	Nitrate as (NO3-)	100
BH06	GW_FS01.1	EM2405745 1087789	Turbidity	103
BH06	GW_FS01.1	EM2405745 1087789	TDS	44
BH06	GW_FS01.1	EM2405745 1087789	Ammonia as N	173
BH06	GW_FS01.1	EM2405745 1087789	Nitrogen Total	42
BH06	GW_FS01.1	EM2405745 1087789	Kjeldahl Nitrogen Total	138
BH16	GW-FD03	EM2405745	Turbidity	46

Primary Sample	Duplicate Sample	Report Number	Analyte	RPD (%)
BH16	GW-FD03	EM2405745	Phosphorus (Total)	75
BH16	GW_FS03	EM2405745 1087789	Turbidity	37
BH16	GW_FS03	EM2405745 1087789	Alkalinity (Bicarbonate as CaCO3)	157
BH16	GW_FS03	EM2405745 1087789	Nitrogen Total	71
BH16	GW_FS03	EM2405745 1087789	Kjeldahl Nitrogen Total	147
BH16	GW_FS03	EM2405745 1087789	Phosphorus (Total)	180

3.5 Rinsate blank samples

One rinsate blank sample was collected at each monitoring event from field (equipment) listed below in Table 5. A total of three rinsate blank samples were collected during the field investigation.

Most rinsate blank sample results were reported below the laboratory LOR with minor detections for some analytes at concentrations which do not materially change the report outcomes. Tabulated results for the rinsate samples are provided at the end of the QAQC report.

Overall, based on the results for the monitoring period, GHD considers the decontamination procedures conducted during the soil and groundwater sampling programs to be acceptable.

Table 5 Rinsate sampling equipment

Lab Report Number	Sample date	Equipment
EM2320487	15/11/2023	Stericup filter
EM2405745	10/04/2023	Bailer
EM2401890	07/02/2024	Syringe

4. Laboratory QA/QC

Results of the internal laboratory quality control programs are included as part of the laboratory reports. Laboratory QA/QC results are summarised in the following sections.

4.1 Laboratory duplicate review

4.1.1 Laboratory control spikes

Laboratory control spike analysis of the analysis of either a reference material or a control matrix fortified with analytes representative of the analyte class. The purpose of laboratory control spike samples is to monitor method precision and accuracy independent of the sample matrix. Typically, the percentage recovery of the laboratory control spike sample is compared to the dynamic recovery limits based on the statistical analysis of the processed laboratory control spike analysis. Recoveries should lie between 70% and 130% for inorganics and metals, and 60% to 140% for organics. Reported results will not include an adjustment for recovery.

No laboratory control spike outliers occurred in the investigation over all three sampling periods.

4.1.2 Surrogate spikes

Surrogate spike samples are samples with known additions of known amounts of compounds, which are similar to analytes of interests in terms of extractability, recovery through clean-up procedures and response to chromatographic or other measurement. Surrogate compounds may be alkylated or halogenated analogues or structural isomers of analytes of interest. The purpose of surrogate spikes, which are added immediately before the sample extraction step, is to provide a check for every analysis that no gross processing errors have occurred.

All reported surrogate spike recoveries were reported within the acceptable limits as specified by the laboratories.

4.1.3 Matrix spikes

Matrix spike samples analysis is the analysis of one or more replicate portions of samples from the batch, after fortifying the additional portion(s) with known quantities of the analyte(s) of interest. The percentage of recovery of target analyte(s) from matrix spike samples is used to determine the bias of the method in the specific sample matrix. Recoveries should typically lie between 70% and 130%, however this varies based on the organic nature of the analyte.

All reported matrix spike percentage recoveries were reported within the acceptable range as specified by the laboratories.

4.1.4 Laboratory control sample

All laboratory control samples were reported within the acceptable range as defined by the laboratories.

4.1.5 Internal duplicates

Laboratory blind duplicates provide data on the analytical precision and reproducibility of the analytical results. The laboratory blind duplicate is created by sub sampling from one of the primary samples submitted for analysis. Laboratory blind duplicates are analysed at a rate equivalent to one in twenty (20) samples per analytical batch, or one sample per batch if less than twenty samples (20) are analysed in a batch.

All reported internal duplicate concentration were within the acceptable RPD ranges.

4.1.6 Method Blanks

Method or analysis blank samples are the analysis of a sample that is as free as possible of the analytes of interest but has been prepared the same way as the samples under investigation. The analysis is to ascertain if laboratory analytical process contributes to the reported concentration of the analyte.

All reported method blank concentrations were less than their respective laboratory LOR and indicates that potential laboratory cross contamination was unlikely to have occurred.

4.1.7 Laboratory quality control sample frequency

No Quality control frequency outliers were identified for laboratory duplicates, matrix spikes and laboratory control samples for both soil and groundwater samples.

5. Discussion and Conclusion

Several non-conformances of RPDs for blind and spilt duplicates and holding times were recorded. However, as discussed above, these are not considered to have impacted the overall outcome of the investigation.

The results of the QA/QC program are considered to provide an acceptable degree of confidence in the analytical program completed. Overall, the analytical data set is considered to be valid and of acceptable quality upon which to base the assessment.

Attachments

Attachment 1

Calibration Certificates

Multi Parameter Water Meter

Instrument YSI Quatro Pro Plus
Serial No. 21D101751

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. D.O		0 ppm		407802	0 ppm
2. Conductivity		2760uS		414103	2760uS
3. pH7		pH 7.00		413995	pH 7.00
4. pH4		pH 4.00		414101	pH 4.00
5. ORP mV		229.82		411371 / 398193	229.82
6. Temp °C		21.9		33938728	21.9

Calibrated by: David Trengove

Calibration date: 8-Nov-23

Next calibration due: 6-May-24

3/11/23

Oil / Water Interface Meter

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Instrument Interface Meter (30M)
Serial No. 312504

Item	Test	Pass	Comments
Battery	Compartment	✓	
	Capacity	✓	
Probe	Cleaned/Decon.	✓	
	Operation	✓	
Connectors	Condition	✓	
		✓	
Tape Check	Cleaned	✓	
	Checked for cuts	✓	
Instrument Test	At surface level	✓	

Certificate of Calibration

This is to certify that the above instrument has been cleaned and tested.

Calibrated by: Cody Zethof

Calibration date: 3/11/2023

Next calibration due: 2/01/2024

Multi Parameter Water Meter

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Instrument YSI Quatro Pro Plus
Serial No. 18L101817

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. D.O		0 ppm		399958	0 ppm
2. Conductivity		2760uS		414103	2760uS
3. pH7		pH 7.00		413995	pH 7.00
4. pH4		pH 4.00		414101	pH 4.00
5. ORP mV		230.7		411371 / 398193	230.7
6. Temp °C		21.5		33938728	21.5

Calibrated by: Cameron Ensor

Calibration date: 23-Jan-24

Next calibration due: 21-Jul-24

Oil / Water Interface Meter

Instrument **Interface Meter (30M)**
Serial No. **288151**

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Compartment	✓	
	Capacity	✓	
	above 7.9V		
Probe	Cleaned/Decon.	✓	
	Operation	✓	
Connectors	Condition	✓	
		✓	
Tape Check	Cleaned	✓	
Connectors	Checked for cuts	✓	
Instrument Test	At surface level	✓	

Certificate of Calibration

This is to certify that the above instrument has been cleaned and tested.

Tested by: **Haydn Lyall**

Test date: **25/01/2024**

Next Test due: **23/07/2024**

Multi Parameter Water Meter

Instrument YSI Quatro Pro Plus
Serial No. 21D101751

Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Charge Condition	✓	
	Fuses	✓	
	Capacity	✓	
Switch/keypad	Operation	✓	
Display	Intensity	✓	
	Operation (segments)	✓	
Grill Filter	Condition	✓	
	Seal	✓	
PCB	Condition	✓	
Connectors	Condition	✓	
Sensor	1. pH	✓	
	2. mV	✓	
	3. EC	✓	
	4. D.O	✓	
	5. Temp	✓	
Alarms	Beeper		
	Settings		
Software	Version		
Data logger	Operation		
Download	Operation		
Other tests:			

Certificate of Calibration

This is to certify that the above instrument has been calibrated to the following specifications:

Sensor	Serial no	Standard Solutions	Certified	Solution Bottle Number	Instrument Reading
1. D.O		0 ppm		407802	0 ppm
2. Conductivity		2760uS		414103	2760uS
3. pH7		pH 7.00		413995	pH 7.00
4. pH4		pH 4.00		414101	pH 4.00
5. ORP mV		232.46		411371 / 398193	232.46
6. Temp °C		20.7		33938728	20.7

Calibrated by: Cameron Ensor

Calibration date: 3-Apr-24

Next calibration due: 30-Sep-24

Oil / Water Interface Meter

Instrument Solinst Interface Meter (30M)
Serial No. 312392

airmet
Air-Met Scientific Pty Ltd
1300 137 067

Item	Test	Pass	Comments
Battery	Compartment	✓	
	Capacity above 7.9v	✓	
Probe	Cleaned/Decon.	✓	
	Operation	✓	
Connectors	Condition	✓	
		✓	
Tape Check	Cleaned	✓	
Connectors	Checked for cuts	✓	
Instrument Test	At surface level	✓	

Certificate of Calibration

This is to certify that the above instrument has been cleaned and tested.

Calibrated by: Cameron Ensor

Calibration date: 03-Apr-24

Next calibration due: 30-Sep-24

Attachment 2

QA/QC result tables

Appendix G
Table 1
RPD Results

		Date	14 Nov 2023	14 Nov 2023		15 Nov 2023	15 Nov 2023		06 Feb 2024	06 Feb 2024		06 Feb 2024	06 Feb 2024		07 Feb 2024	07 Feb 2024		07 Feb 2024	07 Feb 2024	
		Field ID	Boggy 1 p/u 2	SW - Dup		BH16	GW-Dup		Boggy 2	SW-FD02		Boggy 2	SW-FS02		BH16	GW-FD02		BH16	GW-FS02	
		Lab Report Number	EM2320487	EM2320487		EM2320487	EM2320487		EM2401890	EM2401890		EM2401890	1067359		EM2401890	EM2401890		EM2401890	1067359	
		Matrix Type	Water	Water	RPD	Water	Water	RPD	Water	Water	RPD	Water	Water	RPD	Water	Water	RPD	Water	Water	RPD
	Unit	EQL																		
Field Parameters																				
pH (Field)	pH units		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Redox (Field)	mV	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NA																				
Dissolved Oxygen	mg/L	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate as N in ASLP 5.0	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus reactive (as P)	mg/L	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inorganics																				
pH (Lab)	pH units	0.01	6.09	7.09	15	5.78	5.84	1	-	-	-	-	-	-	-	-	-	-	-	-
pH Redox	pH units	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Electrical conductivity (lab)	µS/cm	1	16	18	12	17	17	0	23	23	0	23	73	**104**	17	17	0	17	56	**107**
Dissolved Oxygen (Lab) (filtered)	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Redox (Lab)	mV	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature	°C		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	NTU	0.1	0.6	0.8	29	23.7	21.7	9	0.5	0.5	0	0.5	<1	0	158	151	5	158	33	**131**
Total Dissolved Solids	mg/L	5	15	10	**40**	<10	<10	0	30	28	7	30	3,200	**196**	66	41	**47**	66	4,600	**194**
Total Dissolved Solids (filtered)	mg/L	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	mg/L	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acidity & Alkalinity																				
Alkalinity (Carbonate as CaCO3)	mg/L	1	<1	<1	0	<1	<1	0	<1	<1	0	<1	<10	0	<1	<1	0	<1	<10	0
Alkalinity (Bicarbonate as CaCO3)	mg/L	1	6	9	**40**	2	3	**40**	9	9	0	9	39	**125**	4	3	29	4	<20	0
Alkalinity (Bicarbonate)	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity (Hydroxide as CaCO3)	mg/L	1	<1	<1	0	<1	<1	0	<1	<1	0	<1	<20	0	<1	<1	0	<1	<20	0
Alkalinity (total as CaCO3)	mg/L	1	6	9	**40**	2	3	**40**	9	9	0	9	39	**125**	4	3	29	4	<20	0
Hardness as CaCO3	mg/L	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Major Ions																				
Calcium	mg/L	0.1	-	-	-	-	-	-	-	-	-	-	1.8	-	-	-	-	-	1.0	-
Calcium (filtered)	mg/L	0.1	1	1	0	1	1	0	2	2	0	2	-	-	<1	1	0	<1	-	-
Magnesium	mg/L	0.1	-	-	-	-	-	-	-	-	-	-	0.7	-	-	-	-	-	<0.5	-
Magnesium (filtered)	mg/L	0.1	<1	<1	0	<1	<1	0	<1	<1	0	<1	-	-	<1	<1	0	<1	-	-
Potassium	mg/L	0.1	-	-	-	-	-	-	-	-	-	-	<0.5	-	-	-	-	-	<0.5	-
Potassium (filtered)	mg/L	0.1	<1	<1	0	<1	<1	0	<1	<1	0	<1	-	-	<1	<1	0	<1	-	-
Sodium	mg/L	0.1	-	-	-	-	-	-	-	-	-	-	2.3	-	-	-	-	-	2.0	-
Sodium (filtered)	mg/L	0.1	2	2	0	2	2	0	2	2	0	2	-	-	2	2	0	2	-	-
Chloride	mg/L	1	<1	<1	0	1	<1	0	<1	1	0	<1	1.1	10	1	<1	0	1	1.3	26
Sulfate	mg/L	1	-	-	-	-	-	-	-	-	-	-	<5	-	-	-	-	-	<5	-
Sulfate (filtered)	mg/L	1	<1	<1	0	<1	<1	0	<1	<1	0	<1	-	-	<1	<1	0	<1	-	-
Sulfate as S	mg/L	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cations Total	meq/L	0.01	0.14	0.14	0	0.14	0.14	0	0.19	0.19	0	0.19	-	-	0.09	0.14	**43**	0.09	-	-
Anions Total	meq/L	0.01	0.12	0.18	**40**	0.07	0.06	15	0.18	0.21	15	0.18	-	-	0.11	0.06	**59**	0.11	-	-
Ionic Balance	%	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Minor Ions																				
Bicarbonate ion (HCO3-)	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbonate ion	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nutrients																				
Ammonia as N	mg/L	0.01	-	-	-	-	-	-	<0.01	<0.01	0	<0.01	-	-	<0.01	<0.01	0	<0.01	-	-
Nitrate (as N)	mg/L	0.01	0.11	0.11	0	0.92	0.71	26	0.09	0.09	0	0.09	0.10	11	0.89	0.89	0	0.89	0.97	9
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	0	<0.01	<0.01	0	<0.01	<0.01	0	<0.01	<0.02	0	<0.01	<0.01	0	<0.01	<0.02	0
Nitrogen (Total Oxidised) (as N)	mg/L	0.01	0.11	0.11	0	0.92	0.71	26	0.09	0.09	0	0.09	0.10	11	0.89	0.89	0	0.89	0.97	9
Nitrogen (Total)	mg/L	0.1	0.1	0.1	0	0.9	0.7	25	0.4	<0.1	**120**	0.4	0.4	0	1.5	1.1	**31**	1.5	1.3	14
Kjeldahl Nitrogen Total	mg/L	0.1	<0.1	<0.1	0	<0.1	<0.1	0	0.3	<0.1	**100**	0.3	0.3	0	0.6	0.2	**100**	0.6	0.3	**67**
Nitrate (as NO3-)	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphate total (P)	mg/L	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus (Total)	mg/L	0.01	0.03	0.01	**100**	0.03	0.02	**40**	0.02	0.01	**67**	0.02	<0.01	**67**	0.38	0.41	8	0.38	<0.01	**190**
Metals																				
Arsenic (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium (filtered)	mg/L	0.0001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (III+VI) (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron (filtered)	mg/L	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercury (filtered)	mg/L	0.0001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium (filtered)	mg/L	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc (filtered)	mg/L	0.005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

***RPDs have only been considered where a concentration is greater than 1 times the EQL.**

****Elevated RPDs are highlighted as per QAQC Profile settings (Acceptable RPDs for each EQL multiplier range are: 30 (1 - 10 x EQL); 30 (10 - 30 x EQL); 30 (> 30 x EQL))**

*****Interlab Duplicates are matched on a per compound basis as methods vary between laboratories. Any methods in the row header relate to those used in the primary laboratory**

Appendix G
Table 1
RPD Results

		Date	09 Apr 2024	09 Apr 2024		09 Apr 2024	09 Apr 2024		09 Apr 2024	09 Apr 2024		10 Apr 2024	09 Apr 2024		10 Apr 2024	10 Apr 2024		10 Apr 2024	09 Apr 2024	
		Field ID	Boggy 1 P/U 1	SW_FS01.1		Boggy 2	SW-FD03		Boggy 2	SW_FS03		BH06	GW_FS01.1		BH16	GW-FD03		BH16	GW_FS03	
		Lab Report Number	EM2405745	1087789		EM2405745	EM2405745		EM2405745	1087789		EM2405745	1087789		EM2405745	EM2405745		EM2405745	1087789	
		Matrix Type	Water	Water	RPD	Water	Water	RPD	Water	Water	RPD	Water	Water	RPD	Water	Water	RPD	Water	Water	RPD
	Unit	EQL																		
Field Parameters																				
pH (Field)	pH units		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Redox (Field)	mV	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NA																				
Dissolved Oxygen	mg/L	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate as N in ASLP 5.0	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus reactive (as P)	mg/L	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Inorganics																				
pH (Lab)	pH units	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH Redox	pH units	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Electrical conductivity (lab)	µS/cm	1	30	28	7	28	29	4	28	33	16	58	50	15	19	18	5	19	20	5
Dissolved Oxygen (Lab) (filtered)	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Redox (Lab)	mV	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Temperature	°C		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	NTU	0.1	2.0	1.6	22	0.6	0.7	15	0.6	<1	0	4.8	15	**103**	89.8	144	**46**	89.8	130	**37**
Total Dissolved Solids	mg/L	5	44	39	12	49	79	**47**	49	59	19	53	83	**44**	25	16	**44**	25	47	**61**
Total Dissolved Solids (filtered)	mg/L	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Suspended Solids	mg/L	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acidity & Alkalinity																				
Alkalinity (Carbonate as CaCO3)	mg/L	1	<1	<10	0	<1	<1	0	<1	<10	0	<1	<10	0	<1	<1	0	<1	<10	0
Alkalinity (Bicarbonate as CaCO3)	mg/L	1	13	260	**181**	10	10	0	10	240	**184**	2	<20	0	4	3	29	4	33	**157**
Alkalinity (Bicarbonate)	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity (Hydroxide as CaCO3)	mg/L	1	<1	-	-	<1	<1	0	<1	-	-	<1	-	-	<1	<1	0	<1	-	-
Alkalinity (total as CaCO3)	mg/L	1	13	-	-	10	10	0	10	-	-	2	-	-	4	3	29	4	-	-
Hardness as CaCO3	mg/L	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Major Ions																				
Calcium	mg/L	0.1	-	1.5	-	-	-	-	-	1.7	-	-	3.4	-	-	-	-	-	0.5	-
Calcium (filtered)	mg/L	0.1	2	-	-	2	2	0	2	-	-	3	-	-	<1	<1	0	<1	-	-
Magnesium	mg/L	0.1	-	<0.5	-	-	-	-	-	0.6	-	-	1.3	-	-	-	-	-	<0.5	-
Magnesium (filtered)	mg/L	0.1	<1	-	-	<1	<1	0	<1	-	-	1	-	-	<1	<1	0	<1	-	-
Potassium	mg/L	0.1	-	<0.5	-	-	-	-	-	<0.5	-	-	<0.5	-	-	-	-	-	<0.5	-
Potassium (filtered)	mg/L	0.1	<1	-	-	<1	<1	0	<1	-	-	<1	-	-	<1	<1	0	<1	-	-
Sodium	mg/L	0.1	-	2.3	-	-	-	-	-	2.0	-	-	2.1	-	-	-	-	-	1.7	-
Sodium (filtered)	mg/L	0.1	3	-	-	2	2	0	2	-	-	2	-	-	2	2	0	2	-	-
Chloride	mg/L	1	2	1.6	22	2	1	**67**	2	1.4	**35**	2	3.0	**40**	1	1	0	1	1.2	18
Sulfate	mg/L	1	-	<5	-	-	-	-	-	20	-	-	<5	-	-	-	-	-	<5	-
Sulfate (filtered)	mg/L	1	<1	-	-	<1	<1	0	<1	-	-	<1	-	-	<1	<1	0	<1	-	-
Sulfate as S	mg/L	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cations Total	meq/L	0.01	0.23	-	-	0.19	0.19	0	0.19	-	-	0.32	-	-	0.09	0.09	0	0.09	-	-
Anions Total	meq/L	0.01	0.32	-	-	0.26	0.23	12	0.26	-	-	0.10	-	-	0.11	0.09	20	0.11	-	-
Ionic Balance	%	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Minor Ions																				
Bicarbonate ion (HCO3-)	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbonate ion	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nutrients																				
Ammonia as N	mg/L	0.01	<0.01	<0.01	0	<0.01	<0.01	0	<0.01	0.02	**67**	0.28	0.02	**173**	<0.01	0.02	**67**	<0.01	0.02	**67**
Nitrate (as N)	mg/L	0.01	0.12	0.13	8	0.10	0.10	0	0.10	0.10	0	4.91	5.9	18	0.92	0.91	1	0.92	0.96	4
Nitrite (as N)	mg/L	0.01	<0.01	<0.02	0	<0.01	<0.01	0	<0.01	<0.02	0	<0.01	<0.02	0	<0.01	<0.01	0	<0.01	<0.02	0
Nitrogen (Total Oxidised) (as N)	mg/L	0.01	0.12	0.13	8	0.10	0.10	0	0.10	0.10	0	4.91	5.9	18	0.92	0.91	1	0.92	0.96	4
Nitrogen (Total)	mg/L	0.1	0.3	0.8	**91**	0.2	0.2	0	0.2	1.1	**138**	5.3	8.1	**42**	1.1	1.2	9	1.1	2.3	**71**
Kjeldahl Nitrogen Total	mg/L	0.1	0.2	0.7	**111**	0.1	0.1	0	0.1	1.0	**164**	0.4	2.2	**138**	0.2	0.3	**40**	0.2	1.3	**147**
Nitrate (as NO3-)	mg/L		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphate total (P)	mg/L	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus (Total)	mg/L	0.01	<0.01	<0.01	0	<0.01	<0.01	0	<0.01	<0.01	0	<0.01	<0.01	0	0.19	0.42	**75**	0.19	<0.01	**180**
Metals																				
Arsenic (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium (filtered)	mg/L	0.0001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (III+VI) (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron (filtered)	mg/L	0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercury (filtered)	mg/L	0.0001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium (filtered)	mg/L	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin (filtered)	mg/L	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc (filtered)	mg/L	0.005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix G
Table 2
Rinsate Results

Date			15 Nov 2023	07 Feb 2024	10 Apr 2024
Field ID			Rinsate	R2	R3
Lab Report Number			EM2320487	EM2401890	EM2405745
Matrix Type			Water	Water	Water
	Unit	EQL			
Inorganics					
pH (Lab)	pH units	0.01	**5.64**	-	-
Electrical conductivity (lab)	µS/cm	1	<1	<1	<1
Turbidity	NTU	0.1	<0.1	**2.0**	**4.8**
Total Dissolved Solids	mg/L	10	<10	<10	<10
Acidity & Alkalinity					
Alkalinity (Carbonate as CaCO3)	mg/L	1	<1	<1	<1
Alkalinity (Bicarbonate as CaCO3)	mg/L	1	<1	**1**	<1
Alkalinity (Hydroxide as CaCO3)	mg/L	1	<1	<1	<1
Alkalinity (total as CaCO3)	mg/L	1	<1	**1**	<1
Major Ions					
Calcium (filtered)	mg/L	1	<1	<1	<1
Magnesium (filtered)	mg/L	1	<1	<1	<1
Potassium (filtered)	mg/L	1	<1	<1	<1
Sodium (filtered)	mg/L	1	<1	<1	<1
Chloride	mg/L	1	<1	<1	<1
Sulfate (filtered)	mg/L	1	<1	<1	<1
Cations Total	meq/L	0.01	<0.01	<0.01	<0.01
Anions Total	meq/L	0.01	<0.01	**0.02**	<0.01
Nutrients					
Ammonia as N	mg/L	0.01	-	<0.01	**0.05**
Nitrate (as N)	mg/L	0.01	<0.01	<0.01	<0.01
Nitrite (as N)	mg/L	0.01	<0.01	<0.01	<0.01
Nitrogen (Total Oxidised) (as N)	mg/L	0.01	<0.01	<0.01	<0.01
Nitrogen (Total)	mg/L	0.1	<0.1	<0.1	**0.1**
Kjeldahl Nitrogen Total	mg/L	0.1	<0.1	<0.1	**0.1**
Phosphate total (P)	mg/L	0.05	-	-	-
Phosphorus (Total)	mg/L	0.01	**0.03**	<0.01	<0.01