17 July 2017

Mt Buller Mt Stirling Resort Management
Alpine Central
MT BULLER, VIC, 3723

Our ref: 31/30733

c/o Alicia Burnett (ERM)

Dear Sir/Madam

Mt Buller Sustainable Water Security Project
Mt Buller Off-Stream Storage Dam - Geotechnical risk addendum

1 Purpose of this document

GHD has been requested to provide a short report which includes:

- A qualitative assessment of geotechnical risk to identified environmental assets associated with the Mt Buller Off-Stream Storage project (the Project) based on the current concept design (refer Section 3).
- Additional commentary in relation to the current "low to moderate" preliminary residual risk ratings assigned to the supplementary dam-related hazards identified within the existing Geotechnical Risk Assessment, including discussion of risk levels following detailed design (refer Section 4).
- Commentary on the potential for an increase to the project construction footprint (PCF) or changes to the design of the storage and ancillary infrastructure during the detailed design process as part of the risk reduction requirements (refer Section 5).
- Further discussion regarding the geotechnical risks associated with the environmental watering system (HEMAMP) (refer Section 6).

This letter should be read in conjunction with the Geotechnical Risk Assessment for the Project concept design (GHD, 2016, Doc No. 233153).

2 Background

GHD has previously completed a Geotechnical Risk Assessment (December 2016) (the Report) for the concept design of the Project. This report has been independently peer reviewed by Douglas Partners Pty Ltd.

The Report was undertaken in accordance with Clauses 3.1 and 3.2 of Schedule 1 of the Erosion Management Overlay (EMO) which requires (amongst other things) that a qualitative assessment of geotechnical hazards associated with the project before, during and after construction is completed in accordance with the guidelines set out in 'Landslide Risk Management Concepts and Guidelines' published in the Australian Geomechanics Journal, Vol. 37 No. 2 May 2002, or as updated by the Australian Geomechanics Society ("AGS Guidelines").

Where the risk in the Report was identified as being greater than "Low" a semi quantitative risk assessment was completed to determine if risk levels were at acceptable levels. It should be noted that geotechnical-related dam hazards were also included in a preliminary qualitative risk assessment of the

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concept design. These were included for completeness and are considered indicative only. They should not be considered a part of the main preliminary risk assessment of the Project.

3 Environmental asset risk assessment

3.1 Method

Although not stipulated in the requirements for a risk assessment in line with the EMO, it has been requested that an assessment of the geotechnical risk to environmental assets be completed.

For the purposes of this assessment an environmental asset is considered to be a biophysical and measureable feature in the vicinity of the proposed Mt Buller Off-Stream Storage Project site.

The planning and environmental assessments undertaken for the Project focus on the potential direct and indirect impacts to the environment (primarily) within or immediately adjacent to the PCF.

This risk assessment is intended to evaluate the risks to environmental assets adjacent to, but outside of the PCF.

Flora and fauna assets for the Project site (PCF) and the wider area have been documented in Biosis (2016). The environmental assets included in this risk assessment are listed as follows:

- **Native vegetation** within and adjoining the PCF
  - Sub-alpine Wet Heathland (EVC 210) and Alpine Peaty Heathland (EVC 1011) (EPBC Act: endangered; FFG Act: threatened) downslope of the PCF;
  - Sub-alpine Woodland (EVC 43)
  - Alpine Grassy Heathland (EVC 1004)
  - Multiple DELWP Advisory List flora species
- **Potential non-core habitat for Mountain Pygmy-possum** *Burramys parvus* (EPBC Act: endangered; FFG Act: threatened) [note that habitat for the species has not been recorded in the PCF];
- **Listed fauna species**
  - Broad-toothed Rat *Mastacomys fuscus mordicus* (EPBC Act: vulnerable; FFG Act: listed; Advisory List: endangered) (present in the PCF);
  - Alpine Bog Skink *Pseudemoia cryodroma* (FFG Act: listed; Advisory List: endangered)(present in the PCF)
  - Tussock Skink *Pseudemoia pagenstecheri* (Advisory List: vulnerable). (likely to be present in the PCF)
- **Waterways** located downslope of the PCF, specifically the aqueduct, tributaries and headwaters of the Boggy Creek
  - **Water flow**
  - **Water quality**
- **Visual amenity** – landscape characteristics which contribute to the visual amenity of the Project area and adjoining areas.

The risk to environmental assets has been assessed using the standard descriptors of consequence and likelihood described in the geotechnical risk assessment report. As some of the consequence descriptors do not readily lend themselves to assessment of environmental assets, the descriptors have been adjusted to suit. The adjusted descriptors are presented in Table 1. The results of the risk assessment, recommended control measures and residual risk levels are presented in Table 2.

Table 1 Environmental risk descriptors

Description	Consequence Descriptor
Asset completely destroyed and large scale damage requiring major rehabilitation. Could also cause extensive damage to neighbouring assets	Catastrophic
Extensive damage to asset which extending beyond Project boundaries requiring significant rehabilitation work. Moderate damage caused to neighbouring assets.	Major
Moderate damage to some of the asset requiring large rehabilitation works	Medium
Limited damage to asset, part of site requiring some rehabilitation works	Minor
Little damage to assets.	Insignificant

Table 2 Environmental Risk Assessment

Environmental asset	HAZARD	Initial risk rating			Control measures	Residual risk rating		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
Native Vegetation outside of PCF	Large scale global rotational or translational landslide or debris flow caused by dam construction destroying vegetation.	Possible	Major	High	Undertake geotechnical investigation, engineering design and slope stability assessment during detailed design (and in accordance with ANCOLD for dam construction). Reduce batter angles or other stabilisation or retaining methods. Excavation angles must be at or below angles recommended by geotechnical engineer for both temporary and permanent batter slopes, and may require support. Works to be halted in adverse weather. Cut excavations to be inspected by geotechnical engineer at regular intervals. Ensure proper maintenance checks of structures and pipelines is undertaken Leaking pipes or pits are to be repaired immediately. Undertake engineering design and slope stability assessment during detailed	Rare	Major	Low

Environmental asset	HAZARD	Initial risk rating			Control measures	Residual risk rating		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
					design in accordance with ANCOLD.			
Native Vegetation outside of PCF	Small scale, localised failures associated with excavations and other construction activities destroying vegetation.	Rare	Insignificant	Very Low	Works to be halted in adverse weather. Cut excavations to be inspected by geotechnical engineer at regular intervals. Minimise the time that excavations are open.	Rare	Insignificant	Very Low
Potential Non-Core habitat for Pygmy Possum outside of PCF	Large scale global rotational or translational landslide or debris flow caused by dam construction destroying potential habitat.	Possible	Major	High	Undertake geotechnical investigation, engineering design and slope stability assessment during detailed design (and in accordance with ANCOLD for dam construction). Reduce batter angles or other stabilisation or retaining methods. Excavation angles must be at or below angles recommended by geotechnical engineer for both temporary and permanent batter slopes, and may require support. Works to be halted in adverse weather.	Rare	Major	Low

Environmental asset	HAZARD	Initial risk rating			Control measures	Residual risk rating		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
					Cut excavations to be inspected by geotechnical engineer at regular intervals. Ensure proper maintenance checks of structures and pipelines is undertaken Leaking pipes or pits are to be repaired immediately. Undertake engineering design and slope stability assessment during detailed design in accordance with ANCOLD.			
Potential Non-Core habitat for Pygmy Possum outside of PCF	Small scale, localised failures associated with excavations and other construction activities destroying potential habitat.	Rare	Insignificant	Very Low	Works to be halted in adverse weather. Cut excavations to be inspected by geotechnical engineer at regular intervals. Minimise the time that excavations are open.	Rare	Insignificant	Very Low
Listed Fauna Species outside of PCF	Large scale global rotational or translational landslide or	Possible	Major	High	Undertake geotechnical investigation, engineering design and slope stability assessment during detailed design (and in accordance	Rare	Major	Low

Environmental asset	HAZARD	Initial risk rating			Control measures	Residual risk rating		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
	debris flow caused by dam construction destroying fauna and fauna habitat.				with ANCOLD for dam construction). Reduce batter angles or other stabilisation or retaining methods. Excavation angles must be at or below angles recommended by geotechnical engineer for both temporary and permanent batter slopes, and may require support. Works to be halted in adverse weather. Cut excavations to be inspected by geotechnical engineer at regular intervals. Ensure proper maintenance checks of structures and pipelines is undertaken Leaking pipes or pits are to be repaired immediately. Undertake engineering design and slope stability assessment during detailed design in accordance with ANCOLD.			
Listed Fauna Species outside of PCF	Small scale, localised failures associated with	Rare	Insignificant	Very Low	Works to be halted in adverse weather. Cut excavations to be inspected by geotechnical engineer at regular intervals.	Rare	Insignificant	Very Low

Environmental asset	HAZARD	Initial risk rating			Control measures	Residual risk rating		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
	excavations and other construction activities destroying fauna and fauna habitat.				Minimise the time that excavations are open.			
Waterways outside of PCF	Large scale global rotational or translational landslide or debris flow caused by dam construction causing blockage or diversion of waterway	Possible	Major	High	Undertake geotechnical investigation, engineering design and slope stability assessment during detailed design (and in accordance with ANCOLD for dam construction). Reduce batter angles or other stabilisation or retaining methods. Excavation angles must be at or below angles recommended by geotechnical engineer for both temporary and permanent batter slopes, and may require support. Works to be halted in adverse weather. Cut excavations to be inspected by geotechnical engineer at regular intervals.	Rare	Major	Low

Environmental asset	HAZARD	Initial risk rating			Control measures	Residual risk rating		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
					Ensure proper maintenance checks of structures and pipelines is undertaken Leaking pipes or pits are to be repaired immediately. Undertake engineering design and slope stability assessment during detailed design in accordance with ANCOLD.			
Waterways outside of PCF	Small scale, localised failures associated with excavations and other construction activities causing blockage or diversion of waterway	Rare	Insignificant	Very Low	Works to be halted in adverse weather. Cut excavations to be inspected by geotechnical engineer at regular intervals. Minimise the time that excavations are open.	Rare	Insignificant	Very Low
Waterways outside of PCF	Water flow reduction caused by change or redirection of groundwater flows	Possible	Medium	Moderate	Dam excavation to be drained. Balance flows from environmental watering system with any measured reduction in flow in the water courses.	Unlikely	Medium	Low

Environmental asset	HAZARD	Initial risk rating			Control measures	Residual risk rating		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
					Any watering should only be undertaken in accordance with a project specific Hydrological and Ecological Monitoring and Adaptive Management Program (HEMAMP) based on pre-determined trigger levels and associated monitoring.			
Waterways outside of PCF	Turbidity increase caused by erosion and deposition of fines into watercourse	Likely	Minor	Moderate	Works to be halted in adverse weather. Construct appropriate vehicular crossings over water courses (where required). Control stormwater run-off from stockpile areas and excavations during construction and provide erosion protection to disturbed ground or fill post construction. Use silt fences or other appropriate methods to prevent flow of turbid water outside of PCF.	Unlikely	Minor	Low
Visual Amenity outside of PCF	Large scale global rotational or translational	Possible	Major	High	Undertake geotechnical investigation, engineering design and slope stability assessment during detailed	Rare	Major	Low

Environmental asset	HAZARD	Initial risk rating			Control measures	Residual risk rating		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
	landslide or debris flow caused by dam construction causing reduction in visual amenity.				design (and in accordance with ANCOLD for dam construction). Reduce batter angles or other stabilisation or retaining methods. Excavation angles must be at or below angles recommended by geotechnical engineer for both temporary and permanent batter slopes, and may require support. Works to be halted in adverse weather. Cut excavations to be inspected by geotechnical engineer at regular intervals. Ensure proper maintenance checks of structures and pipelines is undertaken Leaking pipes or pits are to be repaired immediately. Undertake engineering design and slope stability assessment during detailed design in accordance with ANCOLD.			
Visual Amenity outside of PCF	Small scale, localised failures associated	Rare	Insignificant	Very Low	Works to be halted in adverse weather. Cut excavations to be	Rare	Insignificant	Very Low

Environmental asset	HAZARD	Initial risk rating			Control measures	Residual risk rating		
		Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
	with excavations and other construction activities causing reduction in visual amenity.				inspected by geotechnical engineer at regular intervals. Minimise the time that excavations are open.			

3.2 Risk Assessment Summary

Initial risk levels to environmental assets outside the PCF range from “high” for large scale failures to “very low” for small scale failures. Initial risk levels of “moderate” were identified for potential hazards of increased turbidity or change in flow conditions within the waterways adjacent to the PCF.

Provided that the recommended control measures (including adequate levels of slope stability assessment and design) are allowed for / incorporated at the detailed design stage, and simple controls such as having regular geotechnical inspections and stopping work during adverse weather conditions are enacted during construction, it is considered that the residual geotechnical risk levels to the identified environmental assets adjacent to the PCF can be reduced to “low” or “very low” levels.

The preliminary residual risk rating is the risk believed to be associated with the dam and relevant ancillary components of the project post construction. It assumes that the dam will be constructed as per a (to be developed) detailed design in accordance with ANCOLD and ICOLD best practice, utilising all risk mitigation and defensive measures as detailed in the (future) detailed design documentation.

In accordance with Clause 3.2 of the EMO further quantitative or semi-quantitative risk assessment is not deemed necessary for the environmental assets assessed, provided all recommended control measures in Table 2 are adopted.

Based on the findings of this assessment, the site is considered to be suitable for the proposed development providing the recommendations given in Table 2 and the Report are followed.

4 “Low to Moderate” residual dam-related geotechnical risk ratings

4.1 Current preliminary qualitative risk assessment (screening)

As part of the geotechnical risk assessment and in recognition of the nature of the project (construction of a water storage), geotechnical-related dam hazards were also included in a preliminary qualitative risk assessment.

As stated in Section 3.1 of the Report, **this indicative preliminary risk assessment is indicative only and should not be considered as part of the main geotechnical risk assessment of the Project. The indicative and preliminary qualitative risk assessment will be superseded by further quantitative assessments of risk to be completed during the detailed design process.** This process of quantitative risk assessment follows the requirements of the EMO (which states that any risk with a residual risk level of greater than “low” should be assessed quantitatively).

The dam-related hazards were preliminarily assessed as a screening process in order to identify additional dam-specific geotechnical hazards to be considered and assessed as part of the detailed design of the dam. As stated in Section 3.4.2 of the Report, the geotechnical hazards associated with construction of the storage will be further assessed during detailed design in accordance with ANCOLD (Australian National Committee on Large Dams) guidelines. Table 3 of the Report identifies and presents risks for comparative purposes. It does not present a societal risk profile of the proposed storage dam in accordance with ANCOLD tolerable limits.

4.2 Future quantitative risk assessment

The ANCOLD guidelines require that dam-specific geotechnical hazards are assessed (along with other project hazards) using the quantitative probabilistic “event tree analysis” method and are then further assessed to determine if the level of risk to property, the environment and people is acceptable. It should

be noted that the outcome of the detailed design risk assessment is *not* presented in the form of a simple qualitative assessment (ie. it will not be referred to in qualitative terms of risk such as “low” or “moderate”).

The results of the risk assessment of dam specific hazards, including geotechnical hazards will be probabilistic and will determine if the risk imposed to people, the environment and property after construction is acceptable to individuals and society. Therefore, all of the hazards with higher than (the currently) “low” residual risk will be fully quantitatively assessed in line with the EMO once sufficient details of the design of the dam are known. It is not possible to complete this assessment prior to detailed design as insufficient detail about the design is currently known to form a reliable assessment.

The starting point of the detailed dam design will be to achieve an “As Low as Reasonably Practicable” (ALARP) risk to life, the environment and property on a societal or individual level. If this cannot be achieved in the detailed design, then the dam will not be constructed.

ANCOLD guidelines, together with the regulated requirements of the Department of Environment, Land, Water and Planning (DELWP), define the tolerable level of risk that a dam can impose. **Furthermore, DELWP requirements for the design, construction and operation of water storage dams (under the *Water Industry Act 1994* or the *Water Act 1989*) require that acceptable risk levels are achieved and maintained.**

All identified dam-related geotechnical hazards will be assessed at or to a greater level of detail than the requirements of the EMO prior to any construction taking place. Acceptable levels of risk, although discussed in terms of probability, could also be interpreted and described as equating to “low” levels of qualitative risk (although the mixing of these terms is not strictly correct and is generally avoided).

It is suggested that any planning permit conditions should stipulate that a comprehensive risk assessment of dam related hazards including geotechnical risks, should be completed at the detailed design stage of the Project in accordance with quantitative/probabilistic ANCOLD procedures, and that the Project cannot proceed beyond detailed design stage if any of these risks are determined to be unacceptable as per DELWP regulations.

In summary:

- The Report presents a preliminary qualitative risk assessment of geotechnical risks based on the Project concept design. A range of risk mitigation measures have been identified which would be further developed and documented in the detailed design.
- Dam-related qualitative geotechnical risks were included in the Report for completeness and to inform subsequent stages of the design process. The qualitative risk assessment is preliminary and will be superceded in subsequent design stages by a detailed quantitative risk assessment process in accordance with ANCOLD guidelines and DELWP requirements. The outputs of this process will not be expressed as a simple qualitative change (for example from “moderate” to “low”) but as a comparison between the assessed societal risk of the storage and the ANCOLD tolerability criteria for societal risk.

4.3 Potential for enlargement of the PCF

The PCF (presented in Attachment 1) has been identified and determined based on the currently proposed concept design for the Project. This concept design has been developed as part of an iterative constraints identification process. The design considers constructability and access aspects, as well as

short and longer term ancillary infrastructure requirements. The currently proposed PCF has been heavily constrained in order to avoid and minimise environmental impacts and vegetation removal.

At this stage in the design process is it not anticipated that construction outside of the PCF will be required in order to successfully mitigate project specific geotechnical risk. Likewise, it is also anticipated that construction outside of the PCF will not be required to successfully reduce dam safety related risk levels to acceptable levels after the detailed design stage is completed.

Proposed examples of risk mitigation measures that would typically be located *within* the currently identified PCF include:

- Temporary drainage arrangements for stockpile areas.
- Erosion protection.
- Permanent drainage infrastructure below the storage dam liner.
- Trenches to include impermeable water stops to prevent erosion along backfilled trenches in the event that a trench intersects springs.
- Retention systems at the break tank.

The detailed design has not yet been undertaken for the Project. Whilst it is possible that minor changes to the proposed infrastructure or specific locations may occur as part of the detailed design, it is considered unlikely that these changes would be required to be undertaken outside the currently nominated PCF, for the purposes of geotechnical risk mitigation.

5 Environmental Watering System

An environmental watering system is proposed for the Project in order to mitigate potential impacts on the Alpine Bogs located downslope of the PCF. A hydrological and ecological monitoring and adaptive management program (HEMAMP) has been developed (Biosis and GHD, 2017). The watering system would allow water to be discharged from the dam and applied in a targeted and controlled manner via a series of pits located below the storage dam and upslope of the Alpine Bogs.

The HEMAMP includes information on the proposed operation and monitoring of the environmental watering system and Alpine Bogs. Water discharges will not be undertaken within 20 m of the toe of the storage embankment, and the timing and quantity of water discharges would be managed so as not to exceed the flows entering the area prior to construction. The ongoing monitoring of groundwater levels at the toe of the storage / upslope of the Alpine Bogs is also proposed.

The environmental watering system and the assessed levels of geotechnical risk are presented in the Report. An initial “screening” of this component of the project was completed using a qualitative assessment methodology. The residual geotechnical risk was identified as being of “moderate” level, so as stipulated in the EMO, a semi-quantitative risk assessment was completed. The results of the semi-quantitative assessment are presented in Section 3.5 of the Report. The level of geotechnical risk to property and people associated with the environmental watering was assessed to be within tolerable limits provided the recommended mitigation measures (Section 4.1.6) are incorporated at detailed design and during construction and operation.

The environmental watering system is therefore expected to present a sufficiently low level of risk to allow construction and operation to proceed with the appropriate monitoring, management measures and controls in place.

6 References

Biosis (2016) *Mt Buller Sustainable Water Security Project - Off-Stream Storage Flora and Fauna Assessment* (August, 2016).

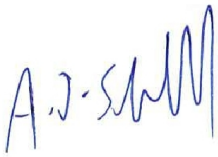
Biosis and GHD (2017) *Mt Buller Sustainable Water Security Project - Off-Stream Storage Hydrological and Ecological Monitoirng and Adaptive Management Program* (April, 2017).

GHD (2016) *Mt Buller Sustainable Water Security Project - Off-Stream Storage Geotechnical Risk Assessment* (December 2016) Doc No. 233153.

I trust that this letter will assist with the understanding of the geotechnical risk assessment undertaken to date, the potential geotechnical risks to identified environmental assets, and the expected future risk assessment processes associated with the design and construction of the storage.

Please feel free to contact me if further information is required.

Sincerely
GHD Pty Ltd



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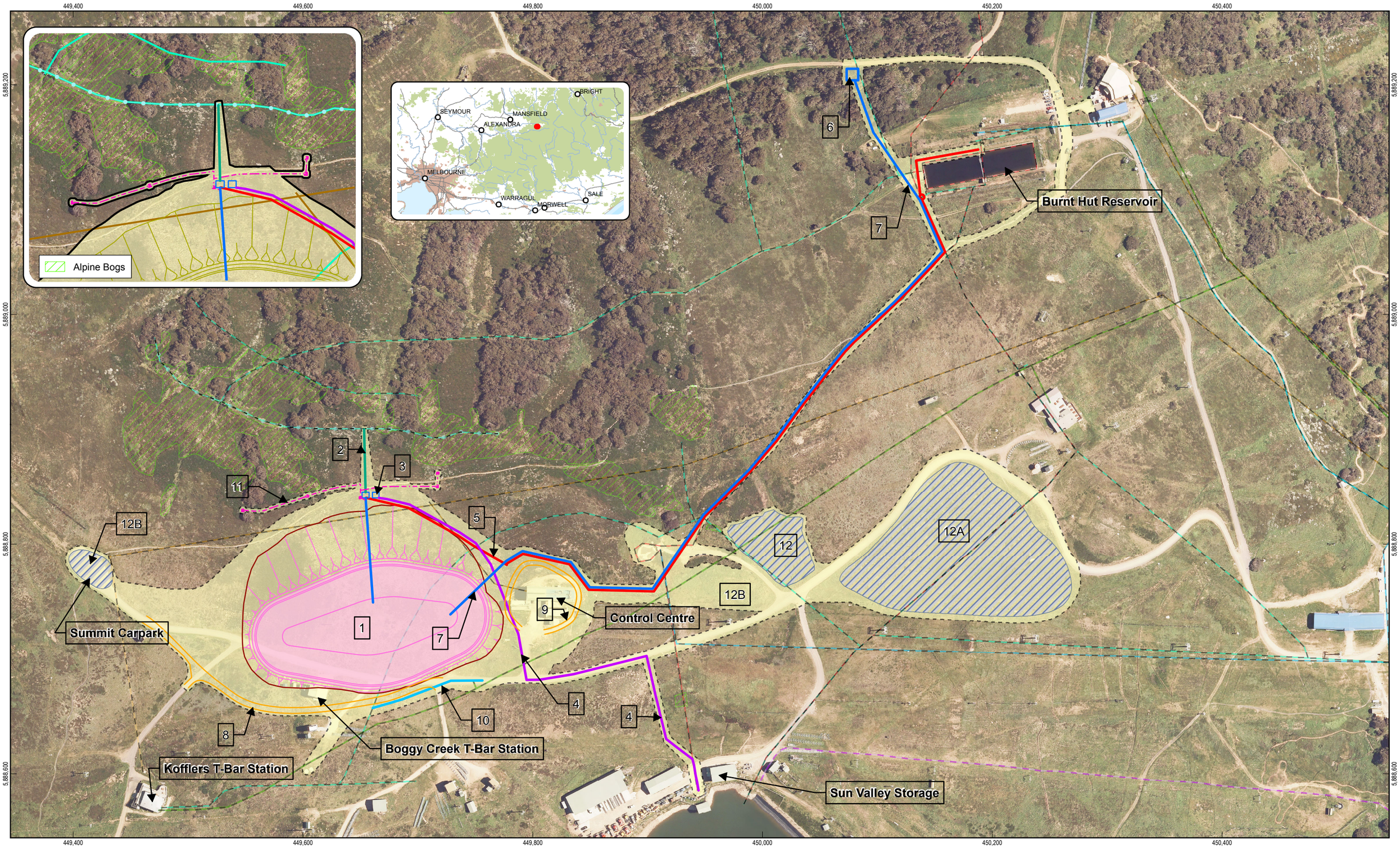
Attachment 1: Project Concept Design



Paper Size A3

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Metres

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

New Infrastructure

- Construction footprint
- Proposed stockpiles(12)
- Dam Option (1)
- Buller Irrigation Pipeline(11)
- New Road Alignments (8,9)
- Kofflers Water Supply Pipeline(10)
- Outlet Pipeline(2)
- Storage Tank(6)
- Sun Valley Water Supply Pipeline(4)
- Treatment Supply Pipeline(5)
- Water Supply Pipeline(7)
- Water Supply Pump(3)
- Aqueduct

Exisiting Water Infrastructure (approximate location)

- Water main
- Sewerage Main
- Sewerage Rising Main
- Recycled Water Main
- Gas Main
- Sewerage Main
- Water Infrastructure
- Potable Water Pipeline

Mt Buller & Mt Stirling Resort Management
Mt Buller Sustainable Water Security Project

Job Number 31-30733
Revision E
Date 15 Jun 2017

Project Concept Design

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Data source: Mt Buller & Mt Stirling Resort Management, Aerial imagery, 2011; ARI, bog mapping. Created by:tworth

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