Mt Buller and Mt Stirling Alpine Resort Management Board

Mt Buller Sustainable Water Security Project - Off-Stream Storage

Options Assessment Report

July 2014

Executive summary

Background and Context

The Mt Buller and Mt Stirling Alpine Resort Management Board (RMB) is responsible for the management of the Mt Buller and Mt Stirling Alpine Resorts. These Resorts cover an area of 5,000 hectares in North East Victoria. The RMB has a series of performance obligations and objectives associated with its management of the Mt Buller and Mt Stirling Alpine Resorts. One of these objectives is the provision of a safe and reliable water supply.

The Mt Buller Alpine Resort (the Resort) has significant constraints on its water supply. The annual water demand for Mt Buller is influenced by climatic conditions and varies significantly from year to year. A number of strategic and planning documents relevant to the Resort propose an increase in visitation both within and outside the peak winter period. This increased year round visitation has implications for the Resort potable and snowmaking water supply infrastructure.

The practice of snowmaking has become an important means of ensuring adequate snow cover in the Resort during the peak winter visitation period, and has a significant role to play in securing the economic viability of the Resort. Snowmaking activities require large volumes of water in a short period of time in order to take advantage of suitable weather conditions. Increased snowmaking (either on current snowmaking areas or over an expanded area) will require a supply of water which can be delivered in a way which matches the demand profile.

The RMB has established the Mt Buller Sustainable Water Security Project which encompasses a series of projects designed to assist it in meeting its obligation to provide a safe and reliable water supply to the Resort, both now and in the future. One component of the Mt Buller Sustainable Water Security Project is the development of an Off-Stream Storage facility and an associated upgrade of the Resort water supply and treatment infrastructure.

Investigations into potential water supply augmentation options and water storage locations have been undertaken periodically by the RMB. Based on a number of these previous investigations and reviews, the RMB have determined that a 100 ML on mountain storage is required to meet current and future potable and snow making water demands. In late 2013 the RMB commenced detailed investigations into the potential siting and design of a 100 ML storage and the ancillary infrastructure required to service this asset.

Review of Strategic Water Supply Options

A review of the range of strategic water supply options potentially available to the Resort was undertaken in the initial phase of the Project. The review included an assessment against a range of criteria. Water supply options considered included:

- Demand management (reduction of water demand / improved efficiency) ;
- On mountain and off mountain storages;
- Increased surface water extractions;
- Use of alternative supplies such as stormwater, rainwater, and groundwater;
- A combination of the above; and
- Do nothing.

The ability to meet both peak potable and snowmaking demands, whilst minimising capital and operating costs, resulted in an on mountain storage being selected as the most appropriate water supply option.

Site Options Assessment

An options assessment for the siting of a 100 ML on mountain off-stream water storage has been undertaken by GHD and the RMB. A two stage assessment process was undertaken to identify and evaluate potentially suitable sites for an on mountain storage.

A multi-criteria assessment (MCA) process was developed and employed on three potential sites utilising a range of objectives and criteria sourced from relevant planning and strategy documents, and from RMB organisation specific objectives. Assessment criteria (developed in conjunction with RMB and with input from Buller Ski Lift (BSL)) included land use planning, environment, heritage, social, economic, ski resort utility, technical and engineering, construction, operation and bushfire management considerations.

The first stage of the process evaluated three sites (Tirol, Koflers and Control Centre), and was informed from prior investigations, as well as limited site specific geotechnical and ecological investigations. This stage utilised the MCA. One site (Koflers) was considered to be inferior and was eliminated from the shortlist of potential sites. The Control Centre site was considered to have sufficient merit to be the preferred site, but additional information was required in order for this to be confirmed.

The second stage of the site selection process was undertaken following a series of more detailed geotechnical, hydrogeological and ecological investigations, in conjunction with a preliminary concept design process. This concept design considered a larger footprint than the first stage in order to take account of storage construction methodology, and the need to install and relocate ancillary infrastructure. Following these investigations, the MCA was reviewed to ensure that the preferred site remained preferred in light of the additional information which had been gained.

Preferred Site

A comparison of the Control centre with the Tirol site using the key project criteria indicates that:

- The area of direct impact to native vegetation is similar between sites, however there is potential for the construction of the Control Centre storage to result in indirect (hydrology related) impacts to the downslope alpine bog vegetation. A range of mitigation measures have been identified to address the indirect impacts. Additional investigations are recommended as part of the detailed design phase. A monitoring and management plan which integrates groundwater and ecological information is required in order to facilitate adaptive management of site and the mitigation of impacts;
- There is significant geotechnical complexity associated with both sites, however the geotechnical risks, and the risks associated with failure to achieve a 100 ML storage during the construction phase are considered to be lower at the Control Centre site;
- The potential impacts on skiable terrain, connectivity and Resort functionality are significantly lower at the Control Centre site. Construction at the site would require decommissioning of the Boggy Creek T bar (something which has been proposed in the Resort Master Plan); and
- The construction costs associated with the Control Centre site are expected to be lower than Tirol due to the smaller quantities of rock to be handled and processed.

Following a review of available information, the Control Centre site was confirmed as the preferred site for the 100 ML off-stream storage. The review and assessment processes undertaken as part of this site options assessment have identified a range of risks which would need to be addressed in the project planning, design, construction and operational phases of the project.

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Glossary

ARCC	Alpine Resorts Coordinating Council
ARPS	Alpine Resorts Planning Scheme
BSL	Buller Ski Lift Pty Ltd
CHMP	Cultural Heritage Management Plan
DEPI	Department of Environment and Primary Industries
DSEWPaC	Department of Sustainability, Environment, Water Population and Communities
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EVC	Ecological Vegetation Class
FFG Act	*Flora and Fauna Guarantee Act 1988* (State)
GDE	Groundwater Dependent Ecosystem
GMW	Goulburn Murray Water
ha	Hectare
LiDAR	Laser Imaging Detection and Ranging
MCA	Multi-Criteria Assessment
ML	Megalitre
MNES	Matters of National Environmental Significance
P&E Act	*Planning and Environment Act 1987* (State)
RMB	Mt Buller Mt Stirling Alpine Resort Management Board
STP	Sewerage Treatment Plant
VAHR	Victorian Aboriginal Heritage Register
VHR	Victorian Heritage Register

1. Introduction

This report for the Mt Buller Sustainable Water Security Project – Off-Stream Storage (the Project) documents the need for the proposed Off-Stream Storage, the alternatives considered, the assessment of potential storage sites, and the development of a concept design for the preferred site.

1.1 Background

The Mt Buller Mt Stirling Alpine Resort Management Board (RMB) is responsible for the management of the Mt Buller and Mt Stirling Alpine Resorts. These Resorts cover an area of 5,000 hectares in North East Victoria. The RMB has a series of performance obligations and objectives associated with its management of the Mt Buller and Mt Stirling Alpine Resorts. One of these objectives is the provision of a safe and reliable water supply.

The Mt Buller Alpine Resort (the Resort) has significant constraints on its water supply. The water requirements of the Resort are determined by the need to service the resident and visitor populations, and to maintain the amenity and functionality of the Resort during winter for skiing and snow-play.

The annual water demand for the Mt Buller Resort is influenced by climatic conditions and varies significantly from year to year. The Alpine Resorts 2020 Strategy (2004), the Mt Buller Master Plan (2010) and the Alpine Resorts Strategic Plan (2012) propose not only an increase in total visitor numbers for Mt Buller Resort, but also an increase in visitation outside the peak winter period. This increased year round visitation has implications for the Resort's potable and snowmaking water supply infrastructure.

The aforementioned plans also identify snowmaking as a means to provide increased resilience to climate variability, and to underpin current and future commercial opportunities at the Resort. Snowmaking requires large volumes of water in a short period of time in order to take advantage of suitable weather conditions. Raw water extracted from the local Boggy Creek catchment or Class A recycled water is currently utilised for snowmaking at Mt Buller. The specific location of infrastructure determines the water source(s) used. Increased snowmaking (either on current snowmaking areas or over an expanded area) would require a supply of water which can be delivered in a way that matches the demand profile. This in turn influences future water supply, storage and infrastructure options.

Investigations into the augmentation of existing water supply options and infrastructure, and potential water storage locations have been undertaken periodically by the RMB over the last two decades. A range of water supply options and potential sites for water supply storages have been assessed to varying degrees.

The RMB has established the Mt Buller Sustainable Water Security Project which encompasses a series of projects designed to assist it in meeting its obligation to provide a safe and reliable water supply to the Resort, both now and in the future.

One component of the Mt Buller Sustainable Water Security Project is the development of an Off-Stream Storage and an associated upgrade of the Resort water supply and treatment infrastructure. Based on a number of previous investigations and reviews, the RMB have determined that a 100 ML on mountain storage is required to assist it in meeting future potable and snow making water demands. In late 2013 GHD were commissioned by the RMB to undertake investigations into the siting and concept design of a 100 ML storage, and the ancillary infrastructure required to service this asset. The proposed project is known as the Mt Buller Off-Stream Storage Project (hereafter referred to as the Project).

1.2 Purpose of this report

This report has been prepared by GHD for Mt Buller and Mt Stirling Alpine Resort Management Board and may only be used and relied on by Mt Buller and Mt Stirling Alpine Resort Management Board for the purpose agreed between GHD and the Mt Buller and Mt Stirling Alpine Resort Management Board as set out in this section of the report.

GHD otherwise disclaims responsibility to any person other than Mt Buller and Mt Stirling Alpine Resort Management Board arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The purpose of this report is to document the process from the decision to develop an Off-Stream Storage through to development of the concept design for the preferred site. It will be used by the RMB to inform a number of project planning and approvals requirements.

Specifically this report documents:

- The background and context of the Project (section 2);
- Water supply options considered for the augmentation of the Resorts' water supply (section 3);
- The methodology and framework for the Multi-Criteria Assessment (MCA) used to assess and select the preferred site for the Off-Stream Storage (section 4);
- Identification of sites and preliminary concept designs for the Off-Stream Storage (section 5); and
- Analysis of results of the MCA and development of the concept design for the preferred site (section 6).

1.3 Scope and limitations

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.

GHD has prepared this report on the basis of information provided by Mt Buller and Mt Stirling Alpine Resort Management Board and others who provided information to GHD (including government authorities and Buller Ski Lifts Pty Ltd), 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 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 assessment information presented, whilst considering a range of potential impacts, is not in itself a detailed assessment of any particular impact.

2. Project Overview & Context

This section of the report provides an outline of the current water supply system at the Mt Buller Resort including; its development over time, current and forecast demand for water and the strategic planning context of the proposed Project.

2.1 Mt Buller Alpine Resort Water Supply

The annual water demand for the Mt Buller Resort is influenced by climatic conditions and varies significantly from year to year. The location of the Resort at high elevations and on sloping land near the summit of Mt Buller means that there is limited catchment nearby from which to collect or store water. The security of water supplies is not a new problem to the Resort, with investigations into potential water supply augmentation options being undertaken since the 1990's.

The water supply and treatment infrastructure at the Resort has developed over several decades in response to changes in the nature and scale of the activities being undertaken. Regulatory and policy requirements for drinking water and for the reuse of treated effluent have also influenced the development of water supply, treatment, storage and reuse infrastructure at the Resort.

2.1.1 Historical development of water supply infrastructure

The key developments and investigations associated with the Mt Buller water supply infrastructure are outlined as follows:

1965: Burnt Hut Reservoir was constructed. This 4.2 ML reinforced concrete reservoir allows water to be stored and treated adjacent to the Resort and distributed by gravity (low level reticulation system) or by pumping (high level reticulation system) to the Mt Buller village.

1987: Rural Water Commission released a report entitled 'Mt Buller Alpine Resort Water Supply Augmentation'. The report identified two sites at approximately 1,250 m elevation for a 10 ML storage.

1988-89: The Boggy 2 pump station was constructed to supply additional water to the Resort from the Boggy Creek catchment. The Baldy high level tank (1 ML) was also constructed to supply the higher altitude sections of the village and to replace an outdated tank located at the Tirol lodge.

1992-93: The 70 ML capacity Sun Valley Reservoir was constructed together with supporting infrastructure to meet the increasing water supply demands of the Resort.

1994: Snowmaking activities commenced on Mt Buller.

1993-1996: The Alpine Resorts Commission investigated additional water supply and storage options. The Chalet Creek and Boggy 2 areas were evaluated as potential 50 ML storage dam sites. It was concluded that these sites were geologically unsuitable for storages (Rhithroecology, 1996). Augmentation and further investment in the water supply infrastructure (Boggy 1 and Boggy 2 pump stations) was also investigated.

2004-2010: Drought conditions experienced between 2004 and 2010 highlighted the need for more secure and alternative water supplies. The yield of Boggy Creek in late summer / early autumn has at times been extremely low, particularly during extended periods of low rainfall.

2007-08: The Sustainable Water Re-Use Project was completed. This involved the construction of a separate Class A Sewerage Treatment Plant (STP) and a variety of ancillary infrastructure to facilitate the recycling and reuse of treated effluent received from the primary wastewater

treatment facility. The Class A recycled water upgrade provided water to meet increased snowmaking demand and other non-potable uses within the Resort.

Whilst the use of the Sun Valley Reservoir for the storage of Class A recycled water allowed some substitution of raw water to be undertaken, it also meant that the capacity to store water for subsequent treatment and potable use was reduced. This storage capacity reduction, together with a general increase in demand for both raw and potable water to the Resort, prompted further evaluation into raw water supply and storage.

2007-09: A feasibility study to investigate the reliability of water supplies from Boggy Creek and site options for the proposed storage (Maunsell | AECOM, 2008) was commenced. Further concept design and water supply (catchment) analyses were completed in 2009 (AECOM, 2009). A water storage of 80 to 100 ML capacity was considered feasible.

2011: The RMB commissioned a Water Supply Demand Strategy Review (GHD, 2013) coinciding with the development of the Alpine Resorts Strategic Plan (ARCC, 2012). The review was undertaken in order to identify the best mix of measures to maintain a balance between the demand for water and available supply as at 2011, and for the future. It was intended to review and confirm the need for a storage and to provide an indication of the storage capacity required. This investigation determined that the preferred strategic option involved the construction of an on mountain storage with further augmentation of ancillary infrastructure to meet on-going water supply demands. Based on a range of factors influencing the supply demand balance, a requirement for an additional storage with capacity between 100 and 150 ML was identified.

2013: The RMB established the Mt Buller Sustainable Water Security Project in recognition of the fact that no single water supply, demand management, monitoring or treatment initiative is likely to be sufficient to secure the quality and quantity of Mt Buller's water supplies over the long term. The project includes a range of initiatives designed to assist RMB in meeting its obligation to provide a safe and reliable water supply to the Resort. One component of the Mt Buller Sustainable Water Security Project is the development of a 100 ML off-stream storage and associated infrastructure, which is the subject of this report.

2.1.2 Water demand and supply

This section provides a summary of the key components of the existing Mt Buller water supply and treatment system in the context of current and future demand.

The Mt Buller water supply system receives water from two main sources; diversions from Boggy Creek (and its tributaries), and Class A recycled water from the Mt Buller Wastewater Treatment Plant. A third source is obtained from a licensed diversion of a tributary of the Howqua River into the Sun Valley Reservoir. This is achieved via a temporary (20 ML/year) diversion licence to supplement demand for snow making purposes, with the infrastructure owned and operated by Buller Ski Lifts Pty Ltd (BSL).

A map showing the location of catchments and key infrastructure associated with the Mt Buller water supply is presented in Figure 1. A schematic of the current water supply system is presented in Figure 2.

Current and estimated future average annual water demand figures, assuming a medium growth scenario are presented in Table 1. There is currently limited information on the annual variability in potable demand, so the 2013 figures shown in this table are approximate only.

Paper Size A3

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Metres

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

N

LEGEND

- River
- Stream
- Aqueduct
- Approximate Catchment Boundary
- Resort Boundary

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

Job Number 31-30733
Revision A
Date 04 Jul 2014

Mt Buller Water Supply Key Features

Figure 1

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Data source: DEPI, Vicmap, 2013. Created by:mjahanshahi

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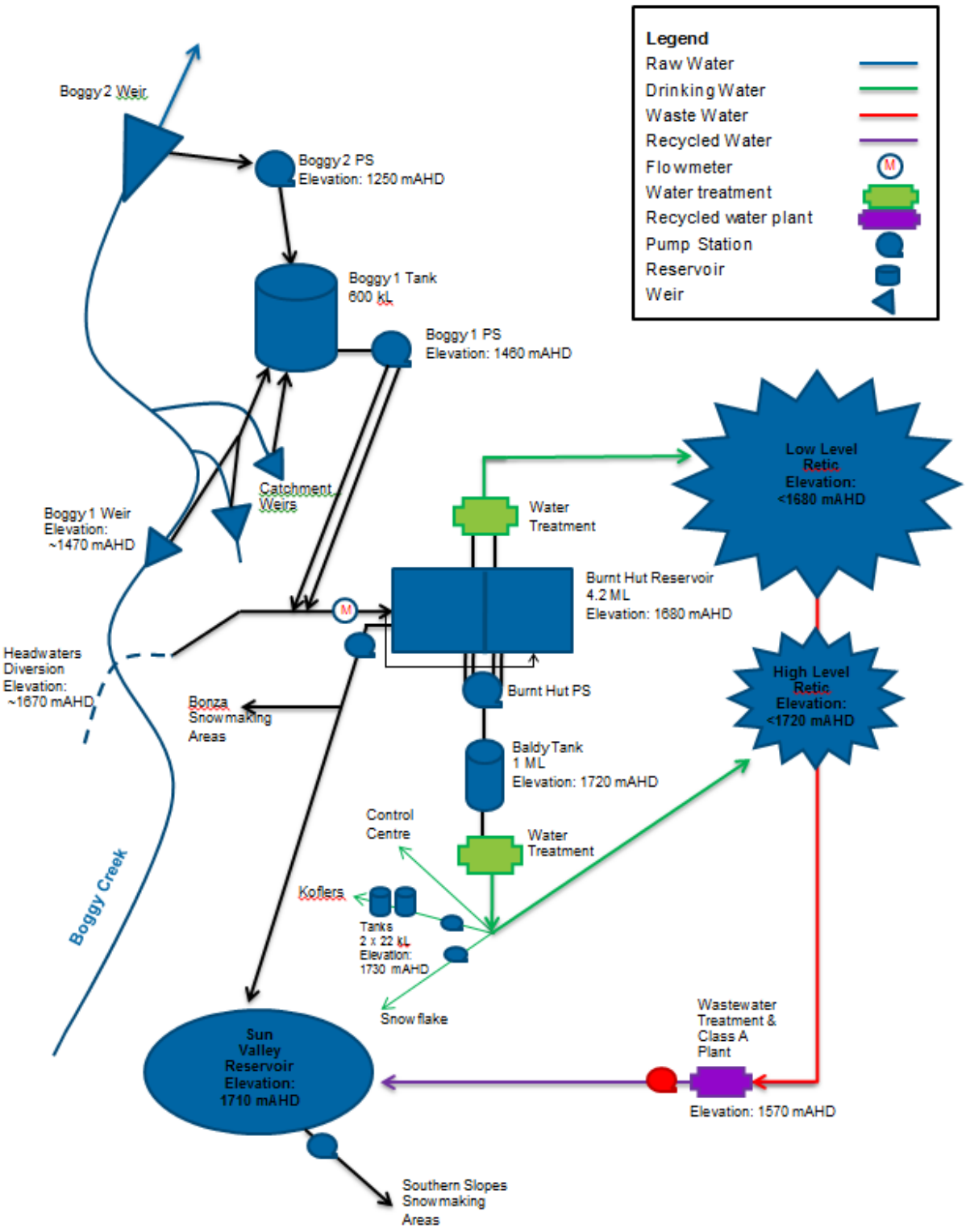


Figure 2 Mt Buller Water Supply System Schematic

Potable Water Demand and Supply

The population of Mt Buller varies seasonally, with a large number of visitors to the Resort during the winter ski season. Therefore the water demand for potable water use also varies seasonally, with higher demand during winter months. The current annual average potable water demand at Mt Buller is around 167 ML/yr and varies between 5 and 36 ML/month depending upon seasonal visitation.

Ongoing annual demand for potable water is expected to be strongly correlated to visitation numbers during the winter period, which is ultimately related to climatic conditions (i.e. snow coverage), noting that a decrease in snow coverage by five to 48 days per season due to climate change is predicted by 2020[1]. With projections of shorter snow seasons[2], increased variability and seasonality, RMB recognise that the Resort needs to expand activities and businesses to facilitate a more year-round focus. Over time the annual average potable water demand is expected to increase to 205 ML/yr by 2035.

The potable water supply for the Resort is sourced from the Boggy Creek and its tributaries. The Boggy Creek catchment is located on the northern slopes of Mt Buller and is part of the Delatite and Goulburn River catchments (refer Figure 1). A series of aqueducts and weirs within the Boggy Creek catchment collect and divert water to extraction points. Water is then either gravity fed or pumped into the Burnt Hut reservoir or a series of small tanks. The main storage facility at Burnt Hut reservoir has a capacity of 4.2 ML, and additional storage located within the supply system has a total capacity of approximately 1.6 ML[3].

Diversions from the Boggy Creek occur pursuant to the *Water Act 1989*. The RMB maintains a Section 51 Annual Diversion Licence issued by Goulburn-Murray Water (GMW). This licence permits up to 700 ML to be diverted each year between the months of May and October (inclusive) at a maximum diversion rate of 4 ML/day. The restriction of extraction to the months May – October is known as the 'winter fill requirement', which is a standard condition in accordance with current government policy, to provide for environmental flows over the 'summer' months.

Table 1 Current and estimated future annual average demand – medium growth scenario (in ML)

Type and Season	2013	2025 Estimate	2035 Estimate
Potable Demand			
May – October	134	161	161
November – April	33	44	44
Total	**167**	**205**	**205**
Snow Making Demand			
May – October	283	413	481
Total Demand (Winter + Summer)	**450**	**618**	**686**

Source: GHD (2014) Mt Buller Off-stream Storage Water Supply Concept Design Investigations

Currently the demand for potable water between November and April ('summer' months) is estimated to be 33 ML per annum. As the existing storages (5.8 ML in total) provide just under 14% of the capacity currently required (excluding growth) to meet current potable demands for the 'summer' months, water is diverted from Boggy Creek during this time as part of a temporary exemption to the existing winter period diversion licence condition. However this

[1] Climate change impacts on snow in Victoria, CSIRO December 2012
[2] Climate change impacts on snow in Victoria, CSIRO December 2012
[3] GHD (2014) Mt Buller Offstream Storage Water Supply Concept Design Investigations

practice is not desirable as it reduces environmental flows to the Boggy Creek during the summer months, and the continuance of the temporary exemption to the licence condition cannot be relied upon into the future. A new storage would allow adequate water to be diverted during the 'winter' months (May – October) to supply the Resort during the 'summer' months (November – April) in accordance with diversion licence conditions.

The reliability of the existing water supply system is low during low catchment inflow years as evidenced during the years of drought 2004-2010. Reliability is particularly problematic if low inflow years coincide with years where natural snow coverage is also poor, as this results in reduced recharge of the soil and groundwater systems from melted snow, which contribute to the storage and supply of water to the Boggy Creek.

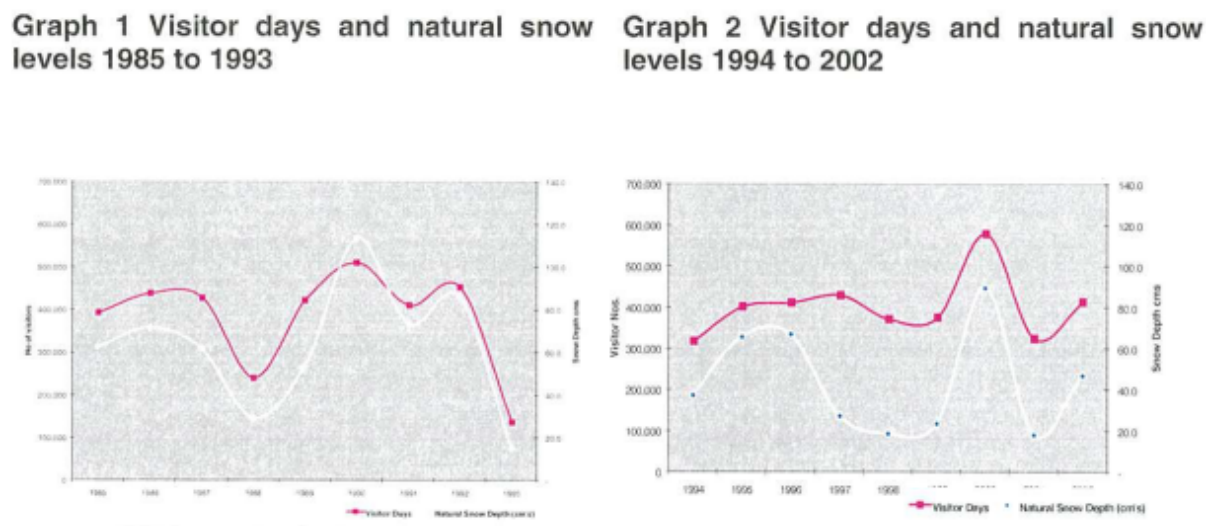
The existing raw water treatment system complies with the current requirements of the Australian Drinking Water Guidelines. However any future change in standards, together with the increased emphasis on multiple barrier approaches to water treatment, would require investment in the treatment system regardless of the Project.

The other key demand for water at Mt Buller is for snowmaking during winter.

Snowmaking Demand and Supply

Snowmaking activities on Mt Buller commenced in 1994. The snowmaking area increased from 43 ha in 1996 to 72 ha in 2012 as additional water was made available for this purpose. Water for snowmaking is sourced from the Burnt Hut reservoir (when excess is available) and the Class A Sewerage Treatment Plant (STP), which treats effluent received from the primary wastewater treatment facility to the Class A standard. Most snow making water is stored in the 70 ML capacity Sun Valley Reservoir. The current annual average snowmaking demand at Mt Buller is around 283 ML (May to October).

Figure 3 presents the impact that snowmaking has on visitor numbers. Graph 1 in the diagram shows visitor days and natural snow depth without any snowmaking facilities. Graph 2 illustrates how snowmaking facilities reduce the reliance on natural snow depth for visitor numbers. The graphs imply that snowmaking facilities have a significant role to play in the continuing viability of the winter season at Mt Buller.



Source: Saturn Corporate Resources (2002)

Figure 3 Relationship between visitor days and natural snow depth

Snowmaking activities require significant volumes of water (at times in excess of 10 ML/day) to be supplied during a short period of time when conditions are optimal. However under current licence conditions, diversions from Boggy Creek are limited to 4 ML/day. This requirement, combined with the limited storage capacity of the Sun Valley Reservoir (70 ML) constrains water use in peak snow making periods. In addition, for public health purposes the Class A recycled water cannot be used to supply potable demand and cannot be reused on areas which fall within the potable water supply catchment area (i.e. the Boggy Creek and Delatite River catchments). The inability to reuse recycled water in the Boggy Creek and Delatite River catchment means that any expansion of snowmaking in new areas of the Resort must utilise water sourced from the waterways in the vicinity of the Resort (i.e. the Boggy Creek catchment).

Firefighting Demand and Supply

Water stored at the Mt Buller Resort is not only required to meet potable water consumption and snowmaking demands, but is also required in order for the RMB and other agencies to effectively respond to emergency situations such as structural fires or bushfires.

Currently there is a minimal supply of water for firefighting within the village, or for a larger bushfire response, stored at the Burnt Hut Reservoir. For much of the village this is not a gravity fed supply, so relies on pumping and therefore an electricity supply, which can fail during a fire.

The bushfires at Mt Buller in 2006 / 2007 highlighted bushfire risks to the Resort, and the importance of having an adequate water resource available for firefighting.

Additional water supply or storage capacity would improve the fire-fighting capability and bushfire event response across the Resort.

An appropriately located storage could supply water to the Resort via gravity, overcoming the issues associated with power supply failure, and may also allow helicopter access for fire suppression purposes.

Supply constraints

The current annual average demand for potable and snowmaking water combined is around 450 ML/year. Under the existing licence, the total volume permitted to be diverted from Boggy Creek each year (700 ML/yr) is adequate to supply the current annual average potable and snowmaking demand (450 ML/yr), and forecast annual demand by 2035 (686 ML/yr). However, the limited storage capacity in the current system and the maximum diversion rate per day (4 ML) constrain supply as described in the previous section and summarised below:

- Adequate supply cannot be stored from winter diversions to supply the Resort during summer. Water is currently diverted during summer under a temporary exemption to the winter fill condition. This limits the ability to achieve environmental flows in Boggy Creek and is not a desirable or reliable long term solution; and
- Water use for snow making during peak periods is limited because of the maximum diversion rate from Boggy Creek (4 ML/day) and the limited storage capacity of the Sun Valley Reservoir (70 ML). Furthermore for public health reasons, recycled water cannot be used for snow making within the potable water supply catchment areas of the Resort.

Investigations and modelling undertaken for the Resort (Maunsell/AECOM, 2008 and AECOM, 2009) and the recent water supply demand strategy (GHD, 2013) indicate that a storage in the order of 100 ML is required to meet potable and snowmaking water demands throughout the year.

A number of different strategic solutions to these supply constraints, including development of a 100 ML storage, have been considered as described in section 3 of this report.

Benefits of addressing supply constraints

Resolution of the supply constraints described would lead to a number of benefits, including (but not limited to) the following.

Sustained summer tourism growth

- The Government's Alpine Regions Strategic Plan4 aims to increase non-winter visitors to the region. Additionally, the Alpine Resorts Strategic Plan and the Master Plan (2010) for the Mt Buller Mt Stirling Alpine Resort both propose an increase in total tourism numbers outside the peak period (i.e. during summer months), as well as during the peak winter period.
- Summer visitation is more likely to increase when there are activities and businesses within the Resort to attract visitors. A reliable and adequate supply of potable water is necessary to attract the operators and businesses that would provide these services in order to attract these visitors.
- Current potable water storage on the mountain is insufficient to provide adequate water supply to the current levels of tourism demand and so it is unlikely that there would be sufficient supply for any forecast or desired growth in tourist numbers over the summer period.
- Resolution of supply constraints would enable the growth of summer tourism which is considered important for diversity and resilience of the Resort.

Improved environmental outcomes

- Additional storage capacity would enable RMB to divert water from the Boggy Creek during 'winter' months only in accordance with licence conditions, and avoid limiting environmental flows during 'summer' months.

Improved fire-fighting capability and bushfire event response

- Additional water supply or storage capacity would improve the fire-fighting capability and bushfire event response across the Resort.

Growth in winter recreation and overall visitation

- Access to a reliable supply of water would provide an improved level of certainty for any future investment in snow-making technology. Therefore increased water storage capacity would facilitate an increase in snow making on existing areas, as well as provide for the potential expansion of snowmaking across the Resort. This is likely to result in increased economic benefits (such as those measured by the Gross State Product) from tourism and recreation.

2.2 Strategic and Planning Context

There are a variety of strategic planning documents and management objectives which either directly or indirectly refer to the provision of a safe and reliable water supply at the Resort. In some cases they refer directly to the identified requirement for additional on-mountain water storage. The construction of a storage is considered key to the implementation of a number of objectives listed in these planning documents.

The strategic and planning documents also provide guidance as to how development should occur having consideration to environmental, social and economic factors. The following

[4] Alpine Resorts Co-ordinating Council, 2012

sections provide a summary of the key strategic and planning documents relevant to the Project.

2.2.1 Alpine Resorts 2020 Strategy

The Alpine Resorts 2020 Strategy (DSE, 2004) was developed in order to guide sustainable long term planning and management, and to assist in investment attraction in Victoria's six alpine resorts. The strategy seeks to 'secure the long term viability of the Resorts by providing for long term sustainable growth within an environmentally friendly management framework'.

Relevant aspects of the strategy in terms of the Project include:

- The commitment to snow industry tourism and proactive planning for the impacts of climate change;
- Development of four season use as a priority; and
- Strengthening existing environmental management plans by giving further attention to water management as investment in snow making increases.

Chapter 4 of the strategy outlines the key aspects of sustainability as applied to the Resort. The chapter highlights the need to balance ecological, economic and social considerations, and to be considerate of environmental impacts such as:

- Biological diversity and health;
- Climate change, energy use and the impacts on snow cover; and
- Quality and quantity of water use, wastewater disposal and catchment impacts.

Chapter 5 of the document 'Strategic directions' highlights the need to:

- Retain strong investment in winter visitation;
- Make further investment in snow making technology and infrastructure;
- Assess the visual impacts of development in the context of the broader landscape impacts and vistas enjoyed from land outside the resorts;
- Manage and protect alpine flora and fauna living in and adjacent to the resorts; and
- Respect and manage cultural and historical heritage and consult with indigenous stakeholders.

Chapter 6 of the document 'Challenges and actions' discusses (amongst other things):

- The potential impacts of climate change and the need to facilitate further investment in snow making infrastructure in order to enhance natural snow cover;
- The need to grow the winter visitation market for the overall benefit of the industry;
- The benefits of increasing the number of permanent residents in order to build community and resort viability, and underpin year round activity;
- The need to consider energy efficiency and adopt energy efficient practices in order to mitigate climate change impacts;
- Fire management and the need to assess fire management issues relating to human habitation and development;
- The need to understand and manage catchment hydrology and locate catchment and storage infrastructure to minimise impacts on catchment hydrology; and
- The importance of geotechnical investigation in ensuring that development proposals pay due regard to land stability considerations.

The document also identifies opportunities for each Alpine resort. The Mt Buller Resort opportunities presented are consistent with the above chapters, namely development of the snow making system, augmentation of the water supply, provision of a permanent residential population, and increasing the range of services and facilities for summer time visitors.

2.2.2 Mt Buller Master Plan 2010

The Mt Buller Master Plan refers to the same themes as those presented in the 2020 Strategy including development of additional snowmaking, expansion of non-winter business, sustainability and landscape issues.

It also presents a series of development concepts for the village and the wider Resort.

Section 4.10 'The Skifields' identifies areas of proposed additional snowmaking, and discusses the need for a water storage to support the proposed new snow making activities. An additional water storage facility for both potable and snowmaking uses is identified as a short term priority project in section 7.2 'Project Priorities'.

2.2.3 Alpine Resorts Strategic Plan 2012

This Strategic Plan (ARCC, 2012) is reviewed on a 5 yearly basis. The current plan has six strategic objectives, a number of which are directly relevant to the Project. Relevant objectives and plans include:

Objective 1 – Enhancing the visitor experience and developing resorts

The benefits of snowmaking to Resort visitation in the face of variable snow cover are highlighted, and further enhancement to snowmaking is proposed (whilst recognising that there are financial, environmental, water supply and energy issues to be considered).

The benefits of 'Green season' visitation on Resort diversity and resilience are noted, together with the need to develop a more year round visitation focus given the projections of shorter snow seasons.

Objective 2 – Delivering resort services and infrastructure efficiently and accountably

Infrastructure is identified as fundamental to winter and summer resort use. The need for upgraded potable water supplies to meet drinking water standards and requirements to support winter and green season visitation is recognised.

Objective 4 – Respecting the alpine environment

The need to manage and develop areas to retain their unique alpine environmental values for the benefit of current and future generations, while supporting economically and socially sustainable alpine resort communities is discussed. The potential coincidence of high altitude slopes suitable for skiing and snowboarding with the restricted habitats of threatened or significant flora and fauna is also noted. The provision of reliable and safe drinking water year round, including linking to long term capital planning is identified as an important key performance indicator.

Objective 5 – Broadening access opportunities

Public safety is identified as a prime consideration. Two of the major risks to public safety are considered to be sudden mass land movement and bushfire. Both of these aspects are relevant to the siting and planning of the storage facility.

Objective 6 – Regulatory reform

This section of the document highlights the need for (1) better interpretation of the native vegetation offsets regulations in the alpine setting, and, (2) the need to deal with the apparent policy conflicts associated with increasing green season visitation whilst also avoiding placing people at risk in fire-prone locations. In terms of (1), recent vegetation reforms and policies have been undertaken / developed which may provide some clarity on vegetation removal and offsetting as part of this project. In relation to (2), the provision of an additional water supply capable of contributing to a bushfire response (via the snowmaking system or via the Resort water supply) is also consistent with the strategic plan.

The document also identifies barriers and constraints to be addressed for each Resort. The provision of an 'additional water supply for potable and snow-making purposes, with additional water storage capacity' is identified as a key issue for Mt Buller.

2.2.4 Alpine Resorts Planning Scheme (ARPS)

The Alpine Resorts Planning Scheme (ARPS) sets out the policies and controls for the development and protection of land within the Alpine Resorts. Within the ARPS, the Mt Buller Strategic Statement describes the vision and key issues specific to Mt Buller while the zones control development including buildings, works and land uses. A series of overlays also specify particular requirements for any new development. The Environmental Significance Overlay (ESO), Erosion Management Overlay (EMO), and Wildfire Management Overlay (WMO) are relevant to the development of the Project.

The ARPS land use planning objectives include:

- [for infrastructure] to optimise the snow user capacity of the skifields and ensure provision of appropriate infrastructure to meet current and future needs of the Resort taking into account environmental constraints;
- [for settlement] strengthening the role of the Resort as a year round destination through provision of a range of facilities and support services including infrastructure; and
- [for economic development] promotion of year round visitation.

Section 21.05-03 (Objectives – Strategies – Implementation) (Infrastructure) identifies the need for augmentation of existing water supplies in order to increase snowmaking, and encourages the provision of additional water supply and storage facilities for snow making purposes within the Resort. It also requires that infrastructure and services are designed and located in order to minimise environmental and visual impacts, including minimisation of impacts on the surrounding natural systems.

The ARPS identifies a series of precincts within the Resort area. The siting options assessed for the on mountain storage are located within the 'Skifield Development Precinct'.

2.2.5 Mt Buller Mt Stirling Strategic Management Plan 2013 - 2018

The Strategic Management Plan (SMP) provides a link between the Alpine Resorts Strategic Plan 2012, a number of other relevant Government policies and documents, and specific management objectives and commitments for the Mt Buller and Mt Stirling Resorts. In this way it provides an interface between long term strategic planning and specific short to medium term actions.

The Plan lists a number of 'key' commitments that are considered key to the sustainable prosperity of the Resort. One of these commitments is to:

- Develop an additional Water Storage facility for snowmaking and potable water supply, as detailed within the Resort's Water Supply Demand Strategy.

A range of other five year commitments associated with RMB services, environment, tourism, community, people and corporate governance are also presented in the Plan. A number of these including the following, are of direct relevance to the Project:

- Continue investment in upgrade and modernisation of plant and systems to improve asset management and resilience of systems (1.1.2);
- Implement to Water Supply Demand Strategy to facilitate appropriate and sustainable supply of water (1.1.3);
- Enhance habitat and protection of the Mountain Pygmy-possum, to improve the sustainability of the population (2.1.1);
- Continue with the implementation and investment in both the Mt Buller Resort Master Plan and the Mt Stirling Resort Plan (4.1.1); and
- Continue to ensure that the RMB is skilled and capable of managing and coordinating our response to emergency situations, including bushfires and structural fires (5.5.2).

Key objectives from the Mt Buller Mt Stirling Strategic Management Plan 2013 - 2018 have been used to inform the development of objectives and criteria for the Multi-Criteria Assessment (MCA) of sites as described in section 4 of this report.

3. Consideration of Water Supply Options

This section provides a description of water supply options for Mt Buller, including the 100 ML capacity on mountain off-stream water storage (the Project) and potential alternatives to it. These strategic options were identified in the 2013 Mt Buller Water Supply Demand Strategy undertaken by GHD, or have been previously considered by the RMB, or were discussed and reviewed by GHD and RMB at the commencement of this project. The purpose of this section is to provide justification for selection of the proposed Project in the context of other potential options to address the water supply constraints identified.

3.1 Strategic options overview

A number of criteria were utilised as part of identifying and assessing the range of potential water supply options for the Resort. These criteria were established based upon criteria used in previous documentation and feasibility assessments, or in discussions with the RMB. They are as follows:

- *Requirement to meet peak potable water demand* – it is necessary for the option to be able to meet peak (winter time) potable demand which is currently in the order of 1 ML/day (GHD, 2013);
- *Requirement to meet peak snowmaking water demand* – in order to contribute to 'on demand' snowmaking it is necessary for the option to be able to supply a large volume of water over a short period of time (nominally around 10 ML/day);
- *Compliance with winter fill extraction* – the preferred option should allow the RMB to comply with the winter fill extraction requirement of its existing water diversion licence (extraction between May and October inclusive);
- *Assist with bushfire management* – an option which can supply water to the Resort via gravity (during power failure when no pumping is possible) or provide a water source for helicopter based suppression activities, is preferred over an option which is reliant upon electricity from the existing supply network;
- *Capital cost* – RMB seeks to minimise the capital investment associated with the water supply option and the associated ancillary infrastructure required to support it;
- *Operating cost* – RMB seeks to minimise the costs associated with operating and maintaining the water supply option;
- *Energy use and greenhouse gas emissions* – RMB seeks to minimise energy use and improve energy efficiency in its operations. RMB greenhouse gas emissions are principally associated with the use of electricity;
- *Project footprint* – this criterion refers to the area of land likely to be affected by the project and includes ancillary infrastructure (for example roads, tracks, power lines and pipelines required to operate the option). Environmental impacts can generally be minimised by minimising the project footprint and area disturbed as a result of the project construction; and
- *Technical feasibility* – this criterion relates to the technical and / or regulatory issues expected to be encountered by the option (and to be addressed in order for the option to be successfully implemented).

The strategic options which have been assessed against these criteria are discussed in this section. For an option to be considered feasible it must meet both potable and snowmaking demands, be considered technically feasible and satisfactorily resolve the identified supply

constraints. Minimisation of capital and operating costs is also an important consideration. A summary of the review of each option against the criteria listed above is presented in Table 2.

3.1.1 Strategic Option 1: New on mountain off-stream storage

Option 1 involves construction of a new 100 ML capacity on mountain, off-stream water storage facility within the Resort (the proposed Project). This option would be consistent with the previous investigations undertaken at the Resort (which indicated that a storage of 100 ML was required), and would require the identification of an appropriate storage site.

This option would enable the RMB to divert water from Boggy Creek during winter in compliance with current licencing requirements, and to store sufficient water for the summer period. It would also enable the RMB to meet the peak water demands over winter months, and facilitate additional snowmaking. The option is considered to provide the greatest level of year round water security for the Resort and is considered feasible.

The option would require significant capital investment in new and ancillary infrastructure. It would be necessary to relocate a range of existing services on the mountain. A significant construction footprint would be necessary and this would require a variety of environmental, visual and Resort utility impacts to be considered.

If appropriately sited, the storage could provide a gravity fed supply of water for firefighting purposes, which is independent of electricity supply.

This option could resolve supply constraints and is technically feasible.

3.1.2 Strategic Option 2: Expand Sun Valley on mountain storage

This option would provide additional on mountain storage capacity by augmenting the current Sun Valley storage (70 ML capacity). The Sun Valley storage has a number of significant geotechnical constraints and is currently in the process of being remediated. Expansion of the storage would require a significant capital investment in ancillary infrastructure and the storage itself. Because of its design and location, it would not be feasible to achieve an additional 100 ML of capacity.

The storage contains Class A recycled water and is an important part of the Resort's strategy to recycle water and minimise extraction from waterways. Recycled water would not be suitable for potable purposes and would not be suitable for snow making use in the Boggy Creek and Delatite River catchments.

The option would not resolve supply constraints because:

- It could not store an additional 100 ML;
- It does not assist with meeting peak potable water demands; and
- It is unlikely to meet all snowmaking demands because of geographic constraints on the use of recycled water.

3.1.3 Strategic Option 3: Demand management/water efficiency measures

This option would require a range of measures to manage and reduce consumption at the Resort. Measures would be expected to include:

- Improvements in the metering of flows throughout the Resort and the reconciliation of supply and demand in order to identify usage and potential losses within the water supply system;
- Investigation followed by maintenance and repairs to any infrastructure identified as contributing to system losses (for example leaking supply pipework);

- Installation and retrofitting of water saving devices and more efficient technologies;
- Restrictions on the use of potable water; and
- Public and Resort staff education programs.

This option may result in improvements in water use efficiency and contribute to a reduction in demand, however it is expected to be relatively expensive and time consuming to implement for the volume of water likely to be saved. The water savings which might be achieved are very unlikely to be large enough to avoid having to implement other measures. Assuming peak potable demand in winter is ~1 ML/day, savings associated with this measure would not assist in meeting peak potable or snow making demands.

It is considered very unlikely that the cumulative impact of this initiative would, on its own, provide an adequate solution. Unintended consequences of this approach would also need to be considered, as a reduction in potable water use may affect the operability of the recycled water plant and the volume of recycled water available for snowmaking.

The option would not resolve supply constraints primarily because it would not allow peak potable and snowmaking water demands to be met, but also because it would not assist in improving water supplies for bushfire management.

3.1.4 Strategic Option 4: Increase Boggy Creek surface water extractions

Option 4 assumes an increase in extractions from Boggy Creek by altering the licence extraction arrangements to allow summertime extraction, and extractions above the current licence limit of 4 ML/day.

No additional storage would be required, but the current extraction infrastructure (currently only capable of extracting at the rate of 2.5 ML/day) may require upgrading (new power supply, offtake and pumping equipment). If the licence were amended to allow routine diversion of water during the summer months, this could potentially improve the long term water reliability to summer residents, businesses and visitors especially in years where winter flows (and existing storages) are low.

This option would only be a partial solution for supply during ‘summer’ months (assuming adequate rainfall occurs) and during extended dry periods Boggy Creek yields may be insufficient. Catchment yields would not be able to meet peak demands during ‘winter’ months.

There may be significant ecological impacts on the Boggy Creek in the vicinity of the extraction point and downstream, particularly during ‘summer’ months. Increased extractions during very high flow periods could be technically feasible and environmentally acceptable assuming the water was able to be stored.

The option is contradictory to current government policy (winter fill requirement) and so regulatory approval is considered unlikely.

Whist this option may not require significant changes in the infrastructure footprint (only an upgrade of existing infrastructure), it would not assist in improving water supplies for bushfire management.

The option would not resolve supply constraints, primarily because it does not meet peak snowmaking demand, and regulatory approval of extractions during ‘summer’ months is considered unlikely.

3.1.5 Strategic Option 5: Additional extraction from the Howqua/Delatite River without a storage

This option proposes additional surface water extraction and pumping from the Howqua or Delatite River catchments (refer Figure 1) to increase the volume of water supplied to the Resort. These rivers would generally have sufficient flow to address the catchment yield issues associated with Boggy Creek. The option assumes that it is possible to obtain an appropriate water licence and allocation to facilitate this option. This option also assumes that no large storage is constructed. In order to meet peak water demands it would be necessary to pump large quantities of water (up to 10 ML/day) a considerable distance and also a considerable elevation (up the mountain).

The temporary BSL licenced extraction from the Howqua River (20 ML/year) would not be adequate to meet the total Project water demand for this option. At best it could supplement snowmaking demand in winter, but would require new infrastructure in order to meet peak demand and potable supply requirements.

This option would require significant capital investment and impose substantial ongoing operating costs on the Resort. The footprint of the required infrastructure (break tanks, pipelines, pumps, power supply) would be relatively large when compared with the alternatives. The option would incur a number of technical challenges (for example geotechnical conditions), and the energy use associated with pumping would result in relatively high levels of greenhouse gas emissions.

This option may assist in improving water supplies for bushfire management, however it is contingent upon a reliable and uninterrupted supply of electricity (which cannot be guaranteed in a bushfire event).

The option could resolve supply constraints but is not preferred because of the very high capital and operating costs associated with meeting peak snowmaking demand.

3.1.6 Strategic Option 6: Alternative source – groundwater

Option 6 would see the continued use of the existing diversion licence and water storage facilities. It would then look to supplement the existing water supply with water from groundwater sources. This option assumes that a suitable groundwater resource would be available for exploitation, and that a large and extensive network of bores, pumps and pipelines could be constructed in order to transfer groundwater to the Resort.

Preliminary work suggests that the groundwater resource is likely to be connected to surface water systems and that the conjunctive management of these two water resources would be required, potentially resulting in restrictions on groundwater extraction/supply during the summer period. In addition, the fractured aquifer system may not yield the volumes required during the summer season. Because of this it is unlikely that the option is viable from a regulatory or technical perspective.

In order to meet peak flow demands associated with snowmaking, the option would require an extensive network of bores and ancillary infrastructure (pipes, pumps, valves, large storage tanks or a small reservoir, power supply). These flow demands would incur very high capital and operating costs. Footprint impacts and greenhouse gas emissions would also be significant when compared to other options.

This option may assist in improving water supplies for bushfire management, however it is contingent upon a reliable and uninterrupted supply of electricity (which cannot be guaranteed in a bushfire event).

The option would not address the supply constraints associated with peak snowmaking demands. It has a high degree of technical and regulatory uncertainty due to the volumes of water that would need to be extracted, and it would incur significant capital and operating costs.

3.1.7 Strategic Option 7: Alternative source – stormwater/rainwater harvesting

This option would involve harvesting rainwater and/or stormwater within and/or below the Resort. Although this approach would allow the maximum use of natural resources, the volumes able to be harvested would not meet the current or projected snowmaking water demands.

Rainwater harvesting would require buildings to be retrofitted with gutters, as well as collection and storage systems. There are practical issues associated with snow collecting on rooves and gutters and with the installation and operation of the collection system in an environment which freezes.

Stormwater could contribute to the snowmaking supply, but would be unsuitable for potable use without regulatory issues being addressed and significant investment in treatment and storage. Electricity costs may be moderate but would depend upon pumping and treatment requirements. Treatment costs (both capital and operating) would be significant.

The option relies on appropriate climatic conditions (adequate rainfall). Low rainfall periods would impact the viability of this option.

The small and dispersed harvesting and storage locations, as well as the uncertainty of supply during the bushfire season means that this option would be unlikely to assist in improving water supplies for firefighting.

This option would not resolve supply constraints due to the technical issues and costs associated with reliably meeting potable water quality requirements, and the inability to meet snowmaking volume demand.

3.1.8 Strategic Option 8: 'Off mountain' storage

A 100 ML 'off mountain' storage would potentially have the following advantages over an 'on-mountain' storage:

- Provide access to a larger and more reliable water supply catchment;
- Allow dam construction on a site with 'simpler' geological and geotechnical characteristics;
- Avoid development in sensitive alpine ecosystems containing rare or threatened flora and fauna species, and/or species with a naturally limited range;
- Avoid or reduce visual impacts; and
- Avoid impacts upon ski resort utility.

The disadvantages of an 'off mountain' storage as compared to an 'on mountain' storage would be:

- Environmental impacts and capital costs of ancillary infrastructure required to transfer the water up the mountain (pumps, power supply, water pipeline, intermediate storages)
- Significant operating costs (and greenhouse gas emissions) associated with power supply and the operation of pumping equipment (particularly during periods of peak demand).

An appropriately sized storage could potentially meet peak snowmaking and potable water demand but it would be necessary to pump significant quantities of water (up to 10 ML/day) over a substantial elevation, in order to deliver it to the Resort.

This option may assist in improving water supplies for bushfire management, however it is contingent upon a reliable and uninterrupted supply of electricity (which cannot be guaranteed in a bushfire event).

This option could resolve supply constraints and is technically feasible however it was considered inferior to Option 1 (the Project) due to the significant additional capital and operating costs associated with transferring stored water to the Resort.

3.1.9 Strategic Option 9: Do nothing

The 'do nothing' option assumes no new infrastructure or modifications to existing infrastructure, no demand reduction strategies, or changes to the current diversion licences.

This option would mean that:

- Water would need to be diverted during summer under an exemption or modification to the extraction licence, which limits environmental flows to Boggy Creek. This is not considered a desirable or reliable long term solution. This in turn limits the growth of summer tourism, the capacity to respond to bushfires, and overall reliability of the Resort water supply.
- Water use for snow making during peak periods would continue to be limited because of the maximum diversion rate and limited storage capacity. Increased snowmaking in current areas or expansion into new areas would not be possible. This would be expected to limit visitation and the development potential of winter tourism.

This option would not resolve the current water supply constraints. The constraints would persist and worsen as demand for water grows. The current water supply constraints for firefighting purposes would also remain in place.

3.1.10 Combination of options

As per the summary presented in Table 2, a number of options may potentially allow peak potable water demands to be met. However, only direct pumped extraction from the Howqua or Delatite River catchments, or a storage option would allow peak snowmaking demands to be met.

A storage option at an altitude above the Resort is required in order for fire-fighting requirements (gravity supply without reliance in electricity) to be met.

Given that the objective of the project is to meet both potable and snowmaking water demands, and to minimise capital and operating costs, an on mountain storage is expected to provide the lowest cost solution.

Demand management and water efficiency measures are always likely to have a degree of relevance in the management of the Resort water supplies, and should be implemented as part of good practice, and as part of any new development in the village.

From a supply perspective, some of the other options (for example groundwater supply or surface water extraction from other locations) may prove useful in augmenting water supplies and could potentially be used in combination with a storage. Given the peak water demands, cost and uncertainties with the reliability of supply for these options, it is unlikely that the use of these options in combination with a storage would significantly reduce the required (100 ML) storage volume.

3.2 Evaluation of strategic water supply options

A summary of the strategic water supply options considered, together with a high level assessment against the criteria described previously is presented in Table 2.

3.3 Recommended strategic option

Analysis indicates that Option 1 (a new 100 ML on mountain storage) is the most appropriate option as it provides the Resort with significant operational flexibility all year round, and allows it to balance raw water, potable and recycled water demands. A storage of this size would allow the RMB to divert water during 'winter' months only, in accordance with the condition of their extraction licence and would also provide an adequate, gravity fed (if appropriately sited) supply for firefighting. A storage is considered to be the best way to manage the inherent variability in climate and streamflow associated with the Mt Buller region.

A storage would enable the size of diversion (or extraction) infrastructure to be much smaller than that required to meet peak rates of demand. This avoids the potential for overcapitalisation in infrastructure where a larger capacity requirement is required infrequently, or not required until the design level of demand eventuates. The provision of a large volume of on-site storage at Mt Buller would improve the cost effectiveness of any future water supply option, reducing the flow rate for water transferred and ultimately the cost of associated infrastructure.

The on mountain off-stream storage option is therefore considered to be an integral part of improving the security of water supplies to Mt Buller.

Table 2 Evaluation of strategic water supply options

Option No.	Strategic Option	Meet peak potable demand?	Meet peak snowmaking demand?	Comply with 'winter fill' extraction arrangements?	Assist with bushfire management?	Capital cost	Operating cost	Energy use & greenhouse gas emissions	Footprint	Technical feasibility
1	New 'On mountain' 100 ML storage	Yes	Yes	Yes	Yes	High	Moderate	Moderate	Significant	Feasible based on geotechnical and concept design investigations undertaken
2	Expand Sun Valley for increased 'on mountain' storage and use of recycled water	No	Partial (recycled water cannot be used in Delatite River. catchment)	Unlikely	Unlikely	Very High (geotechnical issues)	Moderate	Moderate	Moderate	Significant geotechnical issues. Cannot achieve additional 100 ML storage capacity
3	Demand management & water efficiency measures	Unlikely (but may contribute)	No	No	No	High	Moderate	Low - Moderate	Low - Moderate	Retrofit, modify, replace. Small volumes.
4	Increase Boggy Creek surface water extraction (alter licence extraction limits or period – no additional storage)	Partial	No	Yes - assuming modification to licence	No	Moderate	Moderate	Low	No change	Regulatory issues, catchment yield, infrastructure constraints, potential aquatic impacts, security issues in low flow periods
5	Additional Howqua / Delatite River surface water extraction and pumping (no large storage)	Yes	Possible	Yes – assuming adequate supply available	Unlikely (reliable power supply required)	Very High	Very High	Very High	Significant (new pipeline, pumps, power supply)	Identify suitable site and alignments, supply infrastructure, geotechnical issues
6	Alternative source - groundwater	Possible	No	Unlikely – conjunctive use?	Unlikely (reliable power supply required)	Very High	Very High	Very High (bore pumping)	Significant	Suitable aquifers? Regulatory issues? Large bore network required
7	Alternative source – rainwater / stormwater harvest	Possible (flow) No (quality)	No	No	No	High (dam, pump, pipelines, treatment)	High	Moderate	Moderate	Volumes inadequate Unlikely to be allowed for potable purposes. Reliant on rainfall

Option No.	Strategic Option	Meet peak potable demand?	Meet peak snowmaking demand?	Comply with 'winter fill' extraction arrangements?	Assist with bushfire management?	Capital cost	Operating cost	Energy use & greenhouse gas emissions	Footprint	Technical feasibility
8	'Off mountain' Storage	Yes	Yes	Yes	Unlikely (reliable power supply required)	Extremely high (if pump and pipeline capacity sized to meet snowmaking demand)	Very High	Very High	Significant (dam site, new pipeline, pumps, power supply)	Identify suitable site and alignments, supply infrastructure, geotechnical issues
9	Do nothing	No	No	No	No	Nil However, upgrade of existing water treatment plant and storage is required regardless	Nil However investment in water supply infrastructure would simplify system and reduce some operating costs	No change	No change	Feasible, however investments in potable water supply and treatment are still required.

4. Multi-Criteria Assessment (MCA) Methodology

This section of the document describes the Multi-Criteria Assessment methodology used to assess and compare potential sites for the Project, the information sources utilised, and the staging of the assessment.

4.1 Multi-Criteria Assessment (MCA) Framework

A Multi-Criteria Assessment (MCA) approach was developed jointly by GHD / RMB and used to inform the selection of a suitable site for the off-stream storage. Input was sought from the Mt Buller Ski Lift Company (BSL) as part of confirming and finalising the MCA approach and criteria.

Initially, a MCA framework comprising objectives, criteria, measures and descriptors was developed, relevant to the Project and location. A number of the objectives in the MCA framework were based on relevant objectives from the *Alpine Resorts Planning Scheme – Mt Buller Strategic Statement*, and the *Mt Buller and Mt Stirling Alpine Resort Management Board Strategic Management Plan (2013-2018)*. Other project-specific objectives were developed and agreed between GHD and the RMB. Each of the MCA objectives is presented in Table 3 and the documents that informed each are indicated in the left-hand column.

4.1.1 MCA Objectives

Alpine Resorts Planning Scheme – Mt Buller Strategic Statement

Under Clause 21.05-2 Vision-Strategic Framework, strategic land use planning objectives are identified, which are to be satisfied by use and development applications. Relevant objectives under the following headings were selected to inform the MCA framework; Environmental and Landscape Values, Natural Resources Management, Infrastructure, Environmental Risks, Built Environment and Heritage.

Under these same headings in Clause 21.05-3 Objectives-Strategies-Implementation, more specific objectives and associated strategies are identified, and from these, relevant objectives were selected to inform the MCA framework.

RMB Strategic Management Plan 2013-2018

The Mt Buller Mt Stirling Alpine Resort Management Board Strategic Management Plan 2013-2018 describes the intent behind six key focus areas identified to ‘guide the future planning, development and management of the Mt Buller and Mt Stirling Resorts’. Under each of these key focus areas a series of objectives and specific five year commitments are identified. Under the key focus areas of; Our Services, Our Environment and Our Community, objectives and five-year commitments that were complementary to those already selected from the Alpine Planning Scheme, were selected to inform the MCA framework.

After consideration of the objectives selected from the Alpine Resorts Planning Scheme and the RMB Strategic Management Plan, the RMB and GHD also developed a complementary series of project specific MCA objectives. These objectives were associated with technical, construction and operational aspects of the Project, and were intended to assist with site selection.

4.1.2 Aspects

As a result of the development process undertaken, the MCA objectives cover a broad range of aspects that are relevant to the selection of a suitable site for the Project. These considerations can be categorised as:

- Land Use Planning;
- Environment and Heritage;
- Social;
- Economic;
- Ski Resort Utility;
- Technical & Engineering;
- Construction;
- Operational; and
- Bushfire Management.

The MCA objectives and the documents that informed them are outlined in Table 3 and detailed in full in Appendix A.

Table 3 MCA Objectives

Aspect / Informed by	MCA Objective
Land Use Planning	Minimise complexity of planning and environmental approvals and associated risks to project timeframes and costs
Environment & Heritage Informed by Alpine Resorts Planning Scheme (21.05).	Avoid / minimise impacts to native vegetation
	Avoid / minimise significant impacts to EPBC listed communities / species
	Avoid / minimise significant impacts to FFG listed communities/ species
	Avoid impacts on Mountain Pygmy Possum habitat (Type 1 and 2)
	Avoid / minimise potential impacts to waterways and aquatic habitat
	Protect water supply catchment area (Delatite catchment)
	Avoid / minimise potential impacts to indigenous cultural heritage
Social Informed by Alpine Resorts Planning Scheme (21.05).	Avoid / minimise significant impacts to areas of high scenic quality or visual sensitivity
	Storage dam design, construction and operation which minimises public and employee safety risks
Economic Informed by RMB Strategic Management Plan 2013-2018 *and* RMB - Project Specific Objectives.	Minimise dam construction cost
	Minimise ancillary infrastructure construction cost
	Minimise construction program
	Balance cut and fill in order to minimise construction cost and program, as well as other impacts (transport, amenity, environment)
	Minimise operational cost and complexity of infrastructure, and integrate storage efficiently into existing system
	Integrate new storage and water supply efficiently into snowmaking system in order to minimise capital and operating costs
	Maximise use of gravity to minimise electricity and operating costs. Minimise greenhouse gas emissions.
Ski Resort Utility Informed by Alpine Resorts Planning Scheme (21.05) *and* RMB Strategic Management Plan 2013-2018.	Avoid / minimise potential impacts to winter use terrain currently available to skiers, or potentially available for use in the future
	Avoid / minimise potential impacts to existing ski infrastructure
	Avoid / minimise impacts to core skiable areas currently supported by snowmaking
	Avoid / minimise impacts to future areas used for snowmaking
	Avoid / minimise impacts to areas identified for future recreational use in the Resort Master Plan
Technical / Engineering Informed by Alpine Resorts Planning Scheme (21.05) *and* RMB - Project Specific Objectives.	Maximise site 'flexibility' in order to adjust design in line with geotechnical or footprint constraints, whilst still achieving required storage volume (reduce project risk)
	Minimise geotechnical risks through appropriate siting, design and construction
	Geotechnical risk to achieving 100 ML storage volume
	Minimise dam break risk and the potential to impact upon ski infrastructure, resort and road infrastructure, life and property
Construction Considerations Informed by RMB Draft Strategic Management Plan 2013-2018 *and* RMB - Project Specific Objectives.	Avoid impacts to potable water quality during construction phase
	Maintain continuity of Resort operations during construction - particularly for water treatment and supply
	Avoid / minimise the requirement for relocation of services or construction of new services - in order to minimise cost, environmental, business continuity impacts
Operational Considerations Informed by RMB - Project Specific Objectives.	Avoid / minimise potential impacts from planned or unplanned discharges - overtopping, storage maintenance, scouring
	Safe and efficient access to dam site and associated facilities

Aspect / Informed by	MCA Objective
Bushfire Considerations Informed by Alpine Resorts Planning Scheme (21.05)	Ensure infrastructure enhances Resort fire preparedness and incident response Minimise potential for bushfire damage to storage and associated infrastructure

4.1.3 MCA Criteria and Descriptors

In order to assess the sites against each objective, criteria and descriptors were developed for each objective. The criteria are more specific and measurable statements of the objective. Three descriptors were developed for each criterion to guide the rating of sites. An example is provided in Table 4.

A 'traffic light' approach (as opposed to a numerical/weighted approach) to the assessment of the sites for each criterion was adopted in order to simplify the assessment process, and because only a small number of storage siting options (three) were available for comparison.

Table 4 Example of MCA objective, criterion and descriptors

MCA Objective	Criteria	Descriptor	Rating
Avoid / minimise impacts to native vegetation	Impact to native vegetation	Low proportion (<50 %) of dam footprint is covered by intact/undisturbed native vegetation, low likelihood of threatened species / community impact	
		Med. proportion (50-75 %) of dam footprint is covered by intact/undisturbed native vegetation, mod. likelihood of threatened species / community impact	
		High proportion (>75 %) of dam footprint is covered by intact/undisturbed native vegetation, high likelihood of threatened species / community impact	

4.1.4 Key Project Criteria

Whilst all the criteria were considered important and relevant to the Project and to the consideration of siting options, key project criteria representing key project drivers, were identified through the MCA process.

In some cases these key criteria stood out because they were considered to be critical to the feasibility of the Project. If such a criterion was rated poorly, then that option could be considered unfeasible or at best would require serious reconsideration. In contrast, other criteria in the same category were important, but not considered critical to the feasibility of an option.

In other cases one criterion was a surrogate (or partial surrogate) for other criteria. For example, the 'impact to native vegetation' criterion is also relevant to Mountain Pygmy Possum habitat, EPBC and FFG listed communities and species.

The key project criteria identified were:

- Impact to native vegetation;
- Geotechnical suitability and risk to achieving 100 ML storage volume;
- Impact to existing skiable terrain, connectivity and Resort functionality; and
- Storage construction cost.

4.2 Information Sources and Staging

The site assessment, selection and dam design process has been an iterative one. In documenting the whole process, there are two distinct stages.

4.2.1 Stage 1

In Stage 1, three sites were assessed using the MCA framework, based upon the initial storage concept designs and dam footprints as described in section 5.

Each of the sites was assessed by the GHD project team with input from the RMB and BSL. The assessment process included a review of RMB internal working documents, reports of prior investigations, as well as desktop and field assessments. Information sources included:

- Biosis Research (2006) Habitat mapping for the Mountain Pygmy-*possum Burramys parvus* at Mount Buller, Victoria;
- Biosis Research (2007) Targeted survey for Alpine Marsh-marigold *Caltha introloba* and associated species from *Caltha introloba* Herbland Community, Mount Buller and Mount Stirling Alpine Resorts, Victoria;
- Maunsell | AECOM (2008) Water Storage Feasibility Study;
- AECOM (2009) Mt Buller Water Storage - Concept Design Report;
- AECOM (2009) Mt Buller Water Storage Feasibility Study - Flora and Fauna Assessment Report;
- Biosis Research (2009) Draft Flora, terrestrial fauna and net gain assessment of the proposed Water Storage Facility, Mount Buller, Victoria;
- Coffey Geotechnics (2010) Geotechnical Assessment – Proposed Water Storage, Summit Road, Mt Buller, Victoria;
- AECOM (2011) Mt Buller Water Storage - Hydrological Design;
- Biosis Research (2011) Comparison of the proposed Tirol Flat and Boggy Creek Water Storage Facilities, Mt Buller Alpine Resort;
- Biosis Research (2011) Flora, fauna and net gain assessment of proposed Water Storage Facility, Tirol Flat, Mount Buller, Victoria;
- Victorian Biodiversity Atlas (VBA), (October 2013), using a 10 km radius search area, centred on the site options;
- Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Act 1999 Protected Matters Search Tool, (October 2013)[5], using a 10 km radius search area, centred on the site options;
- Victorian Biodiversity Interactive Map database (DEPI) (October 2013)[6] ; and
- Review of the Victorian Aboriginal Heritage Register, Heritage Register, interactive mapping tool information, cultural heritage surveys and cultural heritage management plans undertaken in the area (October, 2013).

Whilst the level of information available for each of the potential storage sites differed, the information available was considered adequate to make an assessment against the MCA criteria.

One of the sites had obvious disadvantages and was abandoned early.

The MCA assessment then focused on the key project criteria (refer Section 4.1.4) to identify a preferred site between the two remaining sites. The MCA was completed in December 2013 and a preferred site was selected pending further investigation of certain aspects. A summary of

[5] http://www.environment.gov.au/epbc/pmst/
[6] http://mapshare2.dse.vic.gov.au

the outcomes of the MCA of the three sites is included in section 6 and the full MCA assessment is presented in Appendix A.

4.2.2 Stage 2

In January 2014 preliminary geotechnical testing of the preferred site was completed. The results indicated that sufficient rock would not be available for a full rock fill embankment to achieve the desired 100 ML volume. This was a significant change in project assumptions. The concept design of the preferred site was altered assuming a mixed rock and earthen fill embankment, resulting in a larger footprint.

Areas were also identified for ancillary infrastructure and for construction (primarily for temporary stockpiling of material) which would be required to construct the storage.

As a result of the change in embankment design (and the need for stockpiling of material), the overall footprint was much larger than had been assumed in the concept assessed for the MCA. Due to these changes, the team decided to reassess the revised concept designs of the last two sites against key project criteria from the MCA to check that the preferred site remained the preferred site.

The additional information sources available as a result of the stage 2 assessment included:

- Flora and fauna assessment of the revised footprints (refer Appendix B);
- Geological mapping and hazard assessment completed by GHD for the geotechnical risk assessment of the preferred site and associated ancillary infrastructure; and
- Hydrogeological and hydrological information.

5. Identification of Sites and Concept Development

This section documents the process undertaken to identify and shortlist potential sites for the Project, as well as the development of concept designs for each.

5.1 Identification of potential storage dam sites

The process of identifying and shortlisting potential sites for a 100 ML capacity water storage involved:

- Review of previous investigation reports commissioned by RMB for potential water storage sites;
- Consultation and discussions with RMB and BSL to identify and confirm potential sites and likely issues or constraints; and
- Site inspections by GHD dams engineers, geotechnical, planning and environmental personnel to confirm and develop a shortlist of potential sites.

The above process resulted in the identification of three potential sites within the vicinity of the Resort. The potential sites are known as ‘Tirol’, ‘Koflers’ and ‘Control Centre’. A series of site photos are presented in Figure 4, Figure 5, and Figure 6. The location of the sites is presented in Figure 7.

Figure 4 Views of the Tirol site

Figure 5 Views of the Koflers site

Figure 6 Views of the Control Centre site

5.2 Development of storage dam concepts

Once the three potential storage sites were identified, preliminary 100 ML concept designs were developed in order to understand how a storage would fit on each site. This provided the team with information on footprint, embankment dimensions, excavation quantities and depth.

The preliminary concept designs allowed initial investigations into potential visual and ecological impacts to be undertaken. They were also used to facilitate a series of discussions with the RMB and BSL on issues such as potential impacts on Resort users and existing infrastructure.

The development of concept designs was undertaken in two key stages as previously described in section 4:

The MCA was based on the Stage 1 designs of the three sites. The assessment of Tirol and Control Centre sites was then revisited once the Stage 2 designs were available.

5.2.1 Stage 1 – Preliminary concept designs

There were a number of iterations of the concept designs for each site during Stage 1. The MCA assessed the final Stage 1 concepts as described below.

Tirol site

Three concept designs were developed for the Tirol site.

- The initial concept was developed based on existing site information and known constraints. It assumed a rock fill storage as per previous RMB investigations and concept designs (AECOM, 2009).
- A second concept was developed based on improved survey information (LiDAR), and on additional constraint and infrastructure information provided by BSL. This option also assumed a rock fill embankment.
- The third Stage 1 concept was developed following further discussions and negotiations with BSL during a site inspection on 17 October 2013, as well as detailed review and assessment of available rock material (based on the Coffey Geotechnics (2010) report (refer 4.2.1)). Based on the understanding of the rock profile at Tirol at the time, it was considered unlikely that sufficient rock would be available for a full rock fill embankment to achieve the desired 100 ML volume. Therefore a mixed rock and earthen fill embankment was designed, resulting in larger slopes (1V:2.5H). This change in embankment slope impacted on the preferred site access constraints identified by BSL.

Koflers site

Two concept designs were developed for the Koflers site.

- The initial concept was developed without any site specific geotechnical information and relied upon general site access constraints.
- A second Stage 1 concept was developed based on improved survey information (LiDAR), infrastructure and refined constraint information.

Control Centre site

Three options were developed for the Control Centre site based on information and feedback provided by RMB and BSL and information gained following a preliminary geotechnical investigation.

- The initial concept was developed by utilising a preferred footprint provided by BSL which included the impact/removal of BSL ski infrastructure. This concept assumed the construction of the storage utilising rock fill (1.5: 1) and earthen (2.4:1) embankments.
- A second concept was developed based on preliminary geotechnical drilling information and an attempt to avoid removal of BSL infrastructure and the Mt Buller access road. This option was deemed unviable as the extent of the embankments resulted in direct impacts to downslope EPBC and FFG listed vegetation (alpine bog) communities.
- The third Stage 1 concept was a refinement of the second concept based on preliminary geotechnical drilling information and refined earthworks modelling. It avoided direct removal and impact to the downslope EPBC and FFG listed vegetation (alpine bog) communities.

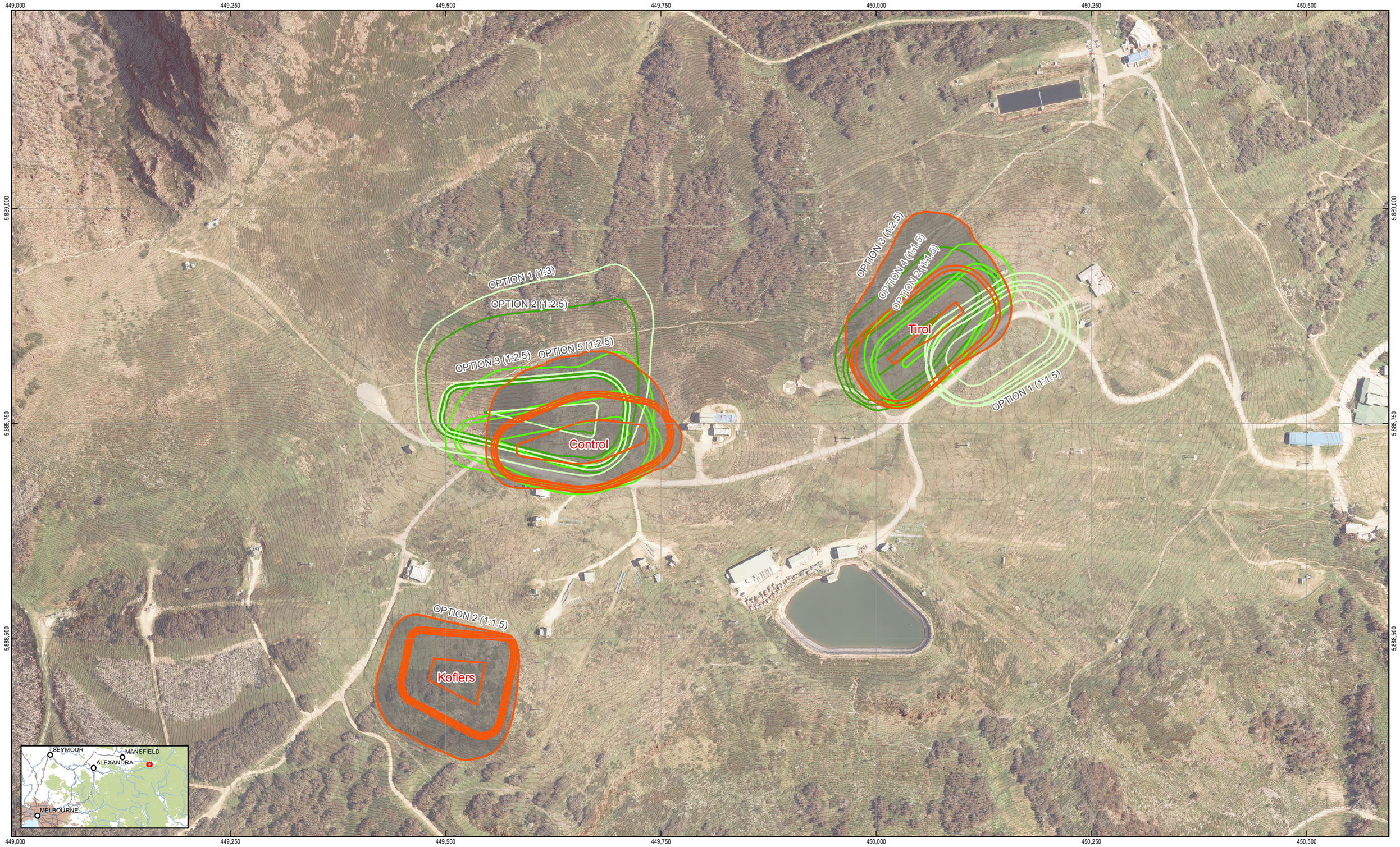
Summary

A summary of key design parameters for each of the preliminary (Stage 1) concept designs as described above is presented in Table 5. The concept design footprints for each site are also presented in Figure 7.

The final three preliminary (Stage 1) concept designs (Tirol, Koflers and Control Centre) were assessed using the MCA framework. One site was eliminated early. The assessment then focused on key project criteria to determine a preferred site, pending further investigations into certain aspects.

Table 5 Mt Buller Preliminary (Stage 1) Storage Option Design Parameters

Parameter	Tirol v3	Koflers v2	Control Centre v3
Storage volume (ML)	99.41	114.28	102.91
Cut volume (m3)	71,000	93,000	73,000
Fill volume (m3)	73,000	40,000	50,000
Max section height (m)	25	16	18
Dam footprint area (m2)	28,900	21,600	29,200
Batters	1V: 2.5H	1V:1.5H	1V:2.5H
Embankment material	Rock & Earthen	Rock	Earthen



Paper Size A3

0 20 40 80 120 160

Metres

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

N

LEGEND

- Final Option
- Third Option
- Second Option
- First Option
- Contours 1m

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

Storage Options General Arrangements

Job Number	31-30733
Revision	A
Date	04 Jul 2014

Figure 7

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Data source: DEPI, Vicmap, 2013. Created by:mjahanshahi

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5.2.2 Stage 2 – Concept designs

The MCA of the Stage 1 concept designs highlighted a number of project aspects that warranted more detailed investigation and confirmation. Further ecological (December 2013) and phase 1 geotechnical (November 2013) investigations were undertaken in order to obtain more information on the sites more broadly and the preferred (Control Centre) site in particular.

In January 2014 phase 2 geotechnical investigations of the Control Centre site were completed. Additional works included geophysical seismic survey, as well as additional geotechnical boreholes and test pitting.

Due to the highly variable nature of the ground conditions, including historic landslip materials, two previous basaltic lava flows, mudstone deposits and granitic rock, a computerised ground model was developed. This was also utilised in determining the availability of suitable embankment materials.

The results indicated that sufficient rock would not be available for a full rock fill embankment to achieve the desired 100 ML volume. All investigations prior to this (including AECOM, 2009) had assumed that a full rock fill embankment would be the most feasible embankment construction.

The requirement to construct an earthen storage embankment meant that the dam footprint (batter slopes etc) would need to change. The concept design was altered assuming a mixed rock and earthen fill embankment, resulting in a larger overall footprint.

The phase 2 geotechnical investigations included installation of groundwater monitoring bores and hydrogeological testing to allow an evaluation of groundwater on and in the vicinity of the Control Centre site, as this had been identified as a potentially significant environmental issue for both sites (but particularly the Control Centre site).

As a result of the change to embankment material and the confirmation of ancillary infrastructure and construction areas, the total project footprint for the Control Centre and Tirol sites were substantially larger than the Stage 1 concept design footprints that had been assumed in the MCA.

As stated earlier, given the significant change in project footprint, the team decided to review key MCA criteria for both Control Centre and Tirol sites to confirm that the preferred site was still preferred. The concept designs for both the Control Centre and Tirol sites were re-evaluated. This re-evaluation involved the following investigations:

- Additional geotechnical investigation (Control Centre);
- Hydrological and hydrogeological investigations (Control Centre);
- Further inspection of geotechnical stability (Control Centre and Tirol);
- Additional flora and fauna field assessment (Control Centre and Tirol);
- Consideration of ancillary infrastructure options by RMB; and
- Further discussions with RMB and BSL in relation to footprints, resort utility impacts and operational aspects.

The concept design for Control Centre was developed further based on the information gained from these assessments.

Refinement of the Control Centre concept design

To further develop the dam concept design (including the requirement for 100 ML capacity), existing LiDAR information was used as a basis for developing a three dimensional dam model. Some considerations utilised in preparing the dam designs included:

- Limiting embankments so as to avoid mapped sensitive environmental communities (downslope alpine bog communities);
- Limiting embankments so as to avoid existing ski lift infrastructure (removal of the Boggy Creek T-Bar could not be avoided);
- Minimising embankment volumes to minimise construction costs;
- Minimising visual impacts of the dam on surrounding areas, particularly regularly visited and trafficked areas;
- Avoidance of existing ski runs and skier movement routes;
- Minimising depth of the dams in order to reduce the potential for intersection of groundwater (and potential stability and ecological issues);
- Minimisation of other construction costs; and
- Balancing of cut and fill volumes in order to minimise construction costs and avoid the import or export of material

Development of Project Footprint

Ancillary Infrastructure

As the dam concept design developed, further consideration was given to the ancillary infrastructure required to service the Project. Some of the ancillary infrastructure was new, whilst other ancillary infrastructure was associated with the relocation of existing services. A number of infrastructure options and cost estimates for the transfer and treatment of water were reviewed by the RMB, and a preferred option selected.

The design and location of ancillary infrastructure took account of previously disturbed areas. These areas were utilised in preference to undisturbed areas.

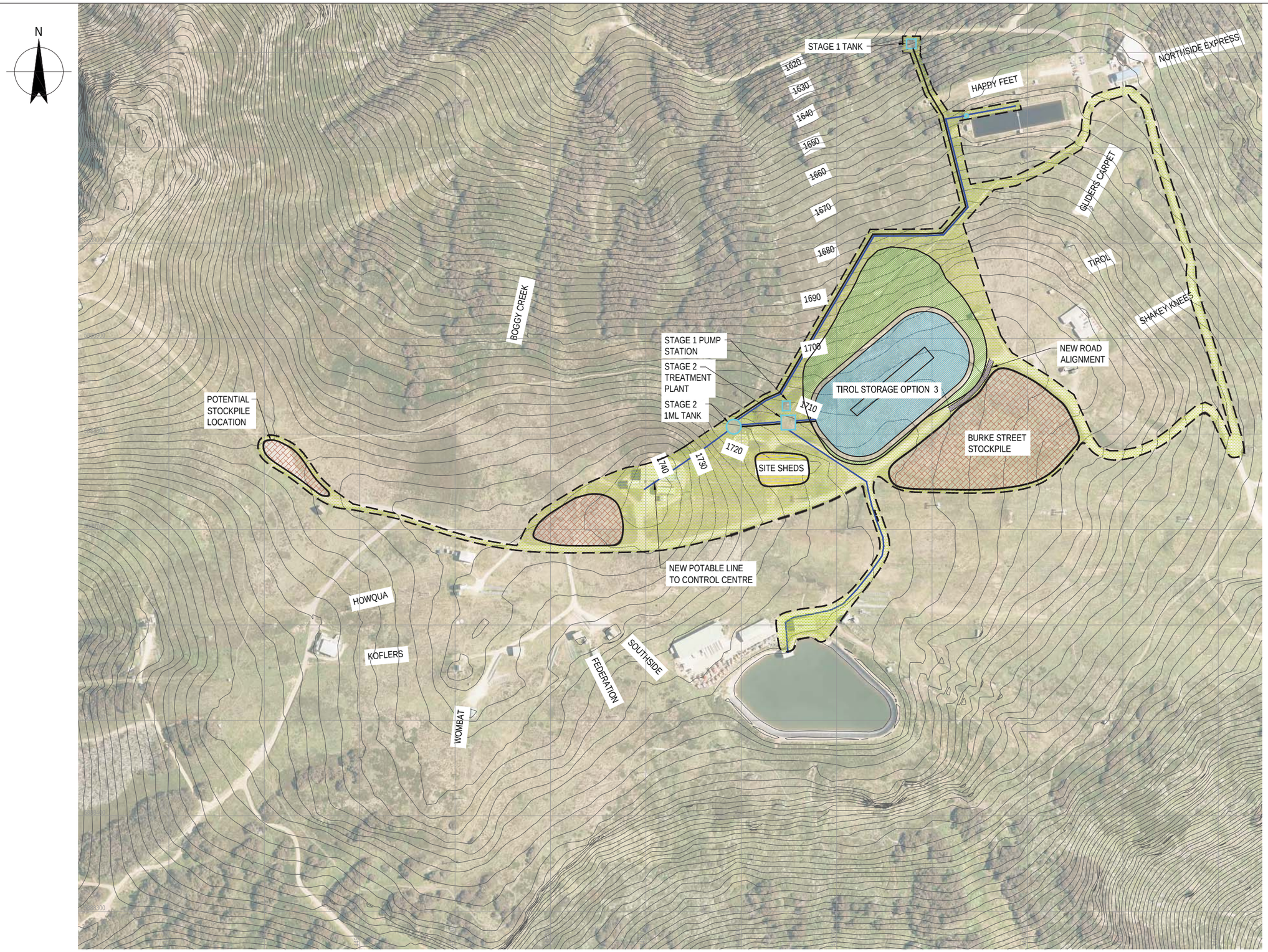
Once the dam design was refined, consideration was given to the alignment and required ancillary infrastructure.

Construction areas and Stockpiles

Geological modelling undertaken as part of the dam design provided an estimate of the quantities and types of material required to be excavated as part of the storage construction program. This allowed stockpiling requirements to be determined. A series of potential stockpile locations were nominated based on a range of criteria including the preferential use of previously disturbed areas. Other areas required for construction, for example equipment laydown and parking areas, as well as temporary office and amenities areas were also identified.

The project footprint for the Control Centre and Tirol sites was delineated based on the concept design which incorporated the storage, ancillary infrastructure, stockpiles and other construction activities. The concept designs for the Control Centre and Tirol sites (incorporating project construction footprint) are presented in Figure 8 and Figure 9 respectively.

A flora and fauna assessment of the Stage 2 project footprints for the Control Centre and Tirol sites is provided in Appendix B. This was used to inform the Stage 2 assessment, which is presented in section 6.2



PRELIMINARY

No	Revision	Note: * indicates signatures on original issue of drawing or last revision of drawing	Drawn	Job Manager	Project Director	Date
A	PRELIMINARY		RMS			

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SCALE 1:2000 AT ORIGINAL SIZE

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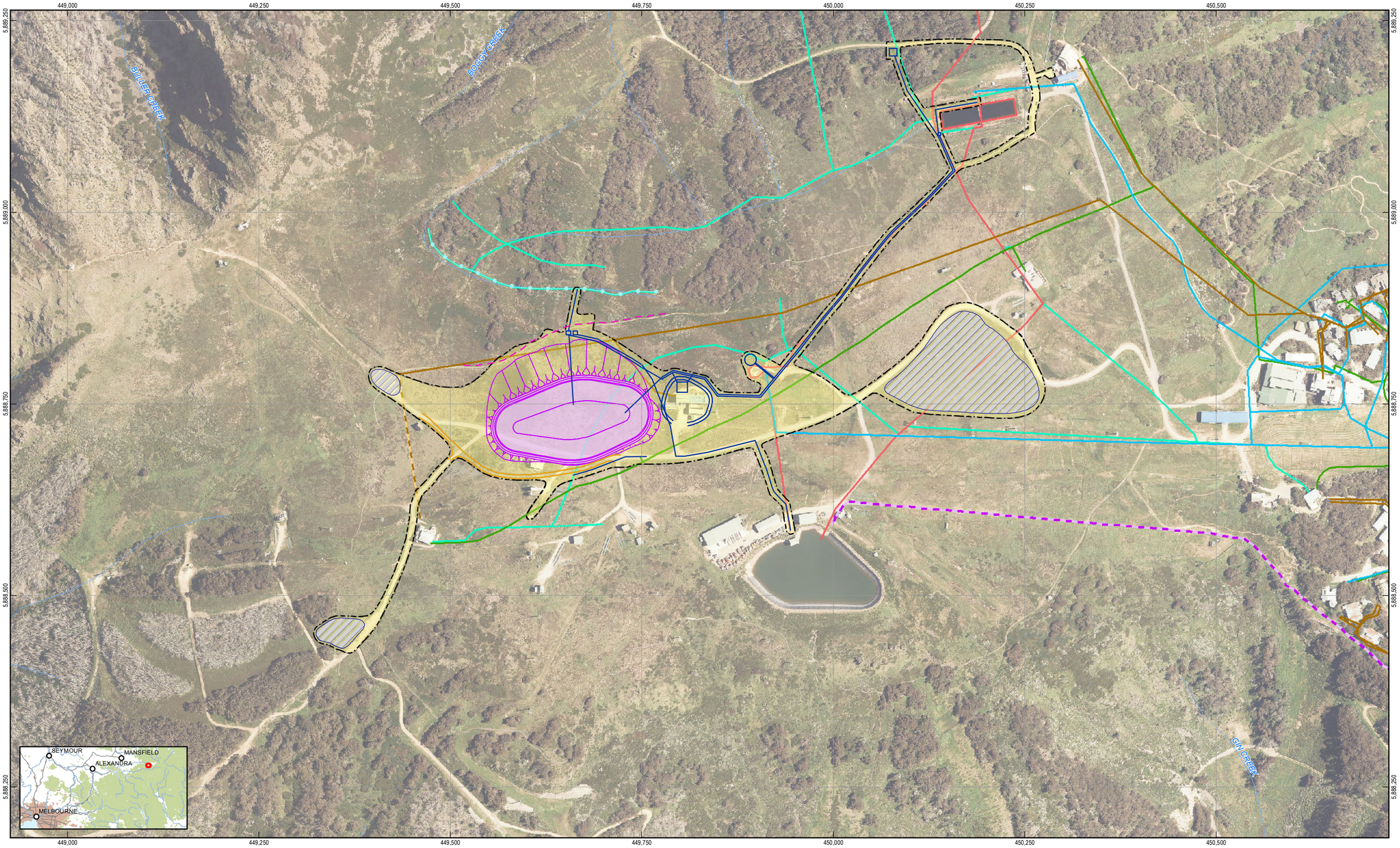
DO NOT SCALE

Drawn R.SLARKS		Designer G. JONES
Drafting Check		Design Check
Approved (Project Director)		
Date		
Scale 1:1000	This Drawing must not be used for Construction unless signed as Approved	

Client **MOUNT BULLER RESORT**
Project **MOUNT BULLER STORAGE OPTIONS**
Title **PIPELINE ALIGNMENTS AND DISTURBED AREAS GENERAL ARRANGEMENT**

Original Size **A1** Drawing No: **31-30733-FIGURE 8** Rev: **A**



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Metres

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

N

LEGEND

- Irrigation Line
- Proposed Pipelines
- New Road Alignment
- Stockpiles
- Project Disturbed Areas
- Dam Option
- Recycled Water Main
- Sewerage Main
- Sewerage Rising Main
- Water Main
- Gas Main
- Sewerage Main
- Water Infrastructure
- Potable Water Pipeline
- Stream
- Aqueduct

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Mt Buller Sustainable Water Security Project

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Revision A
Date 22 Jul 2014

Control Centre Stage 2 Concept Design

Figure 9

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Data source: DEPI, Vicmap, 2013. Created by:mjahanshahi

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6. Options Assessment and Development

6.1 Stage 1 Results - Comparison of Storage Options

This section summarises the results the Stage 1 MCA assessment process which was undertaken. The MCA ratings are presented in Table 6, with more detailed information on each assessment criteria provided in Appendix A.

Discussion of site characteristics in this section is focussed on the criteria which rated well (green) or badly (red) and thus differentiate the sites. 'Key' project criteria (refer section 4.1.4) are identified with an (*).

6.1.1 Tirol Site

Key advantages of the Tirol site (refer Figure 7) were considered to be:

- Avoidance of areas identified as supporting EPBC and FFG listed species and communities, as well as areas previously identified as being important Mountain Pygmy Possum habitat;
- Avoidance of existing snowmaking areas;
- (*) Geotechnical suitability for dam construction and for achieving the 100 ML storage target (based on previous geotechnical investigations); and
- Accessibility – the site is readily accessed from the Resort all year round, which would assist with supervision, maintenance and monitoring activities.

Key disadvantages of the site were considered to be:

- Potential for Aboriginal cultural heritage impacts – based on mapping of areas of cultural heritage sensitivity based on the Aboriginal Heritage Regulations 2007
- Impacts upon visual amenity – the location is prominent and the storage would be located immediately above one of the main entry points to the ski area. It would also be visible from a number of areas of the Alpine National Park;
- (*) Impacts to skiable terrain, connectivity and Resort functionality – the storage site occurs immediately adjacent to a ski lift load/unload area (Tirol T-bar), a beginners ski area, and would partially occupy an area of skiable terrain used to traverse to and from these areas. A new ski run alignment around the storage site would also be required;
- Impact to existing ski infrastructure – the storage would require relocation of the Tirol T-Bar load/unload area;
- Potential to impact on future snowmaking areas – the storage footprint included areas identified and mapped by BSL as being suitable for future snowmaking;
- Potential to impact on Resort Master Plan and future recreational areas – the storage footprint incorporated a flat area previously identified as a potential future football oval in the Resort Master Plan; and
- Requirement to relocate a large number of existing services including a gas main, water main, sewer main, snowmaking water main and underground electrical cables.

Table 6 MCA results (December 2013)

Aspect	Criteria	Key Criteria	Tirol	Koflers	Control Centre
Land Use Planning	Complexity of planning and environmental approvals				
Environment & Heritage	Impact to native vegetation	✓			
	Impact to EPBC listed communities or species				
	Impact to FFG listed communities or species				
	Proximity to Mountain Pygmy Possum habitat				
	Impact to water quality and / or hydrology				
	Protect water supply catchment area (Delatite catchment)				
	Potential for Aboriginal cultural heritage impacts				
Social	Impact on visual amenity				
	Public safety & associated controls				
Economic	Dam Construction Cost - embankment material availability	✓			
	Dam Construction Cost - ripping and blasting required for rock cut	✓			
	Dam Construction Cost - minimise earthworks volume	✓			
	Ancillary Infrastructure Construction Cost				
	Construction program duration				
	Quantity of material to be imported or exported				
	Excess material can be reused on site in landscaping				
	Ability to integrate storage, simplify & rationalise long term, reduce operating / management costs				
	Ability to integrate storage / water supply into existing snowmaking infrastructure				
	Operating cost (energy use) (operating head)				
Ski Resort Utility	Impact to existing skiable terrain, connectivity and Resort functionality	✓			
	Impact to existing ski infrastructure				

Aspect	Criteria	Key Criteria	Tirol	Koflers	Control Centre
	Impact to existing snow making areas	☐			
	Impact to future snow making areas	☐			
	Impact to Master Plan and proposed future recreational areas	☐			
Technical / Engineering	Capacity to adjust dimensions of the footprint during detailed design and construction	☐			
	Geotechnical suitability	✓			
	Geotechnical risk to achieving 100 ML storage volume	✓			
	Dam Break Consequence Category	☐			
Construction Considerations	Dust impacts to Burnt Hut water storage quality during construction	☐			
	Impacts to continuity of existing water supply	☐			
	Relocation of services, construction of new services	☐			
Operational Considerations	Discharge location / treatment	☐			
	Ease of site access throughout the year	☐			
Bushfire Considerations	Water supply to Resort can be maintained during power failure	☐			
	Storage and associated infrastructure is defendable, location in the landscape minimises risk	☐			

6.1.2 Koflers

Key advantages of the Koflers site (refer Figure 7) were considered to be:

- (*) Avoidance of potential impacts on skiable terrain, connectivity and Resort functionality, primarily due to its relative isolation from the main Resort areas;
- Avoidance of impacts on existing ski infrastructure, as well as current and proposed future snowmaking areas;
- No impact on the Resort Master Plan or on areas identified for future recreational use; and
- Avoidance of potential construction dust impacts on the existing Burnt Hut water supply storage, due to its relative isolation.

Key disadvantages of the site were considered to be:

- (*) Impacts on native vegetation (removal of previously undisturbed vegetation), including potential impacts on FFG listed vegetation communities;
- Part of the footprint would be located within areas of identified Mountain Pygmy Possum habitat;
- Technical difficulty and cost associated with conveyance and segregation of raw water and recycled water supplies for snowmaking purposes. This is primarily because of the location of the storage in relation to existing snowmaking infrastructure and pipelines;
- (*) Significant imbalance in cut and fill volumes (refer Table 5) which would result in substantial additional costs associated with removal of excavated material from the construction area. Excess material was considered unlikely to be able to be reused in landscaping on site due to the location, steeply sloping topography and native vegetation in the vicinity of the site;
- (*) High construction costs associated with sourcing / crushing suitable embankment material, and with the excavation of the site;
- High operational energy use due to the higher operating head and pumping distances required;
- (*) Geotechnical (and ultimately construction risks and costs) associated with being able to excavate and achieve the required 100 ML storage volume on a heavily constrained site footprint;
- Emergency or maintenance related discharges from the storage have the potential to enter sensitive (Mountain Pygmy Possum) habitat and are more difficult to direct to treatment systems because of the location;
- Site is potentially inaccessible during winter, and would require the access road to be upgraded;
- Inability to gravity feed water to the Resort, in order to provide an uninterrupted water supply during bushfire events;
- Isolated location adjoined by trees at the top of a slope, (which may result in higher intensity bushfires) and be more difficult to defend in the event of a bushfire.

Based on the above disadvantages, a number of which were key project criteria (*), the Koflers site was not considered by GHD and the RMB to be a suitable storage location.

A workshop with BSL on 10 October, 2013 confirmed that the Koflers site was not considered ‘equal to or better than’ the Tirol site (the subject of the previous 2008 and 2009 investigations),

had significant limitations, and was therefore deemed not to be preferable. No further investigations into the Koflers site were subsequently undertaken.

6.1.3 Control Centre

The Control Centre (refer Figure 7) had not previously been the subject of geotechnical and flora and fauna assessments. Investigations previously undertaken for the Tirol site (refer 4.2.1), were used to provide background information for site specific assessments. These site specific assessments included a phase 1 geotechnical investigation, and flora and fauna investigations (refer Appendix B).

Key advantages of the site were considered to be:

- Avoidance of areas identified as being important Mountain Pygmy Possum habitat;
- (*) Reduced construction costs associated with the available construction material (less rock ripping and blasting);
- Potential to utilise excess material around the storage to assist with landscaping and minimisation of visual and skier utility impacts;
- Avoidance of existing and future snowmaking areas;
- No impact on the Resort Master Plan, or on areas identified for future recreational use;
- Avoidance of potential construction dust impacts on the Burnt Hut water supply storage, due to its separation distance; and
- Accessibility – the site is readily accessed from the Resort all year round and is located adjacent to the BSL operations office, which would assist with supervision, maintenance and monitoring activities.

Key disadvantages of the site were considered to be:

- Potential to impact upon local hydrology, which is expected to have indirect impacts to EPBC and FFG listed alpine bog communities downslope of the site;
- Impact to the existing Boggy Creek T-bar, which would require decommissioning. Whilst this infrastructure is proposed to be decommissioned in the longer term (in the current Resort Master Plan), the use of this site for a storage would result in an immediate unavoidable impact on existing Resort ski infrastructure;
- (*) Inadequate information on geotechnical and hydrogeological conditions, leading to concerns with regards to slope stability. This aspect was identified and actioned as an item to be addressed as part of the process to confirm a preferred site (refer stage 2); and
- Potential for emergency or maintenance discharges to impact on downslope alpine bog community (unless mitigation measures could be implemented).

6.1.4 Assumptions in relation to specific criteria

Protection of soil and water during construction

It was assumed that a variety of soil and water protection / impact mitigation measures would be successfully developed, installed and managed during the construction and site rehabilitation process regardless of site location.

Public safety

Public and employee safety was included as part of storage siting considerations. Aspects such as avoidance of main thoroughfares and lift infrastructure, as well as the ability to restrict access and monitor / supervise the storage were considered. It has been assumed that the storage

would be security fenced in order to exclude members of the public. The location, design and erection of fences is expected to require detailed and site specific consideration in order to minimise risks to public safety (regardless of site), and visual impacts .

6.1.5 Stage 1 Results

Comparison against project criteria

All sites have relative advantages or disadvantages when assessed against individual criteria and against each other.

Of the three sites assessed via the MCA process, the Koflers site is clearly inferior for a range of criteria. This led to it being discarded early in the process. Based on the information available at the time of the assessment (December, 2013) and the status of the dam designs and footprints, the Tirol and Control Centre sites showed a similar overall rating in terms of the number of positive and negative attributes.

Comparison against key project criteria

As discussed previously, the key project criteria identified for the Project were:

- Impact to native vegetation;
- Geotechnical suitability and risk to achieving 100 ML storage volume;
- Impact to existing skiable terrain, connectivity and Resort functionality; and
- Storage construction cost.

These are highlighted by the blue colouring in Table 6 and the key project criteria subset is presented in Table 7.

Table 7 MCA results for key project criteria (December 2013)

Aspect	Criteria	Tirol	Control Centre
Environment & Heritage	Impact to native vegetation		
Economic	Dam Construction Cost - embankment material availability		
	Dam Construction Cost - ripping and blasting required for rock cut		
	Dam Construction Cost - minimise earthworks volume		
Ski Resort Utility	Impact to existing skiable terrain, connectivity and Resort functionality		
Technical / Engineering	Geotechnical suitability		
	Geotechnical risk to achieving 100 ML storage volume		

In terms of the key project criteria the Tirol and Control Centre sites compared as follows:

- The Control Centre site was assessed to have a slightly smaller direct impact upon native vegetation (2.35 ha) than Tirol (2.52 ha). 34% of the Tirol footprint was mapped as previously disturbed, whereas 21% of Control Centre was previously disturbed.
- Storage construction cost was considered to be lower at the Control Centre site due to the increased quantity of rock that was expected to be encountered at the Tirol site.

- The impact to existing skiable terrain, connectivity and Resort functionality was considered to be significantly greater at Tirol due the location of the storage in the vicinity of beginner ski runs, ski lifts, traverse and access areas.
- Geotechnical suitability and risk to achieving the required 100 ML storage volume was considered to be greater at Control Centre. This was based on limited site information derived from the phase 1 geotechnical investigation at the Control Centre which suggested that the site was complex in terms of underlying geology and groundwater. Visual mapping of ground conditions indicated the presence of historical landslides and general slope instability in the adjoining and wider area. This suggested a high to very high risk of slope instability and the nature and condition of the former landslide areas required further detailed assessment to inform concept design. Whilst the available Tirol site geotechnical information was not comprehensive (for example the geotechnical bores were only relatively shallow) it provided a level of confidence which did not exist at Control Centre (primarily due to a paucity of geotechnical and groundwater information).

Preferred site

After a consideration of the range of criteria (both the 'general' and the 'key' project criteria), the RMB and GHD concluded that the Control Centre site had sufficient merit to be considered the preferred site, but that confirmation of its 'preferred' status would not be possible until additional information was obtained on the:

- Site geotechnical risks (and associated construction costs); and
- Potential for indirect (offsite) impacts on the downslope alpine bog vegetation communities as a result of the storage construction and the alteration of surface and groundwater flow.

6.2 Stage 2 Results - Comparison of Storage Options

Despite the Control Centre being the preferred site, the investigations undertaken as part of Stage 1 of the Project highlighted that the construction of a storage on either the Tirol or the Control Centre sites would require additional information to inform design work, construction methodology and costs, and confirm the feasibility of the Project. A series of investigations were undertaken in conjunction with a concept design process to allow siting options to be assessed in more detail. Detailed information on the additional investigations and the concept design process for Stage 2 of the project is presented in 5.2.2.

A review of the revised concept designs incorporating the construction footprint for the Tirol and Control Centre sites against key project criteria, and other relevant criteria was undertaken in Stage 2 as described in this section.

6.2.1 Review against 'key' project criteria

A review of the revised concept designs for Tirol and Control Centre sites against the key project criteria is provided within this section.

Impact to native vegetation

Table 8 provides details of the potential native vegetation impacts at the Tirol and Control Centre sites based on the concept designs and expanded project footprint areas developed (refer also Appendix B).

Footprint design sought to utilise previously disturbed ground in preference to undisturbed native vegetation. The area of previously disturbed ground at Tirol (6.01 ha, 56% of site) was slightly greater than at Control Centre (5.84 ha, 52% of site).

The proposed impact on native vegetation at Tirol (6.47 ha) is slightly less than at Control Centre (6.96 ha).

Table 8 Impacts on native vegetation

	Tirol	Control Centre
Total footprint of disturbance incorporating native vegetation extent and area of previously disturbed ground (preliminary dam construction footprint)	• 10.76 ha	• 11.27 ha
Native vegetation extent	• 6.47 ha (native vegetation) • 4.29 ha (degraded treeless vegetation)	• 6.96 ha (native vegetation) • 4.31 ha (degraded treeless vegetation)
EVCs present	• Alpine Grassy Heathland (intact) (EVC 1004) (5.81 ha) – Rare • Alpine Grassy Heathland (weedy) (0.57 ha) – Rare • Sub-alpine Woodland (EVC 43) (0.07 ha) – Least Concern • Sub-alpine Wet Heathland (EVC 210) (0.02 ha) - Endangered	• Alpine Grassy Heathland (intact) (EVC 1004) (6.14 ha) – Rare • Alpine Grassy Heathland (weedy) (0.73 ha) – Rare • Sub-alpine Woodland (EVC 43) (0.07 ha) – Least Concern • Sub-alpine Wet Heathland (EVC 210) (0.02 ha) - Endangered
Area of previously disturbed ground (BSL mapping)	• 6.01 ha (56% of site)	• 5.84 ha (52% of site)

Given that the impact to native vegetation criteria was also a surrogate criterion for other potentially significant flora and fauna impacts; these have also been briefly discussed within this section. Refer to Appendix B for more detailed information.

Direct impacts to significant communities (Table 9) were considered to be similar for Tirol and Control Centre; however the potential for indirect impacts was greater at the Control Centre site. This is primarily due to the location of the alpine bog habitat immediately downslope of the Control Centre site.

Table 9 Impacts on threatened communities

	Tirol	Control Centre
EPBC-listed Community		
Alpine Sphagnum Bogs and Associated Fens	0.02 ha direct impact **Small** area (<1 ha) downslope potential indirect impact	0.02 ha direct impact **Moderate** area (>1 ha) downslope potential indirect impact
FFG-listed Community		
Alpine Bog Community	0.02 ha direct impact **Small** area (<1 ha) downslope potential indirect impact	0.02 ha direct impact **Moderate** area (>1 ha) downslope potential indirect impact
Caltha introloba Herbland Community	No direct impact	No direct impact

A number of State significant flora, and Nationally and State significant fauna were recorded, or were identified as having potential to occur on the Tirol and Control Centre sites. Due to the proximity of these sites, the investigation results were similar in terms of the species involved. However, more rare or threatened flora species were identified for the Tirol footprint (13 rare) than for Control Centre (11 rare, 1 vulnerable).

Temporary stockpiling for the Control Centre (Koflers stockpile area) means that the project footprint is closer to identified Mountain Pygmy-possum Type II habitat than for the Tirol site (70 metres, vs 176 metres for Tirol).

In terms of the original scoring of this criteria (both sites being scored similarly (refer Table 6)), it was concluded that both sites were likely to have a similar direct impact, but that there was potential for a greater indirect impact at Control Centre.

In terms of the project risk based pathway for applications to remove native vegetation (DEPI, 2013), both sites would require assessment via the ‘High’ risk pathway.

The hydrogeological and ecological investigations undertaken for the Project identified a range of impact mitigation measures available for the Control Centre site. Further detailed investigations as part of the detailed design process (for example in relation to ancillary infrastructure micro alignment and the alpine bog hydrology) were also recommended. The development and implementation of a monitoring and management plan which integrates groundwater and ecological information in order to facilitate adaptive management was also proposed in order to understand and manage the potential indirect impacts of the project.

Storage construction cost

The original MCA scoring (refer Table 6) indicated that construction costs at Control Centre were likely to be lower based primarily on the smaller quantities of rock to be handled and processed.

Based on the investigations and reviews undertaken, it was concluded that:

- The availability of embankment material would be similar for either site;
- The amount of ripping and blasting for rock cut would be greater at Tirol; and
- The earthworks volumes to be handled would be similar, however, based on the concept designs, Tirol would require material to be imported, and Control Centre would produce an excess of material (to be reused on site).

In terms of the original MCA scoring it was concluded that storage construction costs at Control Centre would continue to be lower than for Tirol.

Impact to skiable terrain, connectivity and Resort functionality

The concept design layouts for each site (Figure 8 and Figure 9) sought to avoid and minimise impacts to Resort users. Feedback on potential impacts and mitigation options was provided by RMB and BSL and incorporated into the Stage 2 concept designs.

The original MCA scoring (refer Table 6) indicated that impacts to skiable terrain, connectivity and Resort functionality would be more significant at Tirol.

Based upon the storage concept designs developed as part of the Stage 2 investigations, it was concluded that the Tirol site would continue to score more poorly on this criteria than the Control Centre.

The Control Centre storage would require the realignment of the access road which links the Resort to the Mt Buller summit car park. Decommissioning of the Boggy Creek ski lift infrastructure and building would also be required (note that this is proposed in the Resort Master Plan). The concept design incorporated a 10 metre wide skier access lane beyond the southern toe of the embankment in order to minimise impacts to users.

The Tirol storage would require relocation of the Tirol ski lift and would impact upon skier access to the beginner slope area adjacent to the Burnt Hut reservoir. It would also be necessary to relocate part of the Mt Buller summit access road.

Geotechnical suitability and risk to achieving storage volume

As described previously, a number of investigations into the geotechnical characteristics of the Control Centre and Tirol sites (and adjoining areas) were undertaken.

The investigations included site inspections and geological mapping as part of the project risk assessment. These have identified potential signs of slope instability along the edge of the basalt outcrop to the north of the Tirol site. An area of potential foundation weakness identified by Coffey Geotechnics (2010) was inspected and is interpreted to be postulated failure, with the rock potentially sliding on the weaker layer as identified.

Following the Stage 2 stability assessment and review of the slope stability model developed by Coffey, it is now considered that the geotechnical risk at the Tirol site is expected to be greater than the geotechnical risk at the Control Centre Site.

In terms of assessment against the key project criteria, it is concluded that:

- In terms of geotechnical suitability, both sites are complex, however based on the information now available, the Control Centre site demonstrates a lower geotechnical risk than the Tirol site; and
- In terms of the risk of achieving 100 ML storage volume, both sites are considered to be capable of supporting a 100 ML storage, however the underlying geological conditions at the Tirol site mean that the risks associated with achieving this criteria are considered to be greater.

The risk issues identified at the Tirol site have the potential to impact upon key project criteria including the ability to construct a 100 ML storage, construction cost and ski resort utility as a result of significant changes in design criteria which would potentially be required to mitigate the risk.

6.2.2 Review against other selected criteria

The revised storage designs and project footprints were also evaluated against the other criteria used in the MCA in order to identify any changes or to reinforce previous conclusions. Relevant criteria are discussed in this section.

Impact on visual amenity

The Tirol storage would require a large embankment up to 25 metres in height. Because of the slope on which it is located, the northern batter extends for a considerable distance (approximately 70 meters downslope). The southern batter would also be raised above the existing ground level. The Tirol storage was considered to have a significant visual amenity impact because of its location in relation to the Resort and surrounding areas.

The Control Centre storage would also result in visual amenity impacts, however the impacts were considered to be lower due to its position within the landscape and the potential to implement landscaping measures more easily.

Relocation of services, construction of new services

Both storages would require the relocation of existing services, however the Tirol site required a larger number of services to be relocated and constructed. These included a gas main, water main, sewer main, snowmaking water main and underground electrical cables.

The Control Centre storage would require existing sewer and water mains to be relocated.

The impact on specific services and relocation requirements would be confirmed during detailed design.

Discharge location / treatment

The MCA identified that there was a greater risk of impacts from storage dam discharges associated with the Control Centre site (primarily because of its proximity upslope of alpine bog communities). The development of the concept design and ancillary infrastructure for the Control Centre has allowed risk mitigation measures and operational controls to be considered in more detail (for example a low level off take to allow dam drawdown and controlled transfer, and/or desilting at another location such as the Sun Valley reservoir), and a high level overflow to direct and control flows. Similar infrastructure would be required for the Tirol site.

Design and operational procedures would be expected to reduce discharge risks from the Control Centre site, however its proximity in relation to the alpine bog communities remains unchanged.

6.2.3 Preferred site

A two stage MCA development and review process has been undertaken. This process has been progressively informed by a series of on-site investigations.

Based on the investigations undertaken and a consideration of project criteria (both key project and other relevant project criteria), it was concluded that, on balance, the Control Centre site is the preferred site for the location of the 100 ML off-stream storage dam proposed by RMB.

The review and assessment processes have identified a range of risks which would need to be addressed in the project planning, design, construction and operational phases of the Project.

7. Conclusion

This report for the Mt Buller Sustainable Water Security Project – Off-Stream Storage (the Project) documents the need for the proposed 100 ML Off-Stream Storage, the alternatives considered, the assessment of potential storage sites, and the development of a concept design for the preferred site.

7.1 Water supply constraints and supply options

Background and contextual information on the Project (section 2) highlights the importance of a safe and reliable water supply to the achievement of the RMB performance obligations and objectives, and for the ongoing economic viability of the Resort. The factors influencing water demand and supply and the existing constraints have also been presented. From this it may be seen that the Resort water supplies (for both potable and snowmaking use) are significantly constrained, and likely to come under increasing pressure as strategies to increase summertime visitation and to mitigate the impacts of climate change on snow cover are implemented. The requirement for a 100 ML storage is identified in order to address the constraints. The benefits of addressing these constraints include:

- *Sustained summer tourism growth*, which improves the economic viability of the Resort;
- *Improved environmental outcomes* by avoiding water extraction during the drier periods of the year (maintaining and improving environmental flows);
- *Improved fire-fighting capability and bushfire event response*, through the provision of an on mountain water gravity fed water supply to the Resort capable of supporting fire suppression activities; and
- *Growth in winter recreation and overall visitation*, due to the capability to increase snowmaking on existing areas, or expand snowmaking onto new areas.

Section 2 of the report also identifies a range of policies, strategies, plans and objectives which support the implementation of the Project. The requirement for the Resort water supply issues to be addressed is a theme in a number of documents, and has been highlighted as a priority.

Section 3 documents the range of water supply options and alternatives to an on mountain off-stream storage which have been considered. The options that were evaluated against a range of criteria (ability to meet peak potable and snowmaking demand, compliance with winter fill extraction, assist bushfire management, capital and operating cost, energy use and greenhouse gas emissions, footprint size and technical feasibility) were:

- The proposed option (on mountain off-stream storage);
- Expansion of the Sun Valley reservoir;
- Demand management and water efficiency measures;
- Increased surface water extraction or extraction from other catchments;
- Alternative sources – groundwater and rainwater/stormwater harvesting;
- Off mountain storage; and
- Do nothing.

The results of the evaluation indicate that a new 100 ML on mountain storage is the most appropriate option as it:

- Allows peak potable and snowmaking water demands to be met;
- Facilitates achievement of the winter fill criteria;
- Would provide a gravity fed supply and assist with fire preparedness and suppression;
- Would have relatively lower capital, operating costs, energy use and greenhouse gas emissions; and
- Is considered technically feasible.

A range of water supply and demand management measures may still need to be implemented by the RMB over the longer term.

7.2 Off-stream storage site options assessment

Section 4 of the report describes the multi criteria assessment (MCA) methodology adopted for the assessment of potential storage sites. This MCA utilised a range of considerations associated with land use planning, environment, heritage, social, economic, ski resort utility, technical and engineering, construction, operation and bushfire management considerations.

A series of detailed assessment criteria and descriptors for the MCA were developed in conjunction with the RMB, based on relevant planning and strategy documents, and from RMB organisation specific objectives. Key criteria for the Project were identified as:

- Impact to native vegetation;
- Geotechnical suitability and risk to achieving 100 ML storage volume;
- Impact to existing skiable terrain, connectivity and Resort functionality; and
- Storage construction cost.

Section 5 of the report describes the process of storage site identification and the development of storage dam concepts. A two stage process was implemented. Three sites (called ‘Tirol’, ‘Koflers’ and ‘Control Centre’) were identified for evaluation.

Section 6 of the report describes the results of the options assessment process and the comparison of storage options against the MCA criteria. A two stage site options assessment process was undertaken to identify and evaluate potentially suitable sites for an on mountain storage.

The first stage of the process evaluated three sites (Tirol, Koflers and Control Centre), and was informed from prior investigations, as well as limited site specific geotechnical and ecological investigations. This stage utilised the MCA. One site (Koflers) was considered to be inferior and was eliminated early. The Control Centre site was considered to have sufficient merit to be the preferred site, but additional information was required in order for this to be confirmed.

The second stage of the site selection process was undertaken following a series of more detailed geotechnical, hydrogeological and ecological investigations, in conjunction with a preliminary concept design process. This concept design considered a larger footprint than the first stage in order to take account of storage construction methodology, and the need to install and relocate ancillary infrastructure. Following these investigations, the MCA was reviewed to ensure that the preferred site remained preferred in light of the additional information which had been gained.

7.3 Preferred site

The Control Centre site has been determined as the preferred site for the 100 ML off-stream storage. A comparison of the Control centre with the Tirol site using the key project criteria indicates that:

- The area of direct impact to native vegetation is similar between sites, however there is potential for the construction of the Control Centre storage to result in indirect (hydrology related) impacts to the downslope alpine bog vegetation. A range of mitigation measures have been identified to address the indirect impacts. Additional investigations are recommended as part of the detailed design phase. A monitoring and management plan which integrates groundwater and ecological information is required in order to facilitate adaptive management of site and the mitigation of impacts;
- There is significant geotechnical complexity associated with both sites, however the geotechnical risks, and the risks associated with failure to achieve a 100 ML storage during the construction phase are considered to be lower at the Control Centre site;
- The potential impacts on skiable terrain, connectivity and Resort functionality are significantly lower at the Control Centre site. Construction at the site would require decommissioning of the Boggy Creek T bar (something which has been proposed in the Resort Master Plan); and
- The construction costs associated with the Control Centre site are expected to be lower than Tirol due to the smaller quantities of rock to be handled and processed.

The review and assessment processes undertaken as part of this site options assessment have identified a range of risks which would need to be addressed in the project planning, design, construction and operational phases of the project.

8. References

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Appendices

Appendix A – Project Multi-Criteria Assessment

December 2013

Alpine Resorts Planning Scheme (21.05) - Relevant Objectives

Planning Scheme - Strategic Objectives	Planning Scheme - Objectives	MCA Ref No.	MCA Objective
Environmental and Landscape values. To conserve and protect the natural environmental systems and landscape values within and adjacent to the Mt Buller Alpine Resort so as to minimise disturbance to flora and fauna communities and to areas of high scenic quality or visual sensitivity	To maintain, preserve and enhance the natural environmental features of the Resort	2.1	Avoid / minimise impacts to native vegetation
	To maintain, preserve and enhance the habitat of threatened species and communities within the Resort	2.2	Avoid / minimise significant impacts to EPBC listed communities / species
		2.3	Avoid / minimise significant impacts to FFG listed communities/ species
		2.4	Avoid impacts to Mountain Pygmy Possum habitat (Type 1 and 2)
	To ensure that use and development minimises environmental impact through sensitive siting and implementation of sound construction and management techniques	2.5	Avoid / minimise potential impacts to waterways and aquatic habitat
		3.1	Avoid / minimise significant impacts to areas of high scenic quality or visual sensitivity
Natural Resource Management To ensure that use and development within the Mt Buller Alpine Resort is undertaken in an ecologically sustainable manner	To protect the quality and integrity of natural water systems and aquatic ecosystems		*Refer Reference No. 2.5*
		2.6	Protect water supply catchment area (Delatite catchment)
Infrastructure To optimise the snow user capacity of the skifields and ensure provision of appropriate infrastructure to meet current and future needs of the Resort taking into account environmental constraints.	To ensure that service and infrastructure is provided in a manner that minimises impacts on existing natural built, cultural and environmental values of the Resort	5.1	Avoid / minimise potential impacts to winter use terrain currently available to skiers, or potentially available for use in the future
		5.2	Avoid / minimise potential impacts to existing ski infrastructure
To achieve a high level of performance and safety for all development and service infrastructure for all users.		3.2	Storage dam design, construction and operation which minimises public and employee safety risks
	To minimise the impact of stormwater and other discharges on the water quality of the Howqua and Delatite Rivers		*Refer Reference No. 2.5*
Environmental Risks	To take proper account of geotechnical stability considerations	6.2	Minimise geotechnical risks through appropriate siting, design and construction
	To ensure the safety of the Resort from bushfire	9.1	Ensure infrastructure enhances Resort fire preparedness and incident response
		9.2	Minimise potential for bushfire damage to storage and associated infrastructure
Built Environment and Heritage	To protect and improve identified and potential places, sites and objects of Aboriginal and European cultural, historical and architectural significance.	2.6	Avoid / minimise potential impacts to indigenous cultural heritage.
	To ensure protection of significant vegetation on development sites		*Refer Reference No. 2.1, 2.2, 2.3*

RMB Strategic Management Plan 2013-2018 - Relevant Objectives

Strategic Management Plan Objective	5 Year Commitments	MCA Ref No.	MCA Objective
Our Services Provide safe and reliable water and wastewater, and waste removal facilities and services	Continue investment in upgrade and modernisation of plant and systems to improve assets management and resilience of systems	4.5	Minimise operational cost and complexity of infrastructure, and integrate storage efficiently into existing system
		7.1	Avoid impacts to potable water quality during construction phase
		7.2	Maintain continuity of Resort operations during construction - particularly for water treatment and supply
	Implement water supply demand strategy to facilitate appropriate and sustainable supply of water		
Develop initiatives to further snow-making capabilities	Provide ongoing commitment to support infrastructure and best practice in snow making technology	5.3	Avoid / minimise impacts to core skiable areas currently supported by snowmaking
		5.4	Avoid / minimise impacts to future areas used for snowmaking
Maximise asset performance by striving for best use, and improving asset efficiency....	Develop and maintain long-term asset management and investment plan		
Our Environment Manage the endemic alpine flora and fauna communities within the Resorts	Enhance habitat and protection of Mountain Pygmy possum to improve sustainability of the population		*Refer Reference No. 2.4*
	Monitor and manage threats to listed flora and fauna species and communities		*Refer Reference No. 2.2, 2.3, 2.4*
Reduce the Resorts' environmental footprint by developing and promoting sustainable practices and programs	Implement programs and projects to improve Resort resources and efficiencies	4.7	Maximise use of gravity to minimise electricity and operating costs. Minimise greenhouse gas emissions.
Our Community Develop and enhance village and community centres	Continue with the implementation and investment in the Mt Buller Resort Master Plan	5.5	Avoid / minimise impacts to areas identified for future recreational use in the Resort Master Plan
Acknowledge the cultural heritage of our region and celebrating our community's history	Continue to work with local arts, culture and heritage based groups....		*Refer Reference No. 2.7*
Facilitate essential and emergency services required by the community	Continue to ensure that the RMB is skilled and capable of managing and coordinating our response to emergency situations, including bushfires and structural fires		*Refer Reference No. 9.1, 9.2*

RMB - Other Relevant Project Specific Objectives

	Economic, Technical & Operational Objectives	4.1	Minimise dam construction cost
		4.2	Minimise ancillary infrastucture construction cost
		4.3	Minimise construction program
		4.4	Balance cut and fill in order to minimise construction cost and program, as well as other impacts (transport, amenity, environment)
		4.6	Integrate new storage and water supply efficiently into snowmaking system in order to minimise capital and operating costs
		6.1	Maximise site 'flexibility' in order to adjust design in line with geotechnical or footprint constraints, whilst still achieving required storage volume (reduce project risk)
		6.3	Minimise dam break risk and the potential to impact upon ski infrastructure, resort and road infrastructure, life and property
		7.3	Avoid / minimise the requirement for relocation of services / construction of new services in order to minimise cost, environmental, business continuity impacts
		8.1	Avoid / minimise potential impacts from planned or unplanned discharges - overtopping, storage maintenance, scouring
		8.2	Safe and efficient access to dam site and associated facilities

MT BULLER OFF STREAM STORAGE - MCA CRITERIA (17/12/13)

Aspect	Ref No.	MCA Objectives	Criteria	Descriptor	Rating	Explanatory Notes
Land Use Planning	1	Minimise complexity of planning and environmental approvals and associated risks to project timeframes and costs	Complexity of planning and environmental approvals	Planning permit under existing planning scheme provisions		
				More complex approval eg. planning scheme amendment, EPBC Act referral likely to be required		
				Environment Effects Statement and EPBC referral required		
Environment & Heritage	2.1	Avoid / minimise impacts to native vegetation	Impact to native vegetation	Low proportion (<50 %) of dam footprint is covered by intact/undisturbed native vegetation, low likelihood of threatened species / community impact		Utilisation of previously disturbed sites in order to avoid / minimise impacts. Note - dam footprint only at this stage
				Med. proportion (50-75 %) of dam footprint is covered by intact/undisturbed native vegetation, mod. likelihood of threatened species / community impact		
				High proportion (>75 %) of dam footprint is covered by intact/undisturbed native vegetation, high likelihood of threatened species / community impact		
	2.2	Avoid / minimise significant impacts to EPBC listed communities / species	Impact to EPBC listed communities or species	No direct or indirect impact considered likely		EPBC listed species may be different to FFG listed species and trigger different approvals - therefore separated from FFG (below)
				Potential direct or indirect impact		
				Certain direct or indirect impact		
	2.3	Avoid / minimise significant impacts to FFG listed communities/ species	Impact to FFG listed communities or species	No direct or indirect impact considered likely		
				Potential direct or indirect impact		
				Certain direct or indirect impact		
	2.4	Avoid impacts on Mountain Pygmy Possum habitat (Type 1 and 2)	Proximity to Mountain Pygmy Possum habitat	Footprint > 100m from mapped habitat		Potential risk of direct / indirect impacts from construction (vibration, sediment etc) or operation. Distance from mapped habitat used as descriptor - assumes risk of impact reduces with increased distance. 30m buffer to habitat also applies.
				Footprint between 50m and 100m from mapped habitat		
				Footprint < 50m from mapped habitat, potential for direct or indirect impacts during construction or operation		
	2.5	Avoid / minimise potential impacts to waterways and aquatic habitat	Impact to water quality and / or hydrology	Storage dam unlikely to significantly alter site hydrology or create water quality issues		Assumes construction mitigation measures can be successfully applied. Consideration to be given to potential aquatic impacts associated with both construction and operation.
				Storage dam may result in minor changes to site hydrology and / or create water quality issues		
				Storage dam will significantly alter surrounding hydrology and / or create water quality issues		
	2.6	Protect water supply catchment area (Delatite catchment)	Minimise risks to drinking water through segregation of snowmaking water supplies (potable and recycled). Avoid use of recycled water in Delatite catchment.	Allows full segregation of water sources by catchment area		Use of recycled water for snowmaking in water supply catchment introduces risks. Risks will be reflected in new treatment plant design. There are also best practice / regulatory considerations.
				Requires minor augmentation to segregate water sources		
				Difficult to segregate, requires significant new infrastructure to achieve segregation		
	2.7	Avoid / minimise potential impacts to indigenous cultural heritage.	Potential for Aboriginal cultural heritage impacts	Footprint outside any area of cultural heritage sensitivity		No VHR or VAHR sites are present on Mt Buller Resort ski area. Areas of sensitivity (where there is potential for as yet unknown cultural heritage to occur) based on Vic Govt cultural heritage sensitivity mapping have been used.
				Footprint partially within an area of cultural heritage sensitivity		
				Footprint wholly within an area of cultural heritage sensitivity		
Social	3.1	Avoid / minimise significant impacts to areas of high scenic quality or visual sensitivity	Impact on visual amenity	Storage not visible from main vantage points near Resort or access roads		
				Storage partially visible from vantage points near Resort and access roads		
				Storage easily visible from Resort and access roads. Significant feature in the landscape.		
	3.2	Storage dam design, construction and operation which minimises public and employee safety risks	Public safety and associated controls	Location avoids main thoroughfare, public access can be restricted and monitored, storage not traversed by ski lift		
				Located near main thoroughfare, public access can be restricted but difficult to monitor, storage not traversed by ski lift		
				Located on main thoroughfare, public access difficult to restrict and monitor, storage close to ski lift		
Economic	4.1	Minimise dam construction cost	Availability of embankment construction material	Extensive amount of material available from cut for embankment		
				Moderate amount of material available from cut for embankment		
				Limited amount of material available from cut for embankment		
			Ripping and blasting required for rock cut	Limited amount of ripping or blasting likely to be required		
				Moderate amount of ripping or blasting likely to be required		
				Extensive amount of ripping or blasting likely to be required		
			Minimise earthworks volume and handling	Relatively low earthworks volume for required storage <35,000 m3. No double handling of materials.		
				Moderate earthworks volume for required storage 35,000 - 75, 000 m3. Some double handling of materials.		
				Relatively high earthworks volume >75,000 m3. Significant double handling of materials.		
	4.2	Minimise ancillary infrastructure construction cost	Ancillary infrastructure (pipelines, power, road) construction cost	Infrastructure cost relatively low		Influenced by distances, connection and control points. Relocation of existing services and access roads.
				Infrastructure cost moderate		
				Infrastructure cost relatively high		
	4.3	Minimise construction program	Construction program duration	Can commence early works at the end summer 2013/14 (subject to planning approvals)		
				Can be constructed over a single summer		
				May require two summer construction periods		
	4.4	Balance cut and fill in order to minimise construction cost and program, as well as other impacts (transport, amenity, environment)	Quantity of material to be imported / exported	Cut / fill quantities are balanced (+/- 10% of total quantity)		
				Cut / fill quantities unbalanced (+/- 20% of total quantity to be imported / exported)		
				Cut / fill quantities unbalanced (+/- 30% of total quantity to be imported / exported)		
			Excess material can be reused on site in landscaping	All excess material can be reused on site		Excess material can potentially be used for landscaping the storage embankment in order to minimise visual amenity impact
				Majority of excess material can be reused on site		
				No excess material can be reused on site - must be exported		
	4.5	Minimise operational cost and complexity of infrastructure, and integrate storage efficiently into existing system	Ability to integrate storage into existing infrastructure, simplify and rationalise infrastructure long term, reduce operational / management costs	Infrastructure integrates with existing system and allows simplification / rationalisation long term, provides operational cost savings		Requires consideration of distances, existing infrastructure, potential to redesign
				Infrastructure partially integrates with existing system, operating cost neutral		
				Infrastructure does not easily integrate, duplicates or increases complexity long term, increases operational costs		
	4.6	Integrate new storage and water supply efficiently into snowmaking system in order to minimise capital and operating costs	Ability to integrate storage / water supply into existing snowmaking infrastructure	Infrastructure integrates with existing system		
				Infrastructure partially integrates with existing system requiring minor additional infrastructure		
				Infrastructure does not easily integrate requiring significant additional infrastructure		
	4.7	Maximise use of gravity to minimise electricity and operating costs. Minimise greenhouse gas emissions.	Operating cost (energy use / pumping duty)	Storage location and conveyance infrastructure can utilise gravity to a large extent, short pipeline length		Operating head and pipeline length used to determine relative differences in energy use
				Storage location and conveyance infrastructure can partially utilise gravity feed but additional pumping will be required, mod. pipeline length		
				Storage location and conveyance infrastructure require significant additional pumping, long pipeline length		

Aspect	Ref No.	MCA Objectives	Criteria	Descriptor	Rating	Explanatory Notes
Ski Resort Utility	5.1	Avoid / minimise potential impacts to winter use terrain currently available to skiers, or potentially available for use in the future	Impact to existing skiable terrain, connectivity and Resort functionality	No impact on skiable terrain or existing ski runs. Connectivity and functionality of runs/lifts unaffected.		Includes skiable terrain available for use (based on BSL mapping). Connectivity to maintain efficient skier movement is important. Note: Additional criteria for snowmaking areas (below) provided due to importance during poor seasons.
				Reduction in skiable terrain which requires minor modification of existing ski runs in order to maintain connectivity and Resort functionality		
				Significant reduction in skiable terrain, requires major modification of existing ski runs to retain connectivity and Resort functionality		
	5.2	Avoid / minimise potential impacts to existing ski infrastructure	Impact to existing ski infrastructure	No impact to existing infrastructure		
				Minimal impact to existing infrastructure - modification or relocation required		
				Major impact to existing infrastructure - requires decommissioning or major modification to one or more lifts		
	5.3	Avoid / minimise impacts to core skiable areas currently supported by snowmaking	Impact to existing snow making areas	No impact on existing snow making areas or infrastructure		Based on BSL mapping of current snowmaking areas.
				Minimal impact on existing snow making areas or infrastructure		
				Significant impact on existing snow making areas requiring modification of infrastructure and runs		
	5.4	Avoid / minimise impacts to future areas used for snowmaking	Impact to future snow making areas	No impact on future snow making areas		Based on BSL mapping of future snowmaking areas
				Minimal impact on future snow making areas		
				Significant impact on future snow making areas requiring modification of infrastructure and runs		
	5.5	Avoid / minimise impacts to areas identified for future recreational use in the Resort Master Plan	Impact to Master Plan and proposed future recreational areas	No impact		Based on Mt Buller Master Plan Report October 2010
				Minimal impact		
				Significant impact requiring modification of plans		
Technical & Engineering	6.1	Maximise site 'flexibility' in order to adjust design in line with geotechnical or footprint constraints, whilst still achieving required storage volume (reduce project risk)	Capacity to adjust dimensions of the footprint during detailed design and construction	No significant footprint constraints for the required volume.		Additional geotechnical information being obtained. Flexibility of dam footprint is highly desirable to minimise project construction risks & ensure target storage volume can be achieved.
				Project footprint is constrained, but has some flexibility for adjustment.		
				Project footprint is heavily constrained. No flexibility.		
	6.2	Minimise geotechnical risks through appropriate siting, design and construction	Geotechnical suitability	Geotechnical conditions predictable and uniform		
				Geotechnical conditions have potential areas of complexity, likely to require specific engineering measures		
				Geotechnical conditions complex, require detailed investigation and testing throughout project, specific additional engineering measures		
			Geotechnical Risk to achieving 100 ML volume (based on current information)	Geotechnical info provides sufficient confidence of achieving 100 ML objective		No geotechnical info for Koflers. Potential to compromise 100ML storage requirement. Assumptions made about rock/geotechnical conditions based on site inspection.
				Limited geotechnical info - uncertainty of achieving 100 ML objective		
				Only surface assessment of geological conditions - potential to significantly compromise 100 ML storage objective		
	6.3	Minimise dam break risk and the potential to impact upon ski infrastructure, resort and road infrastructure, life and property	Dam Break Consequence Category (ANCOLD)	Minimal potential to impact upon the built environment, life and property. (Very Low to Low consequence category)		Ratings determined by ANCOLD Guidelines
				Potential for localised impacts on the built environment, life or property. (Significant to High (C) consequence category)		
				Potential for significant impacts on the built environment, life or property. (High (B) to Extreme consequence category)		
Construction Considerations	7.1	Avoid impacts to potable water quality during construction phase	Dust impacts to Burnt Hut water storage quality	No potential dust impact on water quality in Burnt Hut storage		Burnt Hut storage is open to the air and potentially impacted upon by airborne contaminants mobilised during construction
				Some potential dust impact on water quality within Burnt Hut storage requiring additional treatment to maintain potable standard		
				Significant potential dust impact on water quality within Burnt Hut storage compromising ability to meet potable water standard		
	7.2	Maintain continuity of Resort operations during construction - particularly for water treatment and supply	Impacts to continuity of existing water supply	Can be constructed with no / minimal impact to existing water supply, treatment and conveyance systems		
				Construction will result in periodic but manageable interruptions to water supply, treatment and conveyance systems		
				Construction will result in significant interruption to existing water supply / treatment / conveyance and complex 'work arounds'		
	7.3	Avoid / minimise the requirement for relocation of services or construction of new services - in order to minimise cost, environmental, business continuity impacts	Relocation of services, construction of new services	Requires minimal relocation of existing services, new services all within previously distrubed areas		
				Requires relocation of services and construction of new services, primarily within previously disturbed areas		
				Requires significant relocation of existing services and/or construction of new services in undisturbed areas.		
Operational Considerations	8.1	Avoid / minimise potential impacts from planned or unplanned discharges - overtopping, storage maintenance, scouring	Discharge location / treatment	Discharges from storage can be easily directed to least sensitive environments and/or treatment systems		
				Discharges from storage will require significant engineering to direct to least sensitive environments and/or treatment systems		
				Discharges from storage have potential to enter identified sensitive environments eg. boulder fields, MPP habitat, bogs		
	8.2	Safe and efficient access to dam site and associated facilities	Ease of site access throughout the year	Site easily accessible all year round		
				Site generally accessible all year round		
				Site potentially inaccessible at times		
Bushfire Management	9.1	Ensure infrastructure enhances Resort fire preparedness and incident response	Water supply to Resort can be maintained during power failure	Water can gravity feed to the Resort in the event of power failure, multiple supply options / redundancy possible		
				Water can gravity feed to the Resort in the event of power failure		
				Water cannot gravity feed in the event of power failure		
	9.2	Minimise potential for bushfire damage to storage and associated infrastructure	Storage and associated infrastructure is defendable, location in the landscape minimises risk	Storage location is defendable, adjoining vegetation provides low fuel load		Storage will be lined with a membrane which is susceptible to fire.
				Storage location is defendable, adjoining vegetation provides moderate fuel load		
				Storage location is not easily defendable, adjoining vegetation provides high fuel load		

EVALUATION (17/12/13)

Land Use Planning

Option	1.0 Complexity of planning and environmental approvals		Potential to manage/reduce impact or risk?
	Rating	Comments	
Tirol		Planning permit with EPBC referral likely to be required (potential for *direct & indirect* impact on Alpine bog community)	Partial - direct impact on small area, design to avoid/mitigate hydrology impacts
Koflers		Planning permit with EPBC referral likely to be required (potential to impact on Pygmy Possum)	No - footprint constrained
Control Centre		Planning permit with EPBC referral likely to be required (potential for *indirect* impact on Alpine bog community (via groundwater). Note: requires assessment of indirect impacts (hydrogeo & geotech investigations)	Yes - design solution to avoid direct impact to sub alpine wet heath / bog communities. Potential for management and monitoring to support mitigation of hydrology impacts.

Environment & Heritage

Option	2.1 Impact to native vegetation		
	Rating	Comments	
Tirol		~80% of dam footprint estimated to be intact, remainder disturbed or degraded	
Koflers		~100% of dam footprint estimated to be intact. Footprint includes a variety of EVCs	No - dam footprint limited flexibility
Control Centre		~70% of dam footprint estimated to be intact, remainder disturbed or degraded.	
	2.2 Impact to EPBC listed communities or species		
	Rating	Comments	
Tirol		Footprint avoids EPBC listed vegetation community. Potential for direct / indirect impacts associated with construction activities or changes in hydrology.	
Koflers		Small area of listed vegetation community, close proximity to MPP habitat. Referral may be required.	
Control Centre		No EPBC listed veg communities on site. Significant potential for local hydrology changes and indirect impact to EPBC listed communities below dam site. Referral likely to be required. Requires further investigation	
	2.3 Impact to FFG listed communities or species		
	Rating	Comments	
Tirol		Footprint avoids listed veg. community, a number of listed flora and fauna species likely to occur. FFG listed community (Sub alpine wet heathland) adjacent and downslope.	Yes - optimise footprint to avoid FFG listed wet heathland community
Koflers		Small area of listed veg. community impacted, a number of listed flora and fauna species likely to occur	No - dam footprint limited flexibility
Control Centre		No listed veg communities on site. Significant potential for local hydrology changes and indirect impact to FFG listed communities below dam site. A number of listed flora and fauna species likely to occur.	Yes - optimise footprint to avoid FFG listed wet heathland community
	2.4 Proximity to Mountain Pygmy Possum habitat		
	Rating	Comments	
Tirol		Outside Revised Management Area. Dam footprint approx 360 m from Habitat 2 and 550 m from Habitat 1 (excludes 30 m buffer)	
Koflers		Part of footprint within Revised Management Area. Dam footprint approx 50 m from Habitat 2, 130 m from Habitat 1. Small patch of potential habitat present within the footprint (excludes 30 m buffer).	No - dam footprint limited flexibility
Control Centre		Outside Revised Management Area. Dam footprint approx 300 m from Habitat 2 and 340 m from Habitat 1 (excludes 30 m buffer)	
	2.5 Impact to water quality and / or hydrology		
	Rating	Comments	
Tirol		Localised impact on hydrology likely. Assumes erosion mitigation measures can be successfully applied.	
Koflers		Localised impact on hydrology likely. Assumes erosion mitigation measures can be successfully applied.	
Control Centre		Significant potential for localised impact on hydrology. Assumes erosion mitigation measures can be successfully applied. Level of impact on hydrology and catchment yield to be investigated.	Yes - requires investigation and development of mitigation measures
	2.6 Protect water supply catchment area (Delatite catchment)		
	Rating	Comments	
Tirol		Segregation achieved though valving and new snow making pump	
Koflers		Segregation difficult / costly to achieve	
Control Centre		Segregation achieved though valving and new snow making pump	
	2.7 Potential for Aboriginal cultural heritage impacts		
	Rating	Comments	
Tirol		Wholly within ACHS due to 'high plains' regulation. Large part of footprint previously surveyed with no heritage identified.	Yes - undertake CHMP
Koflers		Footprint partially within ACHS due to proximity (within 200m) of waterway.	Yes - undertake CHMP
Control Centre		Footprint partially within ACHS due to 'high plains' regulation. Part of footprint previously surveyed with no heritage identified.	Yes - undertake CHMP

Social

Option	3.1 Impact on visual amenity		
	Rating	Comments	
Tirol		Visible from a number of vantage points and access roads. Significant 'presence'.	Partial - minimise through landscape treatment / design
Koflers		Visible from a some vantage points and access roads	
Control Centre		Visible from a some vantage points and access roads. Any excess fill can potentially assist with landscaping.	
	3.2 Public Safety & associated controls		
	Rating	Comments	
Tirol		Located near thoroughfare, can restrict public access but limited ability to monitor, fencing potentially a safety issue due to skier traffic near Summit Road	
Koflers		Located near thoroughfare, can restrict public access but limited ability to monitor.	
Control Centre		Located near thoroughfare, can restrict public access. Can be monitored more closely from control centre building	

Economic

Option	4.1 (a) Dam construction cost - Availability of embankment construction material		
	Rating	Comments	
Tirol		Known to be available but to limited depth (encounter XW granite at depth). Earthen embankment or combination rock / earthen likely to be required.	
Koflers		Bedrock at surface level however depth is unknown. No geotech info available.	
Control Centre		Material available but will be an earthen embankment. Additional geotech info required in order to complete design.	
	4.1 (b) Dam construction cost - Ripping and blasting required for rock cut		
	Rating	Comments	
Tirol		Moderate amount of ripping and blasting expected	
Koflers		Significant deep cut required (and therefore significant ripping and blasting likely to be required)	No - dam design dictates significant depth 30m+
Control Centre		Limited amount of ripping and blasting expected. Based on preliminary geotech - boulders / floaters expected but cannot be defined at this stage	
	4.1 (c) Dam construction cost - Minimise earthworks volume and handling		
	Rating	Comments	
Tirol		Cut 71,000 m3 and fill 73,000 m3 modelled (14/11/13). Some double handling of material expected including rock crushing.	
Koflers		Cut 93,000 m3 and fill 40,000 m3 modelled (4/10/13)	No - dam design dictates significant depth
Control Centre		Cut 73,000 m3 and fill 50,000 m3 modelled (13/11/13). Some double handling of material expected for moisture conditioning.	
	4.2 Ancillary infrastructure (pipelines, power, road) construction cost		
	Rating	Comments	
Tirol		Road relocation required, gas pipeline relocation likely, other services to be relocated	
Koflers		New and duplicated services required, greater distances increase capital cost (estim 2 x Tirol), access road upgrade	No - distance is determined by location
Control Centre		Road relocation required, other services including sewer, water and comms to be relocated. Marginal increase in pipeline distances when compared with Tirol	No - distance is determined by location
	4.3 Construction program duration		
	Rating	Comments	
Tirol		Can be constructed in a single summer	
Koflers		Can be constructed in a single summer	
Control Centre		Can be constructed in a single summer	
	4.4 (a) Quantity of material to be imported or exported		
	Rating	Comments	
Tirol		Current storage design balances cut / fill with a high level of confidence	
Koflers		Current storage design balances cut / fill, however geotech conditions unknown, no ability to alter footprint.	
Control Centre		Current storage design balances cut / fill however geotech conditions highly variable. Site footprint provides some flexibility to assist with balance. Some import of sand or stabilising material likely to be required.	
	4.4 (b) Excess material can be reused on site in landscaping		
	Rating	Comments	
Tirol		A number of options available to utilise excess material on uphill side of storage. No reuse possible on toe of storage	
Koflers		Footprint and slope constraints - no capacity to utilise excess material in landscaping	No - dam design / site constraints
Control Centre		A number of options available to utilise excess material around dam site.	
	4.5 Ability to integrate storage, simplify & rationalise long term, reduce operating / management costs		
	Rating	Comments	
Tirol		Preliminary assessment indicates integration and longer term efficiencies possible. Requires further evaluation and decisions on system preferences.	
Koflers		Relative remoteness makes integration, rationalisation more difficult.	
Control Centre		Preliminary assessment indicates integration and longer term efficiencies possible. Requires further evaluation and decisions on system preferences. Potentially offers greater operational efficiencies than Tirol.	

		4.6 Ability to integrate storage / water supply into existing snowmaking infrastructure	
	Rating	Comments	
Tirol		Preliminary assessment indicates integration and longer term efficiencies possible. Requires further evaluation and decisions on system preferences.	
Koflers		More difficult to integrate because of location, potential duplication of pipelines	
Control Centre		Preliminary assessment indicates integration and longer term efficiencies possible. Requires further evaluation and decisions on system preferences.	
		4.7 Operating cost (energy use / pumping duty)	
	Rating	Comments	
Tirol		Closer proximity to pumping / treatment plant, gravity feed to village	
Koflers		Greater distances to convey water, possibly larger diameter pipes / pump capacity required	No - dam distance from supply is fixed
Control Centre		Greater distances to convey water, however gravity feed option to village with greater pressure	

Ski Resort Utility

Option		5.1 Impact to existing skiable terrain, connectivity and Resort functionality	
	Rating	Comments	
Tirol		Dam site footprint partially within mapped skiable terrain. Includes an existing ski run important for connectivity and functionality (particularly for beginners).	Partial - through dam footprint & new ski run alignment
Koflers		Dam site footprint occurs wholly within mapped skiable terrain (excluding tree patches). However terrain not generally utilised - minimal impact	
Control Centre		Dam site footprint wholly within mapped skiable terrain, but not a high use area / thoroughfare, potential connectivity issues along Summit Road and Howqua lift can be managed including via landscaping	
		5.2 Impact to existing ski infrastructure	
	Rating	Comments	
Tirol		Requirement to relocate (shorten) the Tirol T-Bar unload station in order to avoid conflicts with embankment. Relocation of existing run to the north of the storage required	
Koflers		No impact identified	
Control Centre		Will require decommissioning of Boggy Ck T-Bar. Note that this is planned for in the Resort Master Plan	No - impact not reduced but decommissioing has been previously proposed / planned
		5.3 Impact to existing snow making areas	
	Rating	Comments	
Tirol		Current dam footprint avoids snowmaking areas	
Koflers		Current dam footprint avoids snowmaking areas	
Control Centre		Current dam footprint avoids snowmaking areas (small area potentially impacted)	
		5.4 Impact to future snow making areas	
	Rating	Comments	
Tirol		Current dam footprint includes a proposed snowmaking area	
Koflers		Current dam footprint avoids proposed snowmaking areas	
Control Centre		Current dam footprint avoids proposed snowmaking areas	
		5.5 Impact to Master Plan and proposed future recreational areas	
	Rating	Comments	
Tirol		Master Plan identifies a proposed sporting oval - impacted by proposed dam footprint.	Possible - relocate proposed sports oval to Burnt Hut site?
Koflers		No impact on proposed future recreational areas in the Master Plan	
Control Centre		No impact on proposed future recreational areas in the Master Plan. Triggers removal of Boggy Creek T-Bar which is consistent with Master Plan.	

Technical & Engineering

Option		6.1 Capacity to adjust dimensions of the footprint during detailed design and construction	
	Rating	Comments	
Tirol		Site constrained. Current footprint determined via negotiation with BSL. Limited potential to adjust dimensions or to investigate earthfill if rock fill availability is a problem.	
Koflers		Site heavily constrained. Rock fill embankment only (no room for earthfill due to steepening natural slope to north)	No - dam footprint limited flexibility
Control Centre		Site constrained. Some potential to adjust dimensions, but limited by significant environmental constraints/values down slope.	
		6.2 (a) Geotechnical suitability	
	Rating	Comments	
Tirol		Existing investigations indicate site is suitable. Some parts of footprint and specific areas require further investigation. Geotechnical risk considered to be medium.	Yes - geotech investigations to understand risk / implement measures
Koflers		No geotechnical information currently available other than limited surface assessment. Assumed to be suitable. Geotechnical risk considered to be medium.	Yes - geotech investigations to understand risk / implement measures
Control Centre		Existing investigations indicate material is suitable but highly variable. Slope stability risk is considered high to very high based upon field observation of former large adjoining landslides. Additional detailed investigations of site, adjoining landslides and groundwater required to determine whether site is appropriate or has a level of risk acceptable for the storage. Groundwater control measures required.	Yes - geotech investigations to understand risk / implement measures
		6.2 (b) Geotechnical risk to achieving 100 ML storage volume (based on current info)	
	Rating	Comments	
Tirol		High level of confidence of achieving 100 ML volume , but footprint potentially constrained by Resort activities	
Koflers		Potential for 100 ML volume to be compromised - no geotech info and no site flexibility to adjust design based on future geotech info	Yes - detailed geotech investigation to understand / reduce risks
Control Centre		High level of confidence of achieving 100 ML volume but significant footprint constraints associated with native vegetation	
		6.3 Dam Break Consequence category	
	Rating	Comments	
Tirol		Potential for localised impacts on the built environment, life or property. Significant to High (C) consequence category likely	
Koflers		Potential for localised impacts on the built environment, life or property. Significant to High (C) consequence category likely	
Control Centre		Potential for localised impacts on the built environment, life or property. Significant to High (C) consequence category likely	

Construction Considerations

Option		7.1 Dust impacts to Burnt Hut water storage quality during construction	
	Rating	Comments	
Tirol		Footprint close to Burnt Hut - dust impacts likely	Yes - cover storage, additional treatment/monitoring
Koflers		Footprint further from Burnt Hut - minimal dust impacts expected	
Control Centre		Footprint further from Burnt Hut - minimal dust impacts expected	
		7.2 Impacts to continuity of existing water supply	
	Rating	Comments	
Tirol		Periodic impacts during construction which can be managed	
Koflers		Periodic impacts during construction which can be managed	
Control Centre		Periodic impacts during construction which can be managed	
		7.3 Relocation of services, construction of new services	
	Rating	Comments	
Tirol		Relocation of existing services required (gas, sewer, water, snowmaking) primarily within previously disturbed areas	
Koflers		New services to be constructed, some within undisturbed areas	
Control Centre		Relocation of sewer, minor comms and water. New services to be constructed, some within undisturbed areas	

Operational Considerations

Option		8.1 Discharge location / treatment	
	Rating	Comments	
Tirol		Less sensitive receiving environment - still some potential to impact alpine bog	Yes - through design and operation
Koflers		Potential discharge to Mountain Pygmy Possum habitat	No (difficult)- determined by location
Control Centre		Potential discharge to alpine bog EVC's	Yes - through design and operation
		8.2 Ease of site access throughout the year	
	Rating	Comments	
Tirol		Site easily accessible throughout the year	
Koflers		Upgrade of access road required. Pump station below dam may be difficult to access	Partial - upgrade of access road
Control Centre		Site generally accessible. Upgrade and deviation of main access road required.	

Bushfire Management

		9.1 Water supply to Resort can be maintained during power failure	
	Rating	Comments	
Tirol		Need to review / confirm supply options & redundancy. Gravity feed possible	
Koflers		Gravity feed not possible	
Control Centre		Need to review / confirm supply options & redundancy. Gravity feed possible	
		9.2 Storage and associated infrastructure is defendable, location in the landscape minimises risk	
	Rating	Comments	
Tirol		Bushfire risk to infrastructure considered to be medium due to adjoining vegetation fuel load/structure	
Koflers		Bushfire risk to infrastructure considered to be high due to adjoining vegetation fuel load/structure	
Control Centre		Bushfire risk to infrastructure considered to be medium due to adjoining vegetation fuel load/structure	

SUMMARY (17/12/13)

Aspect	Ref No.	Criteria	Key Project Driver or Criteria?	Tirol	Koflers	Control Centre
Land Use Planning	1	Complexity of planning and environmental approvals				
Environment & Heritage	2.1	Impact to native vegetation				
	2.2	Impact to EPBC listed communities or species				
	2.3	Impact to FFG listed communities or species				
	2.4	Proximity to Mountain Pygmy Possum habitat				
	2.5	Impact to water quality and / or hydrology				
	2.6	Protect water supply catchment area (Delatite catchment)				
	2.7	Potential for Aboriginal cultural heritage impacts				
Social	3.1	Impact on visual amenity				
	3.2	Public safety & associated controls				
Economic	4.1 (a)	Dam Construction Cost - embankment material availability				
	4.1 (b)	Dam Construction Cost - ripping and blasting required for rock cut				
	4.1 (c)	Dam Construction Cost - minimise earthworks volume				
	4.2	Ancillary Infrastructure Construction Cost				
	4.3	Construction program duration				
	4.4 (b)	Quantity of material to be imported or exported				
	4.4 (a)	Excess material can be reused on site in landscaping				
	4.5	Ability to integrate storage, simplify & rationalise long term, reduce operating / management costs				
	4.6	Ability to integrate storage / water supply into existing snowmaking infrastructure				
	4.7	Operating cost (energy use) (operating head)				
Ski Resort Utility	5.1	Impact to existing skiable terrain, connectivity and Resort functionality				
	5.2	Impact to existing ski infrastructure				
	5.3	Impact to existing snow making areas				
	5.4	Impact to future snow making areas				
	5.5	Impact to Masterplan and proposed future recreational areas				
Technical / Engineering	6.1	Capacity to adjust dimensions of the footprint during detailed design and construction				
	6.2 (a)	Geotechnical suitability				
	6.2 (b)	Geotechnical risk to achieveing 100 ML storage volume				
	6.3	Dam Break Consequence Category				
Construction Considerations	7.1	Dust impacts to Burnt Hut water storage quality during construction				
	7.2	Impacts to continuity of existing water supply				
	7.3	Relocation of services, construction of new services				
Operational Considerations	8.1	Discharge location / treatment				
	8.2	Ease of site access throughout the year				
Bushfire Considerations	9.1	Water supply to Resort can be maintained during power failure				
	9.2	Storage and associated infrastructure is defendable, location in the landscape minimises risk				

Appendix B - Stage 1 and 2 Preliminary Flora and Fauna assessment

Mt Buller and Mt Stirling Alpine Resort Management Board

Mt Buller Sustainable Water Security Project - Off Stream Storage

Preliminary Flora and Fauna Review of Tirol, Koflers and Control Centre Options

July 2014

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Appendices

1. Introduction

1.1 Project background

The Mt Buller and Mt Stirling Alpine Resort Management Board (RMB) propose to construct a 100 ML water storage facility at Mt Buller, which would be used to supply water for potable uses and snowmaking. GHD has been engaged to undertake concept design for the water storage facility and ancillary infrastructure and develop an options assessment (GHD 2014), which is designed to review three potential locations for the facility: Tirol, Koflers and Control Centre.

Information within this preliminary flora and fauna report contributed to a Multi Criteria Assessment (MCA) and the development of the overall options assessment, which included an assessment of all aspects of the proposed Project (e.g. social, economic, environmental) as they pertained to each of the site options (GHD 2014).

1.2 Scope of work

As part of the concept design process, a comparison of potential ecological impacts of the three potential water storage facility locations was undertaken by GHD. This comparison was done in two stages.

Stage 1 incorporated an initial review to compare known and potential ecological values at the three site options, with respect to native vegetation and significant species. The options assessment for this initial comparison was based on *preliminary* project footprints for each site and did not include impacts associated with ancillary infrastructure or material stockpile areas for construction[1]. The assessment incorporated information gained during site assessments and a review of available databases and a number of previous reports, some of which have reported on assessments of earlier iterations of the Tirol and Control Centre options (note: Control Centre was formerly known as Boggy Creek). No detailed site investigations had been previously undertaken for the Koflers option.

Following the Stage 1 assessment, the Koflers option was dismissed and no longer considered for reasons outlined in the Options Assessment Report (GHD 2014), but in part due to its close proximity to known habitat for Mountain Pygmy-possum, which is listed under the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*.

Stage 2 incorporated a review of known and potential ecological values at the Tirol and Control Centre site options, which were refined to include ancillary infrastructure such as a pump station, storage tank and pipelines, as well as material stockpile areas[2]. These refined construction footprints were subsequently used to calculate potential ecological impacts for both options.

1.3 Study area

This report compares three sites for the initial Stage 1 assessment, Tirol, Koflers and Control Centre), and two sites for the more detailed Stage 2 assessment, Tirol and Control Centre (refer Appendix A).

The study area is located at Mt Buller, Victoria, approximately 150 km north-east of Melbourne. Mt Buller is in the Victorian Alps, which are well known for their ecological significance. Their climate and topography give rise to unique alpine and sub-alpine habitats that support a range

[1] The reasons for this approach are outlined in the Options Assessment Report (GHD 2014).

[2] *Id.*

of threatened species and communities, including many endemic forms (i.e, communities, species or sub-species that occur only on the highest peaks).

The study area occurs within the Victorian Alps Bioregion (VAlp) and the Goulburn Broken Catchment Management Authority (CMA) area. The Alpine Resorts Planning Scheme (administered by the Department of Transport, Planning and Local Infrastructure (DTPLI)) provides land use and development controls for the Mt Buller Resort.

2. Methods

This assessment informed the MCA for the Project (GHD 2014), which included objectives and criteria to assess the following key ecological aspects, which are the focus of this assessment:

- Native vegetation extent
- Listed ecological communities
- Listed flora and fauna species

2.1 Desktop review

A desktop review of available databases and reports was undertaken to assist in comparing the three options. The desktop review was limited to the following databases and reports:

- Victorian Biodiversity Atlas (VBA), 2013, using a 10 km radius search area centred on the site options (Victorian Biodiversity Interactive Map database, DEPI 2013)[3].
- Flora Information System (FIS), 2013, using a 10 km radius search area.
- Atlas of Victorian Wildlife (AVW), 2013, using a 10 km radius search area.
- Commonwealth EPBC Act Protected Matters Search Tool (PMST), 2013[4], using a 10 km radius search area, centred on the site options.
- Biodiversity Interactive Map – 3.2[5] (*Strategic Biodiversity Score* layer, *Native Vegetation Site Condition* layer, *Native Vegetation Location Risk* layer)
- Brief surveys of the herpetofauna of the Mt Buller – Mt Stirling alpine area, with an annotated list of species known from the area (Clemann 2008).
- Habitat mapping for the Mountain Pygmy-possum *Burramys parvus* at Mount Buller, Victoria (Biosis Research 2006).
- Targeted survey for Alpine Marsh-marigold *Caltha introloba*[6] and associated species from *Caltha introloba* Herbland Community, Mount Buller and Mount Stirling Alpine Resorts, Victoria (Biosis Research 2007).
- Mt Buller Water Storage Feasibility Study - Flora and Fauna Assessment Report (AECOM 2009).
- Flora, terrestrial fauna and net gain assessment of the proposed Water Storage Facility, Mount Buller, Victoria (Biosis Research 2009).
- Comparison of the proposed Tirol Flat and Boggy Creek Water Storage Facilities, Mt Buller Alpine Resort (Biosis Research, 23 September, 2011a).
- Comparison of the proposed Tirol Flat and Boggy Creek Water Storage Facilities, Mt Buller Alpine Resort (Biosis Research, 5 September, 2011b).
- Flora, fauna and net gain assessment of proposed Water Storage Facility, Tirol Flat, Mount Buller, Victoria (Biosis Research 2011c).
- Desktop flora and fauna assessment of proposed water storage facility, Boggy Creek, Mt Buller, Victoria (Biosis Research 2011d).

[3] http://mapshare2.dse.vic.gov.au

[4] http://www.environment.gov.au/epbc/pmst/

[5] http://mapshare2.dse.vic.gov.au/MapShare2EXT/imf.jsp?site=bim

[6] Note: *Caltha introloba* is now known as *Psychrophila introloba*; however, the name of the listed community remains the same.

- Mount Buller Ski Field: Vegetation Management Plan – Part 1: Management Plan (Biosis 2013).
- Mapping of 'previously disturbed ground' (provided by Buller Ski Lifts BSL)).

No site-specific reports associated with the Koflers option were available for review.

It should be noted that the mapping of 'previously disturbed ground' (provided by BSL) does not correlate with mapping of 'degraded treeless vegetation' undertaken by Biosis (2013), although the mapping does overlap to a degree. It is our understanding that the previously disturbed ground mapping does not necessarily relate to vegetation cover; instead, it is simply a mapping layer that depicts parts of the Mt Buller landscape where the ground has been physically disturbed, whether permanently (e.g. roads, buildings) or temporarily (e.g. pipelines). Conversely, the degraded treeless vegetation mapping identifies parts of the landscape that have been disturbed, some of which may still support native vegetation, but in a highly modified state. Areas mapped as previously disturbed ground may now support patches of native vegetation, while some areas mapped as degraded treeless vegetation have the potential to recover over time to the point where they support patches of native vegetation.

2.2 Site assessment

In addition to the desktop review, two site assessments were undertaken to inform the options assessment.

First, a brief site assessment of the Tirol and Koflers options was undertaken by Dr Tim Wills (Principal Botanist) on 30 September 2013. The site assessment involved spending 1.5 hours walking over each of the two sites and making observations regarding the extent of native vegetation, accuracy of existing vegetation mapping (Biosis 2013), presence of communities or species listed under the EPBC Act or FFG Act, extent of disturbed areas, presence of waterways, and presence of potential habitat for the Mountain Pygmy-possum (*Burramys parvus*).

Second, a detailed site assessment of the Tirol and Control Centre options was undertaken by Tim Wills and Dr Richard Retallick (Senior Zoologist) on 2-6 December 2013. The site assessment involved walking across the entire investigation area, making observations regarding the extent and condition of native vegetation and fauna habitat, mapping the presence of communities and species listed under the EPBC Act or FFG Act, and noting the extent of disturbed areas and the presence of potential habitat for rare or threatened flora and fauna species. In addition, the threatened alpine bog community downslope (to the north) of the investigation area was visited to gain an appreciation of indirect impacts that may result from changes to the groundwater regime and how this may affect the functioning of the sensitive bog community.

Although the vegetation of the study area was mapped by GHD during the second site assessment, the mapping was not completed until a third visit in April 2014. Therefore, GHD has used the Biosis (2013) mapping for the purpose of comparing between the various site options.

2.3 Limitations

2.3.1 Survey timing

The flora and fauna assessment was undertaken in early summer, which is considered a suitable time of year for conducting flora and fauna surveys in alpine areas. Additional flora species may have been recorded if the survey was undertaken in mid-summer when more ephemeral species are flowering and identifiable. The assessment is also supplemented by the database searches and a review of previous ecological reports undertaken at Mt Buller.

2.3.2 Use of databases

Using the VBA, FIS and AVW databases, defined geographical areas can be searched to produce species lists of flora and fauna that have been documented within the searched area. These databases are only as accurate as the quality and quantity of data that have been recorded and documented from the area. The use of these databases in a desktop assessment has the following limitations:

- Observations were last updated in 2013;
- The datasets are not exhaustive. In other words, many locations locally and across Victoria have a low level of documented survey effort for one or more groups of flora and fauna. During field surveys, it is not uncommon to find species at locations for which there are few or no previous database records.

2.3.3 Hydrological modelling

This review was done prior to hydrological and hydrogeological modelling being undertaken as part of the Project. Consequently, a quantitative comparative analysis of potential indirect impacts on *Alpine Sphagnum Bogs and Associated Fens* (listed as endangered under the EPBC Act) and *Alpine Bog Community* (listed as threatened under the FFG Act) for each option was not undertaken at the options assessment stage. Therefore, the potential impacts outlined in this report are only qualitative in nature.

2.3.4 Aquatic ecology

This review does not include an assessment of aquatic ecology values within or downstream of the study area.

3. Results – Stage 1 Ecological impacts (three options)

The options assessment presented here is based on preliminary project footprints only, and does not include ancillary infrastructure such as pump station, storage tank, pipelines or material stockpile areas required for construction.

3.1 Native vegetation

3.1.1 Ecological Vegetation Classes

Detailed mapping of Ecological Vegetation Classes (EVCs) (Figure 2) undertaken by Biosis (2013) and provided to GHD by Buller Ski Lifts (BSL) indicates that:

- Tirol and Control Centre both support Alpine Grassy Heathland (EVC 1004) (rare in the Victorian Alps bioregion) (Plates 1 and 2) and Degraded Treeless Vegetation[7].
- Koflers supports Alpine Grassy Heathland (EVC 1004) (rare) (Plate 3), Sub-alpine Shrubland (EVC 42) (rare), Sub-alpine Woodland (EVC 43) (least concern) and Degraded Treeless Vegetation.

The site inspections indicated that the existing EVC mapping is reliable and suitable to be used for this options assessment. However, one previously unmapped small patch (*c.* 80 m^2) of Alpine Coniferous Shrubland (EVC 156) (vulnerable) was recorded at the south-west edge of the Koflers site (GHD site visit, September 2013).

Table 1 provides details of the proposed native vegetation impacts at the three sites. In summary, the proposed impact on native vegetation at Koflers (2.16 ha) is slightly less than at Control Centre (2.35 ha) and at Tirol (2.52 ha). However, while Tirol and Control Centre have larger proposed footprints, the area of previously disturbed ground (information provided by BSL) at Tirol (34% of site) and Control Centre (21% of site) is considerably greater than at Koflers (1% of site) (Figure 3).

3.1.2 Native Vegetation Site Condition

According to the Native Vegetation Site Condition layer on the Biodiversity Interactive Maps, native vegetation condition is generally higher at Tirol and Koflers (both 0.61-1.00) than Control Centre (0.41-0.80). However, the degree of resolution is very coarse and should be interpreted with caution.

3.1.3 Strategic Biodiversity Score

According to the Strategic Biodiversity Score layer on the Biodiversity Interactive Maps, all sites are equal, with a score of 0.81-1.00.

[7] Degraded Treeless Vegetation in this instance most likely corresponds to vegetation that is not classified as a patch of native vegetation, i.e. the cover of native understorey species comprises less than 25% of the overall understorey vegetative cover. However, there is a possibility that Degraded Treeless Vegetation (as mapped by Biosis 2013) could support native species that occupy more than 25% of the understorey cover, albeit in a highly modified state. Furthermore, the term 'Degraded Treeless Vegetation' is now redundant in a regulatory context,

Table 1 Impacts on native vegetation

	Tirol	Koflers	Control Centre
Total area of disturbance incorporating native vegetation extent and area of previously disturbed ground (preliminary project footprint)	• 2.89 ha	• 2.17 ha	• 2.92 ha
Native vegetation extent	• 2.52 ha (native vegetation) • 0.37 ha (degraded treeless vegetation)	• 2.16 ha (native vegetation) • 0.01 ha (degraded treeless vegetation)	• 2.35 ha (native vegetation) • 0.57 ha (degraded treeless vegetation)
EVCs present	• Alpine Grassy Heathland (EVC 1004) (2.52 ha) – Rare	• Sub-alpine Shrubland (EVC 42) (1.23 ha) – Rare • Alpine Grassy Heathland (EVC 1004) (0.63 ha) – Rare • Sub-alpine Woodland (EVC 43) (0.29 ha) – Least Concern • Alpine Coniferous Shrubland (EVC 156) (0.01 ha) – Vulnerable	• Alpine Grassy Heathland (EVC 1004) (2.35 ha) – Rare
Area of previously disturbed ground (BSL mapping)	• 0.97 ha (34% of site)	• 0.02 ha (1% of site)	• 0.62 ha (21% of site)
Native Vegetation Site Condition	• 0.61-1.00	• 0.61-1.00	• 0.41-0.80
Strategic Biodiversity Score	• 0.81-1.00	• 0.81-1.00	• 0.81-1.00

Plate 1: Tirol site location, near Tirol lift, looking west toward Mt Buller.

Plate 2: Koflers site location, near Koflers Restaurant, looking south.

Plate 3: Control Centre site location, looking east toward the top of the ABOM Express chairlift.

3.1.4 Significant vegetation and/or communities

Based on previous reports (Biosis Research 2011a,b,c), Tirol supported two listed threatened communities within a small area (0.024 ha) of Sub-alpine Wet Heathland (EVC 210):

- *Alpine Sphagnum Bogs and Associated Fens* (listed as endangered under the EPBC Act)
- *Alpine Bog Community* (listed as threatened under the FFG Act)

These two communities are synonymous with each other.

However, since the Biosis Research reports were prepared, the proposed project footprint at Tirol has been revised to avoid direct impact on these communities. These communities are located immediately west of the currently proposed footprint of the Tirol storage.

Nevertheless, significant areas of the listed alpine bog communities occur immediately downslope of the Control Centre, and to a lesser extent, Tirol option (Table 2). While not directly impacted, these sensitive communities are considered likely to be indirectly impacted via altered hydrological regimes.

In addition, a small area of *Caltha introloba* Herbland Community (listed under the FFG Act) occurs approximately 100 m east of the Koflers site (Biosis Research 2007). This community would not be impacted by this option.

Table 2 Impacts on threatened communities

	Tirol	Koflers	Control Centre
EPBC-listed Community			
Alpine Sphagnum Bogs and Associated Fens	No direct impact Small area (<1 ha) downslope potential indirect impact	No direct impact Negligible downslope potential indirect impact	No direct impact Moderate area (>1 ha) downslope potential indirect impact
FFG-listed Community			
Alpine Bog Community	No direct impact Small area (<1 ha) downslope potential indirect impact	No direct impact Negligible downslope potential indirect impact	No direct impact Moderate area (>1 ha) downslope potential indirect impact
Caltha introloba Herbland Community[8]	No direct impact	No direct impact	No direct impact

3.2 Significant species

The likelihood of occurrence for flora and fauna species was based on the findings of the desktop and field assessments, and mapping by DEPI (Figures 4 and 5). Results are presented in Table 3. It should be noted that these results are based on the information available and that Koflers has been subjected to substantially less survey effort than Tirol and Control Centre.

A total of 71 native terrestrial flora species and 27 terrestrial fauna species of conservation significance[9] are documented to occur, predicted to occur or have habitat occurring, within a 10 km radius of the study area (VBA, FIS, AVW and PMST)[10].

Eleven species of native birds are listed as Migratory. The Marine status of fauna species (as defined under the EPBC Act) was not considered because the study site is not in or near a Commonwealth marine area.

Some species were classified as having an unknown likelihood of occurrence for the Koflers site as this site has been less thoroughly surveyed. The higher number of species likely to occur in the threatened fauna categories at the Koflers site is partially representative of the presence of trees but also indicates a conservative approach given the lower level survey completed at this site. Results are presented in Table 3.

[8] Note: *Caltha introloba* is now known as *Psychrophila introloba*; however, the name of the listed community remains the same.

[9] Species of conservation significance are those species listed in a threat category under one or more of the Commonwealth EPBC Act, the Victorian FFG Act, the Advisory List of Rare or Threatened Plants in Victoria (DSE 2005) and/or the Advisory Lists of Threatened Vertebrate Fauna (DSE 2013) and Invertebrate Fauna (DSE 2009) in Victoria

[10] These numbers exclude freshwater aquatic and marine fauna (e.g. marine mammals, fish and aquatic invertebrates). These species are not included in this assessment, because the project considers terrestrial fauna only.

Table 3 Threatened species known or likely to occur in the three site options

	Tirol	Koflers	Control Centre
Flora			
Nationally Significant (EPBC Act)	No species known or likely to occur	No species known or likely to occur	No species known or likely to occur
State Significant (FFG and VRoTs)	7 species known (all rare) (GHD current study, Biosis Research 2011c) • *Aciphylla glacialis* • *Agrostis muelleriana* • *Brachyscome tadgellii* • *Craspedia* sp. 1 • *Gentianella muelleriana* subsp. *willisiana* • *Senecio pinnatifolius* var. *alpinus* • *Trachymene humilis* subsp. *breviscapa* Predicted habitat for another 39 rare or threatened species (based on FIS and VBA searches)	No species known (no detailed survey undertaken) Predicted habitat for up to 46 rare or threatened species (based on FIS and VBA searches)	Six species known (all rare) (GHD current study) • *Aciphylla glacialis* • *Euphrasia lasianthera* • *Olearia phlogopappa* var. *flavescens* • *Ranunculus gunnianus* • *Senecio pinnatifolius* var. *alpinus* • *Trachymene humilis* subsp. *breviscapa* Predicted habitat for another 40 rare or threatened species (based on FIS and VBA searches)
Terrestrial fauna			
Nationally Significant (EPBC Act)	Two species may occur within site: • Spot-tailed Quoll (low likelihood) • Mountain Pygmy-possum (medium likelihood) Neither species recorded in the site historically (Biosis Research 2011c), and no database records of the quoll within 10 km. Pygmy-possum well known to occur in suitable habitat on Mt Buller, and species may disperse through the area that includes this site. Proposed footprint is outside the Mountain Pygmy-possum Revised Management Area (Biosis Research 2006). The footprint is approximately 330 m from nearest Habitat 2[11] area and 500 m from nearest Habitat 1[12] area (Figure 6)	Three species may occur within site: • Spot-tailed Quoll (low likelihood) • Mountain Pygmy-possum (medium likelihood) • Smoky Mouse (low likelihood) None of these species recorded in the site historically, and no database records of the quoll within 10 km. Four records of Smoky Mouse within 10 km, but no records since 1982. Part of the proposed footprint occurs within the Mountain Pygmy-possum Revised Management Area (Biosis Research 2006). The footprint is approximately 44 m from nearest Habitat 2 area and 145 m from nearest Habitat 1 area (Figure 6). In addition, a small patch (80 m^2) of potential habitat (rocky outcrop with *Podocarpus lawrencei*) is present in the south-west corner of the site. This outcrop is the most likely patch of Pygmy-possum habitat across all three options.	Three species may occur within site: • Spot-tailed Quoll (low likelihood) • Mountain Pygmy-possum (medium likelihood) • Smoky Mouse (low likelihood) None of these species recorded in the site historically, and no database records of the quoll within 10 km. Four records of Smoky Mouse within 10 km, but no records since 1982. Proposed footprint is outside the Mountain Pygmy-possum Revised Management Area (Biosis Research 2006), but species may disperse through the area that includes this site. The footprint is approximately 310 m from nearest Habitat 2 area and 356 m from nearest Habitat 1 area (Figure 6)

[11] Note: Habitat 2 areas comprise the preferred habitat of *Burramys*, where the species occurs at relatively low densities (Biosis Research 2006).

[12] Note: Habitat 1 areas comprise the preferred habitat of *Burramys*, where the species breeds and occurs at relatively high densities (Biosis Research 2006).

	Tirol	Koflers	Control Centre
State Significant* (FFG Act and DEPI Advisory list)	Nine species may occur within site: • High likelihood (4) - Broad-toothed Rat, White-throated Needletail, Alpine Bog Skink, Tussock Skink; • Low likelihood (5) - Eastern Pygmy-possum, Latham's Snipe, Eastern Great Egret, Black Falcon, Mountain Skink. Two species (Broad-toothed Rat and Alpine Bog Skink) recorded during Biosis Research assessments (2011c). Alpine Bog Skink also recorded very near site by GHD in December 2013.	Ten species may occur within site: • High likelihood (4) - Broad-toothed Rat, White-throated Needletail, Alpine Bog Skink and Tussock Skink; • Low likelihood (4) - Eastern Pygmy-possum, Latham's Snipe, Eastern Great Egret, Black Falcon. • Unknown likelihood (2) - Mountain Skink, Brown Toadlet. Two species (Broad-toothed Rat and Alpine Bog Skink) recorded in area (but not site) during Biosis Research assessments (2011c). Alpine Bog Skink also recorded approximately 100 m north of site by GHD in December 2013.	Nine species may occur within site: • High likelihood (4) - Broad-toothed Rat, White-throated Needletail, Alpine Bog Skink and Tussock Skink; • Low likelihood (5) - Eastern Pygmy-possum, Latham's Snipe, Eastern Great Egret, Black Falcon, Mountain Skink. Two species (Broad-toothed Rat and Alpine Bog Skink) recorded in area (but not site) during Biosis Research assessments (2011c). Alpine Bog Skink recorded near site by GHD in December 2013.

*Species listed in the State Significant category are in addition to those listed as Nationally Significant as some species are both Nationally and State Significant.

4. Results – Stage 2 Ecological impacts (two options)

The options assessment presented here is based on Tirol and Control Centre footprints that include ancillary infrastructure such as pump station, storage tank and pipelines, as well as material stockpile areas required for construction.

4.1 Native vegetation

4.1.1 Ecological Vegetation Classes

Detailed mapping of Ecological Vegetation Classes (EVCs) (Figure 8) undertaken by Biosis (2013) and provided to GHD by Buller Ski Lifts (BSL) indicates that Tirol and Control Centre both support Alpine Grassy Heathland (EVC 1004) (rare in the Victorian Alps bioregion), Sub-alpine Woodland (EVC 43) (Least Concern) and Sub-alpine Wet Heathland (EVC 210) (Endangered) and Degraded Treeless Vegetation.

The site inspections indicated that the existing EVC mapping is reliable and suitable to be used for this options assessment. Table 4 provides details of the proposed native vegetation impacts at the two sites. In summary, the proposed impact on native vegetation at Tirol (6.47 ha) is marginally less than at Control Centre (6.96 ha). In addition, the area of previously disturbed ground at Tirol (56% of site) is slightly greater than at Control Centre (52% of site) (Figure 9).

Table 4 Impacts on native vegetation

	Tirol	Control Centre
Total area of disturbance incorporating native vegetation extent and area of previously disturbed ground (preliminary construction footprint)	• 10.76 ha	• 11.27 ha
Native vegetation extent	• 6.47 ha (native vegetation) • 4.29 ha (degraded treeless vegetation)	• 6.96 ha (native vegetation) • 4.31 ha (degraded treeless vegetation)
EVCs present	• Alpine Grassy Heathland (intact) (EVC 1004) (5.81 ha) – Rare • Alpine Grassy Heathland (weedy) (0.57 ha) – Rare • Sub-alpine Woodland (EVC 43) (0.07 ha) – Least Concern • Sub-alpine Wet Heathland (EVC 210) (0.02 ha) - Endangered	• Alpine Grassy Heathland (intact) (EVC 1004) (6.14 ha) – Rare • Alpine Grassy Heathland (weedy) (0.73 ha) – Rare • Sub-alpine Woodland (EVC 43) (0.07 ha) – Least Concern • Sub-alpine Wet Heathland (EVC 210) (0.02 ha) - Endangered
Area of previously disturbed ground (BSL mapping)	• 6.01 ha (56% of site)	• 5.84 ha (52% of site)
Native Vegetation Site Condition	• 0.41-1.00	• 0.41-1.00
Strategic Biodiversity Score	• 0.81-1.00	• 0.81-1.00

4.1.2 Native Vegetation Site Condition

According to the Native Vegetation Site Condition layer on the Biodiversity Interactive Maps, both sites are comparable, with a score that varies from 0.41-1.00. However, the degree of resolution is very coarse and should be interpreted with caution.

4.1.3 Strategic Biodiversity Score

According to the Strategic Biodiversity Score layer on the Biodiversity Interactive Maps, both sites are comparable, with a score that varies from 0.81-1.00.

4.1.4 Significant vegetation and/or communities

Although there would be a minor (0.02 ha) direct impact (via the project construction footprint) on Alpine Sphagnum Bogs and Associated Fens (listed as endangered under the EPBC Act) and Alpine Bog Community (listed as threatened under the FFG Act), there is likely to be a potentially greater indirect impact on the listed alpine bog communities immediately downslope of the Control Centre, and to a lesser extent, Tirol (Table 5), via altered hydrological regimes (both surface and groundwater), owing to construction of the dam. At this stage, it is unclear as to how, and to what extent, mitigation measures would be able to maintain the natural flow of water into this sensitive community.

Table 5 Impacts on threatened communities

	Tirol	Control Centre
EPBC-listed Community		
Alpine Sphagnum Bogs and Associated Fens	0.02 ha direct impact **Small** area (<1 ha) downslope potential indirect impact	0.02 ha direct impact **Moderate** area (>1 ha) downslope potential indirect impact
FFG-listed Community		
Alpine Bog Community	0.02 ha direct impact **Small** area (<1 ha) downslope potential indirect impact	0.02 ha direct impact **Moderate** area (>1 ha) downslope potential indirect impact
Caltha introloba Herbland Community	No direct impact	No direct impact

4.2 Significant species

The likelihood of occurrence for flora and fauna species was based on our desktop and field assessment and mapping by DEPI (Figures 4 and 5). Results are presented in Table 6.

A total of 71 native terrestrial flora species and 27 terrestrial fauna species of conservation significance[13] are documented to occur, predicted to occur or have habitat occurring, within a 10 km radius of the study area (VBA, FIS, AVW and PMST)[14].

Eleven species of native birds are listed as Migratory. The Marine status of fauna species (as defined under the EPBC Act) was not considered because the study site is not in or near a Commonwealth marine area.

[13] Species of conservation significance are those listed on one or more those species listed in a threat category under one or more of the Commonwealth EPBC Act, the Victorian FFG Act, the Advisory List of Rare or Threatened Plants in Victoria (DSE 2005) and/or the Advisory Lists of Threatened Vertebrate Fauna (DSE 2013) and Invertebrate Fauna (DSE 2009) in Victoria

[14] These numbers exclude freshwater aquatic and marine fauna (e.g. marine mammals, fish and aquatic invertebrates). These species are not included in this assessment, because the project considers terrestrial fauna only.

Table 6 Threatened species known or likely to occur

	Tirol	Control Centre
Flora		
Nationally Significant (EPBC Act)	No species known or likely to occur	No species known or likely to occur
State Significant (FFG and VRoTs)	13 species known (all rare) (GHD current study, Biosis Research 2011c) • *Aciphylla glacialis* • *Agrostis muelleriana* • *Brachyscome tadgellii* • *Craspedia* sp. 1 • *Euphrasia lasianthera* • *Gentianella muelleriana* subsp. *willisiana* • *Olearia phlogopappa* var. *flavescens* • *Pimelea ligustrina* subsp. *ciliata* • *Ranunculus gunnianus* • *Scleranthus singuliflorus* • *Senecio pectinatus* var. *major* • *Senecio pinnatifolius* var. *alpinus* • *Trachymene humilis* subsp. *breviscapa* Predicted habitat for another 33 rare or threatened species (based on FIS and VBA searches)	12 species known (11 rare, 1 vulnerable) (GHD current study) • *Aciphylla glacialis* • *Cardamine lilacina* • *Craspedia jamesii* • *Euphrasia lasianthera* • *Gentianella muelleriana* subsp. *willisiana* • *Olearia phlogopappa* var. *flavescens* • *Pimelea ligustrina* subsp. *ciliata* • *Ranunculus gunnianus* • *Scleranthus singuliflorus* • *Senecio pectinatus* var. *major* • *Senecio pinnatifolius* var. *alpinus* • *Trachymene humilis* subsp. *breviscapa* Predicted habitat for another 34 rare or threatened species (based on FIS and VBA searches)
Terrestrial fauna		
Nationally Significant (EPBC Act)	Three species may occur within site: • Spot-tailed Quoll (low likelihood) • Mountain Pygmy-possum (medium likelihood) • Smoky Mouse (low likelihood) None of these species recorded in the site historically, and no database records of the quoll within 10 km. Four records of Smoky Mouse within 10 km, but no records since 1982. Pygmy-possum well known to occur in suitable habitat on Mt Buller, and species may disperse through the area that includes this site. Proposed footprint is outside the Mountain Pygmy-possum Revised Management Area (Biosis Research 2006). The footprint is approximately 176 m from nearest Habitat 2 area and 304 m from nearest Habitat 1 area (Figure 10)	As for Tirol, except for the location of the footprint with respect to the Mountain Pygmy-possum Revised Management Area (Biosis Research 2006). The footprint for this option is approximately 70 m from nearest Habitat 2 area and 221 m from nearest Habitat 1 area (Figure 10)

	Tirol	Control Centre
State Significant* (FFG Act and DEPI Advisory list)	Nine species may occur within site: • High likelihood (4) - Broad-toothed Rat, White-throated Needletail, Alpine Bog Skink, Tussock Skink; • Low likelihood (5) - Eastern Pygmy-possum, Latham's Snipe, Eastern Great Egret, Black Falcon, Mountain Skink. Two species (Broad-toothed Rat and Alpine Bog Skink) recorded during Biosis Research assessments (2011c). Both species also recorded in site by GHD.	Nine species may occur within site: • High likelihood (4) - Broad-toothed Rat, White-throated Needletail, Alpine Bog Skink and Tussock Skink; • Low likelihood (5) - Eastern Pygmy-possum, Latham's Snipe, Eastern Great Egret, Black Falcon, Mountain Skink. Two species (Broad-toothed Rat and Alpine Bog Skink) recorded in area (but not site) during Biosis Research assessments (2011c). Both species recorded in site by GHD.

*Species listed in the State Significant category are in addition to those listed as Nationally Significant as some species are both Nationally and State Significant.

5. Project Risk-based pathway

All applications for a permit to remove native vegetation in Victoria are assigned a level of risk: low, moderate or high. The risk-based pathway assigned determines the process for how an application is assessed (DEPI 2013a; 2013b).

The risk-based pathway is determined by combining the **extent** risk (size of clearing) and the **location** risk (from map maintained by DEPI) of the project area, in accordance with the Guidelines (DEPI 2013a).

Location risk assesses the likelihood that removing a small amount of vegetation at a location could have a significant impact. Location risk mapping is available on the DEPI Biodiversity interactive mapper. Three location risk categories are recognised (DEPI 2013b):

- Location A: where the removal of greater than or equal to 1 hectare of native vegetation at a particular location could have a significant impact on a rare or threatened species habitat.
- Location B: where the removal of greater than or equal to 0.5 hectares but less than 1 hectare of native vegetation at a particular location could have a significant impact on a rare or threatened species habitat.
- Location C: where the removal of less than 0.5 hectares of native vegetation at a particular location could have a significant impact on a rare or threatened species habitat.

Where a site contains areas of different location risk, the higher category is applied to the entire site.

In summary, the Tirol and Control Centre options incorporate areas of Location C for both Stage 1 and 2 footprints, while the Koflers option contains an area of Location B (Figure 11). As the amount of native vegetation required to be removed for each option would involve more than one hectare, all sites would need to be assessed via the 'High' risk pathway, which necessitates the requirement for a site-based Habitat hectare (HabHa) assessment of native vegetation proposed to be removed.

6. Legislation

Table 7 briefly summarises relevant legislation for the project as it applies to all three Stage 1 options. The recommendations for Tirol and Control Centre remain the same when the Stage 2 detailed option comparison is considered. This is not an exhaustive list and other Acts, Regulations, Plans and Strategies may also need to be considered.

Table 7 Summary of Legislation

Legislation	Tirol	Koflers	Control Centre
Environment Protection and Biodiversity Conservation (EPBC) Act 1999 - Ramsar sites	Referral based on Ramsar sites not required. Site more than 100 km from any Ramsar site; no impacts on Ramsar-listed wetlands expected.	As for Tirol	As for Tirol
EPBC Act – Threatened Species and Communities	Species • Referral based on this MNES unlikely to be required Communities • Referral based on this MNES **possibly** required on the basis of potential indirect impact to <1 ha of alpine bog community	Species • Referral based on this MNES **possibly** required on the basis of loss of small area of habitat for Mountain Pygmy-possum. Communities • Referral based on this MNES unlikely to be required	Species • Referral based on this MNES unlikely to be required Communities • Referral based on this MNES **likely** to be required on the basis of potential indirect impact to >1 ha of alpine bog community
EPBC Act – Listed Migratory Species	Referral based on Migratory species unlikely. Site does not provide important habitat for an ecologically significant proportion of any migratory species	As for Tirol	As for Tirol
Flora and Fauna Guarantee Act 1988	Permit would be required to remove protected flora The Project must be undertaken in accordance with Action Statement #2 for Mountain Pygmy-possum (*Burramys parvus*) and the Recovery Plan for this species	As for Tirol	As for Tirol
Environment Effects Act 1978	Referral unlikely to be required for ecological impacts as relevant referral criteria are unlikely to be triggered. Although total area of disturbance is 10.76 ha and 11.27 ha respectively for the Tirol and Control Centre sites, the impact on native vegetation is clearly less than 10 ha (T. Wills, pers. obs.).		
Planning and Environment Act 1987	Would require a planning permit to remove, destroy or lop	As for Tirol	As for Tirol

Legislation	Tirol	Koflers	Control Centre
	native vegetation. Would require loss of native vegetation to be offset in accordance with *Biodiversity Assessment Guidelines*, although some specific offset criteria are likely to be difficult to meet.		
Wildlife Act 1975	Permit likely required for handling of wildlife during construction	As for Tirol	As for Tirol

7. Conclusion

In summary, none of the sites are markedly better or worse from an ecological perspective; however, some differences are evident, as outlined below.

Koflers has the smallest footprint, but is considered to be the least appropriate site with regard to potential impacts on the EPBC Act-listed Mountain Pygmy-possum, owing to presence of suitable habitat within the proposed footprint and the close proximity of the site to mapped known habitat for the species.

Control Centre is considered to be the least appropriate site with regard to potential impacts on the EPBC Act-listed community, *Alpine Sphagnum Bogs and Associated Fens*, owing to the considerable area (>1 ha) of alpine bog community immediately downslope of the proposed dam embankment, and the uncertainty surrounding mitigation measures associated with maintaining appropriate water flow to this community following dam construction.

Tirol is considered a marginally more appropriate site, particularly in regard to its slightly lower extent of native vegetation clearing and its lower risk of causing indirect impacts to the downslope alpine bog community.

All sites (Stage 1 and 2) would need to be assessed via the 'High' risk pathway (for Biodiversity Assessment) as they include areas of Location B and C and the amount of native vegetation required to be removed for each option would involve more than one hectare.

A comparative summary of expected impacts at the site options is as follows:

Stage 1

- Similar extent of total clearing proposed at Tirol and Control Centre (2.89 ha vs 2.93 ha respectively). Less total clearing at Koflers (2.17 ha).
- Higher extent of intact native vegetation at Tirol than at Control Centre (2.52 ha vs 2.35 ha respectively). Less intact native vegetation at Koflers (2.16 ha).
- Larger extents of degraded treeless vegetation at Control Centre (0.57 ha) and Tirol (0.37 ha) than at Koflers (0.01 ha).
- Larger area (and proportional area) of previously disturbed ground at Tirol (0.97 ha vs 0.62 ha at Control Centre and 0.02 ha at Koflers).
- Similar numbers of rare flora species at Tirol (7 known) and Control Centre (6), while the number of rare or threatened flora species at Koflers is unknown[15].
- Presence of a small patch (*c.* 80 m^2) of potential Mountain Pygmy-possum habitat at Koflers (none at Tirol or Control Centre).
- Koflers site considerably closer than other sites to Mountain Pygmy-possum habitat (44 m vs 310 m at Control Centre and 330 m at Tirol).
- Part of Koflers footprint occurs within the Revised Mountain Pygmy-possum Management Area. Neither of the other sites occurs within this Management Area.
- Potential significant downslope impacts (indirect) on EPBC Act and FFG Act-listed alpine bog habitats at Control Centre. Less potential for impact at Tirol and Koflers.

[15] Note: Caution should be exercised when comparing options based on number of rare or threatened species recorded, especially when the Koflers site was not assessed in detail.

Stage 2

- Marginally smaller extent of total clearing proposed at Tirol than at Control Centre (10.76 ha vs 11.27 ha respectively).
- Marginally higher extent of intact native vegetation at Control Centre than at Tirol (6.96 ha vs 6.47 ha respectively).
- Similar extents of degraded treeless vegetation at Control Centre (4.31 ha) and Tirol (4.29 ha).
- Larger area (and proportional area) of previously disturbed ground at Tirol (6.01 ha, 56% of site) than at Control Centre (5.84 ha, 52% of site).
- More rare or threatened flora species identified for Tirol (13 rare) than for Control Centre (11 rare, 1 vulnerable)[16].
- Control Centre temporary stockpiling (Koflers stockpile area) means that the project footprint is considerably closer to Mountain Pygmy-possum habitat than for Tirol (70 m to Type II habitat, vs 176 m for Tirol).
- Potential indirect downslope impacts on EPBC Act and FFG Act-listed alpine bog habitats would be greater at Control Centre compared to Tirol, mainly due to the greater extent of downslope bog habitat immediately below Control Centre.

[16] Note: Caution should be exercised when comparing options based on number of rare or threatened species recorded, especially when the Koflers site was not assessed in detail.

8. References

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Appendices

Appendix A – Figures

Paper Size A3

0 50 100 200 300 400

Metres

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

N

LEGEND

Dam Footprints
Control Centre
Koflers
Tirol
Contours 1m

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

Job Number 31-30733
Revision A
Date 06 May 2014

Site Location - Initial Three Options

Figure 1

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Data Source: DSE: Vicmap - 2013; GHD - 2013. Created by: mjahanshahi

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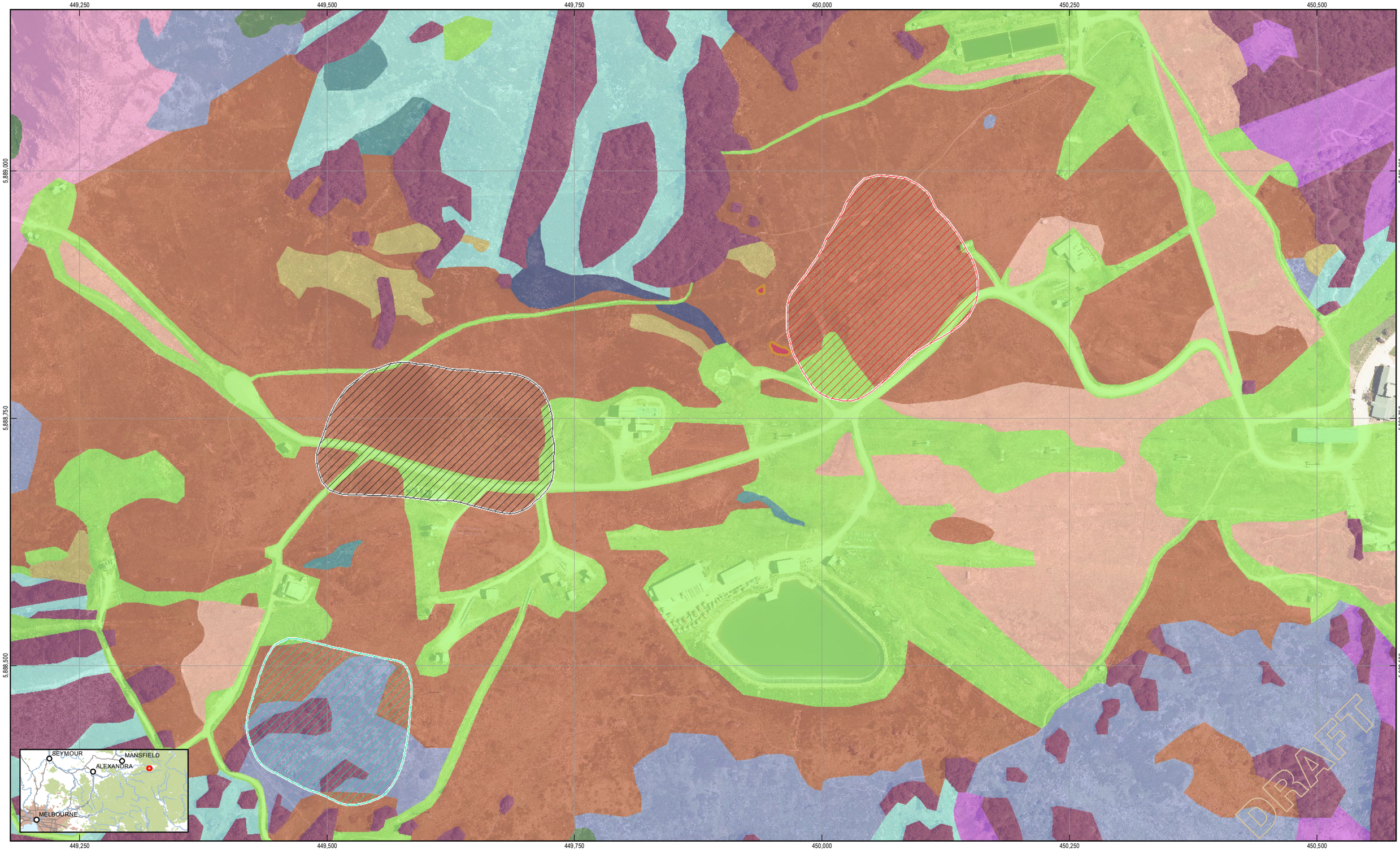

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Metres

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

N

LEGEND

Dam Footprints
- Control Centre
- Koflers
- Tirol
- EVC 210 (Biosis 2011)

Ecological Vegetation Classes
- Alpine Coniferous Shrubland (156)
- Alpine Grassy Heathland (1004)
- Alpine Peaty Heathland (1011)
- Degraded Treeless Vegetation
- Sub Alpine Shrubland (42)
- Sub Alpine Treeless Vegetation (44)
- Sub Alpine Wet Heathland (210)
- Sub Alpine Wet Heathland Sphagnum (210)
- Sub Alpine Woodland (43)
- Treeless Sub Alpine Woodland (43)
- Weedy Alpine Grassy Heathland (1004)
- Weedy Treeless Sub Alpine Woodland (43)

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

Job Number 31-30733
Revision A
Date 06 May 2014

Ecological Vegetation Classes - Initial Three Options

Figure 2

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Paper Size A3

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Metres

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

N

LEGEND

Dam Footprints
Control Centre
Koflers
Tirol
Previously Disturbed Ground

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

Previously Disturbed Ground - Initial Three Options

Job Number 31-30733
Revision A
Date 06 May 2014

Figure 3

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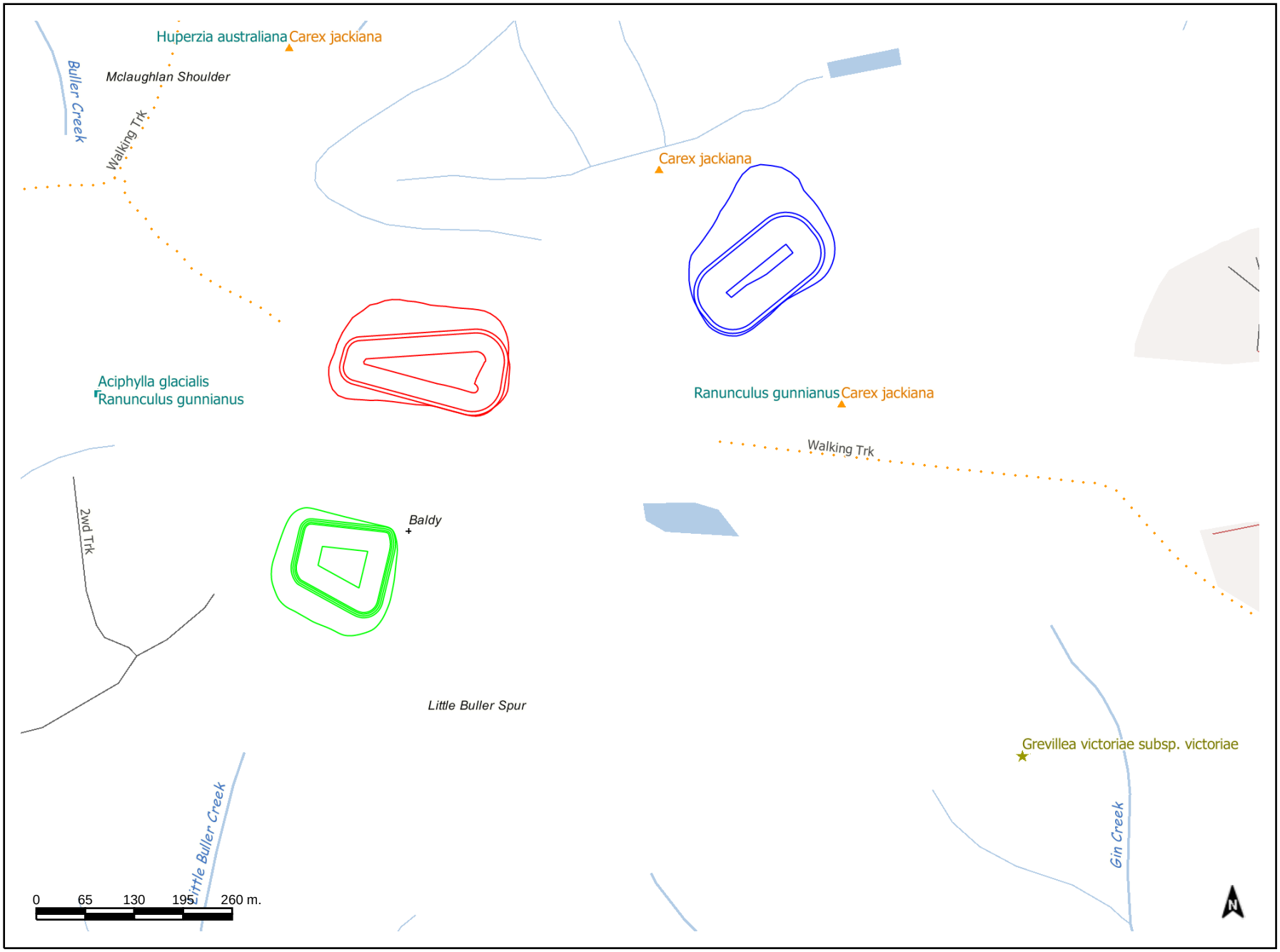
Threatened Flora- Less than 100m



Department of Environment and Primary Industries

Victoria

* Refer to page 2 for legend details

Figure 4

Map Scale 1:7,167

Biodiversity Interactive Map A4 Landscape

Produced on Fri Apr 11 16:41:44 EST 2014

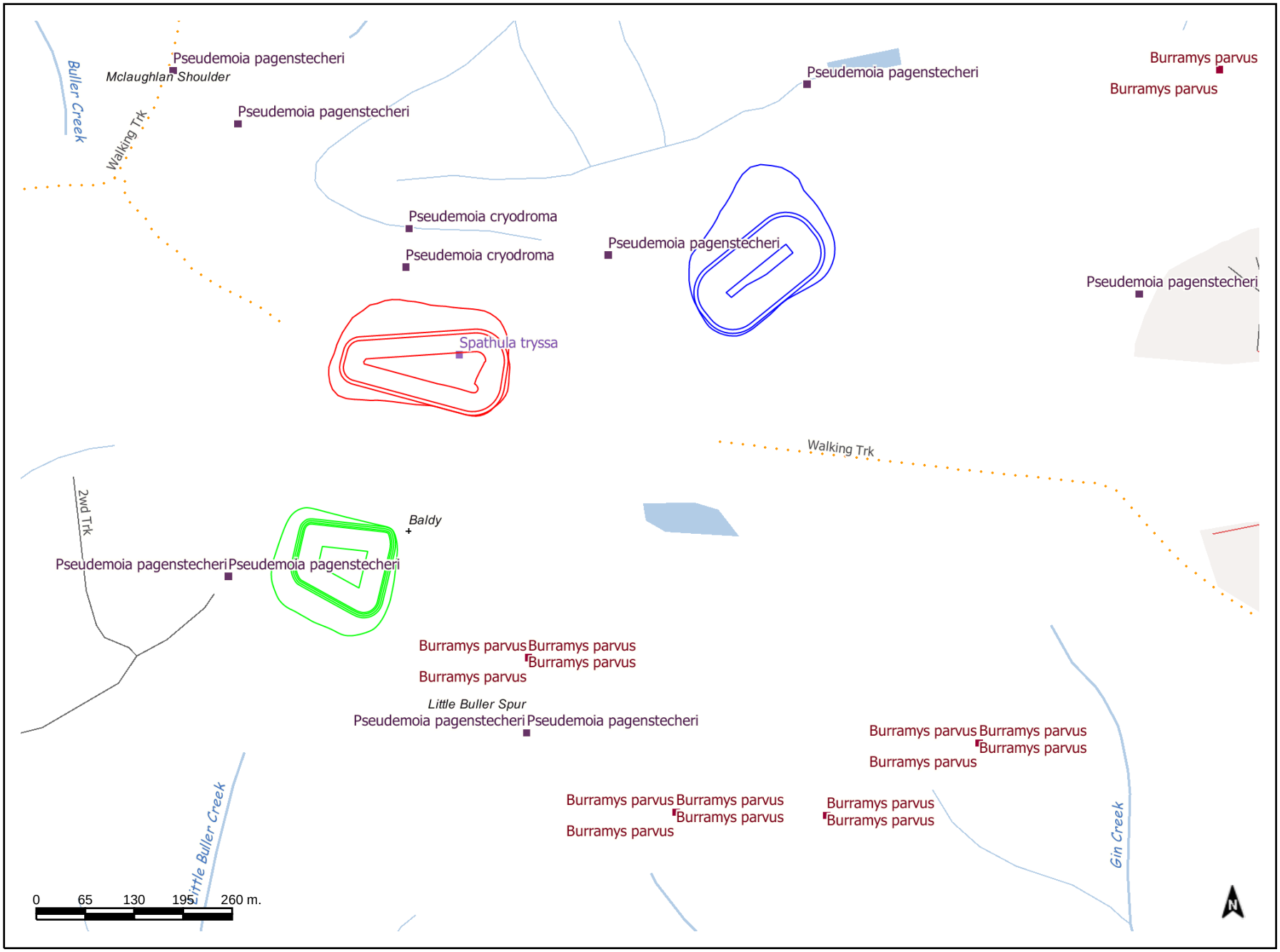
GDA Vicgrid94

Victoria


Threatened Climbers (lt 100m accuracy)
Threatened Epiphytes (lt 100m accuracy)
Threatened Tree Ferns (lt 100m accuracy)
Threatened Ground Ferns (lt 100m accuracy)
Threatened Hummock Grass (lt 100m accuracy)
Threatened Graminoids (lt 100m accuracy)
Large Tufted Graminoid
Medium to Small Tufted Graminoid
Tiny Tufted Graminoid
Large Non-Tufted Graminoid
Medium to Tiny Non-Tufted Graminoid
Threatened Herbs (lt 100m accuracy)
Large Herb
Medium Herb
Small or Prostrate Herb
Threatened Shrubs (lt 100m accuracy)
Medium Shrub
Small Shrub
Prostrate Shrub
Threatened Understorey Trees (lt 100m accuracy)
Threatened Mallee Trees (lt 100m accuracy)
Threatened Palms (lt 100m accuracy)
ROADS

Freeway
Highway
Main Road
Secondary Road
Local Road
2WD (Unsealed)
4WD Only
Walking or Cycle Track
WATERCOURSES
UNNAMED DRAINAGE LINES
WATERBODIES
Watercourse Area
Permanent Waterbody
Wetland Area
Inundation Area
BUILT UP AREAS

Threatened fauna- less than 100 metres



* Refer to page 2 for legend details

Figure 5

Map Scale 1:7,167

Biodiversity Interactive Map A4 Landscape

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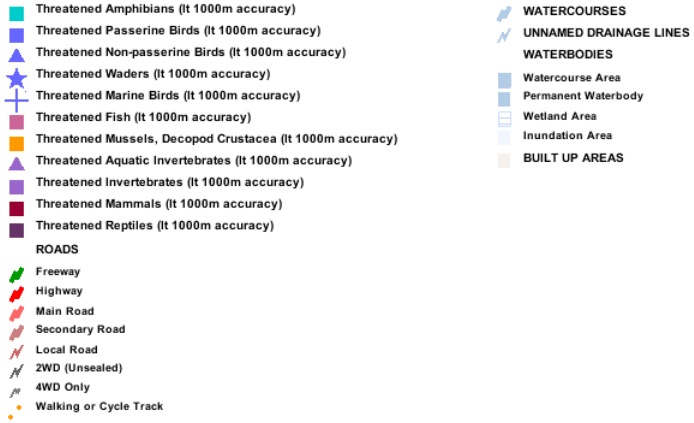
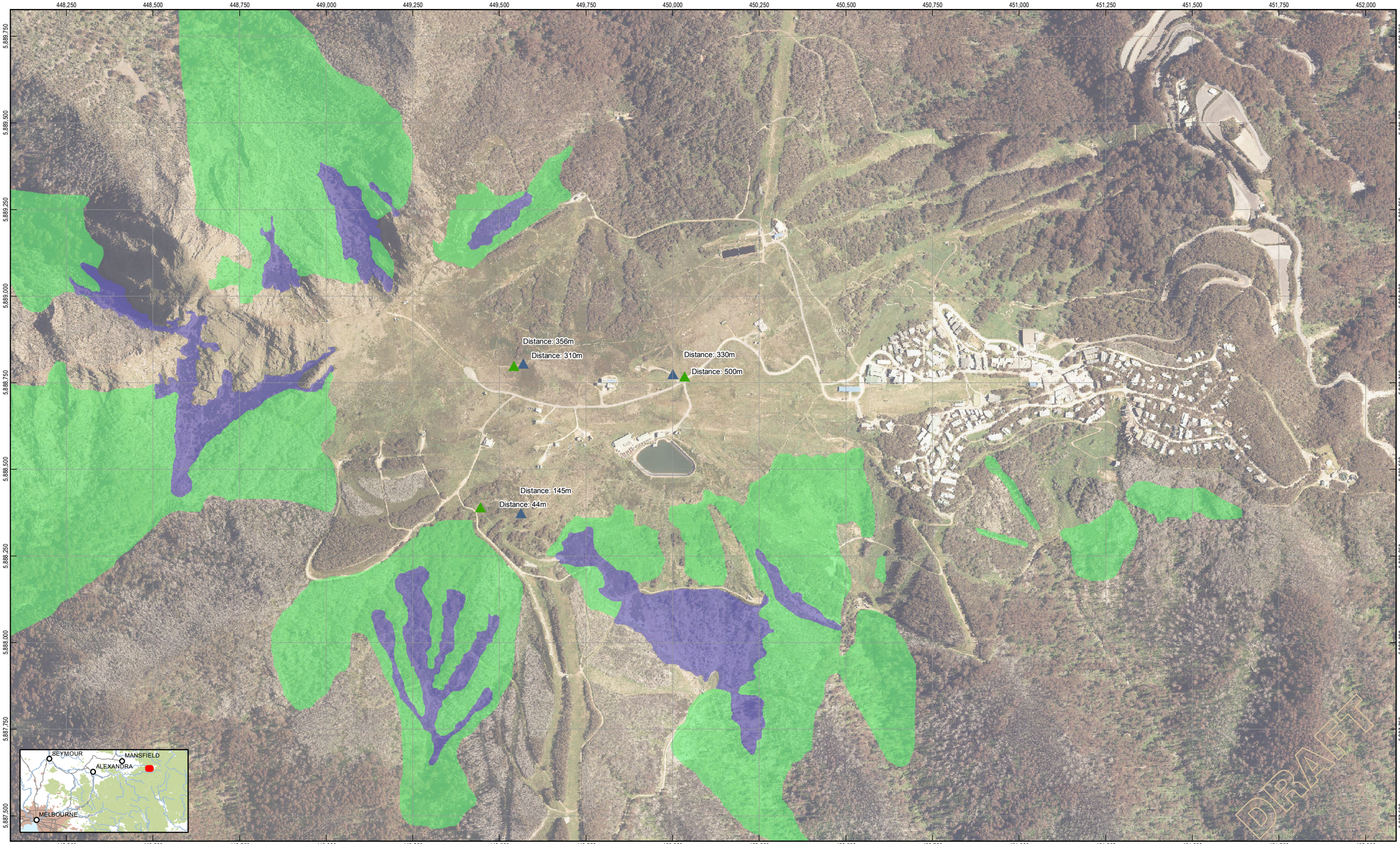

Threatened Amphibians (lt 1000m accuracy)
Threatened Passerine Birds (lt 1000m accuracy)
Threatened Non-passerine Birds (lt 1000m accuracy)
Threatened Waders (lt 1000m accuracy)
Threatened Marine Birds (lt 1000m accuracy)
Threatened Fish (lt 1000m accuracy)
Threatened Mussels, Decopod Crustacea (lt 1000m accuracy)
Threatened Aquatic Invertebrates (lt 1000m accuracy)
Threatened Invertebrates (lt 1000m accuracy)
Threatened Mammals (lt 1000m accuracy)
Threatened Reptiles (lt 1000m accuracy)
ROADS
Freeway
Highway
Main Road
Secondary Road
Local Road
2WD (Unsealed)
4WD Only
Walking or Cycle Track
WATERCOURSES
UNNAMED DRAINAGE LINES
WATERBODIES
Watercourse Area
Permanent Waterbody
Wetland Area
Inundation Area
BUILT UP AREAS



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Metres

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

N

LEGEND

Closest Point to Mountain Pygmy Possum Habitat
- Habitat 1
- Habitat 2

Mountain Pygmy Possum
- Habitat 1
- Habitat 2

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

Job Number 31-30733
Revision A
Date 14 May 2014

Closest Point to Mountain Pygmy-possum Habitat - Initial Three Options

Figure 6

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Data Source: DSE: Vicmap - 2013; GHD - 2013; Pygmy Possum Habitats, Biosis - 2013. Created by: mjahanshahi

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Paper Size A3

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

N

LEGEND

Contours 1m
Control Project Disturbed Area
Tirol Project Disturbed Area

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

Site Location - Final Two Options

Job Number 31-30733
Revision A
Date 12 May 2014

Figure 7

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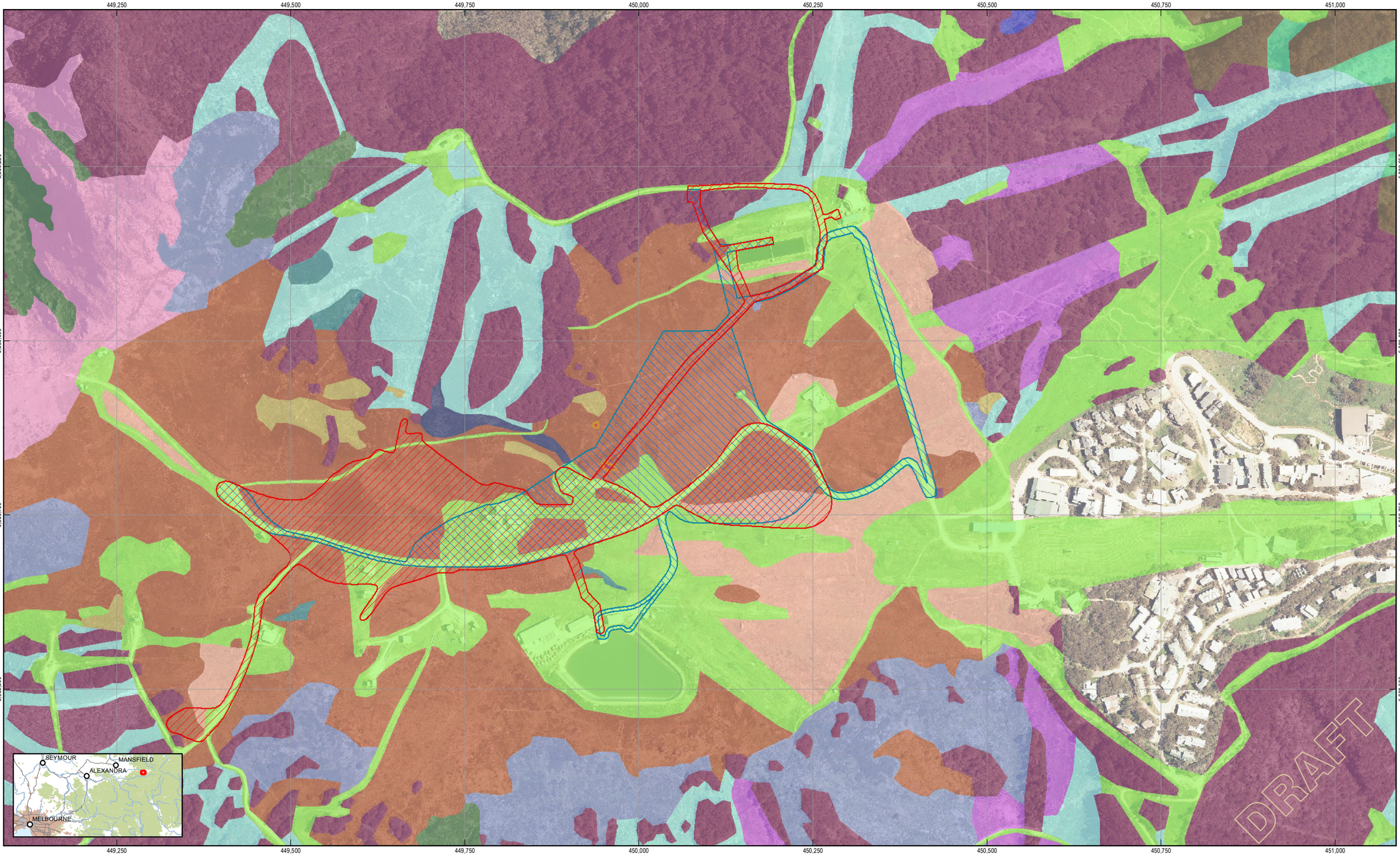

Paper Size A3

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Metres

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

N

LEGEND

Ecological Vegetation Classes

- Alpine Coniferous Shrubland (156)
- Alpine Grassy Heathland (1004)
- Alpine Peaty Heathland (1011)
- Degraded Treeless Vegetation
- Montane Damp Forest (38)
- Montane Riparian Thicket (41)
- Sub Alpine Shrubland (42)
- Sub Alpine Treeless Vegetation (44)
- Sub Alpine Wet Heathland (210)
- Sub Alpine Wet Heathland Sphagnum (210)
- Sub Alpine Woodland (43)
- Treeless Montane Damp Forest (38)
- Treeless Sub Alpine Woodland (43)
- Weedy Alpine Grassy Heathland (1004)
- Weedy Treeless Sub Alpine Woodland (43)
- EVC 210 (Biosis 2011)

- Control Project Disturbed Area
- Tirol Project Disturbed Area

GHD

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

Job Number	31-30733
Revision	A
Date	14 May 2014

Ecological Vegetation Classes - Final Two Options

Figure 8

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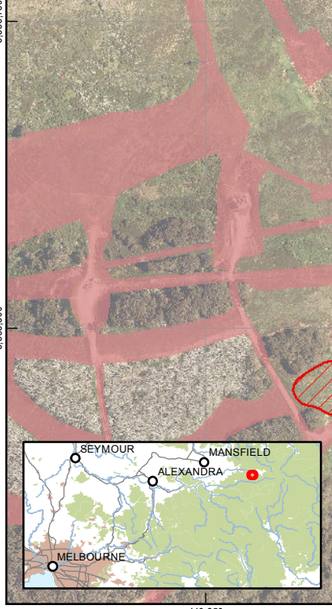

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Metres

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

N

LEGEND

- Previously Disturbed Ground
- Control Project Disturbed Area
- Tirol Project Disturbed Area

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

Previously Disturbed Ground - Final Two Options

Job Number	31-30733
Revision	A
Date	14 May 2014

Figure 9

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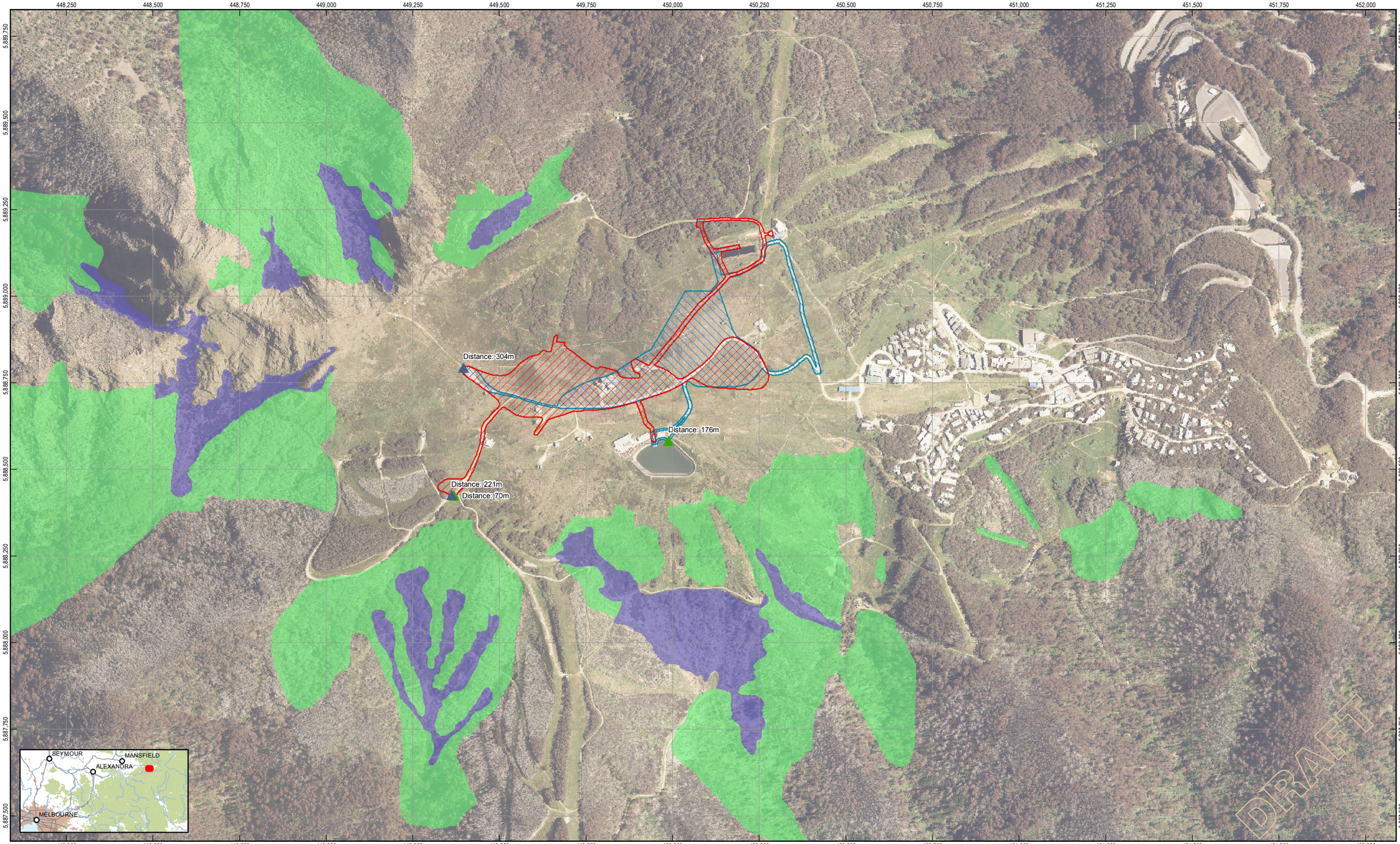

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Metres

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

N

LEGEND

- Closest Point to Mountain Pygmy Possum Habitat 1
- Closest Point to Mountain Pygmy Possum Habitat 2

Mountain Pygmy Possum

- Habitat 1
- Habitat 2
- Control Project Disturbed Area
- Tirol Project Disturbed Area

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

Job Number 31-30733
Revision A
Date 14 May 2014

Closest Point to Mountain Pygmy-possum Habitat - Final Two Options

Figure 10

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Data Source: DSE: Vicmap - 2013; GHD - 2013; Pygmy Possum Habitats, Biosis - 2013. Created by: mjahanshahi

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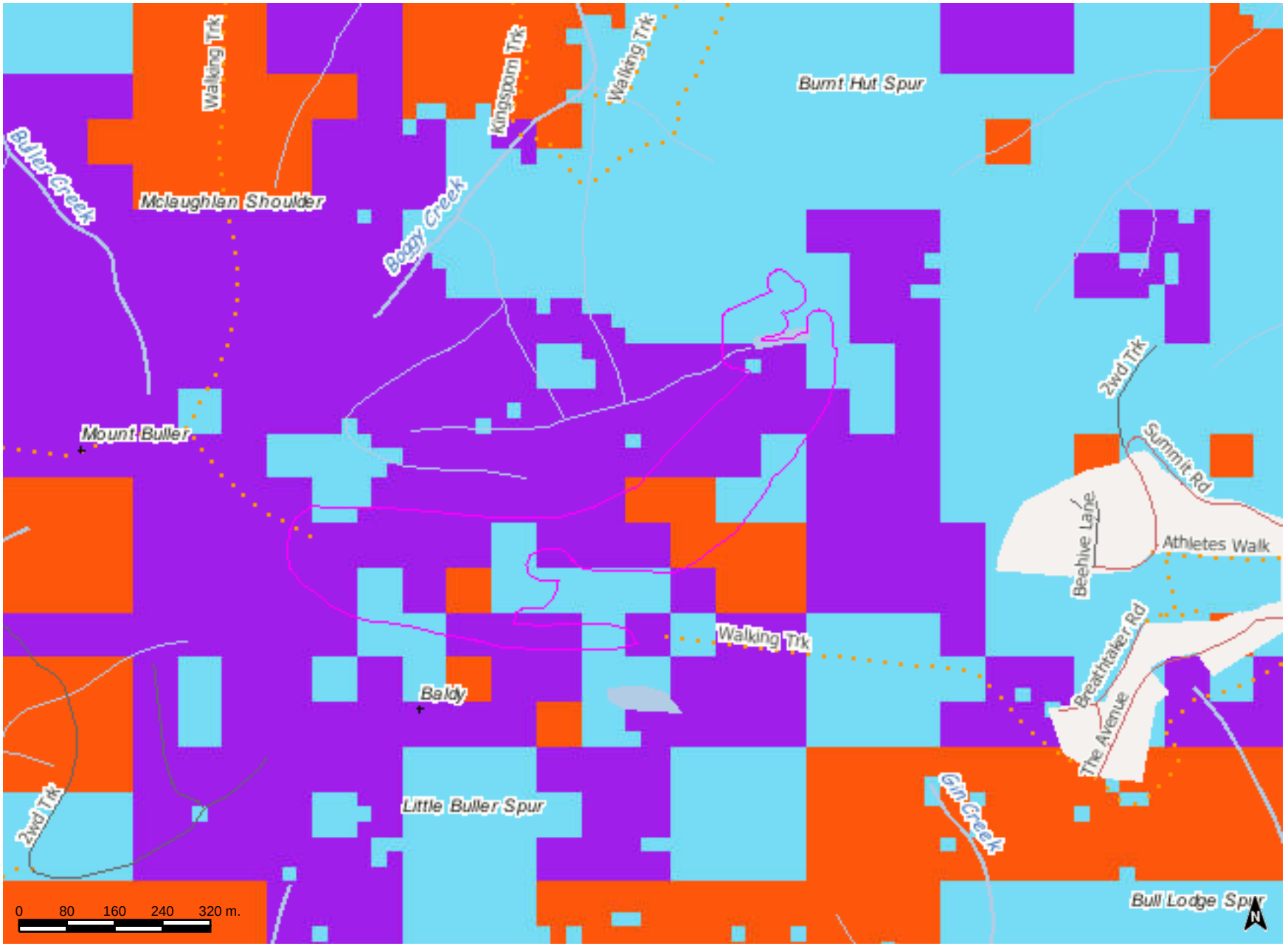

ROADS
- Freeway
- Highway
- Main Road
- Secondary Road
- Local Road
- 2WD (Unsealed)
- 4WD Only
- Walking or Cycle Track

WATERCOURSES

UNNAMED DRAINAGE LINES

WATERBODIES
- Watercourse Area
- Permanent Waterbody
- Wetland Area
- Inundation Area

BUILT UP AREAS

Figure 11

Map Scale 1:9,331

Biodiversity Interactive Map A4 Landscape

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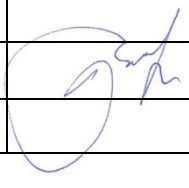
Draft	T. Wills R. Retallick	S. Dahl N. Cunningham		G. Jones		04/07/14
0	T. Wills R. Retallick	S. Dahl		G. Jones		11/07/14

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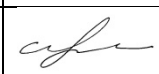
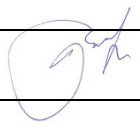
0	S Dahl G Jones	N Cunningham		G Jones		11/07/14

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