Bega Valley Shire Council

Yellow Pinch WTP – Scoping Study Report

March 2021

Executive Summary

The townships of Merimbula, Pambula, Tura Beach, Eden, Wolumla, Candelo and surrounding regions are supplied with drinking water from a combination of the Tantawanglo Creek Weir, the Bega Borefield and the Kiah Borefield. The water reticulation network and treatment plants are managed by local Bega Valley Shire Council (BVSC).

Currently, source water is chlorinated and supplied to these townships via a network of storage tanks and pump stations, as well as the large Yellow Pinch Dam (YPD) and smaller Ben Boyd Dam. Based on the elevation of the Yellow Pinch Dam and the connecting pipeline, water can currently flow via gravity from YPD through to Merimbula.

A new water treatment plant (WTP) is planned near the Yellow Pinch Dam to ensure treated water supply will meet demand through to 2048. The purpose of this work was to select the most appropriate site for the new WTP based on the following factors, among others:

- Energy usage related to the hydraulics of pumping raw and treated water
- Proximity to existing pipelines and access roads
- Site topography and spatial constraints
- Biodiversity and Aboriginal heritage constraints
- Complexity of land acquisition
- Social considerations (e.g. impact on neighbours, acquiring private land)

A multicriteria analysis (MCA) was undertaken to compare sites against agreed triple bottom line criteria. The weightings and scores were agreed upon during a workshop on 18 March 2021. The results of the MCA showed that the site at 43 Red Gum Rd is preferred to carry forward into the next stage of planning.

The next phase of this work will include:

- Planning proposal for rezoning of 43 Red Gum Rd to SP2. It is proposed that some existing E3 land will be retained in the heavily vegetated sections of the lot (NW and NE corners and possibly along the eastern boundary). The footprint of the WTP is expected to be contained majorly within the existing cleared areas of the lot
- Strategic bushfire study to support the planning proposal and to confirm the required asset protection zone for the WTP
- Detailed site survey
- Traffic report to demonstrate safe access to the area and entry and egress for large vehicles
- Detailed process options assessment including jar testing to confirm chemical dosing strategy.
- Reference design including any required additional site investigations such as geotechnical investigations
- Additional community consultation if required

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

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1. Introduction

1.1 Background

The townships of Merimbula, Pambula, Tura Beach, Eden, Wolumla, Candelo and surrounding regions are supplied with drinking water from a combination of the Tantawanglo Creek Weir, the Bega Borefield and the Kiah Borefield. The water reticulation network and treatment plants are managed by the local Bega Valley Shire Council (BVSC).

Currently, source water is chlorinated and supplied to these townships via a network of storage tanks and pump stations, as well as the large Yellow Pinch Dam (YPD) and smaller Ben Boyd Dam. Based on the elevation of the Yellow Pinch Dam and the connecting pipeline, water can currently flow via gravity from YPD through to Merimbula.

A new water treatment plant (WTP) is planned near the Yellow Pinch Dam to ensure treated water supply will meet demand through to 2048.

The WTP will introduce an additional treatment step (floatation/filtration) and UV disinfection to complement the existing chlorination. This will be expected to improve water quality and increase water security in the reticulation network.

A key element in designing the new Yellow Pinch WTP is selecting the most appropriate site for the plant. BVSC has assessed the region extensively for suitable sites and has developed a list of potential options for the new WTP. For the list to be narrowed to one preferred location, the following factors, among others, were considered:

- Energy usage related to the hydraulics of pumping raw and treated water
- Proximity to existing pipelines and access roads
- Site topography and spatial constraints
- Biodiversity and Aboriginal heritage constraints
- Complexity of land acquisition
- Social considerations (e.g. impact on neighbours, acquiring private land)

1.2 Purpose of this report

The purpose of this report is to develop the site selection criteria and recommend a preferred site location/s for a new WTP near the Yellow Pinch Dam based on the results of a multi-criteria analysis (MCA).

1.3 Scope and limitations

The scope of this report includes:

- Demonstration of project need and high-level process definition
- Development of indicative site layout and engineering site assessment (including hydraulics, power, access, and site connections and desktop geotechnical review)
- Environmental and planning site assessment, including review of previous constraints mapping and on-site biodiversity and heritage specialist studies
- Net present cost (NPC) analysis
- WTP site multi criteria analysis including NPC, environmental and social outcomes (triple bottom line)

This report: has been prepared by GHD for Bega Valley Shire Council and *may only be used and relied on by Bega Valley Shire Council for the purpose agreed between GHD and the Bega Valley Shire Council as set out in section 1.2 of this report.*

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

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

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

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

2. Raw Water Sources

The new Yellow Pinch WTP will be required to treat raw water from three sources, as described in Table 2.1. To determine the plant footprint required at each potential site, the most suitable treatment process train must be established.

Based on the summary below, and the fact that the new WTP will be required to treat water from all three sources, a DAFF plant with UV disinfection is proposed. This process train is the basis for determining the plant footprint in section 4.2.

Table 2.1 Summary of raw water sources to be treated by the Yellow Pinch WTP

	Tantawanglo Weir	Bega Borefield	Yellow Pinch Dam
Catchment category	Cat. 2	Cat. 4	Cat. 4
Minimum treatment	Filtration; UV	Filtration; UV	Filtration; UV
Solids Load	Medium-High	Low	Medium
Algae	Yes	None	Yes
Potential solids removal technology	DAFF	Filtration	DAFF

This report primarily focusses on identifying the most suitable location for the new WTP, and this is not expected to be greatly impacted by the treatment processes within the plant. Subsequent steps in this project will involve a more thorough assessment of the raw water quality considerations and how they might impact plant design.

For this work, it has been assumed that a new water treatment plant will comprise a DAFF process followed by UV disinfection, as a minimum.

3. Plant Siting Options

3.1 Options long list

BVSC has previously assessed the region surrounding the Yellow Pinch Dam to identify suitable sites. A long list of site options was developed. Table 3.1 provides a summary of the sites and the sites are depicted in the aerial image shown in Figure 1.

Within some of the areas listed there are multiple sub-options as described in Section 8.2.

Of the sites investigated, four are privately owned meaning there will be a need to acquire part/some of the property. Two areas are within National Parks which may require additional approvals effort and cost for rezoning. The only council-owned land that is considered feasible at this stage is the area above the Yellow Pinch Dam either side of the dam access road.

Table 3.1 Long list of WTP site options

Ref	Area	Land Ownership	Comment
A	West Wolumla	Private (E3)	
B	Back of Dam	Private (E3)	
C	Above Dam	Council (SP2)	2 options within this area: • WTP at 240 m • WTP at 210 m
D	Electricity Easement	National Parks (E1)	2 options within this area: • WTP partially in easement • WTP outside easement
E	Red Gum Rd	Private (E3)	4 options within this area: • 43 Red Gum Rd • 109 Red Gum Rd (Nth) • 109 Red Gum Rd (Sth) • 71 Red Gum Rd
F	Chlorinator	National Parks (E1)	2 options within this area: • Chlorinator • 2467 Princes Hwy
G	Boggy Creek Rd	Private (E3)	

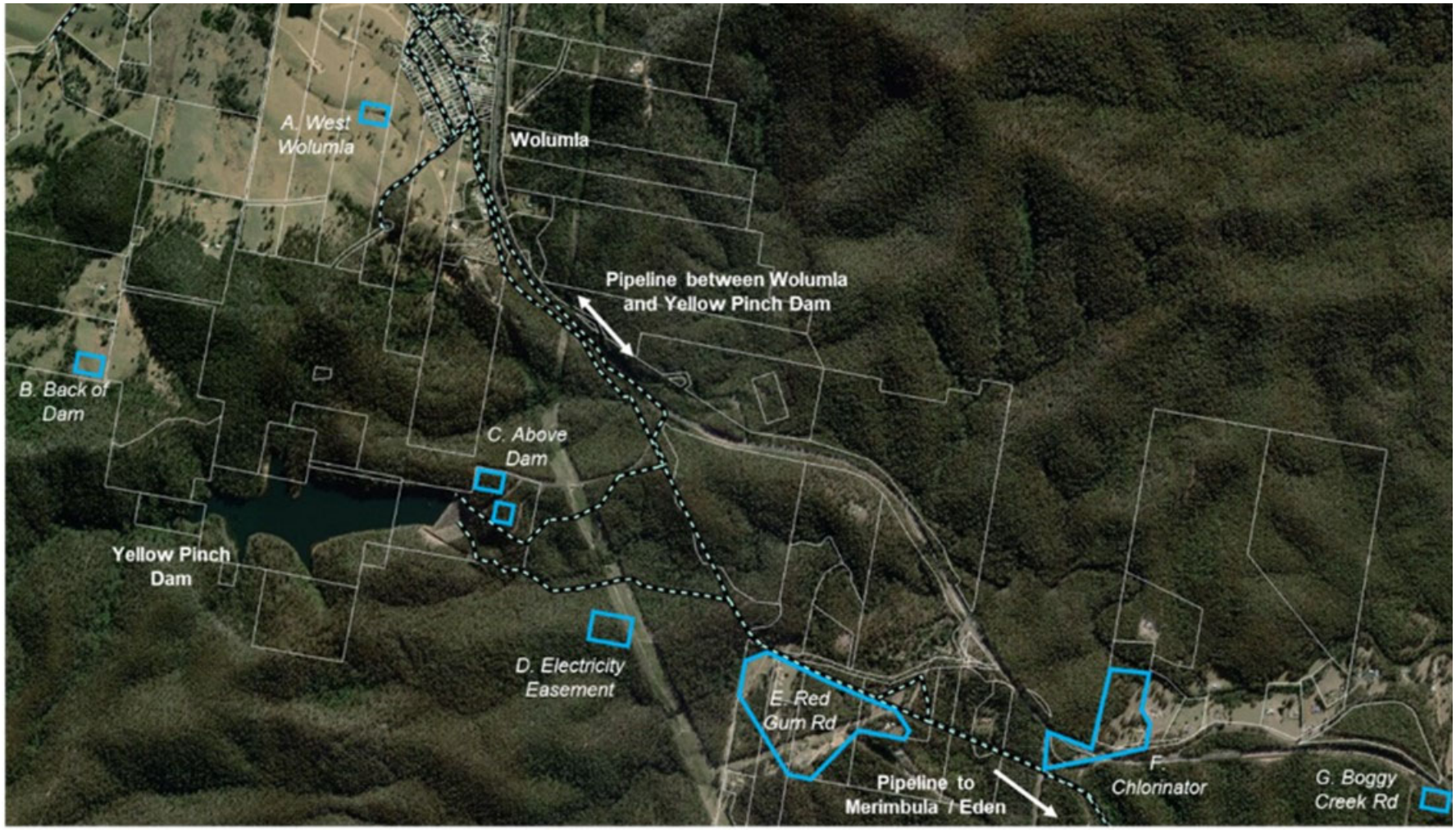


Figure 1 Aerial map of longlisted areas under consideration

4. Plant Sizing

4.1 Demand

Table 4.1 summarises the current and expected future demands for the region.

The new WTP needs to be sized for approximately 18 ML/day to accommodate 2048 demands for the whole region. It is noted that the strategy for supplying Eden is to be confirmed, and the Yellow Pinch WTP may not supply Eden for the whole design horizon. The plant footprint has been developed on the basis of 18 ML/d as a conservative approach to space proofing.

As discussed in Section 6, the hydraulic calculations have been based on BVSC annual average demand projections for the whole region for 2030 (Appendix F in project brief). A sensitivity was undertaken which looked at 2048 demands, both with and without supplying Eden, and there was no material difference to the outcomes.

Table 4.1 Regional water demands and plant sizing

	Merimbula	Eden	Candelo & Wolumla	Total
2020 Peak Day Demand (ML/day)	9.3	3.9	1.6	14.8
2048 Peak Day Demand (ML/day)	11.3	4.9	2.0	18.1
2030 Annual Average Demand (ML/year)	1300	500	150	1950

4.2 WTP footprint

An approximate footprint of the plant and associated infrastructure is required to determine the suitability of a particular location. Preliminary site selection involves overlaying the approximate WTP footprint on each of the sites and determining whether the site is suitable for the new plant. Suitability is assessed against the following main constraints:

- Spatial – sufficient space is required to situate the plant, preferably without the need to clear excess trees or remove obstacles.
- Topographical – site contours allow determination of relative grade of the proposed site, which indicates the level of earthworks that may be required to level the ground.
- Social –construction of a plant may require acquisition of an entire property and/or demolition of an existing dwelling. There may also be an impact to neighbouring properties.

Generally, most constraints can be designed around, however this can come at additional cost. The three key elements of the new WTP are listed below and described in further detail in this section:

- The plant itself, including all process and mechanical equipment
- Treated water storage tank/s
- Sludge handlings facilities – lagoons or drying beds

4.2.1 Water treatment plant

The following key process units and buildings are required within the WTP plant:

Plant element	Indicative size
DAFF unit/s	20 x 12 m
Control and electrical building	5 x 20 m
Mechanical room (includes TW pumps, air scour blowers, backwash pumps, service water, compressor for DAFF)	26 x 10 m
Chemical building, with provision for • Alum • Soda Ash/Lime • Chlorine • Fluoride	6 x 30 m
UV building	10 x 8 m

Combining all of these process units, the total treatment plant footprint required is approximately 30 x 50 m (or equivalent area). Allowance for an access ring road is required for chemical deliveries, staff access and emergency access.

4.2.2 Treated water storage

The following components were used to determine the necessary volume of treated water storage available on site:

- Chlorine contact time - 0.8 ML
  - Requires 1 hr chlorine contact at peak rate of 17 ML/day.
  - 17 (ML/day) / 22 (hours/day) – 0.8 ML/h
- Filter backwash: 0.6 ML
  - 17,000 (ML/day) / 22 (hours/day) = 770 m^3/hr
  - Typical filtration rate of 8 m/hr: 770 (m^3/hr) / 8 (m/hr) = 100 m2
  - Assuming 2 no. filter units: 100 m2 / 2 = 50 m^2 per filter
  - Assuming 2 m filter bed depth, and a volumetric backwash requirement of 3 times the filter bed volume: 100 m^3 volume * 3 bed volumes = 300 m^3 = ~0.3 ML
  - Reduced output during backwash 0.3 ML
- Diurnal balancing of local demand = 0.3 ML (estimated)
- Dead storage – 0.2 ML
  - Assuming 20 m tank diameter
- Fire fighting volume – 0.2 ML
  - Using Brogo WTP as reference
- Total – 2.1 ML

However, as a rule, the total recommended volume of on-site treated water is 4 hours storage, which in this case is equal to 3.2 ML. The greater value is adopted in this case.

Therefore, the tank sizing can be determined as follows:

- Assuming 2 no. TWS tanks: 1.6 ML each (1,600 m^3)
- Assuming each tank is 5 m high the tank diameter is approximately 20 m

4.2.3 Sludge drying lagoons

Sludge lagoons are the preferred option for sludge handling. If there is insufficient space on site, there may be a need to consider drying beds which have a smaller footprint but are more expensive.

The sludge drying lagoons were sized using the following assumptions.

Table 4.2 Sludge drying lagoon sizing assumptions

Assumption	Value	Comment
Concentration of solids (kg/ML)	9.0	Based on average water quality across the three sources: Tantawangalo Weir, YPD, and Bega Borefield
Flow (ML/year)	1,950	Total 2030 flow based on Appendix F in project brief
Sludge loading rate (kg/m^2/year)	15	Based on simple lagoon with no underdrainage
Months of sludge storage required	18	
Number of lagoons	2	One filling, one drying

Based on these assumptions, the lagoons were sized conservatively as:

Base area required (each lagoon)	1,200 m^2
Top of lagoon dimensions	50 m width x 90 m length each
Three smaller lagoon dimensions*	40 m width x 65 m length each

* If it was deemed infeasible to two large lagoons on a site, the option of three smaller sludge lagoons was considered. This is an alternative to using drying beds and should be considered during detailed design.

4.2.4 Sludge drying beds

During the process of shortlisting, site constraints were identified which necessitated the use of sludge drying beds rather than lagoons. Examples of these constraints include: electrical easements and power lines, steep sections, dense forest with ecologically important flora, etc.

For the purposes of this study, the sludge drying beds were conservatively assumed to have the following dimensions:

Drying bed dimensions	30 m width x 50 m length
Number of beds required	Two

5. Desktop Geotechnical Assessment

A preliminary desktop geotechnical assessment was carried out for all of the proposed sites. Refer to Appendix A for details of the assessment. Four of seven proposed sites (sites A, C, D and F) assessed during a site walkover by an engineering geologist on the 13 October 2020. The remaining three sites (sites B, E and G) did not have a site walkover performed. Information presented from the site walkover relates to the actual areas observed, and may differ slightly to the locations shown in Figure 1. The sites have been discussed individually in their respective sections below.

Table 5.1 Summary of sites for geotechnical assessment

Ref	Area	Assessment
A	West Wolumla	Desktop, site walkover
B	Back of Dam	Desktop only
C	Above Dam	Desktop, site walkover
D	Electricity Easement	Desktop, site walkover
E	Red Gum Rd (43 Red Gum Rd)	Desktop only
F	Chlorinator	Desktop, site walkover
G	Boggy Creek Rd	Desktop only

5.1 Summary and recommendations

Based on the above site observations we conclude the following:

- The general slope conditions indicate no obvious slope instability or erosion within or immediately around Sites A, D, E and F. Sites B and C have estimated slope angles of between 5 and 10°, this will need to be considered during the design phase however this is unlikely to present any major slope instability constraint to the proposed development. Site G is located in a topographically low relief area and appears to have a creek passing through the site which could present some erosion and local instability issues. Sites B, E and G were undertaken as desktop study only and as such slope conditions and stability could not be fully assessed.
- It is likely that rock occurs at shallow depth at Sites B, C, D and E due to their somewhat higher topographic position and presence of rock exposures at Site C.
- Rock types at sites C, D, E, F and G are likely to be sedimentary in origin, conglomerate and sandstone. The rock types at Site A and part of Site B are likely to be granodiorite. Both sites will likely have low or non-plastic soil types and shallow soil profiles.

6. Hydraulic Assessment

6.1 Overview

Each of the proposed sites were hydraulically modelled to understand the requirement for new pump station/s and the energy cost for pumping. The result of this exercise is manifested in the net present cost of each option (refer to Section 8).

The system hydraulics has five principal components:

1. Pumping of raw water to the YP WTP for the Merimbula, Eden and Wolumla regions (if required)
2. Losses through the YP WTP and associated tanks
3. Pumping treated water to Merimbula (if pumping is required)
4. Pumping treated water to the Wolumla Reservoir for Wolumla
5. Pumping treated water to the Bellbird Reservoir for Eden (via the existing Hart's Flat pump station)

6.2 Assumptions

6.2.1 General hydraulic assumptions

The following assumptions apply to all options:

- Yellow Pinch Dam TWL 180 m
- DAFF height 5 m
- Treated water storage tank at WTP 5 m
- Pump station pipework losses 3 m
- Pump electricity consumption 5 kWh/ML per m head

6.2.2 Treated water to Wolumla hydraulics

The following assumptions are incorporated into the hydraulic model to determine the pumping requirements to Wolumla

- Wolumla Reservoir TWL 263 m
- Friction losses 0.25 m / km
- Annual pumping volume 150 ML/year*

* Annual volume based on BVSC demand projections for 2030 (Appendix F in project brief)

For the above dam sites a new pump station is required to supply Wolumla with treated water.

For the electricity easement sites, the chlorinator sites, Red Gum Rd sites, and Boggy Creek Rd, the existing drought return pump station will be utilised.

For the Wolumla site, a new pump station will be required to pump treated water up to the Wolumla Reservoir.

The pumping energy and electricity cost for the Wolumla transfer is based on the total head to the Wolumla Reservoir (town tank) and may be a single pump or the existing pumps with a new smaller intermediate balance tank near the existing Wolumla balance tank.

6.2.3 Treated water to Eden

The following assumptions were used to determine the pumping requirement to supply Eden with treated water from the new WTP using the existing Hart's Flat pump station. Note that the pump head assumptions are estimates only as the system hydraulics have not been modelled in detail.

Hart's Flat pump station lift requirements:

- Above Dam (210m) 10 m head
- Electrical Easement (both options) 40 m head
- Chlorinator (all sites), Red Gum Rd (all sites) and Boggy Creek Rd 40 m head

Pumping to Eden is required for all siting options except the sites at > 210 m where it is assumed that no pumping will be required (Wolumla site, Back of Dam site, and Above Dam 240 m site).

The pump duty was calculated according to the following annual demand for Eden:

- Annual pumping volume 500 ML/year*

* Annual volume on BVSC demand projections for 2030 (Appendix F in project brief)

6.2.4 Raw water and treated water to and from WTP

The annual flows of RW and TW to and from the new WTP is calculated as the sum of annual demand for Merimbula, Wolumla and Eden. For this section of pipework, the following assumptions apply:

- Friction losses 3.5 m / km
- Annual pumping volume to Merimbula 1,300 ML/year*
- Total pumping volume 1,950 ML/year**

* Annual volume on BVSC demand projections for 2030 (Appendix F in project brief)

** Sum of Merimbula, Wolumla and Eden demands

7. Net Present Cost

7.1 Overview and assumptions

Net present cost (NPC) was used to compare the financial feasibility of each site. The following assumptions were built into NPC calculations:

- A real discount rate of 4% was used
- NPC analysis is over 25 years
- Using these figures, the NPC for pipelines with 100-year asset life is calculated as follows:

$$NPC = CAPEX\ (1 - 0.75 / (1.04)^{25}) = 0.72\ CAPEX$$

- For annual operating costs:
    - Electricity (Lower) - $0.20 / kW.hr[1]
    - Electricity (Upper) $0.30 / kW.hr
    - Carbon cost for electricity (Lower) $30 / tonne CO_2
    - Carbon cost for electricity (Upper) $100 / tonne CO_2[2]
    - Carbon consumption - 1 kg CO_2 / kW.hr = $0.10/kWhr
    - Annual electricity usage costs were converted to NPC using a 16 x annual OPEX factor. This accounts for the demand increasing by approximately 1% per annum.
    - Annual carbon costs were converted to NPC using a factor of 15 times the annual OPEX.
- The private land purchase price and electricity power supply costs need verification.
- The capital cost and operating cost associated with the treatment plant infrastructure is not included in the NPC as this is common for all options.
- The approval costs for using Council's own land or land swapping with National Park are included.
- The route and length of the pipeline to the Back of Dam site is wholly uncertain.
- The cost estimates have been prepared for the purpose of comparing options and must not be used for any other purpose.
- The cost estimates are preliminary estimates only. Actual prices, costs and other variables may be different to those used to prepare the cost estimates and may change. No detailed quotations have been obtained. GHD does not represent, warrant or guarantee that the project can or will be undertaken at a cost which is the same or less than the cost estimates.

[1] Note: The electricity cost range is estimated and considers both energy charges and network charges.
[2] Note: Based on $2500/kW installed solar and a 20 year asset life, with a reduction of 1250 kWh/year, this corresponds to a carbon price of $100/tonne CO2 and this compares with current purchase of green power at $0.03/kWhr or $30/tonne CO_2

8. Shortlisting of Sites

Shortlisting of sites was undertaken on the basis of the hydraulic assessment and preliminary net present cost (NPC) analysis. Figure 2 and Figure 9-2 summarise the NPC outcomes. NPC results are broken down into their components to allow comparison of each.

The following observations are made.

- The Back of Dam and Wolumla sites are the highest NPC options and are unattractive due to high pipeline costs and high energy costs.
- The Boggy Creek site is the next highest NPC option and is unattractive due to the very high energy costs.
- The Above Dam (240 m AHD) site is the next highest NPC option and is unattractive due to high energy costs.
- The Red Gum Road site is the most attractive option from an NPC perspective due to the low pipeline and access costs. The key issue for this site is private land acquisition and demolition of a private dwelling.
- The next most attractive options from an NPC perspective (Chlorinator and Easement) are both in National Park.
- The Chlorinator site is attractive due to the low pipeline and access costs.
- A key cost component for the Electricity Easement sites is the access road and associated tree clearing, as the electricity easement access is too steep.
- The Above Dam site (210 m AHD) should be retained as it is on Council owned land rather than requiring land swapping with National Park or acquiring private land. Revocation of National Park land may be difficult to achieve, even with land swapping. Forest would still need to be removed on this site, however the approval process is likely to be significantly easier.
- The order of options does not change with the sensitivity on carbon price.
- With the treatment plant costs included (estimated at nominal $15M with contingency), the percentage difference in NPC for the Above Dam site (210 m AHD) compared with National Park sites would be substantially reduced.

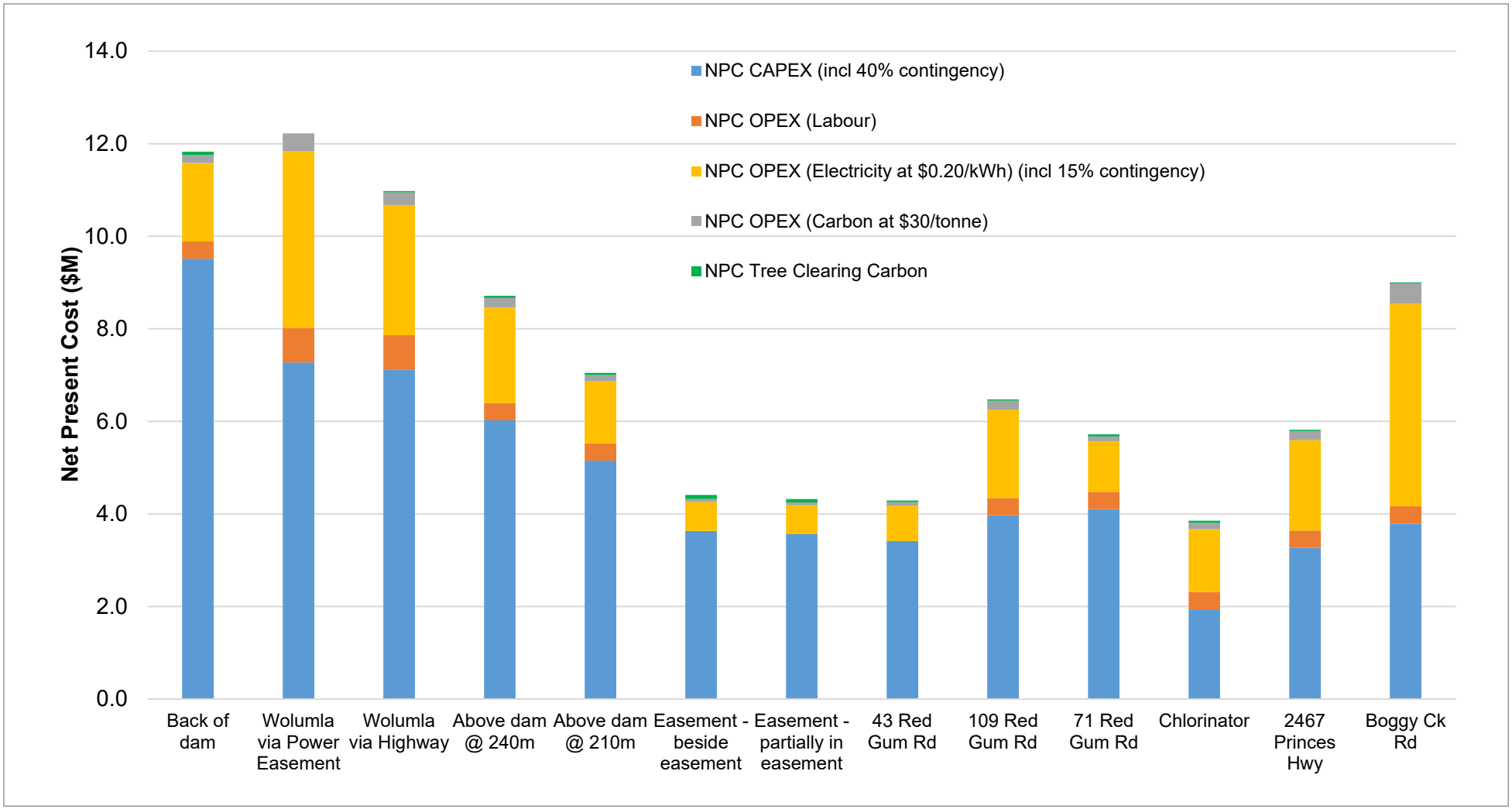


Figure 2 Net present cost comparison with carbon cost as $30/tonne CO_2 and electricity cost as $0.20/kWh

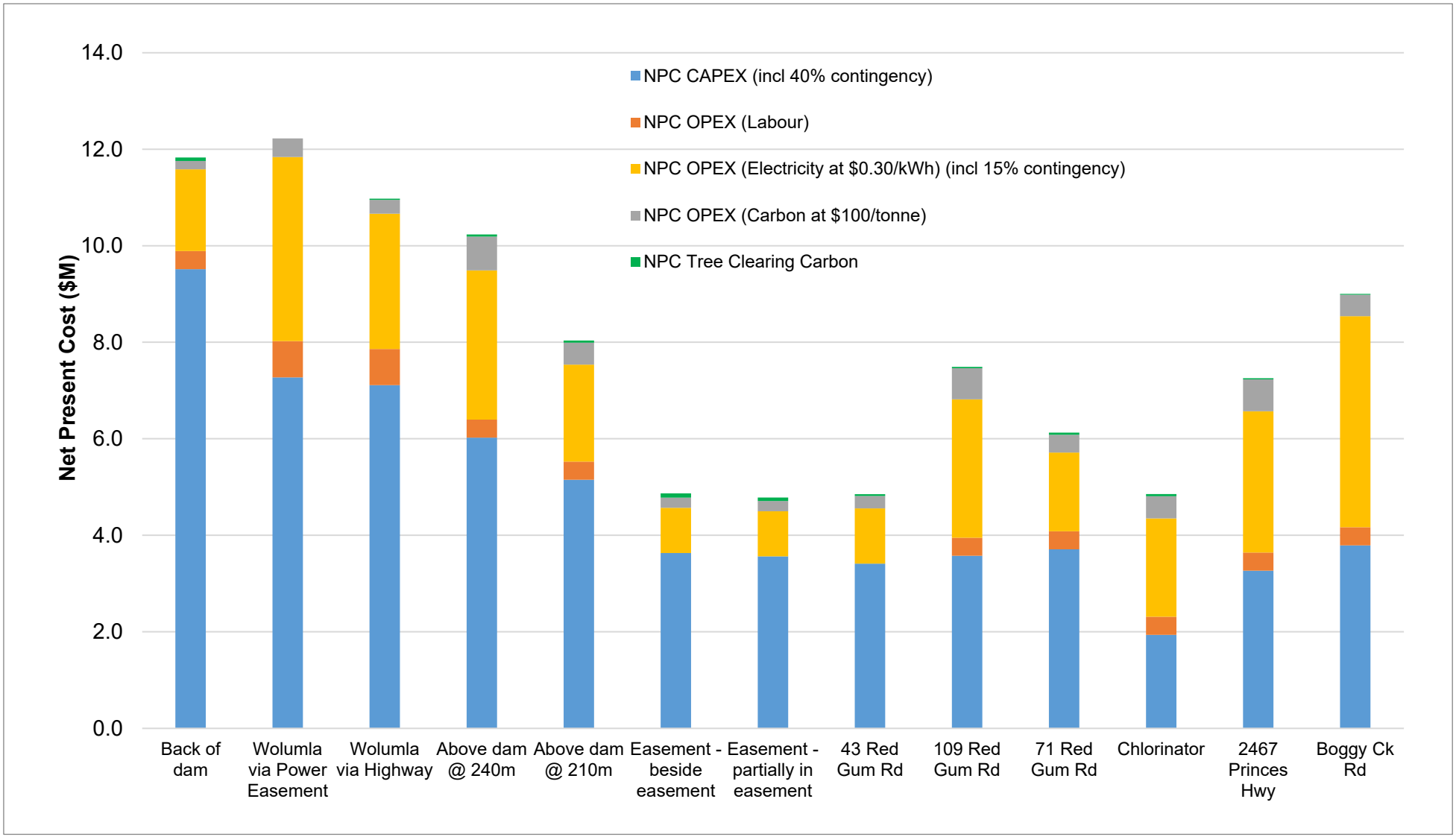


Figure 3 Net present cost comparison with carbon cost as $100/tonne CO_2 and electricity cost as $0.30/kWh

8.1 Eliminated sites

Three areas were eliminated as a result of the hydraulic and NPC assessment. The eliminated areas were:

- West Wolumla

  This area was eliminated due to the large energy requirements to pump water back over a number of hills to Wolumla from Yellow Pinch Dam, as well as the high capital cost and clearing of National Park associated with approximately 3km of new connecting pipework.

- Back of Dam

  This area was eliminated due to the distance from the existing treated water pipeline and Yellow Pinch Dam outlet, resulting in a very high capital cost for roads and connecting pipework and requiring removal of large areas of National Park.

- Boggy Creek Rd

  This area was eliminated as it is too low in elevation (25 m AHD), thus requiring a large amount of pumping energy to transfer water to Merimbula and Wolumla.

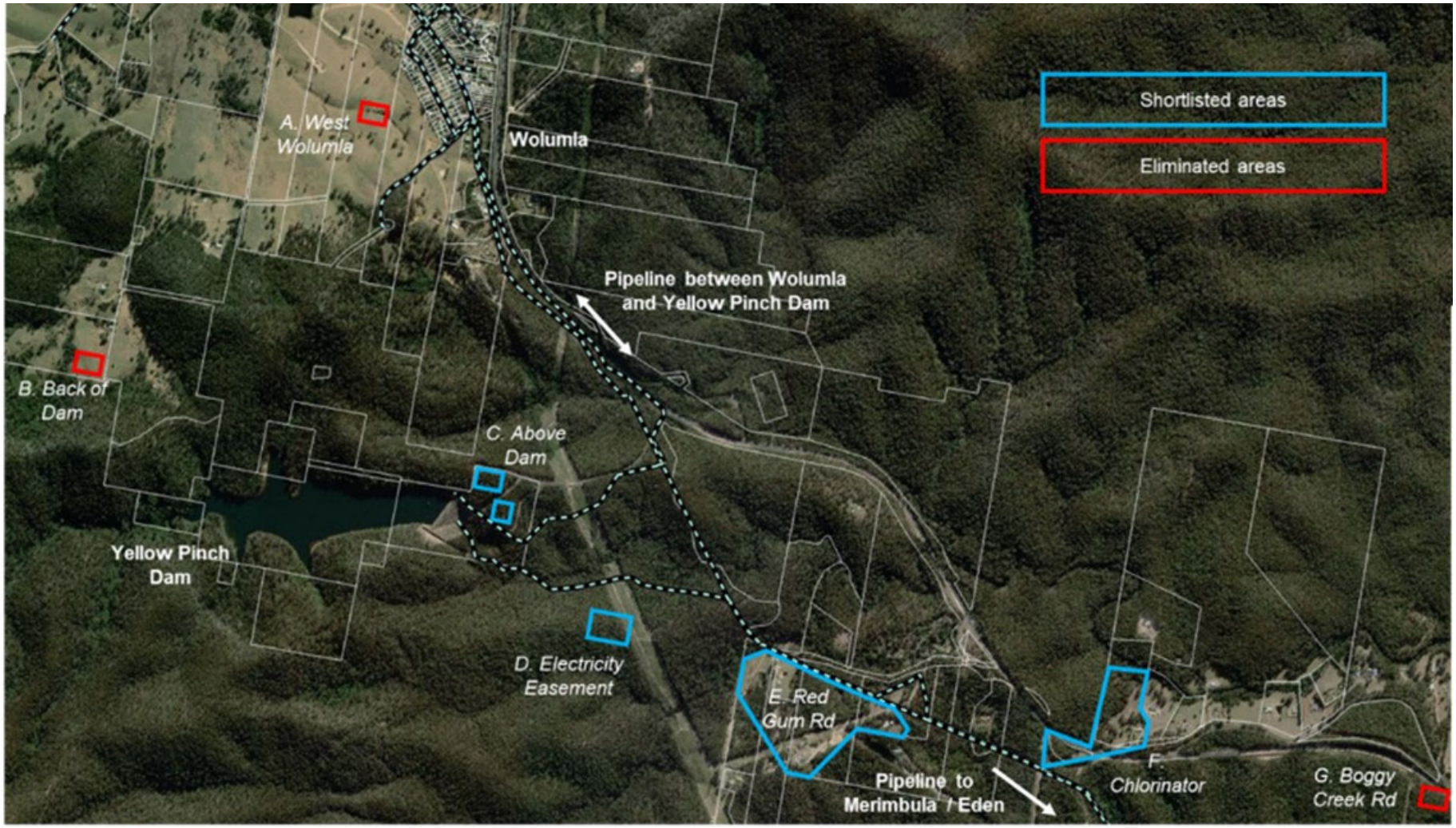


Figure 4 Aerial map of areas of interest including eliminated options

8.2 Shortlisted sites

Considering the eliminated sites as described above, Table 8.1 is a list of the remaining shortlisted sites to be further considered.

Table 8.1 Summary of shortlisted sites for new Yellow Pinch WTP

Ref	Area	Land Ownership	Comment
C	Above Dam	Council	2 options within this area: • WTP at 240 m • WTP at 220 m
D	Electricity Easement	National Park	2 options within this area: • WTP partially in easement • WTP outside easement
E	Red Gum Rd	Private	3 options within this area: • 43 Red Gum Rd • 109 Red Gum Rd • 71 Red Gum Rd
F	Chlorinator	See comment	2 options within this area: • Chlorinator (National Park) • 2467 Princes Hwy (Private)

9. Concept Layouts for Shortlisted Sites

Indicative concept layouts are provided in Figure 5. The following notes and assumptions are pertinent to these layouts:

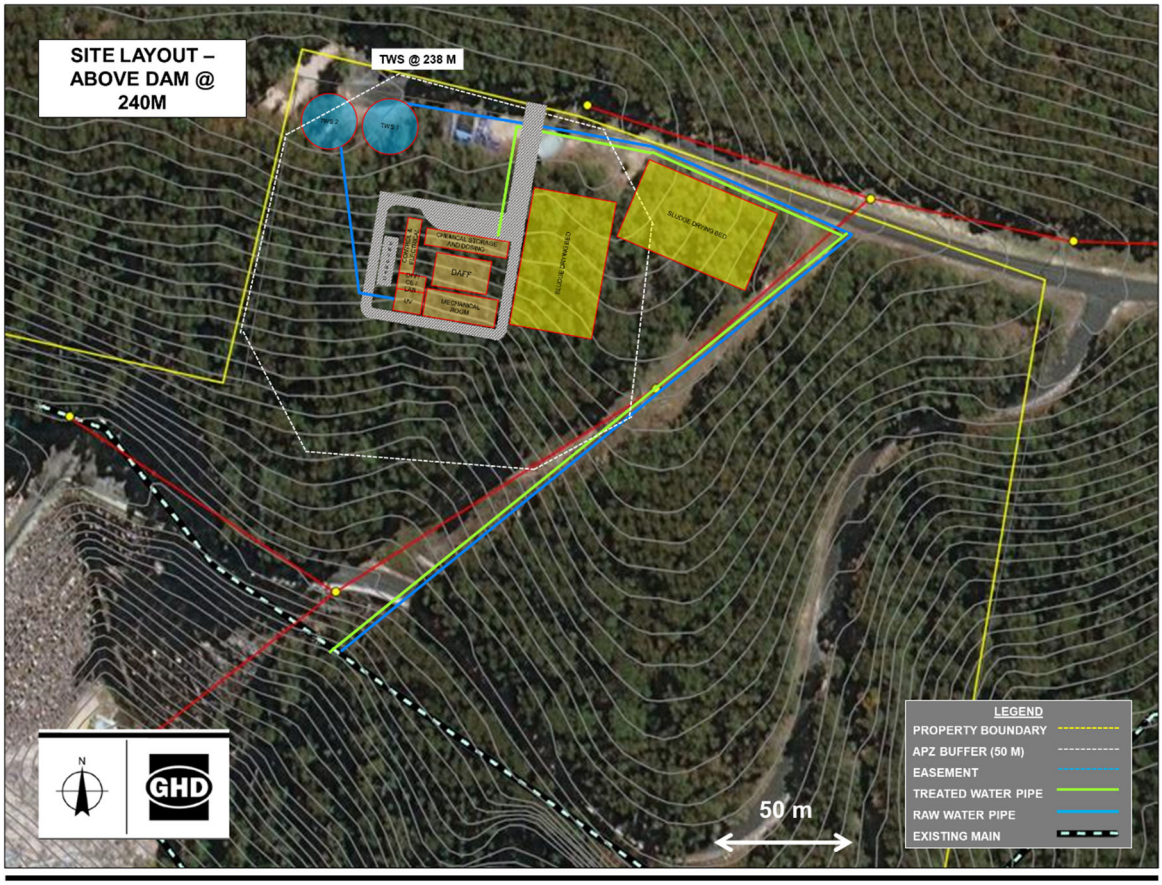
- These preliminary layouts are a result of a desktop analysis and should only be used in the context of high-level comparison. No surveying, geotechnical or other physical investigations were undertaken in their development.
- Infrastructure sizing is based on the dimensions detailed in Section 4.2.
- Property boundaries are approximate only and require confirmation by site survey. It is noted that the cadastral boundaries sourced from the NSW Digital Cadastral Database are not survey based and do not accord with the aerial imagery. A cadastral survey would need to be undertaken to establish the true position of these boundaries.
- Asset protection zones (APZ) are taken as 50 m from any plant building (excluding sludge lagoons and storage tanks). This is expected to be conservative. In practice, this buffer zone varies depending on the specific situation.
- Access road and pipeline corridors are included as illustrative only.

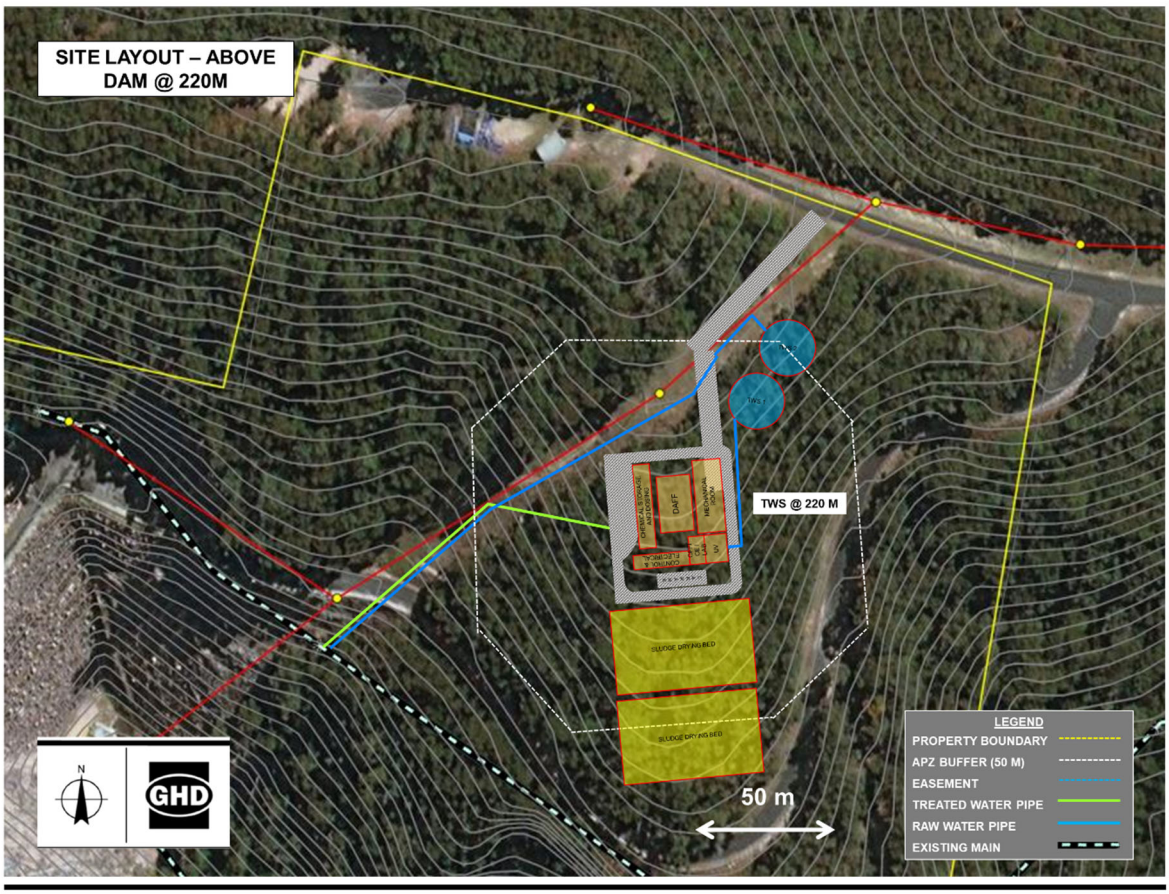
A summary of the key considerations for each shortlisted site is provided in Table 9.1.

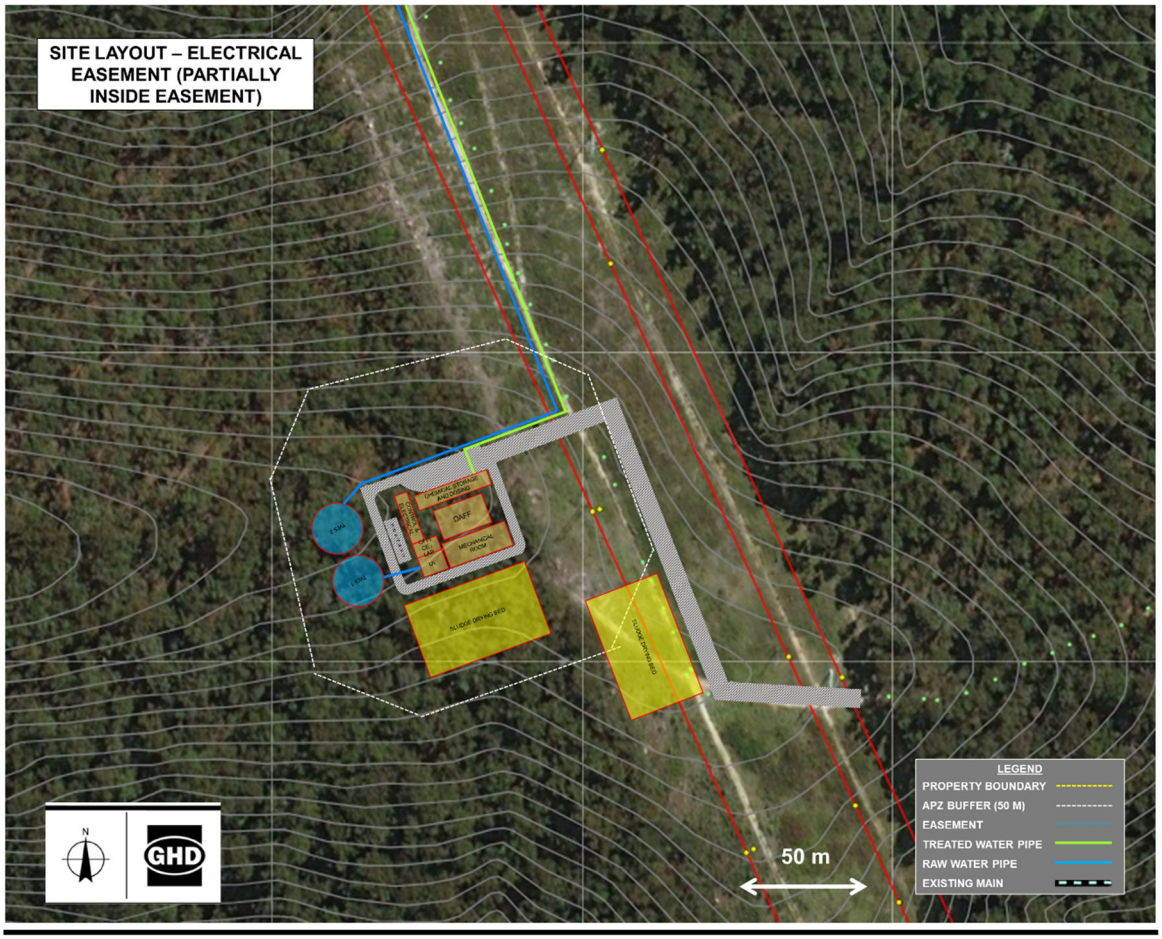
Table 9.1 Summary of key site considerations for the shortlisted sites

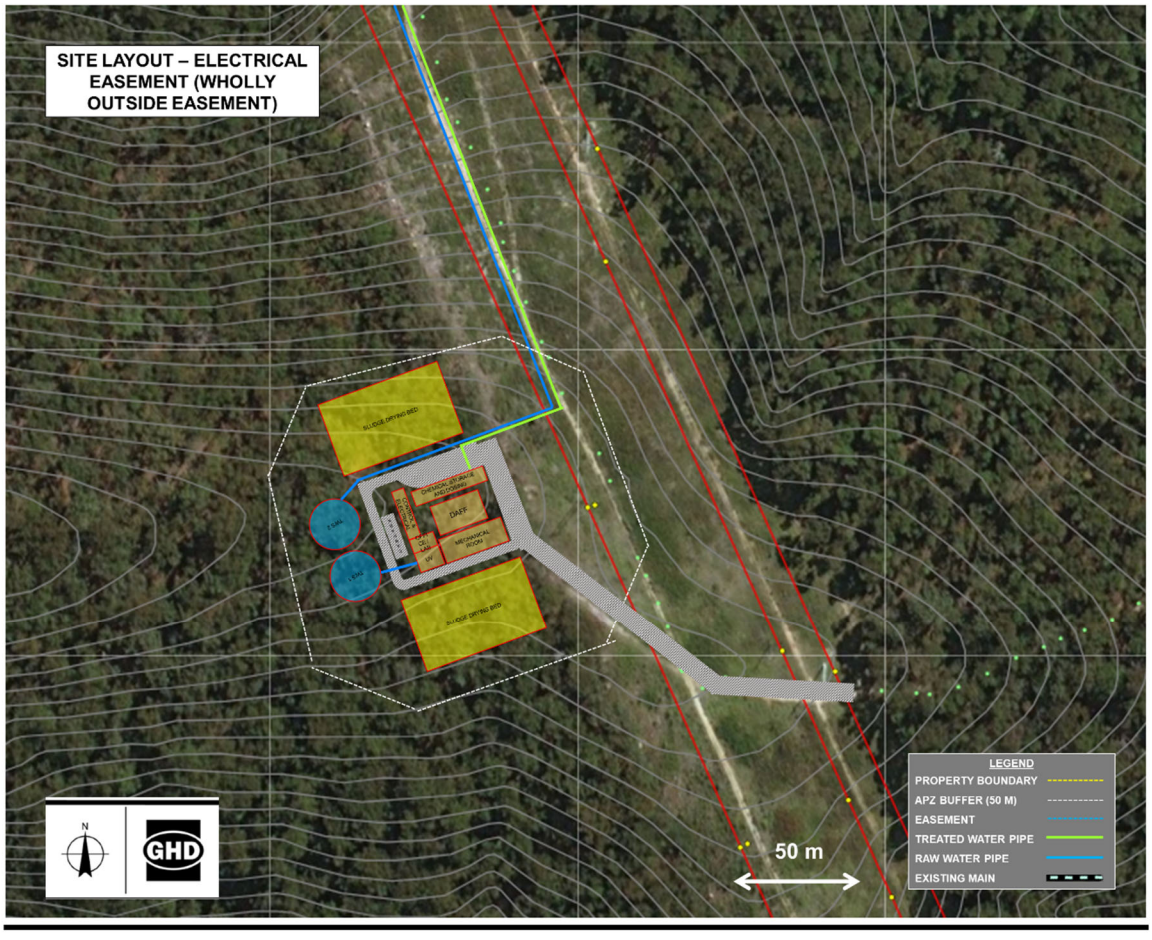
Site	Pros	Cons
Above Dam @ 240 m Council owned (SP2) Treated water storage (TWS) at 240 m	• Good road access • Council-owned land (no acquisition, rezoning still required)	• WTP on very steep ground • Pipelines in easement and relatively long • TWS at 240 m requires large amount of raw water pumping from Yellow Pinch Dam • Heavily forested
Above Dam @ 220 m Council owned (SP2) TWS at 220 m	• Good road access • Council-owned SP2 land (no acquisition or rezoning)	• WTP on steep ground • Pipelines in easement • Access road in easement • Heavily forested
Electricity Easement (outside easement) National Park (E1) TWS at 170 m	• Hydraulically favourable	• Pipelines in easement • Access road long and through heavily forested Aboriginal Reserve • Heavily forested • National Park (revocation required)
Electricity Easement (partially in easement) National Park (E1) TWS at 170 m	• Hydraulically favourable	• Same issues as above, and • Drying bed in easement to require Essential Energy approval
43 Red Gum Rd Private (E3) TWS at 160 m	• Hydraulically favourable (RGR hill is the local high point of existing TW main) • Willing seller • Close to existing main and access road (RGR)	• Somewhat spatially constrained (easements, existing mains)
109 Red Gum Rd (Nth) Private (E3) TWS at 120 m	• Willing seller • Close to existing main and access road (RGR)	• Poor hydraulics (WTP < 120 m) requiring more TW pumping • Nearby neighbour • Narrow property
109 Red Gum Rd (Sth) Private (E3) TWS at 150 m	• Willing seller • Hydraulically favourable	• Long access road, pipeline • Narrow property • Heavily forested • Steep southern section
71 Red Gum Rd Private (E3) TWS at 154 m	• Hydraulically favourable • Cleared land	• Unwilling seller (potential for poor social outcome)
Chlorinator National Park (E1) TWS at 132 m	• Close to pipeline and access road • Hydraulically favourable	• Heavily forested • Steep • National Park (revocation required) • Easement through plant footprint (requiring buried power line)
2467 Princes Hwy Private (E3) TWS at 108 m	• Close to access road (Princes Hwy)	• Nearby neighbour • Poor hydraulically

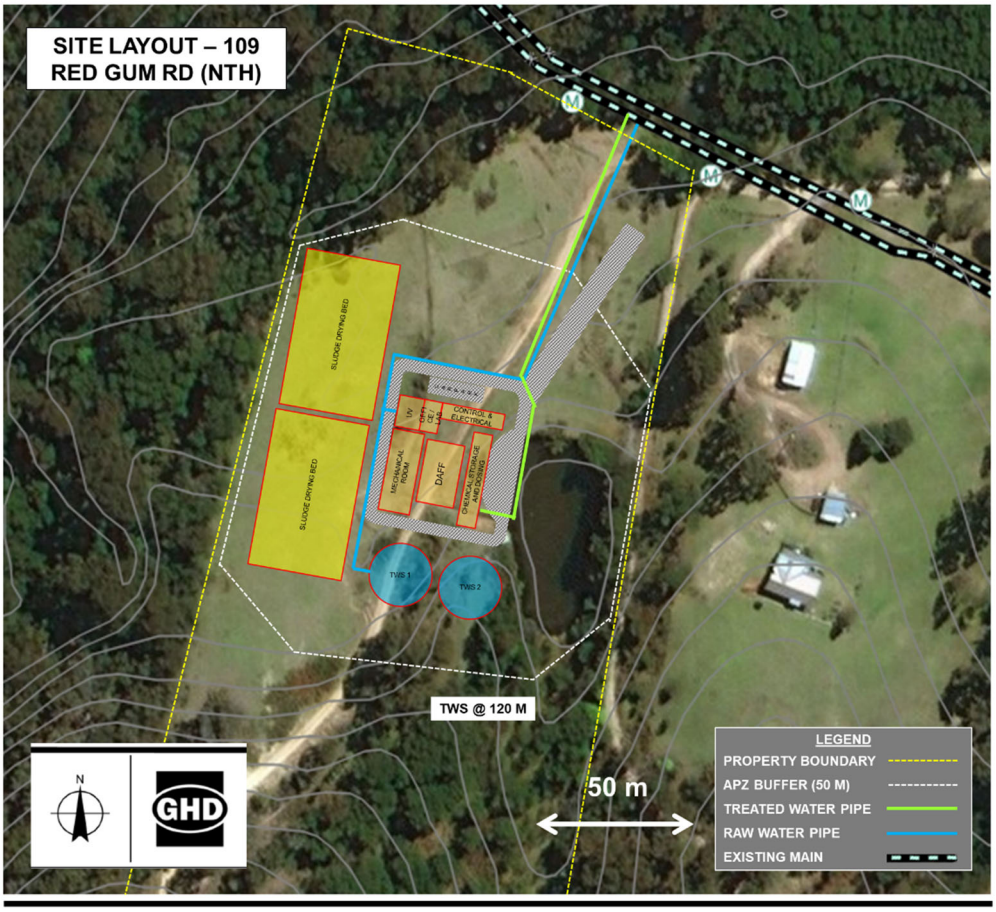
Figure 5 Concept layouts for shortlisted sites

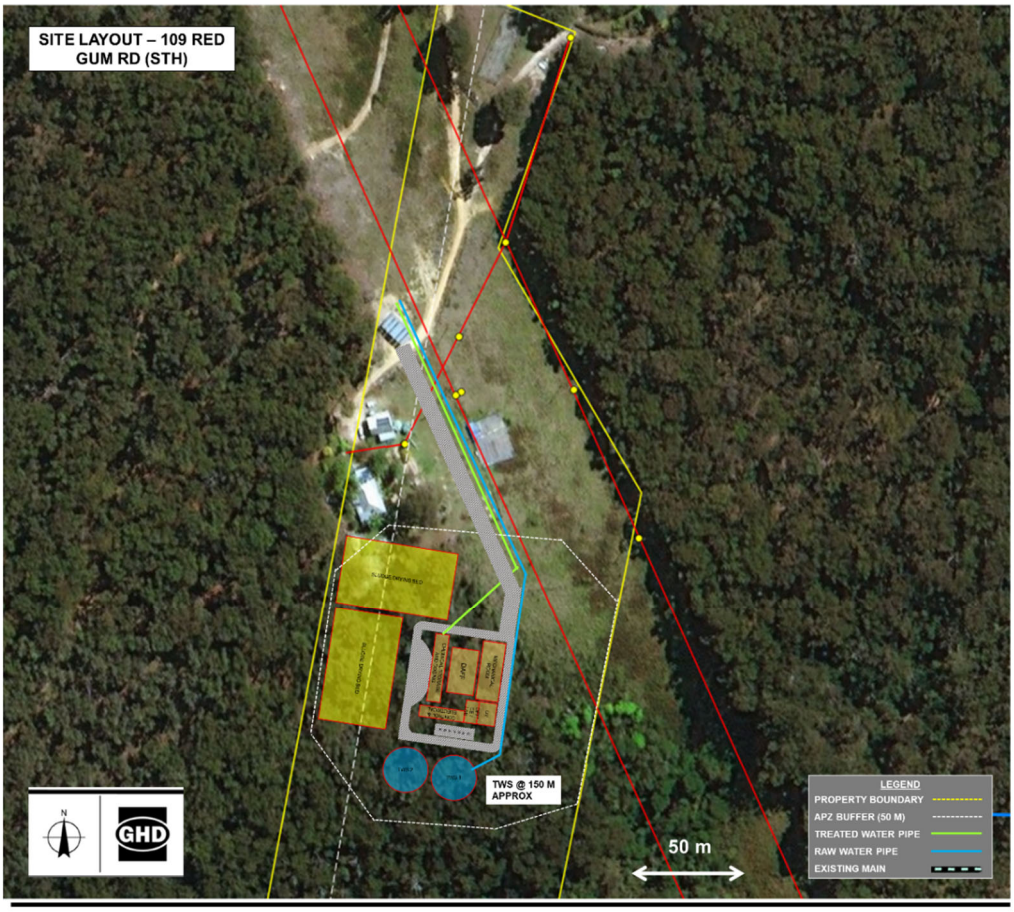


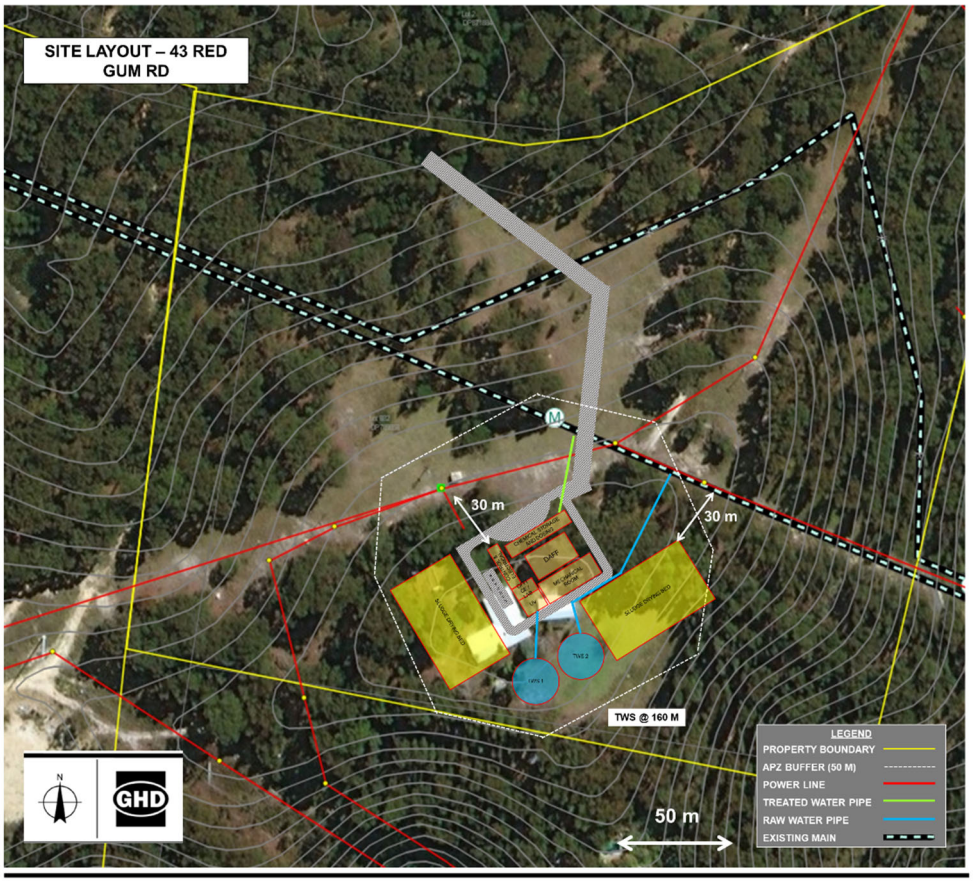


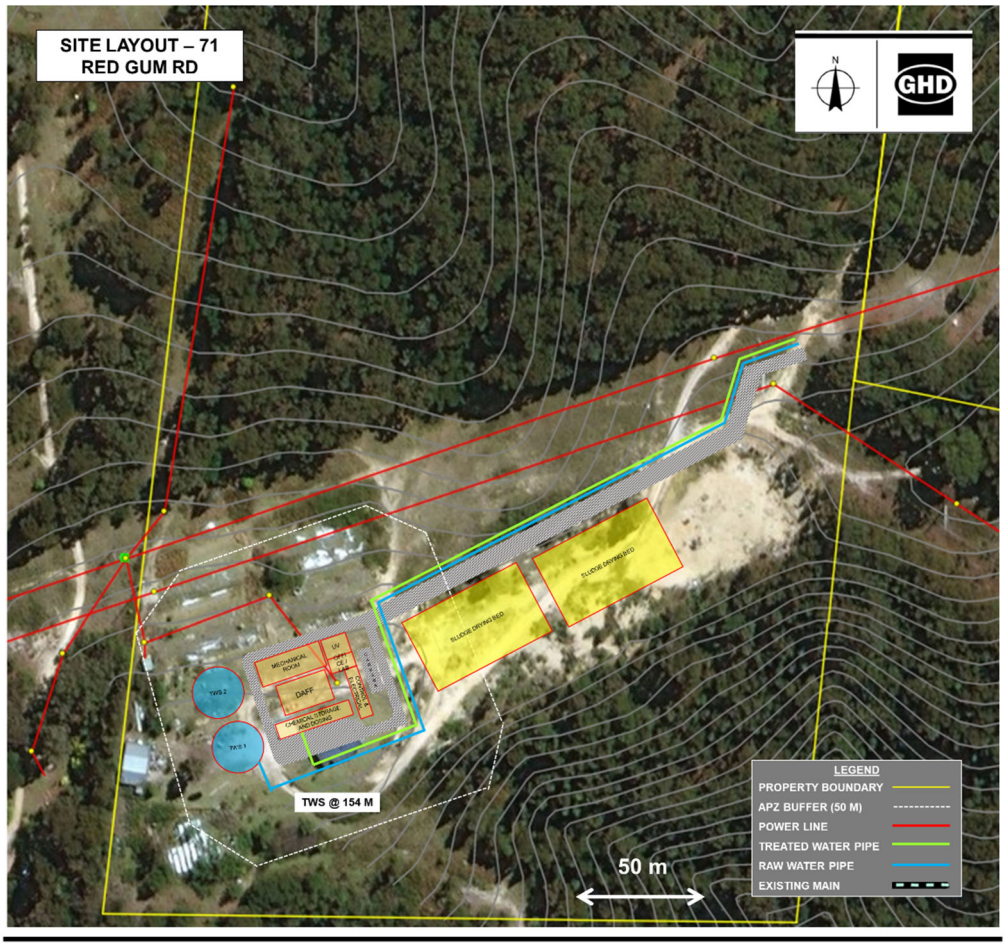

SITE LAYOUT – ELECTRICAL EASEMENT (PARTIALLY INSIDE EASEMENT)
N
GHD
50 m
LEGEND
PROPERTY BOUNDARY
APZ BUFFER (50 M)
EASEMENT
TREATED WATER PIPE
RAW WATER PIPE
EXISTING MAIN

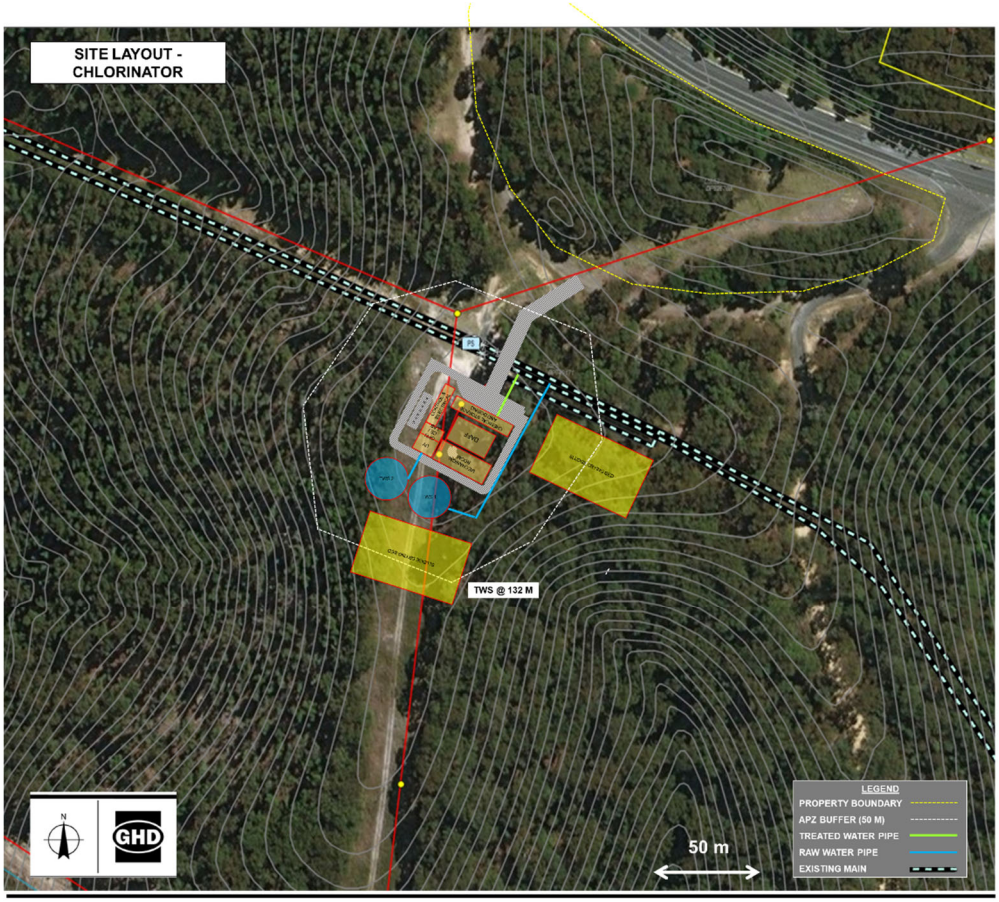

SITE LAYOUT – ELECTRICAL EASEMENT (WHOLLY OUTSIDE EASEMENT)
N
GHD
50 m
LEGEND
PROPERTY BOUNDARY
APZ BUFFER (50 M)
EASEMENT
TREATED WATER PIPE
RAW WATER PIPE
EXISTING MAIN


SITE LAYOUT – 109 RED GUM RD (NTH)
SLUDGE DRYING BED
SLUDGE DRYING BED
MECHANICAL ROOM
DAFF
CHEMICAL STORAGE & MIXING ROOM
CONTROL & ELECTRICAL
TWS 1
TWS 2
TWS @ 120 M
50 m
N
GHD
LEGEND
PROPERTY BOUNDARY
APZ BUFFER (50 M)
TREATED WATER PIPE
RAW WATER PIPE
EXISTING MAIN


SITE LAYOUT – 109 RED GUM RD (STH)
TWS @ 150 M APPROX
50 m
N
GHD
LEGEND
PROPERTY BOUNDARY
APZ BUFFER (50 M)
TREATED WATER PIPE
RAW WATER PIPE
EXISTING MAIN


SITE LAYOUT – 43 RED GUM RD
30 m
30 m
TWS @ 160 M
50 m
LEGEND
PROPERTY BOUNDARY
APZ BUFFER (50 M)
POWER LINE
TREATED WATER PIPE
RAW WATER PIPE
EXISTING MAIN
N
GHD


SITE LAYOUT – 71 RED GUM RD
TWS @ 154 M
50 m
LEGEND
PROPERTY BOUNDARY
APZ BUFFER (50 M)
POWER LINE
TREATED WATER PIPE
RAW WATER PIPE
EXISTING MAIN
N
GHD


SITE LAYOUT -
CHLORINATOR
TWS @ 132 M
50 m
LEGEND
PROPERTY BOUNDARY
APZ BUFFER (50 M)
TREATED WATER PIPE
RAW WATER PIPE
EXISTING MAIN
GHD


SITE LAYOUT – 2467
PRINCES HWY
TWS @ 108 M
50 m
LEGEND
PROPERTY BOUNDARY
APZ BUFFER (50 M)
TREATED WATER PIPE
RAW WATER PIPE
EXISTING MAIN
GHD

10. Environmental Constraints

10.1 Overview

A review of the environmental constraints has been undertaken for each of the shortlisted sites outlined in section 8.2. Four of the shortlisted sites have previously been reviewed by NGH in Draft Site Options Assessment (NGH, 2020). A review of this assessment identified that information for these sites was still valid, however further Aboriginal heritage and biodiversity assessment works was completed (see sections 10.2.1 and 10.2.2 respectively) to provide more detailed information.

The remaining sites were reviewed using information contained within the NGH report where relevant or where required additional desktop investigations were undertaken.

Sites with an asterisk (*) indicate instances where information has been sourced from the NGH report.

10.2 Environmental constraints assessment

10.2.1 Aboriginal heritage

10.2.1.1 Methodology

All shortlisted sites were surveyed by New South Wales Archaeology in February 2021. A representative of the Bega Local Aboriginal Land Council (BLALC) was also present at the survey.

A copy of the survey report is located in Appendix C, with a summary provided in section 10.2.1.2.

10.2.1.2 Summary of Outcomes

Survey of all the identified sites was undertaken with no Aboriginal objects being identified. As no items have been identified at any of the sites, they were all considered to have very low to negligible archaeological potential. While some sites were considered to have very low to negligible potential and others negligible, as the potential is considered so low, all sites were considered to have the same constraint for the purpose of the MCA. Due to this, heritage was not included in the MCA as there are no differentiating constraints between options.

10.2.2 Biodiversity

GHD ecologists prepared a biodiversity constraints assessment for the project. A summary of this report is provided in the below sections, while a copy of the report can be found in Appendix D

10.2.2.1 Methodology

Desktop assessment

A desktop assessment was undertaken to identify threatened flora and fauna species, populations and ecological communities listed under the BC Act and FM Act, and MNES listed under the EPBC Act that may occur in the study area.

Further details of this desktop assessment are located in Appendix D.

Field survey

All shortlisted sites were surveyed by two ecologists on the 15th to 19th of February 2021. The survey included the following:

- preparation of vegetation mapping of community types
- habitat assessment and identification of resources for fauna
- opportunistic searches for threatened plants
- opportunistic fauna and plant observations throughout the study area.

Further details of the field survey are located in Appendix D.

Constraints assessment

Biodiversity constraints were classified into classes based on conservation significance and sensitivity to impacts arising from development. The following classes were used as part of the assessment with the below providing a summary of what each class includes (see section 5.1.2 of Appendix D for further discussion on constraints classes):

- low constraint: low biodiversity value consisting of primarily cleared land, exotic vegetation or developed areas
- moderate constraint: moderate biodiversity value consisting of a moderate condition vegetation with limited habitat value
- high constraint: high biodiversity value consisting of remnant vegetation (which may be listed under legislation) containing an abundance of habitat resources and where it is located adjacent to or within National Parks or connected to other tracts of vegetation.

10.2.2.2 Results

Vegetation within all sites was not considered to be representative of threatened ecological communities, however vegetation is considered native vegetation with some introduced vegetation. Table 10.1 provides a summary of the constraints identified at each of the shortlisted sites. A detailed breakdown of the vegetation located at each site is provided in section 4.1 of Appendix D. Table 10.1 also outlines the impacts for each site based on the indicative layouts developed as part of this report (presented in section 9).

The overall constraints of a site (site as a whole or the impacted indicative footprint) where based upon the following classes:

- High: 75% or more of area is high constraint
- Moderate to high: 50% to 75% of area is high constraint
- Moderate: Low and moderate areas form the majority with some high constraint areas
- Low to moderate: Low and moderate constraint areas only
- Low: All low constraint areas.

In addition to the above, the number of hollow-bearing trees to be impacted were factored into the overall constraints level of a site. Where the number of hollow-bearing trees identified is high and the ratio of high constraint areas is at the upper limit of the class outlined above, the constraint of this location was increased. Two sites have such a low area of high impact they were considered to have no impact on high for the purposes of the MCA.

While detailed flora and fauna surveys were not completed, all sites are considered to contain vegetation considered habitat for threatened flora and fauna species based on the likelihood of occurrence assessment undertaken (see section 4.4.2 of Appendix D). Table 10.1 also outlines the number of hollow-bearing trees which were recorded in each of the sites. It is noted that due to the limited nature of the survey that not all hollow-bearing trees were identified and that only those opportunistically identified were recorded. These numbers are considered to provide an indication of the abundance of the hollow bearing trees at each of the sites.

Table 10.1 Environmental constraints – biodiversity

Site	Summary of overall site constraints	Indicative layout impacts[1]
Above dam	Highly constrained: 4.21 ha Moderately constrained: Nil Low constrained: 0.40 ha Hollow bearing trees: 13 Overall constraint: **High constraint**	Layout 1 @ 240 metres Highly constrained: 1.8 ha Moderately constrained: Nil Low constrained: 0.2 ha Hollow bearing trees: 3 Overall constraint: **High constraint**
		Layout 2 @ 220 metres Highly constrained: 1.6 ha Moderately constrained: Nil Low constrained: 0.3 ha Hollow bearing trees: 10 Overall constraint: **High constraint**
Easement	Highly constrained: 4.95 ha Moderately constrained: Nil Low constrained: 1.67 ha Hollow bearing trees: 11 Overall constraint: **High constraint** (note that access to site also includes high constraint and impacts to hollow bearing trees)	Layout 1 – Lagoon in easement Highly constrained: 1 ha Moderately constrained: Nil Low constrained: 0.8 ha Hollow bearing trees: 6 Overall constraint: **Moderate to high constraint** with consideration of the requirement for access this layout would have a **high constraint**
		Layout 2 – Lagoon out of easement Highly constrained: 1.2 ha Moderately constrained: Nil Low constrained: 0.6 ha Hollow bearing trees: 7 Overall constraint: **Moderate to high constraint** with consideration of the requirement for access this layout would have a **high constraint**

Site	Summary of overall site constraints	Indicative layout impacts[1]
109 Red Gum Road (north)	Highly constrained: 0.86 ha Moderately constrained: 0.82 ha Low constrained: 1.74 ha Hollow bearing trees: 0 Overall constraint: **Moderate constraint**	Highly constrained: 0.06 ha Moderately constrained: 0.3 ha Low constrained: 1.2 ha Hollow bearing trees: Nil Overall constraint: **Low-moderate** due to the very small area of high impacted
109 Red Gum Road (south)	Highly constrained: 1.65 ha Moderately constrained: Nil Low constrained: 1.32 ha Hollow bearing trees: 3 Overall constraint: **Moderate-high constraint**	Highly constrained: 1.2 ha Moderately constrained: Nil Low constrained: 0.4 ha Hollow bearing trees: 3 Overall constraint: **High constraint**
71 Red Gum Road	Highly constrained: 1.30 ha Moderately constrained: 0.31 ha Low constrained: 2.91 ha Hollow bearing trees: 0 Overall constraint: **Moderate constraint**	Highly constrained: 0.08 ha Moderately constrained: 0.1 ha Low constrained: 1.7 ha Hollow bearing trees: 0 Overall constraint: **Low to moderate constraint** due to the very small area of high impacted
43 Red Gum Road	Highly constrained: 6.48 ha Moderately constrained: Nil Low constrained: 2.12 ha Hollow bearing trees: 12 Overall constraint: **High constraint**	Highly constrained: 0.9 ha Moderately constrained: Nil Low constrained: 0.8 ha Hollow bearing trees: 2 Overall constraint: **Moderate-high constraint**
Chlorinator	Highly constrained: 5.71 ha Moderately constrained: Nil Low constrained: 1.01 Hollow bearing trees: 24 Overall constraint: **High constraint**	Highly constrained: 1.3 ha Moderately constrained: Nil Low constrained: 0.4 ha Hollow bearing trees: 7 Overall constraint: **High constraint**

Site	Summary of overall site constraints	Indicative layout impacts[1]
North-east of chlorinator	Highly constrained: 3.46 ha Moderately constrained: 1.3 ha Low constrained: 1.58 ha Hollow bearing trees: 5 Overall constraint: **Moderate-high constraint**	Highly constrained: Nil Moderately constrained: 0.8 ha Low constrained: 0.9 ha Hollow bearing trees: 1 Overall constraint: **Low-moderate constraint**

Note:

1. Areas are rounded to one decimal place with the exception of areas less than 0.1 which are rounded to two decimal places

Figure 6 Above dam (240m) biodiversity constraints

Figure 7 Above dam (220m) biodiversity constraints

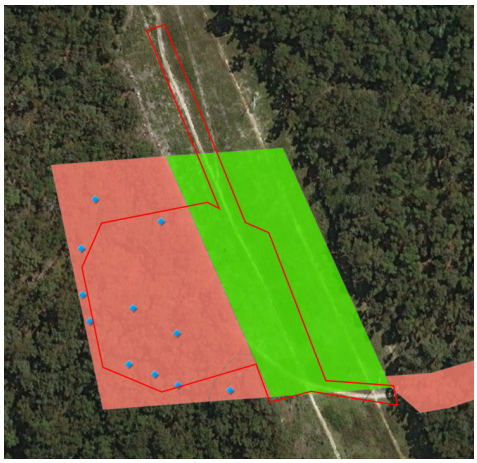


Figure 8 Easement biodiversity constraints

Figure 9 109 Red Gum Road north) biodiversity constraints

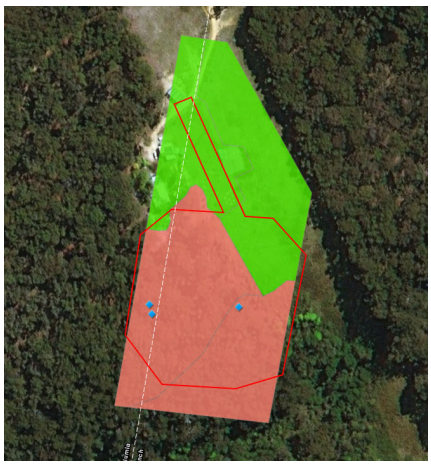


Figure 10 109 Red Gum Road (south) biodiversity constraints

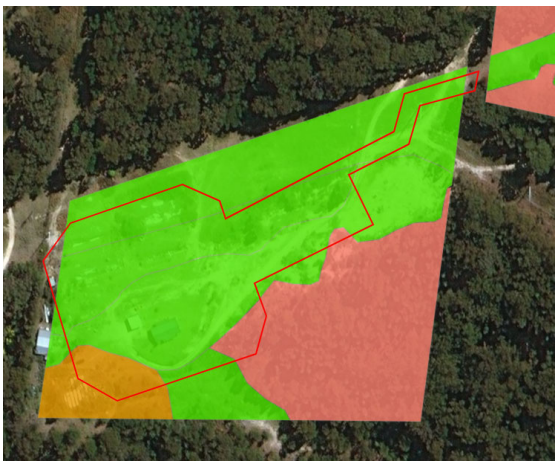


Figure 11 71 Red Gum Road biodiversity constraints

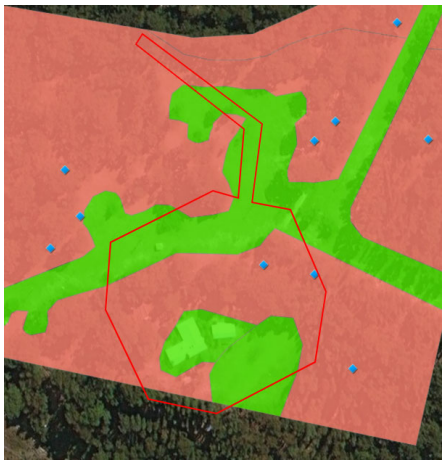


Figure 12 43 Red Gum Road biodiversity constraints

Figure 13 Chlorinator biodiversity constraints

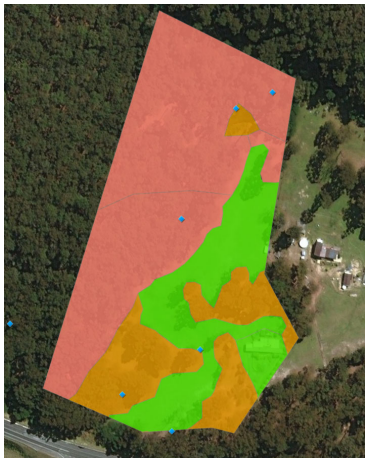


Figure 14 2467 Princes Hwy biodiversity constraints

A review of each of the sites against the site wide constraints identified that vegetation clearance required (when considering the clearance of the vegetation only) is unlikely to result in a significant impact at most sites. When consideration of fauna habitat impacts is taken into account, a number of sites are considered to potentially result in significant impacts as vegetation, while not threatened, could be habitat for threatened flora and fauna species. Further field surveys would be required to confirm the presence of species or their habitat and therefore the significance of any impacts.

Impacts on habitat for threatened species is considered to be amplified in this region due to the 2019/2020 bushfire resulting in an extensive reduction of fauna habitat in the region. This means that any remaining habitat is considered more valuable than it would have been had the fires in the region not occurred.

In the event significant impacts are identified following further surveys, preparation of a Biodiversity Development Assessment Report would be required. Where significant impacts are not identified, a biodiversity assessment report would be required to accompany any approval documents (i.e., a REF). A summary of the identified significance of impacts for each site based upon the information available and survey completed is located in Table 10.2.

Table 10.2 Potential significance of impact at sites

Site	Likelihood of significance	Implications for assessment and approval of a development
Above dam	Potential	Potential to have a significant impact to threatened biota and require the preparation of a BDAR
Easement	Potential	Potential to have a significant impact to threatened biota and require the preparation of a BDAR
109 Red Gum Road (north)	Unlikely	Biodiversity assessment report to accompany a REF
109 Red Gum Road (south)	Potential if not within low constraint areas	Potential to have a significant impact to threatened biota and require the preparation of a BDAR if in low constraint areas a biodiversity assessment report to accompany a REF would be required
71 Red Gum Road	Unlikely	Biodiversity assessment report to accompany a REF
43 Red Gum Road	Unlikely	Biodiversity assessment report to accompany a REF
Chlorinator	Potential	Potential to have a significant impact to threatened biota and require the preparation of a BDAR
2467 Princes Hwy	Unlikely	Biodiversity assessment report to accompany a REF

10.2.3 Land use and zoning

10.2.3.1 Results

Table 10.3 provides a summary of the existing environment at each of the shortlisted sites in relation to land use and zoning.

Table 10.3 Environmental constraints – land use zoning

Site	Summary of existing environment
Above dam*	Yellow Pinch Dam Site (owned by Council) SP2 Infrastructure – WTP permissible with consent and no rezoning would be required. (**Low constraint**)
Easement*	South East Forest National Park (owned by NSW NPWS) E1 National Parks and Nature Reserves – WTP prohibited and would require a rezoning for works to be permissible. (**High constraint**)
109 Red Gum Road (north)	Private rural residential property (no dwelling in shortlisted site area) E3 Environmental Management – WTP prohibited and would require a rezoning for works to be permissible. (**Moderate constraint**)
109 Red Gum Road (south)	Private rural residential property (dwelling in shortlisted site area) E3 Environmental Management – WTP prohibited and would require a rezoning for works to be permissible. (**Moderate to high constraint**)
71 Red Gum Road	Private rural residential property (dwelling in shortlisted site area) E3 Environmental Management – WTP prohibited and would require a rezoning for works to be permissible. (**Moderate to high constraint constraint**)
43 Red Gum Road*	Private rural residential property (dwelling in shortlisted site area) E3 Environmental Management – WTP prohibited and would require a rezoning for works to be permissible. (**Moderate constraint**)
Chlorinator*	South East Forest National Park (owned by NSW NPWS) E1 National Parks and Nature Reserves – WTP prohibited and would require a rezoning for works to be permissible. (**High constraint**)
2467 Princes Highway	Private rural residential property (dwelling in shortlisted site area) E3 Environmental Management – WTP prohibited and would require a rezoning for works to be permissible. (**Moderate to high constraint**)

Where a rezoning would be required (i.e. the majority of the sites outlined above), rezoning of the land is recommended to not be applied to the whole impacted lot and should only impact upon land which is required for the WTP with allowance for potential future expansion. This approach would ensure that the environmental protection zones which apply to all the sites would be partially maintained which is considered to be a good outcome. Ongoing development of the plant layout could include more detailed siting of infrastructure in areas that are already cleared and thus are not considered to be as representative of the existing environmental protection zonings.

10.2.1 Bushfire

10.2.1.1 Results

Table 10.4 provides a summary of the existing environment at each of the shortlisted sites in relation to bushfire.

Table 10.4 Environmental constraints – bushfire zoning

Site	Summary of existing environment
Above dam*	This land is mapped as Category 1 bush fire prone land (**High constraint**).
Easement*	This land is mapped as Category 1 bush fire prone land (**High constraint**).
109 Red Gum Road (north)	The majority of the land is mapped as Category 3 bush fire prone land with some mapped as Category 1 bush fire prone land (**High constraint**).
109 Red Gum Road (south)	The majority of the land is mapped as Category 3 bush fire prone land with some mapped as Category 1 bush fire prone land (**High constraint**).
71 Red Gum Road	The majority of the land is mapped as Category 3 bush fire prone land with some mapped as Category 1 bush fire prone land (**High constraint**).
43 Red Gum Road*	This land is mapped as Category 3 bush fire prone land (**Moderate constraint**)
Chlorinator*	This land is mapped as Category 1 bush fire prone land (**High constraint**).
2467 Princes Highway	The land is mapped as combination of Category 1 and Category 3 bush fire prone land (**High constraint**).

Note: Sites with an asterisk (*) indicate instances where information has been sourced from the NGH report.

For the purposes of the MCA the risk of bushfire is not considered to be a constraint as the provision of asset protection zones have been factored into the design for all sites thus reducing any bushfire risk to a level at which is consistent across the site.

10.2.2 Amenity

10.2.2.1 Results

Table 10.5 provides a summary of the existing environment at each of the shortlisted sites in relation to amenity.

Table 10.5 Environmental constraints – amenity

Site	Summary of existing environment
Above dam*	There are minimal amenity impacts due to separation of this site from any dwellings/residential zoned land (**Low constraint**).
Easement*	Noise, vibration, visual and air quality impacts relatively low due to separation from residences (**Low constraint**).
109 Red Gum Road (north)	Noise, vibration, visual and air quality impacts due to proximity to rural residential properties in surrounding area (**Moderate constraint**).
109 Red Gum Road (south)	Noise, vibration, visual and air quality impacts due to proximity to rural residential properties in surrounding area (**Moderate constraint**).
71 Red Gum Road	Noise, vibration, visual and air quality impacts due to dwellings in surrounding area and assumption that on site dwelling would be removed (**Moderate constraint**).
43 Red Gum Road*	Noise, vibration, visual and air quality impacts due to proximity to rural residential properties in surrounding area (**Moderate constraint**).
Chlorinator*	Noise, vibration, visual and air quality impacts relatively low due to separation from residences (**Low constraint**).
2467 Princes Highway	Noise, vibration, visual and air quality impacts due to dwellings in surrounding area and assumption that on site dwelling would be removed (**Moderate constraint**).

Note: Sites with an asterisk (*) indicate instances where information has been sourced from the NGH report.

10.3 Potential land swap sites

Council identified seven potential council owned properties which, in the event that the preferred option involved the requirement for National Park, land could potentially be swapped with National Parks as part of the revocation process. These sites were surveyed to confirm the condition of existing vegetation on these sites to determine if they would be suitable as part of a land swap.

Figure 15 Identified potential land swap sites

10.3.1 Results of survey of these properties

10.3.1.1 Biodiversity

Table 10.6 provides a summary of the vegetation identified within each of the potential land swap sites. This includes details of the condition of the vegetation, its biodiversity value and whether any threatened ecological communities were identified.

Table 10.6 Condition of vegetation at land swap sites

Site	Summary of vegetation
15554	Good condition vegetation across the site including about 1.27 hectares of remnant rainforest vegetation. Vegetation on site considered to be of high biodiversity value. Some large hollow bearing trees present.
5201	Good condition vegetation across the site with high biodiversity value. Some large hollow bearing trees present. About 0.10 hectares considered a threatened ecological community (River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC under the BC Act and CEEC under the EPBC Act)).
14464	Good condition vegetation across the site including 0.68 hectares of remnant rainforest vegetation. Vegetation on site considered to be of high biodiversity value. Some large hollow bearing trees present.
8842	Medium to good condition vegetation on the site. Includes 0.60 hectares of good condition high biodiversity value which is considered a threatened ecological community (River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC under the BC Act and CEEC under the EPBC Act)). 0.36 hectares of medium quality vegetation consists of regrowth threatened ecological community (River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast,

Site	Summary of vegetation
	Sydney Basin and South East Corner Bioregions (EEC under the BC Act and CEEC under the EPBC Act)).
5273	Good condition vegetation consisting of threatened ecological community (River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (EEC under the BC Act and CEEC under the EPBC Act)).
22310	Good condition vegetation with large hollow bearing trees. Vegetation on site considered to be of high biodiversity value.
7735	Good condition vegetation with large hollow bearing trees. Vegetation on site considered to be of high biodiversity value.

Further details of this vegetation can be found in section 4.1.2 of Appendix D.

In summary, the proposed land swap sites are considered to have an equal or greater biodiversity value than the potentially impacted sites within National Parks land. This would include some sites containing threatened ecological community and vast tracts of remnant vegetation undisturbed by development.

10.3.1.2 Aboriginal heritage

A survey of the identified potential land swap sites was undertaken with all sites identified as containing no sites and therefore being considered to be of low archaeological potential. This low potential was due primarily to the nature of the terrain which contains limited landscape features which would have made them a focus of Aboriginal activity including the remoteness form a permanent source of water. The extensive prior disturbance and/or erosional contexts also contribute to the low archaeological potential of the site.

10.4 Review of revocation assessment

GHD reviewed section 3.3.2 of NGH's Draft *Site Options Assessment Report* (NGH, 2020) which outlined the revocation of National Park land. The revocation of land would be required should the Chlorinator or Electricity Easement sites be the preferred option. The review concluded that the summary of the process within NGH's report and the advice from Planning Law Solutions is correct.

GHD's understanding of the National Park revocation process is that it is a particularly arduous and protracted process as outlined in the NGH report involving an Act of Parliament and an amendment to the *National Parks and Wildlife Act 1974* (NPW ACT). In GHD's experience acting for developers and government agencies, the acquisition of National Park land for an infrastructure site involving the revocation of part of a National Park is not a recommended process, unless there is definitely no other suitable land available for acquisition.

Summary of revocation tasks to be undertaken:

- As advised in the NGH Report, engage with NPWS initially with the preparation of brief outline of the proposal.
- Providing NPWS provide an indication of acceptance of the proposal, prepare a formal submission to NPWS for the revocation of the selected site including the provision of the compensatory land.
- Develop a program of the tasks to be completed including legal review of the process, land conveyancing required, cadastral survey and plan of subdivision,

- Assess and determine the suitability of the compensatory land (ie proposed land swaps sites considered as part of the surveys undertaken as part of this report).
- On selection of the compensatory land, obtain an option to acquire the land which would be subject to the approval of the revocation of the NPWS land selected for the WTP.
- BVSC to consult with the Minister for Local Government and Minister of Environment offices regarding the proposal, the preparation of the bill to amend the Act and the legislative program for introduction of the bill.

Though the timing of the proposed construction of the water treatment plant is not planned for about five years, it is considered for the sake of program that commencing revocation process as soon as possible is in the interest of BVSC due to the potential duration the process. A review of past revocation amendments to the NPW Act, suggest that revocations only take place every three to five years following the receipt of a number of separate revocations to allow a single bill to be past. Consultation with NPWS undertaken by Council confirmed that the latest revocation bill was passed in 2020 and therefore the timing to the next potential bill could be a number of years. Further consultation would potentially be required to confirm the likely timing of any future revocations in the event that the proposed revocation is held up awaiting further revocations to allow the bill to be introduced.

A key risk to be considered is the possibility that the above process is undertaken with its associated costs, and in unforeseen circumstances the revocation proposal is ultimately rejected by NPWS, the Minister or a change in government.

Costs associated with the revocation process are difficult to determine as they are not legislated and GHD staff have not been involved in any revocation process directly. In considering the above a conclusion is reached that the cost would substantially more than if there is an acceptable WTP site which can be acquired outside of the National Park.

11. Multi-criteria Analysis (MCA)

11.1 MCA criteria and weightings

The MCA criteria and weightings were workshopped and agreed with BVSC. Table 11.1 summarises the criteria and weightings adopted for the base case MCA.

Some of the MCA inputs were quantitative (e.g. NPC, impact on biodiversity, energy consumption) and some were qualitative (ease of acquiring site, impact on neighbours, ease of access for operators).

Table 11.1 Summary of MCA criteria and weightings

Criteria	Weighting	Comment
Net present cost (NPC)	50%	Based on an upper and lower bound NPC analysis. Refer to Appendix E for a summary of the assumptions related to the upper and lower bounds. The standard deviation from the mean NPC value was used to allocate a MCA score between 1-5
Ease of acquiring site, rezoning	15%	A qualitative assessment based on the following major factors: • National Park vs. council-owned vs. privately owned land • Willingness of owner to sell • Likely rezoning effort • Other constraints (e.g. a need to construct within electrical easement/s)
Impact on biodiversity	15%	Based on the area of tree clearing required for the WTP, solids handling facilities and access roads/pipelines. Additional consideration of the number of hollow bearing trees on the property as these are of high ecological importance for fauna.
Impact on neighbours	5%	The likelihood that construction/operation will cause disruption to a nearby neighbour. This criterion also accounts for the need for the Easement sites to be accessed via an Aboriginal Reserve.
Ease of access for operators (e.g. during bushfires)	10%	The remoteness and accessibility of each site is assessed. Options with difficult access routes (e.g. long, winding roads through dense forest) are scored poorly for this criterion.
Less absolute energy (Council green future)	5%	Based on the total pumping energy requirement (in MWh/year) for each option. The standard deviation from the mean energy consumption was used to allocate a MCA score between 1-5.

Criteria	Weighting	Comment
		This criterion is included to emphasise the desire to reduce energy consumption, regardless of the energy source (e.g. renewables, power grid, etc.) 5% weighting was deemed sufficient due to energy "penalty" being incorporated in NPC calculation

11.2 MCA scoring

Based on the criteria and weighting outlined above, the MCA scores were determined as shown below (Figure 16).

The options are scored on a scale of 0-5, where:

A score of 1: Very Poor

A score of 2: Poor

A score of 3: Neutral

A score of 4: Good

A score of 5: Very Good

11.3 MCA results

Based on the results, it was agreed that the 43 Red Gum Rd (RGR) site should be taken forward as the preferred location for the new WTP. Various sensitivities were tested during the workshop and none of these showed reason to doubt this conclusion. This section provides some more detail on the results of the base case and sensitivity analyses.

11.3.1 Base case

Results of the base case are displayed below in Figure 16. The weightings for this case are as described in section 11.1 and the scoring was agreed upon in the workshop.

It is noted that the initial Biodiversity rating for 43 RGR was 2. This was marginal and could have been given a 3 based on the environmental constraints scoring system. The score was adjusted to 3 based on this and the scope to rearrange the plant layout to avoid the ecologically significant areas. The other site with a score of 2 (Easement, under power line) has no scope to avoid ecologically sensitive areas and hence a score differentiation was deemed appropriate.

As shown in Figure 16, 43 RGR scored highest overall with 3.89 (out of five), followed by 71 RGR on 3.65.

Criteria	Weighting	Above Dam @ 240m		Above Dam @ 220m		Easement under power line		Easement		43 Red Gum Rd		109 Red Gum Rd (Nth)		109 Red Gum Rd (Sth)		71 Red Gum Rd		Chlorinator		2467 Princes Hwy	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
NPC Mid Point	50%	1.0	0.5	2.9	1.4	3.6	1.8	3.7	1.8	3.7	1.8	2.4	1.2	3.0	1.5	3.8	1.9	3.1	1.6	2.9	1.4
		$8.5m		$6.8m		$6.2m		$6.1m		$6.1m		$7.3m		$6.8m		$6.0m		$6.6m		$6.8m	
Ease of acquiring site, rezoning	15%	4	0.6	4	0.6	1	0.15	2	0.3	5	0.75	5	0.75	3	0.45	2	0.3	2	0.3	4	0.6
		Council-owned land		Council-owned land		Unlikely to get permission to build under 66 kVA line		National Park		Willing sellers		Willing sellers		Willing sellers		Unwilling sellers		National Park		Willing sellers	
Impact on biodiversity	15%	1	0.15	1	0.15	1	0.15	2	0.3	3	0.45	4	0.6	1	0.15	4	0.6	1	0.15	4	0.6
		1.8 ha of high constraint, some hollow bearing trees		1.6 ha of high constraint, large number of hollow bearing trees		1 ha of high constraint and hollow-bearing trees plus access road being high constraint		1.2ha of high constraint, large number of hollow-bearing trees		0.9 ha of high constraint, some hollow bearing trees		Very small amount of high constraint no hollow bearing trees		1.2ha of high constraint and hollow-bearing trees		Very small amount of high constraint with no hollow bearing trees		1.3ha of high constraint and large number of hollow bearing trees		No high constraint impact and low number of hollow-bearing trees	
Impact on neighbours	5%	5	0.25	5	0.25	4	0.2	4	0.2	3	0.15	2	0.1	3	0.15	3	0.15	5	0.25	2	0.1
						Road nearby Aboriginal Reserve		Road nearby Aboriginal Reserve				Near neighbouring house (top of site). Neighbour not overly concerned based on initial consultation		Near neighbouring house (top of site). Neighbour not overly concerned based on initial consultation						Nearby neighbour	
Ease of access for operators (e.g. during bushfires)	10%	5	0.5	5	0.5	2	0.2	2	0.2	5	0.5	4	0.4	3	0.3	5	0.5	5	0.5	5	0.5
						Long winding road through dense forest		Long winding road through dense forest													
Less absolute energy (Council green future)	5%	1.6	0.08	3.0	0.15	4.5	0.23	4.5	0.23	4.2	0.21	1.4	0.07	3.2	0.16	3.7	0.18	3.0	0.15	1.0	0.05
		500 MWh/year		335 MWh/year		170 MWh/year		170 MWh/year		210 MWh/year		520 MWh/year		320 MWh/year		265 MWh/year		340 MWh/year		565 MWh/year	
RESULT	**100%**	**2.08**		**3.09**		**2.71**		**3.06**		**3.89**		**3.13**		**2.69**		**3.65**		**2.90**		**3.30**	

Figure 16 Summary of MCA scores for base case

11.4 Sensitivity Analysis

As there were a number of assumptions used in developing these scores (in particular for NPC), a sensitivity analysis was undertaken to further interrogate the results. The following sensitivities were performed:

- 0% NPC to remove cost from consideration
- 100% NPC to consider the least-cost option
- 25% Biodiversity weighting
- 25% Ease of acquiring site/rezoning weighting
- Secondary MCA with revised options and criteria

A summary of the sensitivity analysis is shown below in Figure 17. The summary shows that in all cases, 43 RGR is the most, or narrowly second-most, preferred site.

The subsequent pages of this section provide some more detail on each of the scenarios.

Sensitivity	Above Dam @ 240m	Above Dam @ 220m	Easement under power line	Easement	43 Red Gum Rd	109 Red Gum Rd (Nth)	109 Red Gum Rd (Sth)	71 Red Gum Rd	Chlorinator	2467 Princes Hwy
Base Case	2.08	3.09	2.71	3.06	3.89	3.13	2.69	3.65	2.90	3.30
0% NPC	3.16	3.30	1.85	2.45	4.12	3.84	2.42	3.47	2.70	3.70
100% NPC	1.00	2.88	3.57	3.67	3.67	2.42	2.96	3.84	3.10	2.89
25% Biodiversity	1.73	2.74	2.66	3.06	3.69	3.08	2.49	3.70	2.65	3.30
25% Acquisition/ rezoning	2.18	3.19	2.66	3.06	3.99	3.23	2.79	3.40	2.80	3.30

Figure 17 Summary of MCA sensitivity assessment

11.4.1 Sensitivity - 0% NPC

This sensitivity is included to determine whether the relative NPC determined for each site was having a significant impact on the overall results. The results are shown in **Error! Reference source not found.** (Appendix B).

As shown, when cost is not considered, 43 RGR is still the preferred option. 109 RGR (North) and 2467 Princes Hwy become more favourable because this site is relatively expensive from an NPC perspective (due to high TW pumping requirements).

11.4.2 Sensitivity - 100% NPC

This sensitivity is a ranking of each site based on relative NPC. Results are shown in **Error! Reference source not found.** (Appendix B).

If only cost is considered, 71 RGR is preferred as this site has the lowest NPC. It should be noted that the difference in NPC between this site and 43 RGR is only $0.1 million, and that the total project NPC (including the WTP NPC which is common to all options) is expected to be around $30 million.

Given that the private owner of 71 RGR is unwilling to sell under the terms proposed by BVSC, selecting this site on the basis of NPC alone may constitute an unacceptable risk to Council if they wish to avoid compulsory acquisition of the property.

11.4.3 Sensitivity – 25% Biodiversity

This sensitivity prioritised biodiversity over the other criteria (when compared to the base case). Results are shown in **Error! Reference source not found.** (Appendix B).

71 RGR is preferred (very slightly) over 43 RGR due to being a well cleared site with minimal high constraint areas within the plant footprint.

11.4.4 Sensitivity – 25% Ease of access/rezoning

This sensitivity prioritised the ease of acquiring the site and rezoning above the other criteria (when compared to the base case). Results are shown in **Error! Reference source not found.** (Appendix B).

43 RGR comes out well on top when applying these weightings, while 71 RGR remains the second preference. This is largely due to the fact that the owner of 43 RGR is willing to sell their land, whereas the owner of 71 RGR is less willing.

11.4.5 Secondary MCA with revised options and criteria

Based on the results of the base case and subsequent sensitivity analysis, it became clear that neither of the Easement sites would be preferred. This location was the key differentiator for the ease of access criterion, as the Easement sites were difficult to access through a long, winding trail flanked on both sides by forest. These two sites were omitted, and the ease of access criterion removed, with results displayed in **Error! Reference source not found.** (Appendix B).

As shown, 43 RGR is preferred, again followed by 71 RGR.

12. Conclusions and Recommendations

Bega Valley Shire Council (BVSC) has plans to construct a new water treatment plant (WTP) near the Yellow Pinch Dam to ensure treated water supply will meet demand in the region through to 2048.

The purpose of this work was to select the most appropriate site for the plant based on the following factors, among others:

- Energy usage related to the hydraulics of pumping raw and treated water
- Clearing of National Park land for plant, associated pipework, and access roads
- Proximity to existing pipelines and access roads
- Site topography and spatial constraints
- Biodiversity and Aboriginal heritage constraints
- Social considerations (e.g. ease of land acquisition)

A multicriteria analysis (MCA) was undertaken to compare sites against the agreed triple bottom line criteria. The weightings and scores were agreed upon during a workshop on 18 March 2021. The results of the MCA showed that the site at 43 Red Gum Rd is preferred to carry forward into the next stage of planning.

12.1 Next Steps

The next phase of this work will include:

- Planning proposal for rezoning of 43 Red Gum Rd. It is proposed that some existing E3 land will be retained in the heavily vegetated sections of the lot (NW and NE corners and possibly along the eastern boundary). The footprint of the WTP is expected to be contained majorly within the existing cleared areas of the lot
- Strategic bushfire study to support the planning proposal and to confirm the required asset protection zone for the WTP
- Detailed site survey
- Traffic report to demonstrate safe access to the area and entry and egress for large vehicles
- Detailed process options assessment including jar testing to confirm chemical dosing strategy.
- Reference design including any required additional site investigations such as geotechnical investigations
- Additional community consultation if required

Appendices

Appendix A – Geotechnical Desktop Review

A preliminary desktop geotechnical assessment was carried out for all of the proposed sites, with four of seven proposed sites (sites A, C, D and F) assessed during a site walkover by an engineering geologist on the 13 October 2020. The remaining three sites (sites B, E and G) did not have a site walkover performed. Information presented from the site walkover relates to the actual areas observed, and may differ slightly to the locations shown in Figure 1. The sites have been discussed individually in their respective sections below.

Table 12-1 Summary of sites for geotechnical assessment

Ref	Area	Assessment
A	West Wolumla	Desktop, site walkover
B	Back of Dam	Desktop only
C	Above Dam	Desktop, site walkover
D	Electricity Easement	Desktop, site walkover
E	Red Gum Rd	Desktop only
F	Chlorinator	Desktop, site walkover
G	Boggy Creek Rd	Desktop only

Site A - West Wolumla

Site A is situated south-west of Wolumla township, in open grassed paddocks as seen in Figure 1. Observations were undertaken from the Ferndale Lane approximately 400 m west of the site, a walkover of the actual proposed site was not undertaken. The proposed site is situated on shallow sloping undulating paddocks. Some farm dams and gullies were observed within this site. Tree cover was sparse, with only a few large, scattered trees observed. The ground surface conditions observed at the observation point comprised of residual or extremely weathered granitic material, it is likely that the site has a similar soil type. Site photographs 1 and 2 are presented in Appendix A.

Site B- Back of Dam

Site B is situated north west of Yellow Pinch dam as seen in Figure 1. A review of current aerial photographs of the site show that Site B is positioned in grassed paddocks on northerly sloping hillside, with an estimated gradient between 5 and 10°. The area to the south of the site is heavily vegetated, with many large established trees. Based on aerial imagery there does not appear to be any permanent water bodies at the site. No walkover of this site was undertaken by our engineering geologist.

Site C - Above Dam

Site C is situated north-east of Yellow Pinch dam, in a forested area south of Yellow Pinch Dam Road as seen in Figure 1. The site elevation falls gradually to the south-southwest towards Yellow Pinch Dam, following the natural topography. No permanent water bodies were observed in the immediate area assessed. Site C is a forested area and has many medium to large established trees. In-situ rock type appeared to be of sedimentary origin, observed as small rock

outcrops at the surface. The ground surface was firm underfoot for the walkover assessment. Site photographs 3 to 6 are presented in Appendix A.

Site D - Electricity easement

Site D is situated south east of Yellow Pinch Dam and west of the electricity easement, as seen in Figure 1. The site is within in a near level forested area containing many large established trees. No permanent water bodies were observed during the site walkover and the ground was firm underfoot. No outcrops of in-situ rock were observed at this site, the soil exposed at the ground surface appeared to be residual or extremely weathered soil possibly of sedimentary origin. Site photographs 7 to 10 are presented in Appendix A.

Site E - Red Gum Rd

Site E is situated south-east of Yellow Pinch dam and south of Red Gum Rd, as seen in Figure 1. A review of current aerial photographs of the site shows that the site is positioned in an area with partially cleared vegetation. The area appears to be used for an overhead electricity easement and has access/service tracks. The site appears to be situated on a slightly raised area compared to the surrounding landscape. Areas surrounding the site are vegetated. Based on aerial imagery there do not appear to be any permanent water bodies at the site. No walkover of this site was undertaken by our engineering geologist.

Site F - Chlorinator

Site F is situated southwest of the Princes Highway, off Milligandi Road as seen in Figure 1. The site appears to be situated on slightly elevated are or crest compared to the surrounding landscape. Existing features at the site include the chlorinator, reverse pumping station to Candelo and cleared areas for the electricity easement. Some small-scale cut/fill earthworks have taken place around the existing chlorinator/pumping station and access/service roads. Multiple buried services were evident at the proposed site based on the presence of service pits evident over the surface. The ground observed had a cover of predominantly non-plastic imported gravel and weathered granitic material. Some medium to large trees are present in parts of the site. No permanent water bodies were present in the area observed, the ground was firm underfoot for the walkover assessment. No outcrops of in-situ rock were observed. Site photographs 11 to 14 are presented in Appendix A.

Site G - Boggy Creek Rd

Site G is situated south-east of Yellow Pinch Dam and south of Millingandi Road, as seen in Figure 1. A review of current aerial photographs of the site show that the proposed site is within a heavily vegetated area. The area does not appear to have any infrastructure present, although some access/service tracks appear to present based on aerial imagery. The site appears to be in an area of topographically low relief compared to the surrounding landscape. Based on aerial imagery of the site a creek appears to pass through the site. No walkover of this site was undertaken by our engineering geologist.

Geology and Soils

Reference to the 1:250,000 Bega-Mallacoota Geological Series Sheet SJ/55-4 published by the Department of Mineral Resources in 1995 and shows the proposed sites have the following geology:

- Site A and part Site B - Kameruka Granodiorite, part of the Kameruka Suite described as biotite granodiorite.
- Site B - Yurammie Granodiorite, part of the Candelo Suite described as hornblende-biotite granodiorite.

- Sites C, D, E, F and G - Undifferentiated sandstones and conglomerate, part of the Merimbula group.

Summary and recommendations

Based on the above site observations we conclude the following:

- The general slope conditions indicate no obvious slope instability or erosion within or immediately around Sites A, D, E and F. Sites B and C have estimated slope angles of between 5 and 10°, this will need to be considered during the design phase however this is unlikely to present any major slope instability constraint to the proposed development. Site G is located in a topographically low relief area and appears to have a creek passing through the site which could present some erosion and local instability issues. Sites B, E and G were undertaken as desktop study only and as such slope conditions and stability could not be fully assessed.
- It is likely that rock occurs at shallow depth at Sites B, C, D and E due to their somewhat higher topographic position and presence of rock exposures at Site C.
- Rock types at sites C, D, E, F and G are likely to be sedimentary in origin, conglomerate and sandstone. The rock types at Site A and part of Site B are likely to be granodiorite. Both sites will likely have low or non-plastic soil types and shallow soil profiles.

Appendix B – MCA sensitivity results

Criteria	Weighting	Above Dam @ 240m		Above Dam @ 210m		Easement under power line		Easement		43 Red Gum Rd		109 Red Gum Rd (Nth)		109 Red Gum Rd (Sth)		71 Red Gum Rd		Chlorinator		2467 Princes Hwy	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
NPC Mid Point	0%	1.0	0.0	2.9	0.0	3.6	0.0	3.7	0.0	3.7	0.0	2.4	0.0	3.0	0.0	3.8	0.0	3.1	0.0	2.9	0.0
		$8.5m		$6.8m		$6.2m		$6.1m		$6.1m		$7.3m		$6.8m		$6.0m		$6.6m		$6.8m	
Ease of acquiring site, rezoning	30%	4.0	1.2	4.0	1.2	1.0	0.3	2.0	0.6	5.0	1.5	5.0	1.5	3.0	0.9	2.0	0.6	2.0	0.6	4.0	1.2
		Council-owned land		Council-owned land		Unlikely to get permission to build under 66 kVA line		National Park		Willing sellers		Willing sellers		Willing sellers		Unwilling sellers		National Park		Willing sellers	
Impact on biodiversity	30%	1.0	0.3	1.0	0.3	1.0	0.3	2.0	0.6	3.0	0.9	4.0	1.2	1.0	0.3	4.0	1.2	1.0	0.3	4.0	1.2
		1.8 ha of high constraint, some hollow bearing trees		1.6 ha of high constraint, large number of hollow bearing trees		1 ha of high constraint and hollow-bearing trees plus access road being high constraint		1.2ha of high constraint, large number of hollow-bearing trees		0.9 ha of high constraint, some hollow bearing trees		Very small amount of high constraint no hollow bearing trees		1.2ha of high constraint and hollow-bearing trees		Very small amount of high constraint with no hollow bearing trees		1.3ha of high constraint and large number of hollow bearing trees		No high constraint impact and low number of hollow-bearing trees	
Impact on neighbours	10%	5.0	0.5	5.0	0.5	4.0	0.4	4.0	0.4	3.0	0.3	2.0	0.2	3.0	0.3	3.0	0.3	5.0	0.5	2.0	0.2
						Road near by Aboriginal Reserve		Road near by Aboriginal Reserve				Near neighbouring house (top of site). Neighbour not overly concerned based on initial consultation		Near neighbouring house (top of site). Neighbour not overly concerned based on initial consultation							
Ease of access for operators (e.g. during bushfires)	20%	5.0	1	5.0	1	2.0	0.4	2.0	0.4	5.0	1	4.0	0.8	3.0	0.6	5.0	1	5.0	1	5.0	1
						Long winding road through dense forest		Long winding road through dense forest													
Less absolute energy (Council green future)	10%	1.6	0.16	3.0	0.30	4.5	0.45	4.5	0.45	4.2	0.42	1.4	0.14	3.2	0.32	3.7	0.37	3.0	0.30	1.0	0.10
		500 MWh/year		335 MWh/year		170 MWh/year		170 MWh/year		210 MWh/year		520 MWh/year		320 MWh/year		265 MWh/year		340 MWh/year		565 MWh/year	
RESULT	100%	3.16		3.30		1.85		2.45		4.12		3.84		2.42		3.47		2.70		3.70	

Figure 18 Summary of MCA scores for 0% NPC sensitivity

Criteria	Weighting	Above Dam @ 240m		Above Dam @ 210m		Easement under power line		Easement		43 Red Gum Rd		109 Red Gum Rd (Nth)		109 Red Gum Rd (Sth)		71 Red Gum Rd		Chlorinator		2467 Princes Hwy	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
NPC Mid Point	100%	1.0	1.0	2.9	2.9	3.6	3.6	3.7	3.7	3.7	3.7	2.4	2.4	3.0	3.0	3.8	3.8	3.1	3.1	2.9	2.9
		$8.5m		$6.8m		$6.2m		$6.1m		$6.1m		$7.3m		$6.8m		$6.0m		$6.6m		$6.8m	
Ease of acquiring site, rezoning	0%	4.0	0	4.0	0	1.0	0	2.0	0	5.0	0	5.0	0	3.0	0	2.0	0	2.0	0	4.0	0
		Council-owned land		Council-owned land		Unlikely to get permission to build under 66 kVA line		National Park		Willing sellers		Willing sellers		Willing sellers		Unwilling sellers		National Park		Willing sellers	
Impact on biodiversity	0%	1.0	0	1.0	0	1.0	0	2.0	0	3.0	0	4.0	0	1.0	0	4.0	0	1.0	0	4.0	0
		1.8 ha of high constraint, some hollow bearing trees		1.6 ha of high constraint, large number of hollow bearing trees		1 ha of high constraint and hollow-bearing trees plus access road being high constraint		1.2ha of high constraint, large number of hollow-bearing trees		0.9 ha of high constraint, some hollow bearing trees		Very small amount of high constraint no hollow bearing trees		1.2ha of high constraint and hollow-bearing trees		Very small amount of high constraint with no hollow bearing trees		1.3ha of high constraint and large number of hollow bearing trees		No high constraint impact and low number of hollow-bearing trees	
Impact on neighbours	0%	5.0	0	5.0	0	4.0	0	4.0	0	3.0	0	2.0	0	3.0	0	3.0	0	5.0	0	2.0	0
						Road nearby Aboriginal Reserve		Road nearby Aboriginal Reserve				Near neighbouring house (top of site). Neighbour not overly concerned based on initial consultation		Near neighbouring house (top of site). Neighbour not overly concerned based on initial consultation							
Ease of access for operators (e.g. during bushfires)	0%	5.0	0	5.0	0	2.0	0	2.0	0	5.0	0	4.0	0	3.0	0	5.0	0	5.0	0	5.0	0
						Long winding road through dense forest		Long winding road through dense forest													
Less absolute energy (Council green future)	0%	1.6	0.00	3.0	0.00	4.5	0.00	4.5	0.00	4.2	0.00	1.4	0.00	3.2	0.00	3.7	0.00	3.0	0.00	1.0	0.00
		500 MWh/year		335 MWh/year		170 MWh/year		170 MWh/year		210 MWh/year		520 MWh/year		320 MWh/year		265 MWh/year		340 MWh/year		565 MWh/year	
RESULT	100%	1.00		2.88		3.57		3.67		3.67		2.42		2.96		3.84		3.10		2.89	

Figure 19 Summary of MCA scores for 100% NPC sensitivity

Criteria	Weighting	Above Dam @ 240m		Above Dam @ 210m		Easement under power line		Easement		43 Red Gum Rd		109 Red Gum Rd (Nth)		109 Red Gum Rd (Sth)		71 Red Gum Rd		Chlorinator		2467 Princes Hwy	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
NPC Mid Point	50%	1.0	0.5	2.9	1.4	3.6	1.8	3.7	1.8	3.7	1.8	2.4	1.2	3.0	1.5	3.8	1.9	3.1	1.6	2.9	1.4
		$8.5m		$6.8m		$6.2m		$6.1m		$6.1m		$7.3m		$6.8m		$6.0m		$6.6m		$6.8m	
Ease of acquiring site, rezoning	10%	4	0.4	4	0.4	1	0.1	2	0.2	5	0.5	5	0.5	3	0.3	2	0.2	2	0.2	4	0.4
		Council-owned land		Council-owned land		Unlikely to get permission to build under 66 kVA line		National Park		Willing sellers		Willing sellers		Willing sellers		Unwilling sellers		National Park		Willing sellers	
Impact on biodiversity	25%	1	0.25	1	0.25	1	0.25	2	0.5	3	0.75	4	1	1	0.25	4	1	1	0.25	4	1
		1.8 ha of high constraint, some hollow bearing trees		1.6 ha of high constraint, large number of hollow bearing trees		1 ha of high constraint and hollow-bearing trees plus access road being high constraint		1.2ha of high constraint, large number of hollow-bearing trees		0.9 ha of high constraint, some hollow bearing trees		Very small amount of high constraint no hollow bearing trees		1.2ha of high constraint and hollow-bearing trees		Very small amount of high constraint with no hollow bearing trees		1.3ha of high constraint and large number of hollow bearing trees		No high constraint impact and low number of hollow-bearing trees	
Impact on neighbours	5%	5	0.25	5	0.25	4	0.2	4	0.2	3	0.15	2	0.1	3	0.15	3	0.15	5	0.25	3	0.15
						Road nearby Aboriginal Reserve		Road nearby Aboriginal Reserve				Near neighbouring house (top of site). Neighbour not overly		Near neighbouring house (top of site). Neighbour not overly							
Ease of access for operators (e.g. during bushfires)	5%	5	0.25	5	0.25	2	0.1	2	0.1	5	0.25	4	0.2	3	0.15	5	0.25	5	0.25	5	0.25
						Long winding road through dense forest		Long winding road through dense forest													
Less absolute energy (Council green future)	5%	1.6	0.08	3.0	0.15	4.5	0.23	4.5	0.23	4.2	0.21	1.4	0.07	3.2	0.16	3.7	0.18	3.0	0.15	1.0	0.05
		500 MWh/year		335 MWh/year		170 MWh/year		170 MWh/year		210 MWh/year		520 MWh/year		320 MWh/year		265 MWh/year		340 MWh/year		565 MWh/year	
RESULT	100%	1.73		2.74		2.66		3.06		3.69		3.08		2.49		3.70		2.65		3.30	

Figure 20 Summary of MCA scores for sensitivity with 25% biodiversity weighting

Criteria	Weighting	Above Dam @ 240m		Above Dam @ 210m		Easement under power line		Easement		43 Red Gum Rd		109 Red Gum Rd (Nth)		109 Red Gum Rd (Sth)		71 Red Gum Rd		Chlorinator		2467 Princes Hwy	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
NPC Mid Point	50%	1.0	0.5	2.9	1.4	3.6	1.8	3.7	1.8	3.7	1.8	2.4	1.2	3.0	1.5	3.8	1.9	3.1	1.6	2.9	1.4
		$8.5m		$6.8m		$6.2m		$6.1m		$6.1m		$7.3m		$6.8m		$6.0m		$6.6m		$6.8m	
Ease of acquiring site, rezoning	25%	4	1	4	1	1	0.25	2	0.5	5	1.25	5	1.25	3	0.75	2	0.5	2	0.5	4	1
		Council-owned land		Council-owned land		Unlikely to get permission to build under 66 kVA line		National Park		Willing sellers		Willing sellers		Willing sellers		Unwilling sellers		National Park		Willing sellers	
Impact on biodiversity	10%	1	0.1	1	0.1	1	0.1	2	0.2	3	0.3	4	0.4	1	0.1	4	0.4	1	0.1	4	0.4
		1.8 ha of high constraint, some hollow bearing trees		1.6 ha of high constraint, large number of hollow bearing trees		1 ha of high constraint and hollow-bearing trees plus access road being high constraint		1.2ha of high constraint, large number of hollow-bearing trees		0.9 ha of high constraint, some hollow bearing trees		Very small amount of high constraint no hollow bearing trees		1.2ha of high constraint and hollow-bearing trees		Very small amount of high constraint with no hollow bearing trees		1.3ha of high constraint and large number of hollow bearing trees		No high constraint impact and low number of hollow-bearing trees	
Impact on neighbours	5%	5	0.25	5	0.25	4	0.2	4	0.2	3	0.15	2	0.1	3	0.15	3	0.15	5	0.25	3	0.15
						Road nearby Aboriginal Reserve		Road nearby Aboriginal Reserve				Near neighbouring house (top of site). Neighbour not overly		Near neighbouring house (top of site). Neighbour not overly							
Ease of access for operators (e.g. during bushfires)	5%	5	0.25	5	0.25	2	0.1	2	0.1	5	0.25	4	0.2	3	0.15	5	0.25	5	0.25	5	0.25
						Long winding road through dense forest		Long winding road through dense forest													
Less absolute energy (Council green future)	5%	1.6	0.08	3.0	0.15	4.5	0.23	4.5	0.23	4.2	0.21	1.4	0.07	3.2	0.16	3.7	0.18	3.0	0.15	1.0	0.05
		500 MWh/year		335 MWh/year		170 MWh/year		170 MWh/year		210 MWh/year		520 MWh/year		320 MWh/year		265 MWh/year		340 MWh/year		565 MWh/year	
RESULT	100%	2.18		3.19		2.66		3.06		3.99		3.23		2.79		3.40		2.80		3.30	

Figure 21 Summary of MCA scores for sensitivity with 25% ease of access/rezoning weighting

Criteria	Weighting	Above Dam @ 240m		Above Dam @ 210m		43 Red Gum Rd		109 Red Gum Rd (Nth)		109 Red Gum Rd (Sth)		71 Red Gum Rd		Chlorinator		2467 Princes Hwy	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
NPC Mid Point	50%	1.0	0.5	2.9	1.4	3.7	1.8	2.4	1.2	3.0	1.5	3.8	1.9	3.1	1.6	2.9	1.4
		$8.5m		$6.8m		$6.1m		$7.3m		$6.8m		$6.0m		$6.6m		$6.8m	
Ease of acquiring site, rezoning	20%	4	0.8	4	0.8	5	1	5	1	3	0.6	2	0.4	2	0.4	4	0.8
		Council-owned land		Council-owned land		Willing sellers		Willing sellers		Willing sellers		Unwilling sellers		National Park		Willing sellers	
Impact on biodiversity	20%	1	0.2	1	0.2	3	0.6	4	0.8	1	0.2	4	0.8	1	0.2	4	0.8
		1.8 ha of high constraint, some hollow bearing trees		1.6 ha of high constraint, large number of hollow bearing trees		0.9 ha of high constraint, some hollow bearing trees		Very small amount of high constraint no hollow bearing trees		1.2ha of high constraint and hollow-bearing trees		Very small amount of high constraint with no hollow bearing trees		1.3ha of high constraint and large number of hollow bearing trees		No high constraint impact and low number of hollow-bearing trees	
Impact on neighbours	5%	5	0.25	5	0.25	3	0.15	2	0.1	3	0.15	3	0.15	5	0.25	3	0.15
								Near neighbouring house (top of site). Neighbour not overly		Near neighbouring house (top of site). Neighbour not overly							
Ease of access for operators (e.g. during bushfires)	0%	5	0	5	0	5	0	4	0	3	0	5	0	5	0	5	0
Less absolute energy (Council green future)	5%	1.6	0.08	3.0	0.15	4.2	0.21	1.4	0.07	3.2	0.16	3.7	0.18	3.0	0.15	1.0	0.05
		500 MWh/year		335 MWh/year		210 MWh/year		520 MWh/year		320 MWh/year		265 MWh/year		340 MWh/year		565 MWh/year	
RESULT	100%	1.83		2.84		3.79		3.18		2.59		3.45		2.55		3.25	

Figure 22 Summary of MCA scores with revised criteria and weightings

Appendix C – Aboriginal Heritage Assessment

Appendix D – Biodiversity Assessment

Appendix E – NPC upper and lower bound assumptions for MCA

Cost component	Lower Bound	Upper Bound
Land costs		
Purchase and legal	$1m for private sites, $0.2m for NP sites	*No Change*
Approvals and zoning	$0.5m for all sites	$0.7m for NP sites, $0.5m for others
Land offset for trees (assume land swap)	0	$0.15m/hectare of trees cleared
Siteworks		
Clearing WTP site	1 hectare required	*No Change*
Clearing for sludge lagoons	Refer to specific site layouts	*No Change*
Clearing for APZ	30 m	50 m
Clearing for pipelines	15 m corridor for pipelines	*No Change*
Clearing for access roads	15 m corridor for roads	30 m corridor for roads
Additional earthworks	$0.75m for above dam sites + chlorinator site, $0.5m for 43 RGR site	$1.5m for above dam sites + chlorinator site, $1.0m for 43 RGR site
Pipework		
New RW pipe	$600/m length	*No Change*
New TW pipe	$600/m length	*No Change*
New plant connections	$0.1m for all options	*No Change*
Pump stations		
RW pump station	Duty/standby. Most favourable elevation on site	Least favourable elevation on site
TW pump station		
Wolumla pump station	Easement, RGR and chlorinator sites to reuse drought return pump – no additional CAPEX	*No Change*
Services		
Access road for trucks and during fires	$0.7m/km for easement site, $0.5m/km for others	$1.0m/km for easement site, $0.7m/km for others
Extra power connection cost	No additional costs assumed at this stage (pending feedback from Essential Energy)	
Annual Operating Costs ($M/year)		
RW pumping	4 kWh/m head @ $0.15/kWh (assuming some solar supply)	4 kWh/m head @ $0.30/kWh
TW pumping		
Wolumla pumping		
Eden pumping	4 kWh/m head. Assumed 10m required for Above dam site (WTP at 210m only) and 40m head required for other sites. @ $0.15/kWh	@ $0.30/kWh
Operation of major pump stations	0.25 FTE required for new PS >40kW	*No Change*
Cost of CO2 for pumping	$30/tonne CO2 and 0.83 kg CO2 / kWh x 50% solar offset	$100/tonne CO2 and 0.83 kg CO2 / kWh
Additional		
NPC Tree Clearing Carbon	600 tonne CO2/ha (Over life of tree, applied as one-off capital cost)	*No Change*

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