Regional Renewable Organics Network

Climate Change Risk Assessment

Barwon Water

13 August 2024

→ The Power of Commitment

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GHD Pty Ltd | ABN 39 008 488 373

180 Lonsdale Street, Level 9

Melbourne, Victoria 3000, Australia

T +61 3 8687 8000 | **F** +61 3 8732 7046 | **E** melmail@ghd.com | **ghd.com**

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1. Introduction

1.1 Background

Barwon Water (BW) has engaged GHD Pty Ltd to prepare a Development Licence Application (DLA) for its proposed Regional Renewable Organics Network (RRON). This Climate Change Risk Assessment (CCRA) has been prepared to support the DLA.

The RRON will be located at BW's Black Rock Water Reclamation Plant (WRP) located at 405 Blackrock Road, Connewarre, approximately 18 km south of Geelong. The Black Rock WRP is an established organic waste recycling facility that treats wastewater and produces Class A and Class C recycled water, as well as processing approximately 60,000 t/y of biosolids.

The RRON facility is proposed to process approximately 40,000 t/y of comingled food organics and garden organic (FOGO) waste predominately from local Municipalities. This FOGO stream will be pre-processed and separated into a food organics (FO) rich stream and a garden organics (GO) rich stream. The facility will also process other feedstocks including bulk green waste (~9,000 t/y), commercial and industrial (C&I) organic waste (~2,000 t/y), and biosolids (from BW's WRPs). The main processes proposed for the RRON include:

– Thermal processing via carbonisation of the GO-rich stream (separated from FOGO), bulk green waste and biosolids
– Plug flow anaerobic digestion (PFAD) of the FO-rich stream (separated from FOGO) and FO-rich C&I organic waste

The RRON will produce the following product streams:

– Biochar (from carbonisation), a high-value product for agriculture and production of advanced sustainable materials
– Syngas (from carbonisation), which will be used within the RRON facility to dry the carbonisation feedstocks down to a suitable moisture content for carbonisation
– Digestate (from the PFAD), a product containing high levels of nutrients, which is beneficial in agricultural applications
– Biogas (from the PFAD), which will be transferred to the neighbouring biosolids drying facility and converted into heat via a biogas boiler, reducing the demand for natural gas

Further information on the environmental setting of the RRON facility and a detailed process description are provided in the DLA report. This report should be read in conjunction with the DLA report.

1.2 Purpose

The CCRA has been prepared by GHD to assess the risks associated with climate change impacting on the development of the RRON and to identify mitigation and/or adaptation measures to manage these identified risks. The CCRA has been produced on behalf of BW to support the EPA DLA for the RRON in accordance with the EP Act (2017), EPA publication 1799.2 *Permissions Scheme Policy*.

1.3 Scope of works

To establish how climate change may impact the BW RRON, GHD has compiled historical weather and climate projection data and undertaken a CCRA with participants from Barwon Water. A CCRA is required to identify the physical risks to the RRON infrastructure and operations from climatic conditions with consideration of the effects of climate change. This report provides the methodology, limitations, and outcomes of the CCRA performed for the BW RRON.

Specifically, this report:

– Assesses and quantifies climate change risks in accordance with current guidelines
– Identifies the potential climatic events and hazards that could impact the design, and operation of the project, based on its scale, location, project components and design life
– Assesses climate change risk under two potential climate scenarios to provide an indication of potential risks and impacts
– Links project vulnerability associated with climate change, and proposed adaptation options for design and operation to improve project resilience

1.4 Key assumptions

This CCRA report presents findings from an initial and high-level climate risk assessment performed by project personnel from BW and facilitated and documented by GHD during May 2023 (see Appendix B for list of workshop attendees).

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Bureau of Meteorology (BOM) climate baseline and projection data were used for the climate risk assessment. It is assumed that climate change impacts at the BW RRON will follow CSIRO climate change projections for the Southern Slopes cluster. This initial CCRA provides no warranty that all key climate change related risks in respect of the BW RRON have been identified, and that the assessment by BW's management stakeholders in respect of how effectively BW controls these risks is accurate.

– The scope of work did not include climate related financial disclosures or any form of compliance certification.
– A CCRA considers climate change projections and scenarios that may occur in the future, based on available and identified information at the time of assessment. However, there is inherent uncertainty as to the rate to which society will decarbonise and thus, which future emissions scenario to select. This assessment used a high emissions scenario (i.e., the most conservative emissions scenario) to identify and assess risks. This report provides no warranty that the projections or scenario used are complete and accurate and provides no warranty that the future will unfold materially similar to the identified projections and scenarios used.
– Whilst sea level rise and flood risk were considered in the climate projection, specific modelling of the extent to which the site could be affected under each climate scenario was not completed. Detailed modelling or site assessments were also not completed for other risks.
– This assessment is indicative of relevant risks based on emerging design at the time of the risk assessment.
– This assessment is based on current, publicly available climate science.
– Analysis of climate change is based on best-available climate change projections at the time of assessment. Combined with a historic measured climatic baseline at or near the project site, these are the best available projections of likely future climatic conditions at the project site – as such, they have inherent uncertainties as to the likelihood of occurrence and intensity of events.

At the time of completing this assessment, the final design for the RRON had not been completed. As such, all identified adaptation measures are indicative measures suggested to reduce any high risks. It is anticipated that the final design will have the same (or lower) final risk ratings, either through implementation of the suggested adaptations, or through suitable alternative options.

1.5 Limitations

This report has been prepared by GHD for Barwon Water and may only be used and relied on by Barwon Water for the purpose agreed between GHD and Barwon Water as set out in Section 1.1 of this report.

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

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

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

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

GHD has prepared this report based on information provided by BW 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 that were caused by errors or omissions in that information.

2. Assessment methodology

2.1 Legislative and policy context

Guidelines used in the BW RRON climate change risk assessment are listed in Table 1.

Table 1 Guidelines used in methodology and assessment processes

Required guideline	Influence on assessment method
Climate Change Act 2022	The Climate Change Act 2022 outlines Australia's greenhouse gas reduction targets, provides for annual climate change statements, and informs the advisory function of the Climate Change Authority.
Climate Change Act 2017 (Vic)	The Climate Change Act 2017 requires the Victorian EPA to consider climate change in permission decisions, which includes issuing or refusing an application for a development licence. The EPA is required to have regard for: - The potential impacts of climate change relevant to the decision or action - The potential contribution to the State's greenhouse gas emissions of the decision or action - Any guidelines issued by the Minister (Victorian Minister for Energy, Environment and Climate Change) under section 18. To date, no such guidelines have been issued. The relevant considerations for the EPA regarding the potential impacts of climate change may include: - Biophysical impacts - Long and short term economic, environmental, health and social impacts - Beneficial and detrimental impacts - Direct and indirect impacts - Cumulative impacts The relevant considerations for the EPA regarding the potential contribution to the State's greenhouse gas emissions may include: - Short-term and long-term greenhouse gas emissions - Direct and indirect greenhouse gas emissions - Increases and decreases in greenhouse gas emissions - Cumulative impacts of greenhouse gas emissions
AS ISO 31000:2018 Risk Management – Principles and guidelines	The AS/ NZS ISO 31000:2009 has been superseded by AS ISO 31000:2018. Both provide a framework for an overarching risk management process that may be applied to climate change risk as to any other risk area. This climate change risk assessment follows the principles of ISO 31000, and steps through the process described in Chapter 6 of the standard up to 6.5.3, whereby this report describes the context, risk assessment and treatment, but not ongoing implementation, monitoring, and review.
AS 5334-2013 Climate change adaption for settlements and infrastructure – A risk-based approach	The Standard provides guidance on managing climate change risks and includes implementation plans for suitable and effective adaptation (treatment). The Standard follows the International Standard, AS/ NZS ISO 31000:2018.

2.2 Climate variables

The following climate variables were considered during the assessment, the variables were chosen based on the Australian standard (AS 5334-2013) and the site context:

- Extreme temperatures and heatwaves
- Increased fire danger
- Drought/earth movement
- Severe storms: wind, hail and lightning
- Sea level rise/coastal inundation
- Extreme rainfall/flooding

2.3 Climate projection data

The climate change risk assessment undertaken for the BW RRON considered two climate change scenarios: a mid-term intermediate emissions scenario (2050, RCP 4.5), and a mid-term, high emissions scenario (2050, RCP 8.5). This time period represents a scenario that is 27 years from now, which covers the 25-year expected design life of the facility.

Climate projection information to identify climate change risks were sourced from the following references:

- CSIRO BOM 2015, Climate Change in Australia Projections Cluster Report – Southern Slopes (Grose, M. et al, 2015)
- CSIRO BOM 2015, Climate Change in Australia Summary Data Explorer – Southern Slopes (Vic West)
- CSIRO BOM 2015, Climate Change in Australia Extremes Data Explorer – Southern Slopes (Vic West)
- IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K.]

Projected changes were applied to historical weather data from nearby Bureau of Meteorology weather stations.

These 2015 projections were used in preference to the Vic19 update due to the inclusion of a greater number of climate change parameters in the 2015 data. Both are based on the IPCC AR5 projections, however the advantage of the 2019 materials would be the granularity. A visual review of the gridded Vic19 projections for the site location confirmed that this assessment would not underestimate any risks by using the less-granular 2015 results.

2.4 Climate scenarios

The Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5) developed four scenarios for global climate projections that relate to how the world may respond to the challenge of a changing climate, the need to continue to produce and use energy and resources, and the global greenhouse gas emissions that may occur. These scenarios incorporate diverging tendencies based on alternative economic, globalisation and environmental pathways. These have been modified through subsequent reports and renamed as Representative Concentration Pathways (RCPs) in AR5. These RCPs are described according to atmospheric CO_2 concentration levels and may also be described by anomalies in global mean surface air temperatures for the period 2081 to 2100 relative to the average period 1986 to 2005 (refer Table 2).

Projections currently available for Victoria (from CSIRO and BOM climate projection data) are based on AR5 and these are the emissions scenarios referred to throughout this document. The guidance on emissions scenarios will be updated in future in line with the 2021 IPCC Sixth Assessment Report (AR6), which introduces the use of a range of Shared Socioeconomic Pathways (SSPs) to derive greenhouse gas scenarios for climate modelling.

Table 2 Climate change emission scenarios

Global climate response	Climate scenario	Projected increase in global surface temperature	IPCC report source
Strong immediate response, emissions peak by 2020, with rapid decline in emissions thereafter from global participation and application of technologies	**RCP 2.6**, atmospheric concentration of CO_2 projected at approx. 420 ppm by 2100	Mean projected increase **1.0°C** Anomaly range +0.3 to 1.7°C (by 2081–2100)	AR5 (IPCC, 2014)
Slower response, emissions peak around 2040, then decline	**RCP 4.5**, atmospheric concentration of CO_2 projected at approx. 540 ppm by 2100	Mean projected increase **1.8°C** Anomaly range +1.1 to 2.6°C (by 2081–2100)	AR5 (IPCC, 2014)
Slow response, application of mitigation strategies and technologies	**RCP 6.0**, atmospheric concentration of CO_2 projected at approx. 660 ppm by 2100	Mean projected increase **2.2°C** Anomaly range +1.4 to 3.1°C (by 2081–2100)	AR5 (IPCC, 2014)
Little curbing of emissions, continuing rapid rise throughout the 21st century	**RCP 8.5**, atmospheric concentration of CO_2 projected at approx. 940 ppm by 2100 and continuing to increase	Mean projected increase **3.7°C** Anomaly range +2.6 to 4.8°C (by 2081–2100)	AR5 (IPCC, 2014)

Atmospheric concentration of CO_2 as of April 2023 is at approximately 419 parts per million (ppm), compared to stable concentrations of 280 ppm prior to the industrial revolution, and is increasing by approximately 2.5 ppm per year (US National Oceanic and Atmospheric Administration, 2023). Global mean atmospheric temperatures have increased approximately 1.1 degrees Celsius (°C) compared to pre-industrial levels (NASA, 2022b), and Australia's climate has warmed in both surface air and surrounding sea surface temperatures by around 1.44°C since 1910 (CSIRO and BOM, 2020).

2.5 Workshop methodology

A climate change risk assessment workshop was held on 4 May 2023 with a multidisciplinary team, including technical resources from both GHD and BW. Workshop attendees are listed in Appendix B. The aim of this workshop was to identify physical climate change risks for the BW RRON and to identify mitigation and/ or adaptation measures to manage these identified risks.

The facilitators led the brainstorming and evaluation exercises using a tailored Mural board and MS Teams software. Mural is a digital whiteboard that allows for real-time online collaboration between workshop participants. Attendees brainstormed climate risks associated with various infrastructure/assets and then sorted them via the associated climate hazard on a fishbone diagram (see Figure 1). Following the sorting exercise, climate risks were plotted on a high-level risk evaluation matrix to assign the 2050 RCP 8.5 risk rating (see Figure 2). Risks identified in the workshop, as shown in Figure 1 and Figure 2, are also presented in full in Appendix D.

Likelihood and consequence ratings for each climate risk were allocated based on descriptions in the Barwon Water risk guideline risk tables (Appendix C). Workshop attendees were then guided through the process of identifying treatment measures to manage the climate risk and/ or adaptation measures to enable the project to adjust to the actual or projected climate and its effects.

Following completion of the workshop, risks were reviewed and, where appropriate, consolidated.

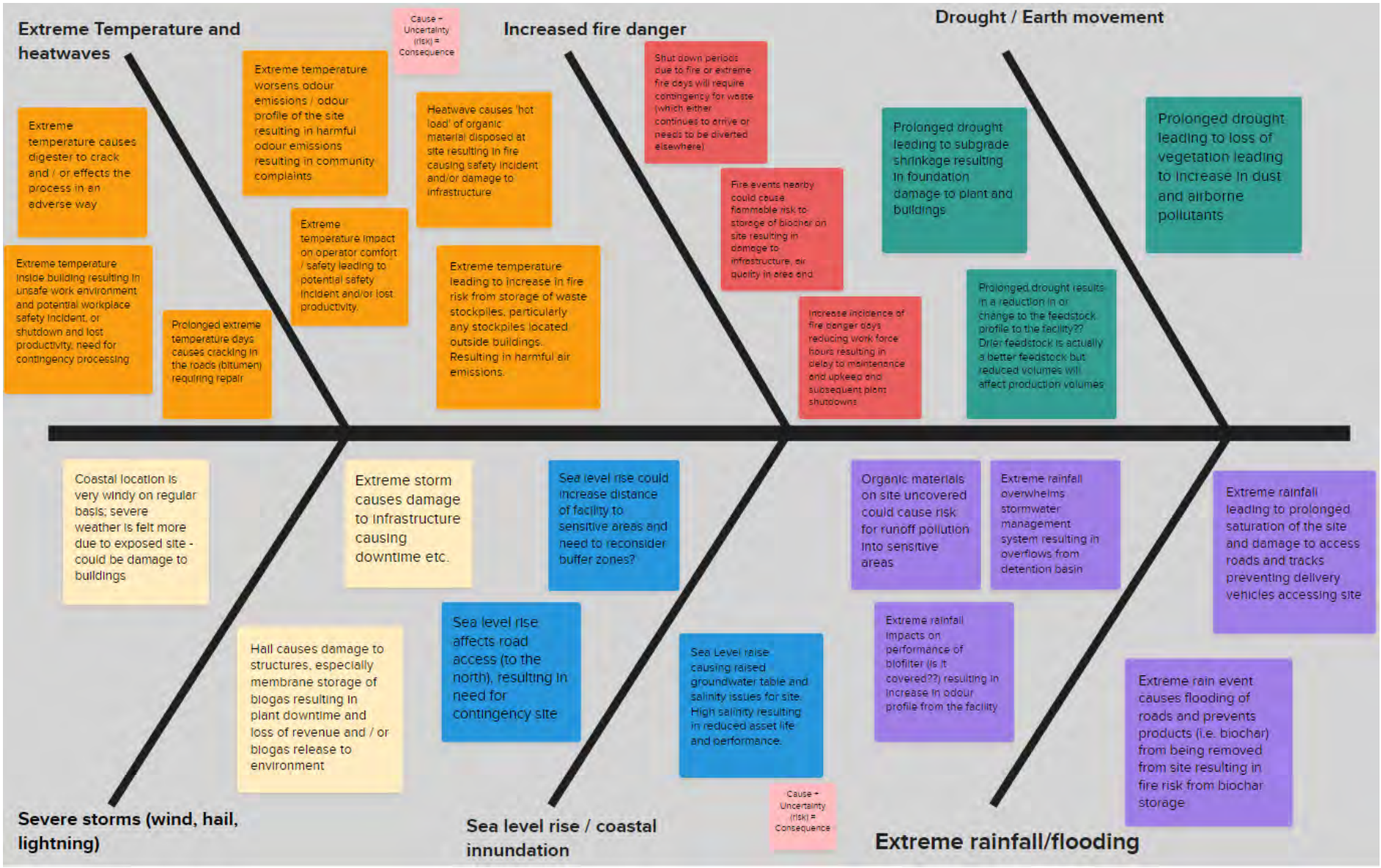

Figure 1 *Climate risk fishbone brainstorm*

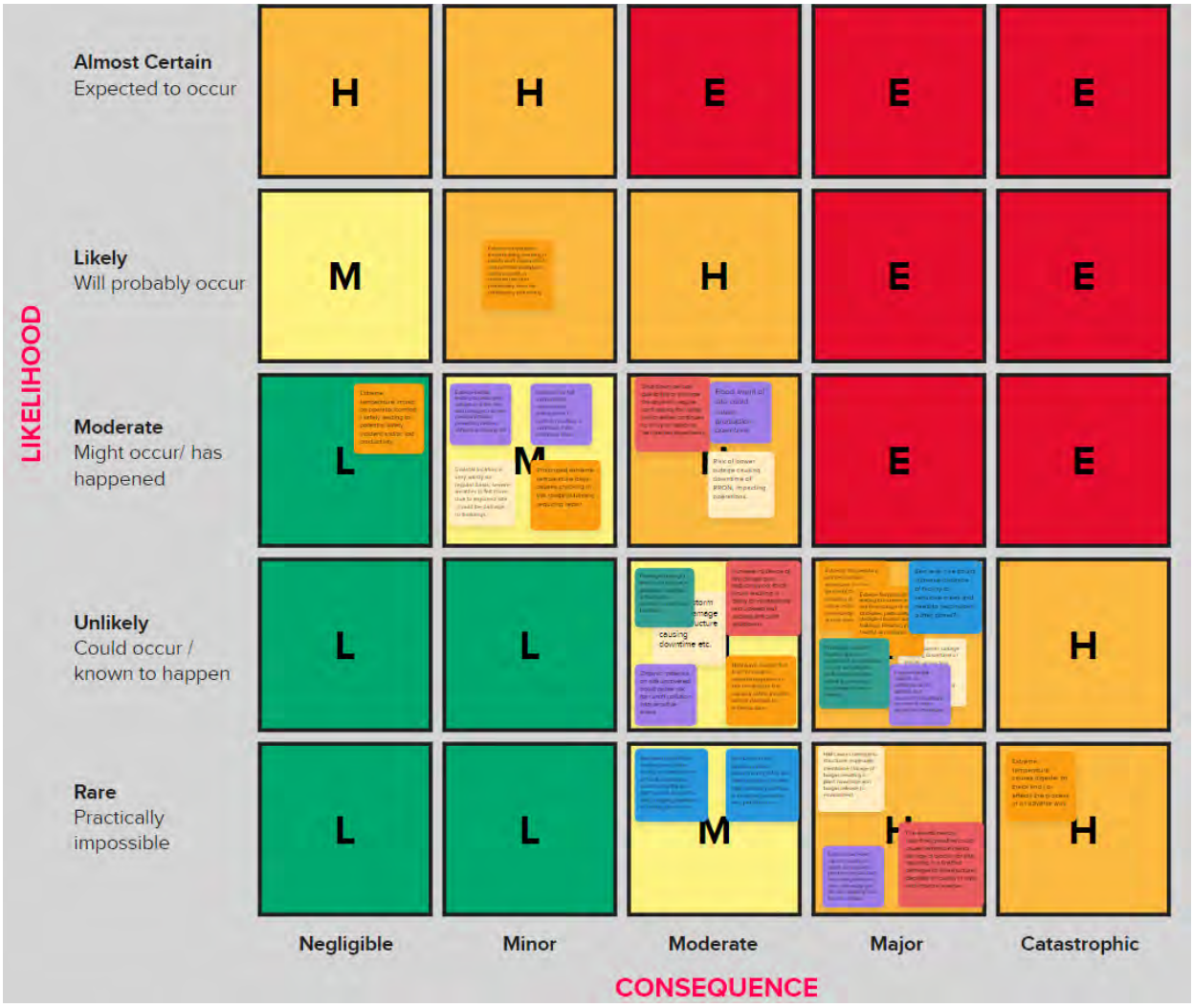

Figure 2 *High-level risk evaluation matrix*

3. Current climate and future climate projections

3.1 Historical weather

Climate baseline data represents a historical trend of weather data obtained from an appropriate nearby weather station, expressed as an average value for different climate variables measured at that station.

The following weather stations were used to inform the climate risk profile and sourced via the Bureau of Meteorology:

– Grovedale (Geelong Airport) (ID: 87163) 1986-2005 data for Max & Min Temperature, Rainfall, Solar exposure, Weather & Climate (1996-2005) (approximately 10 km from the site)
– Geelong (Norlane) (ID: 87117) 1986-1996 data for Weather & Climate (approximately 22 km from the site)

Data from two weather stations that are relatively close together and close to the site were utilised as the closest weather stations did not have complete sets of data for the baseline period. Grovedale had a block of data missing within the IPCC 1986-2005 projection timeframe, therefore Geelong (Norlane) was used to complete the dataset given the weather station is located within a similar biogeographic region to the site location.

The relevant climate variables data for the baseline period (1986 – 2005) is shown in Appendix A.

3.2 Previous extreme weather impacts

No extreme weather events are known to have impacted the site.

3.3 Climate change projections

Key climate projections related to the relevant climate variables include (refer to Appendix A for the full climate projection data):

– Average maximum daily temperature on an annual basis is expected to increase in the site area from 19.1ºC (across the baseline period) to 20.2ºC in 2050 under the RCP 4.5 scenario and 20.6ºC under the RCP 8.5 scenario. Additionally, it is expected that there will be an increase in extreme temperatures/ heat stress:
  - A projected increase in the average number of days per year over 35°C from a baseline of 5.9 days to 7.7 days (2050 RCP 4.5) and 8.1 days (2050 RCP 8.5).
  - A projected increase in the average number of days per year over 40°C from a baseline of 0.8 days to 1.5 days (2050 RCP 4.5) and 1.7 days (2050 RCP 8.5).
  - Maximum temperature increasing from 44.8°C to 46.2°C (2050 RCP 4.5) and 47.2°C (2050 RCP 8.5).
– Average annual rainfall is expected to decline from about 427.9 mm (across the baseline period, to 414 mm in 2050, under the RCP 4.5 scenario and 405.3 mm under the RCP 8.5 scenario. However, there is a projected increase of rainfall intensity during heavy rain periods where:
  - The total amount of rain during a maximum one-day rainfall for a 20-year Average Recurrence Interval (ARI) event increasing by 12.1% (2050 RCP 4.5) and by 10.7% (2050 RCP 8.5).
– Severe fire danger days per year are expected to increase from 1.7 days (across the baseline period) to up to three days in 2050, under the RCP 4.5 scenario and up to 2.2 days under the RCP 8.5 scenario. Figure 3 presents a current Bushfire Management Overlay (BMO) map (in red) used to inform the risk assessment. The site is not currently located in a BMO area; however, it is in a bushfire prone area.
– Sea level is expected to increase by 0.11 m in 2050, under the RCP 4.5 scenario and 0.12 m under the RCP 8.5 scenario. Figure 4 presents a sea level inundation map for 2050, under the RCP 8.5 scenario, used to inform the risk assessment.
– The projected warming, as described above, will contribute to an increase in climatic extremes and variations.

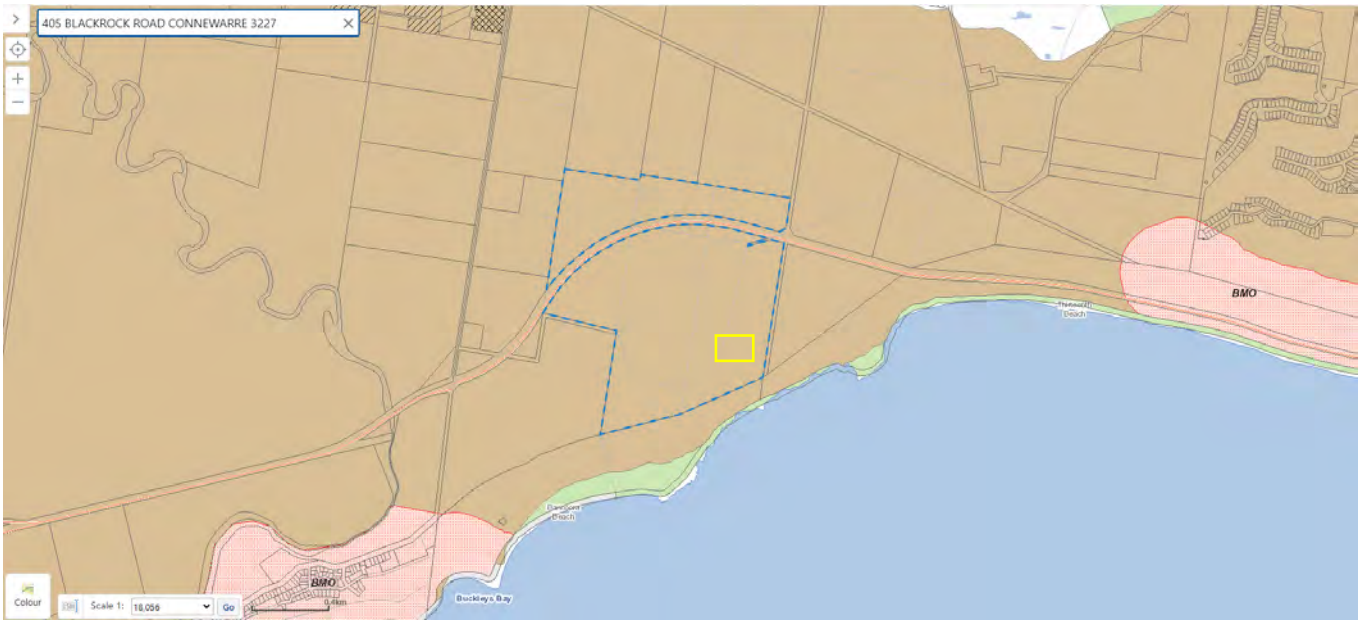

Figure 3 *Current BMO map for BW RRON site (Department of Transport and Planning, 2022) (Red overlay = BMO, Brown = Bushfire Prone Areas (BPA); blue line = site boundary; yellow rectangle = proposed RRON location)*

Figure 4 *Sea level inundation map for 2050, under RCP 8.5 (CoastAdapt, 2023)*

4. Climate change risk assessment

4.1 Initial risk rating

The climate change risk assessment workshop identified a total of 29 risks for the BW RRON site. A summary of the identified risks, taking into consideration the existing controls and assessment of consequence and likelihood for 2050 RCP 4.5 and 2050 RCP 8.5, is provided in Table 3. For each of the risks evaluated as 'high', mitigating controls and/ or adaptation measures were identified which, if implemented, would reduce the consequence and/ or likelihood of the risk. These controls and risk treatment/ adaptation measures or a suitable alternative should be incorporated into the design of the BW RRON and guide development to manage risks from a changing climate.

As shown in Table 3, no 'extreme', 17 'high' and 12 'medium' climate change risks were identified under the 2050 RCP 8.5 emissions scenario. Figure 5 shows the initial risk rating by climate hazard for 2050 RCP 8.5 emissions scenario. The most significant climate hazard identified for the site was extreme temperature and heatwaves.

Table 3 Summary of initial risk ratings

Risk Classification	Initial Risk Rating	
	2050 RCP 8.5	2050 RCP 4.5
Extreme (E)	0	0
High (H)	17	16
Medium (M)	12	11
Low (L)	0	2
Total	29	

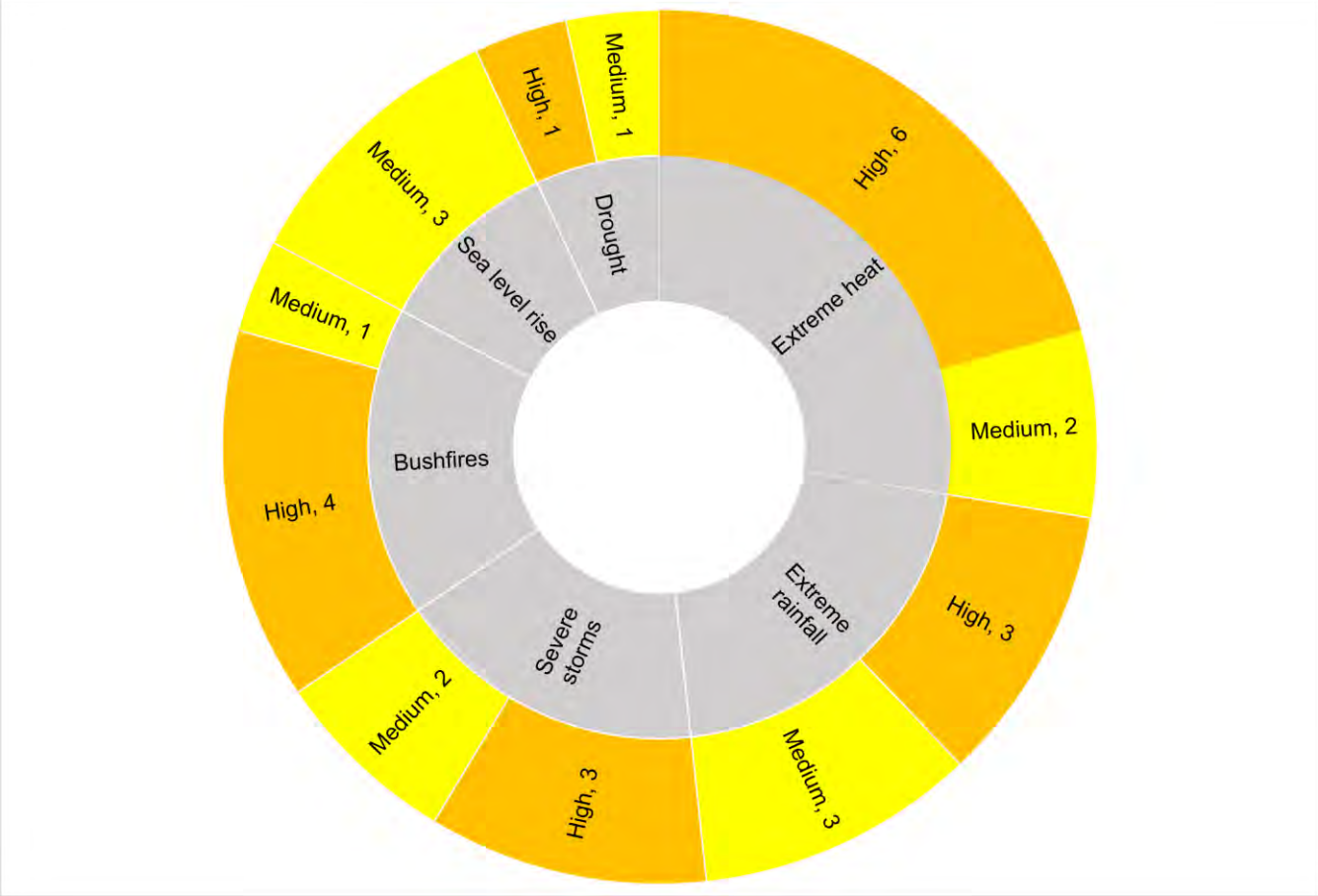

Figure 5 Summary of the initial risk ratings per climate variable (RCP 8.5 emissions scenario)

4.2 Identified adaptation and mitigation measures

Table 4 shows the 17 ‘high’ risks identified and the proposed adaptation and mitigation measures. A full listing of adaptation measures identified for the site are contained in the complete climate change risk register in Appendix D.

The key adaptation measures identified across all risks include:

– Contingency waste storage capacity
– Backup generators or batteries for critical infrastructure
– Incorporation of overflow pathways in stormwater retention system
– Consideration of projected climate change variables in the design of buildings
– Incorporation of extreme temperature and fire warning systems

These actions are to be implemented throughout the design process of the BW RRON.

Table 4 Identified adaptation and mitigation measures for ‘high’ risks only

Climate hazard	Climate change risk	Existing risk management strategies	Control actions	Impact
Extreme heat	Extreme temperature causes digester to crack and/or affects the process in an adverse way	Design of the digester is for outdoor installation. Contingency plan with Councils to accommodate feedstock if digester is unavailable.	Basis of design to include temperature ranges with consideration of 2050 RCP8.5 Climate Change projection.	Digester
Extreme heat	Extreme temperature worsens odour emissions / odour profile of the site resulting in harmful odour emissions and community complaints and/or licence non-compliance	Indoor storage, under negative pressure, of organics limits odour impacts from extreme temperatures. Design will incorporate a biofilter. Odour assessment is being conducted as part of the DLA to determine the existing odour profile and potential impacts of the RRON facility.	Odour control design to consider an increase in high temperature days in the future and potential impacts associated with this.	Site operations and community
Extreme heat	Extreme temperature inside building resulting in unsafe work environment and potential workplace safety incident, or shutdown and lost productivity, need for contingency processing	Cabins where operators are working to be appropriately air conditioned (including mobile plant)	Investigate green walls/roof as way of insulating against climate variability Offer operators amenities that are separate to the main building / workplace and appropriately air conditioned (i.e. at existing Black Rock site). Consider automation of plant and equipment in the design.	Site operations

Climate hazard	Climate change risk	Existing risk management strategies	Control actions	Impact
Extreme heat	Extreme temperature leading to increase in fire risk from storage of waste stockpiles, particularly any stockpiles located outside buildings. Resulting in harmful air emissions.	All incoming stockpiles will be located inside buildings Fire protection design Quenched biochar product to be collected and packaged in bulk bags out of the process rather than stockpiled Incoming waste stockpiles and biochar to be managed in accordance with EPA Publication 1667.3: Management and storage of combustible recyclable and waste materials – guideline.	Investigate use of fire identification cameras/ sensors for waste stockpiles Weather warnings monitoring to be built into Contingency to enable preparedness/ additional precautions to be put in place.	Buildings containing waste stockpiles and community health
Extreme heat	Risk of short-term power outage causing downtime of RRON, impacting operations.	Contingency Plan with Councils	Backup generator / battery to maintain critical processes in event of outage (if required). Backup generator for weighbridge (if required) and/or contingency storage capacity for incoming waste - to allow waste to be accepted during an outage.	Site operations
Extreme heat	Risk of power outage causing downtime of RRON, impacting emissions control technology causing licence breach.	Not identified	Backup generator / battery to maintain critical processes in event of outage (if required).	Site operations
Extreme rainfall	Flood event off site could cause production downtime.	Contingency plan with Councils	On-site stormwater management design (and appropriate design of integration with Black Rock stormwater management) for extreme rainfall events with consideration of 2050 RCP8.5 Climate Change projection scenario.	Site operations
Extreme rainfall	Extreme rainfall impacts on performance of biofilter resulting in increase in odour profile from the facility.	Not identified	Biofilter to be designed / built to cope with extreme rainfall events (i.e., projected rainfall intensity for high emission climate change scenario).	Biofilter
Extreme rainfall	Extreme rain event causes flooding of roads and prevents products (i.e. biochar and digestate) from being removed from site resulting in an increased fire risk from the biochar storage and odour risk from the digestate storage.	Indoor storage capacity where environment and protection of stored biochar and digestate can be controlled.	Whilst designing carbonisation building, consider storage capacity of the biochar bagging process and equipment.	Biochar storage area

Climate hazard	Climate change risk	Existing risk management strategies	Control actions	Impact
Severe storms	Risk of short-term power outage causing downtime of RRON, impacting operations.	Contingency Plan with Councils	Backup generator / battery to maintain critical processes in event of outage (if required). Backup generator for weighbridge (if required) and/or contingency storage capacity for incoming waste - to allow waste to be accepted during an outage.	Site operations
Severe storms	Risk of power outage causing downtime of RRON, impacting emissions control technology causing licence breach.	Not identified	Backup generator / battery to maintain critical processes in event of outage (if required).	Site operations
Severe storms	Wind (and/or hail) causes damage to structures, especially membrane storage of biogas resulting in plant downtime and biogas release to environment.	Infrastructure (including the biogas membrane) is designed to cope with adverse weather conditions, for example high winds given the experience of Black Rock being a known windy site.	Basis of design to include due consideration of wind and storms including 2050 RCP8.5 Climate Change projections. This could include strengthening structures (such as roofing) to withstand increased incidence and intensity of hail storms.	RRON structures, particularly membrane storage
Bushfires	Shut down periods due to fire or extreme fire days will require contingency for waste storage (which either continues to arrive or needs to be diverted elsewhere).	Waste storage capacity to have contingency capacity and a contingency plan to be utilised, with off site option.	Contingency storage capacity allowance Contingency plan to be developed for waste to be taken to licensed facility off-site Onsite plant (for lifting / moving stockpiles and material) within EPA guidelines	Buildings containing waste stockpiles
Bushfires	Fire events nearby (bushfire/ grassfire) could cause flammable risk to storage of biochar on site resulting in a fire that damages to infrastructure, depletes air quality in area and impacts revenue.	Biochar storage / bagging is indoors in carbonisation building. Higher rating fire protection designed into carbonisation building.	Containment of bagged biochar storage- consideration of sprinkler systems and automated systems for temperature monitoring.	Biochar storage area
Bushfires	Risk of short-term power outage causing downtime of RRON, impacting operations.	Contingency Plan with Councils	Backup generator / battery to maintain critical processes in event of outage (if required). Backup generator for weighbridge (if required) and/or contingency storage capacity for incoming waste - to allow waste to be accepted during an outage.	Site operations
Bushfires	Risk of power outage causing downtime of RRON, impacting emissions control technology causing licence breach.	Not identified	Backup generator / battery to maintain critical processes in event of outage (if required).	Site operations

Climate hazard	Climate change risk	Existing risk management strategies	Control actions	Impact
Drought	Prolonged drought leading to loss of vegetation and increase in dust and airborne pollutants impacting offsite (community complaints/ licence breech).	Landscaping, which includes the establishment of tree and mounded perimeter. Management of grass lands.	Increase in drought tolerant landscaping and land care services and possibility for dust suppression should consistent dust sources be identified throughout a drought period.	Community health

4.3 Residual risk rating

The residual risk assessment is an evaluation of the potential effectiveness of the identified controls to manage the identified climate change risks and is not the final climate change risk assessment. For the climate change risks to be effectively 'treated' or 'mitigated' the controls need to be implemented by way of incorporation into future project design/management plans and project construction scopes.

Following consideration of the proposed adaptation measures for climate risks identified for the BW RRON, the risk profile of potential impacts was reassessed as follows (also see Figure 6):

For 2050 RCP 8.5:

– No 'extreme' risks
– No 'high' risks (previously 17)
– 16 'medium' risks (previously 12)
– 13 'low' risks (previously 0)

For 2050 RCP 4.5:

– No 'extreme' risks
– No 'high' risks (previously 16)
– 14 'medium' risks (previously 11)
– 15 'low' risks (previously 2)

The initial risk assessment under RCP 8.5 and RCP 4.5 at 2050 found no 'extreme' risks. After implementation of adaptation measures, all residual risks are reduced to 'medium' or lower.

As noted in Section 1.4, at the time of completing this assessment, the final design for the RRON had not been completed. As such, all identified adaptation measures are indicative measures suggested to reduce any high risks. The final design will allow for the same (or lower) final risk ratings for risks, either through the suggested adaptations, or through alternative options.

Where possible, efforts should be undertaken in future design phases to consider and mitigate the identified risks, including designing site components to withstand the more extreme rainfall and temperatures predicted. The full climate change risk register is provided in Appendix D.

None of the adaptation measures specifically relate or contribute to how BW may reduce greenhouse gas emissions; however, these are addressed separately in the GHG assessment technical report.

Figure 6 ***Summary of the RCP 8.5 residual risk ratings per climate variable***

5. Conclusion

The key outcomes of the BW RRON climate risk and adaptation plan were as follows:

– A total of 29 climate change risks were identified for the project phase across climate variables including extreme heat, extreme rainfall, severe storms, bushfires, drought and sea level rise (see Table 5).

Table 5 Summary of number of risks

Climate Variable	No. risks
Extreme heat	8
Extreme rainfall	6
Severe storms	5
Bushfire	5
Drought	2
Sea level rise	3

– The initial risk assessment under the RCP 4.5 emissions scenario (for 2050) and RCP 8.5 emissions scenario (for 2050) found:
  - No risks rated 'extreme' for both scenarios.
– 17 'high' risks were identified for 2050 RCP 8.5 emissions scenario relating to all climate variables except sea level rise.
– A residual risk assessment was conducted to evaluate the effectiveness of the proposed controls. This assessment provided the following outcomes:
  - No risks rated as 'extreme' or 'high' for both the RCP 4.5 and 8.5 scenario (if controls are implemented).
– The potential adaptation measures for reducing the 'high' risks included the following design considerations:
  - Contingency storage capacity in the carbonisation building.
  - Implementation of fire identification cameras and sensors.
  - Sprinkler systems and automated temperature monitoring systems for biochar containment.
  - Back-up generators or batteries in the event of a power outage for critical infrastructure.
  - Odour control to allow for expected increases in high temperature days.
  - Amenities for operators that are separate to the main building and workplace that are appropriately air conditioned.
  - On-site stormwater management design for extreme rainfall events that is integrated with Black Rock stormwater management.
  - Drought-tolerant landscaping and land care services.
– While these risks have been 'treated' in a risk assessment scenario, they have yet to be mitigated at the site. Only when the identified mitigation and adaptation measures have been selected by the project contractor and implemented can they be classified as effectively treated. The residual risk rating therefore only applies following implementation of the identified mitigation measures otherwise, the initial risk rating stands. It is noted that alternative mitigation risk measures may be identified throughout the design instead of those provided in this report. Newly identified mitigation will at a minimum have the same residual risk rating as those proposed in this report.

As climate change risk management is an iterative process, this CCRA should be periodically reviewed and updated as per the following timeframes/triggers:

– When updated climate change data and/or information becomes available
– During the design stage of a future development or project
– Following completion of a development project

This will allow the CCRA to remain appropriate, current, and effective in terms of identifying and reducing the risk associated with climate change at the BW RRON site.

6. References

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Appendices

Appendix A

Climate change projections

Variable		Current climate		Climate change projections			
Climate variable		Annual historical trend 87163 (8.7 km from site)	Baseline period	General trend	Mid century, moderate scenario 2050, RCP 4.5	Mid century, very high scenario 2050, RCP 8.5	Source
Temperature	Mean maximum daily temperature (°C) - Annual	19.1	1986 to 2005	↑	+1.1 (0.8 to 1.6) i.e. 20.2°C (19.9 to 20.6)	+1.5 (1.2 to 2) i.e. 20.6°C (20.2 to 21.1)	2,7
	Mean maximum daily temperature (°C) - Summer (DJF)	23.7	1986 to 2005	↑	+1.4 (0.8 to 1.9) i.e. 25.1°C (24.6 to 25.6)	+1.7 (1.1 to 2.6) i.e. 25.4°C (24.9 to 26.3)	2,7
	Mean minimum daily temperature (°C) - Annual	19.1	1986 to 2005	↑	+1 (0.7 to 1.2) i.e. 20.1°C (19.8 to 20.3)	+1.2 (1 to 1.7) i.e. 20.3°C (20.1 to 20.7)	2,7
	Days p.a. over 35 °C	5.9	1986 to 2005	↑	7.7 days	8.1 days	2,7
	Days p.a. over 40 °C	0.8	1986 to 2005	↑	1.5 days	1.7 days	2,7
	Highest temperature for baseline 1986-2005 (°C)	44.8 25/1/2003	Discrete event	↑	+1.4 (0.1 to 2.5) i.e. 46.2°C (44.9 to 47.3)	+2.4 (0.8 to 3.1) i.e. 47.2°C (45.6 to 47.9)	3,7
	Highest temperature for years on record at AWS (°C)	47.4 7/2/2009	Discrete event		n/a		7
	Days p.a. under 0°C	0.0	1986 to 2005	↓	0 days	0 days	2,7
	Days p.a. under 2°C	0.0	1986 to 2005	↓	0 days	0 day	2,7
	Lowest temperature for baseline 1986-2005 (°C)	7.9 10/7/1995	Discrete event	↑	+1 (0.6 to 1.3) i.e. 8.9°C (8.5 to 9.2)	+1.3 (0.5 to 1.6) i.e. 9.2°C (8.4 to 9.5)	3,7
	Lowest temperature for years on record at AWS (°C)	7.9 10/7/1995	Discrete event		n/a		7
Rainfall	Mean Rainfall (mm) - Annual	427.9	1986 to 2005	↓	-3.3% (-10.9 to 4.5) i.e. 414 mm (381.2 to 447.1)	-5.3% (-13.1 to 4.2) i.e. 405.3 mm (371.9 to 445.9)	2,7
	Mean Rainfall (mm) - Spring (SON)	127.3	1986 to 2005	↓	-7.3% (-18.4 to 2.1) i.e. 117.9 mm (103.8 to 130)	-9.2% (-25.7 to 1) i.e. 115.6 mm (94.5 to 128.5)	2,7
	Mean Rainfall (mm) - Summer (DJF)	87.4	1986 to 2005	↓	-0.8% (-19.7 to 15.2) i.e. 86.7 mm (70.1 to 100.6)	-5.3% (-21.2 to 12.5) i.e. 82.7 mm (68.8 to 98.3)	2,7
	Mean Rainfall (mm) - Autumn (MAM)	99.7	1986 to 2005	↓	-2.8% (-12.2 to 10.6) i.e. 96.9 mm (87.5 to 110.2)	-4% (-15 to 15.3) i.e. 95.6 mm (84.7 to 114.9)	2,7
	Mean Rainfall (mm) - Winter (JJA)	113.7	1986 to 2005	↓	-3% (-9.9 to 7.1) i.e. 110.3 mm (102.4 to 121.7)	-3.1% (-11.3 to 7.5) i.e. 110.1 mm (100.8 to 122.2)	2,7
	Highest daily rainfall event for baseline 1986-2005	100 27/1/2005	Discrete event	↑	+11.2% (-7.7 to 22.4) i.e. 111.2 mm (92.4 to 122.4)	+6.4% (-4.1 to 14.9) i.e. 106.4 mm (95.9 to 114.9)	3,7
	Highest daily rainfall (mm) for years on record at AWS	100 27/1/2005	Discrete event		n/a		7

Variable		Current climate		Climate change projections			
Climate variable		Annual historical trend 87163 (8.7 km from site)	Baseline period	General trend	Mid century, moderate scenario 2050, RCP 4.5	Mid century, very high scenario 2050, RCP 8.5	Source
	Maximum 1 day rainfall for a 20 year ARI event	n/a	n/a	↑	+12.1% (-4.5 to 30.7)	+10.7% (-8.5 to 32.5)	3
Extreme events	Severe fire danger days per year	1.7	1981-2010	↑	1.6 to 3 days	1.6 to 2.2 days	4
Sea conditions	Sea Level Rise (m)	n/a	1986-2005	↑	+0.11 (0.07 to 0.16)	+0.12 (0.08 to 0.17)	6
	Sea surface temperature (°C)	n/a	1986-2005	↑	+0.5 (0.4 to 0.7)	+0.6 (0.3 to 0.9)	6
Daily variables	Evapotranspiration (%)	n/a	n/a	↑	+4.5% (2.3 to 7.5)	+5.7% (4.4 to 9.7)	2
	Maximum wind gust speed (km/h) - 20 year return level	96	1986 to 2005		n/a unclear	n/a unclear	5
	Avg. 9 am wind speed (km/h)	13.4	1986 to 2005	↓	-0.7% (-3.8 to 0.4) i.e. 13.4 km/h (12.9 to 13.5)	-0.1% (-2.6 to 2.1) i.e. 13.4 km/h (13.1 to 13.7)	2,7
	Avg. 3 pm wind speed (km/h)	18.7	1986 to 2005	↓	-0.7% (-3.8 to 0.4) i.e. 18.6 km/h (18 to 18.8)	-0.1% (-2.6 to 2.1) i.e. 18.7 km/h (18.2 to 19.1)	2,7
	Avg. 9 am relative humidity (%)	78.3	1986 to 2005	↓	-0.5% (-1.8 to 0.4) i.e. 77.9 % (76.9 to 78.6)	-0.8% (-1.6 to 0.1) i.e. 77.7 % (77 to 78.4)	2,7
	Avg. 3 pm relative humidity (%)	60.8	1986 to 2005	↓	-0.5% (-1.8 to 0.4) i.e. 60.5 % (59.7 to 61)	-0.8% (-1.6 to 0.1) i.e. 60.3 % (59.8 to 60.8)	2,7
	Mean daily solar exposure (MJ/m²)	15.1	1990 to 2005	↑	+1.5% (0 to 2.8) i.e. 15.3 MJ/m² (15.1 to 15.5)	+1.8% (0.2 to 3.6) i.e. 15.4 MJ/m² (15.1 to 15.6)	2,7
	Soil moisture	n/a	n/a	↓	-2.3% (-4.2 to -0.4)	-2.9% (-4.9 to -0.5)	1

Source references:

1. CSIRO BOM 2015, Climate Change in Australia Projections Cluster Report - Southern Slopes, Appendix Table 1, pg 50 (2050 projection not available, 2030 scenario used in place)
2. CSIRO BOM 2015, Climate Change in Australia Summary Data Explorer, Southern Slopes (VIC West) Sub-Cluster Projections
3. CSIRO BOM 2015, Climate Change in Australia Extremes Data Explorer, Southern Slopes (VIC West) Sub-Cluster Projections
4. CSIRO BOM 2015, Climate Change in Australia Projections Cluster Report - Southern Slopes, Appendix Table 2, Laverton (VIC WEST) Station - Projections and baseline (2050 projection not available, 2030 scenario used in place)
5. CSIRO BOM 2015, Climate Change in Australia Projections Cluster Report - Southern Slopes, Section 4.5.2 , pg 33 (2050 projection not available, 2090 scenario used in place)
6. CSIRO BOM 2015, Climate Change in Australia Projections Cluster Report - Southern Slopes, Appendix Table 3, Stony Point Projections, (2050 projection not available, 2030 scenario used in place)
7. BOM historical climate data

Appendix B

Climate change adaptation workshop attendees

Table B1 Workshop attendees

Name	Company	Role/Discipline
Laura Trotta	GHD	Technical Director – Climate Change (Facilitator)
Claire Marshall	GHD	Environmental Engineer, Sustainability (Facilitator)
Dave Quinn	GHD	Senior Environmental Engineer, Waste
Alister Green	GHD	Senior Engineer, Water Technology
Kaye Lin Tan	GHD	Undergraduate Environmental Engineer, Sustainability
James Moverley	Barwon Water	Circular Economy Project Lead
Philippa Bakes	Barwon Water	Circular Economy Initiatives Manager
Kerryn Lester-Smith	Barwon Water	Circular Economy Business Lead
Giles Flower	Barwon Water	Environmental Advisor, Risk and Compliance
Ben Long	Barwon Asset Solutions	RRON Project Manager

Appendix C

Risk assessment guidance

Table C1 *Risk Control Matrix*

		Consequence				
		Negligible	Minor	Moderate	Major	Catastrophic
Likelihood		1	2	3	4	5
Almost certain	5	High	High	Extreme	Extreme	Extreme
Likely	4	Medium	High	High	Extreme	Extreme
Moderate	3	Low	Medium	High	Extreme	Extreme
Unlikely	2	Low	Low	Medium	High	High
Rare	1	Low	Low	Medium	High	High

Table C2 *Barwon Water Likelihood Descriptions*

Likelihood					
	5	**4**	**3**	**2**	**1**
Definition	**Almost Certain**	**Likely**	**Moderate**	**Unlikely**	**Rare**
Quantitative frequency	>70%	50-70%	30-50%	10-30%	<10%
Qualitative frequency	*(expected)*	*(will probably occur)*	*(might occur - has happened)*	*(could occur - known to happen)*	*(practically impossible)*

Table C3 *Barwon Water Consequence Descriptions*

Consequences						
	People	**Environment**	**Property ($ Impact)**	**Program/Time**	**Regulatory Cost**	**Reputation and Operations**
Negligible (1)	No Incident or First Aid Injury	Negligible Impact	Low $ Loss <5% budget	Less than 1 Day	Fine < $1K	Minimal Publicity or Impact on Asset Service
Minor (2)	Medical Treatment	Minor on-site impact	Medium $ Loss >5% - <10% budget	1 Day - 1 Week	Fine $1K - $10K	Some Local Media Coverage or Minor Impact on Asset Service
Moderate (3)	Alternate Work or Lost Time Injury	Moderate onsite impact	High $ Loss >10% - <15% budget	>1 Week - < 1 Month	Fine $10K - $50K	Media Coverage at State Level or Moderate Impact on Asset Service
Major (4)	Serious or Permanent Injury	Minor offsite or Major onsite impact	Major $ Loss >15% - < 20% budget	> 1 Month - < 3 Months	Fine > $50K or Legal Proceedings	Major Adverse Publicity or Impact on Asset Service
Catastrophic (5)	Fatality	Major offsite impact	Huge $ Loss > 20% budget	> 3 Months	Shutdown of Project Due to Regulatory Breach	Extreme Adverse Publicity or Impact on Asset Service

Table C4 Barwon Water Risk Descriptions

Risk Ranking	Risk description	Control application
Low (21-25)	Tolerable. Monitor, manage and carryout activity in accordance with identified controls.	Any hazard assessed as presenting a low and/or medium risk level will be permitted to be controlled using a combination of controls as appropriate.
Medium (17-20)	Implement strict control measures reduce hazard to ALARP. Management must determine appropriate level of supervision required.	
High (9-16)	Implement strict control measures reduce hazard to ALARP. Activity must not commence without Workplace Manager or higher approval and appropriate supervision present. Review process.	Any hazard assessed as presenting a high risk level will only be allowed to be controlled using a combination of at least one engineering control and lower level controls as appropriate.
Extreme (1-8)	Intolerable. Activity must not commence. Eliminated hazard or introduce further controls to reduce to ALARP.	Any hazard assessed as presenting an extreme risk level will only be allowed to be controlled using elimination and engineering as the primary source of controls.

Appendix D

Climate risk register

4. RISK ASSESSMENT

DESCRIPTION OF IMPACTS AND CONTROLS					RISK ASSESSMENT						ADAPTATION RESPONSES	RESIDUAL RISK			RESIDUAL RISK		
EXPOSURE AND VULNERABILITY			**RISK TYPE**	**PLANNED CONTROLS**	**RATING FOR 2050 RCP 8.5 PROJECTION**			**RATING FOR 2050 RCP 4.5 PROJECTION**			**MANAGEMENT OPTIONS**	**RESIDUAL RISK RATING POST ADAPTATION - 2050 RCP8.5**			**RESIDUAL RISK RATING POST ADAPTATION - 2050 RCP4.5**		
Risk ID:	***Climate variable***	***Description of impact***	***Direct or Indirect***	***Description of controls either planned within current design or assumed to be planned for future packages of work***	***Likelihood***	***Consequence***	***Risk***	***Likelihood***	***Consequence***	***Risk***	***Adaptation Details***	***Likelihood***	***Consequence***	***Risk***	***Likelihood***	***Consequence***	***Risk***
001	Severe Storms	Risk of short term power outage causing downtime of RRON, impacting operations.	Direct	Contingency Plan with Councils	Moderate	Moderate	H	Moderate	Moderate	H	Consider the following in design: 1) Backup generator / battery to maintain critical processes in event of outage (if required). 2) Backup generator for weighbridge (if required) and/or contingency storage capacity for incoming waste - to allow waste to be accepted during an outage.	Moderate	Minor	M	Moderate	Minor	M
002	Severe Storms	Risk of power outage causing downtime of RRON, impacting operations and emissions control technology causing licence breach.	Direct	Not identified	Unlikely	Major	H	Unlikely	Major	H	Consider the following in design: 1) Backup generator / battery to maintain critical processes in event of outage (if required).	Unlikely	Minor	L	Unlikely	Minor	L
003	Severe Storms	Wind (&/or hail) causes damage to structures, especially membrane storage of biogas resulting in plant downtime and biogas release to environment	Direct	Infrastructure (incl. biogas membrane) is designed to cope with adverse weather conditions, including high winds given this is a known windy site	Rare	Major	H	Rare	Major	H	Consider the following in design: Basis of design to include due consideration of wind and storms including 2050 RCP8.5 Climate Change projections. This could include strengthening structures (such as roofing) to withstand increased incidence and intensity of hail storms.	Rare	Moderate	M	Rare	Moderate	M

DESCRIPTION OF IMPACTS AND CONTROLS					RISK ASSESSMENT						ADAPTATION RESPONSES	RESIDUAL RISK			RESIDUAL RISK		
EXPOSURE AND VULNERABILITY			**RISK TYPE**	**PLANNED CONTROLS**	**RATING FOR 2050 RCP 8.5 PROJECTION**			**RATING FOR 2050 RCP 4.5 PROJECTION**			**MANAGEMENT OPTIONS**	**RESIDUAL RISK RATING POST ADAPTATION - 2050 RCP8.5**			**RESIDUAL RISK RATING POST ADAPTATION - 2050 RCP4.5**		
Risk ID:	***Climate variable***	***Description of impact***	***Direct or Indirect***	***Description of controls either planned within current design or assumed to be planned for future packages of work***	***Likelihood***	***Consequence***	***Risk***	***Likelihood***	***Consequence***	***Risk***	***Adaptation Details***	***Likelihood***	***Consequence***	***Risk***	***Likelihood***	***Consequence***	***Risk***
004	Extreme heat	Extreme temperature causes digester to crack and / or effects the process in an adverse way	Direct	Design of the digester is for outdoor installation Contingency plan with councils	Rare	Catastrophic	H	Rare	Catastrophic	H	Consider the following in design: Basis of design to include temperature ranges with consideration of 2050 RCP8.5 Climate Change projection.	Rare	Moderate	M	Rare	Moderate	M
005	Extreme heat	Extreme temperature worsens odour emissions / odour profile of the site resulting in harmful odour emissions and community complaints and/or licence breech	Direct	Indoor storage, under negative pressure, of organics limits odour impacts from extreme temperatures Design will incorporate a biofilter Odour assessment is being conducted as part of the DLAto determine the existing order profile and potential impacts of the RRON facility.	Unlikely	Major	H	Rare	Major	H	Consider the following in design: Odour control design to consider an increase in high temperature days in the future and potetnial impacts assoicated with this.	Unlikely	Moderate	M	Rare	Moderate	M
006	Extreme heat	Extreme temperature inside building resulting in unsafe work environment and potential workplace safety incident, or shutdown and lost productivity, need for contingency processing	Direct	Cabins where operators are working to be appropriately air conditioned (including mobile plant).	Likely	Minor	H	Rare	Minor	L	Consider the following in design: Investigate green walls/roof as way of insulating against climate variability. Offer operators amenities that are separate to the main building / workplace and appropriately air conditioned (i.e. at existing Black Rock site). Design for durations for plant autonomy	Moderate	Minor	M	Rare	Minor	L

DESCRIPTION OF IMPACTS AND CONTROLS					RISK ASSESSMENT						ADAPTATION RESPONSES	RESIDUAL RISK			RESIDUAL RISK		
EXPOSURE AND VULNERABILITY			**RISK TYPE**	**PLANNED CONTROLS**	**RATING FOR 2050 RCP 8.5 PROJECTION**			**RATING FOR 2050 RCP 4.5 PROJECTION**			**MANAGEMENT OPTIONS**	**RESIDUAL RISK RATING POST ADAPTATION - 2050 RCP8.5**			**RESIDUAL RISK RATING POST ADAPTATION - 2050 RCP4.5**		
Risk ID:	***Climate variable***	***Description of impact***	***Direct or Indirect***	***Description of controls either planned within current design or assumed to be planned for future packages of work***	***Likelihood***	***Consequence***	***Risk***	***Likelihood***	***Consequence***	***Risk***	***Adaptation Details***	***Likelihood***	***Consequence***	***Risk***	***Likelihood***	***Consequence***	***Risk***
007	Extreme heat	Extreme temperature leading to increase in fire risk from storage of waste stockpiles, particularly any stockpiles located outside buildings. Resulting in harmful air emissions.	Direct	All imcoming stockpiles will be located inside buildings. Fire protection design. Quenched biochar product to be collected and bagged out of the process rather than stockpiled. Incoming waste stockpiles and biochar to be managed in accordance with EPA Publication 1667.3: Management and storage of combustible recyclable and waste materials – guideline	Unlikely	Major	H	Rare	Major	H	Consider the following in design: Investigate use of fire identification cameras/ sensors for waste stockpiles. Weather warnings monitoring to be built into Contingency to enable preparedness/ additional precautions to be put in place.	Rare	Moderate	M	Rare	Moderate	M
008	Bushfires	Shut down periods due to fire or extreme fire days will require contingency for waste (which either continues to arrive or needs to be diverted elsewhere)	Indirect	Waste storage capacity to have contingency capacity/ contingency plan to be utilised, with offsite disposal	Moderate	Moderate	H	Moderate	Moderate	H	Consider the following in design: Contingency storage capacity allowance Contingency plan to be developed for waste to be taken to licensed facility off-site. Onsite plant (for lifting / moving stockpiles and material) within EPA guidelines	Unlikely	Moderate	M	Unlikely	Moderate	M
009	Bushfires	Fire events nearby (bushfire/ grassfire) could cause flammable risk to storage of biochar on site resulting in a fire that damages to infrastructure, depletes air quality in area and impacts revenue.	Indirect	Biochar storage / bagging is indoors in carbonisation building Higher rating fire protection is designed into carbonisation building	Rare	Major	H	Rare	Major	H	Consider the following in design: Containment of bagged biochar storage- consideration of sprinkler systems and automated systems for temperature monitoring.	Rare	Moderate	M	Rare	Moderate	M

DESCRIPTION OF IMPACTS AND CONTROLS					RISK ASSESSMENT						ADAPTATION RESPONSES	RESIDUAL RISK			RESIDUAL RISK		
EXPOSURE AND VULNERABILITY			RISK TYPE	PLANNED CONTROLS	RATING FOR 2050 RCP 8.5 PROJECTION			RATING FOR 2050 RCP 4.5 PROJECTION			MANAGEMENT OPTIONS	RESIDUAL RISK RATING POST ADAPTATION - 2050 RCP8.5			RESIDUAL RISK RATING POST ADAPTATION - 2050 RCP4.5		
Risk ID:	*Climate variable*	*Description of impact*	*Direct or Indirect*	*Description of controls either planned within current design or assumed to be planned for future packages of work*	*Likelihood*	*Consequence*	*Risk*	*Likelihood*	*Consequence*	*Risk*	*Adaptation Details*	*Likelihood*	*Consequence*	*Risk*	*Likelihood*	*Consequence*	*Risk*
010	Extreme rainfall	Flood event of site could cause production downtime	Direct	Contingency plan with councils	Moderate	Moderate	H	Moderate	Moderate	H	Consider the following in design: On-site stormwater management design (and appropriate design of integration with Black Rock stormwater management) for extreme rainfall events with consideration of 2050 RCP8.5 Climate Change projection scenario.	Moderate	Minor	M	Moderate	Minor	M
011	Drought	Prolonged drought leading to loss of vegetation and increase in dust and airborne pollutants impacting offsite (community complaints/ licence breech)	Indirect	Landscaping, which includes the establishment of tree and mounded perimeter. Management of grass lands.	Unlikely	Major	H	Rare	Major	H	Consider the following in design: Increase in drought tolerant landscaping and land care services and possibility for dust suppression should consistent dust sources be identified throughout a drought period.	Unlikely	Moderate	M	Rare	Moderate	M
012	Extreme rainfall	Extreme rainfall impacts on performance of biofilter resulting in increase in odour profile from the facility	Direct	Not identified	Unlikely	Major	H	Unlikely	Major	H	Consider the following in design: Biofilter to be designed / built to cope with extreme rainfall events (i.e., projected rainfall intensity for high emission climate change scenario).	Rare	Moderate	M	Rare	Moderate	M
013	Extreme rainfall	Extreme rain event causes flooding of roads and prevents products (i.e. biochar and digestate) from being removed from site resulting in an increased fire risk from the biochar storage and an increased odour risk from digestate.	Direct	Indoor storage capacity where environment and protection of stored biochar and digestate can be controlled.	Rare	Major	H	Rare	Major	H	Consider the following in design: Whilst designing carbonisation building, consider storage capacity of the bagged biochar.	Rare	Moderate	M	Rare	Moderate	M

DESCRIPTION OF IMPACTS AND CONTROLS					RISK ASSESSMENT						ADAPTATION RESPONSES	RESIDUAL RISK			RESIDUAL RISK		
EXPOSURE AND VULNERABILITY			**RISK TYPE**	**PLANNED CONTROLS**	**RATING FOR 2050 RCP 8.5 PROJECTION**			**RATING FOR 2050 RCP 4.5 PROJECTION**			**MANAGEMENT OPTIONS**	**RESIDUAL RISK RATING POST ADAPTATION - 2050 RCP8.5**			**RESIDUAL RISK RATING POST ADAPTATION - 2050 RCP4.5**		
Risk ID:	***Climate variable***	***Description of impact***	***Direct or Indirect***	***Description of controls either planned within current design or assumed to be planned for future packages of work***	***Likelihood***	***Consequence***	***Risk***	***Likelihood***	***Consequence***	***Risk***	***Adaptation Details***	***Likelihood***	***Consequence***	***Risk***	***Likelihood***	***Consequence***	***Risk***
014	Extreme rainfall	Extreme rainfall leading to prolonged saturation of the site and damage to access roads and tracks preventing delivery vehicles accessing site	Direct	Standard civil design for drainage of sealed pavements	Moderate	Minor	M	Moderate	Minor	M	Consider the following in design: Increased capacity to sub-surface road drainage to manage projected volumes of stormwater as a result of RCP 8.5 increased rainfall intensity.	Unlikely	Minor	L	Unlikely	Minor	L
015	Extreme rainfall	Extreme rainfall overwhelms stormwater management system resulting in overflows from detention basin	Direct	Indicative stormwater system design assumes overflow will be directed to existing table drain system onsite	Moderate	Minor	M	Moderate	Minor	M	Consider the following in design: Incorporate (or design) overflow pathways in the stormwater retention system to manage projected increase to stormwater	Unlikely	Minor	L	Unlikely	Minor	L
016	Extreme rainfall	Organic materials on site uncovered could cause risk for runoff pollution into sensitive areas	Direct	All organic mateirals to be covered / enclosed at all times. Design intent for all washdown areas in building to be contained and directed to wastewater treatment and for all onsite stormwater to be contained and managed onsite.	Unlikely	Moderate	M	Unlikely	Moderate	M	Design to consider risk of wheels tracking organic material offsite and mitigate this risk.	Unlikely	Minor	L	Unlikely	Minor	L
017	Extreme heat	Prolonged extreme temperature days causes cracking in the roads (bitumen) requiring repair	Direct	Design of suitable pavements and redundancy for repair and high use areas. i.e consider deep lift asphalt over spray seal access roads.	Moderate	Minor	M	Unlikely	Minor	L	Consider the following: Standby water cart to cool pavements on hot days and prevent asphalt reaching melting point should the risk arise with future 2050 RCP8.5 Climate Change predictions.	Moderate	Minor	M	Unlikely	Minor	L

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EXPOSURE AND VULNERABILITY			RISK TYPE	PLANNED CONTROLS	RATING FOR 2050 RCP 8.5 PROJECTION			RATING FOR 2050 RCP 4.5 PROJECTION			MANAGEMENT OPTIONS	RESIDUAL RISK RATING POST ADAPTATION - 2050 RCP8.5			RESIDUAL RISK RATING POST ADAPTATION - 2050 RCP4.5		
Risk ID:	*Climate variable*	*Description of impact*	*Direct or Indirect*	*Description of controls either planned within current design or assumed to be planned for future packages of work*	*Likelihood*	*Consequence*	*Risk*	*Likelihood*	*Consequence*	*Risk*	*Adaptation Details*	*Likelihood*	*Consequence*	*Risk*	*Likelihood*	*Consequence*	*Risk*
018	Extreme heat	Heatwave causes 'hot load' of organic material disposed at site resulting in fire causing safety incident and/or damage to infrastructure	Indirect	Segregated drop-off area within tipping floor at facility (as trucks will be aware if they have a 'hot load'). Fire protection designed into facility. Councils likely to have their own controls as well.	Unlikely	Moderate	M	Rare	Moderate	M	Consider the following in design: Implementation of specific procedure / management plan with Councils when heatwave is occuring. Segregated drop-off area to be clear of any infrastructure	Rare	Moderate	M	Rare	Moderate	M
019	Severe Storms	Coastal location is very windy on regular basis; severe weather is felt more due to exposed site - could be damage to buildings	Direct	Basis of design provides wind data	Moderate	Minor	M	Moderate	Minor	M	Consider the following in design: Basis of design in terms of wind to consider the 2050 RCP8.5 Climate Change projection. This could include increasing wind ratings of new buildings to withstand projected increase in wind velocities in storm events under high emissions scenario.	Unlikely	Minor	L	Unlikely	Minor	L
020	Severe Storms	Extreme storm causes damage to infrastructure causing downtime etc.	Direct	Basis of design provides wind data	Unlikely	Moderate	M	Unlikely	Moderate	M	Consider the following in design: Basis of design in terms of wind to consider the 2050 RCP8.5 Climate Change projection This could include increasing wind rates of new buildings to withstand projected increase in wind velocities in storm events under high emissions scenario.	Rare	Minor	L	Rare	Minor	L
021	Drought	Prolonged drought leading to subgrade shrinkage resulting in foundation damage to plant and buildings	Indirect		Unlikely	Moderate	M	Rare	Moderate	M	Consider the following in design: Civil & structural design adaptations Additional geotech assessments for shrinkage limits on subgrade and founding material	Unlikely	Minor	L	Rare	Minor	L

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Risk ID:	*Climate variable*	*Description of impact*	*Direct or Indirect*	*Description of controls either planned within current design or assumed to be planned for future packages of work*	*Likelihood*	*Consequence*	*Risk*	*Likelihood*	*Consequence*	*Risk*	*Adaptation Details*	*Likelihood*	*Consequence*	*Risk*	*Likelihood*	*Consequence*	*Risk*
022	Bushfires	Increase incidence of fire danger days reducing work force hours resulting in delay to maintenance and upkeep and subsequent plant shutdowns	Indirect	Council contingency plan enacted	Unlikely	Moderate	M	Unlikely	Moderate	M	Consider the following in design: Plant autonomy durations throughout the design	Unlikely	Minor	L	Unlikely	Minor	L
023	Sea level rise	Sea level rise affects road access (to the north), stopping access of trucks delivering waste to facility and staff/ goods access to site, stopping operation of facility/ production	Indirect	Works to be designed in area designated as not effected by future sea level rise - 90 Year forecast	Rare	Moderate	M	Rare	Moderate	M	Consider the following in design: Possible implementation of contingency plan	Rare	Minor	L	Rare	Minor	L
024	Sea level rise	Sea Level rise causing raised groundwater table and salinity issues for site. High salinity resulting in reduced asset life and performance.	Indirect	Ground water monitoring and design facilities to be founded in appropriate material - i.e. dense clays.	Rare	Moderate	M	Rare	Moderate	M	Consider the following in design: Climate Change considerations when determining exposure classification for durability design.	Rare	Minor	L	Rare	Minor	L
025	Sea level rise	Sea level rise could decrease distance of facility to sensitive areas and need to reconsider buffer zones	Direct	Works to be design in area designated as not effected by future sea level rise - 90 Year forecast	Unlikely	Moderate	M	Unlikely	Moderate	M	Consider the following in design: Review of building floor levels during design to ensure they are sufficiently above predicted future sea levels.	Unlikely	Negligble	L	Unlikely	Negligble	L

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026	Extreme heat	Risk of short term power outage causing downtime of RRON, impacting operations.	Direct	Contingency Plan with Councils	Moderate	Moderate	H	Moderate	Moderate	H	Consider the following in design: 1) Backup generator / battery to maintain critical processes in event of outage (if required). 2) Backup generator for weighbridge (if required) and/or contingency storage capacity for incoming waste - to allow waste to be accepted during an outage.	Moderate	Minor	M	Moderate	Minor	M
027	Extreme heat	Risk of power outage causing downtime of RRON, impacting operations and emissions control technology causing licence breach.	Direct	Not identified	Unlikely	Major	H	Unlikely	Major	H	Consider the following in design: 1) Backup generator / battery to maintain critical processes in event of outage (if required).	Unlikely	Minor	L	Unlikely	Minor	L
028	Bushfires	Risk of short term power outage causing downtime of RRON, impacting operations.	Direct	Contingency Plan with Councils	Moderate	Moderate	H	Moderate	Moderate	H	Consider the following in design: 1) Backup generator / battery to maintain critical processes in event of outage (if required). 2) Backup generator for weighbridge (if required) and/or contingency storage capacity for incoming waste - to allow waste to be	Moderate	Minor	M	Moderate	Minor	M
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