Brisbane Energy & Resources Centre (BERC): Climate and Climate Change Assessment

Prepared for:

Cleanaway Operations Pty Ltd

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REV C – Issue for Approval

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Glossary

Term	Definition
km	kilometre
km/h	kilometre per hour
MW	megawatt
m	metres
mm	millimetres
m/s	metres per second
°C	degrees Celsius
Nomenclature	**Definition**
CO_2	carbon dioxide
Abbreviations	**Definition**
AEP	Annual exceedance probability
APCr	Air pollution control residues
AR5	Assessment Report 5 (IPCC)
AR6	Assessment Report 6 (IPCC)
AS/NZS	Australian Standard/New Zealand Standard
BAT	Best Available Technology
BERC	Bromelton Energy and Resource Centre
BoM	Bureau of Meteorology
C&I	Commercial & Industrial
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DELWP	Department of Energy, Land, Water and Planning
EfW	Energy from Waste
EoW	End of Waste
ENSO	El Nino Southern Oscillation
EPR	Environmental Performance Requirement
ESCI	Electricity Sector Climate Information
GCM	Global Climate Model
GHG	Greenhouse gases
IBA	Incinerator bottom ash
IBAA	Incinerator bottom ash aggregate
IED	Industrial Emissions Directive
IOD	Indian Ocean Dipole
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organisation
LULUCF	Land use, land use change, and forestry
MSW	Municipal Solid Waste
NEM	National Electricity Market
NRM	Natural Resource Management
OHS	Occupational Health and Safety
PCBU	Person conducting business or undertaking
RCP	Representative Concentration Pathways
SAM	Southern Annular Mode
SDA	State Development Area
SEQ	South East Queensland
TEPP	Technically, environmentally and economically practical

EXECUTIVE SUMMARY

Cleanaway Operations Pty Ltd (Cleanaway) commissioned Katestone Environmental Australia Pty Ltd (Katestone) to conduct a Climate and Climate Change Risk Assessment for a proposed Energy from Waste (EfW) facility in Queensland known as the Bromelton Energy and Resource Centre (BERC / the Project). The assessment:

- Describes local and regional climate for the Project area
- Determines which aspects of weather, climate, and climate change are material to the construction, operation, and rehabilitation of the Project
- Assesses potential hazards and vulnerability of the Project due to extreme weather events and climate change
- Assesses and describes feasible environmental management measures and strategies to cope with the hazards and risks posed by climate change.

The Project occurs in subtropical South East Queensland (SEQ), a region with warm summers and generally mild winters. Most rainfall occurs during summer and autumn, often in short intense storms. SEQ has been subject to intense storms, extreme rainfall and flooding, heatwaves, and extended drought since records commenced in the 1880s, with major events in the last two decades causing billions of dollars of damage.

Extreme weather events driven by global warming have the potential to adversely affect a) staff health and safety, b) timely, cost-effective, and safe construction, c) infrastructure integrity, and d) operational capacity to receive or process waste and generate electricity.

Weather events (hazards) subject to climate change considered material to the construction, operation, and eventual rehabilitation of the Project include:

- Extreme temperature, with projected increases in the number of days above 35°C
- Heavy rainfall, with projected increases in rainfall intensity
- Wind gusts, with possible increases in maximum wind speed
- Severe storms, with projected increases in tropical cyclone intensity
- Fire weather, with projected extension of fire seasons and an increase in very high fire danger days.

Uncertainties associated with projected climate change and extreme weather events require adaptive management planning and responses to ensure business continuity of critical infrastructure in the face of plausible event scenarios.

Risk scenarios have been considered and the mitigation options that follow are:

- CCA01 Climate change adaptation design measures – Cleanaway will identify acceptable infrastructure risk and prescribe design engineering tolerances to cope with extreme heat, wind, and/or rainfall to the level of acceptable risk
- CCA02 Climate Change Adaptation and Risk Management Plan –
    - Cleanaway to require the principal contractor to engage with appropriate labour representatives to identify and confirm processes, e.g., safety triggers, work hours, and facilities, e.g., shade, water, air conditioning, to ensure that construction can continue as necessary during periods of extreme heat

- Cleanaway to require the principal contractor to establish site rules for construction work during hailstorms, thunderstorms, and (or immediately after) extreme rainfall events
- Cleanaway to apply an early warning system for dangerous thunderstorms and establish site rules for operational work outdoors during thunderstorms
- Cleanaway to identify acceptable infrastructure risk and prescribe design engineering tolerances to cope with extreme heat, wind, and/or rainfall to the level of acceptable risk
- Cleanaway to develop an operational site and near-site fire response and control plan in conjunction with emergency services, and ensure staff training and provision of equipment for fire control
- Cleanaway to establish emergency controls for bypass or plant shutdown in the event of an extended catastrophic transmission infrastructure failure at or near site.

Development of these climate change adaptation design measures and a Climate Change Adaptation and Risk Management Plan will ensure that the Project complies with Section 2.5.10 of the Bromelton State Development Area Development Scheme, which requires demonstrable adaptation to projected climate change conditions in the region.

1. INTRODUCTION

Cleanaway Operations Pty Ltd (Cleanaway) is developing an Energy from Waste (EfW) facility in Queensland known as the Bromelton Energy and Resource Centre (BERC / the Project). The Project will be located within the Special Industry Precinct of the Bromelton State Development Area (SDA), west of Beaudesert within the Scenic Rim Regional Council local government area (Figure 1).

Queensland's Energy from Waste policy[1] provides a framework to help ensure that any EfW facilities developed in Queensland meet technical, environmental, regulatory and community expectations and are in the best interest of Queenslanders. Thermal EfW is considered an acceptable method for energy recovery from municipal solid waste (MSW), commercial and industrial (C&I) waste, and construction and demolition (C&D) waste that is unsuitable for reuse or recycling, and this is preferred over the continued landfilling of organic waste.

Katestone Environmental Australia Pty Ltd (Katestone) has been commissioned by Cleanaway to conduct a climate and climate change risk assessment for the project that meets the requirements of the *Climate-EIS information guideline* (ESR/2020/5298). The requirements are to:

- Provide data and statistics that characterise the existing weather patterns at the project site
- Describe the local and regional climate with regard to seasons and susceptibility to extreme events
- Assess the aspects of local and regional climate that are relevant to the management of the project
- Assess the potential change in climate at the project site over the expected life of the project
- Assess the project's vulnerabilities to projected climate change
- Assess and describe feasible risk management strategies

The assessment is also required to demonstrate how the Project will adapt to the projected climate change conditions in the region (Section 2.5.10 of the Bromelton State Development Area Development Scheme).

[1] https://www.qld.gov.au/__data/assets/pdf_file/0020/118433/energy-from-waste-policy.pdf

Figure 1 Site location

2. PROJECT OVERVIEW

2.1 The Project

The Project has been designed to thermally treat approximately 760,000 tonnes per annum (tpa) of waste feedstock, consisting of residual Municipal Solid Waste (MSW) and residual Commercial and Industrial (C&I) waste. Residual waste is waste that is not technically, environmentally and economically practical (TEEP) to reuse or recycle, which would otherwise be sent to landfill for disposal. The facility's actual annual throughput will vary depending on the calorific value of the feedstock and plant availability. To account for variability in feedstock energy content, the facility will be designed for a maximum processing capacity of up to 10% above the nominal figure (836,000 tpa). The EfW process is summarised in Figure 2.

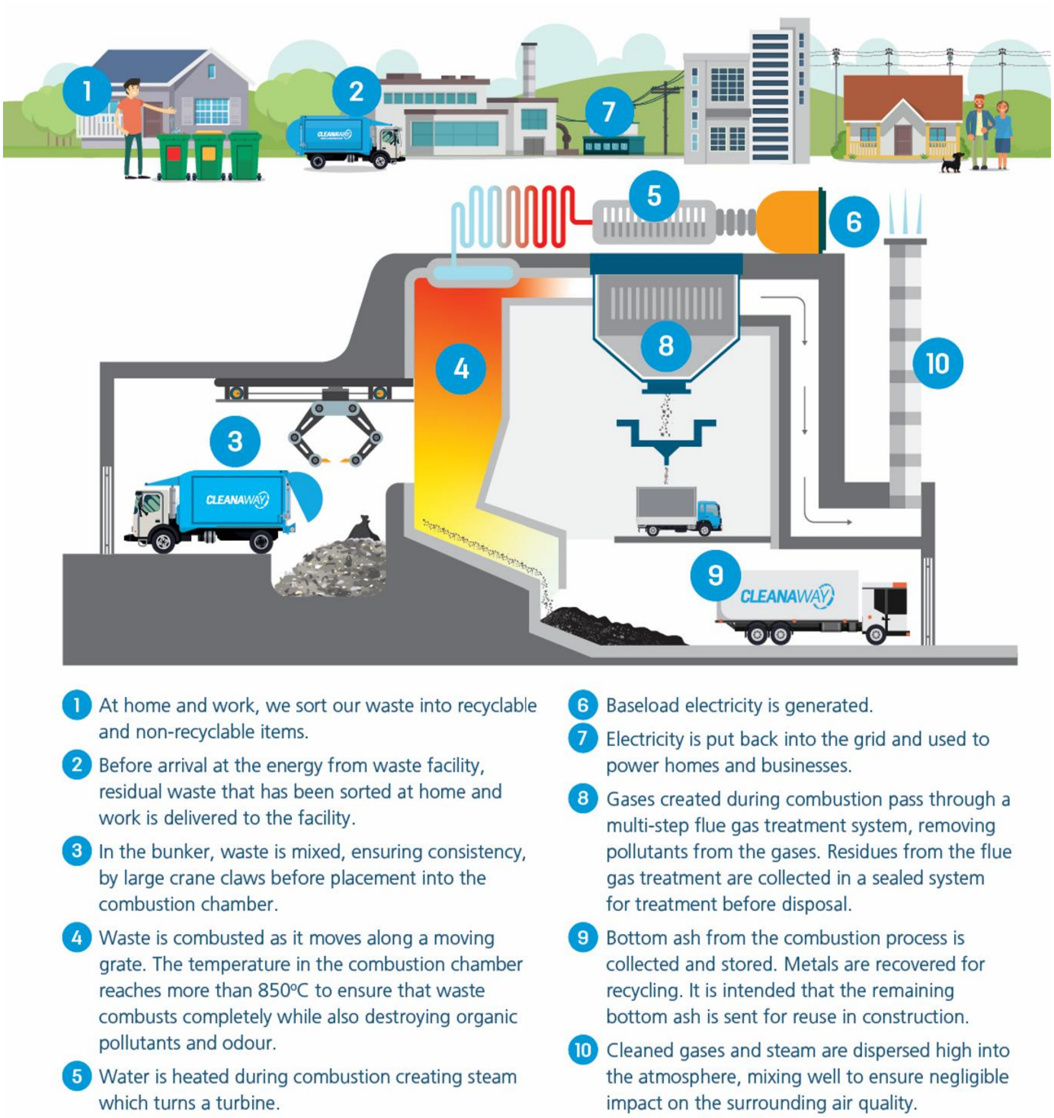

Figure 2 Energy from Waste Process

2.2 Proponent

Cleanaway, an Australian owned company, has operated for more than 50 years, supporting industry, government, communities, and households across Australia. Its mission is to make a sustainable future possible, achieved through action across all levels of the waste hierarchy. Waste generation is minimised through extensive education programs, with Cleanaway's 50 education officers reaching over 120 businesses, 30 councils, and almost 33,000 school participants in the last financial year.

Cleanaway invests heavily in recycling, operating several Material Recovery Facilities nationwide and has partnered with Pact Group, Asahi Beverages, and Coca-Cola to deliver two large-scale PET (polyethylene terephthalate) recycling facilities and a HDPE (high density polyethylene) recycling facility with Pact Group. In addition, in collaboration with Viva Energy, Cleanaway is developing a soft plastics recycling plant. EfW is recognised by Cleanaway as an important part of the future waste management framework, enabling recovery of energy and other resources from residual waste that cannot otherwise be recycled.

2.3 Policy Alignment

The Project aligns with the Queensland EfW Policy and the Queensland EfW Guideline (2021) by diverting residual waste from landfill and delivering economic and social benefits through employment and local business opportunities in South East Queensland.

In accordance with Policy outcome 7 of the Queensland EfW Policy, the Project will be designed to meet the best practice emission standards and requirements of the European Industrial Emissions Directive (IED) (2010) and the associated Best Available Techniques Reference (BREF) Document for Waste Incineration (2019), which sets the European Union environmental standards for waste incineration.

The Project also supports the Queensland Waste Strategy contributing to its 2050 targets to reduce household waste by 25%, recycle 75% of all waste, and divert 90% from landfill. In doing so, the Project will play a key role in advancing Queensland's transition to a circular economy and reducing long-term reliance on landfill.

2.4 Key Components

The key components of the Project are summarised in Table 1.

Table 1 Key Project Components

Project Component	Detail
Address	Lot 1 Beaudesert Road, Bromelton, Queensland, 4285 (Lot 1 on RP45234). Refer Figure 2.
Site Area	63 hectares
Summary of proposed works	The Project includes the construction of a main EfW facility for waste processing, incinerator bottom ash (IBA) maturation and processing facility and an air pollution control residue (APCr) facility. It also includes all onsite infrastructure needed for the EfW facility, such as site utilities, internal roads, weighbridges, parking and hardstand areas, stormwater infrastructure, fencing and landscaping. The Project will include a visitor centre to help educate and inform the community on circular economy principles, the waste hierarchy, including waste avoidance, recycling, resource recovery, the benefits of landfill diversion and the EfW process. The intent behind this education is to drive a shift in community awareness and attitudes toward waste management and resource recovery.

Project Component	Detail
Technology Used	The proposed technology is moving grate combustion technology. This has been used globally for over 100 years and is common in many of the 500 similar operational examples across Europe.
Facility Outputs	Approximately 73.2 MW (577,600 MWh/year, corrected for ambient temperature) exported to the grid as baseload electricity. Potential to supply energy in the form of heat and/or process steam to local industrial users. Residual materials include IBA and APCr. - It is intended that the IBA will be mechanically processed on site to create incinerator bottom ash aggregate (IBAA). During this process, both ferrous and non-ferrous metals are recovered for recycling and sale. It is intended that the remaining material is repurposed for use as an aggregate in construction. - The Project includes a facility to stabilise APCr before removal and disposal at a licensed landfill.
Key infrastructure	EfW facility including administration and visitor's centre IBA maturation and processing facility (2 x pads and 2 x sheds) APCr facility (1 x pad, 1 x shed) Transformer yard and switchyard De-coupling area for trucks Weighbridges Internal road network and carparking 2 x combined storm water treatment and detention basin 1 x lined retention basin Access from Beaudesert Boonah Road via a signalised intersection with Recycling Street
Hours of Operation	24 hours per day, seven days per week (365 days per year)
Operational Staff	Approximately 60 staff

2.5 Project layout

The proposed development is situated within the locality of Bromelton, Queensland, approximately 47 km inland of the Gold Coast and around 56 km south-southwest of Brisbane CBD. Situated in the Scenic Rim region of Queensland, the Project sits near the base of hills directly to the west, with the township of Beaudesert 7 km to the east.

The Project site will incorporate the following key elements:

- Two-line (2 x 140 MW_{th}) EfW facility, with each line comprising: a combustor, boiler, flue gas treatment system, Induced Draft (ID) fan, Continuous Emissions Monitoring System (CEMS) and a dedicated flue. The processing capacity of each line will be approximately 380,000 tpa (760,000 tpa cumulative) at the design CV of 10.6 MJ/kg (LHV) and assuming 8,000 hours per annum boiler availability. The two lines will supply steam to a single steam turbine while flue gas will be discharged through a single stack containing two internal flues. Moving grate combustion will be employed as the preferred thermal treatment technology.

- Incinerator Bottom Ash (IBA) treatment area and sorting plant incorporating: a fully enclosed sorting facility, an enclosed conveyor for delivery of IBA from EfW facility to the IBA treatment area, IBA maturation stockpiles (1-2 months) contained within a 3-sided building and open-air stockpiles for sorted and matured IBA aggregate (IBAA) (1-2 months) with dust control using water spraying, and water capture system around the IBA treatment area, segregated from the site stormwater management system.
- APCr undercover stabilisation and storage facilities where treated APCr (a slurry of APCr, cement and water) is allowed to cure into solid blocks prior to transport offsite for landfill disposal.
- Site infrastructure including roads, weighbridges, inspection bays, dangerous goods tanks, firewater and process water tanks, electrical substation, truck movement areas, offices, on-site car parking areas and a separate main staff and visitor car park. A visitor and education centre is also proposed, to be integrated within the site administration building.

2.6 Construction

Construction is anticipated to take approximately 39 months (exclusive of commissioning and proof of performance testing prior to operations) to complete.

2.7 Operation

Figure 2 provides an overview of the operational features of the Project, which are described further below.

2.7.1 Waste Arrival

Waste deliveries will enter the Project via a security gate house at the weighbridge where the vehicle will be weighed, and delivery details recorded. Waste delivery vehicles may be selected at random to proceed to a designated pre-inspection area to allow the Project operations staff to verify the waste and where feasible, visually inspect the load to confirm its suitability as acceptable waste.

2.7.2 Waste volumes and waste acceptance

The Project will receive approximately 760,000 tpa of a combination of mainly residual MSW and residual C&I waste. The EfW facility is designed to maintain availability of 8,000 hrs/yr per operational line with a nominal throughput for each line of 47.5 tph.

Only wastes that are consistent with the definition of residual waste under the EfW Guideline (DES, 2021) outcome 4 will be accepted as waste feedstock. Examples of non-residual waste include, but are not limited to, uncontaminated comingled recyclables from yellow lid bins; source-separated green waste; and MSW, C&I and C&D waste that has not been source separated.

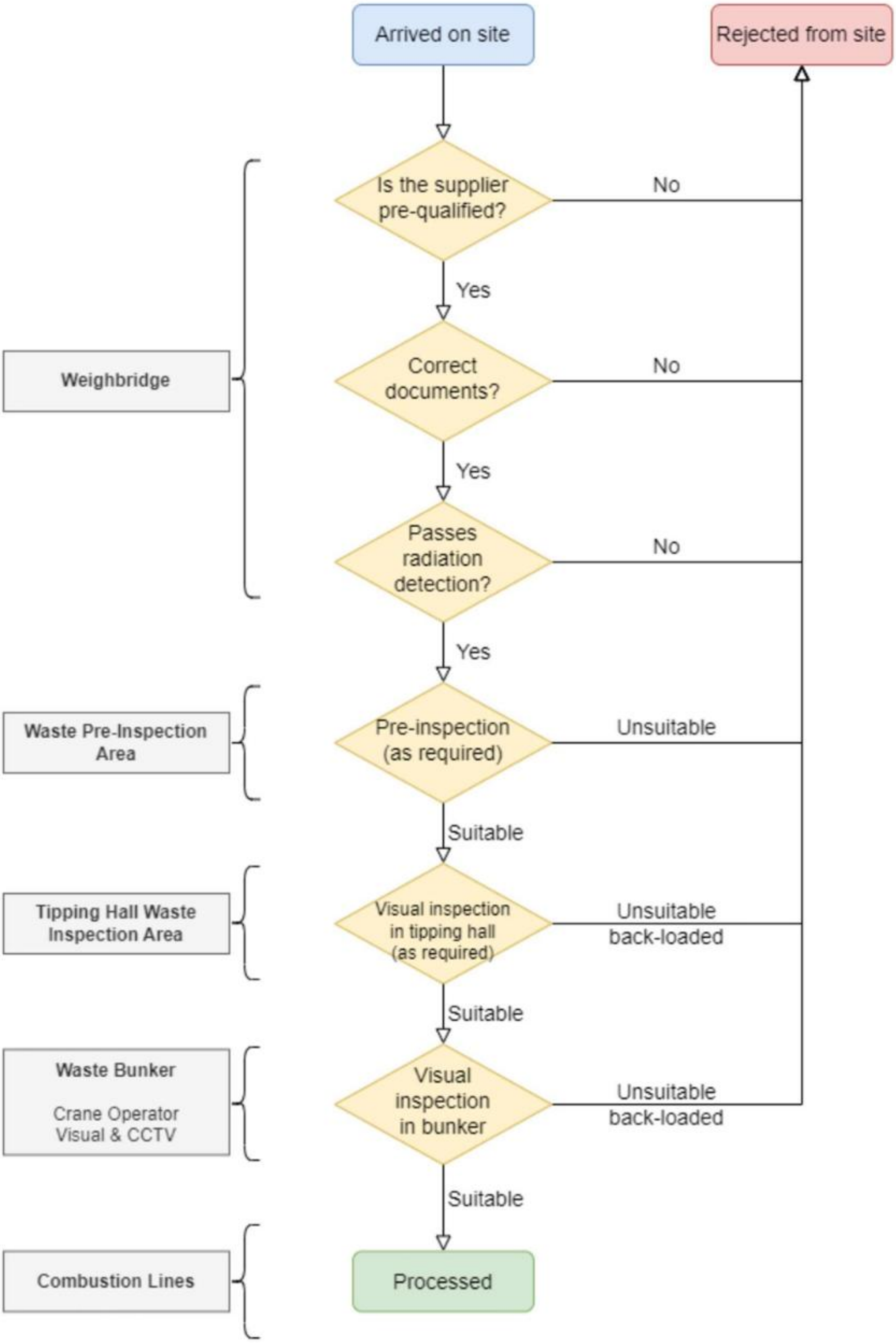

Figure 3 Process on arrival for a waste delivery to the EfW facility

Waste feedstock supplies by Cleanaway and third-party suppliers will be managed in accordance with the BERC Waste Acceptance Protocol (WAP), which defines both acceptable and unacceptable waste types, along with waste arrival and inspection protocols and provisions to divert or remove unacceptable waste or waste loads. The waste acceptance process essentially involves pre-qualification of waste suppliers and waste types through contractual Waste Supply Agreements, identification and logging of all waste deliveries, radiation detection and inspection of the waste at various stages (Figure 3) for size and suitability, aiming to maintain the composition and combustion characteristics of the waste feedstock within an acceptable range and to remove unacceptable materials that may result in unacceptable contaminant levels or may cause damage or blockages to plant and equipment.

Periodic sampling of waste will also be undertaken to determine certain key parameters of the waste profile including ash, moisture, chlorine, sulphur and metallic aluminum. Oversized acceptable waste can be fed to an onsite shredder before being fed to the boiler.

2.7.3 Waste arrival

Waste deliveries will enter the BERC site via a security gate house at the weighbridge where the vehicle will be checked for excessive levels of radiation, weighed, and have their delivery details recorded. Waste delivery vehicles may be selected at random to proceed to a designated pre-inspection and quarantine area to allow the BERC operations staff to verify the waste and where feasible, visually inspect the load to confirm its suitability as acceptable waste.

2.7.4 Tipping hall and waste bunker

Waste will be delivered via a tipping hall, expected to operate seven days per week with the majority of deliveries occurring during a 12 hour-a-day window (6 am – 6 pm) although the facility will be able to accept waste 24/7, if required.

The tipping hall will be designed to cope with the facility ‘peak hour’, which is the hour in the day where the largest number of vehicles is expected to require processing. The preliminary estimate of total waste deliveries is up to approximately 119 waste trucks per day at 10% mechanical overload. The tipping hall will be enclosed and will include quick shutting roller doors for odour control. Negative pressure will be maintained in the hall and waste bunker areas by preferentially drawing potentially odorous air from within the tipping hall and waste bunker area into the boiler furnace as combustion air. Adjustable louvres in the façade of the tipping hall will allow air inflow (for the furnace combustion air system), even if the entry and exit roller doors are closed.

The tipping hall shall include a waste inspection area where random waste loads arriving in compactor size vehicles can be temporarily unloaded for inspection and shall include a waste rejection point to allow removal of unsuitable waste from the bunker.

Tipping hall bays shall include a protection mechanism to mitigate the risk of vehicles overreaching into the bunker.

The waste bunker shall be designed to store approximately seven days of waste at full capacity. The waste bunker is monitored by CCTV in the plant control room.

During delivery hours, the waste crane operators will monitor the operation of the grab cranes, to mix and distribute the waste, and move oversize acceptable waste into the shredder for resizing. The grab cranes will also be used to remove unacceptable waste from the waste bunker. The mixing operation of the grab crane is important for the stable operation of the combustion system and flue gas treatment system, by working to ensure that individual waste loads are mixed together prior to being fed to each grate combustion system.

2.7.5 Combustion system and waste firing

The combustion system will be of a typical moving grate design suitable for combustion of MSW and C&I wastes. The boiler will generate superheated steam suitable for driving the steam turbine. The boiler will be designed to maintain a flue gas temperature of at least 850 degrees Celsius for a residence time of at least two seconds (after last injection of combustion air) to comply with the requirements of EU IED, as required by the EfW Policy (DES, 2021) and EfW Guideline (DES, 2021). The system will include online boiler tube cleaning.

The boiler system will include an allowance for auxiliary fossil fuel burners (e.g., auxiliary diesel fuel burners) for start-up, shutdown and to ensure that the 850 degree Celsius for two seconds residence time criteria is maintained when waste is being combusted.

The Project is designed to operate across a range of CVs with a reasonably selected design point. This is done to accommodate normal variabilities in waste make-up and associated changes in waste CV. Although the plant has a design point of 760,000 tpa with a waste CV of 10.6 MJ/kg (LHV) and 8,000 hours per annum boiler availability, in reality the plant could potentially process up to 836,000 tpa if the waste CV is 10.6 MJ/kg (LHV) (i.e. 10% mechanical overload scenario) and the facility hypothetically maintains a boiler availability of 100% and/or between 100-110% thermal input.

Mixed waste streams such as MSW and C&I waste are expected to constantly fluctuate in composition and combustion characteristics, however, the automated combustion control system will act to maintain stable boiler operation by controlling each boiler to a steam flow setpoint. This setpoint will ideally correspond to the 100% thermal input load for each grate-boiler system.

2.7.6 Emission controls and flue gas treatment

The concentrations of some air pollutants in the flue gas leaving the combustion system, such as nitrogen oxide, nitrogen dioxide (together referred to as NOx), carbon monoxide (CO), volatile organic compounds (VOCs), and dioxins and furans, are directly linked to the performance of the combustion system as well as the composition of the waste. Primary emission control involves:

- Mixing of the waste in the waste bunker prior to feeding each combustion system
- An automatic combustion control system that adjusts the feeder speed, movement of the grate (residence time and thickness of waste on the grate), primary and secondary combustion air flows, to maintain a desired steam generation set point from each boiler
- Careful control of combustion air injection such that excess air levels are controlled, helps to control the primary formation of NOx, though there is a trade-off with CO formation if combustion air levels are too low
- Maintaining stable combustion conditions and ensuring the flue gas temperature remains above 850 degrees Celsius for at least two seconds residence time helps to ensure the destruction of VOCs, dioxins and furans, and other similar organic compounds commonly found in solid fuel combustion systems.

The Project also includes a secondary NOx abatement system within the boiler known as Selective Non-Catalytic Reduction (SNCR). SNCR involves injecting ammonia or urea solution into the flue gas within a temperature range of ~900 – 1050 degrees Celsius. In this temperature range, the ammonia or urea will reduce the majority of the NOx that may be present in the flue gas to nitrogen and water.

After the SNCR system, hot flue gas passes through the boiler where it is used to raise steam and then superheat steam and finally, preheat the boiler feedwater in an economiser section. At the exit of the boiler economiser section, the cooled flue gases will be treated using an air emissions control system that consists of semi-dry flue gas treatment (FGT), and a baghouse filter.

Lime injection will be used to control emissions of acid gas pollutants via chemisorption (in particular HCl, HF, and SO_2) while activated carbon injection is used to control volatile heavy metals (such as mercury, lead, and cadmium) and any residual organic compounds through adsorption, when coupled with a baghouse filter. Indicative quantities of lime, urea, and activated carbon are detailed in Table 2.

The FGT and air emissions control system will be designed to ensure stack emissions at least meet the upper end of the range of associated emission levels of the best available techniques (BAT-AELs) as detailed in the latest Best Available Techniques Reference Document (BREF) for Waste Incineration (WI) (BREF WI) (Newahl F, et.al., 2019) and the short-term (half-hourly average) emission limits specified in the European IED, consistent with international best practice.

Table 2 Indicative quantities of FGT consumables

Consumable	Consumption (kg/h)	Base Case 100% MCR (760,000 tpa @ 10.6 MJ/kg (LHV) - Nominal throughput scenario	10% Mechanical Overload Case (836,000 tpa @ 10.6 MJ/kg (LHV) - Maximum throughput scenario
Quicklime (~90% purity)	1,100 – 1,300	9,200	10,100
40% Urea (or NH_3-H_2O)	480 - 530	3,800	4,200
Activated carbon	51 - 52	410	420

2.7.7 Bottom ash and residue management

The Project will generate two primary residue streams: IBA and APCr.

IBA will be collected from below the grate using a wet ash extraction system. Wetted IBA will be transported via a long, fully enclosed conveyor to the IBA Treatment area where it will undergo maturation and sorting including the removal of ferrous and non-ferrous metals. Sorting and metals recovery will occur indoors, after a period of maturation. Figure 4 illustrates the process.

After maturation and metals recovery, the IBA aggregate (IBAA) is typically considered (after suitable testing and confirmation during commissioning) to be non-hazardous. Recovered IBAA can then be used as an aggregate in construction (such as road bases). This is common practice for recycled IBAA in Europe and the UK. BERC will repurpose the IBAA in accordance with EfW Policy (DES, 2021).

APCr consists of two separate ash streams:

- Boiler ash (recovered in the hoppers below the horizontal pass/convective section of the boiler)
- Flue gas treatment or air pollution control residues (essentially a purge stream of baghouse filter cake, consisting of flue gas treatment residue and residual fly ash).

Boiler ash from the convective section of the boiler may be considered hazardous. To be conservative and align with precedents set for other EfW facilities currently at the development phase in Australia, this boiler ash will be mixed with APCr, which is hazardous and must be treated as such. APCr must be immobilised to avoid the leaching of heavy metals and other hazardous compounds into the environment. This will be achieved through blending with cement and water, which cures to form a solid concrete block, immobilising the hazardous elements. Once fully cured, the cement stabilised APCr will be transported to and disposed of in an appropriately classed landfill.

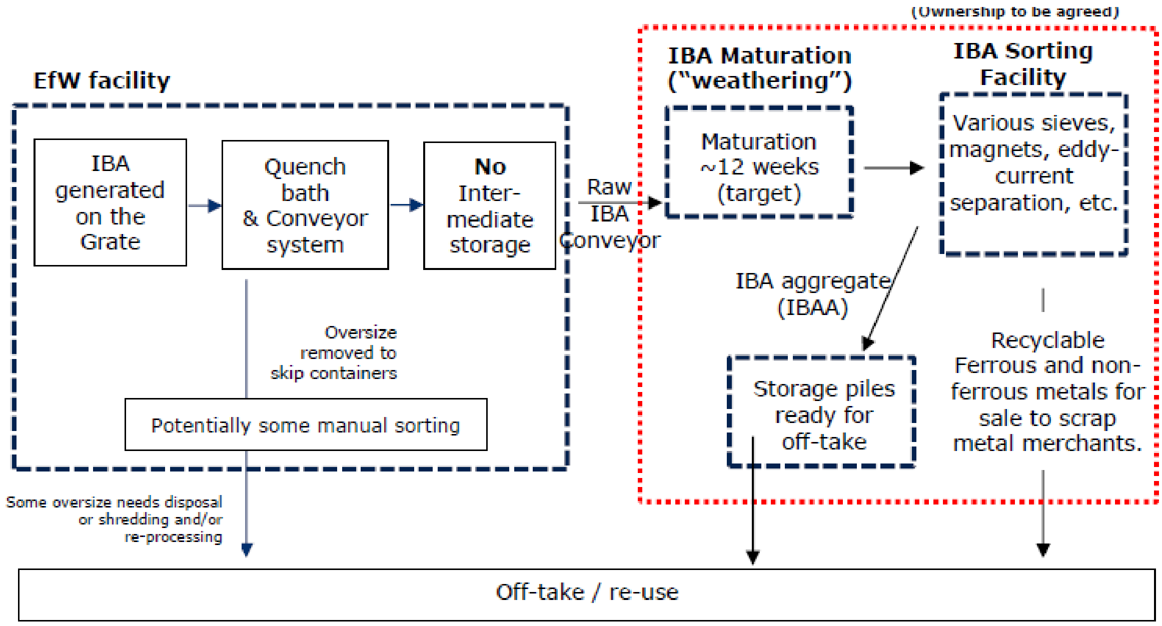

Figure 4 **IBA / IBAA process (Source: REN2021N00922-RAM-ME-00020 BERC IBA Memo v2.0 Issued 09JUL2025)**

3. POLICY CONTEXT AND REGULATORY FRAMEWORK

3.1 Policy, Guidelines, and Strategy

3.1.1 Energy from Waste Policy 2021 & Energy from Waste Guideline 2021

The Energy from Waste Policy[2] and Energy from Waste Guideline[3] provides guidance for establishing EfW facilities in Queensland. It outlines important technical, environmental, regulatory, and social or community outcomes for proponents of EfW facilities to achieve. These include demonstrating the operational performance of proposed facilities, engaging appropriately with potentially affected communities and being good neighbours, using only residual waste for energy recovery, and achieving high levels of energy recovery and environmental protection.

The Policy considers that waste combustion with energy recovery is preferable to landfill gas capture and combustion, as the latter relies on the continued disposal and decomposition of organic material in landfills.

The Policy applies the Precautionary Principle and highlights the importance of siting EfW facilities in locations that reduce potential impacts and unintended consequences. EfW facilities cannot be located within or near sensitive land uses in the urban footprint such as (but not limited to) residential, aged care or childcare facilities.

Three guiding principles outline where development of EfW facilities would be supported, namely where:

- The proposed facility is consistent with the intended or planned development for the proposed location
- Situated away from current and future sensitive land uses
- Economic benefits can be realised through colocation with resource recovery industries in precincts supported by existing or planned infrastructure

3.1.2 Waste Management & Resource Recovery Strategy 2019 – 2022 (Qld)

Queensland's current Waste Management and Resource Recovery Strategy 2019 - 2022, underpinned by a waste disposal levy, provides the strategic framework for Queensland to become a zero-waste society, where waste is avoided, reused, and recycled to the greatest possible extent.

It provides the framework to help deliver coordinated, long-term, and sustained growth for the recycling and resource recovery sector while reducing the amount of waste produced and ultimately disposed of, by promoting more sustainable waste management practices for business, industry, and households. These practices will also contribute to achieving the environmental vision, goals and targets identified in The Queensland Plan.

The Queensland Government is currently seeking submissions on its Waste Reduction and Recycling Plan 2025-2028.

3.1.3 National Climate Resilience and Adaptation Strategy

Australia, as a party to the Paris Agreement on Climate Change[4], has committed to enhancing adaptive capacity, strengthening resilience, and reducing vulnerability of its institutions, infrastructure, environment, and communities

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[2] https://www.qld.gov.au/__data/assets/pdf_file/0020/118433/energy-from-waste-policy.pdf

[3] https://www.qld.gov.au/__data/assets/pdf_file/0018/227241/waste-strategy-guideline-energy-from-waste.pdf

[4] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

to climate change. Investment and activities are guided by the National Climate Resilience and Adaptation Strategy (DCCEEW 2021), which defines the roles and responsibilities of State and local government and businesses as:

- State governments
  - Influence climate adaptation through planning laws and investments in public infrastructure
  - Provide science and information at local and regional scales
- Local governments
  - Ensure that local factors are adequately considered in overall adaptation response
- Businesses
  - Manage climate adaptation risks including maintaining and protecting assets.

3.1.4 Queensland Climate Adaptation Strategy

Queensland's Climate Adaptation Strategy (DEHP 2017) seeks an innovative and resilient Queensland that manages the risks and harnesses the opportunities of a changing climate. It has four key objectives (paraphrased):

- To have Queenslanders understand and recognise the risks and opportunities that a changing climate poses
- To equip Queenslanders with the best science and risk-analysis tools to support adaptation decisions
- To have Queenslanders integrate climate adaptation into policies and processes
- To have Queenslanders collaborate to achieve effective climate adaptation.

3.1.5 The Bromelton State Development Area (SDA) Scheme

In 2008 the Coordinator-General of Queensland declared the Bromelton State Development Area (SDA) in accordance with the *State Development and Public Works Organisation Act 1971* (SDPWO Act). The Bromelton SDA comprises an area of approximately 15,610 ha of land located in the Scenic Rim Regional Council local government area, approximately 6 km west of the town of Beaudesert.

The purpose of the SDA is to promote and facilitate economic development in Queensland, and more specifically to support the growing demand for medium to large scale industries and difficult to locate industries. The Bromelton SDA Development Scheme ('Development Scheme') was prepared, outlining a development assessment framework and processes for making, assessing, and deciding SDA applications.

Section 2.5 of the Development Scheme sets out SDA Wide assessment criteria. This includes Section 2.5.10 regarding climate change, which seeks to ensure that Development minimises its emission of greenhouse gases and demonstrates how it will adapt to projected climate change conditions.

The SDA is divided into six land use precincts and one sub-precinct to ensure that difficult-to-locate industries are appropriately located and buffered by other industrial and rural land uses.

Industries currently established in the Bromelton SDA include:

- Beaudesert Central Waste Management Facility – Scenic Rim Regional Council waste transfer station
- GELITA Australia Pty Ltd – gelatine manufacturer
- A.J. Bush and Son's (Manufactures) Pty Ltd – protein meal and tallow rendering, and biogas production for electricity generation
- SCT Logistics - a $30 million intermodal rail freight facility and warehouses

- Bromelton Quarry – supplier of blue rock
- The Neilsen Group quarry - general quarry and gravel products
- Quickcell Technology Products Pty Ltd – manufacturer of prestressed and precast concrete products.

The Project constitutes a Material Change of Use for Special Industry and is assessable development under the Development Scheme. The SDA application will be assessed against the following provisions of the Development Scheme to the extent relevant:

- Strategic vision for the Bromelton SDA
- Overall outcomes 2.3 (1) (i) manage the risks associated with natural hazards, to protect people and property.
- Preferred development intent for the applicable development precinct.
- SDA wide assessment criteria, including:
    - 2.5.5 Natural hazards – flooding
    - 2.5.6 Natural hazards – other
    - 2.5.10 Climate change (1) Development minimises its emission of greenhouse gases and demonstrates how it will adapt to projected climate change conditions.
    - Other government matters.
    - Engineering standards.

3.1.6 Environmentally Relevant Activities (ERA) Guidelines

Environmentally relevant activities (ERAs) are prescribed activities with the potential to release emissions which can impact on the environment and surrounding land uses. The Project will require assessment by the Department of Environment and Science. A development application for an ERA is also an application for an environmental authority (EA), according to s 115 (2) of the EP Act.

The following ERAs apply for the project:

- ERA 14 Electricity generation
- ERA 54 Mechanical waste reprocessing
- ERA 61 Thermal waste reprocessing and treatment

4. WEATHER AND CLIMATE

SEQ is a subtropical region which experiences warm summers with average maximum temperatures of 29°C and winter average maximum temperatures of 20 °C. Rainfall occurs throughout the year, although most occurs during summer and autumn.

SEQ has been subject to intense storms, extreme rainfall and flooding, heatwaves[5], and extended drought since records commenced in the late 1800s. Severe storm and flood events in the last two decades have resulted in billions of dollars of damage, with the 2022 SEQ rainfall and flooding event alone estimated to have cost $7.7 billion in social, financial, and economic impacts[6].

4.1 Weather and Climate Drivers

Australia's weather and climatic patterns are driven by several processes (drivers), which can have levels of influence depending on their relative strength at the time. The El Niño Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), the Subtropical Ridge, and the Easterly Trough are the drivers with the strongest influence in SEQ[7].

4.1.1 El Niño Southern Oscillation (ENSO)

The ENSO is an oceanic-atmospheric coupling that describes an oscillation in the difference in sea surface temperatures between the eastern and western tropical Pacific Ocean and the strength of the Southern Oscillation Index (SOI). The SOI is a measure of the long-term difference in surface air pressure between Tahiti and Darwin (long-term refers to a period of around a month), which is indicative of the Walker circulation. The Walker circulation is caused by a pressure gradient force resulting from a high-pressure system over the eastern Pacific and a low-pressure system over Indonesia.

During an El Niño event, there is warming across the central and eastern tropical Pacific, off the coast of Peru, and relatively cooler water temperatures in the western Pacific. This leads to drier conditions across eastern Australia and increased risk of heatwaves, droughts, and bushfires. Conversely, La Niña events promote above average rainfall and cooler temperatures in eastern Australia.

Events are usually separated by neutral years where the difference in sea surface temperatures is not significant enough to have a substantial impact on weather patterns.

4.1.2 Indian Ocean Dipole (IOD)

The IOD describes the difference in sea surface temperature (SST) between the eastern and western Indian Ocean in the tropical latitudes. Events typically begin in May to June, peak between August and October, and end when the monsoon arrives in late spring. Events are classified as positive, negative, or neutral. The IOD impacts water temperatures in the Gulf of Carpentaria, which may affect cyclone development but has little impact on rainfall in the region.

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[5] The Bureau of Meteorology defines a heatwave as three or more days in a row when both daytime and night-time temperatures are unusually high—in relation to the local long-term climate and the recent past.

[6] https://www.qra.qld.gov.au/sites/default/files/2022-07/dae_report_-_south_east_queensland_rainfall_and_flooding_event_-_8_june_2022.pdf

[7] http://www.bom.gov.au/watl/about-weather-and-climate/australian-climate-influences.shtml

For SEQ a positive IOD can result in easterly wind anomalies and reduced cloudiness, resulting in less rainfall and hotter sea surface temperatures. A negative event can increase westerly winds, bringing an increased cloudiness with a higher potential for rain.

4.1.3 Subtropical Ridge

The subtropical ridge is a belt of high pressure that occurs across SEQ, and which can suppress cold frontal activity, bringing stable and dry conditions during summer (anticyclones).

4.1.4 Easterly Trough

The easterly trough is a boundary between moist air near the coast and dry air inland. It forms during the summer months due partially to intense heating of the land and is often associated with a high-pressure system in the Tasman Sea.

The impacts of the Easterly Trough on SEQ can be in the form of increased storm activity and widespread showers, with rain areas extending over much of northern New South Wales and southern Queensland. The higher temperatures during the day can cause rain, in some places heavy enough to cause local flooding.

4.2 Weather – Project Area

4.2.1 Data Sources

Historic weather data for the Project area is obtained from the Bureau of Meteorology (BoM) monitoring stations at Beaudesert Drumley Street , Beaudesert Cryna (BC), and the SILO[8] dataset (SILO) (Table 3, Figure 5). The Silo dataset provides interpolated weather statistics for any pixel on a 0.05° × 0.05° grid over the land area of Australia and allows for the estimation of weather patterns closer to a site than may be provided by established weather stations. Interpolated temperature and rainfall data are strongly correlated with monitored data and are reported in Figure 6. Wind speed and direction, and relative humidity are sourced from the BDS monitoring station.

Table 3 Meteorological monitoring sites summary

	BoM - Beaudesert Drumley Street	BoM - Beaudesert Cryna	SILO database grid cell
Site summary	Rural town, 6.5 km east of project, 48 m AHD	Rural town, 10 km southeast of project, 106 m AHD	Rural agricultural region including project site, 62 m AHD
Data range - Temperature	2007-2023	1967-1979	1957-2023
Data range - Rainfall	2007-2023	1887-2012	1957-2023
Data range - Wind	2017-2022		
Data range – Relative Humidity	2017-2022		

[8] https://www.longpaddock.qld.gov.au/silo/

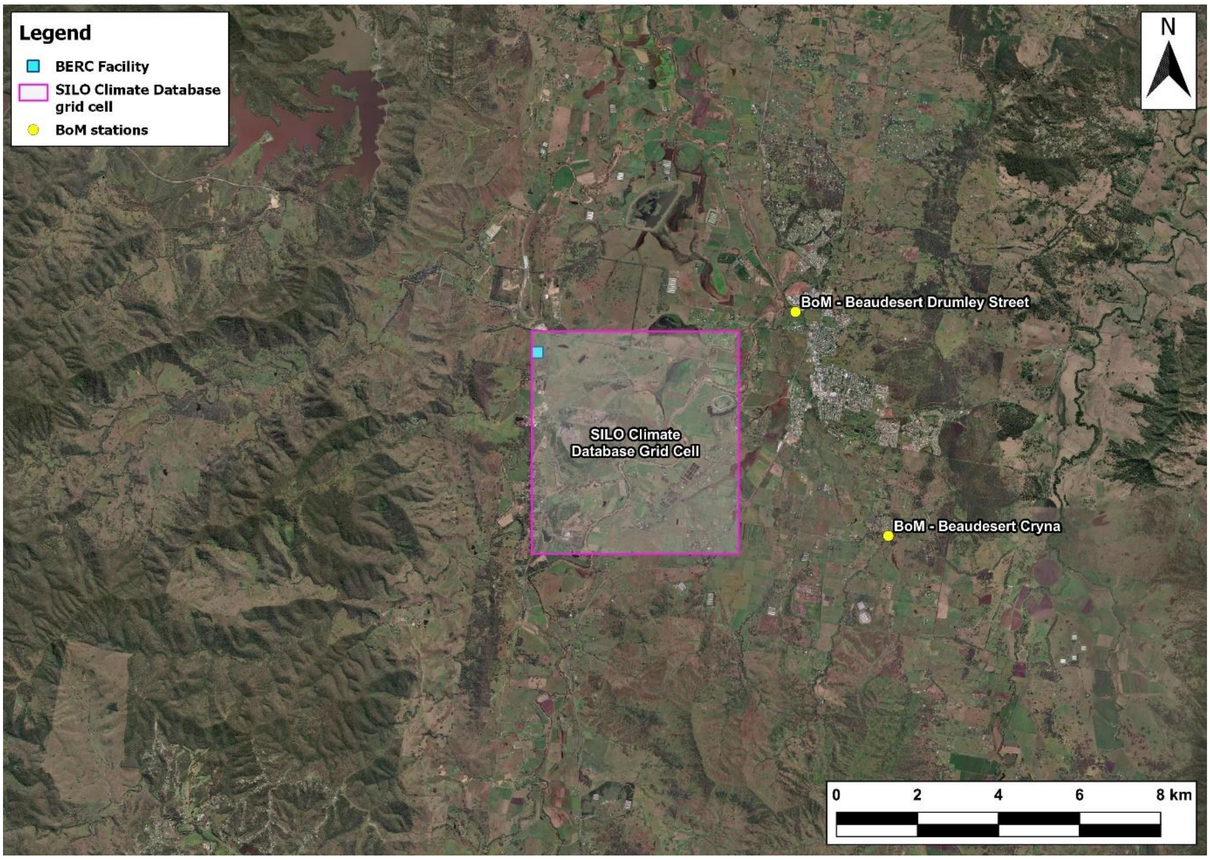

Figure 5 **Meteorological data sites within the vicinity of the Project area**

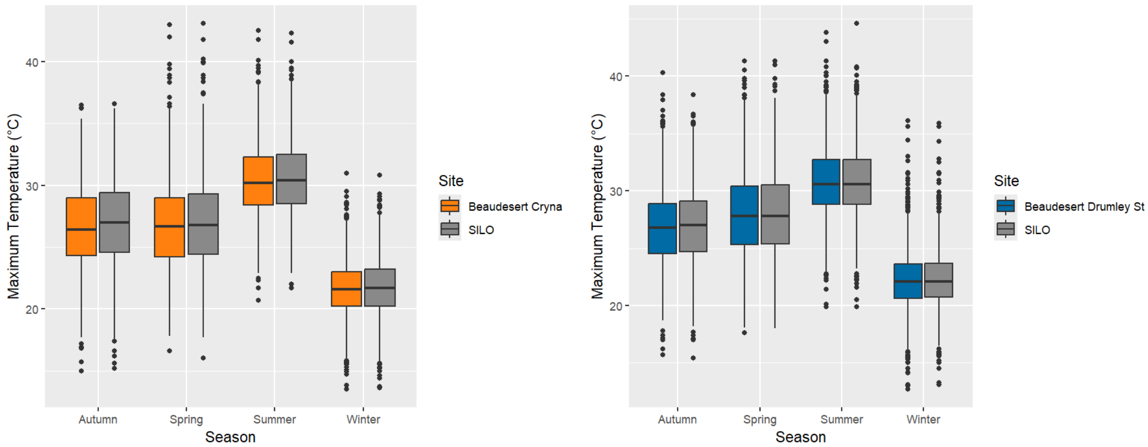

Figure 6 **Comparison of frequency distribution of seasonal temperature at Beaudesert Cryna and SILO from 1967-1979 (left) and Beaudesert Drumley St and SILO from 2007-2025 (right)**

4.2.2 Temperature

The Project area has an average annual temperature of 19.9 °C and has maximum temperatures above 30 °C in every month except June and July (Table 4). Every month except for May – July (late autumn – mid winter) has experienced days above 35 °C with the majority of these occurring in late spring and summer. Temperatures have been below 0 °C in winter (June – August) however the average minimum monthly winter temperatures are 6.7 °C – 8.2 °C (Table 4).

Table 4 **Summary of maximum, minimum, and average temperatures (°C) and number of days >35 ºC at the Project site for the period 1957- 2025**

Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	44.1	43.0	40.3	36.5	32.1	28.7	29.1	36.1	39.3	40.8	43.0	42.5
Average maximum	30.6	30.0	28.8	26.7	23.7	21.3	21.0	22.5	25.3	27.3	28.9	30.2
Minimum	12.5	12.1	9.1	3.7	1.1	-2.8	-3.5	-3.1	0.2	4.0	5.2	9.9
Average minimum	19.5	19.3	17.8	14.6	11.1	8.2	6.7	7.3	10.3	13.6	16.2	18.3
No. of days in month >35 °C	171	85	36	4	0	0	0	2	7	41	101	162

4.2.3 Rainfall

The average annual rainfall for the Project site is 863 mm, however total annual rainfall is highly variable across years peaking at 1550 mm in 2022 (Figure 7).

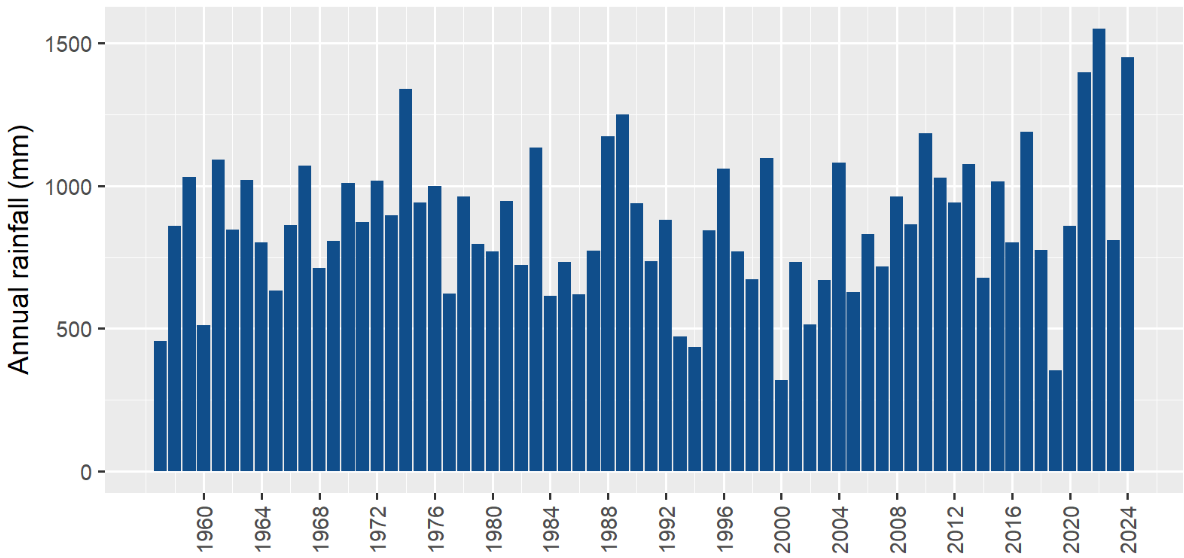

Figure 7 **Total annual rainfall (1957 - 2024) for the Project site (SILO)**

The monthly maximum, minimum and mean rainfall for the relevant period is presented in Table 5 and Figure 8. The maximum monthly rainfall recorded ranged from a low of 121 mm, which occurred in September, to a maximum of 587 mm, which occurred in January. The highest rainfall occurs in summer and the lowest occurs in winter and spring.

Table 5 **Summary of maximum, minimum and average rainfall by month based on SILO data**

Rainfall (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly maximum	587	561	501	400	307	296	179	126	121	342	239	330
Monthly minimum	1.1	8.1	0	2.4	0.6	0.7	0	0	0	1.5	1.2	15.4
Average	121	114	99	53	60	39	36	33	34	71	89	124

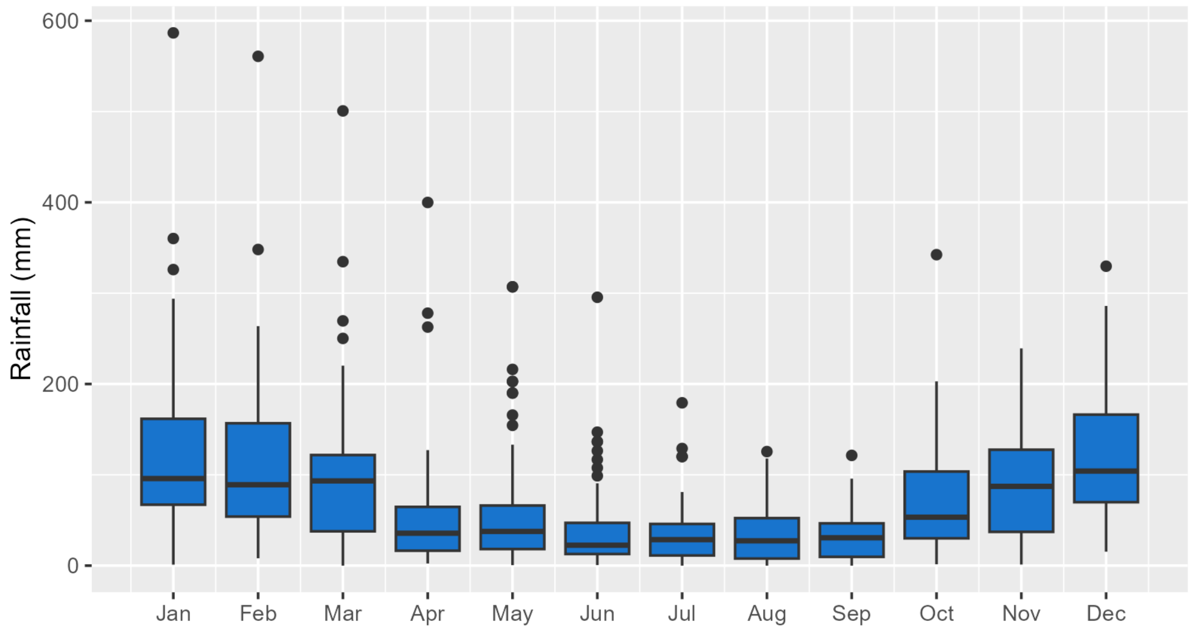

Figure 8 **Distribution of monthly rainfall for the Project site based on SILO data from 1957-2025**

Extreme rainfall events occurring during the period 1957 to 2025 are presented in Figure 9, to demonstrate the potential for extreme rainfall events that may cause localised, regional, and flash flooding. The 20% and 1% Average Return Interval (ARI) (128 mm and 260 mm, respectively) are shown.

4.2.4 Thunderstorms and Hail

The region of the Project area is one of SEQs most intense areas of summer storms, often experiencing extreme thunderstorms with lightning and damaging hail activity (Soderholm *et al* 2017, Dowdy *et al* 2020).

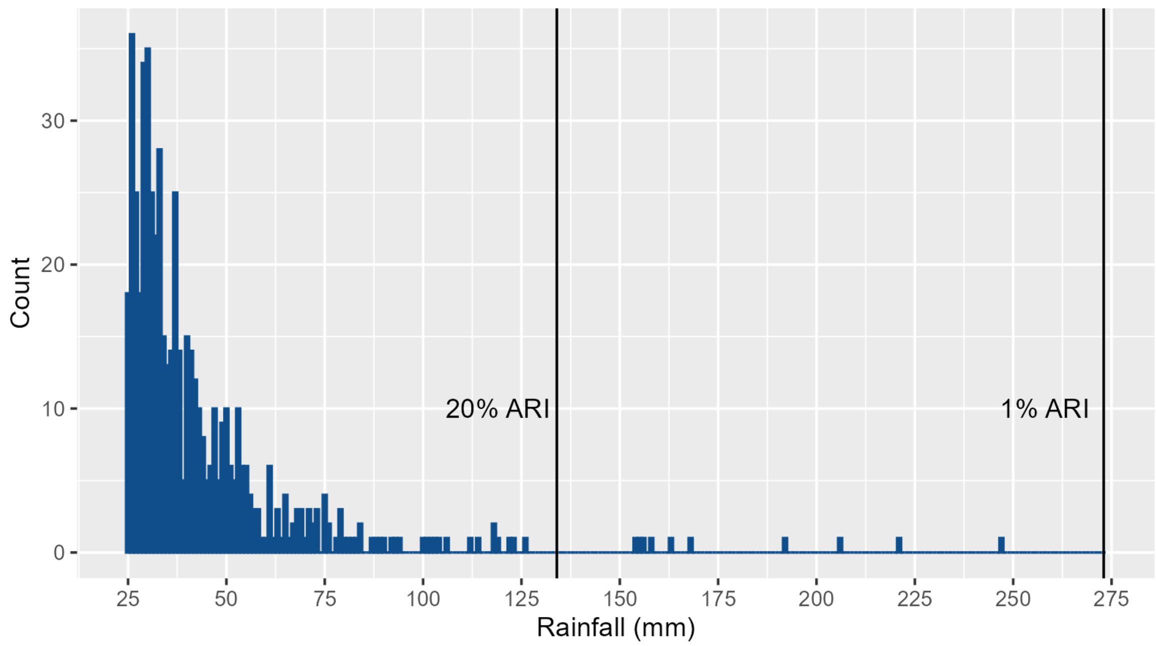

Figure 9 **Frequency distribution of rainfall days greater than 25 mm for the Project area (SILO 1957-2025)**

4.2.5 Wind

Wind speed is measured at BDS and has been characterised for the period 2017 to 2022. The prevailing winds range from northeasterly (predominantly in the spring and summer) to southerly (predominantly in the autumn and winter) (see Figure 10 and Figure 11).

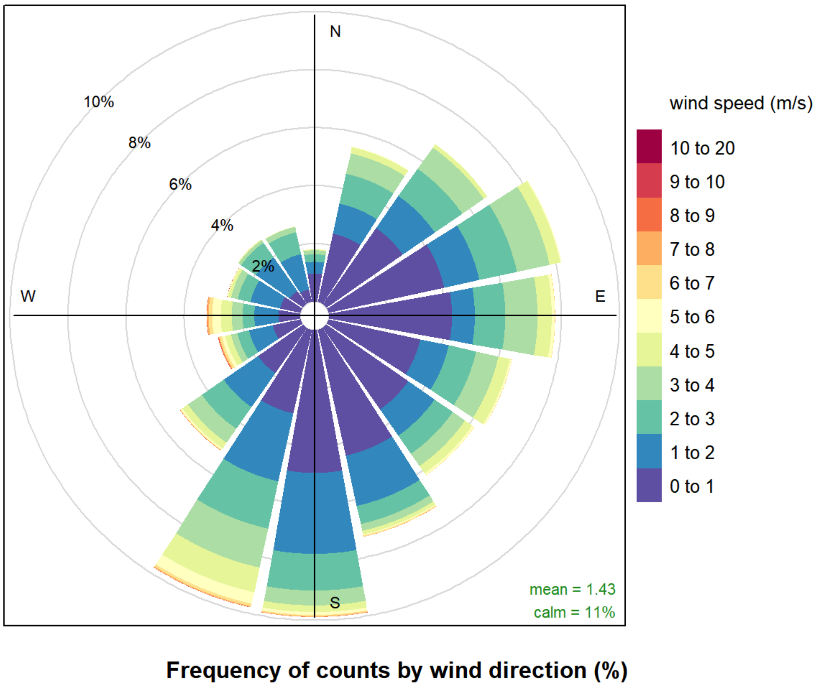

Figure 10 Annual distribution of wind speed and wind direction (Beaudesert Drumley Street 2017-2022)

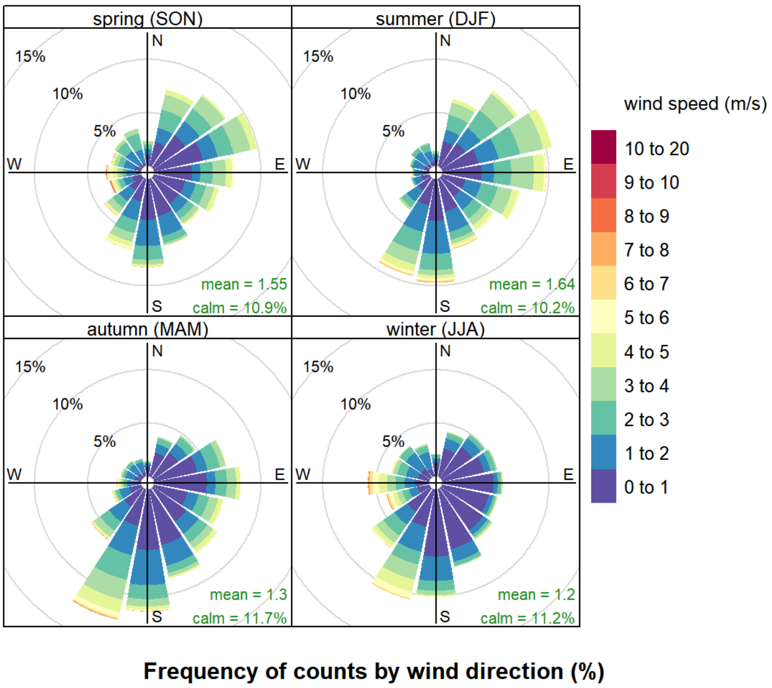

Figure 11 Seasonal distribution of wind speed and wind direction (BDS 2017-2022)

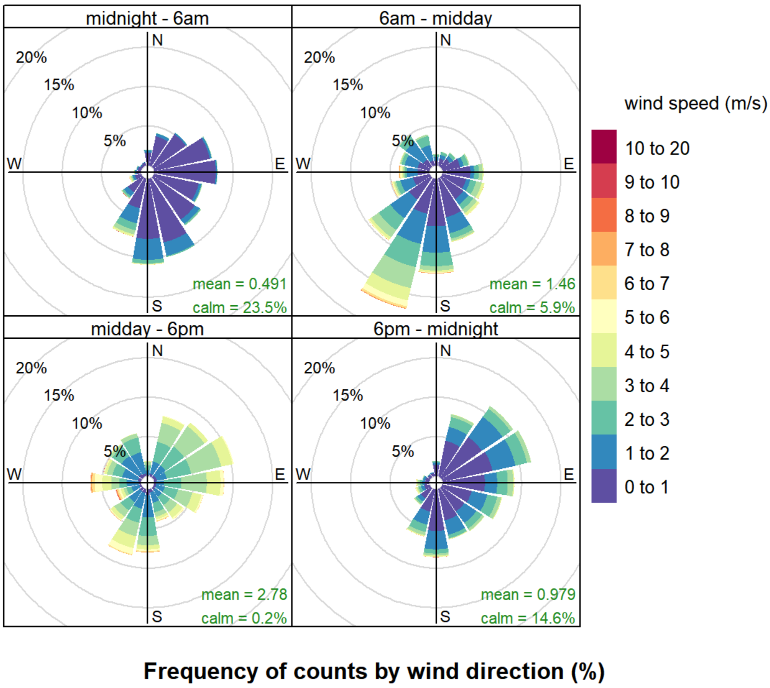

Figure 12 Diurnal distribution of wind speed and wind direction (BDS 2017-2022)

Wind is generally light to moderate with an average wind speed of 1.43 m/s, with calm days (wind speed of 0 m/s) occurring 11% of the time. Wind speeds also tend to be lightest during autumn and winter. Wind speed tends to increase throughout the day and is generally strongest in the afternoon (midday – 6 pm) and lightest overnight (midnight – 6 am) (Figure 12). Maximum wind gusts are predominately between 25 and 35 km/h; however, there were 22 occasions where the 3-second wind gust exceeded 50 km/h over the period (Figure 13).

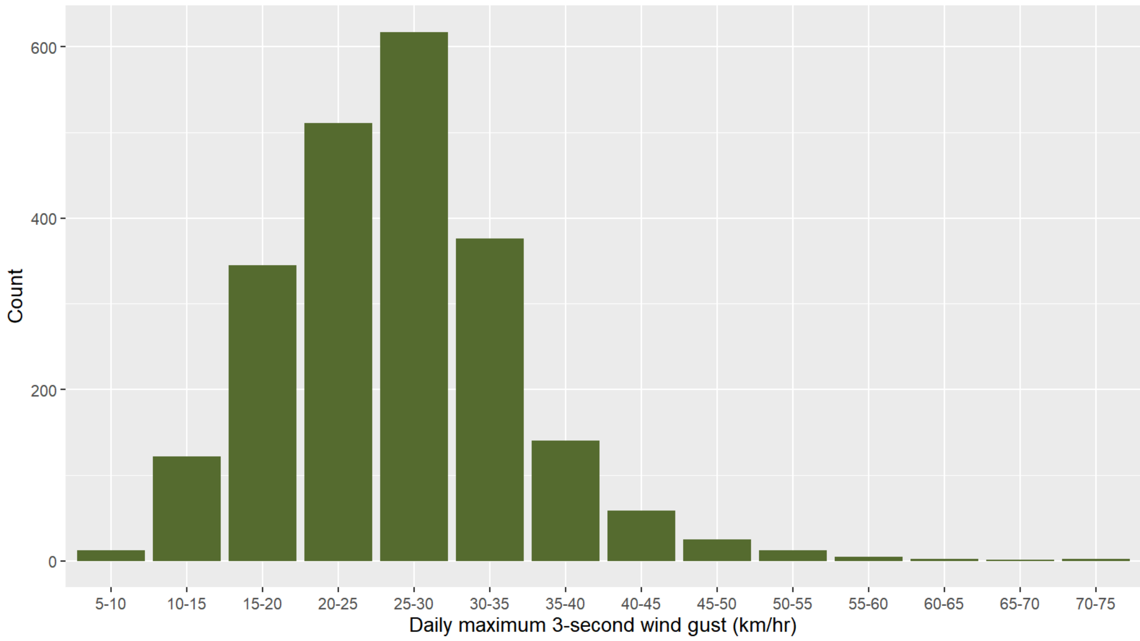

Figure 13 Frequency distribution of 3-second wind gusts (BDS 2017 - 2022)

The maximum speed for 3-second wind gusts by month is presented in Figure 14. The average monthly maximum 3-sec wind gust for the period is 56 km/h, and the strongest wind gust (74 km/h) occurred in December. It is important to note that there were no extreme storms, such as tropical cyclones, during the 2017-2022 period reported here.

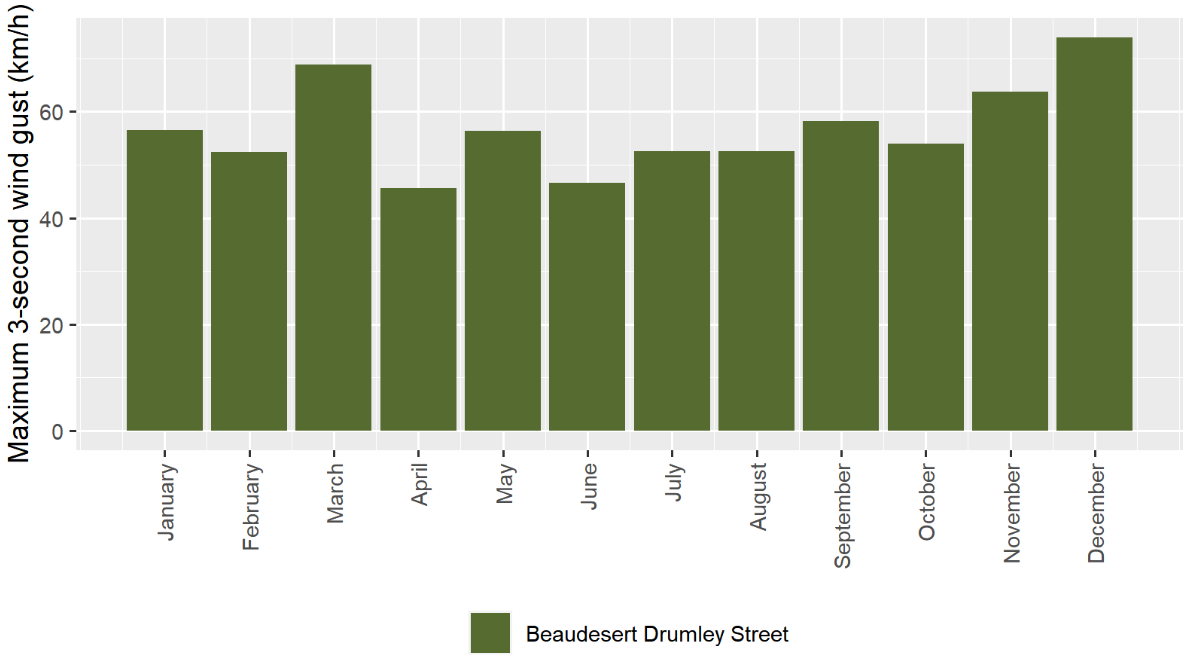

Figure 14 Maximum speed of 3-second wind gusts (BDS 2017 - 2022)

4.2.6 Tropical cyclones

Most destructive tropical cyclones make landfall in central and north Queensland; however, several tropical cyclones have made landfall in SEQ, including the Great Gold Coast Cyclone in 1954, and there have been many that have passed close to the coast, causing significant impacts from wind and rain, e.g., TC Dinah in 1967 and TC Oma in 2019 (QFES and Geoscience Australia 2022). Figure 15 shows the track of 11 tropical cyclones whose eye approached within a 100 km radius of the Project between 1950 and 2022 and that would have caused potentially hazardous conditions at the Project site. This does not include Cyclone Alfred (March 2025) which was initially projected to cross the coast near Brisbane, and which caused significant damage in the Northern Rivers (NSW) and Gold Coast (Qld) regions before becoming a tropical low-pressure system before making landfall.

4.2.7 Fire weather

Figure 16 presents the extent of classified bush fire prone areas within the vicinity of the Project.

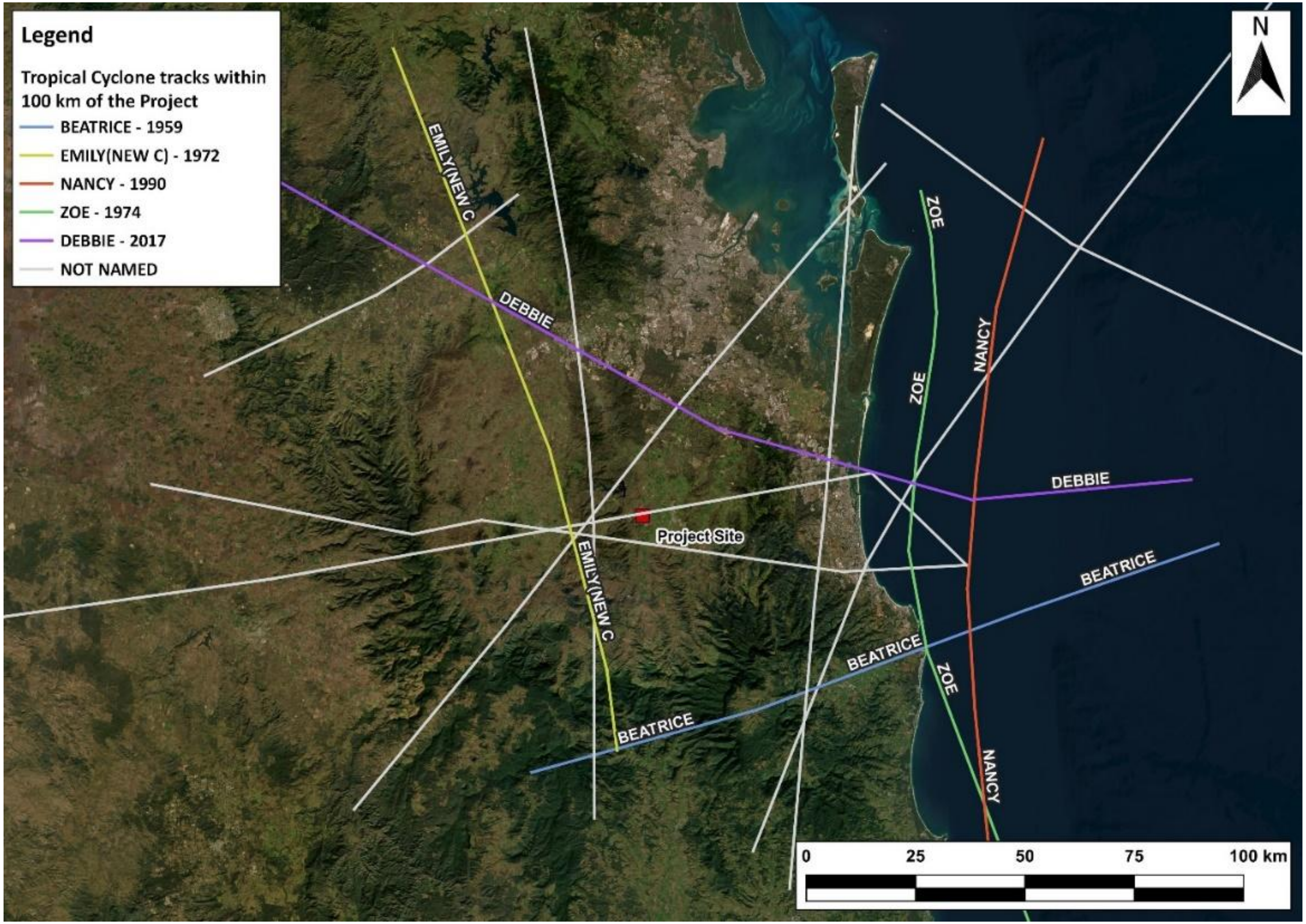

Figure 15 Tropical Cyclone tracks within 100 km of the Project recorded from 1950 to 2022 (data from International Best Track Archive for Climate Stewardship)

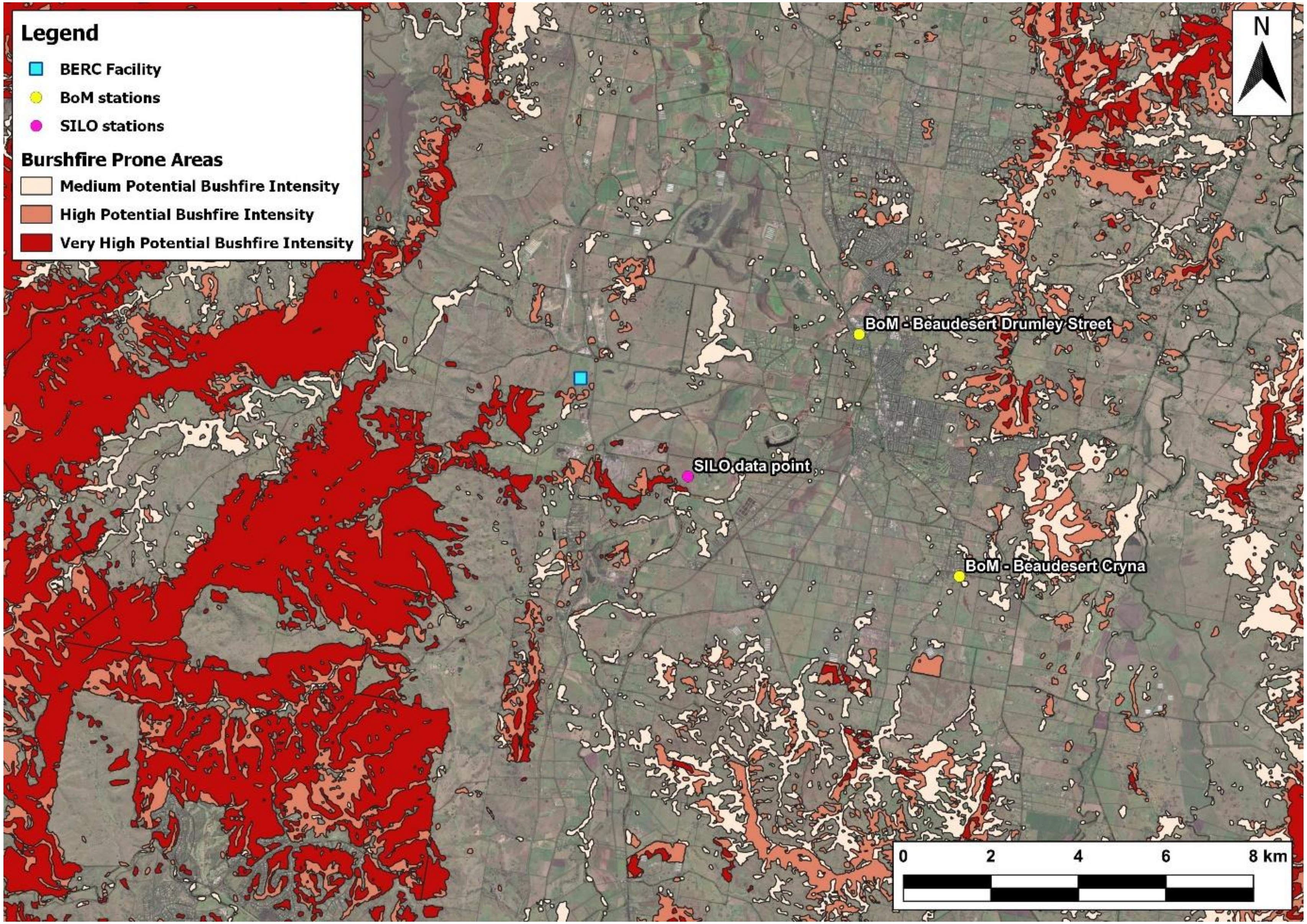

Figure 16 **Bushfire prone areas within the vicinity of the Project area (Queensland Government Open Data Portal)**

5. CLIMATE RISK ASSESSMENT

Extreme weather events driven by global warming have the potential to adversely affect:

a) staff health and safety,

b) timely, cost-effective, and safe construction,

c) infrastructure integrity, and

d) operational capacity to receive or process waste and generate electricity.

Consideration of project vulnerability to extreme weather events and climate change is informed by:

- AS/NZS ISO 31000:2018 Risk management – Principles and guidelines
- AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk-based approach
- Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, Arias *et al*. 2021).
- Electricity Sector Climate Information (ESCI) project[9].

5.1 Material Weather Events and Climatic Conditions

The following weather events (hazards) are considered material to the construction, operation, and eventual rehabilitation of the Project:

- Extreme temperature
    - Number of days above 35°C
    - Number and extent of heatwaves
- Heavy rainfall
    - > 25 mm/d
- Wind
    - Sustained ≥ 63 km/h
    - Gusts ≥ 90 km/h
- Severe storms
    - East Coast lows and tropical cyclones
    - Thunderstorms
        - Hail ≥ 2 cm diameter
        - Wind gusts ≥ 90km/h
        - Intense rainfall ≥ 100 mm/day
        - Lightning
- Fire weather

[9] https://www.climatechangeinaustralia.gov.au/en/projects/esci/

These weather events are not independent of each other, and the likelihood of compounding and cascading weather events is increased under projected climate change (Glasser 2019).

Statistical probabilities, such as the Annual Return Interval (ARI) or Annual Exceedance Probability (AEP), may be used to calculate the likelihood of an extreme event occurring and be used to establish design conditions. However, the data on which these probabilities are calculated is limited and many design events are currently being exceeded.

For example, the 2011 floods in the Lockyer Valley were calculated from 31 years of flood gauge data as having an ARI of 1:2,000 (0.05%). A further extreme flood event in 2013 and subsequent data collection revised this to 1:90 (1.11%). In another case, the February 2022 Lismore flood event at 14.4m was nearly 2 m higher than the 1:100 AEP design flood level[10], nearly 1.4 m higher than the 1:500 AEP design flood level, and 2.3 m higher than the previous highest floods.

Paleoclimate records for SEQ suggest that extreme weather conditions, i.e., floods and droughts, experienced in the last two decades have been exceeded many times over the last 1,000 years and that it is likely for this to happen again (e.g., Kiem et al. 2016, 2020). The likelihood of these extreme events occurring is increased under global warming driven climate change.

It is not necessary to accurately or precisely predict the rare or random events that may have high impact, rather it is necessary to act to reduce vulnerability to them (Taleb, 2015).

5.2 Climate Change in South East Queensland

Climate projections are made with global and down-scaled models that simulate the earth's climate system under a range of GHG emission scenarios. A set of Representative Concentration Pathways, (RCP) that would result in radiative forcing of 2.6, 4.5, 6.0, and 8.5 watts per square metre (w/m^2) (RCP2.6 – RCP8.5), were developed for climate modelling. These RCPs do not consider any political, socio-economic, or technological response leading to an increase, decrease, or maintenance of the current emissions trajectory.

RCP8.5 is applied for risk assessment purposes here as it is considered a worst-case emissions trajectory. Projected changes for Queensland over the next 30 years under RCP8.5 include (Dowdy *et al*. 2015, QFES and Geoscience Australia, 2022, Syktus *et al*. 2020):

- An average annual temperature increase of around 1.3-2.5 °C
- The number of hot days (>35 °C) will increase from approximately two to eight days per year in Brisbane and from approximately four to 14 days per year in Toowoomba (Figure 17)
- Extreme rain events in Queensland are projected to become more intense (Figure 18)
- Queensland is likely to become drier in the winter and early spring months
- East Coast lows are projected to decrease by up to 20%, particularly during winter
- Possible increase in annual maximum wind speed
- The number of tropical cyclones making landfall is projected to decrease by about 8% but the proportion of intense cyclones may increase (Figure 19)
- Queensland can expect longer fire seasons, with around 40% more very high fire danger days.

[10] https://lismore.nsw.gov.au/files/Floodplain_Risk_Management_Plan_appendices.pdf

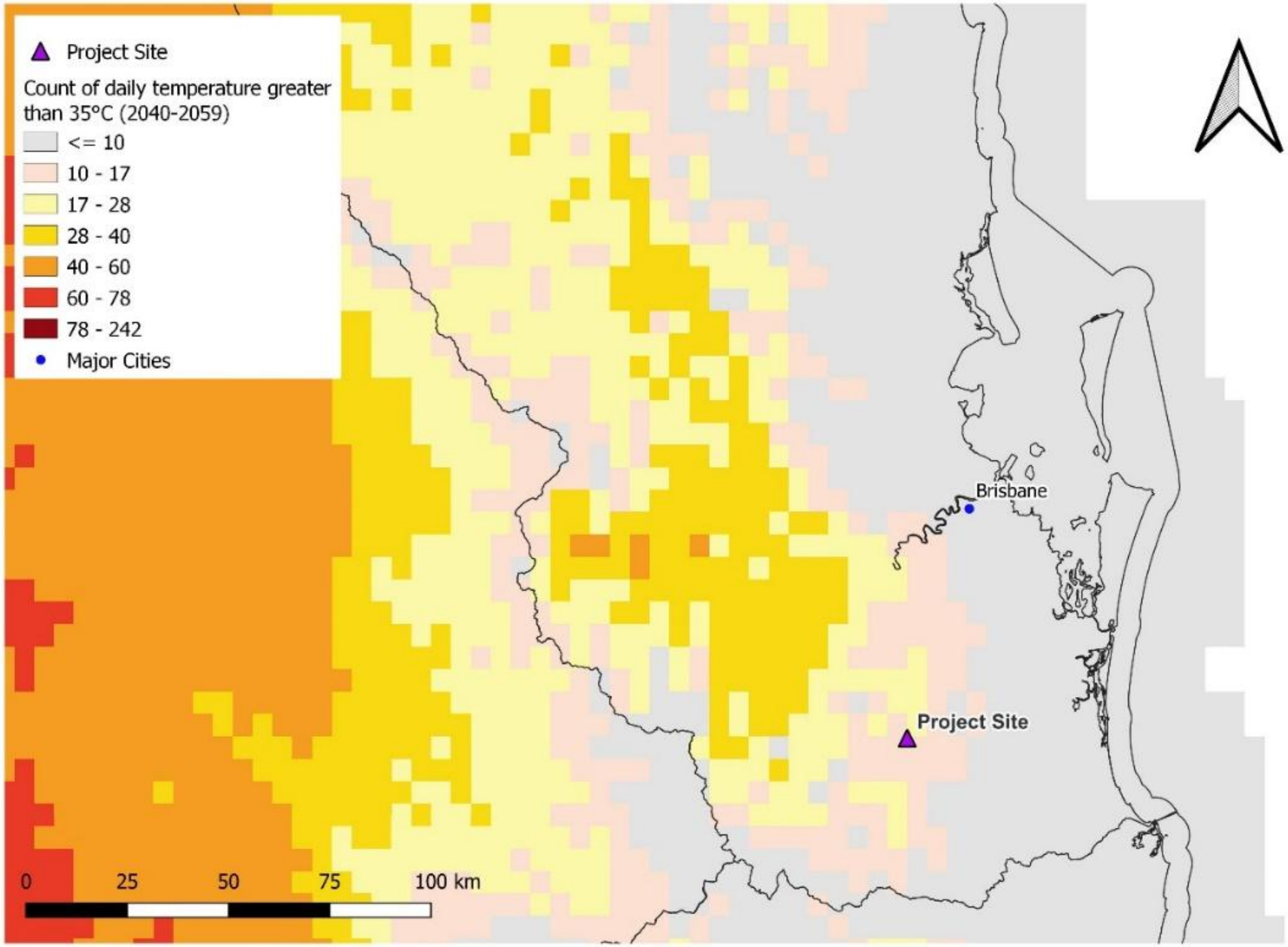

Figure 17 **Projected mean number of days per year >35°C in the region for the period 2040 – 2059 (Queensland Future Climate Dashboard)**

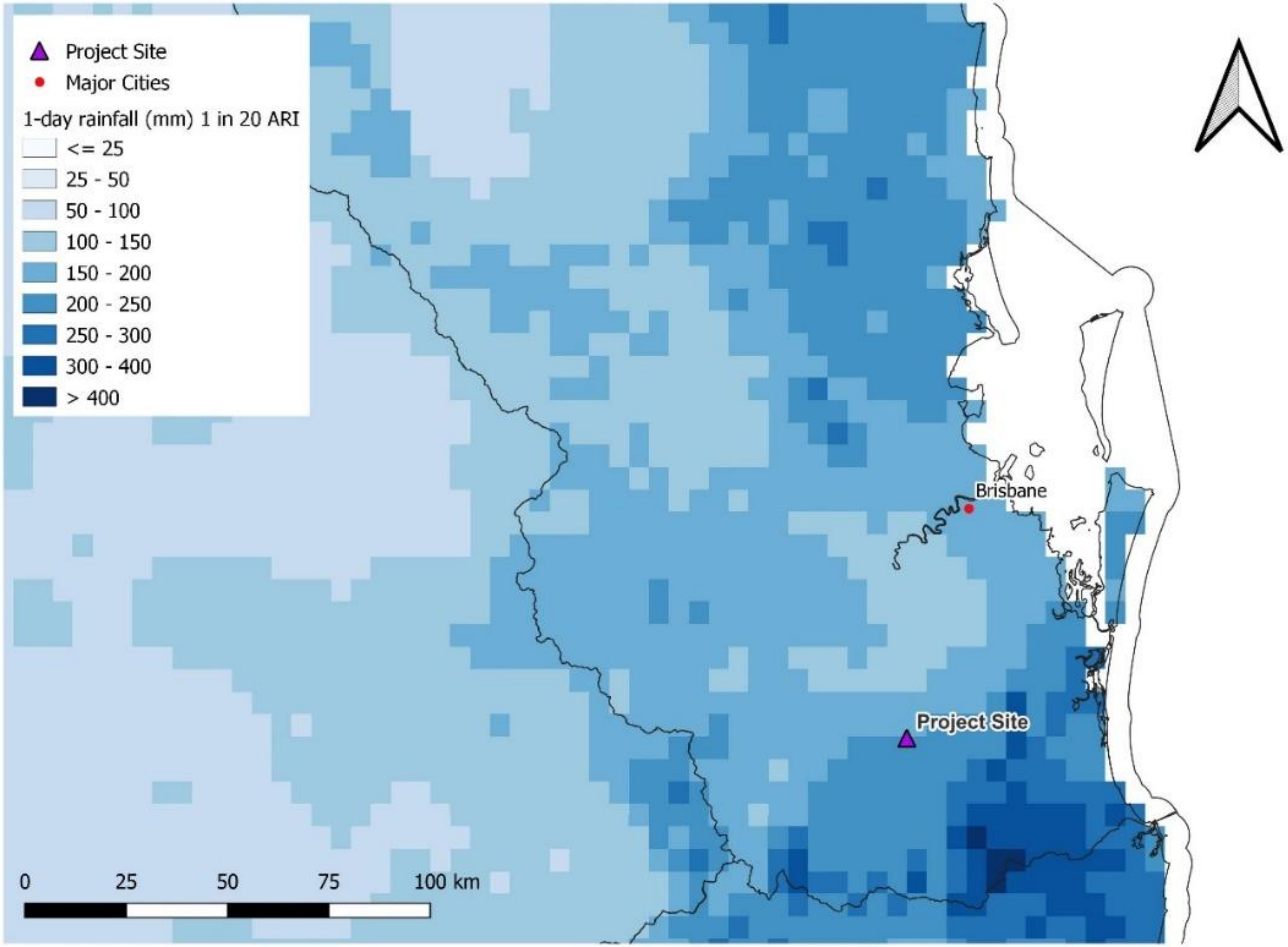

Figure 18 **Maximum 1 day rainfall (mm) with 5% AEP for the period 2040 – 2059 (Queensland Future Climate Dashboard)**

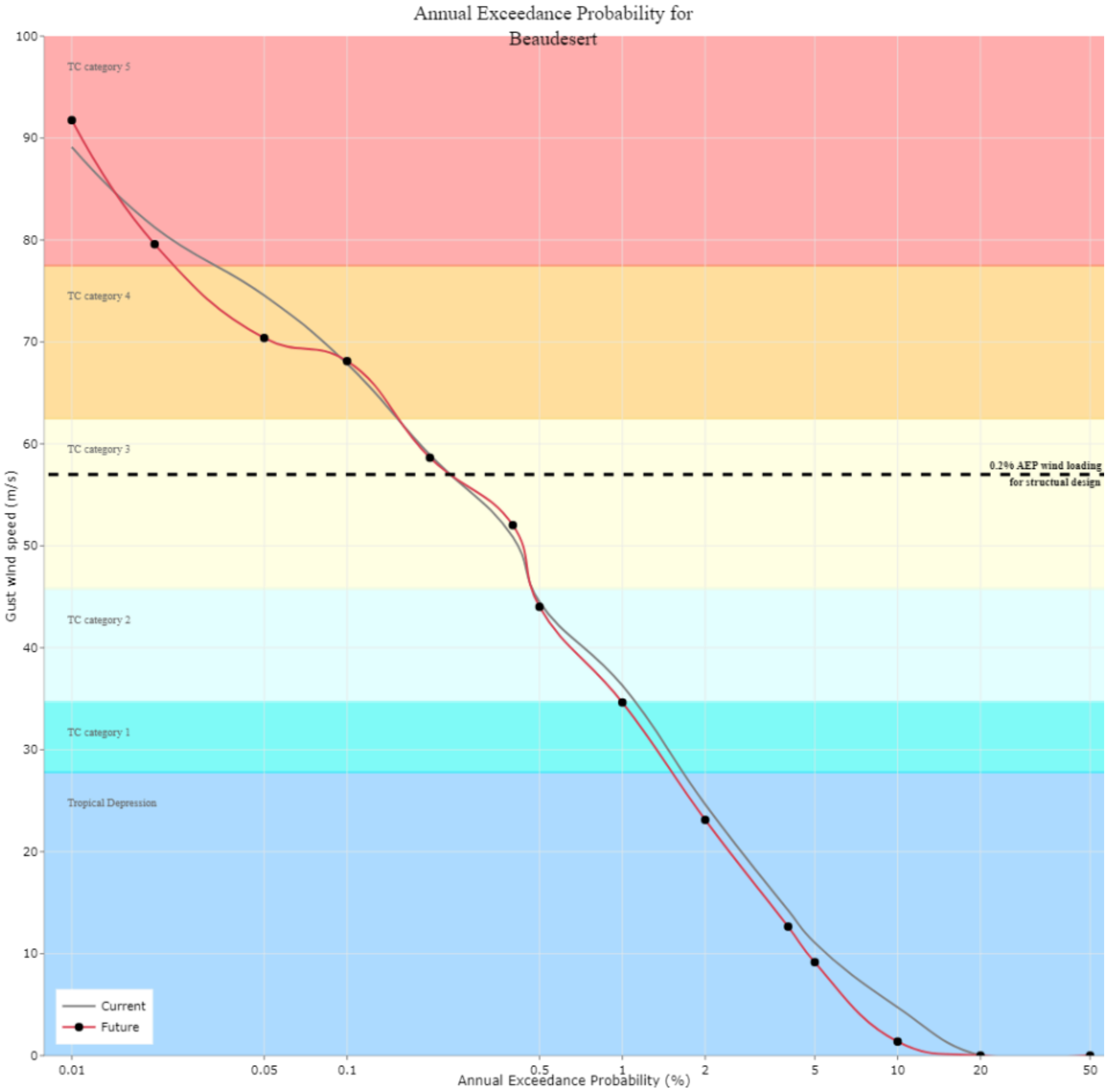

Figure 19 **Annual exceedance probability for tropical cyclones near the Project, including design wind loading for structural design**

5.3 Project vulnerability

The following risk scenarios and statements are developed to identify Project vulnerability and are used to frame risk management.

5.3.1 During Construction

5.3.1.1 Extreme heat

Extended periods of high temperatures (i.e., heat waves), even if they are not extreme, can affect work performance and the safety of workers. For example, warmer nights can lead to reduced sleep quality which can result in worker inattention and poor decision making, leading to accidents and errors.

5.3.1.2 Extreme rainfall

Periods of extreme or extended rainfall can lead to site conditions where it is unsafe to work or continue work, and/or where heavy machinery cannot operate effectively or safely because of ground conditions. It can also cause damage to drainage and drainage-adjacent environments, i.e., erosion, and lead to downstream sedimentation.

5.3.1.3 Thunderstorms

Thunderstorms with potentially hazardous lightning strikes and damaging hail tend to build up and occur on summer afternoons. Working outside in these conditions can be hazardous and pose a risk for workers' health and safety. Lightning strikes and extreme hail can also cause damage to infrastructure and to vehicles on-site.

5.3.2 During Operation

5.3.2.1 Extreme heat

Extreme heat conditions can affect worker safety, the functioning of equipment, and the structural integrity of infrastructure.

5.3.2.2 Extreme rainfall

Intense rainfall or extended periods of rainfall can result in flash flooding and inundation of infrastructure on site and can also affect transport routes to the site which may interrupt the supply of waste feedstock. Regional flooding may also lead to large volumes of contaminated and potentially low-grade waste requiring treatment.

5.3.2.3 Extreme winds

Extreme wind gusts can damage infrastructure with flying materials leading to hazards to human health as well as damaging critical infrastructure and affecting the capacity to operate. High winds in conjunction with extreme temperatures can also spread wildfires.

5.4 Climate Risk Mitigation

Cleanaway will include the risk posed by extreme weather conditions in their construction and operation risk identification and mitigation process to ensure business continuity. The following options follow from the scenarios described above and are indicative rather than comprehensive.

- CCA01 Climate change adaptation design measures –
  - Cleanaway will identify acceptable infrastructure risk and prescribe design engineering tolerances to cope with extreme heat, wind, and/or rainfall to the level of acceptable risk
- CCA02 Climate Change Adaptation Management Plan –
  - Cleanaway to require the principal contractor to engage with appropriate labour representatives to identify and confirm mitigation measures to ensure that construction can continue as necessary during periods of extreme heat
  - Cleanaway to require the principal contractor to establish site rules for construction work during hailstorms, thunderstorms, and (or immediately after) extreme rainfall events
  - Cleanaway to apply an early warning system for dangerous thunderstorms and establish site rules for operational work outdoors during thunderstorms

- Cleanaway to identify acceptable infrastructure risk and prescribe design engineering tolerances to cope with extreme heat, wind, and/or rainfall to the level of acceptable risk
- Cleanaway to develop an operational site and near-site fire response and control plan in conjunction with emergency services
- Cleanaway to establish emergency controls for bypass or plant shutdown in the event of an extended catastrophic transmission infrastructure failure at or near site

6. CONCLUSION

Cleanaway Operations Pty Ltd (Cleanaway) commissioned Katestone Environmental Australia Pty Ltd (Katestone) to conduct a Climate and Climate Change Risk Assessment for a proposed Energy from Waste (EfW) facility in Queensland known as the Bromelton Energy and Resource Centre (BERC / the Project). The assessment:

- Describes local and regional climate for the Project area
- Determines which aspects of weather, climate, and climate change are material to the construction, operation, and rehabilitation of the Project
- Assesses potential hazards and vulnerability of the Project due to extreme weather events and climate change
- Assesses and describes feasible environmental management measures and strategies to cope with the hazards and risks posed by climate change.

The Project occurs in subtropical South East Queensland (SEQ), a region with warm summers and generally mild winters. Most rainfall occurs during summer and autumn, often in short intense storms. SEQ has been subject to intense storms, extreme rainfall and flooding, heatwaves, and extended drought since records commenced in the 1880s, with major events in the last two decades causing billions of dollars of damage.

Extreme weather events driven by global warming have the potential to adversely affect a) staff health and safety, b) timely, cost-effective, and safe construction, c) infrastructure integrity, and d) operational capacity to receive or process waste and generate electricity.

Weather events (hazards) subject to climate change considered material to the construction, operation, and eventual rehabilitation of the Project include:

- Extreme temperature, with projected increases in the number of days above 35°C
- Heavy rainfall, with projected increases in rainfall intensity
- Wind gusts, with possible increases in maximum wind speed
- Severe storms, with projected increases in tropical cyclone intensity
- Fire weather, with projected extension of fire seasons and an increase in very high fire danger days.

Uncertainties associated with projected climate change and extreme weather events require adaptive management planning and responses to ensure business continuity of critical infrastructure in the face of plausible event scenarios.

Risk scenarios have been considered and the mitigation options that follow are:

- CCA01 Climate change adaptation design measures – Cleanaway will identify acceptable infrastructure risk and prescribe design engineering tolerances to cope with extreme heat, wind, and/or rainfall to the level of acceptable risk
- CCA02 Climate Change Adaptation and Risk Management Plan –
  - Cleanaway to require the principal contractor to engage with appropriate labour representatives to identify and confirm processes, e.g., safety triggers, work hours, and facilities, e.g., shade, water, air conditioning, to ensure that construction can continue as necessary during periods of extreme heat
  - Cleanaway to require the principal contractor to establish site rules for construction work during hailstorms, thunderstorms, and (or immediately after) extreme rainfall events

- Cleanaway to apply an early warning system for dangerous thunderstorms and establish site rules for operational work outdoors during thunderstorms
- Cleanaway to identify acceptable infrastructure risk and prescribe design engineering tolerances to cope with extreme heat, wind, and/or rainfall to the level of acceptable risk
- Cleanaway to develop an operational site and near-site fire response and control plan in conjunction with emergency services, and ensure staff training and provision of equipment for fire control
- Cleanaway to establish emergency controls for bypass or plant shutdown in the event of an extended catastrophic transmission infrastructure failure at or near site.

Development of these climate change adaptation design measures and a Climate Change Adaptation and Risk Management Plan will ensure that the Project complies with Section 2.5.10 of the Bromelton State Development Area Development Scheme, which requires demonstrable adaptation to projected climate change conditions in the region.

7. REFERENCES

Arias, P.A., Bellouin, N., Coppola, E., Jones, R.G., Krinner, G., et al. 2021. Technical Summary. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 33−144, doi:10.1017/9781009157896.002.

Australian and New Zealand Standard AS/NZS ISO 31000:2009 *Risk management – Principles and guidelines*

Australian Government, Department of Industry, Science, Energy and Resources, Electricity Sector Climate Information (ESCI) project. Summarised in Climate Change in Australia located at https://www.climatechangeinaustralia.gov.au/en/projects/esci/

Australian Green Infrastructure Council, 2011, Guideline for Climate Change Adaptation, Rev2.1: October 2011

Bebb, J and Kersey, J, 2003, Potential Impacts of Climate Change on Waste Management, Entec UK Limited. Published by Environment Agency

Brockway, A.M., Dunn, L.N. 2020. Weathering adaptation: Grid infrastructure planning in a changing climate. *Climate Risk Management* 30. https://doi.org/10.1016/j.crm.2020.100256

Bureau of Meteorology, 2022, State of Climate 2022 – Greenhouse Gases. Accessed on 10 May 2023 at http://www.bom.gov.au/state-of-the-climate/greenhouse-gas-levels.shtml

Bureau of Meteorology, 2023, Climate classification maps. Accessed on 10 May 2023 at http://www.bom.gov.au/jsp/ncc/climate_averages/climate-classifications/index.jsp?maptype=kpn#maps

Cheng, L., von Schuckmann, K., Abraham, J.P. et al. 2022. Past and future ocean warming. *Nature Reviews: Earth and Environment*. https://doi.org/10.1038/s43017-022-00345-1

CSIRO and Bureau of Meteorology 2020, Climate Change in Australia. Information for Australia's Natural Resource Management Regions: Technical Report, CSIRO and Bureau of Meteorology, Australia.

CSIRO, 2021, Australia Climate Futures. Accessed on 10 May 2023 at https://www.climatechangeinaustralia.gov.au/en/climate-projections/climate-futures-tool/introduction-climate-futures/

DEHP (2017). Pathways to a climate resilient Queensland. Queensland Climate Adaptation Strategy 2017 – 2030. Department of Environment and Heritage Protection, Brisbane. https://www.qld.gov.au/__data/assets/pdf_file/0017/67301/qld-climate-adaptation-strategy.pdf

DES (2022). Climate-EIS information guideline. ESR/2020/5298. Version 1.01. Department of Environment and Science, Brisbane. https://www.qld.gov.au/__data/assets/pdf_file/0011/140006/eis-tm-climate-information-guide.pdf

Dowdy, A. et al. (2015). East Coast Cluster Report, Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports, eds. Ekström, M. et al., CSIRO and Bureau of Meteorology, Australia. https://nrmplan2015.bmrg.org.au/wp-content/uploads/EAST_COAST_CLUSTER_REPORT_1.pdf

Dowdy, A.J., Soderholm, J., Brook, J., Brown, A., McGowan, H. (2020). Quantifying Hail and Lightning Risk Factors Using Long-Term Observations Around Australia. *JGR Atmospheres* 125 (21). https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2020JD033101

Evans, J.P., Di Virgilio, G., Hirsch, A.L. et al. (2021). The CORDEX-Australasia ensemble: evaluation and future projections. Clim Dyn 57, 1385–1401. https://doi.org/10.1007/s00382-020-05459-0

Glasser, R. 2019. Preparing for the era of disasters. Australian Strategic Policy Institute, Canberra. https://www.jstor.org/stable/resrep23057

Grose, M. R., Narsey, S., Delage, F. P., Dowdy, A. J., Bador, M., Boschat, G., et al. (2020). Insights from CMIP6 for Australia's future climate. Earth's Future, 8, e2019EF001469. https://doi.org/10.1029/2019EF001469

Kiem, A.S., F. Johnson, S. Westra, A. van Dijk, J.P. Evans, A. O'Donnell, A. Rouillard, C. Barr, J. Tyler, M. Thyer, D. Jakob, F. Woldemeskel, B. Sivakumar, R. Mehrotra (2016). Natural hazards in Australia: droughts. Climate Change 139 (1): 37-54. 10.1007/s10584-016-1798-7

Kiem, A.S., Vance, T.R., Tozer, C.R., *et al*. (2020). Learning from the past – Using palaeoclimate data to better understand and manage drought in South East Queensland (SEQ), Australia. *Journal of Hydrology: Regional Studies* 29: 100686. https://doi.org/10.1016/j.ejrh.2020.100686.

Neuwahl, F., Cusano, G., Gómez Benavides, J., Holbrook, S., and Roudier, S. 2019. Best Available Techniques (BAT) Reference Document for Waste Incineration; EUR 29971 EN; Luxembourg: Publications Office of the European Union; doi:10.2760/761437

QFES and Geoscience Australia, 2023. Severe Wind Hazard Assessment for Queensland. Executive Summary: An evaluation of current and future tropical cyclone risk. Queensland Fire and Emergency Services, Brisbane. Geoscience Australia, Canberra. https://www.disaster.qld.gov.au/qermf/Pages/Assessment-and-plans.aspx

Soderholm, J.S., McGowan, H., Richter, H., Walsh, K., Weckwirth, T.M., Coleman, M. (2017). An 18-year climatology of hailstorm trends and related drivers across southeast Queensland, Australia. *Quarterly Journal of the Royal Meteorological Society* 143 (703): 1123-1135. https://doi.org/10.1002/qj.2995

Standards Australia, 2013, Australian Standard AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk-based approach

Syktus, J, Trancoso, R, Ahrens, D, Toombs, N & Wong, K. (2023). Queensland Future Climate Dashboard: Downscaled CMIP5 climate projections for Queensland., accessed from https://www.longpaddock.qld.gov.au/qld-future-climate/.

Taleb, N.N. (2015) Silent risk. Descartes. Pp. 436.