Barwon Water Regional Renewable Organics Network

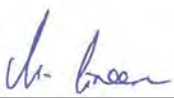
Preliminary Fire Safety Study

Barwon Water

13 August 2024

→ The Power of Commitment

Project name	Barwon Water Regional Renewable Organics Network
Document title	Barwon Water Regional Renewable Organics Network | Preliminary Fire Safety Study
Project number	12585384
File name	12585384_RRON_Fire Safety Study.docx

Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**		
			Name	**Signature**	**Name**	**Signature**	**Date**
S4	0	S. Shankar K. Sotoodeh P. McCluskey	A. Green		D. Joannides		20/11/23
S4	1	S. Shankar K. Sotoodeh P. McCluskey	B Bloom		A Green		13/08/24

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The Power of Commitment

Executive summary

Background

Barwon Water's Strategy 2030 outlines the shift from service provider to regional enabler of economic, social, and environmental prosperity. As part of this, Barwon Water (BW) is fast-tracking the move to renewable energy, with a commitment to achieve 100% renewable electricity by 2025 and net zero emissions by 2030. Traditional organic waste management practices contribute to the emissions profile of Barwon Water (in terms of domestic sewage and trade waste management) and its regional partners, including local government councils (kerbside organics management). In line with this strategy, and in partnership with four local government councils, Barwon Water is developing the Regional Renewable Organics Network (RRON) – an organics processing facility that can receive and convert a range of organic wastes into valuable products and renewable energy.

Previous phases of the project have included feedstock characterisation, and a technology options assessment, which identified a preferred process configuration that includes plug flow anaerobic digestion (PFAD) of received organics, followed by further processing of the digestate via carbonisation. The primary end-products of this process are:

– 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 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

The project is currently in the design phase and, as a component of the design, GHD has conducted a Fire Safety Study (FSS) of the proposed facility to identify the fire prevention, detection, protection, and firefighting measures that are likely to be required for the specific fire hazards posed by the plant. The FSS is based on the guidelines set out in the Hazardous Industry Planning and Advisory Paper (HIPAP) 2: Fire Safety Guidelines (Ref 1).

The FSS is based on the Early Contractor Involvement (ECI) phase design for the facility, which includes the following major infrastructure:

– Main organic waste receival and pre-processing building
– Carbonisation building
– Plug flow anaerobic digestor and associated biogas utilisation infrastructure
– Biofilter
– Office space

It is expected that the FSS will be reviewed by the detailed design contractor and updated as required as the design progresses and/or if additional processes are incorporated into the facility.

Hazardous Materials and Consequence Analysis

For the purpose of this study, a hazardous material is considered to be one that has the potential to ignite and start a fire. For the RRON facility this included biogas, which is generated through anaerobic digestion, temporarily stored onsite and transferred to the neighbouring biosolids drying facility for combustion in a biogas boiler. The other potentially hazardous material produced at the RRON is syngas. Unlike biogas, syngas is not stored on site and is combusted immediately following generation, therefore, this preliminary FSS considered that the risk of syngas release and uncontrolled syngas fire is low.

Accordingly, the credible fire and explosion scenarios considered included the following

– Biogas release from the piping manifold, duct fitting, valve, or flange
– Biogas release from a pressure safety valve (PSV) or vent

Note it is recommended that the Hazard and Operability Analysis (HAZOP), which will be completed during subsequent design phases, should consider different malfunctioning, and failure scenarios, relating to the carbonisation process, to confirm the risk relating to syngas and form the basis of fire and explosion control measures.

A consequence analysis was performed using DNV's commercial software package PHAST (Process Hazard Analysis Software Tool) version 8.71. It identified that:

- A loss of containment of flammable gas could potentially cause explosion
- Potential for explosion to occur for biogas if exposed to high radiant heat or direct flame contact
- Jet fire radiation levels at approximately 1 kW/m² identified 1.8 m from the modelled release point
- Parts of the hazardous area are within proximity to proposed occupied areas. The detailed design and development of proposed buildings shall comply with the National Construction which will dictate the construction type and materials to be applied.
- Emergency vehicle access is via the main site entrance gate
- Biochar storage is assumed to be in bags within the carbonisation building

Fire Prevention

As part of this FSS, which is based on the ECI phase design, the fire prevention strategies to be employed at the RRON are identified as the following,:

- Integrity management
- Separation of ignition sources
- Adequate firefighting facilities such as fire hydrants, fire hose reels and fire extinguishers. A building occupant warning system shall also be installed.
- Adequate fire safety management planning

Three elements must exist simultaneously for a fire to occur, which are a source of ignition, oxygen, and fuel, typically known as the fire triangle. In fighting gas type fires, the most effective way is to remove the fuel element. In a fire scenario, the operating philosophy at RRON should be to initiate an emergency shutdown (isolating fuels from the source) and evacuate. Throughout the detailed design development stages, a cause-and-effect matrix shall be completed to identify the emergency actions that need to be considered. As the design progresses, this will be updated to clearly show the intended RRON operating philosophy for a fire scenario has been implemented.

These requirements were included in the basis of design in relation to fire protection and further detail will be made available as design progresses.

Based on early design input, buildings housing the process equipment are assessed against the performance requirements of the National Construction Code where the implementation of firefighting infrastructure is nominated. However, an Emergency Response Plan is required to detail the resources, responsibilities, and actions to be taken in order to effectively respond and manage emergency situations (especially fire and explosion) that may occur at the RRON.

At the time of writing this report, a detailed Fire Services Layout drawing (showing the location of firefighting infrastructure, emergency manual call points, emergency exits, and muster points where staff must gather after a site evacuation) has not been developed. These details will be developed as part of the next phase of the project.

Recommendations

A list of recommendations in Table 1 has been provided in summary as part of this FSS for consideration & incorporation in subsequent detailed design.

Table 1 Recommendations from the FSS

Recommendation	Description
Recommendation 1	Undertake Hazard and Operability (HAZOP) workshops to develop safety in design features for any risks identified and accounted for. These workshops shall also consider the design changes after the original Hazard Identification (HAZID) and consider whether additional hazards are identified to be addressed further.
Recommendation 2	This FSS shall be reviewed as the design develops, or new equipment is incorporated to the RRON process plant and updated where required.
Recommendation 3	Consider risk and control measures required from the potential loss of syngas in the carbonisation process as part of HAZOP.
Recommendation 4	If FOGO is stored in the pre-treatment area for a period beyond normal operating conditions (e.g., due to a process upset), it is recommended to establish a process to monitor moisture and temperature levels. As detailed in section 2.3, operating conditions are still subject to detailed assessment through further design development.
Recommendation 5	Ensure stockpiles are well maintained and good housekeeping is implemented as part of a site management plan. Provide signage to egress paths to avoid obstructions and trips/slip hazards.
Recommendation 6	Limit stockpile heights and separation distances in accordance with EPA VIC guidelines, specifically the *Management and storage of combustible recyclable and waste materials* guideline. In addition, implement bunding and safe planning of intended stockpiles to limit fire spread
Recommendation 7	Develop a strategy for firewater containment based on external resources and data to fulfil the requirements of the VIC EPA.
Recommendation 8	Add RRON to any existing preventative maintenance or inspection activities/procedures prior to completion of the project.
Recommendation 9	A Hazardous Area Assessment of the RRON facility be undertaken as part of the design process in accordance with AS/NZS 60079.
Recommendation 10	Develop procedures for the RRON which identify safe work operations for the new plant and equipment prior to the completion of the project.
Recommendation 11	Develop relevant policies and procedures to control portable ignition sources at the RRON.
Recommendation 12	Complete a cause and effects matrix and RRON Control Philosophy for the detection of flammable &/or hazardous gases and smoke which will initiate an alarm in the control system logic.
Recommendation 13	Confirm all Emergency Stop Device (ESD) communications to and from equipment packages and site locations.
Recommendation 14	Develop a detailed drawing (fire services layouts) showing the location of ESD push buttons, gas detectors, visual warning devices situated in the primary occupied areas and main control station.
Recommendation 15	During the design development stages and final completion of site layout, complete a building code compliance report through a qualified building certifier.
Recommendation 16	Develop Emergency Response Plan
Recommendation 17	Ensure locations of the main site entrance and alternative access is provided for Emergency Services on a fire protection layout.
Recommendation 18	Provide an alternate path of travel around the receivals hall if this is the intended access for attending firefighting brigades and/or consider fire suppression through the receivals hall to protect firefighting vehicles accessing the site.
Recommendation 19	Include any necessary evacuation routes on site fire services and the designated building entry points and security areas.
Recommendation 20	Include the location of emergency assembly points on the Fire Services Layout drawings and within the emergency response plan.
Recommendation 21	Monitor moisture levels in the biochar the end product using a manual moisture tester. Manual moisture testing should be captured in an operations Environmental Management Plan.

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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 Fire Safety Study (FSS) has been prepared to support the DLA.

The RRON will be located at BW's Black Rock Water Reclamation Plant (WRP) (the site), located at 405 Blackrock Road, Connewarre, approximately 18 km south of Geelong. The Black Rock WRP is an already established organic waste recycling facility that treats wastewater and recycles ~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.

The outbreak of fire due to accidental initiation is the focus of evaluation, within this FSS with limited considerations given to deliberate fire starts. The effect of explosive device, terrorism, arson (e.g., multiple fire starts), or deliberate sabotage of fire safety systems shall be deemed through the stakeholder engagement through further design development.

The goal of 'absolute' or '100%' safety is not attainable and there will always be a finite risk of injury, death, or property loss. Fire and its consequential effects on people and property are both variable and complex. Thus, a fire safety system may not necessarily cope with all possible scenarios, and this must be understood by all stakeholders. Stakeholder liaison shall include Barwon Water staff, RRON designer/s, MFB, CFA and the building Certifier during the design brief for fire and life safety.

1.2 Purpose

The purpose of this report is to determine the potential risks and consequences of fires resulting from combustion of hazardous materials proposed to be stored and processed at the RRON site, and to provide a preliminary assessment of the proposed fire detection and prevention systems to manage potential fire scenarios. This report is intended to be used to support the DLA.

1.3 Scope of work

The scope of this study includes:

- Identification of the fire hazards
- Determination of the consequences of possible fire scenarios (preliminary only)
- Guidance on stockpile limitations and EPA regulatory requirements
- Discussion of fire prevention strategies and measures
- Discussion of proposed fire protection systems
- Discussion of containment and disposal of firefighting water and any contaminated run-off water
- Recommendations

The study has been conducted in accordance with the following guidelines:

- The New South Wales Department Fire Safety Guidelines, Hazardous Industry Planning Advisory Paper No.2 (Ref 1)
- EPA Victoria – Management and Storage of combustible recyclable and waste materials – guideline

At this stage of the design there has been no engagement with FRV or CFA including no previous studies or risk assessments.

It assumed that the project will include, but not be limited to, the following additional safety studies during future phases of design:

- Hazard and operability studies
- Hazard analysis
- Risk assessment

The facility design is currently at the early contractor design stage and it is recommended that a HAZOP study be conducted during detailed design to workshop a basis for Hazard Analysis.

An early contractor involvement (ECI) phase hazard identification (HAZID) workshop was conducted on 5 and 6 October 2023, which was led by Hitachi Zosen Inova (HZI) Australia, the Principal Contractor for the ECI design of the RRON facility. Further details on the ECI HAZID workshop are provided in section 5.

Recommendation 1: Undertake HAZOP workshops to develop safety in design features for any risks identified and accounted for. These workshops shall also consider the design changes after the original HAZID, and consider whether additional Hazards are identified and to be addressed further.

1.4 Key assumptions

The FSS is limited based on the following items:

- The concept design on which the FSS is based on is preliminary in nature only and subject to further design development by the designer. Additional hazards may be identified throughout the detailed design stages of the project.
- The project's proposed equipment may be subject to equipment modifications and change through further design development. Hazards related to the process in this report are defined by the process flow diagram provided in Appendix B of the main application report.
- The project may study additional areas to be considered in the FSS in the future. Equipment or processes are currently limited to those nominated in this FSS.
- Further risk assessment of fire risk shall be undertaken through design development and the FSS shall be updated accordingly

Recommendation 2: this FSS shall be reviewed as the design develops, or new equipment is incorporated to the RRON process plant and updated where required.

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 1.2 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 (refer section(s) 1.2 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

1.6 Abbreviations

Table 2 Project abbreviations

Abbreviation	Definition
AS	Australian Standard
ASD	Aspirated smoke detector
BCA	Building Code of Australia
BOW	Building occupant warning system
BRWRP	Black Rock Water Reclamation Plant
BW	Barwon Water
CFA	Country Fire Authority
ECI	Early Contractor Involvement
EPA	Environmental Protection Authority (Victoria)
ESD	Emergency Stop Device
FEB	Fire Engineering Brief
FOGO	Food Organics and Garden Organics
FRNSW	Fire and Rescue New South Wales
FRV	Fire and Rescue Victoria
FSS	Fire Safety Study
GHD	GHD Pty Ltd
HAC	Hazardous Area Classification
HAZID	Hazard Identification
HAZOP	Hazard and Operability
HIPAP	Hazards Industry Planning Advisory Paper
HZI	Hitachi Zosen Inova Australia Pty Ltd
LED	Light Emitting Diode
LEL	Lower explosive limit
LFL	Lower flammability limit
MFB	Metropolitan Fire Brigade
MFIP	Main fire indicating panel

Abbreviation	Definition
NCC	National Construction Code
NSW	New South Wales
NZS	New Zealand Standards
PFAD	Plug-Flow Anaerobic Digestion
PHAST	Process Hazard Analysis Software Tool
PLC	Programmable logic controller
PSV	Pressure safety valve
PUZ	Public Use Zone
RRON	Regional Renewable Organics Network
SCADA	Supervisory control and data acquisition
UEL	Upper explosive limit
UPS	Uninterruptable power supply
VIC	Victoria
WRP	Water reclamation plant

2. Facility overview

2.1 Site location and equipment layout

Barwon Water's RRON facility will be located adjacent to the existing Black Rock WRP at 395 – 405 Blackrock Road, Connewarre, Victoria. This parcel of land is currently zoned as PUZ1 (Public Use Zone – Service and Utility). Figure 1 shows the location of the WRP relative to major population centres around Port Phillip. The proposed site layout plan and the ground floor plan are provided in Appendix A.

Associated works of the RRON facility are intended to occur within the boundaries of this property with proposed integration with the neighbouring WRP plant and biosolids facilities. The site location is based on a pastoral and agricultural district located in the Greater City area of Geelong with homes and small farms between the main through roads.

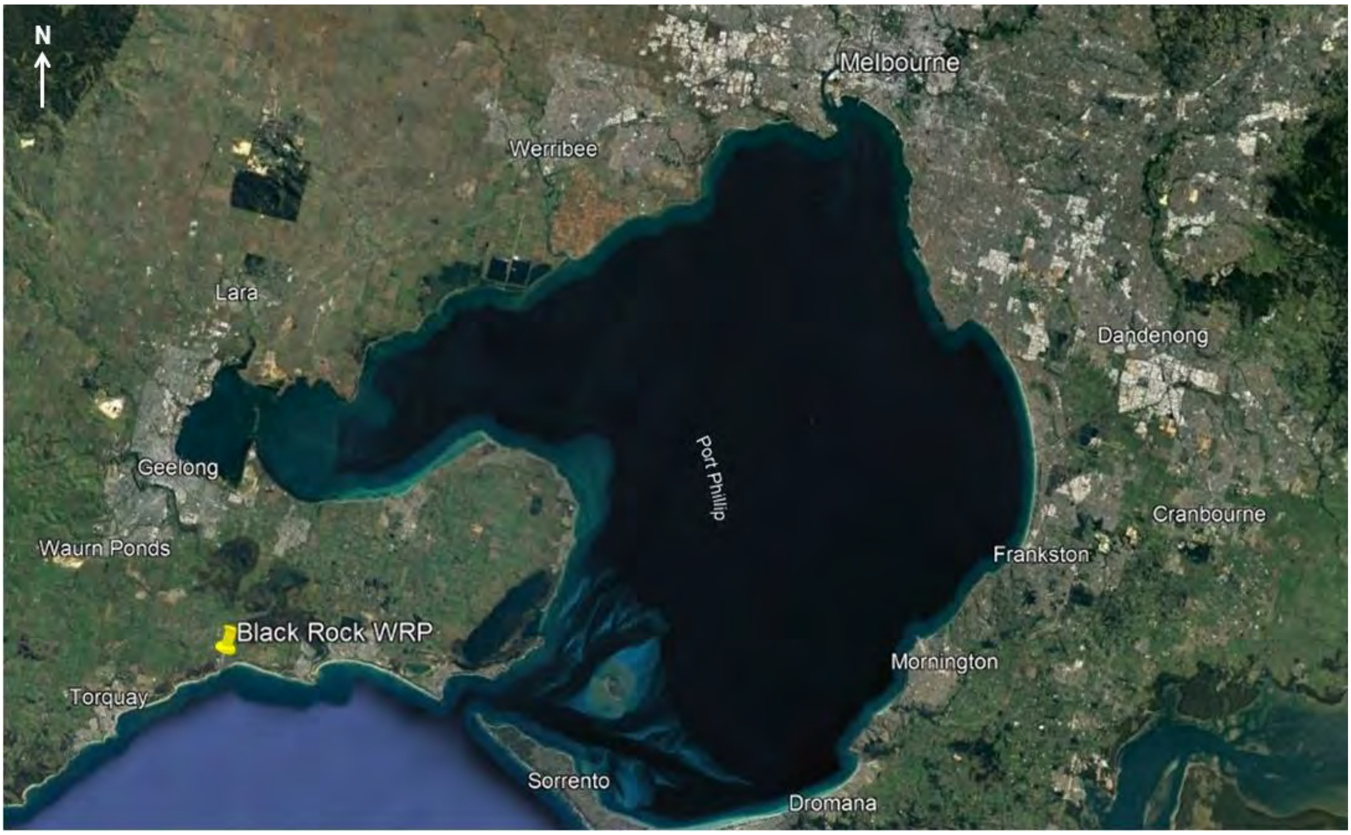


Figure 1 Location of Black Rock WRP site (image courtesy of Google Earth)

2.2 Process description

The proposed RRON facility will consist of the following primary process units located across the facility both externally and internally.

- Feedstock pre-processing
- Plug Flow Anaerobic Digester
- Biogas co-generation equipment
- Digestate dewatering and drying
- Carbonisation unit
- Syngas combustion and associated heat integration equipment
- Ancillary pumps, pipework, and conveyers

Process flow diagrams for the RRON facility are included in Appendix B of the DLA report. A brief summary of each main process unit is included below, and a more detailed process description is included in the DLA report.

2.2.1 Pre-processing

Organic feedstock will be delivered to the site into an unloading area within the main process building. From the feedstock storage area, feedstock will be loaded into the pre-processing equipment which will comprise of contaminant removal, size reduction and separation equipment including picking line/s, shredding, screening, magnetic separation, etc as well as associated transfer equipment (conveyers, pumps, pipes, etc) and interim storages. Following pre-processing of the feedstock;

- The FO-rich stream (separated from FOGO) and FO-rich C&I organic waste will be fed to the PFAD train
- The GO-rich stream (separated from FOGO), the bulk green waste and the biosolids will be fed to the carbonisation train

2.2.2 Plug flow anaerobic digestion

The gas-tight horizontally mounted digester is heated and includes internal paddles mounted on a large shaft to facilitate the passing of the feedstock in a plug flow manner through the length of the digester. Organic feedstock is anaerobically digested producing biogas which is collected and extracted from the top of the digester. After a 14 to 21-day residence time, digestate will be discharged from the end of the digester.

2.2.3 Biogas utilisation

Collected biogas is transferred to a biogas storage vessel. From here, the biogas will be utilised by one of the following two approaches and any excess will be flared:

- Transferred to the neighbouring biosolids drying facility and used in a biogas burner for use in biosolids drying (Year 1 – 7). In this instance, a portion of the biogas will be utilised for heating the digester.
- Power generation via cogeneration process (Years 8 – 25). In this instance, the electricity output of cogeneration will be used at the neighbouring Black Rock WRP, and the heat output of cogeneration will be utilised for heating the digester.

2.2.4 Digestate dewatering and drying

A screw press will separate digestate into liquid digestate and a dry fraction. Liquid digestate will be recycled as process water to the head of the PFAD process and any excess will be discharged as wastewater to the neighbouring wastewater treatment plant. Digestate dewatering takes place indoors within a compartment of the main processing building (labelled as “BN03 – Proposed Building One” on the site layout).

Dewatered (solid) digestate will be loaded using front end loaders into a digestate drying process, which involves arranging the digestate into windrows on a perforated concrete slab and blowing air through the material to remove moisture. The dried digestate will be around 49% moisture content and will be loaded onto trucks from an enclosed area for offsite reuse.

2.2.5 Carbonisation

The GO-rich stream (separated from FOGO), the bulk green waste and the biosolids will be fed into a multi pass rotary drum dryer’s inlet using a high-speed hot air stream. Hot gasses from the gasifier/oxidiser will directly dry the material as it is tumbled through the drum. A downstream cyclone will separate exiting dry material and moist air. The separated dry material will be transferred as the feed material to the gasifier and the moist air will continue through to the air treatment processes before being discharged.

The gasifier will carbonise the dried material in an oxygen-starved environment, producing a combustible syngas and biochar. The fixed bed gasifier will control inputs and outputs with variable frequency drives. Produced syngas exits towards the oxidiser, where air is introduced to create heat through combustion, from which the hot gases continue to the dryer. The solid products will be collected with a discharge conveyer and transferred to a mixing bin, where temperature and moisture can be adjusted using spray water for quenching. Finished biochar will be bagged at a semi-automatic bag rack. Drying and carbonisation occurs indoors within the carbonisation building (labelled as “BN10 – Proposed Building Two” on the site layout).

2.2.6 Air treatment

Moist air from the dryer will be transferred to the air pollution control system which includes wet scrubber and a 2-stage chemical scrubber system before being discharged to atmosphere via a biofilter and stack.

2.3 Design and operating conditions

Design and operating conditions shall be subject to detailed assessment through further design development stages. Where operating conditions will be subject to change throughout detailed design, change registers shall be considered to document the impacts of the change on the intended design conditions. Design and operating conditions shall also be updated in a developed FSS.

2.4 Process control

The RRON facility is intended to have operator presence during nominated shifts, with on-call operator attendance outside shift hours. The main process elements of PFAD and carbonisation are designed to operate continuously with waste receipt usually occurring between the hours of 7 am-4 pm, Monday to Friday.

The RRON control system will be provided with PLC control to control the major process functions, and a safety instrumentation system that will isolate and/or shut down a range of equipment packages, and actively close any major isolation valves during emergency events. A fire detection and alarm system should also be programmed through the PLC system for occupant and emergency awareness. Ethernet over fibre communications links between equipment packages will permit control and monitoring of the equipment via PLC interfaces. For example, biogas level and/or pressure may be measured by transmitters within the biogas storage tank, with data visible to the facility SCADA to enable monitoring of the process.

Operator attendance will be required to interact with alerted functions and clear notified status changes.

2.5 Security and protection

The SCADA system may be used to monitor the site security. All entry points including to the PLC and communication cabinets may be monitored and alarm raised when the panel doors are opened. This alarm can be enunciated on the SCADA system. Typical entry points to consider:

- Site entrance
- Emergency gate locations
- Fire detection and alarm system
- Designated main building entrance.
- PLC / Communications cabinet

2.6 Standards and legislation

Design, construction, and installation of the RRON shall comply with the relevant standards and legislation requirements. A list of relevant standards and legislation are provided in the Project Basis of Design (GHD 2022).

3. Hazard identification

3.1 Hazardous materials

For the purpose of this study, a hazardous material is considered to be one that has the potential to ignite and start a fire.

A HAZID workshop was conducted as part of the ECI phase of the project on 5 and 6 October 2023, which was led by Hitachi Zosen Inova (HZI) Australia the Principal Contractor for the ECI design of the RRON facility. A summary of the HAZID workshop is included in section 5.

3.1.1 Biogas

The potential hazardous material at the RRON is biogas which is stored and used in line with the description in section 2.2. This is due to the presence of the following:

– Methane

Other materials present within the biogas at the RRON that may contribute to the size of a fire or generate toxic fumes in a fire scenario include:

– Hydrogen
– Oxygen
– Hydrogen Sulphide

Refer to Table 7 for the assumed biogas composition for this study. Although the exact proposed storage pressure is unknown at this stage it is not expected to be pressurised based on the use scenarios outlined in section 2.2.

Methane

Methane is the chemical compound CH4. It is a flammable gas, and the methane content of the biogas could vary from 45% to 75% depending on multiple factors such as the feedstock composition and digestion process conditions.

Hydrogen

Hydrogen, H2 is also highly flammable, however, the hydrogen content of the biogas is generally insignificant.

Oxygen

Oxygen on its own is non-flammable but will support combustion of other materials and therefore concentration above ambient air content will increase the flammability of hydrogen.

Hydrogen Sulphide

Hydrogen sulphide, H_2S, is a highly toxic gas that may cause irritation of eyes or respiratory system and could be lethal over 1000 ppm. It is also highly flammable.

Microbial

Build-up of FOGO and the decomposition process can generate heat reaching temperatures greater than the stockpiles materials’ ignition temperature, resulting in surround materials to combust.

3.1.2 Syngas

Further to biogas, it is also noted that syngas from the carbonisation is also generated onsite. Syngas is expected to be primarily comprised of carbon monoxide with the balance being small proportions of hydrogen and methane. Unlike biogas, syngas is not stored onsite and is mixed with oxygen to be combusted in a thermal oxidiser immediately upon release from the carbonisation process.

4. Consequence analysis

The main objective of the consequence analysis was to determine the consequences of the credible release scenario identified and the potential for it to result in offsite impacts. The processes used to complete the analysis include:

– Discharge modelling
– Dispersion modelling of releases
– Fire and explosion impact modelling (thermal radiation and explosion overpressure)

The consequence modelling is performed using DNV's PHAST (Process Hazard Analysis Software Tool) version 8.71 commercial software package. The PHAST package models have been extensively validated and used widely within the industry. The outputs of the consequence modelling will include the estimated downwind distances for the defined limits for thermal radiation and explosion overpressures, as per those defined in the *NSW Planning Government Hazards Industry Planning Advisory Paper (HIPAP) No. 4 Risk Criteria for Land Use Safety Planning*.

4.1 Credible fire and explosion scenarios

Due to the fact that syngas is not stored on site and is combusted immediately following generation (refer section 3.1.2) it was considered in this preliminary FSS that the risk of syngas release and uncontrolled syngas fire is low. Accordingly, the credible fire and explosion scenarios considered were based on biogas, however, it is recommended that the HAZOP which will be completed during subsequent design phases should consider different malfunctioning and failure scenarios to confirm this and form the basis of fire and explosion control measures.

Recommendation 3: Consider risk and control measures required from the potential loss of syngas in the carbonisation process as part of HAZOP to be undertaken as design progresses.

Biogas is approximately 20% lighter than air flammable gases and therefore an ignited release could lead to the following consequences:

– Jet fire
– Flash fire
– Explosion

Credible fire scenarios were identified as part of the consequence analysis resulting in a jet fire 1.8 m from the point of release noting that all process equipment generating, conveying or storing biogas is expected to be located outdoors. Exposure of flammable gases with high radiant heat temperatures could also result in explosion potentially damaging surrounding building elements.

4.2 Release scenario

The key credible release scenario considered in this analysis is shown in Table 3.

Table 3 Release scenarios

ID	Scenario Description	Material	Release Hole Size
1	Loss of containment of biogas from anaerobic digester, biogas pipework or biogas storage	Biogas	5 mm & 15 mm leak case

4.3 Consequence analysis criteria

4.3.1 Thermal radiation effects

The materials and preliminary release scenarios examined could potentially be ignited, resulting in thermal radiation levels that could cause injury or fatality. Table 4 presents the thermal radiation exposure effects for a range of radiation levels as defined in HIPAP No. 4.

Table 4 Thermal radiation effects

Heat Radiation (kW/m^2)	Effects
2.1	Minimum to cause pain after 1 minute
4.7	Will cause pain in 15 – 20 seconds and injury after 30 seconds of exposure (at least second degree burns will occur)
12.6	Significant chance of fatality for extended exposure. High chance of injury. Causes the temperature of wood to rise to a point where it can be ignited by a naked flame after long exposure. Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure.
23	Likely fatality for extended exposure and chance of fatality for instantaneous exposure. Spontaneous ignition of wood after long exposure. Unprotected steel will reach thermal stress temperatures which can cause failure. Pressure vessel needs to be relieved or failure would occur.
35	Cellulosic material will pilot ignite within one minute's exposure. Significant chance of fatality for people exposed instantaneously.

4.3.2 Explosion overpressure effects

A loss of containment of flammable gas could potentially cause an explosion, generating overpressures and drag forces resulting in damage to buildings and structures, and projectiles (fragments of damaged structures, window glass shards or loose objects). In this study, there is potential for an explosion to occur for biogas if exposed to high radiant heat or direct flame contact. The effects of explosion overpressure are described in Table 5, as per HIPAP No. 4.

Table 5 Explosion overpressure effects

Explosion Overpressure (kPa)	Effects
7	Damage to internal partitions and joinery but can be repaired Probability of injury is 10%. No fatality.
14	House inhabitable and badly cracked
21	Reinforced structures distort Storage tanks fail 20% chance of fatality to a person in a building
35	Building uninhabitable Plant items overturned Threshold of eardrum damage 50% chance of fatality for a person in a building and 15% chance of fatality for a person in the open
70	Threshold of lung damage 100% chance of fatality for a person in the building or in the open Complete demolition of building structures

4.4 Input data & assumptions

4.4.1 Scenario parameter

Table 6 below shows the input data used within the modelling analysis.

Table 6 Model input

Input / Parameter	Scenario Description
Scenario 1	Loss of containment of biogas from anaerobic digester, biogas pipework or biogas storage
Temperature (°C)	850
Pressure (kPa)	Atmospheric pressure
Inventory (m^3)	5320 across a duration of 10 hours Based on a biogas flowrate of 532 m^3/hour
Hole size (mm)	5 mm & 15 mm leak case

4.4.2 Biogas composition

Biogas was modelled as a mixture of gases. In the absence of gas analysis specific to this project (due to the preliminary nature of the design), some generic data from the past projects on biogas plants has been used, which must be reviewed once actual gas analysis is available. The gas composition used is shown in Table 7.

Table 7 Biogas composition

Component	Modelled Fraction (vol/vol)
Methane	62%
Carbon dioxide	35%
Nitrogen	0.5%
Hydrogen	0.5%
Hydrogen sulphide	1%
Oxygen	1%
Total	**100%**

4.4.3 Weather data

The weather data conditions used in this model are shown in Table 8, together with the Pasquil stability classes and ambient conditions, to describe the amount of turbulence in the atmosphere for consequence modelling.

Table 8 Weather data

Parameter	Description
Average at 9am	Night time weather
Ambient temperature (°C)	13.8
Relative humidity (%)	76
Wind speed (m/s)	4.44
Pasquil stability	F – stable, night time with light wind and little cloud
Average at 3pm	Day time weather
Ambient temperature (°C)	16.8
Relative humidity (%)	64
Wind speed (m/s)	4.44
Pasquil stability	B – unstable, day time with moderately sunny, light to moderate winds

4.4.4 General assumptions

Table 9 presents the general assumptions used in this study.

Table 9 General assumptions

Parameter	Value	Description
Height of interest	1.5 m	The height for calculating radiation results is set at 1.5 m, representing the approximate chest / face height of a person.
Surface roughness	50 cm	A surface roughness of 50 cm is used for the model to represent parkland, bushes and numerous obstacles within the area. The surface roughness of upwind terrain affects the turbulence in the air as it reaches the release.

4.5 Results

The impacts of fire and explosion scenarios are determined by the thermal radiation effects and explosion overpressure forces experienced whilst a person is within the affected areas.

The consequence assessment results for the scenario examined around the loss of containment of biogas from the anaerobic digester, biogas pipework or biogas storage indicate that there are no fire or explosion impacts resulting from this release scenario that will reach the thresholds/criteria specified in Section 4.2. Whilst the model showed no explosion results at any overpressure reading, the model did generate a jet fire that reached a radiation level of approximately 1 kW/m^2 at 1.8 meters from release point. Additionally, the release did not produce a concentration at the lower flammability limit (LFL), although half LFL fraction concentration was reached up to 1.3 meters from the release point. Given these results, no impacts on personnel are anticipated.

5. Hazard identification workshop

A HAZID workshop was conducted as part of the ECI phase of the project on 5 and 6 October 2023, which was led by Hitachi Zosen Inova (HZI) Australia, the Principal Contractor for the ECI design of the RRON facility. The HAZID is the application of a formal, systematic and rigorous examination to the process and engineering of a plant identifying and assessing the consequences. The method generates a visible record showing that in addition to meeting design standards additional studies have been carried out aimed at attempting to minimise the risk of plant failure.

The outputs of the HAZID workshop included a risk register which considered risks associated with different elements of the site and the process. The risk register was broken down into waste receivals/pre-treatment, PFAD and carbonisation processes. The HAZID process was guided by the Process Flow Diagrams (PFD), and layout drawings. The risk register included an assessment of the identified risks before and after the adoption of current known control measures (preventative and protective). An action register was also developed that outlines actions for response to specific hazards or risk control measures to be further developed through the design phases.

In subsequent design phases the main hazard assessment will be divided into six (6) HAZOP stages by HZI. This mirrors the development of the project through detailed design, construction, commissioning, and ongoing operation:

– Stage 1 HAZOP including assignment of SIL (minimum SIL target levels)
– Stage 2 HAZOP including supplier’s clarification and comments from the client
– Stage 3 Pre-commissioning review including verification of SIL rating
– Stage 4 Occupational safety review

Operation: under responsibility of Operating Company/ Client:

– Stage 5 Post operation
– Stage 6 Process Hazard Review – of existing operations

This structured approach during the entire execution of the project increases the quality of the whole risk assessment and helps to reduce hazardous risks and costs.

This FSS includes a summary table of potential RRON facility fire hazards, causes, results/consequences and prevention/protection measures in Appendix B, which should be reviewed by HZI Australia as part of the Stage 1 HAZOP.

Note: As the original HAZID workshop occurred prior to process updates in 2024, Recommendation 1 made earlier, reinforced below, is recommended in order to capture the changes in the site design.

Recommendation 1: Undertake HAZOP workshops to develop safety in design features for any risks identified and accounted for. These workshops shall also consider the design changes after the original HAZID, and consider whether additional Hazards are identified and to be addressed further.

6. Stockpile management

Effective stockpile management is a critical aspect of fire safety in an organic processing facility; poorly managed stockpiles can create a significant fire risk, potentially leading to damage to the facility, harm to personnel and negative impacts on the environment.

The Environment Protection Authority Victoria (EPA VIC) Guidelines for *the Management and storage of combustible recyclable and waste materials* (CRWM guidelines) provides content for duty holders (those under an EPA licence or permit) on how to fulfil their obligations in ensuring that they identify their risks and practical measures that can be taken to minimise human health and the environment from fire. It is a document designed to support compliance with Victoria's environmental protection laws and act as a guide for implementing best practices regarding waste storage. These guidelines will be used as the primary guidance document to mitigate any fire risks associated with stockpile management.

The CRWM guidelines define the following as CRWM:

– Paper and cardboard
– Wood
– Plastic
– Rubber, tyres, and tyre-derived waste
– Textiles
– Green waste / organic material
– Refuse-derived fuel (RDF)
– Electronic waste (e-waste)
– Metal and other materials with combustible contaminants
– Combustible by-products of metal processing activities (that is floc)

The RRON facility will be receiving Food Organics and Garden Organics (FOGO), which includes incidental amounts of other wastes such as paper and plastic within the FOGO. The expected contamination rates in the FOGO is between 1 to 2%, however, higher contamination rates (indicative range of 3-7%) are likely in the first 12 to 24 months of FOGO service implementation for FOGO being received from Council's that have just introduced a FOGO service and householders adapt to the new waste collection procedures and protocols once implemented. 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 CRWM to be stored at the RRON facility are garden organics, the biochar produced via the carbonisation process, and the digestate produced from anaerobic digestion.

The CRWM guidelines focuses more on risk management for duty holders to implement policies and procedures under an EPA licence, there is limited guidance on the management of stockpiles and organic waste management explicitly related to firefighting i.e., waste receival layout. Data taken from Fire and Rescue NSW document, *Fire Safety in Waste Facilities Guidelines* is thus used as an additional resource with considerable safe options for stockpile management.

6.1 Stockpile material

6.1.1 Food Organics and Garden Organics

The RRON facility will receive a mixture of FOGO, bulk green waste and C&I organic waste that will be sorted within the pre-treatment building. If these materials are stored for a prolonged period it can decompose via microbial and chemical action and heat is generated.,

According to EPA VIC, a stockpile reaching an internal temperature over 90°C can catalyse rapid self-heating and eventual combustion. FOGO stockpiles undergoing composting (chemical and microbial action) can ignite at temperatures between 150°C and 200°C.

Due to the fire risk associated with FOGO stockpiles, EPA VIC guidelines have provided the following recommendations regarding temperature and moisture level and is summarised in Table 10.

It is noted that FOGO, bulk green waste and C&I organic waste in the pre-treatment building will be stored for a short period of time in the storage building before it is processed via the pre-treatment sorting and screening processes and then to the PFAD / carbonisation processes. As such the feedstock material will be below the storage temperature of less than 70°C shown in Table 10.

EPA VIC recommends the implementation of a monitoring process to monitor the operating parameters (temperature and moisture level) are met.

Recommendation 4: If FOGO is stored in the pre-treatment area for a period beyond normal operating conditions (e.g., due to a process upset), it is recommended to establish a process to monitor moisture and temperature levels. As detailed in section 2.3, operating conditions are still subject to detailed assessment through further design development.

Table 10 Stockpile parameters

Parameter	Value	Description
Storage temperature	Less than 70 °C	To reduce the risk of spontaneous combustion, organics storage should be kept below 70°C
Moisture content	< 20 % or > 45%	Moisture content influences spontaneous combustion: Low moisture levels will inhibit biological activity, effectively minimising self-heating by microbial actions. High moisture levels will enable evaporative cooling for the stockpile.

6.1.2 Biochar

The RRON facility utilises different process technologies to treat incoming feedstock. The GO-rich stream (separated from FOGO), the bulk green waste and the biosolids undergo a process known as carbonisation, in which the material is thermally processed. The resulting product is a high-quality biochar, to be sold primarily as soil amendment (e.g. for agriculture) or for the production of advanced sustainable materials. The carbonisation process involves the quenching and bagging of loose biochar inside the carbonisation building, in preparation for its transport out of the facility.

Biochar is a reactive porous media in which it's permeability to air and high surface area per unit volume facilitates heterogeneous oxidation reactions (Francesco Restuccia, 2019). Such media has thus been historically shown to undergo self-heating via spontaneous exothermic reactions (Bowes, 1984). Self-heating has also been found to be most prominent in oxidative atmospheres at low temperatures (Francesco Restuccia, 2019).

After the bagging process the bulk bagged biochar will be periodically stockpiled inside the carbonisation building prior to transportation. According to EPA VIC stockpiles of a self-heating nature are recommended to be managed via:

- Hot spot monitoring
- Passive or active temperature reduction (moisture spraying, shaded storage)
- Activity controls (stock rotation, minimised pile size)

Temperature reduction of the biochar is expected to be employed at the RRON via two main controls: quenching of the biochar as it comes out of the carbonisation process and a mixing bin downstream of the quenching system to mix the biochar and further prevent potential hot spots. The quenching system involves spraying approximately 100-200 L/ hr of water on the biochar to achieve approximately 15% moisture. In addition, to monitor moisture levels a manual moisture testing unit exists to test the moisture content of the end product. This testing unit is not integrated into a control system and requires manual operation. Therefore, although not specifically required by the Victorian guidelines, FRNSW recommends an operations plan to be developed to capture the manual operation of the moisture testing unit. This requirement should be captured in an operations Environmental Management Plan.

It is to be noted that the EPA VIC recommendations for self-heating stockpiles are only applicable if the method is appropriate for the characteristics of the stockpiled material. For instance, stock rotation is not recommended due to both the physical limitations of bulk bagged biochar and the chemical properties of biochar. Exposing loose biochar to oxygen through stock rotation can exacerbate the materials self-heating proprieties as the rush of oxygen promotes heterogeneous oxidation reactions (Francesco Restuccia, 2019). In addition, rotating loose biochar to dissipate heat is not practical with a bulk bagged product. Overall, the management procedures recommended by EPA VIC should be tailored to the produced biochar and the subsequent procedures captured within the facilities Environmental Management Plan.

6.1.3 Digestate

A screw press will separate digestate from the PFAD into liquid digestate and a dry fraction. Dewatered (solid) digestate will be temporarily stored within a bunker (located directly under the screw press), before being loaded using front end loaders into a digestate drying process, which involves arranging the digestate into windrows on a perforated concrete slab and blowing air through the material to remove moisture.

The dried digestate will be around 49% moisture content and will be loaded into trucks from an enclosed area for offsite reuse.

EPA has developed digestate storage and handling guidelines ("Safe production and use of digestate guidelines"). While there are no specific fire safety hazards identified in the guideline, the currently proposed use of an enclosed area for digestate management shall be considered further during the HAZOP (see reiteration of Recommendation 1, below). Most of the identified risk at this preliminary stage has been identified to occur prior to the digestate entering storage, and given the presence of moisture and the forced air (which would be expected to disturb and distribute any remnant combustible gases), general storage guidelines as per the EPA are anticipated to be the most applicable.

Recommendation 1: Undertake HAZOP workshops to develop safety in design features for any risks identified and accounted for. These workshops shall also consider the design changes after the original HAZID, and consider whether additional Hazards are identified and to be addressed further.

6.1.4 Additional stockpiles (transition and biosolids)

As of July 2024, additional stockpiles of materials have been identified internal to the building (see Figure 2). These include transition stockpiles for FO and GO rich material, as well as a biosolids bunker (which will store dewatered biosolids and dried biosolids (bioprill from BW's thermal drying facility at the Black Rock WRP). These stockpiles are anticipated to be subject to the same recommendations and controls found for the FOGO and Biochar portions above (namely, Recommendation 4, for hotspot monitoring in the event of process interruption), however, as they have not had a HAZID/HAZOP undertaken at this time, Recommendation 1 is re-iterated, as further detail around the process controls and hazards associated with the storage of these specific materials are to be detailed by the process team.

General note: Storage and process changes have occurred since the original HAZID. Therefore, it is important that an updated HAZID is undertaken to consider and assess these materials and storage areas in further detail, so that they can be detailed appropriately, prior to further updates of the FSS.

Recommendation 1: Undertake HAZOP workshops to develop safety in design features for any risks identified and accounted for. These workshops shall also consider the design changes after the original HAZID, and consider whether additional Hazards are identified and to be addressed further.

6.2 Stockpile locations

As indicated in Figure 2, the proposed FOGO storage area is within the pre-treatment building and storage of quenched and bagged biochar is within the carbonisation building. As such, the stockpiles can be defined as internal stockpiles of combustible material.

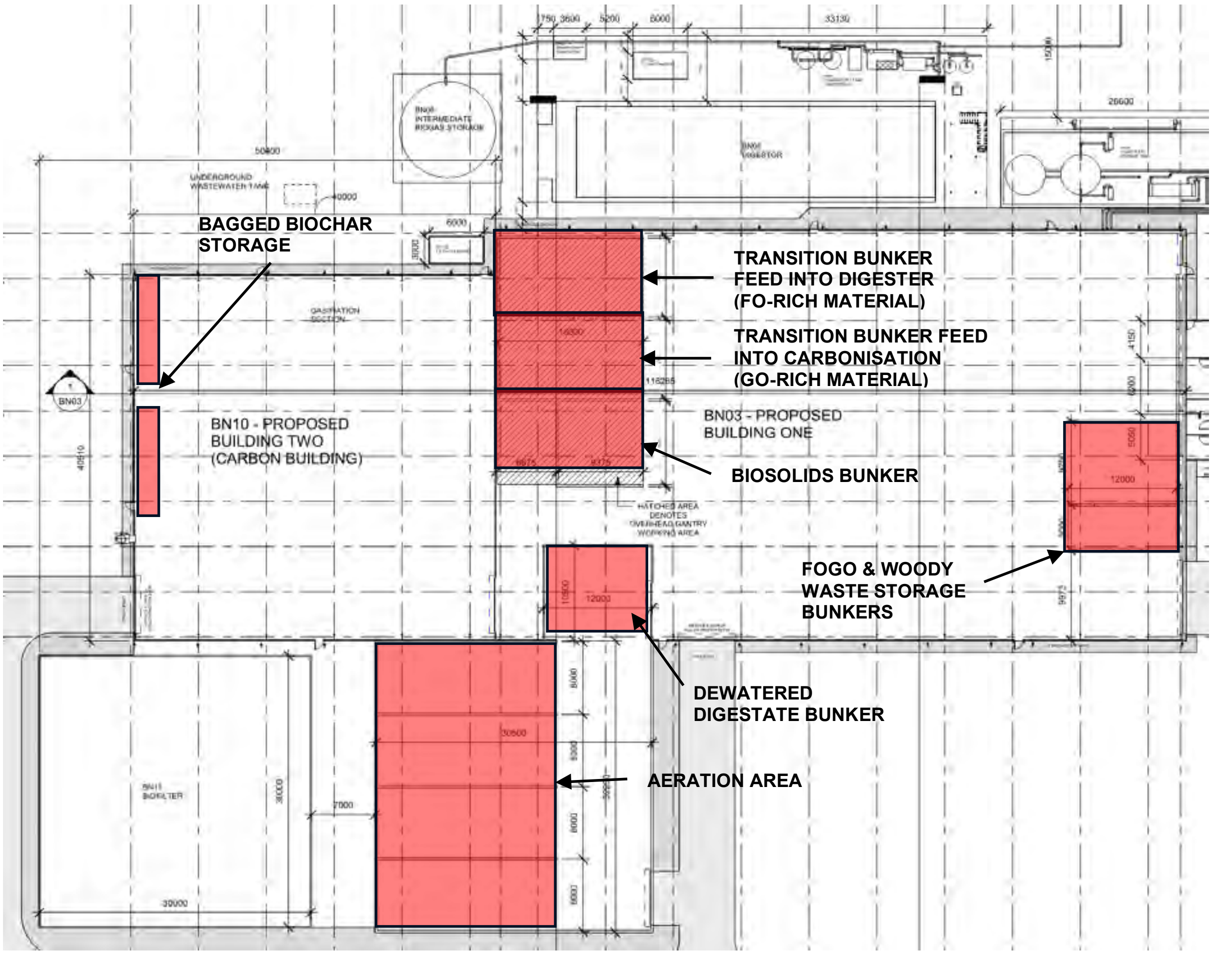


Figure 2 Indicative stockpile locations

All stockpiles should be located away from potential sources of ignition. Consequently, the stockpiles should be adequately separated or protected from any machinery, including the pre-treatment equipment.

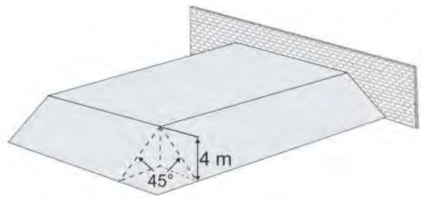
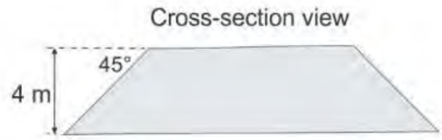
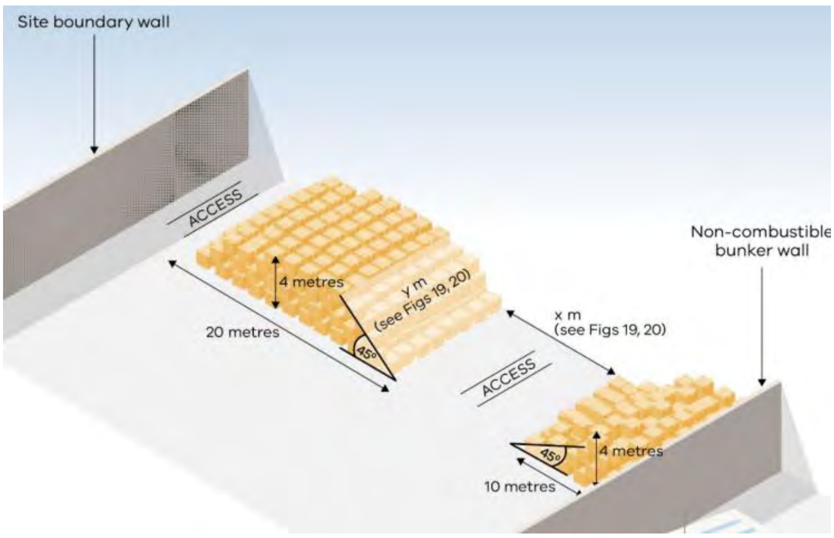
In general terms of occupant safety, when determining the final location of the stockpiles, it is important to ensure that the building's egress points, and the required path of travel are adequately separated from and not blocked by the stockpile.

Recommendation 5: Ensure stockpiles are maintained and good housekeeping is implemented as part of a site management plan. Provide signage to egress paths to avoid obstructions and trips/slip hazards.

6.3 Stockpile physical parameters

Guidelines relating to the physical dimensions of stockpiles and separation distances are outlined in the EPA CRWM guidelines, which are summarised in Table 11. It is to be noted that some images have been sourced from FRNSW's guidance documents to showcase EPA CRWM guidelines identical requirements. These images have been used for increased clarity.

Table 11 Stockpile parameters

Parameter	Value	Description
Stockpile angle	45 °	The uncontained vertical face of the stockpile should not have a slope greater than 45 ° to minimise the risk of collapse and fire spread.  *Figure 3 Stockpile angle (FRNSW, 2020)*
Stockpile height	4 m	It is to be noted that the maximum EPA VIC-approved height is 4 m; it is not the recommended height. The recommended height of the stockpile should be determined based on the width, length, and separation distances of the stockpiles.  *Figure 4 Maximum stockpile height (FRNSW, 2020)*
Stockpile width	10 m or 20 m	20 m width when there is easy access to the pile from both sides 10 m width when there is easy access to pile from only one side  *Figure 5 Stockpile width arrangements (EPA VIC, 2021)*

<table>
<tr><th>Parameter</th><th>Value</th><th>Description</th></tr>
<tr><td>Stockpile length</td><td>Maximum 50 m</td><td>Up to 50 m depending on separation distances and stockpile width.

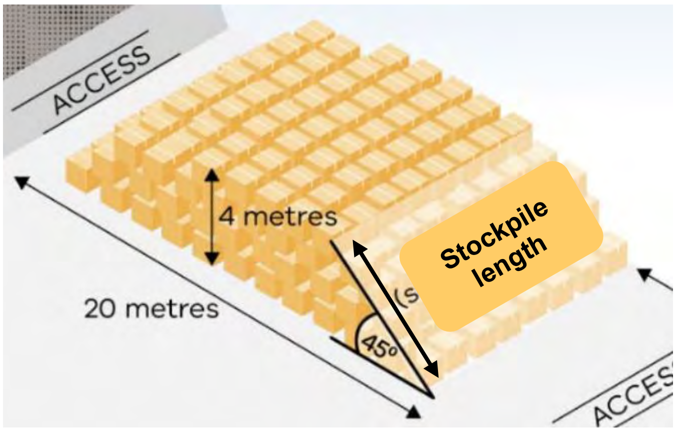


Figure 6 Stockpile length visualisation</td></tr>
<tr><td>Stockpile separation – distance</td><td>Depending on pile length</td><td>The following table sourced from the CRWM guidelines Figure 18 (EPA VIC, 2021) has been recommended for stockpiles of organic material (general CRWM). It determines the required stockpile separation based on the stockpile length. Loose pile to building or baled pile to building refers to external buildings not internal building walls.

<table>
<tr><th></th><th colspan="4">Storage type</th></tr>
<tr><th></th><th>Loose pile to loose pile</th><th>Loose pile to building</th><th>Baled pile to baled pile</th><th>Baled pile to building</th></tr>
<tr><th>Pile length (m)</th><th colspan="4">Separation distance (m)</th></tr>
<tr><td>5</td><td>5</td><td>7</td><td>9</td><td>8</td></tr>
<tr><td>10</td><td>7</td><td>9</td><td>13</td><td>11</td></tr>
<tr><td>15</td><td>9</td><td>11</td><td>15</td><td>13</td></tr>
<tr><td>20</td><td>10</td><td>13</td><td>17</td><td>15</td></tr>
<tr><td>30</td><td>11</td><td>15</td><td>20</td><td>17</td></tr>
<tr><td>50</td><td>12</td><td>17</td><td>23</td><td>20</td></tr>
</table></td></tr>
<tr><td>Stockpile separation - positioning</td><td>Diagonally</td><td>Setting stockpiles diagonally from each other will reduce the intensity of heat being radiated from the emitting stockpile to the receiving stockpile. It is thus recommended for stockpiles using separation distances are protection to be arranged diagonally.

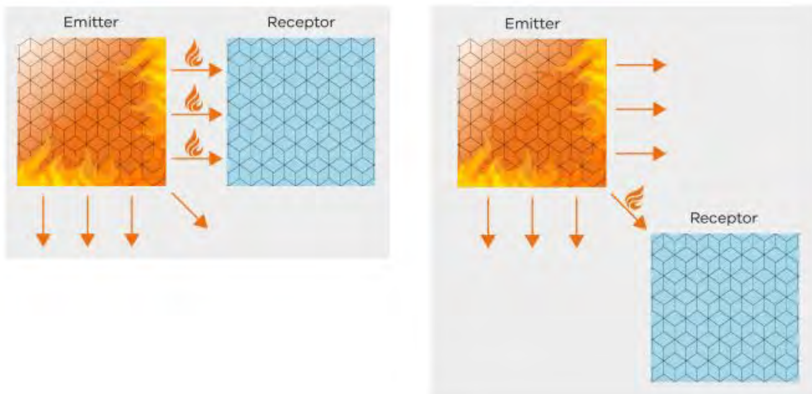


Figure 7 Radiant heat vs stockpile positioning (EPA VIC, 2021)</td></tr>
</table>

<table>
<tr><th>Parameter</th><th>Value</th><th>Description</th></tr>
<tr><td>Stockpile separation – fire bunker walls</td><td>1 m higher than the stockpile

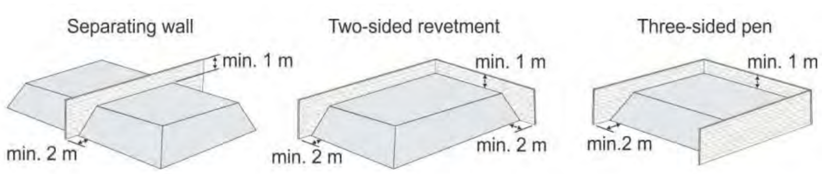
2 m beyond the edge of the outermost stockpile</td><td>Internal stockpiles may be located adjacent to one another when separated by a fire bunker wall. The bunker wall must meet certain height and width requirements to minimise fire spread.


Figure 8 Fire bunker wall dimensions (FRNSW, 2020)

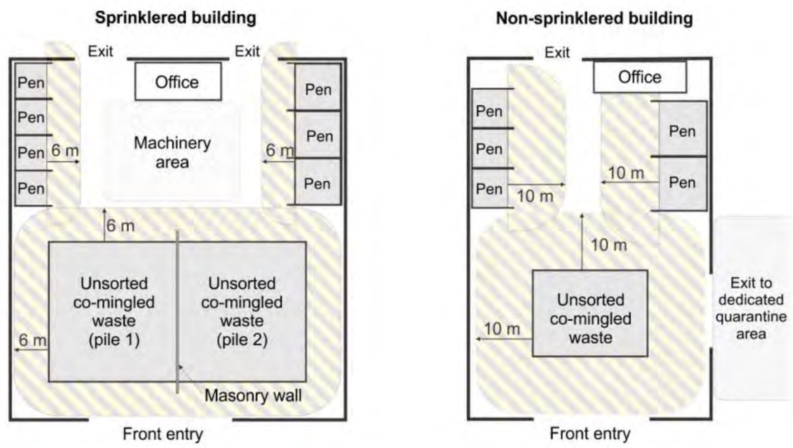
Bunker walls made of concrete are recommended by EPA VIC. Irrespective of the material used, the bunker walls must meet fire ratings for Australian Standards (for example, AS1530.4 ‘Methods for fire tests on building materials, components and structures - Fire-resistance test of elements of construction)</td></tr>
<tr><td>Access around the stockpile</td><td>6 m
or
10 m</td><td>Although EPA VIC discusses the separation distances between stockpiles, there is no recommendation regarding the width of unobstructed access on all accessible sides around the stockpile.
FRNSW guidelines, however, recommend the following:
– 6 m – sprinkler-protected building
– 10 m – non-sprinkler-protected building


Figure 9 Access surrounding stockpiles (FRNSW, 2020)</td></tr>
<tr><td>Stockpile separation to machinery</td><td>Stockpile-to-Stockpile protection</td><td>Similar practices recommended for stockpile-to-stockpile separation should also be implemented for stockpile-to-machinery separation.</td></tr>
</table>

Recommendation 6: limit stockpile heights and separation distances in accordance with EPA VIC guidelines, specifically the *Management and storage of combustible recyclable and waste materials* guideline. In addition, implement bunding and safe planning of intended stockpiles to limit fire spread.

7. Fire water containment

To prevent firewater that has been contaminated by waste and burnt material, liquid run-off management should be considered by the duty holder to contain firewater from entering any nearby catchments and drains within the general areas. The EPA VIC provides guidance to the duty holder to consider engineering controls such as fire water containment. As a general guide to containment, FRNSW guidelines provide some data on required levels of containment based on fire water used on waste facilities.

FRNSW guidelines indicate the following for fire water run-of containment.

1. The waste facility should have effective and automatic means of containing fire water run-off, with primary containment having a net capacity not less than the total hydraulic demand of installed fire safety systems.
2. The total hydraulic demand is the net discharge of water from both fire hydrant systems and any fire sprinkler systems installed.

As the FRNSW guideline is provided as a guide, consideration of this guideline could be given in relation to the water containment management plan and strategy. Although not explicitly provided within VIC EPA, the duty holder is responsible to provide risk control to manage the aftereffects of a fire scenario.

An example of any fire scenario resulting in fire hydrants being used on the site could result in up to 288,000 litres of water as a conservative scenario based on the preliminary figures identified in Section 8.1.2 of the FSS. Containment of this volume should be considered further as part of subsequent design development.

Recommendation 7: develop a strategy for firewater containment based on external resources and data to fulfil the requirements of the VIC EPA.

8. Fire prevention strategies

For a fire to occur, three elements must be present simultaneously which includes oxygen, fuel and heat/ignition sources. Removal of any one of these elements eliminates the possibility of fir to be present.

The RRON facility is designed to be an enclosed facility with oxygen present by building envelope openings allowing natural ventilation. It is not possible to remove oxygen as one of the three elements, therefore the strategy must focus on targeting source of ignitions, and prevention of leaks/ uncontrolled vents and complying stockpile limits.

8.1 Preventative maintenance

Likely fuel contributions towards a fire at the RRON facility are expected to be methane contained within biogas. Construction of the new plant may result in infrequent leaks, accidental losses of containment and maintenance overhauls. Over time it is envisaged that biogas transfer and storage equipment will age and be more susceptible to potential leaks and breakdowns. Preventative maintenance and integrity management is critical to on-going fire prevention measures ensuring maintenance is undertaken to avoid plant disruption and overall wear and tear. It is essential that plant operations maintain the lifespan of the installed equipment to avoid any failures in the process which may involve fire or explosions.

It is expected that Barwon Water manage their preventative maintenance and inspection activities on the new facility which may be similar to the existing or further improved through a review of any existing integrity or preventative system/procedure.

Recommendation 8: Add RRON to any existing preventative maintenance or inspection activities/procedures prior to completion of the project.

8.2 Elimination of ignition sources

Elimination of ignition sources can be completed in many ways including programs, workshops, inductions, and training sessions on workplace safety surrounding fire and life safety. These may include:

- Fire Safety Assessments
- Hot Work Permits
- Hazardous area electrical equipment management
- Static Electricity (earthing)

It is expected that areas around the Anaerobic Digestion process and any equipment transferring or storing biogas will be deemed hazardous areas with electrical equipment installed to the general requirements of AS/NZS 60079. A complete Hazardous areas Classification (HAC) will be required for the RRON facility to AS/NZS 60079.1 where there is the potential for flammable gas and vapours to be present or and AS/NZS.10.2 where combustible dusts are potentially present.

Recommendation 9: A Hazardous Area Assessment of the RRON facility be undertaken as part of the design process in accordance with AS/NZS 60079.

It is assumed Barwon Water manage maintenance on the existing facility through safe working systems policies and procedures. It is expected that all maintenance regimes for the new RRON facility will be updated and managed using this system.

Recommendation 10: develop procedures for the RRON which identify safe work operations for the new plant and equipment prior to the completion of the project.

It would be expected that the control mechanisms in place of portable ignition sources such as radio frequency devices including, but not limited to, mobile phones, radios and other communication devices will be managed by site system procedures and policies.

Recommendation 11: develop relevant policies and procedures to control portable ignition sources at the RRON.

All earths for lightning protection system shall be totally segregated and independent of the main electrical system earthing system. All exposed conductive parts in hazardous areas shall be bonded to earth with equipotential bonds.

9. Fire detection and isolation

9.1 Gas detection

Anywhere within the RRON facility where there is potential for accumulation of flammable or otherwise hazardous gases, gas detection systems shall be considered to ensure early warning and control measures can be enacted via automated ventilation/shutdown and/or operator intervention.

Monitoring instrumentation may take the form of combination or specific gas detectors, with instrument selection and positioning of detectors being influenced by the specific gravities of candidate gases and their associated dispersal behaviours in air (i.e., heavier/settling vs lighter/floating).

Key parameters for monitoring of these and any other potentially hazardous gases within the RRON facility will be as follows:

– Appropriate % Lower Explosive Limit (LEL) measurements in air within at-risk process buildings
– Appropriate % Upper Explosive Limit (UEL) measurements of atmospheres within process vessels which maintain high concentrations of flammable gases (e.g., anaerobic digesters)
– Oxygen % of air within at-risk process buildings (relating to asphyxiation hazards due to displacement)
– Specific thresholds/limits for toxic gases in air (e.g., H_2S)
– Gas detectors

Recommendation 12: complete a cause and effects matrix and RRON Control Philosophy for the detection of flammable &/or hazardous gases and smoke which will initiate an alarm in the control system logic.

9.2 Isolation

It is understood that operating equipment will involve trip and isolation functionalities upon initiation of an Emergency Stop Device (ESD), either via SCADA or an ESD push buttons located around the site.

Shutdowns may include, but not limited to:

– Shutdown of the feedstock pre-processing/digester feeding equipment
– Shutdown of carbonisation process
– Shutdown of ancillary transfer and storage equipment (conveyers, pumps, hoppers, etc)

The FSS has not identified if any of the main equipment packages are affixed with ESD stations although understand will be provided as part of the in-built safety mechanism. Emergency trip and functional signals should be identified through a matrix and signals sent back to the sites main PLC.

At this stage of the design, there is no layout of the plant identifying ESD stations, visual warning devices or audible alarms.

Recommendation 13: confirm all ESD communications to and from process equipment packages and site locations.

Recommendation 14: develop a detailed drawing (fire services layouts) showing the location of ESD push buttons, gas detectors, visual warning devices situated in the primary occupied areas and main control station.

10. Fire safety systems

The design and specification of the RRON fire safety and protection systems will be developed on completion of a detailed fire safety study and stakeholder engagement during detailed design.

For the purposes of early site definition and the basis of design, the site has been assumed to have dedicated fire water storage tanks and fire water pump system supplying a pressurised fire main and hydrant system. Sizing of this infrastructure will be the subject of future stages of the design. New fire water infrastructure shall be subject to further assessment upon subsequent studies of nearby water supplies and municipal infrastructure capacity. As part of the facility design, fire water supply studies will be assessed for performance requirements.

Firefighting measures to the remainder of the site are assumed to be met by a combination of hydrants, hose reels, fire detection and alarm systems, gaseous suppression systems and localised handheld portable fire extinguishers. Various gas detection systems outlined in Section 7 may also be considered to interface with the fire detection and alarm system for the site for evacuation procedures.

Under the Victorian Building Regulation 2018, Regulation 129 requires the report and consent of the chief officer regarding certain fire safety matters, which do not comply to the Deemed-to-satisfy requirements of the Building Code of Australia. Bushfire safety measures shall also be assessed and meet the requirements of Regulation 160 and 161.

10.1 Intended fire systems

10.1.1 Building characteristics

The concept plan of the RRON facility observed in Figure 3 provides an indicative overview of the operations. It should be noted that the building layout and configuration may be subject to change during the detail design phase. All construction requirements of the building shall be completed in accordance with the National Construction Code Volume 1 2021. Where building non-conformance are evaluated and the minimum performance requirements do not comply, fire engineering solutions shall be provided. Table 12 provides preliminary building characteristics. Additional onsite building references are provided in the project BoD.

Table 12 Building performance criteria

Characteristic	Description
Rise in storeys	Receivals/sorting hall: 1 Administration: 2
Effective height	<25 m
BCA Class of use	Receivals/sorting hall 7b Administration: 5
Designation of type of construction	Type C
Largest fire compartment	3,500 m²
Nearest fire station	CFA Barwon Heads Fire Station 11.1 km

Recommendation 15: during the design development stages and final completion of site layout, complete a building code compliance report through a qualified building certifier.

10.1.2 Water supply and storage

The performance requirements of the National Construction Code (NCC) require fire hydrant systems to be provided where the building floor area is over 500 m² and where a fire brigade station is within 50 km of the building as measured along roads. Therefore, as part of the firefighting strategy a fire hydrant system with tanks and pumps has been considered.

Sitewide fire system infrastructure will consist of dedicated fire water storage tanks, assumed to be automatically filled from the municipal water supply and be primarily driven by two fire pumps (minimum) serving the reticulated fire hydrant system for the site.

A minimum water supply quantity should be provided for firefighting capabilities to the proposed fire hydrant system. Table 13 provides an overview of the observed preliminary firefighting component to be considered and nominated water quantity, which shall be provided in two separate static water storage tanks.

As a minimum, the performance criteria of the fire hydrant system will be based on the building compartment size and the requirements of AS2419.1.

Table 13 Fire hydrant design criteria

Component	Design duration (mins)	Est. Vol (L)
Fire hydrants (x2)	240	288,000

Figures are subject to modification upon comprehensive design criteria being established and an understanding of each of the fire scenarios determined for the site.

10.1.2.1 Fire hydrant system

A fire hydrant system for the site shall be designed in accordance with the NCC, AS2419.1 and additional performance requirements outlined through the design development. The hydrant system shall sit on a reticulated services ring main, supplied by the dedicated fire water storage tanks and pumps. Fire hydrants shall form the primary firefighting component for the attending fire crews as a ‘first attack’ option.

Fire hydrants shall be spaced out accordingly and strategically located along paths of travel and protected from trafficable movement, hazardous areas, and combustible building elements. Hydrants shall be located so that each area requiring protection is within 30 m of but not less than 10 m from a hydrant under any conditions of fire, wind, and the cooling effect is optimised.

The design criteria assumed for the site shall consider the NCC performance Specification E1.4 and AS2419.1. The assumed required fire hydrant flow shall be two (2) x hydrants at 10 L/sec unassisted and 5 L/sec assisted (separate operations). The fire hydrant system will require hydraulic calculations to verify system performance and maximum permissible pressure for operation.

Hydrant locations may be amplified with the storage of organic matter within the receivals and sorting halls.

10.1.2.2 Fire hose reels

A fire hose reel system for the site shall be designed in accordance with the NCC, AS2441 and additional performance requirements outlined through the fire safety study. The fire hose reel system shall sit off the reticulated fire hydrant ring main, supplied by the dedicated fire water storage tanks and pumps.

Fire hose reels shall be spaced out accordingly, within 4 m of exits and be strategically located along paths of travel and observed ignition sources throughout the site and applicable to their respective building classifications.

Fire extinguishers shall be strategically located around the site in accordance with the NCC, AS2444, AS1940 and additional performance requirements outlined through the fire safety study. Fire extinguishers shall be readily available and displayed in a prominent position along paths of travel for occupant ‘first attack’ firefighting means.

10.1.3 Fire alarm systems and occupant warning

An automatic fire detection and alarm system for the site shall be designed in accordance with the NCC, AS1670.1 and additional performance requirements outlined through the fire safety study. The fire detection and alarm system will consist of field devices networked back to the MFIP consisting of smoke and heat detectors, manual call points for emergency events and visual warning devices as required.

Heat detectors may be selected for use in the form of rate-of-rise temperature elements which are designed to operate when their temperature rises abnormally quickly from low ambient temperature or fixed-temperature (static) elements, which are designed to operate when they reach a pre-selected temperature. Smoke detectors will depend on combustion products entering the sensing chamber or light beam, and generally consist of photoelectric point-type that operate on the scattering or absorption of light by smoke particles in a light beam. Smoke detectors respond quickly to smoke that is optically dense.

Aspirated smoke detectors (ASD) differ slightly from point-type smoke detectors where they will operate in a much higher sensitivity range and are designed to detect slowly developing fires where the ignition source is likely to be overheated materials components that are likely to smoulder for a period of time before heat is produced.

Emergency white manual call points shall also be designed along paths of travel in and around hazardous risk areas for site operators to signal an emergency event.

The MFIP shall be designed for addressable type applications and be in a visible location to attending fire crews or the site control room for site managing purposes. All main control functions for the site will be managed at this location by attending firefighting personnel.

10.1.3.1 Building occupant warning systems

A building occupant warning system (BOWs) for the site shall be designed in accordance with the NCC, AS1670.1 and additional performance requirements outlined through the fire safety study. The building occupant warning system will be in the form of an input audio card within the proposed MFIP with a front control LED panel allowing alert and evacuation signals to cascade throughout the site. The BOWs may be enhanced with a dedicated emergency microphone for manual operations and announcements and be programmed for multiple evacuation strategies.

The BOWs will consist of an audio function, supplying alert signals through horn speakers located throughout the site. External horn speakers may also be considered for the early warning of site-wide personnel.

10.1.3.2 Main fire indicator panel

For the purposes of early site definition, the site is expected to incorporate a main fire indicating panel (MFIP). The MFIP shall be located at a designated location for local firefighting attendance and marshalling. The panel shall incorporate a building occupant warning system audio output card in accordance with AS1670.1 to provide notification to occupants on-site. The MFIP shall be identified from distance with a visual warning device for attending emergency response personnel and locate major site emergency procedures and documentation.

The MFIP will also contain the main site controls for RRON in addition with various loop capacities for field devices located for the addressable system. All field devices and modules will be configured back to the MFIP and monitored accordingly via site operations. Power supply to the MFIP is required to be fed from the essential supply, equipped with its own back-up power supply.

It should be monitored by the sites main PLC system and trigger any monitored fire devices across the site.

11. Emergency response plan

Any initiation of an ESD or activation of a fire alarm event to notify operators at the plant to evacuate should be formally documented in an Emergency Response Plan. A list of the ESD push buttons and relevant fire alarm activations should be developed into a sitewide Cause and Effect Matrix.

An Emergency Response Plan has yet to be developed for the RRON which is required to determine and document the necessary actions that are required to be taken upon discovering a fire.

Recommendation 16: Develop Emergency Response Plan

11.1 Emergency services access

The RRON facility has not been considered a large-isolated building at this stage of the design, although the facility is intending to provide a services ring road. The proposed main entrance will be determined through detailed design. It is unknown if firefighting apparatuses are required to travel through the receivals hall reception area to navigate around the site. It is highly considerable that an alternate route be made if this was to be the case or consider the inclusion of fire safety systems and measures to offset any risk to attending fire brigades who may have to drive through the receivals hall if a building fire event was to occur.

Recommendation 17: ensure locations of the main site entrance and alternative access is provided for Emergency Services on a fire protection layout.

Recommendation 18: provide an alternate path of travel around the receivals hall if this is the intended access for attending firefighting brigades and/or consider fire suppression through the receivals hall to protect firefighting vehicles accessing the site.

Recommendation 19: include any necessary evacuation routes on site fire services and the designated building entry points and security areas.

11.2 Emergency assembly points

There are currently no documented emergency assembly (muster) points. Consideration should be made for a clear, concise, and effective management plan that ensures effective and efficient management of emergencies that may arise at the RRON. In principle, the minimum requirements of an Emergency Management Plan should align to the guidelines set forth in the EPA Vic.

Recommendation 20: Include the location of emergency assembly points on the Fire Services Layout drawings and within the emergency response plan.

12. References

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Appendices

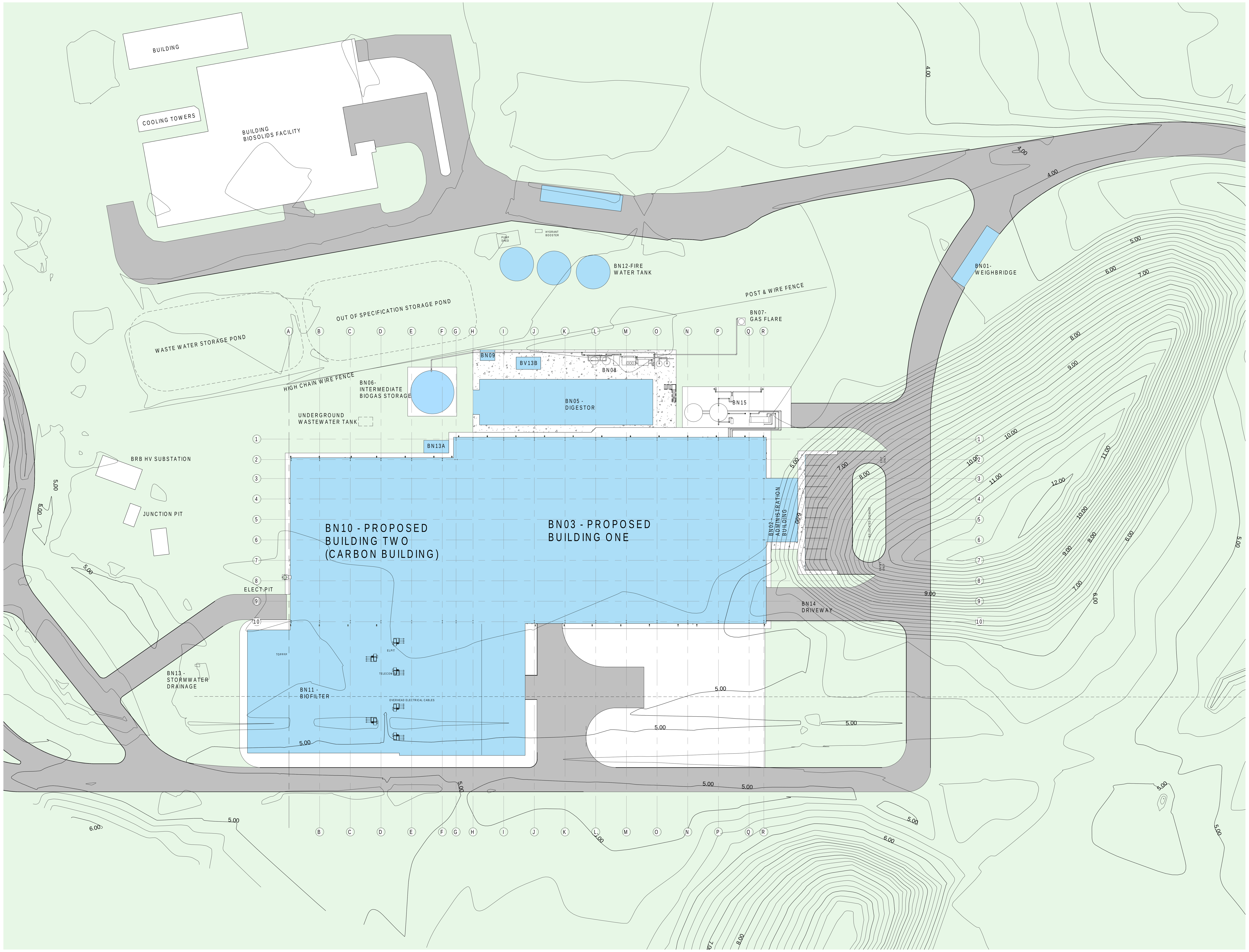
Appendix A

RRON facility layout plan

Bill N of Bill		Element	unit	BN 00
A		ROADS & PAVING		
	A1	Roadworks	m2	
	A2	Geotextile/vapour barrier	m2	
	A3	Curbstones	m1	
	A4	Road gullies and channel gutters	m1	
	A5	Pavements for personnel car parking and pedestrain walks	m2	
	A5	Street lighting	nos	
	A7	Exterior Fire Fighting Main Ring and Hydrants	m1	
B		SOFT LANDSCAPING		
	B1	Landscaping	m3	
	B2	Green areas planting and seeding	m2	
C		FENCING & GATES		
	C1	Fence	m1	
	C2	Gates and barriers	nos	

Notes:

- Applies for layout A
- The detailing and constructing provisions (concrete slab thickness. sand bedding thickness. gravel bed thickness....) must be adapted according to the conditions (soil. climate) and as per Australian standards and regulations.
- This design should be viewed along with the structural engineer specifications prior to construction.
- Water for cleaning hose reel provided by recycle water / rain water tank. - Water for fire fighting hose reel with in the building and fire hydrant provided by the fire water tank network.
- Location of processing equipment is subject to adjustment during detail engineering.



1 SITE PLAN
1 : 500

LEGEND

- Proposed Building Works
- Landscaped Areas - Turf
- Hard Stand Area - Paving
- Hard Stand Area - Asphalt
- Gravel

Project-No.	ProjectName	Description
BN722100	BARWON WATER RRON	

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E-mail: mustafa@nalg.com.au P: 1300 641 206

AIC		Title	SITE PLAN
Weight			
Scale	As indicated		Replaced for:
Status	Basic Design		

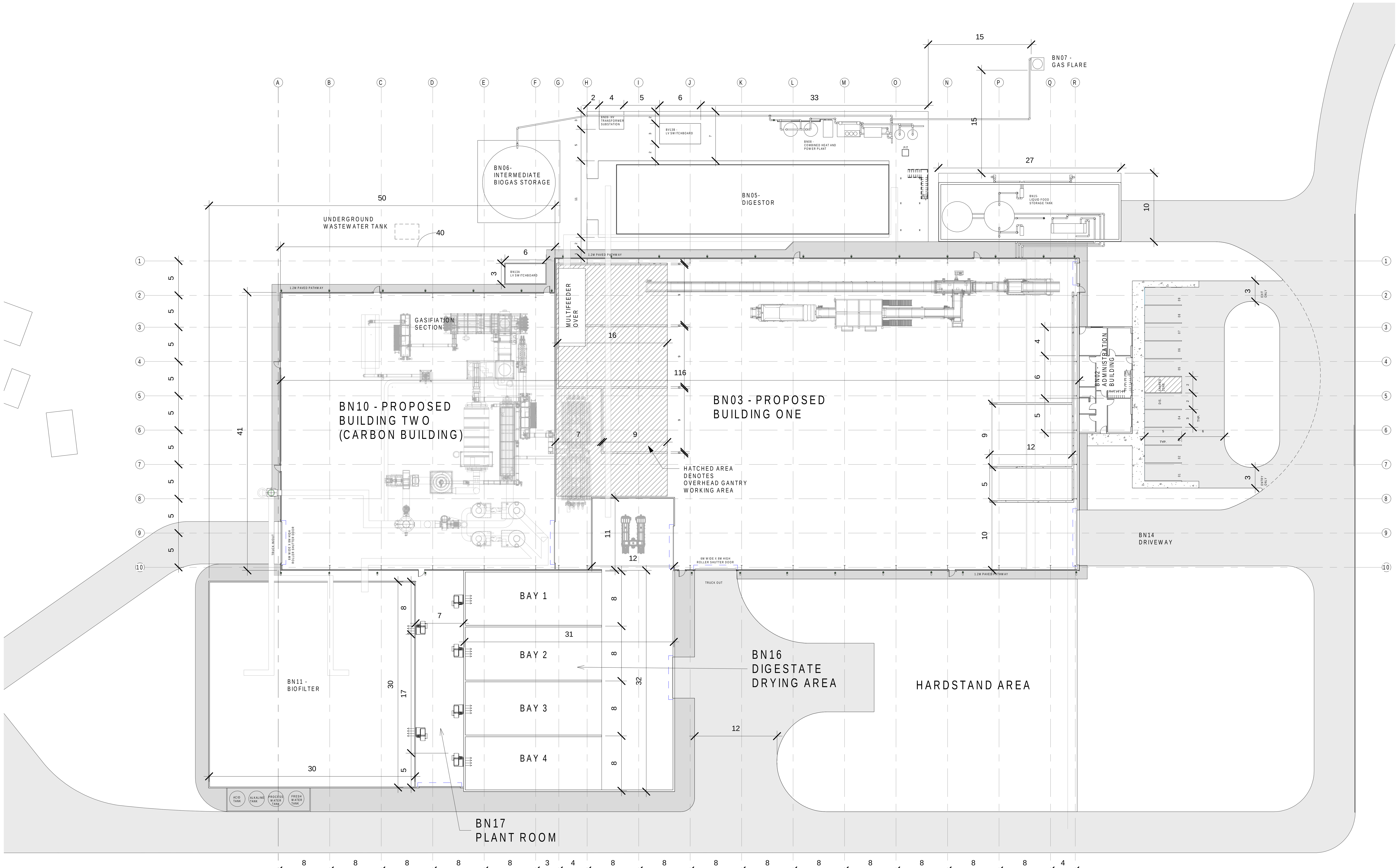
Sheet	Doc Type	Supplier	Drawing-NO.	Revision
1/1			BN00	

NALG | Hitachi Zosen INOVA

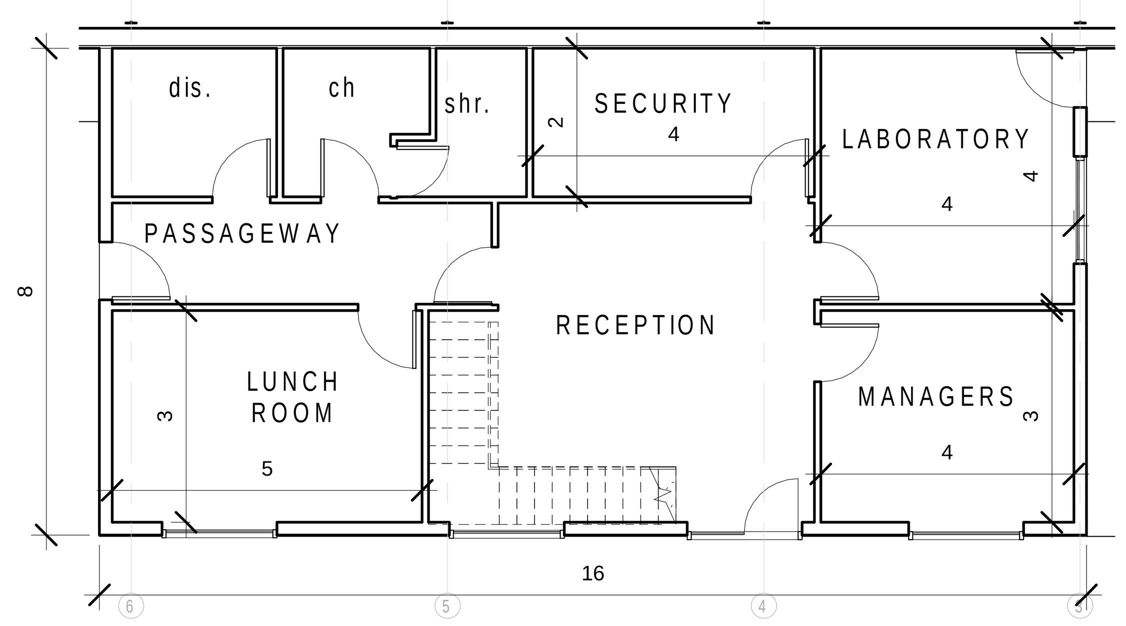
Bill N of Bill		Element	unit	BN 00
A		ROADS & PAVING		
	A1	Roadworks	m2	
	A2	Geotextile/vapour barrier	m2	
	A3	Curbstones	m1	
	A4	Road gullies and channel gutters	m1	
	A5	Pavements for personnel car parking and pedestrain walks	m2	
	A5	Street lighting	nos	
	A7	Exterior Fire Fighting Main Ring and Hydrants	m1	
B		SOFT LANDSCAPING		
	B1	Landscaping	m3	
	B2	Green areas planting and seeding	m2	
C		FENCING & GATES		
	C1	Fence	m1	
	C2	Gates and barriers	nos	

Notes:

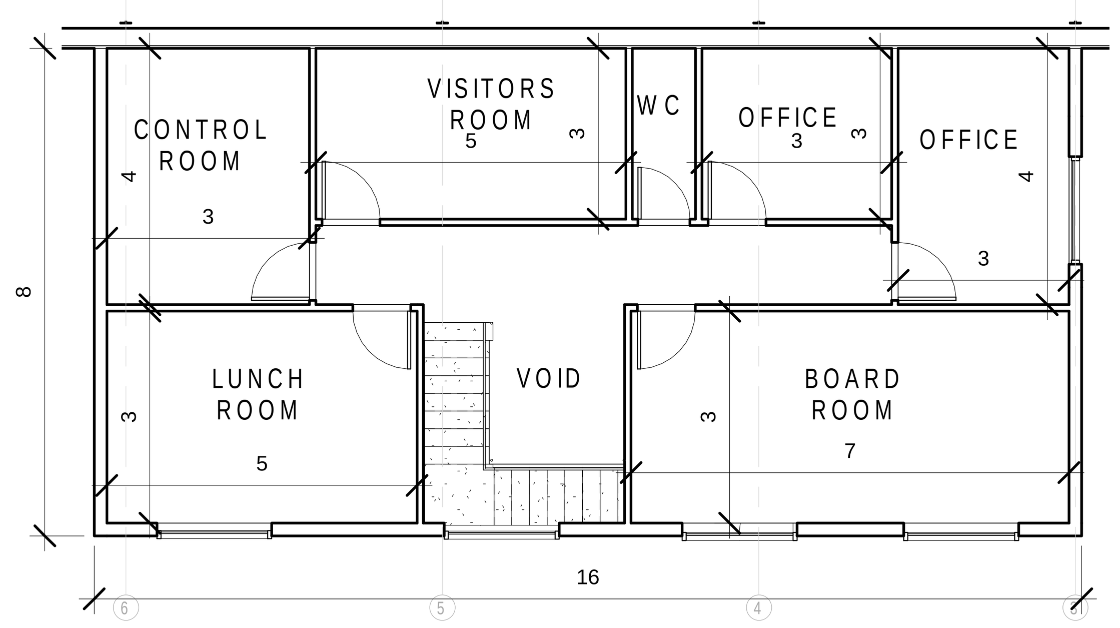
- Applies for layout A
- The detailing and constructing provisions (concrete slab thickness, sand bedding thickness, gravel bed thickness....) must be adapted according to the conditions (soil, climate) and as per Australian standards and regulations.
- This design should be viewed along with the structural engineer specifications prior to construction.
- Water for cleaning hose reel provided by recycle water / rain water tank. - Water for fire fighting hose reel with in the building and fire hydrant provided by the fire water tank network.
- Location of processing equipment is subject to adjustment during detail engineering.



1 GROUND FLOOR PLAN 1 : 325



2 ADMIN GROUND FLOOR 1 : 100



3 ADMIN FIRST FLOOR 1 : 100

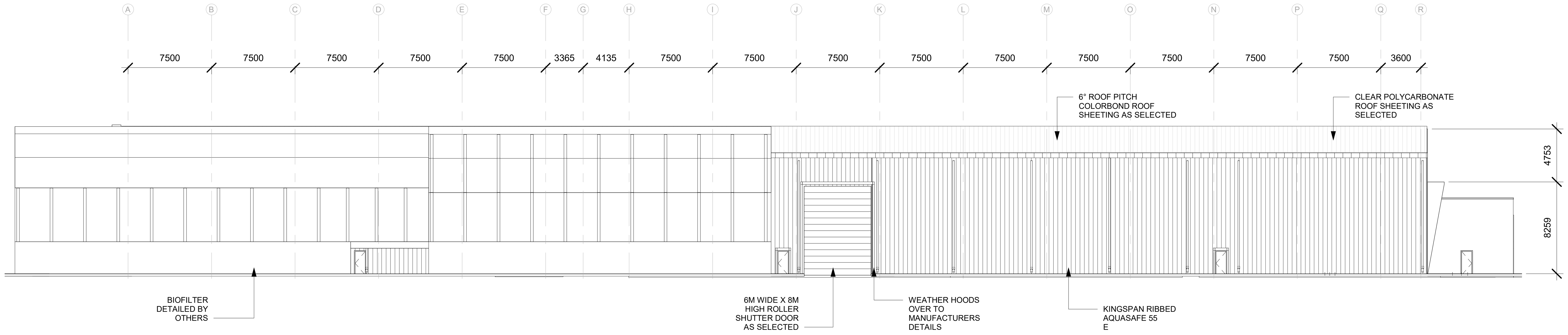
Project-No. BN722100	ProjectName BARWON WATER RRON	Title	FLOOR PLAN
Scale	As indicated		
Status	Basic Design	Sheet 1/1	Drawing-Nr BN01

NALG Hitachi Zosen INOVA

Bill N of Bill	Element		unit	BN 00
A	ROADS & PAVING			
	A1	Roadworks	m2	
	A2	Geotextile/vapour barrier	m2	
	A3	Curbstones	m1	
	A4	Road gullies and channel gutters	m1	
	A5	Pavements for personnel car parking and pedestrain walks	m2	
	A5	Streerlighting	nos	
	A7	Exterior Fire Fighting Main Rind and Hydrants	m1	
B	SOFT LANDSCAPING			
	B1	LAndscaping	m3	
	B2	Green areas planting and seeding	m2	
C	FENCING & GATES			
	C1	Fence	m1	
	C2	Gates and barriers	nos	

Notes:

- Applies for layout A
- The detailing and constructing provisions (concrete slab thickness.sand bedding ihickness.gravel bed thickness....) must be adapted according to the conditions (soil. climate) and as per Australian standards and regulations.
- This design should be viewed along with the structural engineer specifications prior to construction.
- Water for cleaning hose reel provided by recycle water / rain water tank. - Water for fire fighting hose reel with in the building and fire hydrant provided by the fire water tank network.
- Location of the digester, gas storage, flare and other gas processing equipment is subject to adjustment during detail engineering.



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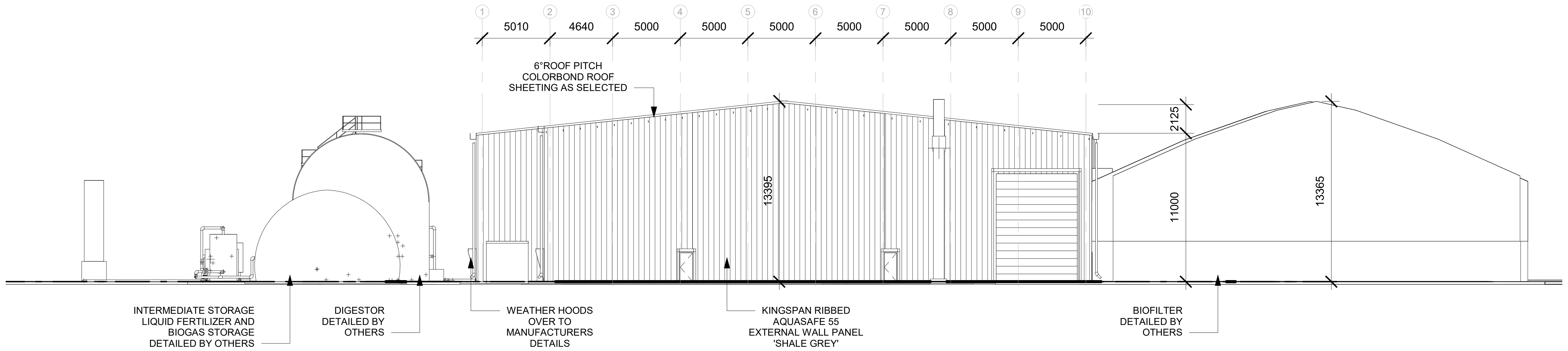

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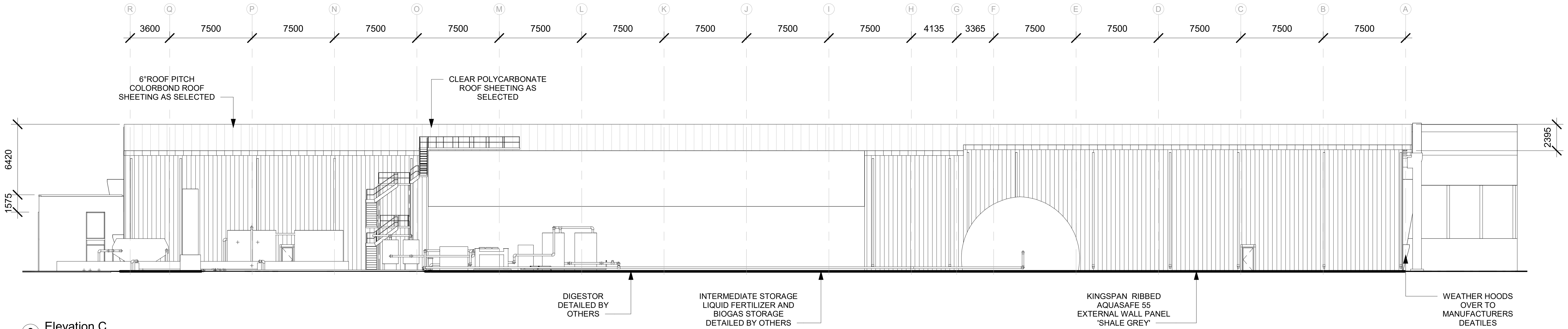

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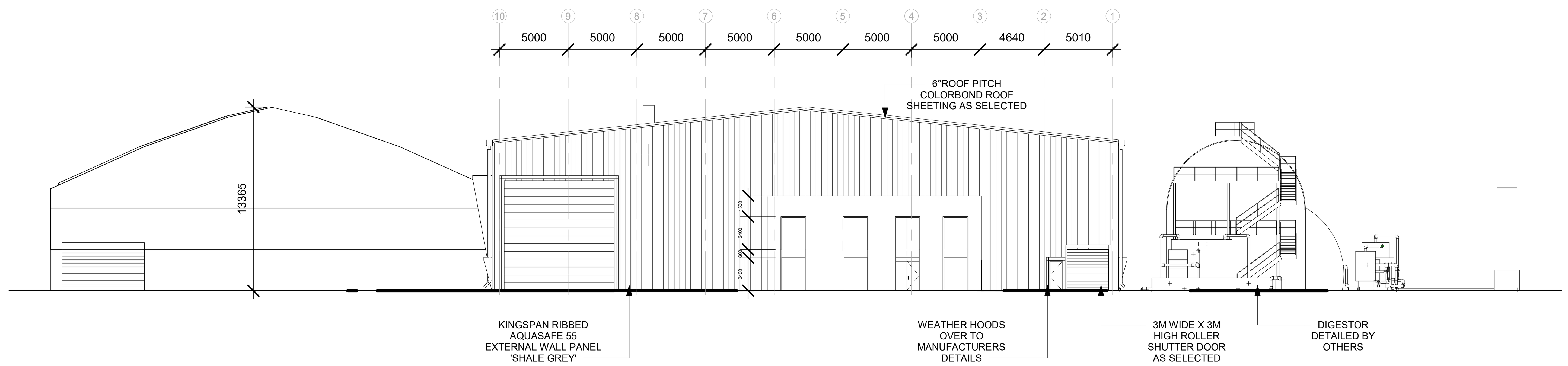

4 Elevation D
1 : 250

Project-No.	ProjectName	Description	
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	AIC	Title	ELEVATONS
	Weight		
	Scale: 1 : 250		Replaced for:
NALG Hitachi Zosen INOVA	Status: Basic Design	Sheet: 1/1 · Doc Type · Supplier	Drawing-NO..: BN02 · Revision

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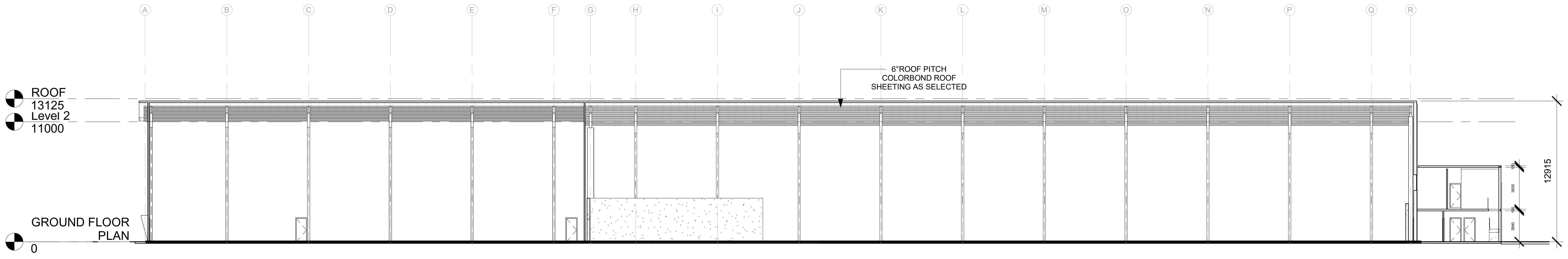
Bill N of Bill		Element	unit	BN 00
A		ROADS & PAVING		
	A1	Roadworks	m2	
	A2	Geotextile/vapour barrier	m2	
	A3	Curbstones	m1	
	A4	Road gullies and channel gutters	m1	
	A5	Pavements for personnel car parking and pedestrain walks	m2	
	A5	Streerlighting	nos	
	A7	Exterior Fire Fighting Main Rind and Hydrants	m1	
B		SOFT LANDSCAPING		
	B1	LAndscaping	m3	
	B2	Green areas planting and seeding	m2	
C		FENCING & GATES		
	C1	Fence	m1	
	C2	Gates and barriers	nos	

Notes:

- Applies for layout A
- The detailing and constructing provisions (concrete slab thickness.sand bedding ihickness.gravel bed thickness....) must be adapted according to the conditions (soil. climate) and as per Australian standards and regulations.
- This design should be viewed along with the structural engineer specifications prior to construction.
- Water for cleaning hose reel provided by recycle water / rain water tank. - Water for fire fighting hose reel with in the building and fire hydrant provided by the fire water tank network.
- Location of the digester, gas storage, flare and other gas processing equipment is subject to adjustment during detail engineering.



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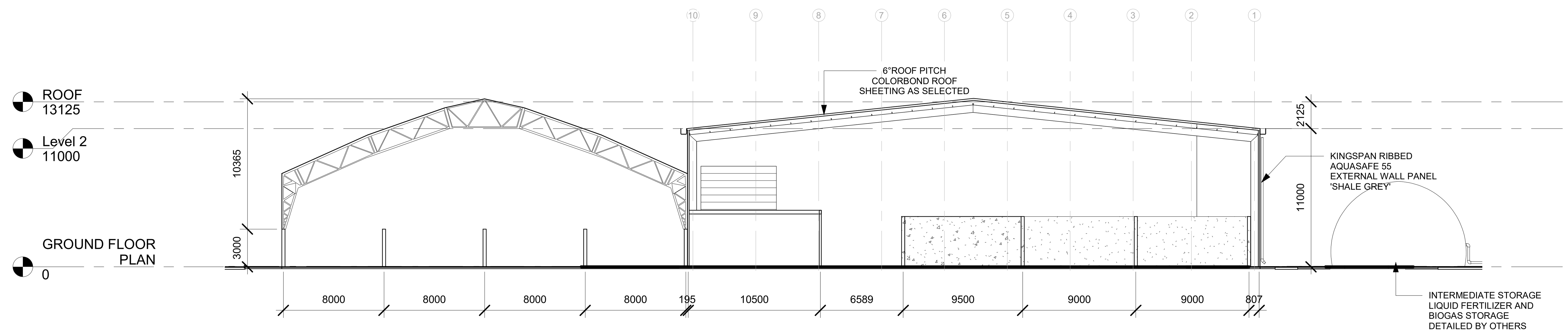

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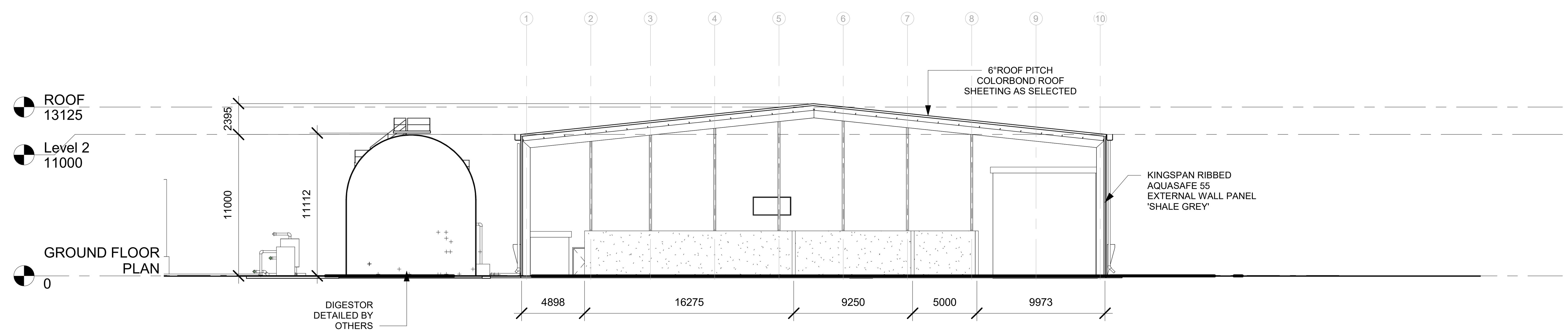

3 Section 3
1 : 250

Project-No.	ProjectName	Description
BN722100	BARWON WATER RRON	

Title: SECTIONS

Scale: 1 : 250

Status: Basic Design

Sheet: 1/1

Drawing-NO: BN03

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Appendix B

Preliminary fire hazard word diagram

Table B1 Preliminary fire hazard word diagram

Facility Event	Cause/Comment	Possible Results/Consequences	Prevention/Detection/Protection Required
Release flammable gas during commissioning	Design, material, and construction defects.	Loss of containment of biogas. Biogas is lighter than air and will disperse well into the atmosphere. If ignition occurs there would be potential for a fire.	All new equipment to be pressure tested. Prefabricated and site installed piping systems shall be leak tested with appropriate air or nitrogen processes.
Release of flammable gas due to overpressure	Error in PLC or failure, pressure control failure, operator error.	Loss of containment of biogas through flanges, pipes, fittings, connections. If heat sources nearby, ignition potentially to occur and cause fire.	Prevention of overpressure is observed through basis process control and local hardwired trips, independent from the PLC, isolating pressure sources. Manufacturer piping and equipment designed with adequate materials of wall thickness and tested to the required standards.
Release of flammable gas due to external impact – mobile machinery or equipment	Mechanical damage caused by external impact e.g., forklift vehicle.	Loss of containment of biogas. Biogas is lighter than air and will disperse into the atmosphere. If ignition occurs there is potential for a fire.	The design should consider a layout which minimises vehicle traffic whilst considering access requirements for maintenance/production etc. Bollards should be considered and installed where required. Provide adequate and identifiable exclusion zones around piping and ductwork. Designate laydown areas for construction when developing the final layout.
Explosion/flash within piping/ductwork	Human error, loose fittings. Air ingress following commissioning	Explosion/flash within piping.	Commissioning procedures to be strictly followed when purging the carbonisation unit. Competency based training should be developed and made compulsory for service operators. Create a register for management of accredited personnel. BW to ensure regular auditing of machinery including procedural activities for the new facility.
Fire/Explosion/Incident within Carbonisation Building.	Overheating, over pressurisation, corrosion, external impacts.	Jet fire, explosion within the building.	The Carbonisation building should be equipped with the relevant building code features in accordance with the NCC. Fire detection and suppression systems available within the building for occupant warning and firefighting intervention. Enclosures within 6 m of the equipment to be protected with structural load bearing walls, fire separation and protection of openings in accordance with the NCC.

Facility Event	Cause/Comment	Possible Results/Consequences	Prevention/Detection/Protection Required
Electrical flash/explosion	Arc flash may occur due to carbonisation equipment current discharge. Could be considered a low risk in this application. Failure of batteries located in the generator or the UPS.	Personnel injury. Stored energy release if battery fails. Potential for fire/explosion.	The carbonisation equipment vendor shall minimise potential for arc flashing in the electrical design. It is recommended a HAZOP action determine if arc flash detection is required and if so to include it in the design. GHD shall also review their design surrounding arc flashing requirements of equipment. BW and battery/electrical vendor management procedures to be applied for battery/electrical management. Preventative maintenance work orders to be created for battery inspection/testing.
FOGO storage temperatures exceeding prescribed minimum	Build-up of FOGO within stockpiles on above ambient temperature days.	Self-heating and spontaneous combustion. Poor stockpile management and over build-up.	Provide monitoring systems within the Receivals Hall. – Temperature control systems – Moisture content control systems BW to ensure regular management of stockpile heights, distances and limits of FOGO stored within buildings.
Vehicle fire in drive through reception	Truck or vehicle fuel leakage.	Outdated or older type trucks or machinery used. Unidentified waste content within disposed waste. Fuel storage tanks expose leakage, including engine oil residue.	Ensure vehicles entering the facility are identified of waste contents. BW to ensure timeframes between drop-offs are limited and occupant notification of vehicle entry is understood. Fire hose reel stations to be located throughout the Receivals Hall accompanied with portable fire extinguishers and external fire hydrants.
Malicious damage, theft etc.	Intruders, vandalism.	Damage to equipment. Theft of expensive parts or equipment.	Secure location, offset from the roadside on an existing parcel of land owned by BW. Facility will be fenced off and locked outside normal operating hours.

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