Teys Australia Southern Properties Pty Ltd

Wagga Wagga Abattoir Upgrade – Preliminary Hazard Analysis

13 July 2022

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Project Manager:	John Herron
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Section 1 Introduction

Wiley & Co Pty Ltd (Wiley) commissioned CDM Smith Australia Pty Ltd (CDM Smith), to complete a Preliminary Hazard Analysis (PHA) for an upgrade to the existing Teys Abattoir facility at 1 Dampier Street, Bomen New South Wales (Lot 1 on DP1213252) (termed the MOD 12 upgrade). The site constitutes a total area of 160.32ha and is located east of East Street and west of Byrnes Road. The northern property boundary is situated south of Bomen Road and the southernmost portion of the site is located north of Hillary Street (refer to Figure 2).

The proponent (Teys Australia Southern Properties Pty Ltd) is proposing to modify the facility to include a new plate freezer/store, a new switch room and temporary workshop. The existing plate freezer capacity does not currently provide for seasonal changes in chilled / frozen export carton numbers during the year. The new plate freezer/store will use ammonia as a refrigerant gas. Ammonia is a Class 2.3 toxic gas and Class 8 corrosive substance under the Australian Dangerous Goods (ADG) Code.

There is existing ammonia stored on site totalling 41.71 tonnes. The existing ammonia circulates in a closed-loop system consisting of compressors, condenser/cooling towers, pumps and accumulator vessels. Gaseous ammonia is condensed, compressed and cooled into liquid form, then pumped to an accumulator vessel where the cold liquid ammonia is pumped through the plate freezers to freeze boxes of meat product. The additional ammonia required for the development is 23.59 tonnes and will be connected through piping to the existing engine room and courtyard ammonia refrigeration system (refer to Table 2-2 and Figure 6). The entire storage onsite (including other disconnected systems) will total 65.30 tonnes.

On 16 February 2022, Ethos Urban on behalf of Teys Australia Southern Properties Pty Ltd (Teys) submitted an application to the New South Wales Minister for Planning and Public Services pursuant to Section 4.55(1A) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to modify Development Consent 220-07-2002-i (DA 220-07-2002-i). On 04 March 2022, the Department of Planning and Environment (DPE) requested the provision of a Preliminary Hazard Analysis (PHA) to assess the increase in ammonia in context of the existing facility as currently approved. The total volume of ammonia exceeds the 5 tonne screening threshold listed in the NSW Government Hazardous and Offensive Development Application Guidelines - Applying SEPP 33 (Department of Planning 2011, hereafter referred to as the SEPP 33 Guidelines).[1]

In accordance with the DPE information request issued on the 4 March 2022, a PHA has been prepared by CDM Smith to identify hazards, consequence, quantification and estimation of risk associated with the storage and use of gaseous anhydrous ammonia in the proposed development. The PHA also considers the cumulative risk of existing stored substances in addition to the additional ammonia introduced as part of the MOD 12 upgrade. Based on the analysis and assessment of residual risks, consideration of the definitions of potentially hazardous industry and potentially offensive industry under SEPP (Resilience and Hazards) 2021 are provided Section 5.7.

[1] Note – on 1 March 222, SEPP 33 Hazardous and Offensive Development has been repealed and the provisions for hazardous and offensive industry now sit within Chapter 3 of SEPP (Resilience and Hazards) 2021.

1.1 Purpose and Scope

This document identifies and assesses hazards and risks associated with the increase and use of hazardous chemicals at the Teys Wagga Wagga Abattoir at 1 Dampier Street, Bomen NSW, for the purposes of planning approval. In accordance with hazard assessment criteria and the purpose of a PHA, the analysis focuses on potential for offsite impacts to determine whether risk levels from changes to the facility are acceptable at the planning approval stage. The PHA is part of the NSW Governments integrated assessment process for safety assurance of development proposals which include the following:

- Hazard and operability studies, fire safety studies, emergency plans and an updated hazard analysis undertaken during a project design phase;
- Construction safety studies carried out to ensure facility safety during construction and commissioning, particularly when there is interaction with existing operations;
- Implementation of a safety management system to give safety assurance during ongoing operation; and
- Regular independent hazard audits.

The process is shown in Figure 1, as extracted from Hazardous Industry Advisory Paper No 5, Hazard Audit Guidelines.

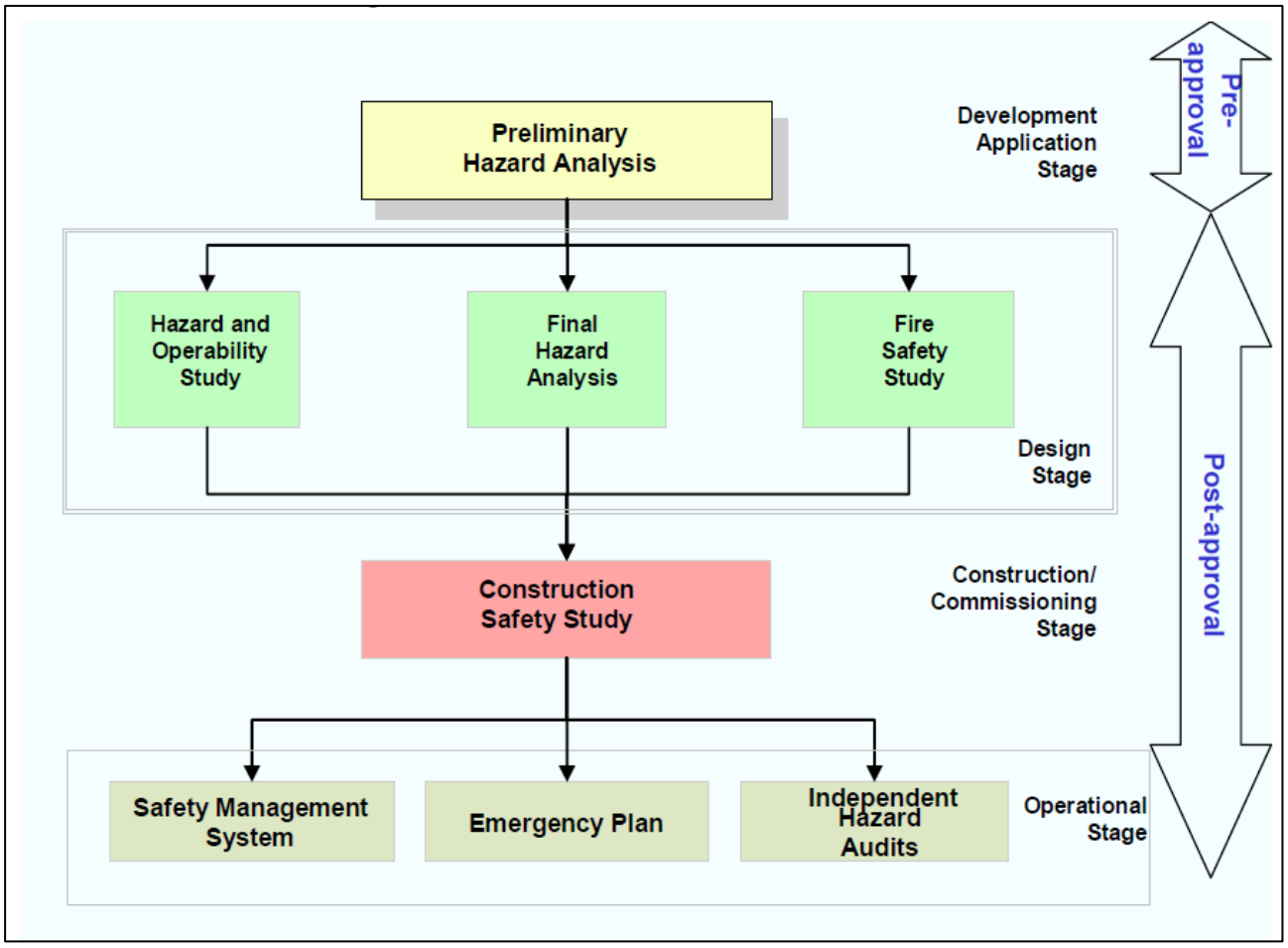

Figure 1 **NSW Hazards-Related Assessment Process**

This document first provides a risk screening conducted as per procedures outlined in the SEPP 33 Guidelines. The SEPP 33 guideline is still taken to be valid, despite the repeal of SEPP 33 and inclusion of provisions for hazardous and offensive development within SEPP (Resilience and Hazards) 2021. The triggers for specific hazard assessment are reviewed and regulatory criteria identified. A PHA is subsequently provided. The aim of the report is to:

- Review of the regulatory planning criteria applying to the storage and use of ammonia;
- Provide a PHA assessment of the hazards and risks associated with the proposed facility;
- Determine the incremental change (increase or decrease) in the risk levels associated with the facility;
- Provide guidance and recommendations for mitigation of hazards; and
- Evaluate the resulting risk levels against As Low As Reasonably Practicable (ALARP) criteria.

1.2 Methodology

The PHA was undertaken using industry best-practice methods as outlined in the Australian/New Zealand Standard AS/NZS 4360:2004 Risk Management through the following steps:

- Review of the design, location and activities associated with the facility to identify potential (valid) risks and hazardous events as a result of the operations. The consequence of each potential hazard was also identified;
- Inspect the facility to confirm the existing infrastructure layout, location of upgrades, storage locations and quantities of existing hazardous substances, confirm validity of potential risks in the site setting and assess the outcomes of previous hazard auditing;
- The frequency (likelihood) of the potentially hazardous event was then estimated, if required by the consequence results;
- The maximum reasonable significance of identified events was quantified by combining the frequency and consequence of each event in a risk matrix to identify the total (cumulative) risk, as appropriate;
- A quantitative assessment of risks to the environment, members of the public and their property as a result of abnormal and atypical events. This was done using Areal Locations of Hazardous Atmospheres (ALOHA) modelling software;
- Potential risk treatment measures (mitigation options) were then proposed to manage the potential hazardous events identified by the facility's operations and design (where applicable); and
- Opportunities to further reduce risks by elimination, minimisation, and/or incorporation of additional protective measures were then identified. This would demonstrate that the operation of the facility will not impose a level of risk that is intolerable with respect to its surroundings.

An overview of the Project team that undertook the assessment is available in Appendix A**.**

Section 2 Site and Development Description

2.1 Surrounding Environment

The development site is in the suburb of Bomen and is proposed for a portion of the Teys Wagga Wagga Abattoir complex. The site comprises two zonings being IN1 General Industry (IN1 zone) and SP2 Infrastructure Zone (SP2 zone) under Wagga Wagga Local Environmental Plan 2010 (WLEP 2010) (Figure 2). The new plate freezer/store is to be located predominantly in the SP2 zone.

Due to the general industry classification of the area, surrounding land uses predominately feature a mixture of manufacturing, warehousing and logistics. While many of the surrounding industrial activities would utilise hazardous chemicals onsite, there are two facilities likely to contain significant volumes: (1) the Southern Oil Refinery which receives, refines and stores waste oils at a site 650 metres (m) to the north of Lot 1 on DP1213252, and (2) the Ampol Bomen Depot which stores and distributes fuels from a site 550 m north of the lot. Refer to Appendix B for a property report of Lot 1 DP1213252.

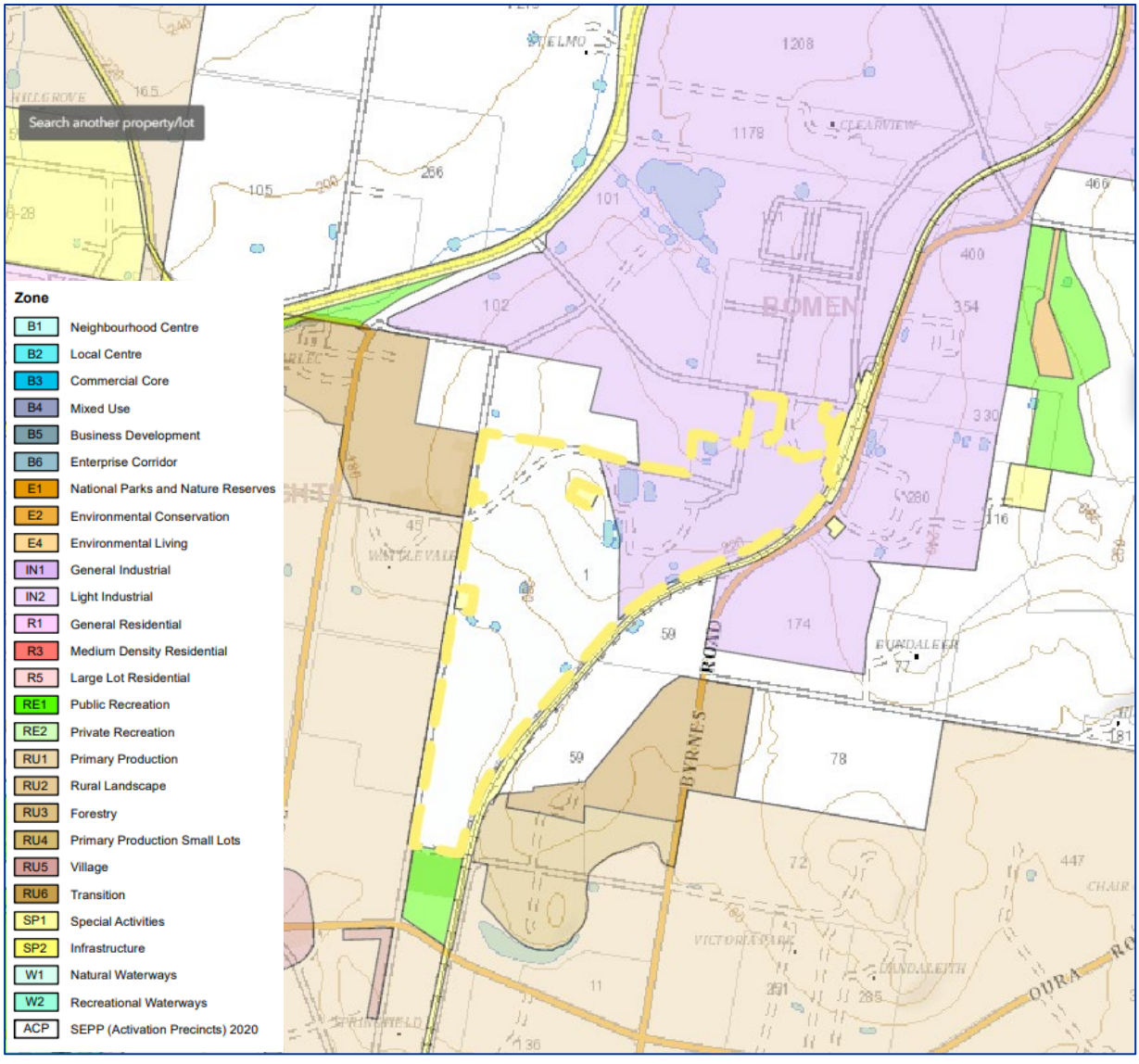

Figure 2 Site Location and Zoning

Figure 3: Site Location and Surrounding Land Uses

- Road
- Railway
- 1DP1213252
- Building Footprint
- Cadastre

Distance From Site

- 300m
- 400m
- 1000m

Land Use Category

- 1.2.0 Managed resource protection
- 2.1.0 Grazing native vegetation
- 3.2.0 Grazing modified pastures
- 3.3.0 Cropping
- 4.3.0 Irrigated cropping
- 5.2.0 Intensive animal production
- 5.3.0 Manufacturing and industrial
- 5.4.0 Residential and farm infrastructure
- 5.5.0 Services
- 5.6.0 Utilities
- 5.7.0 Transport and communication
- 5.9.0 Waste treatment and disposal
- 6.2.0 Reservoir/dam

N

0 280 560
Metres

Date: 5/05/2022
Author: JPH
Coordinate System: GDA 1994 MGA Zone 55

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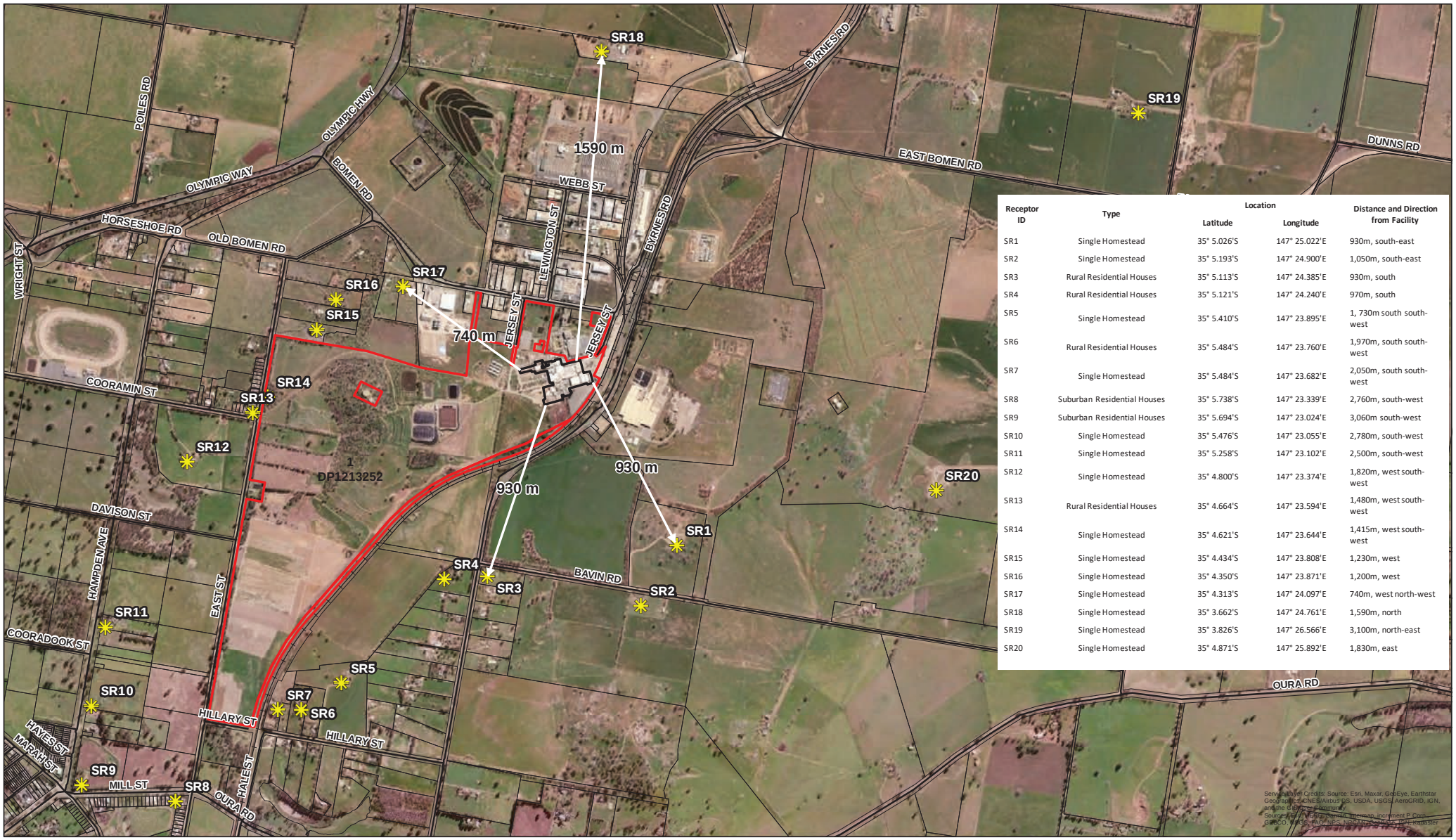
The separation of incompatible land uses from new facilities that use or store dangerous goods is one of the most effective ways to manage hazard and risk. New facilities should be suitably located so they do not pose a risk to sensitive land uses and that incompatible development is not allowed to encroach upon these areas.

The new plate freezer/store is proposed to be located on the eastern boundary of the facility. The immediate adjoining land use to the east is industrial (logistics and storage), with rail and road (Byrnes Road) immediately beyond (Figure 4). Further industrial (warehousing and manufacturing) is located to the east of Byrnes Road, which is surrounded by rural (grazing) and utility uses (Figure 4).

A review of sensitive residential receptor locations was completed to verify location and setback from the facility. Table 2-1 provides a list of the sensitive residential receptors closest to the boundary of Lot 1 on DP1213252 and their distance from the facility (hazardous substances storage location). The location of the sensitive residential receptors is presented in Figure 4.

Table 2-1 Surrounding Sensitive Residential Receptors

Receptor ID	Type	Location		Distance and Direction from Facility
		Latitude	Longitude	
SR1	Single Homestead	35° 5.026'S	147° 25.022'E	930m, south-east
SR2	Single Homestead	35° 5.193'S	147° 24.900'E	1,050m, south-east
SR3	Rural Residential Houses	35° 5.113'S	147° 24.385'E	930m, south
SR4	Rural Residential Houses	35° 5.121'S	147° 24.240'E	970m, south
SR5	Single Homestead	35° 5.410'S	147° 23.895'E	1, 730m south south-west
SR6	Rural Residential Houses	35° 5.484'S	147° 23.760'E	1,970m, south south-west
SR7	Single Homestead	35° 5.484'S	147° 23.682'E	2,050m, south south-west
SR8	Suburban Residential Houses	35° 5.738'S	147° 23.339'E	2,760m, south-west
SR9	Suburban Residential Houses	35° 5.694'S	147° 23.024'E	3,060m south-west
SR10	Single Homestead	35° 5.476'S	147° 23.055'E	2,780m, south-west
SR11	Single Homestead	35° 5.258'S	147° 23.102'E	2,500m, south-west
SR12	Single Homestead	35° 4.800'S	147° 23.374'E	1,820m, west south-west
SR13	Rural Residential Houses	35° 4.664'S	147° 23.594'E	1,480m, west south-west
SR14	Single Homestead	35° 4.621'S	147° 23.644'E	1,415m, west south-west
SR15	Single Homestead	35° 4.434'S	147° 23.808'E	1,230m, west
SR16	Single Homestead	35° 4.350'S	147° 23.871'E	1,200m, west
SR17	Single Homestead	35° 4.313'S	147° 24.097'E	740m, west north-west
SR18	Single Homestead	35° 3.662'S	147° 24.761'E	1,590m, north
SR19	Single Homestead	35° 3.826'S	147° 26.566'E	3,100m, north-east
SR20	Single Homestead	35° 4.871'S	147° 25.892'E	1,830m, east



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SR20	Single Homestead	35° 4.871'S	147° 25.892'E	1,830m, east

Figure 4: Sensitive Residential Receptors Locations

- Sensitive Receptors
- Road
- Railway
- 1DP1213252
- Building Footprint
- Cadastre

N

0 250 500
Metres

Date: 23/05/2022
Author: JPH
Coordinate System: GDA 1994 MGA Zone 55

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2.2 Existing Facility

The existing abattoir was established in the 1940's. On 27 February 2003, the Minister for Planning approved DA-220-07-2002-i for significant upgrades and an expansion to the existing abattoir which included the following components:

- Demolishing some disused buildings;
- Reconstructing and expanding a major portion of the abattoir, including an administration and amenities building;
- Installing a bio-filter to capture and treat odour originating from the rendering plant and ancillary units, the DAF/Clarifier, Rotary Screen and Save-all;
- Augmenting and refurbishing the existing wastewater treatment system;
- Discharging 20% of effluent directly to the sewer system;
- Constructing an access road, internal roads, carparking, security gatehouse and associated infrastructure to service the abattoir;
- Increasing head of cattle per day production throughput; and
- Operating 24 hours a day, seven days a week.

The beef processing operations are summarised in the Figure 5. The main existing processes involving hazardous materials are included in the diagram.

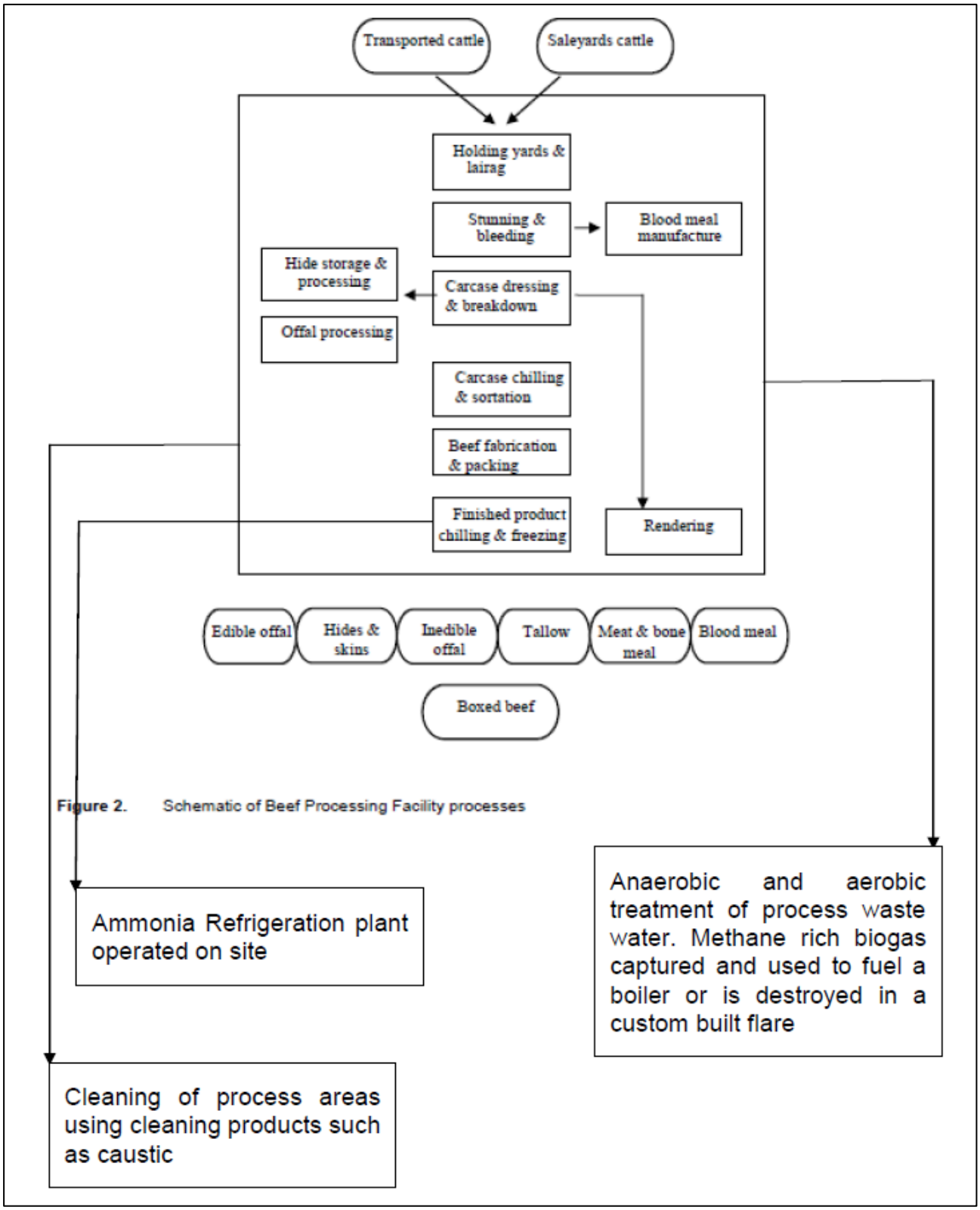


Figure 5 **Flowchart of Existing Facility**

2.3 Proposed Upgrade

The plate freezer/store is the primary facility upgrade relevant to this PHA. Details of the plate freezer/store upgrades are as follows:

- New plate freezer / store, 20.375m in height (inclusive of roof safety handrail), established over an area currently used for internal vehicle access and open-air storage.
- All required services to enable system operation, including:
  - refrigeration infrastructure upgrades and associated modifications to plant room; and
  - electrical infrastructure involving new substation.
- Building works to support plate freezers, conveyor systems and associated infrastructure.
- Manual blast options, including:
  - refurbishment of manual blast area (incl. replacement of EPS panel with PIR) to allow frozen carton storage and manual blast operation; and
  - auto blast tunnel.
- Realignment of the existing internal road to the staff car park in order accommodate the building footprint.
- Approximately 52 m of existing fence is to be removed and replaced with new fencing along the eastern boundary. The fencing will adopt the same style as the existing perimeter fence i.e. galvanised chain wire mesh with 3-strand barbed wire. The fence will be 2.1 m in height.
- Elevated and enclosed conveyor tunnel connecting the proposed plate freezer with the existing boning room.
- Ammonia vessel pit to support cooling of the freezer.

2.3.1 Ammonia Storage

The new plate freezer/ store building will be 20.375 m in height (inclusive of roof safety handrails), established over an area currently used for internal vehicle access and open-air storage. An ammonia extraction duct will be installed on the roof. The plate freezer/store will be a slab on ground, steel frame structure with a raised conveyor tunnel connecting to the existing facility and partially covering the ammonia storage vessel.

The ammonia storage vessel will be mostly embedded below the ground floor surface level on the southern side of the building with the main refrigeration piping wrapping around the eastern side of the structure. The pit will be 3.75m in depth, partially encased in a concrete wall and base. While the ammonia storage vessel is built into the concrete pit structure and surrounded by louvers it is not within an enclosed area. Screening fences will be provided on the outside of the main refrigeration piping on the eastern side. The extent of additional gross floor area (GFA) proposed by the modification is approximately 965m².

The existing ammonia stored on site totals 41.71 tonnes. The additional ammonia required for the development is 23.59 tonnes. The proposed total of ammonia on-site is 65.30 tonnes. A breakdown of the onsite components currently containing and proposed to contain ammonia and the volumes is provided in Table 2-2 and the location of this ammonia is shown in Figure 6.

Table 2-2 Existing and Proposed Anhydrous Ammonia Storage

Location	Component	Volume (Liquid Tonnes)
Existing Storage		
ER – Existing Engine Room	High side chiller	1.19
	Intercooler	1.49
	High side – drop out vessel	1.49
	Low side	1.19
	Condenser plant	2.00
ERCY – Existing Engine Room Courtyard	HP receiver – No. 1	0.26
	HP receiver – No. 2	0.20
	HP receiver – No. 3	0.93
EXPF – Existing Plate Freezer	Low side – plate freezer horizontal accumulator	3.27
	Carton plate freezers	18.00
ARCL – Facility-Wide	Air coolers	11.69
	Sub-Total	**41.71**
Proposed Storage		
PRPF – Proposed Plate Freezer	Plate freezer horizontal accumulator	5.21
	Carton plate freezers	18.38
	Sub-Total	**23.59**
	Total	**65.30**

Refer to Appendix C for the development plans, and Appendix H for the GBI Charge Projection Calculations.

A prior PHA was prepared for the facility in December 2008 and was provided as part of a Statement of Environmental Effects for an upgrade to the abattoir's wastewater treatment ponds (MOD 3 of DA 220-07-2002-i). Several hazard-related conditions were introduced into the consent after the MOD 3 assessment, among which is the current Condition 6.8(c) requiring 3-yearly Hazard Audits in accordance with the Department's HIPAP 5 (January 2011).

The PHA for MOD 3 focused on biogas recovery and not potential releases of ammonia from the refrigeration systems. The main hazards with potential for offsite impact identified were fire and explosion involving the biogas. No toxic gases were identified with the potential to cause injury or fatality at the residential or industrial areas. Based on correspondence received from a representative of the DPE (dated 29 June 2022), it is understood no prior PHA was conducted for the original 2002 facility development application.

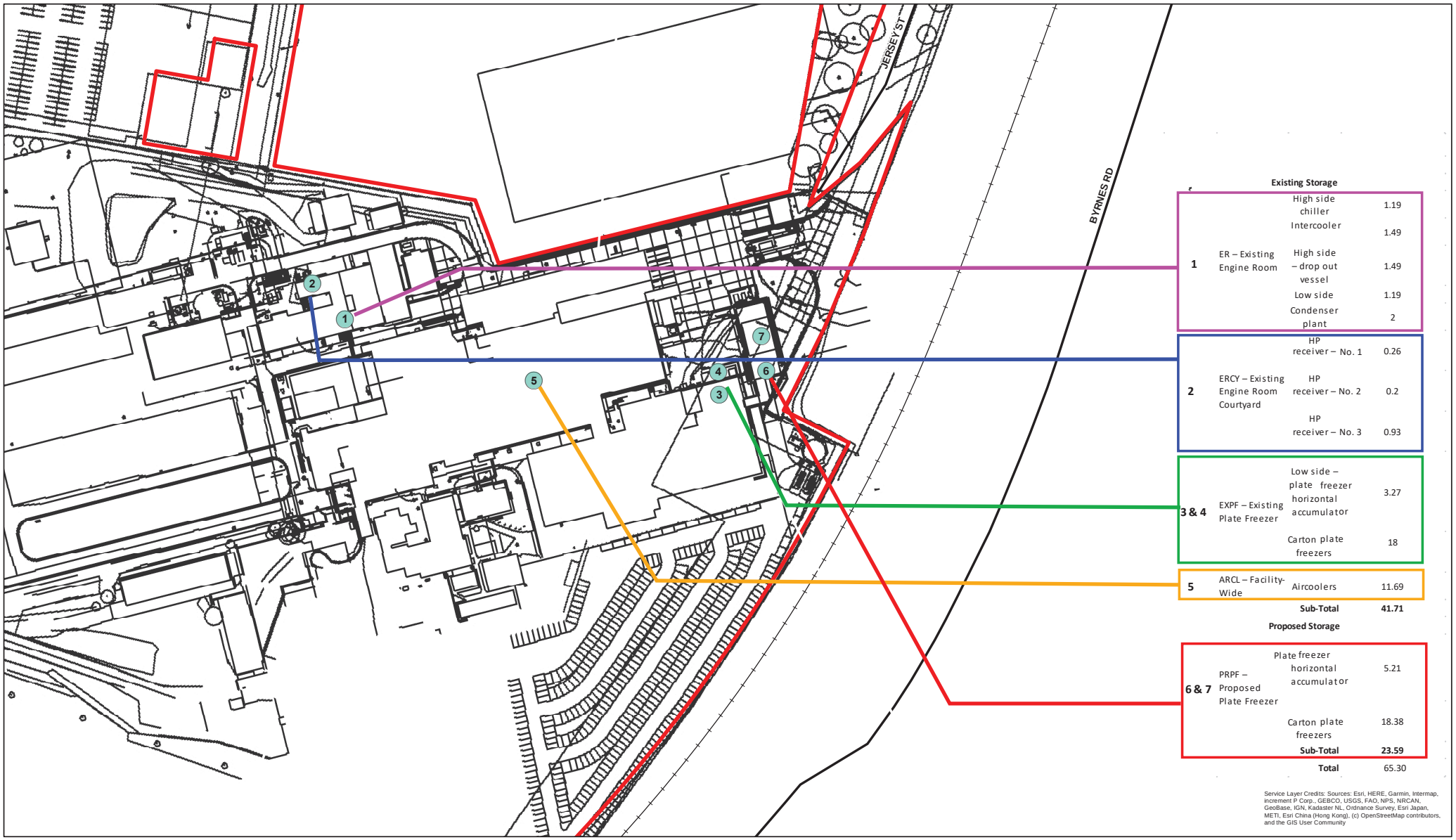
In accordance with the condition to complete facility hazard audits, in 2015 Pinnacle Risk Management was commissioned to undertake a hazard audit. The scope of the audit covered a critical examination of the hardware and safety management systems which exist in order to operate and maintain the facility for the purpose for which it was designed. The hazard audit identified the following:

- Teys is a company that is proactive in safety management;
- At the time of the audit, components of the safety management system were still being developed, e.g. the maintenance system was being updated. Other components of the safety management system, e.g. incident reporting, operating procedures and training, are typical of similar industries and appeared robust;

- Teys had produced risk assessments to identify the occupational health and safety hazards associated with the operations and implemented control measures to control the corresponding risks;
- The changes to the site since the previous hazard audit have no significant impacts to risk; and
- Previous risk studies indicated that off-site risk is acceptable for this site.

Recommendations presented in the audit report, were addressed by Teys. A new hazard audit has been completed in June 2022 to consider the implementation of the initial recommendations and any changes to risk. This updated hazard audit report was not available at the time of preparing the PHA.

The 2015 Hazard Audit Report included an approximation of the stored ammonia quantity onsite at the time to be approximately 35 tonnes equivalent. A subsequent calculation by GBI engineering (Appendix G) determined the actual quantity onsite to be 41.7 tonnes



Existing Storage			
1	ER – Existing Engine Room	High side chiller	1.19
		Intercooler	1.49
		High side – drop out vessel	1.49
		Low side	1.19
		Condenser plant	2
2	ERCY – Existing Engine Room Courtyard	HP receiver – No. 1	0.26
		HP receiver – No. 2	0.2
		HP receiver – No. 3	0.93
3 & 4	EXPF – Existing Plate Freezer	Low side – plate freezer horizontal accumulator	3.27
		Carton plate freezers	18
5	ARCL – Facility-Wide	Aircoolers	11.69
		Sub-Total	**41.71**
Proposed Storage			
6 & 7	PRPF – Proposed Plate Freezer	Plate freezer horizontal accumulator	5.21
		Carton plate freezers	18.38
		Sub-Total	**23.59**
		Total	65.30

Figure 6: Locations of Ammonia Stored or Circulating

- Features
- Road
- Railway
- 1DP1213252

N

0 20 40
Metres

Date: 11/05/2022
Author: JPH
Coordinate System: GDA 1994 MGA Zone 55

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Section 3 Regulatory Criteria Review

The new plate freezer/store will house a single dangerous substance (ammonia). Additional dangerous goods and/or hazardous materials are currently stored onsite and need to be considered for potential cumulative impacts. The majority of the dangerous goods are stored in shipping containers on a concrete pad outdoors (Figure 7). These are stored approximately 120 m away from the nearest component currently storing ammonia (existing engine room courtyard) and 315 m from the proposed additional ammonia storage. There are relatively small quantities of the following substances:

- Flammable gases, e.g., welding gas and spray paint;
- Corrosive materials, e.g., cleaning and sanitising agents, cooling water additives and boiler additives;
- Combustible liquids, e.g., compressor lubricants; and
- Flammable liquids, e.g., anti-corrosion coatings and marking ink.

Dangerous Goods and/or hazardous materials stored and used in larger quantities are:

- Ammonia for the refrigeration system (41.71 tonne in total). Ammonia is both a toxic and flammable gas;
- Oxygen and carbon dioxide (stored in purpose-built 20 te cryogenic tanks);
- Liquified Petroleum Gas (LPG) for forklift cylinder refueling (small bullet of 2.3 m^3 capacity);
- Magnesium hydroxide and alum stored in IBCs (intermediate bulk containers) for the wastewater treatment plant;
- Bulk cleaning agents such as sodium hydroxide. These are corrosive liquids, i.e., Dangerous Goods class 8, which have the potential to harm people, the environment and equipment (due to corrosion); and
- Methane rich biogas, i.e., a flammable gas, which is produced in the digesters and disposed of via a boiler or the flare. Therefore, fires and explosions are possible hazards associated with the biogas.

Each dangerous substance stored and used in the facility has been listed in Table 3-1 including the relevant UN number, Storage and Handling of Dangerous Goods Code of Practice (ADG Code) chemical class, storage quantity and the shortest distance from the point of storage or use to the site boundary of Lot 1 on DP1213252. Each of the listed substance is stored aboveground. Storage locations are shown in Figure 7.

Table 3-1 Hazardous Substances

Hazardous Substance	UN Number	ADG Class	Maximum Quantity and Storage Type	Distance to Site Boundary (approx..)
Bulk Storage of Dangerous Goods				
Ammonia Anhydrous	1005	Class 2.3 and Class 8	41.7 tonne	35 m east, 73 m north (closest)
Diesel	1202	Class 3	1,000 litres	180 m south-west
Liquid Petroleum Gas	1075	Class 2.1	2,841 litres	45 m north (at closest storage)
Carbon Dioxide	2187	Class 2.2	Unknown	120 m north

Hazardous Substance	UN Number	ADG Class	Maximum Quantity and Storage Type	Distance to Site Boundary (approx..)
Biogas (Methane at ~73%)	1971	Class 2.1	Varies	22 m south-east
Packaged Storage of Dangerous Goods				
Oxy Acetylene	1001	Class 2.1	250 KG	35 m north
Natural Gas	1971	Class 2.1	120 KG	Unknown
Argon Acetylene	-	Class 2.2	250 KG	35 m north
Unleaded Fuel	1203	Class 3	Minor	Unknown
Various Paints*	N/A	-	Minor	Varies
Methylated Spirits*	1170	Class 3	Minor	Varies

* Minor quantities stored in fit for purpose chemical storage containers.

Anhydrous Ammonia is a hazardous and dangerous material that is classified as a Class 2.3 toxic gas and Class 8 corrosive substance in accordance with the ADG Code (CoA 2019). Ammonia is a colourless gas with a strong pungent smell, similar to household ammonia products (MDA 2022). Refrigerant grade ammonia is typically 99.95% pure ammonia (USDL 2022). Standard safety data indicates that it is a flammable gas that may explode if heated; however, ignition is difficult in air as flame temperature is typically lower than ignition temperature (~650°C) (MDA 2015) (refer to Section 5.1.5). Anhydrous Ammonia can also cause severe skin burns, eye damage with direct contact and respiratory irritation and toxic effects if inhaled.

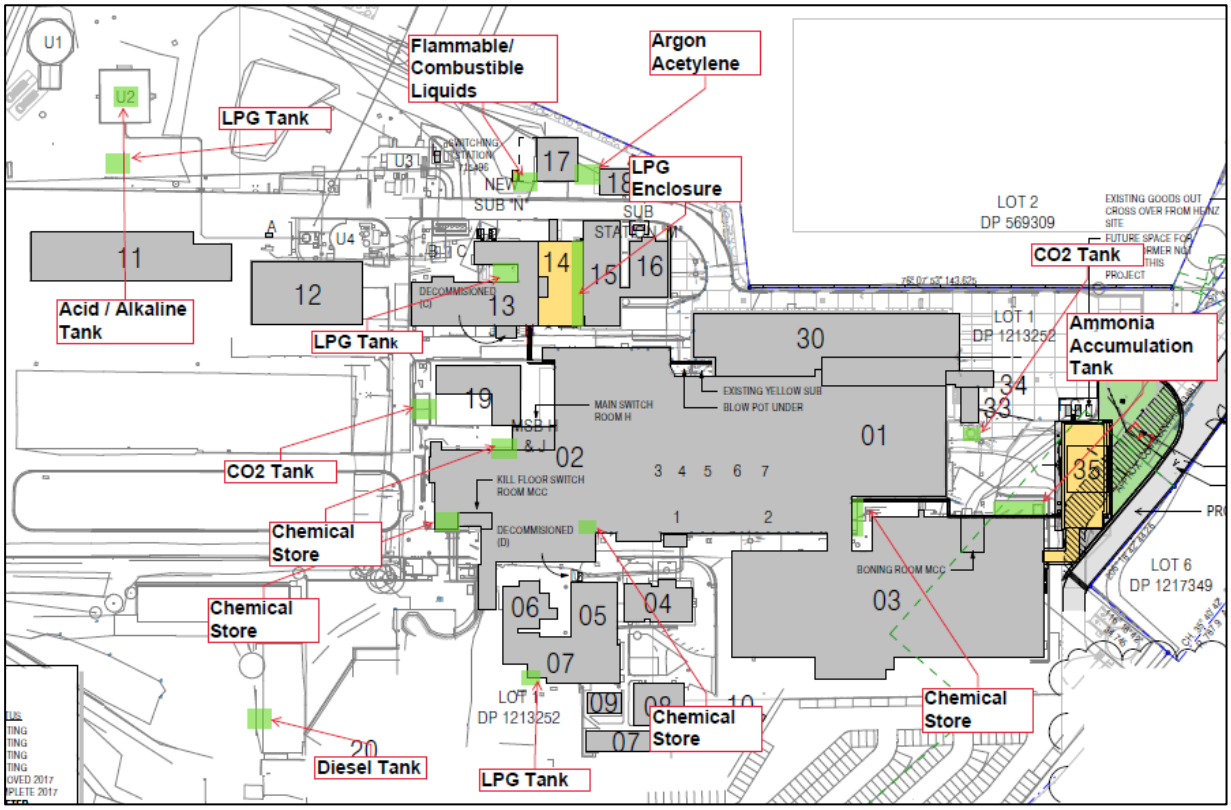


Figure 7 **Existing Dangerous Goods Storage Locations**[2]

[2] Note – biogas (methane) storage location not shown in figure as it is located outside the area presented.

3.1 State Environmental Planning Policy 33

3.1.1 Overview

State Environmental Planning Policy (SEPP) (Resilience and Hazards) 2021 (formerly SEPP 33 applies to all industries that are considered to be a potentially hazardous industry or potentially offensive industry. Through the policy, the permissibility of a proposal to which the policy applies is linked to its safety and pollution control performance.

Activities that involve handling, storing or processing of dangerous goods in certain quantities and which in the absence of locational, technical or operational controls may create an off-site risk or offence to people, property or the environment. Such activities would be defined as potentially hazardous or potentially offensive.

3.1.2 Risk Screening

SEPP (Resilience and Hazards) 2021 defines 'hazardous industry', 'hazardous storage establishment', 'offensive industry' and 'offensive storage establishment' for all NSW planning instruments, existing and future. The definitions enable decisions to approve or refuse a development to be based on the merit of proposal. In accordance with correspondence from the NSW DPE (dated 4/3/22) the DPE considers ammonia storage as potentially hazardous under repealed SEPP 33, given the additional volume of ammonia exceeds the 5-tonne threshold listed in Appendix 4, Table 3 of the Hazardous and Offensive Development Application Guidelines – Applying SEPP 33. Table 2 of SEPP 33 Guidelines also contains screening thresholds for the transportation of substances.

Anhydrous Ammonia will be transported to site for direct filling of the horizontal accumulator. Anhydrous Ammonia is typically transported under pressure as a liquefied gas either in tank transport trucks or nurse wagons. The transport of anhydrous ammonia is regulated under the ADG Code.

The refrigeration system cycles the ammonia for reuse and, following the initial transport to fill the storage tank, minimal top-up shipments will be required. The transportation screening threshold for Class 2.3 hazardous materials in the SEPP 33 Guideline (Table 2) is as follows:

- Vehicle Movements: >100 cumulative annual movements or >6 peak weekly movements; or
- Minimum Quantity (per load): 1 tonne for bulk or 2 tonnes for packages.

Shipments for the facility will not exceed 100 movements annually; however, the storage size of the supplier vehicles has not yet been confirmed.

It is expected to involve 24 x 1 tonne tanks delivered to site over 2 truckloads. Each tank will be discharge into the new plate freezer system one at a time progressively as commissioning processes. This is lower risk than a 20-tonne road tanker and dumping that into the system in a single delivery. Therefore, for the purpose of this assessment it is assumed that either the peak weekly movement threshold or the minimum bulk 1 tonne transport load will be exceeded as part of the initial filling of the storage vessel.

As per the DPE determination, the preliminary risk screen using the threshold values listed in Appendix 4, Table 3 of the SEPP 33 Guideline determines that the proposed storage triggers a PHA. A PHA has been prepared for the Anhydrous Ammonia proposed as part of the cold storage and plate freezer/store complex. In accordance with the SEPP 33 Guideline, a PHA may be done qualitatively and/or quantitatively, depending on the circumstances of the proposal and its location (SEPP 33 Guideline). In accordance with the SEPP 33 Guideline (p. 16), a qualitative PHA may be sufficient in the following circumstances:

- Where the materials are relatively non-hazardous (for example, corrosive substances and some classes of flammables);
- Where there are no major worst-case consequences;

- Where the technical and management safeguards are self-evident and readily implemented; and
- Where the surrounding land uses are relatively non-sensitive.

From the initial risk screen and site assessment it has been determined that there are no major worst-case consequences, the technical safeguards can be readily implemented and the surrounding land uses are non-sensitive. Therefore, a semi-quantitative PHA has been undertaken, with the qualitive assessment supplemented with quantitative hazard scenario modelling.

3.2 Work Health and Safety Regulation 2017

The *Work Health and Safety Act 2011* and *Work Health and Safety Regulations 2017* (WHS Regulation) establishes requirements for the safe use, storage and handling of hazardous chemicals as classified under the Globally Harmonised System of Classification and Labelling of chemicals (the GHS). This classification system includes chemicals classified as dangerous goods and certain combustible liquids.

The WHS Regulation requires a person conducting a business or undertaking (PCBU) to placard the workplace, prepare a manifest and notify the regulator where specified quantities of certain hazardous chemicals exceed threshold amounts. Ammonia is a Class 2.3 dangerous good under the GHS. The placard and manifest quantity for gases under pressure are identified in Schedule 11 of the WHS Regulation (refer to Table 3-3). The dangerous goods manifest and appropriate signage are currently being prepared.

The proposed storage of Ammonia is 23.59 tonnes additional and 65.30 tonnes in total which exceeds the placard quantity of 50 L. Placards are special types of signage required at workplaces that store hazardous chemicals above the placard quantities. Placards provide warnings about the stored hazardous chemicals and contain specific information for emergency service personnel.

Table 3-2 WHS Placard and Manifest Quantities

Hazardous Substance	Placard Quantity	Manifest Quantity	ADG Code Classification
Gases Under Pressure			
Acute toxicity, categories 1, 2, 3 or 4 Note 1—Category 4 only up to LC50 of 5000 ppm*	50 L	500 L	Class 2.3
Skin corrosion categories 1A, 1B or 1C	50 L	500 L	Class 2.3

Note: * ppm = parts per million

Major Hazard Facilities (MHFs) are sites that store above threshold quantities of chemicals listed in Schedule 15 of the WHS Regulation or are determined as a MHF after an inquiry process. Obligations are also placed on facilities where 10% of the threshold quantity is exceeded. The threshold quantity for Ammonia as per Schedule 15 of the WHS Regulation is 200 tonnes. As the facility only proposes to store up to 65.3 tonnes (of combined Class 2.3 substances), this threshold will not be exceeded.

3.3 NSW Hazardous Industry Planning Advisory Paper

3.3.1 Overview

Chapter 3 of SEPP (Resilience and Hazards) 2021 states that PHAs are to be prepared in accordance with the current circulars or guidelines published by the Department of Planning. While SEPP 33 has been repealed and the provisions replaced by SEPP (Resilience and Hazards) 2021, there have been no updates to relevant guidelines. As such, it has been taken that risk assessments are to be prepared in accordance with the following NSW HIPAPs:

- NSW HIPAP No. 4 (Risk Criteria for Land Use Safety Planning) suggest the risk assessment criteria that should be considered when assessing the land use safety implications of industrial development;
- NSW HIPAP No. 5 (Hazard Audit Guidelines) sets out the recommended approach to site inspections and hazard audits (note – while a site inspection was completed to inform the PHA, verification actions from the 2015 Hazard Audit is excluded); and
- NSW HIPAP No. 6 (Guidelines for Hazard Analysis) describes each step in the hazard analysis process (risk assessment process), as shown in Figure 8. Proposed control measures are also included for significant potential risks and may be considered as part of risk management for the proposal. The hazard analysis process is identified in Section 4.

3.3.2 Risk Criteria

The HIPAP No. 4 suggested injury and irritation risk criteria for toxic gas exposure are:

- Irritation – Toxic concentrations in residential and sensitive use areas should not cause irritation to eyes or throat, coughing or other acute physiological responses in sensitive members of the community over a maximum frequency of 50 in a million per year (50×10^{-6});
- Injury – Toxic concentrations in residential and sensitive use areas should not exceed a level which would be seriously injurious to sensitive members of the community following a relatively short period of exposure at a maximum frequency of 10 in a million per year (10×10^{-6}); and
- Fatality – Residential developments and places of continuous occupancy should not be exposed to individual fatality risk levels in excess of one in a million per year (1×10^{-6}). For industrial sites the risk level should be 50 in a million per year (50×10^{-6}).

Establishing criteria for a particular chemical necessitates determination of the terms 'seriously injurious, 'sensitive', 'relatively short' and 'irritation'. For this PHA the following interpretations are made:

- Irritation – Occurs due to toxic exposure to the Acute Exposure Guideline Level 1 (AEGL-1) concentration. AEGL-1 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation or certain asymptomatic, non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure;
- Serious Injury – Occurs due to toxic exposure to the AEGL-2 concentration. AEGL-2 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape; and
- Fatality – Occurs due to toxic exposure to the AEGL-3 concentration. AEGL-2 is the airborne concentration of a substance above which it is predicted that the general population could experience life-threatening health effects or death.

AEGL values are available for a range of exposure durations from 10 mins to 8 hours (refer to Table 5-1 and Table 5-2). Given the 'short duration' component in the definition, the 10 minute and 60 minute AEGL values, which align with the modelling display output, have been used. It should be noted that while the model may show an AEGL (60 min) concentration extent of the plume it does not mean that area is exceeds the AEGL level. The timeframe of exposure determines whether an AEGL limit is exceeded and this has been interrogated in the model.

Section 4 Preliminary Hazard Analysis

4.1 Hazard Analysis Process

HIPAP No. 6 (Hazard Analysis) describes the nature of each step in the hazard analysis process. This can also be referred to as a risk assessment process. Proposed control measures are also included for significant potential risks and may be considered as part of risk management for the proposal. The main elements of hazard analysis are:

- Identification of the nature and scale of hazards at the facility, and the selection of representative worst-case incident scenarios;
- Analysis of the consequences of these incidents on people, property and the biophysical environment through quantitative modelling;
- Evaluation of the likelihood of such events occurring and the adequacy of safeguards through a risk assessment framework as per HIPAP No. 6;
- Consideration of potential cumulative impacts with existing stored chemicals onsite;
- Calculation of the resulting risk levels of the facility; and
- Comparison of these risk levels with established risk criteria and identification of opportunities for risk reduction.

Figure 8 below provides a schematic of the hazard analysis process.

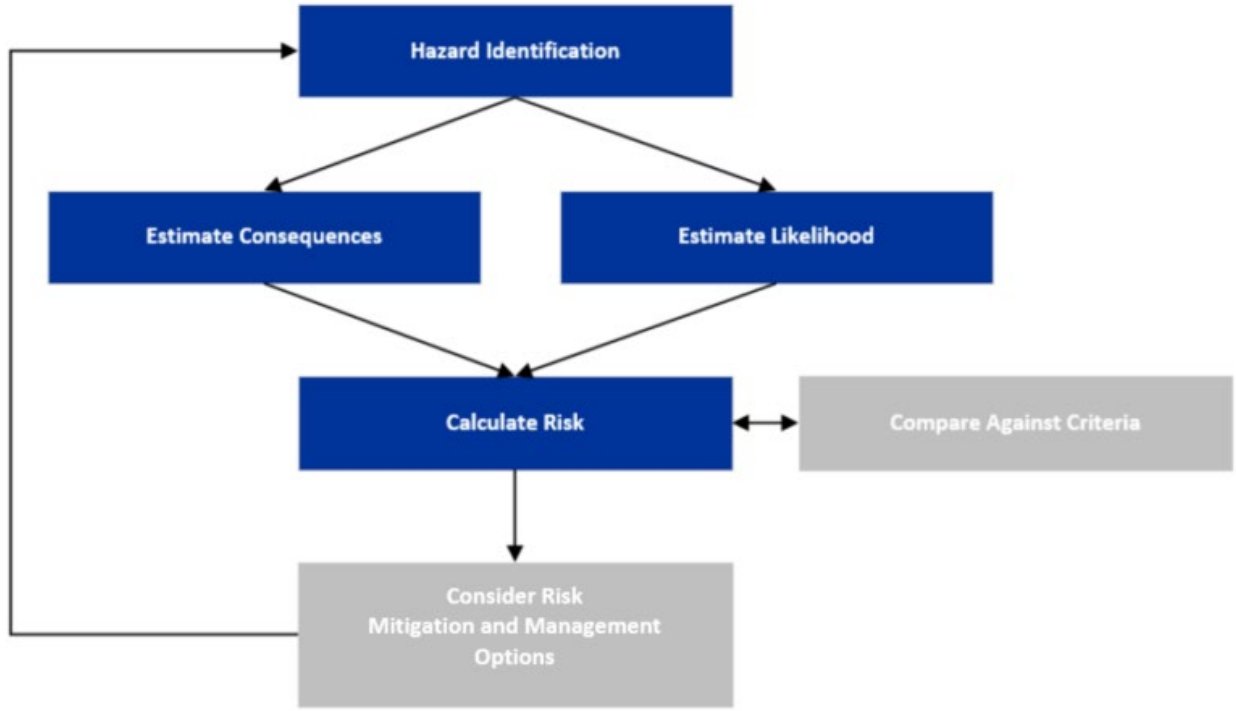


Figure 8 Methodology for Hazard Analysis

4.2 Hazard Analysis and Methodology

4.2.1 Sensitive Receptors

Sensitive land uses refer to residential or other more sensitive land uses. All uses that are not sensitive uses are considered to be 'other uses'. The surrounding land is industrial and the closest resident to the anhydrous ammonia or storage is at 82 Bomen Road, Cartwrights Hill (SR17 on Figure 4) approximately 740 m to the west north-west of the facility (approximately 1,040 m from the proposed ammonia storage). The SR17 receptor is separated from the proposed plate freezer/store by other industrial uses. The SR1 receptor is 930 m from the facility but will be the closest sensitive receptor to the ammonia storage location at 1,010 m to the south-east. All of the closest sensitive receptors to Lot 1 on DP1213252 are residential, with the majority of these being situated to the south and west. To the north the closest sensitive receptor to the facility (SR18) is 1,590 m.

4.2.2 Hazard Identification

The hazard identification includes a review of potential hazards associated with the proposed refrigeration systems. The hazard identification includes an identification of possible causes of potential incidents and their consequences to public safety and the biophysical environment, as well as an outline of the proposed operational and organisational safety controls required to mitigate the likelihood of the hazardous events from occurring. Table 4-7 lists the potential causes of the incidents outlined in Section 4.2.3.

The chemical that is the subject of this study is ammonia. Any uncontrolled loss of containment could present a major risk to the workforce, persons or animals near the plant. Given the substance would release directly as a gas, or liquid that evaporates to a gas and dissipates, the potential for the gas to be a hazard to other biophysical aspects (e.g., terrestrial or aquatic flora) is considered minimal (refer to Section 5.2).

Mixing of ammonia with several chemicals can cause severe fire hazards and/or explosions. Ammonia in sealed environments can also explode in the heat of a fire. As such, the primary hazard from any release of these substances is physiological to persons and animals within areas of high concentration and where that concentration lingers, plus the flammability/explosive potential of ammonia.

A review of the plant process diagrams, storage vessel specifications, proposed site layout and the literature was undertaken to identify potential major hazard scenarios.

Table 4-1 Potential Major Hazardous Incident Scenarios

Area	Scenario Description	Hazardous Impact Potential		Scenario Description	Typical Causes	Controls and Safeguards	PHA
		Toxic	Flammable				
Ammonia Vessel Storage Pit	Large release of ammonia from storage vessel in a gaseous form assuming puncture or failure occurs above the liquid level. This is considered as the tank is >50% set within a concrete base and (with exception of major maintenance overhaul – e.g. once per 3-5 years) the liquid level will be lower than the surface level <50%) See Scenarion 1 and 3. A 10.16 cm (101.6 mm) diameter hole with release rate of kilograms per minute. Scenario 3 accounts for potential liquid leak and puddle. This scenario assumes a tank puncture from equipment such as a forklift which has a standard fork size of 10.16 cm x 5.08 cm).	Yes	Yes	Release of large quantity of ammonia from storage vessel with release rate of kilograms per minute	Primary: External events (including vehicle crash, vandalism, earthquake) Secondary: Generic mechanical failures (including corrosion, impact, leaks from broken fittings or flanges) (for mechanical is would typically require both mechanical and operation failure to produce significant event).	- Bunding/ containment - High and low level indicators - Storage vessel fitted with isolation valves, pressure relief valves in accordance with AS 2022 - Leak detection by automatic sensing devices (ppm and LEL detection) - Weekly Plant Inspections - Regular Corrosion and Integrity Inspections - Routine Maintenance & Testing - Correct Working Procedures - PLC and SCADA automation control systems - Site Emergency Response Plan and associated training. - Physical impact protection barriers	Yes
	Release of small quantity of ammonia from distribution piping or plant (e.g. < 100 ppm to a few kg/day)	Yes	No	Release of small quantity of ammonia from distribution piping or plant (e.g. < 100 ppm to a few kg/day)	Generic mechanical failures (including corrosion, impact, leaks from fittings and flanges)	- As per above controls	No

Area	Scenario Description	Hazardous Impact Potential		Scenario Description	Typical Causes	Controls and Safeguards	PHA
		Toxic	Flammable				
Ammonia Distribution Piping	Release of large quantity of ammonia from distribution piping. See Scenarion 2. A 10.16 cm (101.6 mm) diameter with a release rate of kilograms per minute	Yes	Yes	Release of large quantity of ammonia from storagevessel	Primary: External events (including vehicle crash, vandalism, earthquake) Secondary: Generic mechanical failures (including corrosion, impact, leaks from fittings and flanges) (highest risk is from direct physical impact)	- High and low level indicators - Storage vessel fitted with isolation valves, pressure relief valves in accordance with AS 2022 - Leak detection by automatic sensing devices (ppm and LEL) - Weekly Plant Inspections - Regular Corrosion and Integrity Inspections - Routine Maintenance & Testing - Correct Working Procedures - PLC and SCADA automation control systems - Site Emergency Response Plan and associated training. - Physical impact protection barriers - Vehicular movement and speed controls	Yes
	Release of small quantity of ammonia from distribution piping (e.g. < 100 ppm to a few kg/day)	Yes	No	Release of small quantity of ammonia from distribution piping (e.g. < 100 ppm to a few kg/day)	Generic mechanical failures (including corrosion, impact, leaks from fittings and flanges)	- As per above controls	No

Area	Scenario Description	Hazardous Impact Potential		Scenario Description	Typical Causes	Controls and Safeguards	PHA
		Toxic	Flammable				
Plate Freezer Room, Engine Room and Pump Pit	Ammonia leak in the plate freezer, engine room or pump pit. Sensors trigger suction valve on stacks to evacuate ammonia back to accumulator or release via emergency extraction duct on roof. Volume of release significantly less than the first and third scenarios. High ppm and or LEL will alarm, and risk assess (including fault signals/alarms) to actuate ammonia extraction fan and close off the liquid supply. This allows residual ammonia in the leaky plate to return to the accumulator vessel prior to manually shutting the suction return stop valve for the plate stack.	Yes	Yes (only likely to reach flammable level internally)	Ammonia leak in the plate freezer, engine room or pump pit. Sensors trigger suction valve on stacks to evacuate ammoia back to accumulator or release via emergency extraction duct on roof. Volume of release significantly less than the first and third scenarios)	Generic mechanical failures (including corrosion, impact, leaks from fittings and flanges)	- Exhaust fan vents to ammonia extraction duct - Suction valve on stacks evacuate plate freezer ammonia to accumulator vessel if stack leak - High and low level indicators - Storage vessel fitted with isolation valves, pressure relief valves in accordance with AS 2022 - Leak detection by automatic sensing devices (ppm and LEL) - Weekly Plant Inspections - Regular Corrosion and Integrity Inspections - Routine Maintenance & Testing - Correct Working Procedures - PLC and SCADA automation control systems - Areas are covered by Fire Sprinkler system	No
Ammonia Vessel Loading Bay	Ammonia leak from the transfer of vehicle tanker into the fixed vessel (failure rate for transport of ammonia is 0.6 to 1 x 10^{-6}, leaks of ammonia per delivery) (UK HSE 2017)	Yes	No	Ammonia leak from the transfer of vehicle tanker into the fixed vessel	Generic mechanical failures (including, impact, hoses and fittings Human error.	- Transfer controls - Personnel safety equipment - Shutoff valve on the transport vehicle.	No

The hazardous properties of anhydrous ammonia are summarised in Appendix E. The Table 4-2 provides more detail on the physical effect hazard from exposure to ammonia concentrations under 1,500 ppm. A standard safety data sheet for anhydrous ammonia is provided in Appendix F.

4.2.3 Hazardous Scenarios Modelled

Based on a review of the storage and distribution systems for the ammonia, three scenarios were selected for quantitative modelling:

- Scenario 1 – A worst-case scenario involving a 101.6 mm hole in the wall of the high-pressure tank or a major piping/valve failure releasing gaseous ammonia. In this scenario a non-significant amount of liquid ammonia may evaporate from the tank; however, this is considered to be insignificant to the gaseous release as the liquid content of the tank would remain at low temperature;

- Scenario 2 – A pipe or valve connected to the storage vessel breaks (assumed 101.6 mm hole) causing release of the gaseous ammonia. This accounts for complete mechanical failure of a valve[3] or potential puncture of the external piping on the eastern side of the facility from direct impact; and

- Scenario 3 – The final scenario models a leak from the storage tank or attached return feed piping that feeds a release of ammonia liquid into the ammonia vessel pit creating a puddle that increases to a maximum of 2 m^2 and 2.5 cm in depth. The design of the pit and committed drainage features is the limiting factor in the potential size of the puddle. As per Table 4-7 and Section 5.1.5 the concrete pit floor will be contoured to drain directly into a dry covered sump with no external piping.

Additional details describing each scenario can be found in Sections 5.1.3 through 5.1.5. Because ammonia has a high minimum ignition energy (100 MJ) and a narrow range of explosive concentration (16% to 25%), toxic effects of ammonia releases are the primary hazard considered in the quantitative risk assessment. Nevertheless, each of the scenarios include a limited flammable threat zone whereby if the conditions were met ignition could occur. The flammable area of the vapour cloud has therefore been considered in the scenarios. The toxic gas scenarios considered were as follows.

4.2.4 Consequence Analysis

Consequence analysis was used to quantify the potential for the hazardous incidents identified to cause injury or fatalities, damage property, or harm the biophysical environment. Quantitative modelling has been undertaken for the three scenarios outlined above.

CDM Smith analysed the risks using the ALOHA program which is the air modelling element of Computer-Aided Management of Emergency Operations (CAMEO) software suite, a program suite that assesses the health and safety impacts of emergency releases. It was produced as a joint effort of the US Environmental Protection Agency (US EPA) and the US National Oceanic and Atmospheric Administration (NOAA). It has been successfully used for decades and is currently in revision 5.4.7. The Australian Government has not produced any modelling or endorsed specific modelling packages. The CAMEO program is recognised and supported within industry and ALOHA is widely used for the purposes required in this assessment.

Modelling was undertaken for each major hazard scenario in uncommon steady climatic conditions (Stability Class F) and more common (unsteady) weather conditions (Stability Class D). Atmospheric stability is defined in terms of the tendency of a parcel of air to move upward or downward after it has been displaced vertically by a small amount (Woodward 1998). Class F is reflective of a stable atmosphere which tend to suppress vertical updrafts and reduce turbulence intensity, this is the worst-case meteorological condition in a toxic gas release situation. Class D is reflective

[3] Small valve shaft and compressor shaft leaks are more common than this scenario; however, they would typically only release <100 ppm to several kilograms per day and are not considered a risk for offsite release.

of the normal or typical weather conditions, these were determined through an analysis of historic Bureau of Meteorology records for the Wagga Wagga Weather Station (Site Number 072150).

4.3 Site Inspection

An inspection of the facility was completed on 19 April 2022 with a representative from the CDM Smith PHA team (Andrew Gray) (refer to Appendix A) and four representatives from Teys. Positions titles for the company representatives are listed below and were appropriate to address questions raised during the inspection.

- Site Manager;
- Operation and Maintenance Manager;
- Project Engineer; and
- Former Site Safety Manager.

In accordance with HIPAP No 6 (Hazard Analysis) and the Multi-level Risk Assessment Guideline, the purpose of the site inspection was to inform the identification of hazards to be considered in the assessment and to verify implementation of actions from the 2015 Hazard Audit. While the site inspection followed a systematic and comprehensive approach in accordance with the principles set out in Section 1.2 of HIPAP No.5, it focused on the aspects raised in the 2015 Hazard Audit to primarily verify implementation of recommendations and where relevant implications for risks considered in the PHA. Following the site visit the verification of actions from the 2015 Hazard Audit was excluded from the scope.

CDM Smith representative inspected the existing ammonia system, questioned staff on safety processes/protocols and plant operation and inspected the location of proposed upgrades to further inform hazard identification.

4.4 Ammonia Health Effects

Ammonia is an irritant gas and the respiratory tract is the most sensitive target of inhaled ammonia, thus respiratory effects are the most critical outcome following exposure to ammonia and inhalation (US EPA 2016; ATSDR 2004). In accordance with the Queensland Workplace Health and Safety Emergency Planning for Ammonia-Based Refrigeration Systems Guide 2018, exposure to anhydrous ammonia can have the following health effects:

- Up to 100 ppm – no adverse effect for the average person with no deliberate exposure for long periods permitted;
- 400 ppm – immediate nose and throat irritation with no serious effect after 30 minutes to one hour;
- 700 ppm – immediate eye irritation with no serious effect after 30 minutes to one hour;
- 1,700 ppm – convulsive coughing; severe eye, nose and throat irritation; could be fatal after 30 minutes;
- 2,000-5,000 ppm – convulsive coughing, severe eye, nose, and throat irritation; could be fatal after 15 minutes; and;
- Over 5,000 ppm – respiratory spasm, rapid asphyxia and fatal within minutes.

In addition to the Queensland guidelines, CDM Smith reviewed and summarised available literature on ammonia toxicity with respect to the ammonia concentration, exposure time and severity of effect (dose-response characterisation) (Table 4-2). These consist of regulatory guidelines, emergency response plan guidance and occupational guidelines.

As identified in the Emergency planning for ammonia-based refrigeration systems guide 2018 (WHSQ 2018):

> *Anhydrous ammonia destroys delicate respiratory tissue in the lungs causing pulmonary and respiratory distress. The effect on the eye depends on whether a spray or gas is involved, and may range from mild irritation to eye destruction (WHSQ 2018). Severe ammonia inhalation injury can be followed by a persistent asthma-like syndrome and airway hyper-responsiveness. Moist and sweaty skin is prone to ammonia chemical burns. As an alkali, ammonia causes tissues to liquefy where anhydrous ammonia burns keep spreading until the chemical is diluted. As well as liquefaction, supercooled anhydrous ammonia spray causes a freeze-dry effect like frostbite when it hits skin and is also capable of freezing clothing to skin.*

Table 4-2 Summary of Public and Occupational Exposure Criteria

Effect	Conc. (ppm)	Reported effects of exposure	Reference
No symptoms expected (Increasing complaints of offensive odour)	0.1	US EPA and ATSDR ambient air Chronic Guideline Value – Annual Average (recommended AGVc[F2]). Based on a point of departure for irritation NOAEL of 9.2 ppm (no statistically significant difference in prevalence of respiratory symptoms reported between exposed and control groups).	R1
	0.48	Current WA 1-hour air guideline value for ammonia (0.48 ppm) appears to be based on NSW EPA impact assessment criteria which is extrapolated from the 3-minute "Design Criteria" from the Victorian Government Gazette (2001).	R10
	2	ATSDR ambient air Acute Guideline Value – 1 hour (recommended AGVa[F2]) Based on a point of departure for irritation - LOAEL of 50 ppm	R2
	4.5	OEHHA ambient air Acute Guideline Value – 1 hour Based on a point of departure of 13.6 ppm extrapolated from benchmark dose modelling (expected to produce a response rate of 5%; BC_{05}) for lethality effects to animals.	R3
Increasing risk of symptoms (Respiratory and nervous system)	20	European Union (SCOEL) and German (MAK) occupational exposure limit time-weighted average (TWA-8h). Based on evidence of irritation of mucous membranes at 50 ppm.	R5/R6
	25	Safe Work Australia (SWA) and ACGIH occupational exposure limit time-weighted average (TWA-8h). Based on potential for eye/respiratory tract irritation.	R4/R7
		ERPG-1 – 1 hour (Emergency Response Planning Guideline) Based on irritation/odour. The AIHA concluded that 25 ppm is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1-hr without experiencing or developing effects other than mild, transient health effects or without perceiving a clearly defined objectionable odor.	R9
	30	AEGL-1 – 8 hours (Acute Exposure Guideline Levels) Based on mild irritation.	R8
	35	Safe Work Australia (SWA) and ACGIH occupational exposure limit Short-Term Exposure Limit (STEL). Based on potential for eye/respiratory tract irritation.	R4/R7
	50	European Union (SCOEL) and German (MAK) Short-Term Exposure Limit (STEL)	R5/R6
	110	AEGL-2 – 8 hours (Acute Exposure Guideline Levels) Based on irritation of the eyes and throat and the urge to cough.	R8
	150	ERPG-2 – 1 hour (Emergency Response Planning Guideline) Based on eye and upper respiratory sensations and/or irritation. The AIHA concluded that 150 ppm is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1-hr without experiencing or developing irreversible or other serious adverse health effects.	R9

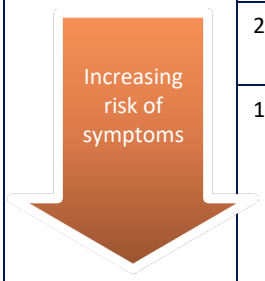
Effect	Conc. (ppm)	Reported effects of exposure	Reference
	160	AEGL-2 – 1 hour (Acute Exposure Guideline Levels) Based on irritation of the eyes and throat and the urge to cough.	R8
	220	AEGL-2 – 30 minutes (Acute Exposure Guideline Levels) Based on irritation of the eyes and throat and the urge to cough.	R8
	1,500	ERPG-3 – 1 hour (Emergency Response Planning Guideline) Based on lethality data in animals. The AIHA concluded that nearly all individuals could be exposed to 1,500 ppm for up to 1-hr without experiencing or developing life-threatening health effects.	R9

Table Notes:

R1 US EPA (2016). Toxicological Review of Ammonia Noncancer Inhalation [CASRN 7664-41-7], Integrated Risk Information System, U.S. Environmental Protection Agency.

R2 ATSDR (2004). Toxicological profile for ammonia. US Department of Health and Human Services. Agency for Toxic Substances and Disease Registry.

R3 OEHHA (2008). Technical Supporting Document for Noncancer RELs, Appendix D2 and Appendix D3.

R4 ACGIH Documentation of the Threshold Limit Values and Biological Exposure Indices (1991), American Conference of Governmental Hygienists Inc. Cincinnati, Ohio 1991.

R5 MAK (2009). Ammonia MAK Value Documentation, 1999. Published in the series Occupational Toxicants, Vol. 13 (1999)

R6 SCOEL (1992). Recommendation from the Scientific Expert Group on Occupational Exposure Limits for ammonia. SEG/SUM/20 1992

R7 Safe Work Australia (2017). Exposure Standards for Atmosphere Contaminants in the Occupational Environment. Hazardous Chemical Information System (HCIS). Accessed online December 2017. http://hcis.safeworkaustralia.gov.au/ExposureStandards

R8 NAP (2007). Acute Exposure Guideline Levels for Selected Airborne Chemicals: Volume 6. National Academies Press (NAP) Committee on Acute Exposure Guideline Levels, Committee on Toxicology, National Research Council ISBN: 0-309-11214-1

R9 AIHA (2014). Emergency Response Planning Guideline (ERPG) Ammonia. American Industrial Hygiene Association (AIHA) Guideline Foundation 2014.

R10 Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (2005)

[F1]AGVc – Acute air guideline recommended by CDM Smith (2017)

[F2]AGVa – Acute air guideline recommended by CDM Smith (2017)

4.5 Risk Assessment Process

To quantify the potential for a given option to cause harm, a preliminary risk assessment process was undertaken with reference to the AS/NZS ISO 31000:2018 criteria. The risk assessment was completed after due consideration of the following:

- The likely frequency of the potential hazard occurring as a result of a given management option;

- Indication of the cumulative impacts to surrounding land uses;
- The duration of any identified hazard;
- The affects and rate of usage of the hazardous substance to be used, stored, processed or produced by a management option;
- Public liability of the State for private infrastructure and visitors of public land; and
- Processes, types of machinery and equipment used within the Project that relate to the hazard and impact.

The risk assessment criteria in AS/NZS ISO 31000 establishes a method for identifying risk profiles through combining the "likelihood" of a hazard or impact occurring with the "consequences" of a hazard or impact occurring, in terms of its effect on the health and safety of personnel and to the environment. Definitions applicable to the risk assessment process as described in this document are outlined in Table 4-3.

Table 4-3 Definitions for Assessment of Hazard and Risk

Term	Definition
Hazard	Something with the potential to cause environmental harm. This can include hazardous substances, plant and equipment, work processes or other aspects of the surrounding environment.
Likelihood	The chance or probability of an event resulting in an impact occurring.
Consequence	How much harm the impact could have, how many people could be affected and the duration of the harm.
Unmitigated Risk	The likelihood that a harmful consequence might result when exposed to the hazard without implementation of the proposed mitigation measures.
Residual Risk	The likelihood that a harmful consequence might result when exposed to the hazard with the effective implementation of the proposed mitigation measures.

4.6 Likelihood Assessment

A qualitative assessment of the possible event frequency was undertaken to assess the likelihood of an impact occurring, based on the ratings included in Table 4-4.

Table 4-4 Ratings for Likelihood of Occurrence

Probability Rank	Description	Description
5	**Almost certain**	Will almost certainly occur. Has a 95% or greater chance of occurring within a 12-month period.
4	**Likely**	Probably will occur. Has a 70% to 95% chance of occurring within a 12-month period.
3	**Possible**	May possibly occur. Has a 30% to 70% chance of occurring within a 12-month period.
2	**Unlikely**	Could possibly occur. Has a 5% to 30% chance of occurring within a 12-month period.
1	**Rare**	Only likely to occur in exceptional circumstances. Has a 5% or less chance of occurring within a 12-month period.

4.7 Consequence Assessment

The potential level of consequence of a management and treatment option resulting in impacts to the predefined criteria were assessed in accordance with the definitions shown in Table 4-5. Each outcome has been individually assessed where a hazardous incident may have multiple impacts.

Table 4-5 Consequence Rating

Score	Maximum Potential Consequence (Realistic)	
	Description	Safety and Health of People
5	**Catastrophic**	Multiple fatalities, significant irreversible effects to >5 people. Extensive long-term harm with widespread impacts that are non-reversible in <10 years. Significant non-compliances with legislative requirements that result in significant degradation to environmental values.
4	**Major**	Fatalities to 1-5 people, severe irreversible disability. Major long-term and widespread harm that is reversible in 2 - 10 years. Non-compliances with legislative requirements that result in major degradation to environmental values.
3	**Moderate**	Moderate irreversible disability or impairment (classified injury). Moderate environmental harm that is contained on-site or minor widespread harm that are reversible in <2 years. Non-compliances with the legislative requirements that result in minimal degradation to environmental values.
2	**Minor**	Reversible disability requiring hospitalisation (medical treatment case). Minor unplanned on-site harm that does not extend off-site. No non-compliances with legislative requirements.
1	**Insignificant**	No medical treatment (First Aid case). Insignificant impacts that are contained on-site. No habitat disturbance and nil non-compliances with legislative requirements.

4.8 Risk Matrix

The risk matrix adopted for the assessment is included in Table 4-6. The colour shading refers to the qualitative bands of risk (impact) level.

For the purposes of this impact assessment, risk levels are defined as follows:

- Extreme – Works must not proceed until suitable mitigation measures have been adopted to minimise the risk. Site would be considered hazardous or offensive industry by the definition Chapter 3 of SEPP (Resilience and Hazards) 2021;
- High – Works should not proceed without consideration of alternative options or additional controls to minimise the risk. A documented action plan is required. Site would be considered hazardous or offensive industry by the definition Chapter 3 of SEPP (Resilience and Hazards) 2021;
- Medium – Acceptable with formal review. A documented action plan is required. Site may be considered hazardous or offensive industry by the definition Chapter 3 of SEPP (Resilience and Hazards) 2021; and
- Low – Acceptable with review.

Table 4-6 Risk Assessment Matrix

Likelihood	Consequence				
	Catastrophic 5	Major 4	Moderate 3	Minor 2	Insignificant 1
Almost Certain 5	Extreme	Extreme	Extreme	High	Medium
Likely 4	Extreme	Extreme	High	Medium	Medium
Possible 3	Extreme	High	High	Medium	Low
Unlikely 2	High	High	Medium	Low	Low
Rare 1	Medium	Medium	Low	Low	Low

Table 4-7 summarises the risks, impacts, and mitigation measures and the likelihood, consequence and risk both before and after mitigation measures.

Table 4-7 Hazard, Impact and Mitigation Table

Risk/Hazard	Activity/Cause	Impact	Unmitigated Risk*			Mitigation Options	Mitigated Risk		
			L	C	R		L	C	R
Large Gaseous Ammonia Release (Scenario 1)	Primary: External events: - Flooding - Earthquake - Cyclone - Lightning - Vehicle crash - Sabotage/ vandalism - Bushfire Secondary: Generic Mechanical Failure: - Vessel failure (for mechanical is would typically require both mechanical and operation failure to produce significant event).	Potential for the gaseous portion of the tank inventory to release to the outside environment. Note – tank will be set mostly below ground level underground and therefore the potential liquid release volume is limited. Typical tank storage level is well below 50% and therefore liquid would not leak in a puncture above the 50% level. For this system it could be expected the typical storage level (outside maintenance) will be between 15%-25%. Abnormal circumstances include when plate freezer is shut down for major maintenance (i.e., several years between such events). As such, a feasible puncture above the liquid level has been considered for this scenario. The model indicates that ammonia gas released in the worst case climate conditions would rapidly increase concentration due to the pressurised release. Under the worst case weather conditions the outdoor concentration at the closest sensitive receptor to the release (SR1) with a direct south-east wind, reaches the AEGL-1 (60 min) level at 18 minutes after the release (peaking at roughly 140 ppm) and dropping below the AEGL-1 (60 min) level at 32 minutes. Under the normal weather conditions the outdoor concentration at the closest sensitive receptor to the release (SR1) with a direct south-east wind, peaks at 25 ppm for outdoor concentration which is below the AEGL-1 (60 min) level of 30 ppm. The indoor concentration never exceeds roughly 2 ppm (Figure 10). The flammable threat zone under both normal and worst case weather conditions is localised to the plant and immediately adjacent laydown, industrial and transport land uses and does not present a hazard to sensitive receptors.	3	3	**High**	- Storage vessel fitted with isolation valves, pressure relief valves in accordance with AS 5149 - Leak detection by automatic sensing devices (ppm and LEL) - Regular Plant Inspections - Regular Corrosion Inspections - Routine Maintenance & Testing - Correct Working Procedures - Adequate Internal Ventilation - Restricted Access - Correct PPE - Regular Non-destructive Testing - Detection, Alarming & Tripping - Emergency Response Plan involving the surrounding industrial operators - Crash Barriers - Bunding Note – mitigation options for failures related to earthquakes are limited. It is assumed the facility and any additions meet seismic construction rating requirements as set out in the National Construction Code of Australia (NCC).	1	3	**Low**

Risk/Hazard	Activity/Cause	Impact	Unmitigated Risk*			Mitigation Options	Mitigated Risk		
			L	C	R		L	C	R
Pipe Failure and Gaseous Ammonia Release (Scenario 2)	External events: - Earthquake - Vehicle crash - Sabotage/ vandalism Generic Mechanical Failure: - Piping failure - Valve failure	Potential for immediate release of charged gaseous ammonia from the piping to the surrounding environment. The high pressure release is short. In either scenario, levels of gaseous ammonia downwind of the release would be temporarily above safe levels for transport on the Byrnes Road and the immediately adjacent transport storage/industrial area, should the release occur during winds which would push the gas east or the north. The concentrations would rapidly peak at approximately 1,100 ppm and dissipate to 0 ppm within 4 minutes. Thus, this level does not reach the AEGL-1 for 10 minutes of exposure. In the worst case (steady) climatic conditions, event scenario 2 could result in a maximum outdoor concentration of 190 ppm of at the closest sensitive receptor (reaching the AEGL-2 (60 min) level but rapidly dissipates and would not result in a risk of injury and unlikely to cause irritation for such a short period (i.e. less than 5 minutes which is less than AEGL-2 (10 min)) (Figure 13). Under normal conditions the concentration would rapidly peak and dissipate to 0 ppm within 4 minutes. Exposure does not exceed the AEGL-1 (60 min) level, but does exceed AEGL (10 min) at the nearest receptor and thus could cause irritation. The flammable threat zone under both normal and worst case weather conditions is localised to the plant and immediately adjacent laydown, industrial and transport land uses and does not present a hazard to sensitive receptors.	3	3	**High**	- Crash Barriers to Exposed Piping on Eastern Side of Plate Freezer/Store Building - Risk Awareness Training to Staff Operating Machinery - Storage vessel fitted with isolation valves, pressure relief valves in accordance with AS 5149 - Leak detection by automatic sensing devices (ppm and LEL) - Regular Plant Inspections - Regular Corrosion Inspections - Routine Maintenance & Testing - Correct Working Procedures - Restricted Access - Regular Non-destructive Testing - Detection, Alarming & Tripping - Emergency Response Plan involving the surrounding industrial operators Note – mitigation options for failures related to earthquakes are limited. It is assumed the facility and any additions meet seismic construction rating requirements as set out in the National Construction Code of Australia (NCC).	1	3	**Low**
Tank or Piping Puddle Leak onto Plant Floor	Generic Mechanical Failure: - Vessel failure - Pipe failure - Coil failure	Potential for a portion of the tank inventory to drain out to leak onto ammonia vessel pit floor resulting in evaporative pool contained within the pit.	2	3	Medium	- Pit floor gradient to convey liquid directly to a dry sump - Sump to be covered (reduce evaporative surface area).	1	3	Low

Risk/Hazard	Activity/Cause	Impact	Unmitigated Risk*			Mitigation Options	Mitigated Risk		
			L	C	R		L	C	R
(Scenario 3)		Using this worst-case climate scenario, the model predicted a concentration of 30 ppm would be present at a maximum distance of 902 m downwind of the facility. The AEGL-3 (60 min) concentration of 1,100 ppm would extend up to 168 m downwind of the tank (refer to Figure 18). The second, and more likely weather scenario, applied a normal (unsteady) climatic environment (Stability Class D) with wind at 3.95 m per second, cloud cover at 5 tenths, air temperature at 22.2oC and a relative humidity of 50%. Under the more likely weather conditions the model predicted a concentration of 30 ppm would be present at a maximum distance of 238 m downwind of the facility. The AEGL-1 (60 min) concentration of 1,100 ppm within 36 m downwind of the tank (refer to Figure 20). The model indicates that ammonia gas released in a normal unsteady climate would dissipate gradually. In either scenario, levels of gaseous ammonia downwind of the release would be temporarily above safe levels for transport on the Byrnes Road and the immediately adjacent transport storage/industrial area, should the release occur during winds which would push the gas east or north. Based on the modelled concentrations under the worst case and normal weather condition scenarios, immediate evacuation of affected areas would be required. The flammable threat zone under both normal and worst case weather conditions is localised to the plant and immediately adjacent laydown, industrial and transport land uses and does not present a hazard to sensitive receptors.				- Sump to be isolated and prevent discharge of captured liquid ammonia - Storage vessel fitted with isolation valves, pressure relief valves in accordance with AS 5149 - Leak detection by automatic sensing devices (ppm and LEL) - Regular Plant Inspections - Regular Corrosion Inspections - Routine Maintenance & Testing - Correct Working Procedures - Bunding - Restricted Access - Correct PPE - Regular NDT - Detection, Alarming & Tripping - Spill Containment/Treatment Plan			

* L-likelihood, C-consequence, R-risk

Section 5 Results and Discussion

5.1 Acute Exposure Guideline Levels

5.1.1 Overview

The scenario releases have been compared potential releases to the Acute Exposure Level Guidelines (AEGLs) used by emergency planners and responders worldwide as guidance in dealing with rare, usually accidental, releases of chemicals into the air. AEGLs are expressed as specific concentrations of airborne chemicals at which health effects may occur. They are designed to protect the elderly and children, and other individuals who may be susceptible.

5.1.2 AEGLs Assigned 1, 2 or 3 According to Severity of Effects

AEGL "levels" are dictated by the severity of the toxic effects caused by the exposure, with Level 1 being the least and Level 3 being the most severe (Table 5-1). The AEGL is the concentration in ppm or milligrams per cubic meter (mg/m^3) above which the general population, including susceptible individuals, could experience. AEGLs are calculated for different exposure periods with the shortest being 10 minutes.

Table 5-1 AEGL Descriptions

AEGL Level	Description
Level 1	Notable discomfort, irritation, or asymptomatic non-sensory effects. The effects are not disabling and are transient and reversible upon cessation of exposure.
Level 2	Irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
Level 3	Life-threatening health effects or death.

The US EPA Acute Exposure Guideline Levels for Selected Airborne Chemical: Volume 6 (UA EPA, 2007) establishes AEGL values for ammonia based on 10 min, 30 min, 1 hr, 4 hr and 8 hr exposure periods. These values are listed in Table 5-2. The AEGLs presented in the ALOHA outputs are based on 60 minute exposure periods (refer to green highlighted row) and these are taken as the short duration period as per the criteria for HIPAP No. 4. The AEGL levels for 10 minutes exposure are also referenced below when assessing potential impacts for irritation, injury and fatality (blue highlighted).

Table 5-2 Summary of Ammonia AEGL Values for Exposure Periods

AEGL Level	10 min	30 min	60 min	4 hr	8hr
AEGL 1	30 ppm	30 ppm	30 ppm	30 ppm	30 ppm
AEGL 2	220 ppm	220 ppm	160 ppm	110 ppm	110 ppm
AEGL 3	2,700 ppm	1,600 ppm	1,100 ppm	550 ppm	390 ppm

5.1.3 Scenario 1 – Ammonia Vessel Hole

Scenario 1 represents the impact of a hole in the ammonia storage tank or a major piping/valve failure above the liquid level, thus releasing ammonia gas. A 101 mm hole in the wall of the high-pressure tank or attached piping with maximum average sustained release rate of 708 grams per second. This scenario assumes a tank puncture from equipment such as a forklift (which has a standard fork size of 10.16 cm x 5.08 cm) or valve rupture. A circular hole with a diameter of 101.6 mm and a rectangular puncture with 101.6 mm length and width of 50.8 mm was tested. Both result in the same release rate and plume extent.

The ammonia rapidly escapes as a gas as the puncture/leak is above the liquid level of the tank and the tank depressurises. This is considered due to the ammonia storage vessel being set mostly underground, with the designs showing <50% of the tank above the ground floor of the pit (i.e., a puncture above the liquid level would not facilitate a loss of liquid that could be hazard modelled). An anhydrous ammonia tank typically maintains a maximum legal capacity of 85% and will often maintain much lower level during usage with ammonia circulating throughout the system (<50%). Given the tank underground placement and typical volume at which ammonia refrigerant storage tanks are kept, it could be several years between maintenance that necessitates draining the system back to the storage vessel and increasing the stored volume. To facilitate a release of gas from the tank the chemical mass in the tank was manipulated in the model. This scenario also assumes that the retained liquid in the tank would evaporate and continue to release ammonia gas but at low levels due to the retained low temperature in the tank limiting evaporation and release of ammonia gas through the hole.

Two weather conditions of this event were modelled. The first weather scenario is an uncommon steady climatic environment (Stability Class F) with wind at 1 m per second, cloud cover at 5 tenths, air temperature at 27^{o}C and a relative humidity of 50%. Using this worst-case weather scenario, the model predicted a concentration of 30 ppm would be experienced at up to a distance of 1.7 km directly downwind of the facility, although this would be short lived (i.e seconds). The AEGL-3 (60 min) concentration of 1,100 ppm within 447 m downwind of the tank (refer to Figure 11). The second, and more likely weather scenario, applied is a normal (unsteady) climatic environment (Stability Class D) with wind at 3.95 m per second[4], cloud cover at 5 tenths, air temperature at 22.2^{o}C and a relative humidity of 50%. These are considered typical weather conditions for Wagga Wagga according to the BoM site 072150 (BoM 2022). Under the more likely weather conditions the model predicted a concentration of 30 ppm would be present at a maximum distance of 887 m downwind of the facility. The AEGL-3 (60 min) concentration of 1,100 ppm extends to 147 m downwind of the tank (refer to Figure 12).

The model indicates that ammonia gas released in the worst case weather conditions would rapidly increase concentration due to the pressurised release. Under the worst case weather conditions the outdoor concentration at the closest sensitive receptor to the release (SR1) with a direct south-east wind, reaches the AEGL-1 (60 min) level at 18 minutes after the release (peaking at roughly 140 ppm) and dropping below the AEGL-1 (60 min) level at 32 minutes.

Under the normal weather conditions the outdoor concentration at the closest sensitive receptor to the release (SR1) with a direct south-east wind, peaks at 28 ppm for outdoor concentration which is below the AEGL-1 (60 min) level of 30 ppm. The indoor concentration never exceeds roughly 2 ppm (Figure 10).

Because ammonia has a high minimum ignition energy (100 MJ) and a narrow range of explosive concentration (16% to 25%), only the toxic effects of ammonia have been considered relevant. The short term exposure limit (STEL) for gaseous ammonia (calculated over a 15 minute period) in the Workplace Exposure Standards for Airborne Contaminants (2013) (SWA 2013) is 35 ppm. A concentration of 1,100 ppm far exceeds the STEL. Ammonia levels of 5,000 to 10,000 ppm are reported to be fatal (Mulder and Van der Zahm 1967), while exposure for 30 minutes to 2,500 to 6,000 ppm are considered dangerous to life (Smyth 1956). Under the worst case weather condition a maximum outdoor concentration

[4] Based on annual mean 3pm for closest weather station. Refer to Appendix C.

of 140 ppm is momentarily reached at the closest sensitive receptor to the release (with an exposure period to that level of no greater than 60 second), but does not exceed the levels referenced above (Figure 9). However, at the boundary of the site the level exceeds all AEGL levels for a period lasting several minutes. This is considered further below in Table 5-3.

Table 5-3 Consequence Results for Loss of Ammonia – Scenario 1

AEGL Level	Stability Class D		Stability Class F		Offsite Impacts	Offsite Population Impacted
	Length	Width	Length	Width		
AEGL 1 (60 min) – Irritation: 30 ppm	<887 m	<127 m	<1,700 m	<37 m	Yes	2.4 – Residential[5] 65 – Industrial
AEGL 2 (60 min) – Injury: 160 ppm	<413 m	<54 m	<889 m	<70 m	Yes	0 – Residential 24.5 - Industrial
AEGL 3 – (60 min) Fatality: 1,100	<147 m	<18 m	<447 m	<130 m	Yes	0 – Residential 4.5 – Industrial

For stability class D, the concentration at the nearest sensitive receptor does not … However, on the eastern boundary (30 m from the release) the concentration reaches up to 30,000 ppm but exceeds AEGL (60 min) for 2 minutes. Nevertheless, this would be sufficient to displace oxygen and could be fatal within minutes. The outer extent of the plume (147 m) only reaches roughly 1,250 ppm for seconds rather than minutes and would not be fatal, nor likely to cause injury for the brief duration. The Heinz Watties factory is 70 m to the north of the release point and at that boundary would exhibit roughly 5,000 ppm for approximately 60 seconds. This would not be a fatal dose.

For stability class F, the concentration at the nearest sensitive receptor does exceeds AEGL-1 (60 min) for approximately 12 minutes. The concentration level of AEGL-1 (60 min) is consistent with AEGL-1 (10 min) and therefore the exposure is taken to have potential to cause irritation (i.e. lasts for longer than 10 min). This would only be relevant to sensitive receptors SR1 – SR4 (beyond these the AEGL-1 limit of 30 ppm does not last for over 10 minutes). Given the maximum 37 m width of the plume and different directions of the sensitive receptors, only one sensitive receptor could be exposed to the plume during an event.

Industrial uses are located much closer to the release than residential sensitive receptors. The greatest quantity of industrial activities are located to the north and therefore, for calculating the potentially impacted personnel, it is assumed that a plume under this scenario would distribute north. The exposure period for irritation using AEGL-1 (10 min) occurs at roughly 1,100 m. Within this extent, based on a plume width of 37 m, it could partially intersect the Heinz-Watties, Proway Livestock Equipment, Southern Steel Supplies, Fulton Hogan depot, the Southern Oil Refinery and a portion of the Livestock Marketing Centre. A calculation of the potentially exposed portion of the peak onsite workforces for these facilities has been prepared to obtain the potentially impacted population presented in Table 5-3.

The exposure period for AEGL-2 (60 min) is not reached at the maximum extent of 889 m for the injury threshold, but the AEGL-2 (10 min) concentration is reached at roughly 400 m from the release point. The exposure period for AEGL-3 (10 min) is not reached at the maximum extent of 447 m for the fatality threshold, but AEGL-3 (10 min) concentration is reached at roughly 225 m from the release point, with a level above 5,000 ppm exceeded for several minutes (refer to the health effects of ammonia summarised in Section 4.4).

Users of the road and rail infrastructure would be travelling and only subject to very short exposure duration if they were passing through the area at the time of the event. It is taken that a release to the north would expose the greatest proportion of personnel.

[5] Taken to be residents of one homestead/house

As indicated by the US National Institute for Occupational Safety and Health Level Immediately Dangerous to Life and Health (NIOSH IDLH) (1994), exposure at a concentration of 300 ppm would require evacuation within 30 minutes to safely avoid harm. Based the modelled concentrations under the worst case and normal weather condition scenarios, immediate evacuation of areas immediately surrounding would be required. The area subject to temporary 1,100 ppm AEGL-3 (60 min) level is modelled at up to 447 m from the release point. There are no sensitive receptors within the 447 m distance to the release point.

When considering this result, it is worth noting that as recommended in HIPAP No.4 the area in the confidence lines should also be considered against the general mobility of members of the public within the areas. Surrounding areas are considered higher mobility including transient public spaces and thus are lower risk areas. Concentrations inside a normally-closed house at the closest sensitive receptor to the release do not exceed 3 - 4 ppm under the worst case scenario, thus unlikely to cause irritation of the eyes and throat. The exposure levels modelled do not pose an offsite risk of fatality at sensitive receptors[6]; however, under the worst case weather conditions, the facility and adjacent industrial uses would require evacuation. Therefore, a frequency and consequence calculation is provided in Section 5.3 due to potential offsite impacts that are largely constrained to the surrounding industrial area.

Scenario 1 modelling input assumptions are provided in Appendix D and Appendix E.

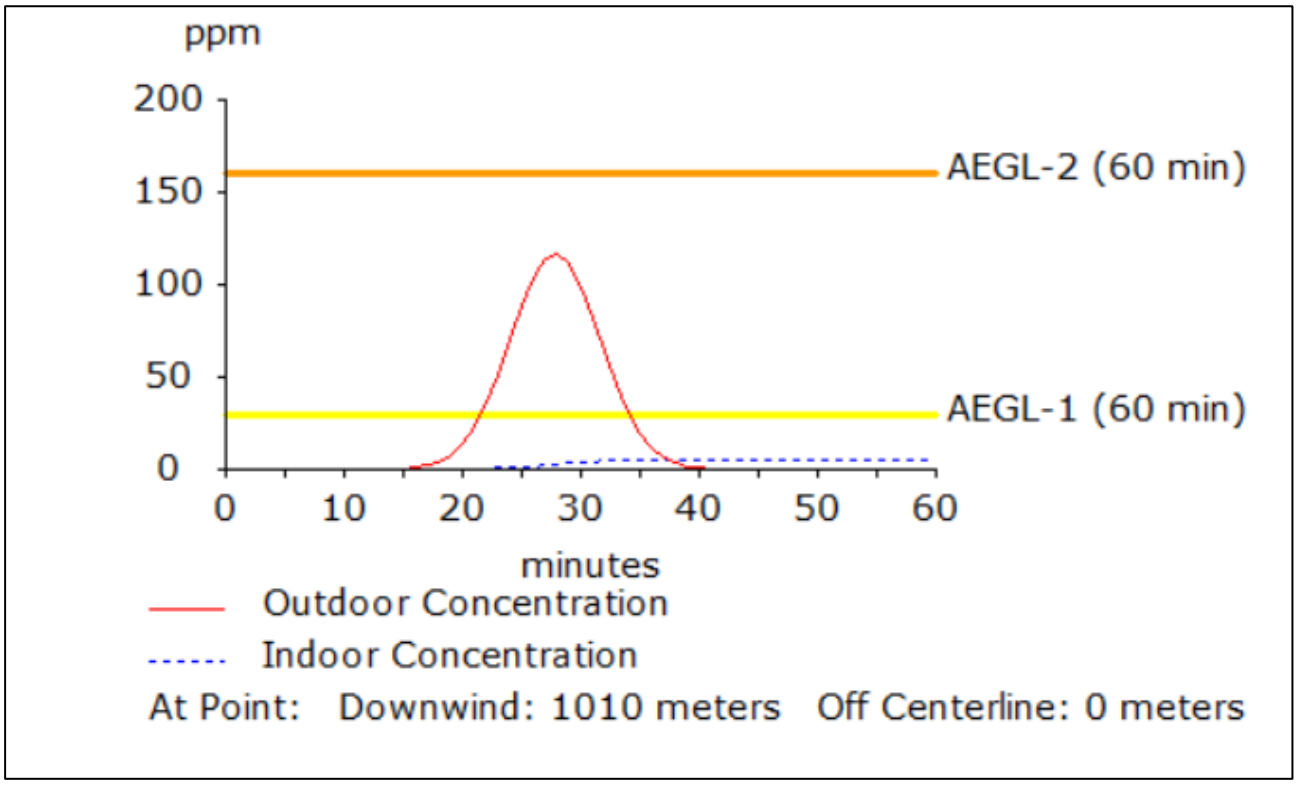


Figure 9 **Anhydrous Ammonia: Scenario 1 Outdoor and Indoor Concentration at Closest Receptor (Worst Case Weather Conditions)**

[6] The AIHA concluded that nearly all individuals could be exposed to 1,500 ppm for up to 1-hr without experiencing or developing life-threatening health effects.

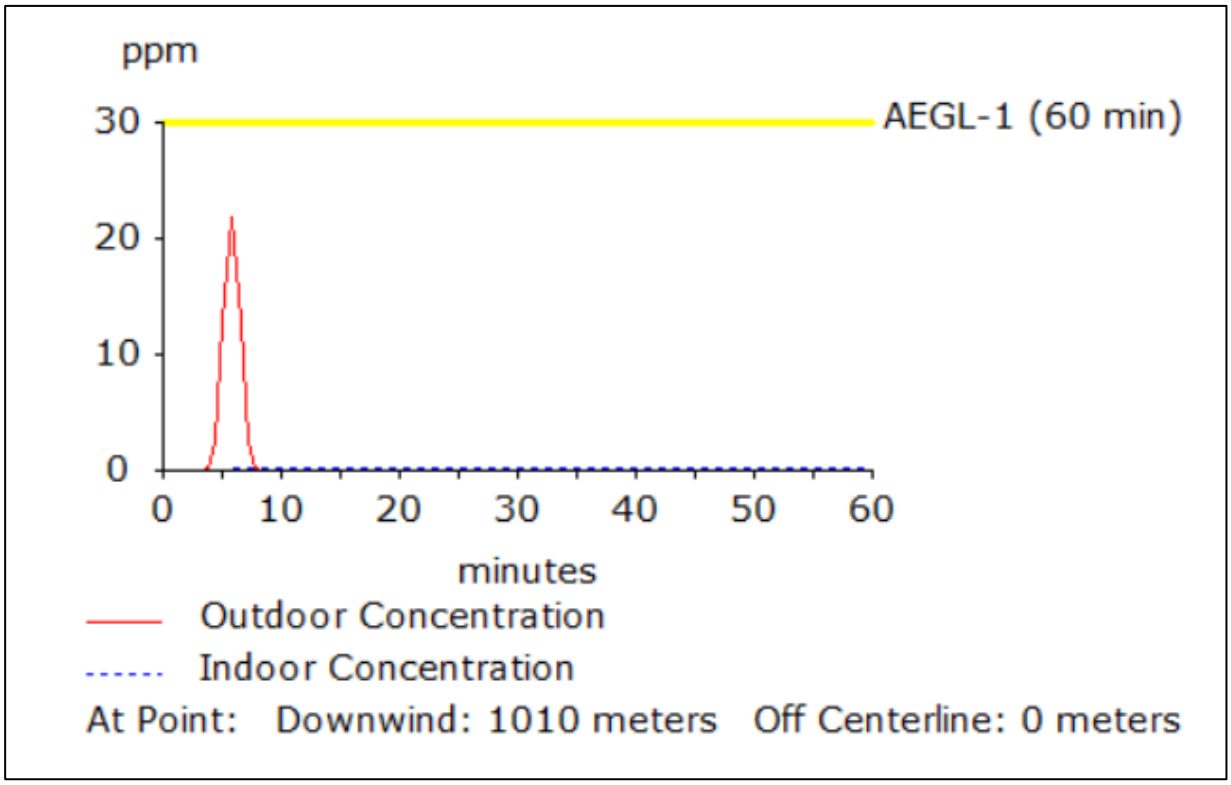


Figure 10 **Anhydrous Ammonia: Scenario 1 Outdoor and Indoor Concentration at Closest Receptor (Normal Weather Conditions)**

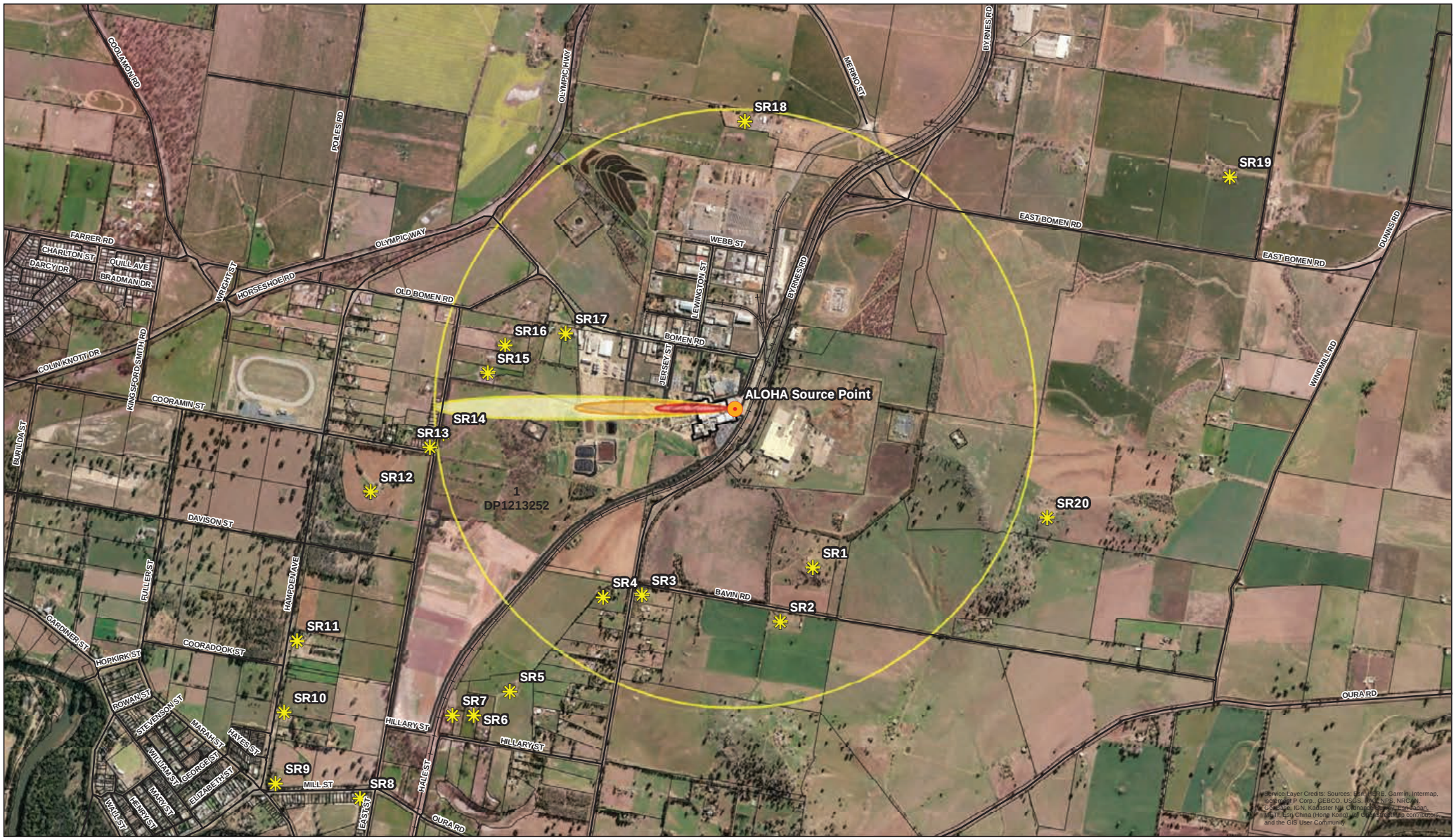


Figure 11: Hazard Modelling Scenario 1 - Worse Case Conditions; Toxic Area of Vapour Cloud

- Sensitive Receptors
- Road
- Railway
- 1DP1213252
- Building Footprint
- Cadastre

Threat Zone:

- Red Threat Zone 1100 ppm = AEGL-3 (60 min)
- Orange Threat Zone 160 ppm = AEGL-2 (60 min)
- Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
- Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)

N

0 500 1,000
Metres

Date: 7/07/2022
Author: JPH
Coordinate System: GDA 1994 MGA Zone 55

CDM Smith
listen. think. deliver.

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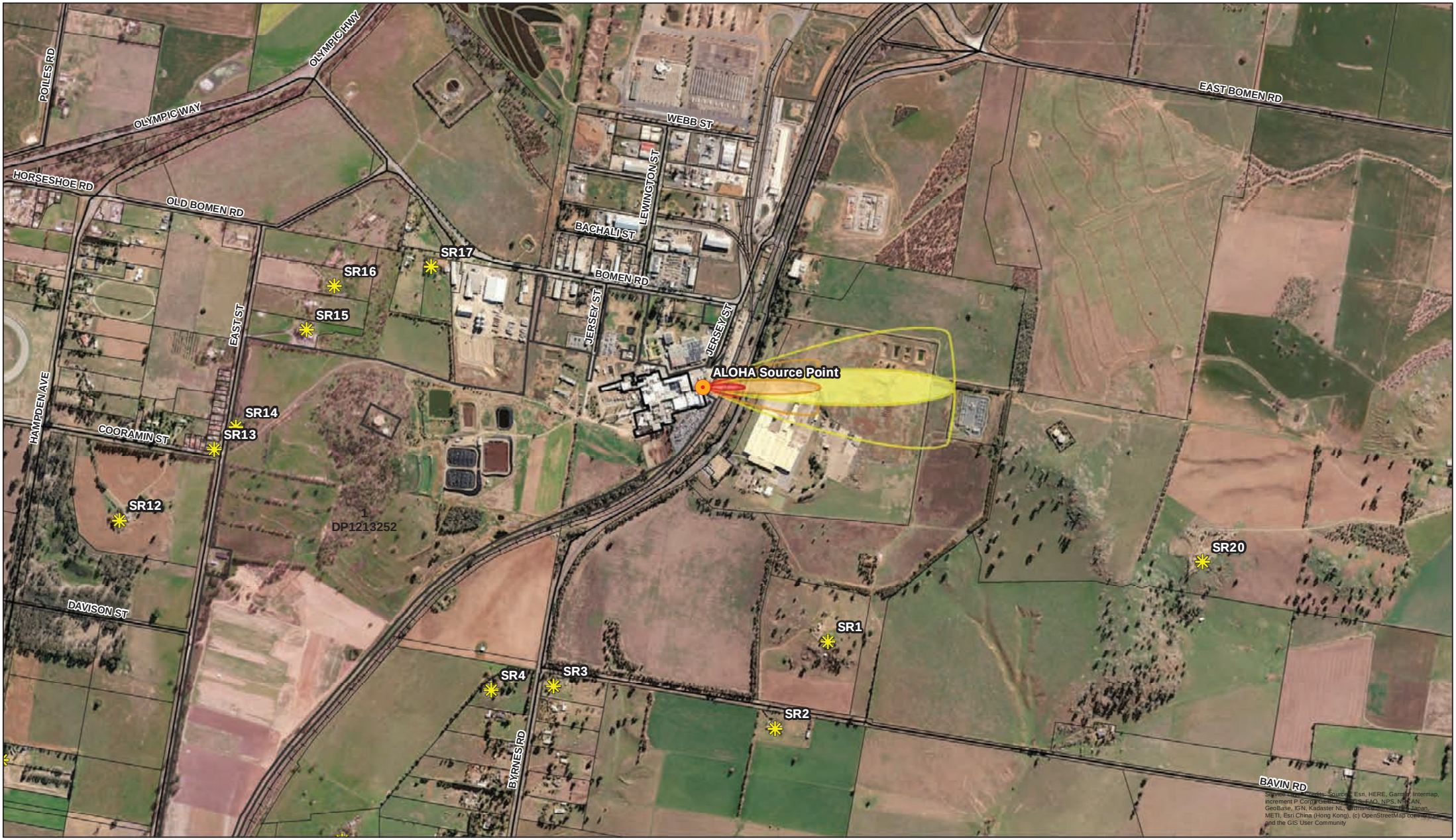

Figure 12: Hazard Modelling Scenario 1 - Normal Conditions; Toxic Area of Vapour Cloud

- Sensitive Receptors
- Road
- Railway
- 1DP1213252
- Building Footprint
- Cadastre

Threat Zone:

- Red Threat Zone 1100 ppm = AEGL-3 (60 min)
- Red Wind Direction Confidence Lines 1100 ppm = AEGL-3 (60 min)
- Orange Threat Zone 160 ppm = AEGL-2 (60 min)
- Orange Wind Direction Confidence Lines 160 ppm = AEGL-2 (60 min)
- Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
- Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)

N

0 250 500
Metres

Date: 7/07/2022
Author: JPH
Coordinate System: GDA 1994 MGA Zone 55

CDM Smith
listen. think. deliver.

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5.1.4 Scenario 2 – High Pressure Pipe Failure

Scenario 2 has a higher probability than the worst-case Scenario 1. It assumes that a pipe or valve connected to the storage vessel breaks causing release of gaseous ammonia. Similar to Scenario 1 it assumes a puncture or break of up to 101.6 mm diameter. This Scenario 2 accounts for an incident involving plant or equipment contacting the eastern side of the plate freezer/store and puncturing the pipe that is located external to the building and adjacent to areas of vehicle movements.

This type of accident was highlighted in a 2001 release by the US EPA which identified a 1992 incident at a meat packing plant where a forklift struck and ruptured a pipe carrying ammonia for refrigeration (US EPA 2001). Workers were evacuated when the leak was detected. A short time later, an explosion occurred that caused extensive damage, including large holes in two sides of the building. The forklift was believed to be the source of ignition. In that incident, physical barriers would have provided mechanical protection to the refrigeration system and prevented a release (US EPA 2001). Based on previous known occurrence this scenario is rated as having a higher likelihood of occurrence in the risk matrix (Table 4-6) compared to Scenarios 1.

Such an event could occur from a small pipe work leak, pump seal failure or accident involving vehicles or plant. In this event the following would occur:

- Release results in a gas plume maintaining a toxic concentration of ammonia;
- Potential flashing and spray close to release source; small running pool for larger emissions, potential for asphyxiation close to source of release; and
- Ammonia released as cold flashing gas with liquid drop out, gas disperses as neutral density or marginally lighter than air plume beyond zone of flow establishment.

Two weather conditions of this event were modelled. The first weather scenario is an uncommon steady climatic environment (Stability Class F) with wind at 1 m per second, cloud cover at 5 tenths, air temperature at 27°C and a relative humidity of 50%. Using this worst-case weather scenario the model predicted a concentration of 30 ppm would be present at a maximum distance 2,100 m downwind of the tank. The AEGL-3 concentration of 1,100 ppm occurs within 525 m downwind of the tank (refer to Figure 15). The second, and more likely weather scenario, applied a normal unsteady climatic environment (Stability Class D) with wind at 3.95 m per second, cloud cover at 5 tenths, air temperature at 22.2°C and a relative humidity of 50%. These are considered typical weather conditions for Wagga Wagga according to the BoM site 072150 (BoM 2022). Under the more likely weather scenario the model predicted a concentration of 30 ppm at a maximum distance of up to 1,100 m downwind of the facility and would rapidly peak and dissipate to 0 ppm within 5 min. The AEGL-3 (60 min) concentration of 1,100 ppm occurs 190 m downwind of the facility, which would just encompass Byrnes Rd in the east and portion of industrial uses to the north and east (refer to Figure 16). The model indicates that ammonia gas released in an unsteady weather would dissipate quickly.

In either scenario, levels of gaseous ammonia downwind of the release would be temporarily above safe levels for transport on the Byrnes Road and the immediately adjacent transport storage/industrial area, should the release occur during winds which would push the gas east or the north. The concentrations would rapidly peak at approximately 1,100 ppm and dissipate to 0 ppm within 4 minutes. Thus, this level does not reach the AEGL-1 for 10 minutes of exposure.

In the worst case (steady) climatic conditions, event scenario 2 could result in a maximum outdoor concentration of 190 ppm of at the closest sensitive receptor (reaching the AEGL-2 (60 min) level but rapidly dissipates and would not result in a risk of injury and unlikely to cause irritation for such a short period (i.e. less than 5 minutes which is less than AEGL-2 (10 min)) (Figure 13). Under normal conditions the concentration would rapidly peak and dissipate to 0 ppm

within 4 minutes. Exposure does not exceed the AEGL-1 (60 min) level, but does exceed AEGL (10 min) at the nearest receptor and thus could cause irritation.

Table 5-4 Consequence Results for Loss of Ammonia – Scenario 2

AEGL Level	Stability Class D		Stability Class F		Offsite Impacts	Offsite Population Impacted
	Length	Width	Length	Width		
AEGL 1 (60 min) – Irritation: 30 ppm	<1,100 m	<128 m	<1,700 m	<145 m	Yes	14.4 – Residential[7] 115 – Industrial
AEGL 2 (60 min) – Injury: 160 ppm	<527 m	<55 m	<889 m	<85 m	Yes	0 – Residential 29.5 - Industrial
AEGL 3 – (60 min) Fatality: 1,100	<190 m	<20 m	<447 m	<42 m	Yes	0 – Residential 4.5 – Industrial

There are several sensitive receptors on the western side of East Street that are intersected by the AEGL-1 (60 min) plume extent. These are 1,600 m from the release point. Interrogating the model indicates the concentration at this point could reach approximately 60 ppm, with AEGL-1 (10 min) level exceeded for approximately 12 minutes. Therefore, irritation is a potential consequence. Based on the plume width of 150 m, a maximum of six sensitive receptors could be exposed under the right weather conditions with winds from the west-north-west. Concentrations at the nearest sensitive receptor do not exceed AEGL-2 (10 min) and therefore injury is not considered a risk for any sensitive receptors.

For industrial uses personnel, the greatest exposure is from a southerly wind directing the plume north. The potential offsite population impacted is based on such a scenario.

Scenario 2 modelling input assumptions are provided in Appendix D and Appendix E.

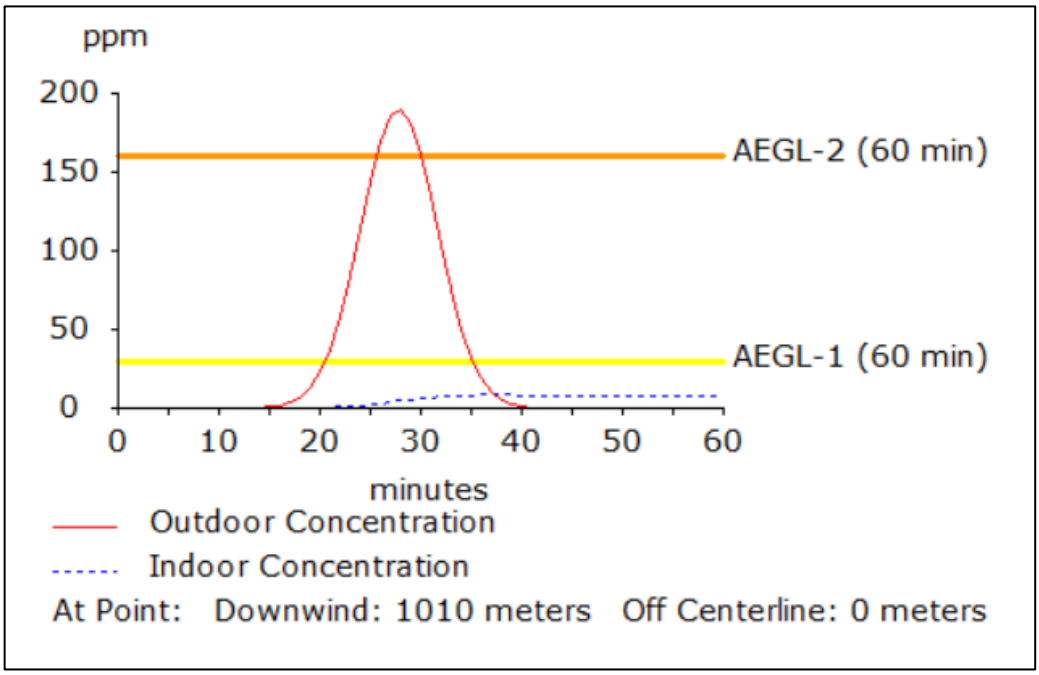

Figure 13 Anhydrous Ammonia: Scenario 2 Indoor and Outdoor Concentration at Closest Sensitive Receptor (Worst Case Weather Conditions)

[7] Taken to be residents of one homestead/house

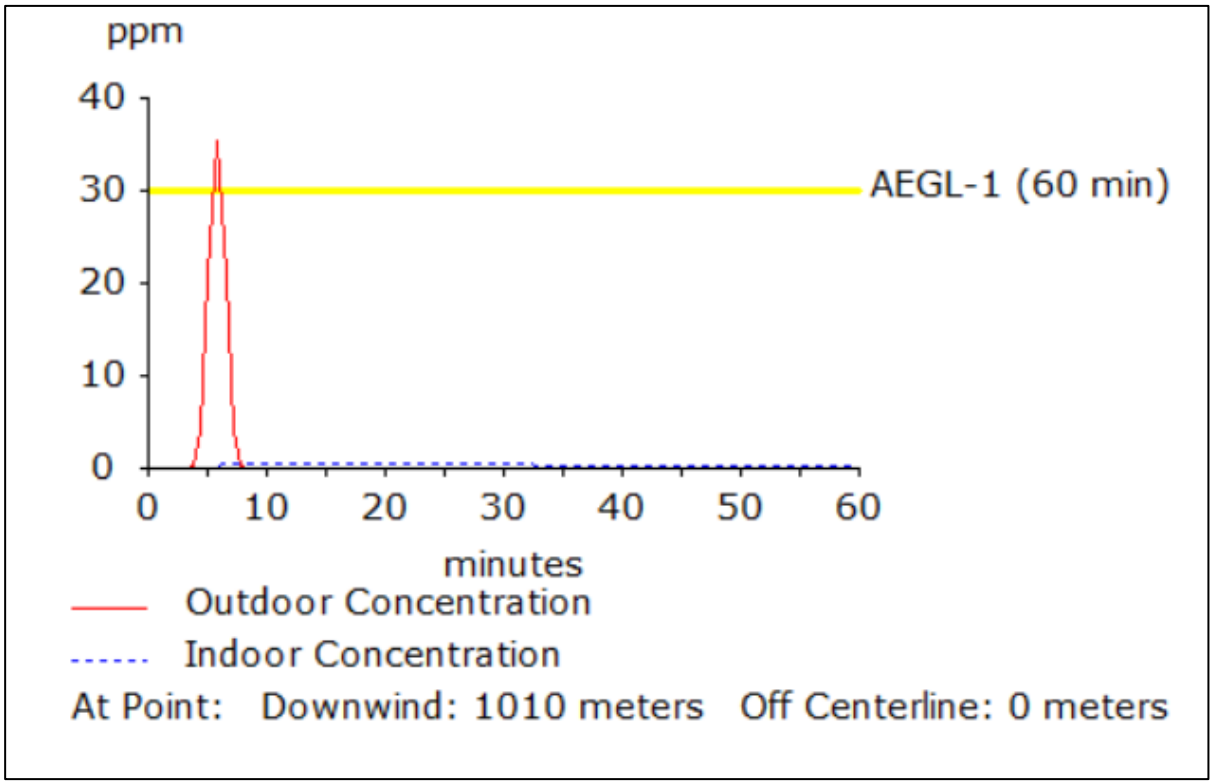

Figure 14 **Anhydrous Ammonia: Scenario 2 Indoor and Outdoor Concentration at Closest Receptor (Normal Weather Conditions)**

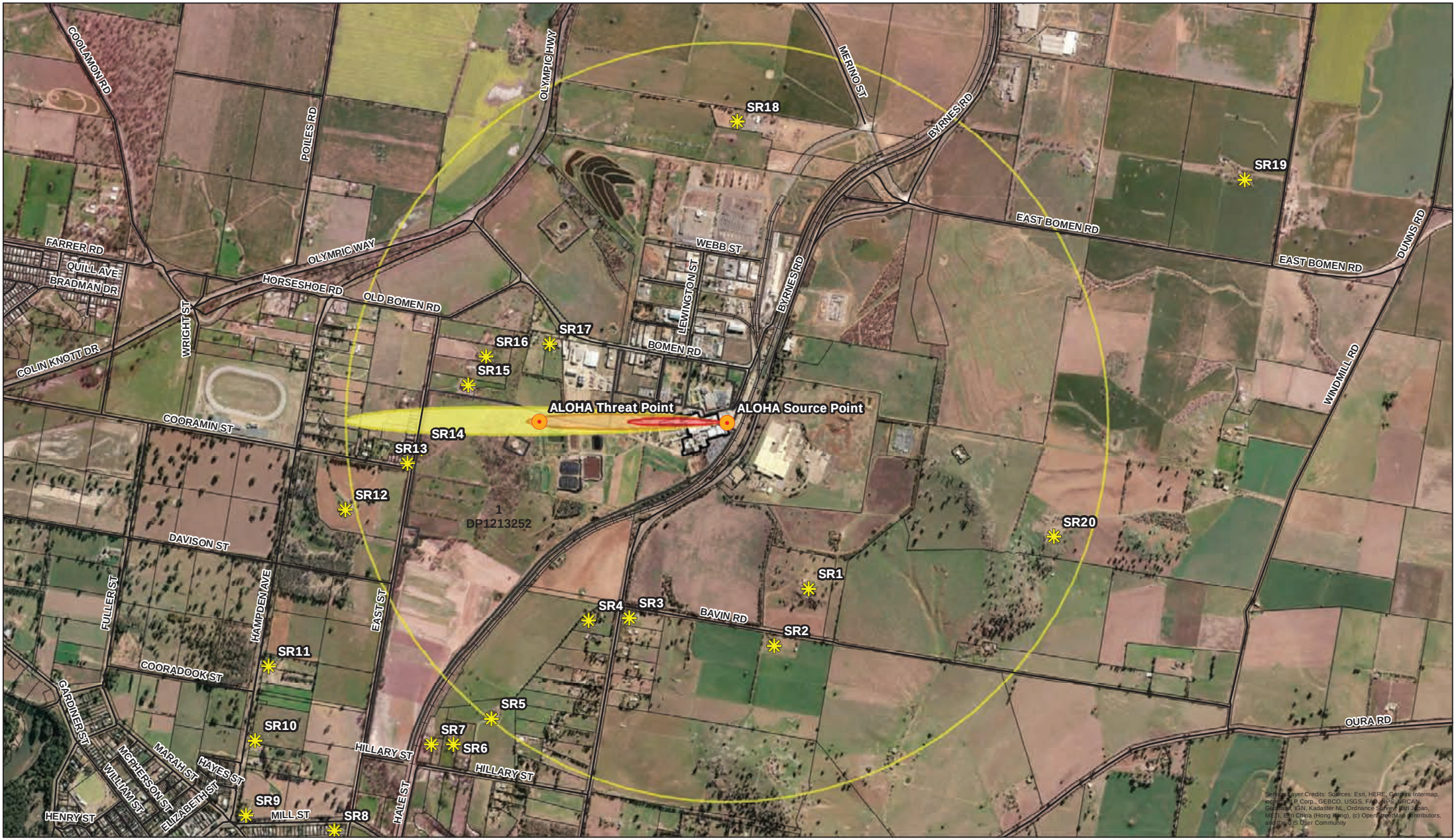

Figure 15: Hazard Modelling Scenario 2 - Worse Case Conditions; Toxic and Flammable Area of Vapour Cloud

- Sensitive Receptors
- Road
- Railway
- ALOHA Source Point
- 1DP1213252
- Building Footprint
- Cadastre

Threat Zone:

- Red Threat Zone 1100 ppm = AEGL-3 (60 min)
- Red Threat Zone 90000 ppm = 60% LEL = Flame Pockets
- Orange Threat Zone 160 ppm = AEGL-2 (60 min)
- Yellow Threat Zone 15000 ppm = 10% LEL
- Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
- Yellow Wind Direction Confidence Lines 15000 ppm = 10% LEL
- Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)

N

0 250 500
Metres

Date: 7/07/2022
Author: JPH
Coordinate System: GDA 1994 MGA Zone 55

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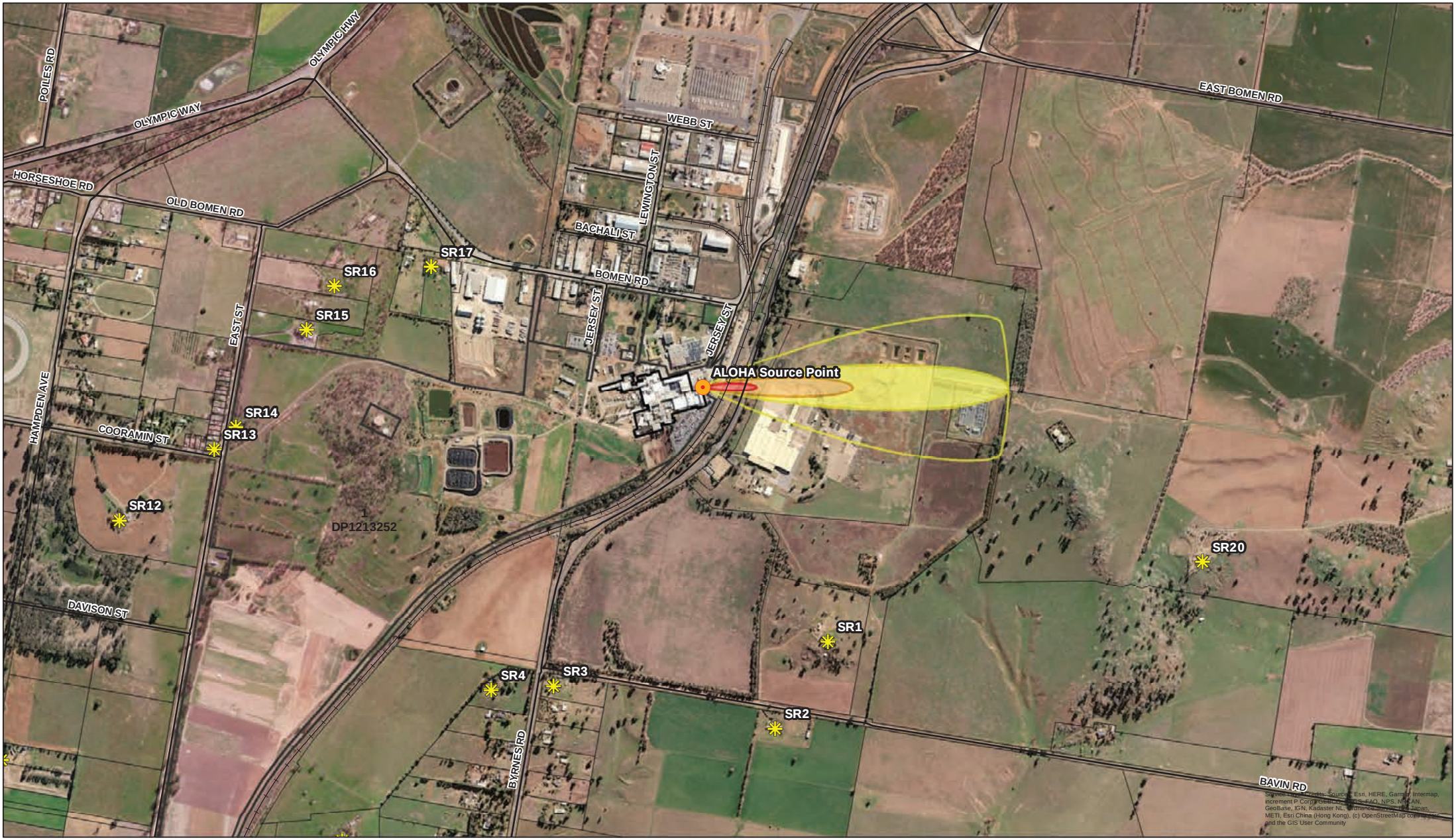

Figure 16: Hazard Modelling Scenario 2 - Normal Conditions; Toxic Area of Vapour Cloud

- Sensitive Receptors
- Road
- Railway
- 1DP1213252
- Building Footprint
- Cadastre

Threat Zone:

- Red Threat Zone 1100 ppm = AEGL-3 (60 min)
- Red Wind Direction Confidence Lines 1100 ppm = AEGL-3 (60 min)
- Orange Threat Zone 160 ppm = AEGL-2 (60 min)
- Orange Wind Direction Confidence Lines 160 ppm = AEGL-2 (60 min)
- Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
- Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)

N

0 250 500
Metres

Date: 7/07/2022
Author: JPH
Coordinate System: GDA 1994 MGA Zone 55

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5.1.5 Scenario 3 – Tank Valve Failure: Explosion Hazard

Scenario 3 models an event in which the tank attached valve or piping suffers a leak that releases ammonia liquid onto the floor of the plant. This scenario assumes the pool is contained within the ammonia vessel pit and drains directly from the pit floor to a dry sump as per the design plans, thus limiting the depth and surface area of the puddle. This assumption is also based on a design commitment to install a gradient in the concrete pit floor and covering over the receiving sump. Release onto the pit floor and creates a very cold puddle 2 m^2 in diameter and 2.5 cm deep. In that case, ALOHA shows a maximum sustained release rate of 2.89 kg/min and a maximum evaporation rate of approximately 2.3 kg/min of gas that gradually decreases.

This 'puddle' event would involve the loss of contents from ammonia storage tank resulting in:

- Gradual loss of tank inventory down to the puncture or release point;
- Pool spreads to 2 m^2 in diameter and is contained within the vessel pit but drains into the pit sump. The surface area is based on the pit floor design including a pit floor gradient that directs any liquid release to the dry sump. The sump is to be covered and thus limits evaporation. There is potential for asphyxiation close to source of release; and
- Partial flashing resulting in vapour/ liquid aerosol which is initially denser than air and slumps to ground close to the release point; gas disperses as denser than air, ground hugging cloud.

As with the previous scenarios, two weather conditions of this event were modelled. The first weather scenario is an uncommon steady climatic environment (Stability Class F) with wind at 1 m per second, cloud cover at 5 tenths, air temperature at 27°C and a relative humidity of 50%. Using this worst-case weather scenario, the model predicted a concentration of 30 ppm would be present at a maximum distance of 902 m downwind of the facility. The AEGL-3 (60 min) concentration of 1,100 ppm would extend up to 168 m downwind of the tank (refer to Figure 18). The second, and more likely weather scenario, applied a normal (unsteady) climatic environment (Stability Class D) with wind at 3.95 m per second, cloud cover at 5 tenths, air temperature at 22.2°C and a relative humidity of 50%. Under the more likely weather conditions the model predicted a concentration of 30 ppm would be present at a maximum distance of 238 m downwind of the facility. The AEGL-1 (60 min) concentration of 1,100 ppm within 36 m downwind of the tank (refer to Figure 20). The model indicates that ammonia gas released in a normal unsteady weather would dissipate gradually.

In either scenario, levels of gaseous ammonia downwind of the release would be temporarily above safe levels for transport on the Byrnes Road and the immediately adjacent transport storage/industrial area, should the release occur during winds which would push the gas east or north. Based on the modelled concentrations under the worst case and normal weather condition scenarios, immediate evacuation of affected areas would be required.

Table 5-5 Consequence Results for Loss of Ammonia – Scenario 3

AEGL Level	Stability Class D		Stability Class F		Offsite Impacts	Offsite Population Impacted
	Length	Width	Length	Width		
AEGL 1 (60 min) – Irritation: 30 ppm	<238 m	<32 m	<902 m	<64 m	Yes	0 – Residential 34 – Industrial
AEGL 2 (60 min) – Injury: 160 ppm	<99 m	<15 m	<394 m	<30 m	Yes	0 – Residential 4.5 - Industrial
AEGL 3 – (60 min) Fatality: 1,100	<36 m	<10 m	<168 m	<15 m	Yes	0 – Residential 4.5 – Industrial

In the worst case (steady) climatic conditions, event scenario 3 could result in a maximum outdoor concentration of 25 ppm of at the closest sensitive receptor from the source, which is below the AEGL-1 (10 min, 60 min) level (Figure 17). The concentration would rapidly peak after approximately 30 minutes and slowly dissipate. AEGL-1 (10 min, 60 min) and AEGL-2 (10 min, 60 min) would not be exceeded at any of the surrounding sensitive receptors. Such concentrations would not result in risk of irritation or injury.

Under normal conditions it take 5 minutes to reach an outdoor concentration peak of 1.8 ppm at the nearest sensitive receptor and does not exceed any AEGL threshold. This is unlikely to result in risk of injury or irritation at the closest sensitive receptor to the release.

For the industrial use, the model does show concentrations lingering above AEGL-3 (60 min) just beyond the northern boundary for over 60 minutes and thus this is accounted for in Table 5-5.

Scenario 3 modelling input assumptions are provided in Appendix D.

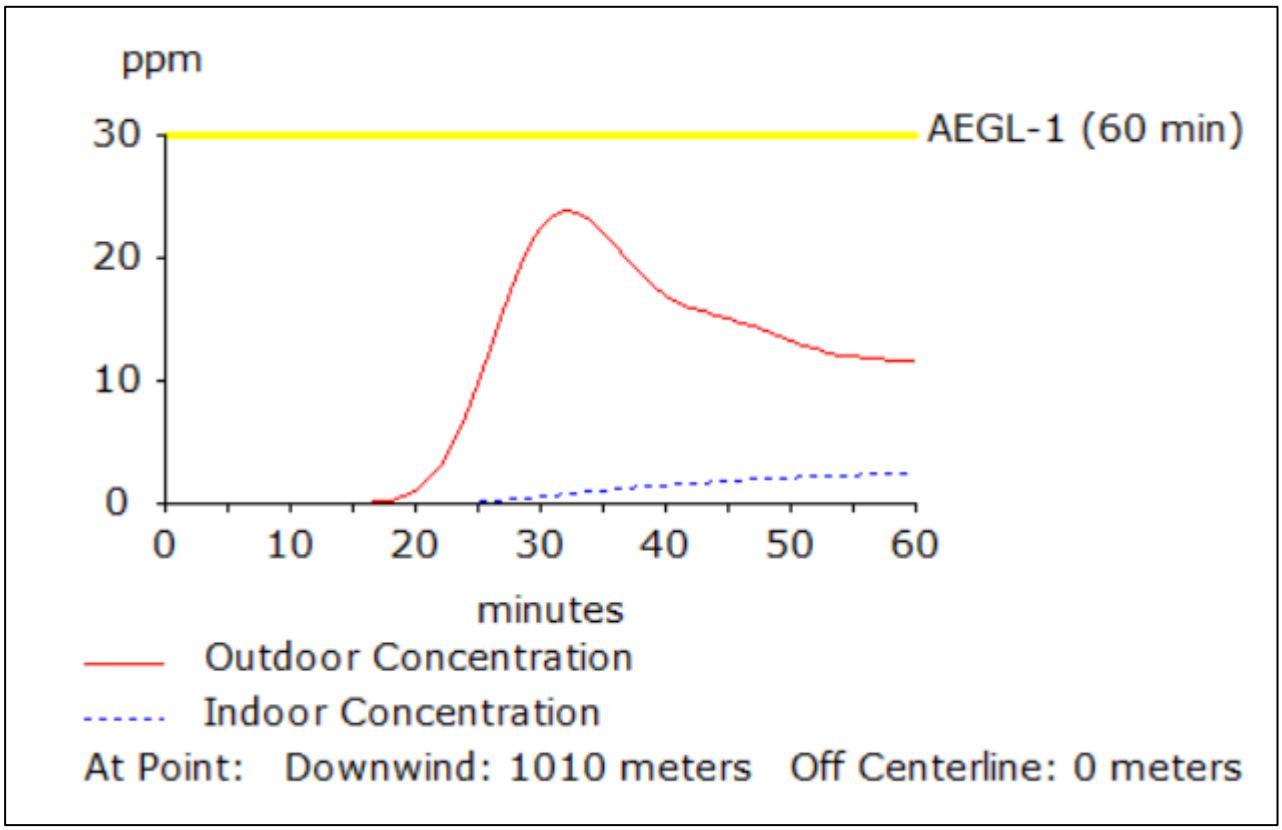

Figure 17 **Anhydrous Ammonia: Scenario 2 Indoor and Outdoor Concentration at Closest Receptor (Worst Case Weather Conditions)**

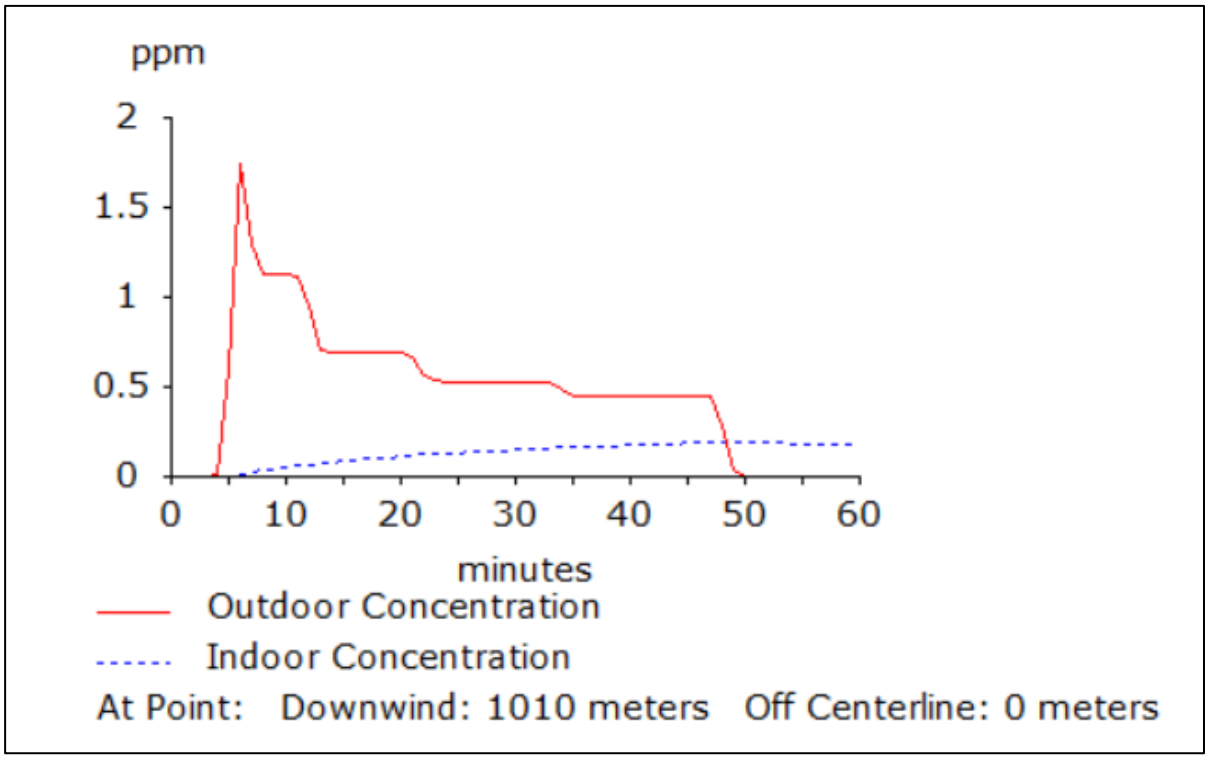

Figure 18 **Anhydrous Ammonia: Scenario 2 Indoor and Outdoor Concentration at Closest Receptor (Normal Weather Conditions)**

Figure 19: Hazard Modelling Scenario 3 - Worse Case Conditions; Toxic and Flammable Area of Vapour Cloud

- Sensitive Receptors
- Road
- Railway
- ALOHA Source Point
- 1DP1213252
- Building Footprint
- Cadastre

Threat Zones:

- Red Threat Zone 1100 ppm = AEGL-3 (60 min)
- Red Threat Zone 90000 ppm = 60% LEL = Flame Pockets
- Orange Threat Zone 160 ppm = AEGL-2 (60 min)
- Yellow Threat Zone 15000 ppm = 10% LEL
- Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
- Yellow Wind Direction Confidence Lines 15000 ppm = 10% LEL
- Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)

N

0 250 500
Metres

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Figure 20: Hazard Modelling Scenario 3 - Normal Conditions; Toxic Area of Vapour Cloud

- Sensitive Receptors
- Road
- Railway
- 1DP1213252
- Building Footprint
- Cadastre

Threat Zones:

- Red Threat Zone 1100 ppm = AEGL-3 (60 min)
- Orange Threat Zone 160 ppm = AEGL-2 (60 min)
- Yellow Threat Zone 30 ppm = AEGL-1 (60 min)
- Yellow Wind Direction Confidence Lines 30 ppm = AEGL-1 (60 min)

N

0 250 500
Metres

Date: 7/07/2022
Author: JPH
Coordinate System: GDA 1994 MGA Zone 55

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Document Path: C:\GIS\GIS_WR\1001317_PHA_Abottoir_NSW_DPIE\FigureX_HazardModel_5.mxd

5.2 Frequency Assessment

The frequency of an event is defined as the number of occurrences of the event over a specified time period. The period adopted in the HIPAP No. 4 risk criteria is that of one year.

This PHA uses generic data to estimate the likelihood of occurrence of the incident scenarios identified where the failure is related to mechanical failure of equipment.

The failure frequency data and source applied for this assessment is outlined in Table 5-6. This information is taken from the Dutch Committee for the Prevention of Disasters (TNO purple Book) (ref) and the UK HSE MHAU Handbook (UK HSE 2017). If both references provided a failure rate for the type of failure, the higher value was selected.

The TNO Purple book failure rates consider the failure of tanks and vessels and the associated instrumentation pipework due to corrosion, fatigue due to vibrations, operating errors and external impacts.

Table 5-6 Failure Rates of Equipment

Type of Failure	Failure Rate	Source	Failure Rate Applied
Storage Vessel Under Pressure (Scenario 1 and 3)			
100 mm hole	5×10^{-7} per year – failure of vessel and the associated instrumentation pipework (based on continuous release of the complete inventory in 10 minutes, at a constant rate of release from tank and instrumentation pipework) – Note that applied failure rate accounts for the tank being more than 50% full only for one day a year.	TNO Purple Book, Table 3.3	1.4×10^{-9} per year
Catastrophic failure	1×10^{-8} – applying in-ground tank value	TNO Purple Book, 3.5	1×10^{-8}per year
Pipes (Scenario 2)			
75 mm – 150 mm	Full bore rupture – 3×10^{-7} m^{-1} y^{-1}	TNO Purple Book, Table 3.7	3×10^{-7} m^{-1} y^{-1}

5.3 Consequence and Frequency Assessment

5.3.1 Individual Fatality Risk

There are no existing residential premises, known future residential premises or recreational areas with population impacted by fatality risks from the potential occurrence of hazardous events from the Project. The risk of fatality at the nearest populated area (industrial) is calculated at 1.35 in a million per year for each scenario. This level is below the criterion for new installations of 50 in a million per year (50×10^{-6}).

5.3.2 Toxic Injury

For all scenarios there is a risk of injury to users of the surround industrial areas. There is no modelled risk of injury to residential receptors. The maximum risk of injury is calculated at 8.85 in a million per year for Scenario 2 which has the highest potential injury impact. Scenario 1 is 7.35 in a million per year and Scenario 3 is 1.35 in a million per year. This is below the recommended HIPAP No. 4 criterion of 10 in a million per year.

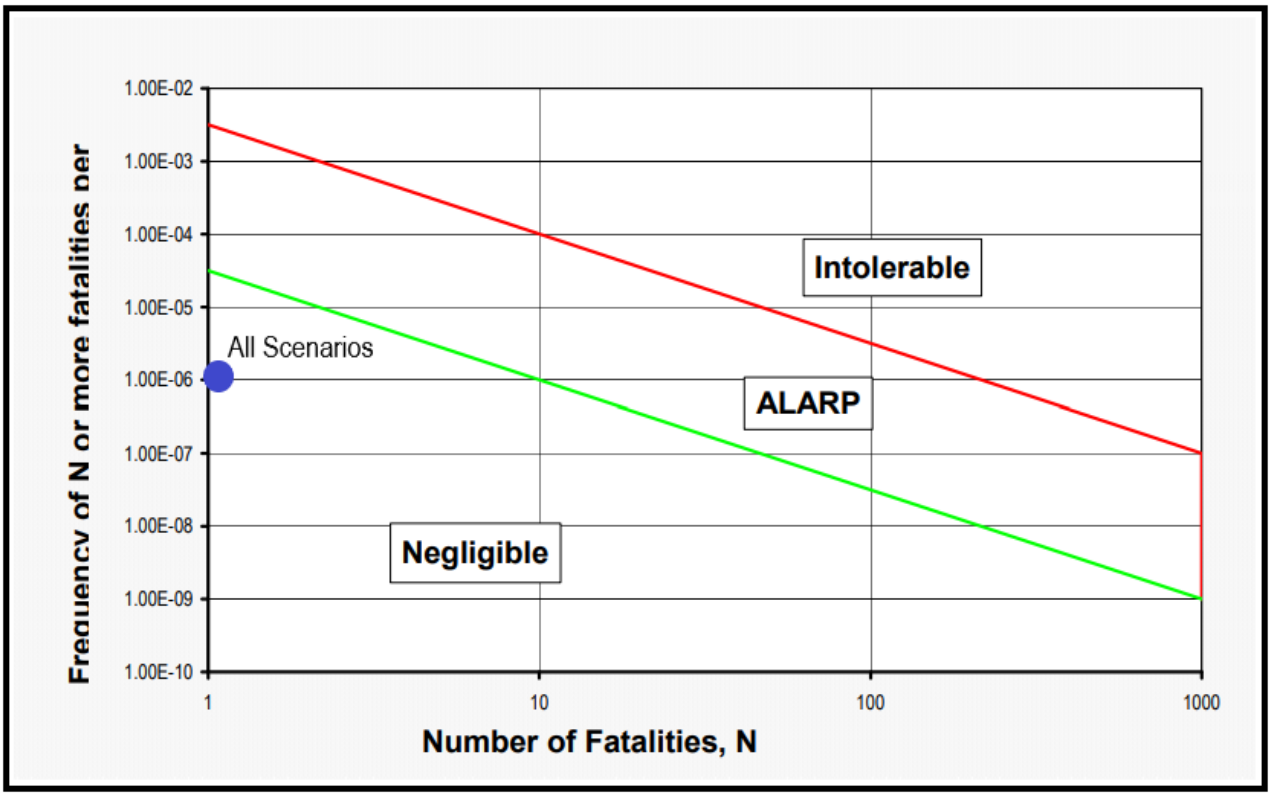
5.3.3 Irritation

For scenarios 1 and 2 there is a risk of irritation to residential surrounding land users of 0.024 in a million per year for Scenario 1 and 0.144 in a million per year for Scenario 2, from hazardous events. This is below the recommended HIPAP No. 4 criterion of 50 in a million per year.

For surrounding industrial land users there is a risk of irritation under all hazardous event scenarios considered. The maximum risk of irritation is calculated at 34.5 in a million per year for Scenario 2. Scenario 1 is 19.5 in a million per year and Scenario 3 is 10.2 in a million per year. These values are below the recommended HIPAP No. 4 criterion of 50 in a million per year.

5.3.4 Societal Risk

HIPAP No. 4 provides indicative societal risk criteria through the use of FN-curves (obtained by plotting the frequency at which such events might kill N or more people, against N). The scenarios have been plotted against the criteria figure below and are within the negligible portion.



5.4 Risk to Biophysical Environment

In Scenario 3, the ammonia releases as a liquid and evaporates to form a gas. The ammonia storage pit area is bunding and containment within the would greatly reduce the puddle size and surface area. Furthermore, the PHA has accounted for concrete pit gradient directing any release straight to the sump, sump cover and isolation of the covered sump to prevent offsite discharge. Based on the design and installation of bunding, release of liquid ammonia offsite is not considered a plausible scenario.

The only impacts to the surrounding environment would be the irritation and possible injury to nasal and respiratory systems of animals present in the potential impact areas. This could include any cattle grazing in the surrounding paddocks to the site.

5.5 Potential Cumulative Impacts

There are 11 existing dangerous good storages onsite. While the total ammonia charge of the connected existing and new systems was considered in Scenario 1, to consider whether an event had potential for cumulative impacts with other bulk chemicals under each scenario were analysed to consider whether blast overpressure could result in a release or trigger secondary ignition (Table 5-8).

Table 5-7 Analysis of Blast Overpressure

Hazardous Substance	Distance from Ammonia Vessel	Scenario 1	Scenario 2	Scenario 3
Ammonia Anhydrous (in existing accumulator)	18 m	6.41 kPa (0.93 psi)	6.55 kPa (0.948 psi)	6.55 kPa (0.948 psi)
Diesel	290 m	No overpressure	No overpressure	No overpressure
Liquid Petroleum Gas	188 m	No overpressure	No overpressure	No overpressure
Carbon Dioxide	44 m	4.25 Pa (0.616 psi)	6.55 kPa (0.948 psi)	No overpressure
Biogas (Methane)	830 m	No overpressure	No overpressure	No overpressure

The modelling indicates the following:

- Scenario 1 – Ignition by spark or flame does not result in exceedance of a Level of Concern (LOC)[8];
- Scenario 2 – Ignition by spark or flame does not result in exceedance of a LOC; and
- Scenario 3 – Ignition by spark or flame does not result in exceedance of a LOC.

The highest overpressure pressure of 0.948 psi for the existing ammonia accumulator is unlikely to cause a failure of the vessel. Table 5-9 provides the level of damage expected at specific overpressure values.

Table 5-8 Expected Level of Damage at Specific Overpressure Values

Overpressure (psig)	Expected Damage
0.15	Typical pressure for glass failure
0.40	Limited minor structural damage
0.70	Minor damage to structures
1.0	Partial demolition of houses
2.0	Partial collapse of walls and roofs of houses
3.0	Steel frame buildings distorted and pulled away from foundation
5.0	Wooden utility poles snapped
7.0	Loaded train cars overturned
9.0	Loaded train box cars demolished
10.0	Probable total building destruction

Source: Frank, 1980.

[8] An overpressure Level of Concern (LOC) is a threshold level of pressure from a blast wave, usually the pressure above which a hazard may exist. Default values are 1.0 psi (shattered glass), 3.5 psi (serious injury likely) and 8.0 psi (destruction of buildings).

5.6 Key Preventative Measures

CDM Smith's scope of works was limited to assessment and modelling of hazardous impacts in accordance with the NSW HIPAP 4 and 6 to determine if hazards related to the proposed facility could impact offsite areas. CDM Smith has determined that potential events arising from the facility could impact offsite areas in the unlikely event of a tank puncture or pipe failure. As such, the following are recommended preventative measures to reduce the likelihood of an event occurring and the consequence of the associated impacts both on and offsite:

Site Design

The external piping along the eastern side of the new plate freezer/store should protected from impact by vehicles or plant transiting along the adjacent road. Physical barriers should be installed to provide mechanical protection to the refrigeration system and speeds in this area must be kept to a minimum (e.g., 5 – 10 km/hr).

The plant room and plate freezer chamber and other possible areas where a leak could occur should have a leak tight floor which is bunded to contain the possible liquid leak. These areas require a means to draining ammonia from the floor into a tank or suitable container.

The plant room and plate freezer chamber, low temperature vessel and medium temperature vessel should have an ammonia gas detection and shunt trip of all possible non-hazardous electrical, ignition devices, general lighting, GPOs and such, as specified in AS1677.

Ammonia Storage Tank Pit Drainage

The following drainage measures are to be implemented in the ammonia storage tank pit to convey and capture potential liquid releases:

- Pit floor gradient to convey liquid directly to a dry sump;
- Sump to be covered (reduce evaporative surface area); and
- Sump to be isolated and prevent discharge of captured liquid ammonia.

Site Ventilation

Onsite ventilation system installed to dilute and disperse any internal spills to reduce the toxic gas exposure. The ventilation system should meet the AS 1677 ventilation rate requirements. This ventilation protects both onsite health and safety of workers and minimises toxic exposure offsite.

The following should be implemented when triggered:

- At 35 ppm (15 minute STEL), the programmable logic controller (PLC) Exhaust Air Fan should be run. Low level warning to be shown on PLC SCADA Screen and dialled out to refrigeration contractor and site manager. Appropriate safety gear (cylinder type respirators and safety goggles) to be used during repairs;
- At 200 ppm (100 ppm below IDHL) PLC should run the Exhaust Air Fan and stop refrigeration plant (soft stop). High level alarm will be shown on PLC SCADA Screen and dialled out to refrigeration contractor and site manager. Room operators should be evacuated as a precaution. Appropriate safety gear (breathing apparatuses and fully encapsulated suits) to be used during repairs; and
- At 20,000 ppm (10,000 ppm below 1/5 of LEL) PLC should run the Exhaust Air Fan and isolate all electrical circuits not protected for use in flammable environment (shunt trip). High level alarm should be shown on PLC SCADA

Screen and dialled out to refrigeration contractor and site manager. Room operators should be evacuated. Emergency services shall be notified. Appropriate safety gear (breathing apparatuses and fully encapsulated suits) to be used during repairs.

Hazardous Areas Classified and Signed

All ammonia hazardous areas on the site should be clearly identified, appropriately signed and correctly classified by industry competent persons.

Detection, Monitoring and Alarms

Section 4.8 of AS 1677.2:1998 (Refrigerating systems) relates to the specific refrigerant leak detector requirements associated with ammonia machinery rooms. The proponent should install within the plant room and vessel area, ammonia ppm detectors and an Ammonia Stack Light & Siren Alarm.

General Mitigation Measures

There are a number of general onsite health and safety practices which can be implemented to minimise the risk of an event which may have an offsite impact, these include:

- All ammonia vessels and pipework are either carbon steel or stainless steel, fully welded and pressure tested;
- Emergency exit lights should be installed above the man door and emergency lighting inside the plantroom;
- Correct and proper labelling of all piping and ammonia areas with appropriate signage is required;
- Scheduled and documented regular piping corrosion under insulation checks, 5 yearly relief valve Checks and 12 yearly vessel checks should be completed;
- Critical ammonia system isolation valves are required to be identified and clearly labelled as such;
- Personal portable ammonia detectors which are calibrated and in perfect working order can be utilised for appropriate personnel;
- A site windsock (or weather station) can be incorporated which is clearly visible from a large portion of the site;
- Site documentation clearly indicating the locations of ammonia vessels, isolation valves, personal protective equipment, emergency showers, emergency evacuation locations to be located at the main entrance to allow emergency services quick response ability to minimise any chance of offsite and onsite impacts;
- A detailed, well documented and regularly rehearsed Emergency Response Plan (addressing ammonia) is required to be developed and implemented. A copy of this should also be located in the Red Hazmat Box at the main site entry gate. Local emergency services should be included in the development, implementation and rehearsal of this plan;
- There are two sets of breathing apparatuses and fully encapsulated suits installed outside the plantroom; and
- Site neighbours within potential injury zones should be included within the site's Emergency Response Plan.

Compliance with Applicable Australian Standards and Codes

To ensure a high standard system the following standards should be meet:

- AS 2430.3.1:2004 (Classification of hazardous areas) & Section 7 of AS 2430.3.9:2004 (Classification of hazardous areas) - specific ventilation requirements associated with the dilution and dispersion of hazardous gases and vapours to the required concentration levels;
- AS60079.10.1:2009 (Explosive atmospheres – Classification of areas – Explosive gas atmospheres (IEC60079-10-1, Ed.1.0 (2008) MOD)); and
- Section 4.7 of AS 1677.2:1998 (Refrigerating systems).

5.7 SEPP (Resilience and Hazards) 2021 Definitions

SEPP (Resilience and Hazards) 2021 provides the definition for potentially hazardous industry and potentially offensive industry. The definitions are used to classifying developments with significant residual offsite risk to human health, life, property or the biophysical environment. The definitions are as follows:

- ***Hazardous industry*** *means a development for the purposes of an industry which, when the development is in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the development from existing or likely future development on other land in the locality), would pose a significant risk in relation to the locality—*

  (a) to human health, life or property, or

  (b) to the biophysical environment.

- ***Hazardous storage establishment*** *means any establishment where goods, materials or products are stored which, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the establishment from existing or likely future development on the other land in the locality), would pose a significant risk in relation to the locality—*

  (a) to human health, life or property, or

  (b) to the biophysical environment.

- ***Offensive industry means*** *a development for the purposes of an industry which, when the development is in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the development from existing or likely future development on other land in the locality), would emit a polluting discharge (including, for example, noise) in a manner which would have a significant adverse impact in the locality or on the existing or likely future development on other land in the locality.*

- ***Offensive storage establishment*** *means any establishment where goods, materials or products are stored which, when in operation and when all measures proposed to reduce or minimise its impact on the locality have been employed (including, for example, measures to isolate the establishment from existing or likely future development on other land in the locality), would emit a polluting discharge (including, for example, noise) in a manner which would have a significant adverse impact in the locality or on the existing or likely future development on other land in the locality.*

Should the proponent implement the management measures involving technical and operational controls listed in Table 4-7, and the key preventative measures in Section 5.6, the resultant mitigated risk for each scenario is considered low, such that it does not align with the definition of hazardous or offensive industry listed above.

Section 6 Conclusion

Wiley commissioned CDM Smith to complete a PHA for an upgrade to the existing Teys Abattoir facility at 1 Dampier Street, Bomen New South Wales (Lot 1 on DP1213252) (termed the MOD 12 upgrade). The proponent (Teys Australia Southern Property Pty Ltd) is proposing to modify the facility to include a new plate freezer/store, a new switch room and temporary workshop. There is existing ammonia stored on site totalling 41.71 tonne. The existing ammonia circulates in a closed-loop system consisting of compressors, condensers, pumps and accumulator vessels. Gaseous ammonia is compressed, condensed and cooled into liquid form, then pumped to an accumulator vessel where the cold liquid ammonia is pumped through the plate freezers to freeze boxes of meat product. The additional ammonia required for the development is 23.59 tonne and will be connected through piping to the existing engine room and courtyard ammonia refrigeration system (refer to Table 2-2 and Figure 6). The new system will contain a total of 32.34 tonnes of ammonia, while the entire storage onsite (including other disconnected systems) will total 65.30 tonnes.

This PHA identifies and assesses hazards and risks associated with the introduction and use of a hazardous chemical at the Teys Wagga Wagga Abattoir, for the purposes of planning approval. In accordance with hazard assessment criteria and the purpose of a PHA, the analysis focuses on potential for offsite impacts to determine whether risk levels from changes to the facility are acceptable at the planning approval stage.

This PHA Report was prepared with consideration of the SEPP 33 Guideline and HIPAP No. 4 and No 6[9]. To determine compliance with the risk criteria in Table 2, quantitative modelling was completed for three hazardous release scenarios for anhydrous ammonia. A summary of each is provided below:

- **Scenario 1** – Under the worst-case weather scenario, the model predicted a concentration of 30 ppm would be experienced at up to a distance of 1.7 km directly downwind of the facility, although this would be short lived (i.e seconds). The AEGL-3 (60 min) concentration of 1,100 ppm within 447 m downwind of the tank. The second, and more likely weather scenario, applied is a normal (unsteady) climatic environment (Stability Class D). Under the more likely weather conditions the model predicted a concentration of 30 ppm would be present at a maximum distance of 887 m downwind of the facility. The AEGL-3 (60 min) concentration of 1,100 ppm extends to 147 m downwind of the tank.

  The model indicates that ammonia gas released in the worst case weather conditions would rapidly increase concentration due to the pressurised release. Under the worst case weather conditions the outdoor concentration at the closest sensitive receptor to the release (SR1) with a direct south-east wind, reaches the AEGL-1 (60 min) level at 18 minutes after the release (peaking at roughly 140 ppm) and dropping below the AEGL-1 (60 min) level at 32 minutes.

  The potential impact on surrounding residential and industrial land users for this scenario was carried through into consequence calculation and frequency assessment, using the worst case weather scenario results. Based on the modelled scenario there is no risk of fatality or injury at a residential receptor, but there is a risk of irritation to a single residence depending on the direction of the plume. The risk of irritation to residential surrounding land users is calculated at 0.024 in a million per year for Scenario 1. This is below the recommended HIPAP No. 4 criterion of 50 in a million per year.

  Surrounding industrial land uses could be exposed to the risk of irritation, injury and fatality. The calculation of the potentially affected land users assumed the plume would be directed to the north, thus impacting the greatest number of persons external to the facility boundary. For Scenario 1 there is a risk of irritation to industrial surrounding land users of 19.5 in a million per year from hazardous events. This is below the recommended HIPAP

[9] The SEPP 33 guideline is still taken to be valid, despite the repeal of SEPP 33 and inclusion of provisions for hazardous and offensive development within SEPP (Resilience and Hazards) 2021

No. 4 criterion of 50 in a million per year. The maximum risk of injury is calculated at 7.35 in a million per year for Scenario 1, which is below the recommended HIPAP No. 4 criterion of 10 in a million per year. The risk of fatality at the nearest populated area (industrial) is calculated at 1.35 in a million per year for Scenario 1 which is below the recommended HIPAP No. 4 criterion of 50 in a million per year (50×10^{-6}).

- **Scenario 2** – In the worst case (steady) weather conditions, event scenario 2 could result in a maximum outdoor concentration of 190 ppm of at the closest sensitive receptor (reaching the AEGL-2 (60 min) level but rapidly dissipates and would not result in a risk of injury and unlikely to cause irritation for such a short period (i.e. less than 5 minutes which is less than AEGL-2 (10 min)) (Figure 13). Under normal conditions the concentration would rapidly peak and dissipate to 0 ppm within 4 minutes. Exposure does not exceed the AEGL-1 (60 min) level, but does exceed AEGL (10 min) at the nearest receptor and thus could cause irritation.

  Under the more likely weather scenario the model predicted a concentration of 30 ppm at a maximum distance of up to 1,100 m downwind of the facility and would rapidly peak and dissipate to 0 ppm within 5 min. The AEGL-3 (60 min) concentration of 1,100 ppm occurs 190 m downwind of the facility, which would just encompass Byrnes Rd in the east and portion of industrial uses to the north and east. The model indicates that ammonia gas released in an unsteady weather would dissipate quickly.

  In either scenario, levels of gaseous ammonia downwind of the release would be temporarily above safe levels for transport on the Byrnes Road and the immediately adjacent transport storage/industrial area, should the release occur during winds which would push the gas east or the north. The concentrations would rapidly peak at approximately 1,100 ppm and dissipate to 0 ppm within 4 minutes. Thus, this level does not reach the AEGL-1 for 10 minutes of exposure.

  Based on the modelled scenario there is no risk of fatality or injury at a residential receptor, but there is a risk of irritation to up to six residential receptors depending on the direction of the plume. The risk of irritation to residential surrounding land users is calculated at 0.144 in a million per year for Scenario 2. This is below the recommended HIPAP No. 4 criterion of 50 in a million per year.

  Surrounding industrial land uses could be exposed to the risk of irritation, injury and fatality. For Scenario 2 there is a risk of irritation to industrial surrounding land users of 34.5 in a million per year from hazardous events. This is below the recommended HIPAP No. 4 criterion of 50 in a million per year. The maximum risk of injury is calculated at 8.85 million per year for Scenario 2, which is below the recommended HIPAP No. 4 criterion of 10 in a million per year. The risk of fatality at the nearest populated area (industrial) is calculated at 1.35 in a million per year for Scenario 2 which is below the recommended HIPAP No. 4 criterion of 50 in a million per year (50×10^{-6}).

- **Scenario 3** – In the worst case (steady) climatic conditions, event scenario 3 could result in a maximum outdoor concentration of 25 ppm of at the closest sensitive receptor from the source, which is below the AEGL-1 (10 min, 60 min) level (Figure 17). The concentration would rapidly peak after approximately 30 minutes and slowly dissipate. AEGL-1 (10 min, 60 min) and AEGL-2 (10 min, 60 min) would not be exceeded at any of the surrounding sensitive receptors. Such concentrations would not result in risk of irritation or injury.

  Under normal conditions it take 5 minutes to reach an outdoor concentration peak of 1.8 ppm at the nearest sensitive receptor and does not exceed any AEGL threshold. This is unlikely to result in risk of injury or irritation at the closest sensitive receptor to the release. For the industrial use, the model does show concentrations lingering above AEGL-3 (60 min) just beyond the northern boundary for over 60 minutes.

  Based on the modelled scenario there is no risk of fatality, injury or irritation at a residential receptor. Surrounding industrial land uses could be exposed to the risk of irritation, injury and fatality. For Scenario 3 there is a risk of irritation to industrial surrounding land users of 10.2 in a million per year from hazardous events. This is below the recommended HIPAP No. 4 criterion of 50 in a million per year. The maximum risk of injury is calculated at 1.35 min a million per year for Scenario 3, which is below the recommended HIPAP No. 4 criterion of 10 in a million per

year. The risk of fatality at the nearest populated area (industrial) is calculated at 1.35 in a million per year for Scenario 3 which is below the recommended HIPAP No. 4 criterion of 50 in a million per year (50 x 10^{-6}).

Under each scenario, the flammable threat zone for both normal and worst case weather conditions is localised to the plant and immediately adjacent laydown, industrial and transport land uses and does not present a hazard to sensitive receptors, nor does the extent of the hazard area incorporate additional offsite users beyond the levels considered for the toxic threat zone.

Based on the findings in the assessment completed as part of this PHA, members of the community at residential sensitive receptors are unlikely to experience a risk of injury or fatality. Persons outdoors within the industrial or rural use zones may experience irritation and injury. Severe injury and fatality risk is limited to the existing facility and neighbouring industrial or open space areas. The consequence calculation and frequency assessment indicates that for each of the scenarios considered the risk of irritation, injury and fatality are below the recommended criterion in HIPAP No. 4.

Should the proponent implement the management measures involving management, technical and operational controls listed in Table 4-7, and the key preventative measures in Section 5.6, the resultant mitigated risk for each scenario is considered sufficiently low so as not to introduce excessive risk to the surrounding community and biophysical environment. The resultant mitigated risk for each scenario does not align with the definition of hazardous or offensive industry listed in Chapter 3 of SEPP (Resilience and Hazards) 2021.

Section 7 References

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Silverman L, Whittenberger J.L and Muller J (1946), *Physiological Response of Man to Ammonia in Low Concentrations*, J Ind Hyg Toxicol 31:74-78.

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Appendix A Project Team

Hazard Analysis Team

Personnel	Qualification	Experience
Andrew Gray	Senior Principal Engineer	Andrew Gray is a Senior Principal Engineer with CDM Smith with over 25 years' experience, based in Melbourne, Australia. Mr. Gray is an engineering professional with a wide range of experience in soil, water and groundwater engineering and remediation, construction dewatering, decommissioning and demolition, industrial water treatment, municipal water supply engineering, permeable reactive barriers and slurry walls, underground storage tank installation and removal, and regulatory compliance and agency interaction. Mr. Gray completed the initial site visit to inform the PHA and acted as technical reviewer.
Karthick Poosekar	Principal Process Safety Engineer	Karthick Poosekar (PE, BCEE) is a Principal Project Manager and Process Safety Engineer with extensive experience in process safety management and risk management for large industrial operations. As a Process Safety Engineer, Karthick responsible for the OSHA Process Safety Management Program and the EPA Risk Management Program for a refinery of about 350 employees and about 300 contractors. Karthick is a Board Certified Environmental Engineer, American Academy of Environmental Engineers and Scientists. Karthick has also amassed considerable experience in regulatory compliance, design of water and wastewater collection and treatment, hazardous waste remediation and environmental due diligence projects. Karthick has worked on the hazard and risk assessment components for numerous industrial projects internationally.
Elizabeth Bott	Senior Environmental Engineer	Elizabeth Bott is an experience environmental engineer with a background in industrial and municipal projects. She has experience providing environmental consulting services to the energy, transportation and manufacturing industries. Her work includes conducting Spill Prevention Control and Countermeasure plans, Stormwater Pollution Prevention Plans, Phase I and II Environmental Site Assessments, Hazardous Waste Analysis and Reporting, and Tier II Reporting. Ms. Bott acted as technical reviewer for the PHA modelling component.
Tim Kinny	Senior Environmental Consultant	Tim Kinny is a Senior Environmental Consultant at CDM Smith. Tim has experience in environmental and hazard risk assessment, due diligence, statutory development, strategic planning and environmental impact assessment roles in government and private industry. Mr. Kinny has been involved in numerous health and safety and hazard and risks assessments for developments, including large-scale resource, waste, energy and infrastructure projects throughout Australia. Mr. Kinny has been working in the sector for over 12 years and has completed numerous risk assessments, including quantitative Preliminary Hazard Analysis. Mr. Kinny was a lead author of the hazard analysis including preparation of the modelling.
John Herron	Principal Environmental Scientist	John Herron has extensive experience in environmental impact, hazard and risk assessment across a variety of infrastructure, energy and resources projects. This experience has been acquired through working on some of the most environmentally, socially and culturally sensitive projects throughout Australia. Mr. Herron acted as a quality reviewer for the PHA.

Appendix B Property Report

Property Report

1 DAMPIER STREET BOMEN 2650

Property Details

Address:	1 DAMPIER STREET BOMEN 2650		
Lot/Section /Plan No:	1/-/DP1213252	1/-/DP1218728	4/-/DP576937
Council:	WAGGA WAGGA CITY COUNCIL		

Summary of planning controls

Planning controls held within the Planning Database are summarised below. The property may be affected by additional planning controls not outlined in this report. Please contact your council for more information.

Land Zoning	RAZ - Rural Activity Zone: (pub. 2-12-2021)
	REZ - Regional Enterprise Zone: (pub. 2-12-2021)
Height Of Building	NA
Floor Space Ratio	NA
Minimum Lot Size	NA
Heritage	NA
Land Reservation Acquisition	NA
Foreshore Building Line	NA
Additional Permitted Uses	
Terrestrial Biodiversity	Environmentally Sensitive Area

Detailed planning information

State Environmental Planning Policies which apply to this property

State Environmental Planning Policies can specify planning controls for certain areas and/or types of development. They can also identify the development assessment system that applies and the type of environmental assessment that is required.

- State Environmental Planning Policy (Biodiversity and Conservation) 2021: Allowable Clearing Area (pub. 2-12-2021)
- State Environmental Planning Policy (Biodiversity and Conservation) 2021: Land Application (pub. 2-12-2021)
- State Environmental Planning Policy (Biodiversity and Conservation) 2021: Subject Land (pub. 2-12-2021)
- State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004: Land Application (pub. 25-6-2004)
- State Environmental Planning Policy (Exempt and Complying Development Codes) 2008: Land Application (pub. 12-12-2008)
- State Environmental Planning Policy (Housing) 2021: Land Application (pub. 26-11-2021)
- State Environmental Planning Policy (Industry and Employment) 2021: Land Application (pub. 2-12-2021)
- State Environmental Planning Policy (Planning Systems) 2021: Land Application (pub. 2-12-2021)
- State Environmental Planning Policy (Precincts—Regional) 2021: Wagga Wagga Activation Precinct (pub. 2-12-2021)
- State Environmental Planning Policy (Primary Production) 2021: Land Application (pub. 2-12-2021)
- State Environmental Planning Policy (Resilience and Hazards) 2021: Land Application (pub. 2-12-2021)
- State Environmental Planning Policy (Resources and Energy) 2021: Land Application (pub. 2-12-2021)
- State Environmental Planning Policy (Transport and Infrastructure) 2021: Land Application (pub. 2-12-2021)
- State Environmental Planning Policy (Transport and Infrastructure) 2021: Subject Land (pub. 2-12-2021)
- State Environmental Planning Policy No 65—Design Quality of Residential Apartment Development: Land Application (pub. 26-7-2002)

Property Report

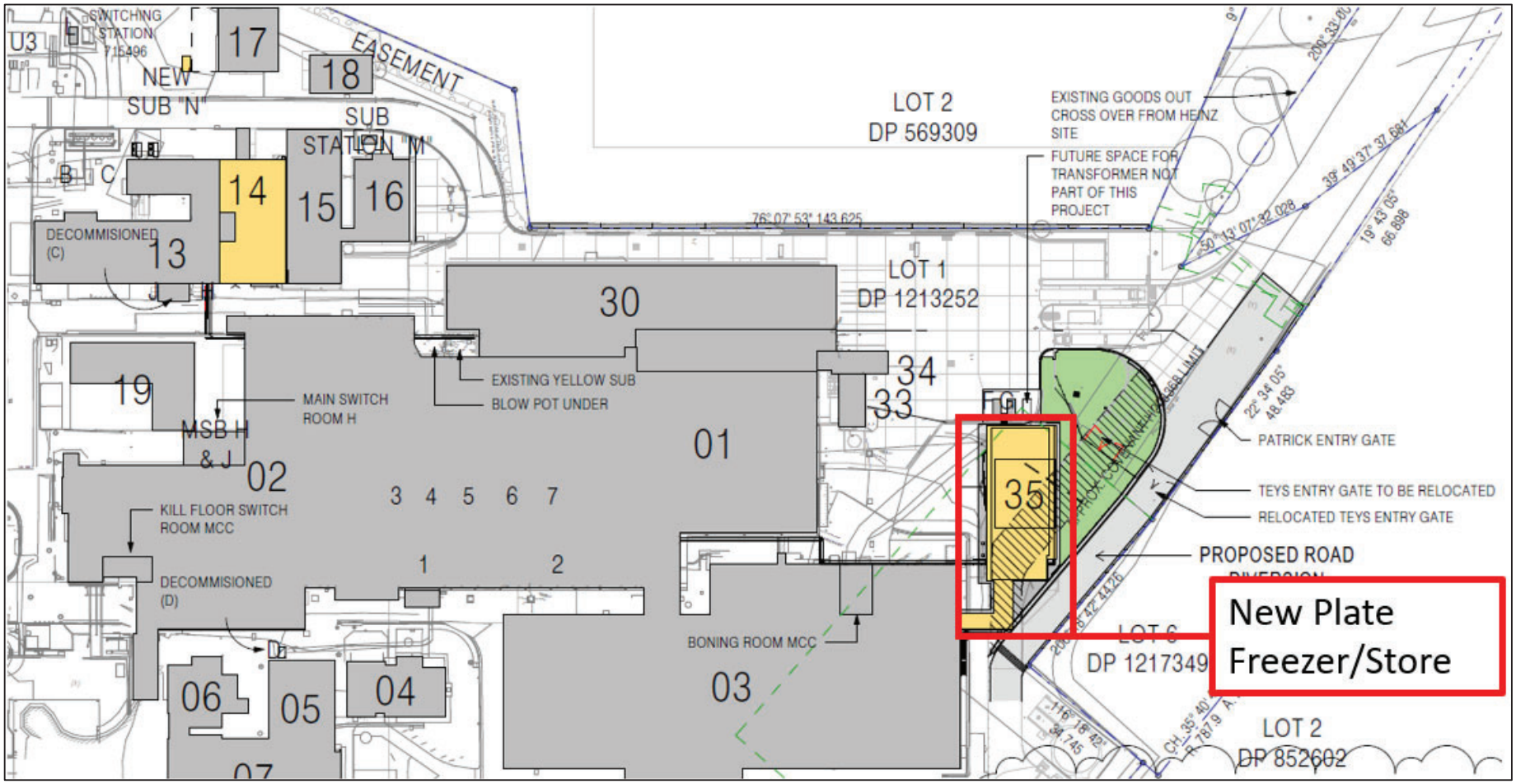
1 DAMPIER STREET BOMEN 2650

Other matters affecting the property

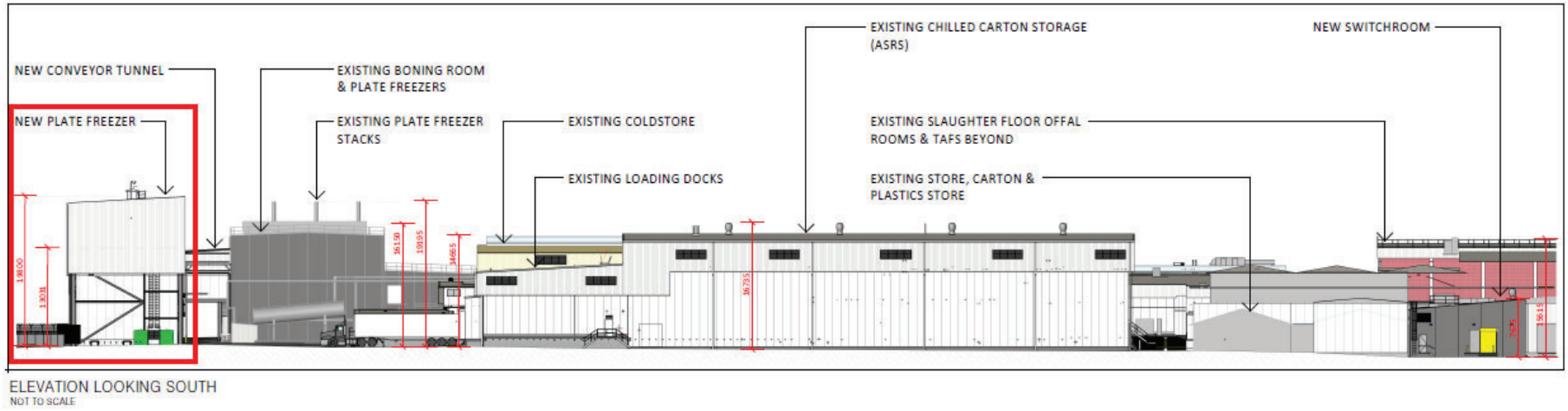
Information held in the Planning Database about other matters affecting the property appears below. The property may also be affected by additional planning controls not outlined in this report. Please speak to your council for more information

Land near Electrical Infrastructure	This property may be located near electrical infrastructure and could be subject to requirements listed under ISEPP Clause 45. Please contact Essential Energy for more information.
Land near High Pressure Pipelines	This property may be located near High Pressure Pipelines and could be subject to requirements listed under ISEPP Clause 66C. Please contact the relevant consent authority for more information.
Local Aboriginal Land Council	WAGGA WAGGA
Regional Plan Boundary	Riverina Murray

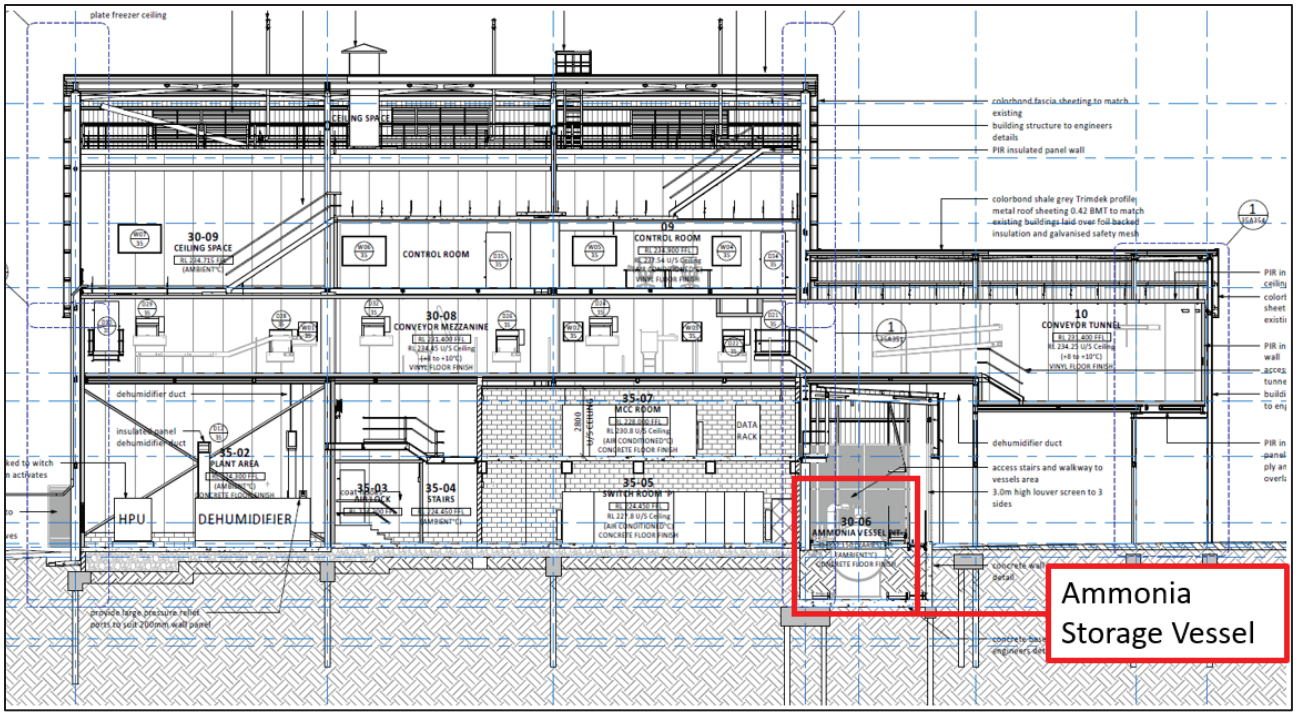
Appendix C Development Plans



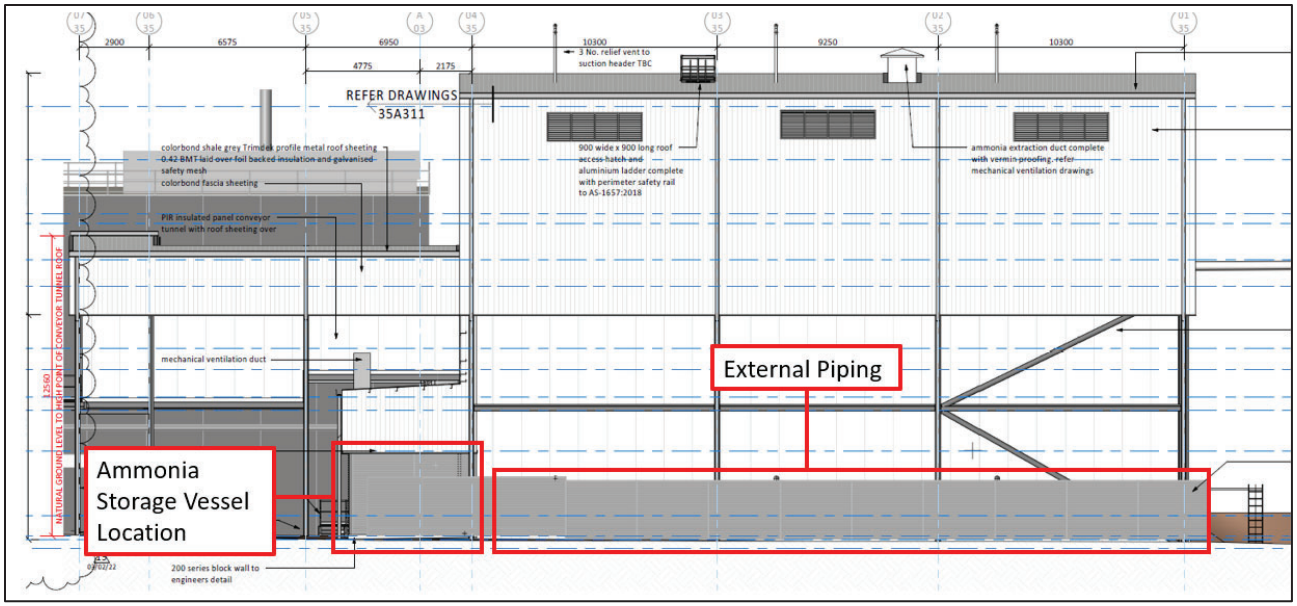
Facility Layout and Plate Freezer/Store Location



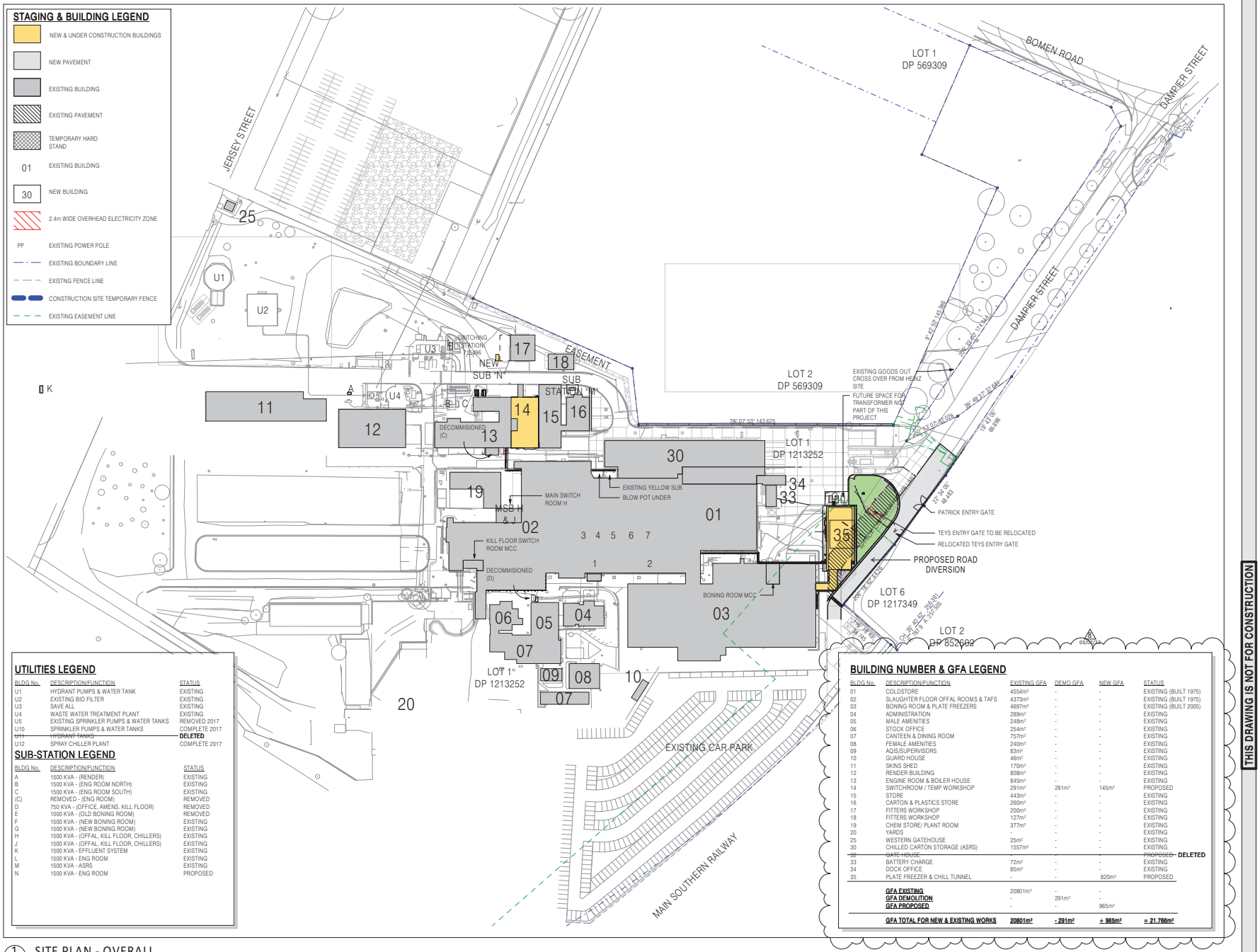
Elevation Looking South Showing Plate Freezer on the Left



Building Section Showing Ammonia Storage Vessel Location



East (External Facing) Elevation Showing Ammonia Storage Vessel and External Piping



UTILITIES LEGEND

BLDG No.	DESCRIPTION/FUNCTION	STATUS
U1	HYDRANT PUMPS & WATER TANK	EXISTING
U2	EXISTING BIO FILTER	EXISTING
U3	SAVE ALL	EXISTING
U4	WASTE WATER TREATMENT PLANT	EXISTING
U5	EXISTING SPRINKLER PUMPS & WATER TANKS	REMOVED 2017
U10	SPRINKLER PUMPS & WATER TANKS	COMPLETE 2017
U11	HYDRANT TANKS	DELETED
U12	SPRAY CHILLER PLANT	COMPLETE 2017

SUB-STATION LEGEND

BLDG No.	DESCRIPTION/FUNCTION	STATUS
A	1500 KVA - (RENDER)	EXISTING
B	1500 KVA - (ENG ROOM NORTH)	EXISTING
C	1500 KVA - (ENG ROOM SOUTH)	EXISTING
(C)	REMOVED - (ENG ROOM)	REMOVED
D	750 KVA - (OFFICE, AMENS, KILL FLOOR)	REMOVED
E	1000 KVA - (OLD BONING ROOM)	REMOVED
F	1500 KVA - (NEW BONING ROOM)	EXISTING
G	1500 KVA - (NEW BONING ROOM)	EXISTING
H	1500 KVA - (OFFAL, KILL FLOOR, CHILLERS)	EXISTING
J	1500 KVA - (OFFAL, KILL FLOOR, CHILLERS)	EXISTING
K	1500 KVA - EFFLUENT SYSTEM	EXISTING
L	1500 KVA - ENG ROOM	EXISTING
M	1500 KVA - ASRS	EXISTING
N	1500 KVA - ENG ROOM	PROPOSED

BUILDING NUMBER & GFA LEGEND

BLDG No.	DESCRIPTION/FUNCTION	EXISTING GFA	DEMO GFA	NEW GFA	STATUS
01	COLDSTORE	4554m²	-	-	EXISTING (BUILT 1975)
02	SLAUGHTER FLOOR OFFAL ROOMS & TAFS	4373m²	-	-	EXISTING (BUILT 1975)
03	BONING ROOM & PLATE FREEZERS	4697m²	-	-	EXISTING (BUILT 2005)
04	ADMINISTRATION	289m²	-	-	EXISTING
05	MALE AMENITIES	248m²	-	-	EXISTING
06	STOCK OFFICE	254m²	-	-	EXISTING
07	CANTEEN & DINING ROOM	757m²	-	-	EXISTING
08	FEMALE AMENITIES	240m²	-	-	EXISTING
09	AQIS/SUPERVISORS	83m²	-	-	EXISTING
10	GUARD HOUSE	46m²	-	-	EXISTING
11	SKINS SHED	170m²	-	-	EXISTING
12	RENDER BUILDING	808m²	-	-	EXISTING
13	ENGINE ROOM & BOILER HOUSE	845m²	-	-	EXISTING
14	SWITCHROOM / TEMP WORKSHOP	291m²	291m²	145m²	PROPOSED
15	STORE	443m²	-	-	EXISTING
16	CARTON & PLASTICS STORE	260m²	-	-	EXISTING
17	FITTERS WORKSHOP	200m²	-	-	EXISTING
18	FITTERS WORKSHOP	127m²	-	-	EXISTING
19	CHEM STORE/ PLANT ROOM	377m²	-	-	EXISTING
20	YARDS	-	-	-	EXISTING
25	WESTERN GATEHOUSE	25m²	-	-	EXISTING
30	CHILLED CARTON STORAGE (ASRS)	1557m²	-	-	EXISTING
32	GATE HOUSE	-	-	-	PROPOSED DELETED
33	BATTERY CHARGE	72m²	-	-	EXISTING
34	DOCK OFFICE	85m²	-	-	EXISTING
35	PLATE FREEZER & CHILL TUNNEL	-	-	820m²	PROPOSED
	GFA EXISTING	20801m²	-	-	
	GFA DEMOLITION	-	291m²	-	
	GFA PROPOSED	-	-	965m²	
	GFA TOTAL FOR NEW & EXISTING WORKS	20801m²	- 291m²	+ 965m²	= 21,786m²

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ADVICE◆ DESIGN◆ ENGINEERING◆ CONSTRUCTION

N

REAL PROPERTY DESCRIPTION

LOT: 1
DP: DP1213252
LGA: WAGGA WAGGA
LOCALITY: 1 DAMPIER STREET, BOMEN, NORTH WAGGA WAGGA
PARISH: NORTH WAGGA WAGGA
COUNTY: CLARENDON

Date	Issue	Amendment	Init
03/02/22	8	REVISED DA ISSUE	AJ
31/01/22	7	GMP SUBMISSION	SC
25/11/21	6	TENDER ISSUE	BC
05/11/21	5	FOR REVIEW	BC
19/10/21	4	FOR CLIENT REVIEW	BC
06/10/21	3	FOR CLIENT REVIEW	BC
05/10/21	2	ISSUED TO MPN	AJ
24/09/21	1	ISSUE FOR REVIEW	AJ

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WAGGA WAGGA, NSW

Drawing Title

OVERALL SITE PLAN

Scale A1 = 1: 1000(A3 = 1: 2000) 0 10 20

Drawn BC | Date SEPT 2021

Project No. W25813 | Bldg No. 00

Drawing No. 00A001 - 8 | Issue

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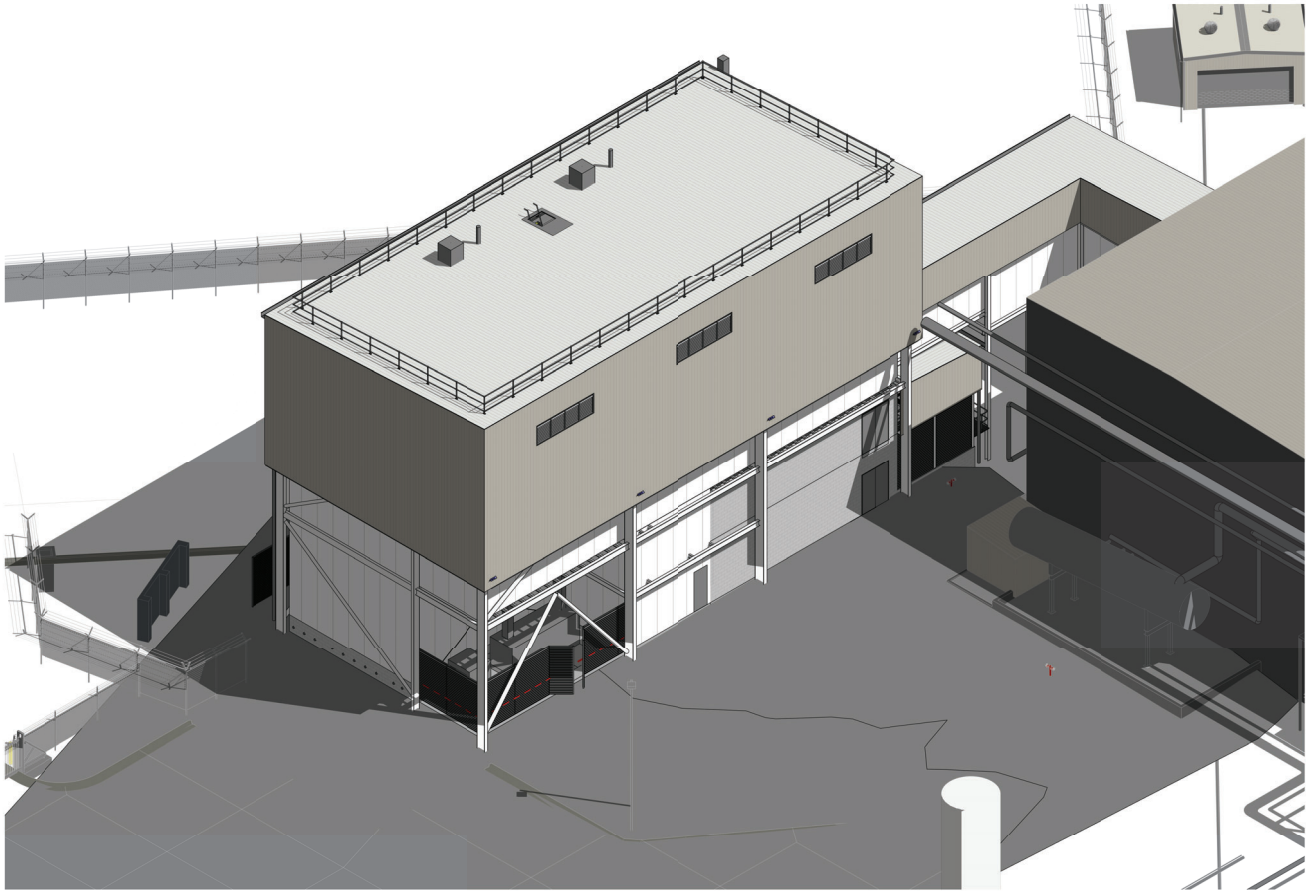
TEYS AUSTRALIA
ABATTOIR PLATE FREEZER
DAMPIER ST, WAGGA WAGGA, NSW



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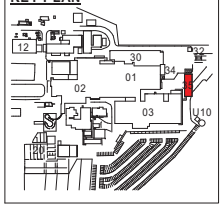

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24/09/21	6	ISSUE FOR REVIEW	AJ
11/06/21	5	VESSEL AREA REVISED	AJ
10/06/21	4	CONCEPT PHASE CLIENT SUBMISSION	AJ
31/05/21	3	AWNING OVER AMMONIA VESSELS ADDED, BLOCK WORK TO MCC & UNDER PLATE FREEZER STRUCTURAL SLAB SHOWN, GENERAL REVISION	AJ
10/05/21	2	REVISIONS AS PER CLIENT MEETING	AJ
06/05/21	1	GENERAL REVISION	AJ

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Drawing Title

COVER PAGE

DRAWING NUMBER LEGEND

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BUILDING No.

00	SITE DRAWINGS
01	BUILDING No. 01 drawings

DRAWING DISCIPLINE

A	ARCHITECTURAL
C	CIVIL
E	ELECTRICAL
F	FIRE
H	HYDRAULICS
K	ARCHITECTURAL SKETCH
M	MECHANICAL
P	PROCESS SKETCH
R	REFRIGERATION
S	STRUCTURAL
X	EXISTING
D	DEMOLITION

DRAWING SERIES

000	SITE & SITEWORKS
100	PLANS
200	ELEVATIONS
300	SECTIONS
400	PART SECTIONS
500	CONSTRUCTION DETAILS
600	TRADE SPECIFIC
700	DETAILED AREAS
800	SPARE
900	SCHEDULES

DRAWING ISSUE / REVISION

1, 2, 3....	DRAWING ISSUE / REVISION

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Bldg No.	35
Drawing No.	35A000
Issue	6

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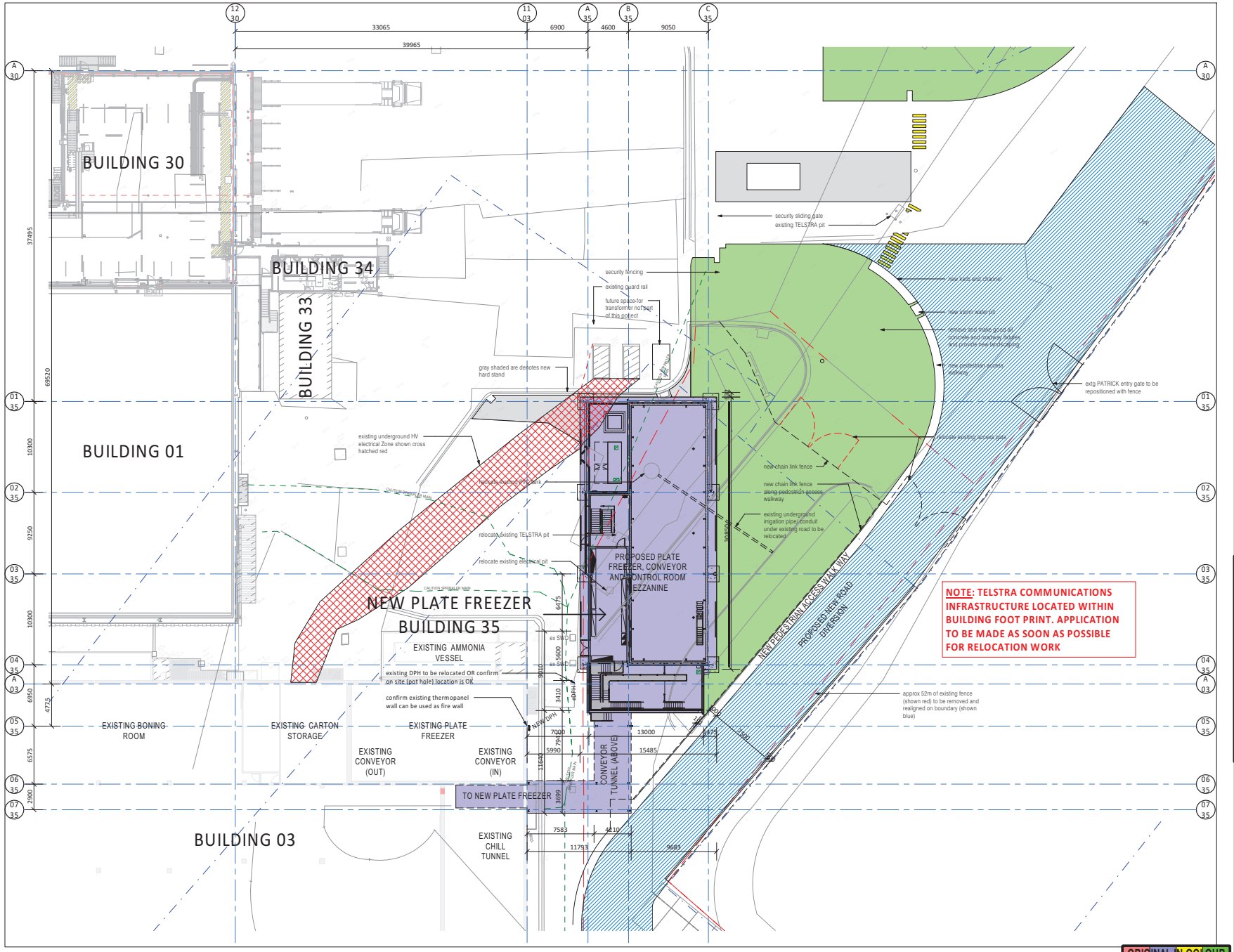

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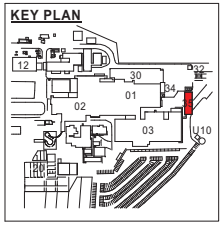

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14/07/21	8	BUILDING 30 REFERENCE GRIDS ADDED	AJ
11/06/21	7	NOTES ADDED, LANDSCAPING , HARDSTAND, PATHWAY, FENCING & GATES SHOWN, VESSELS REVISED	AJ
10/06/21	6	CONCEPT PHASE CLIENT SUBMISSION	AJ
31/05/21	5	AWNING OVER AMMONIA VESSELS ADDED, BLOCK WORK TO MCC & UNDER PLATE FREEZER STRUCTURAL SLAB SHOWN, GENERAL REVISION	AJ

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Drawing Title

PROPOSED NEW PLATE FREEZER BUILDING

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Project No. W25813 | Bldg No. 35
Drawing No. 35A004 - 9 | Issue
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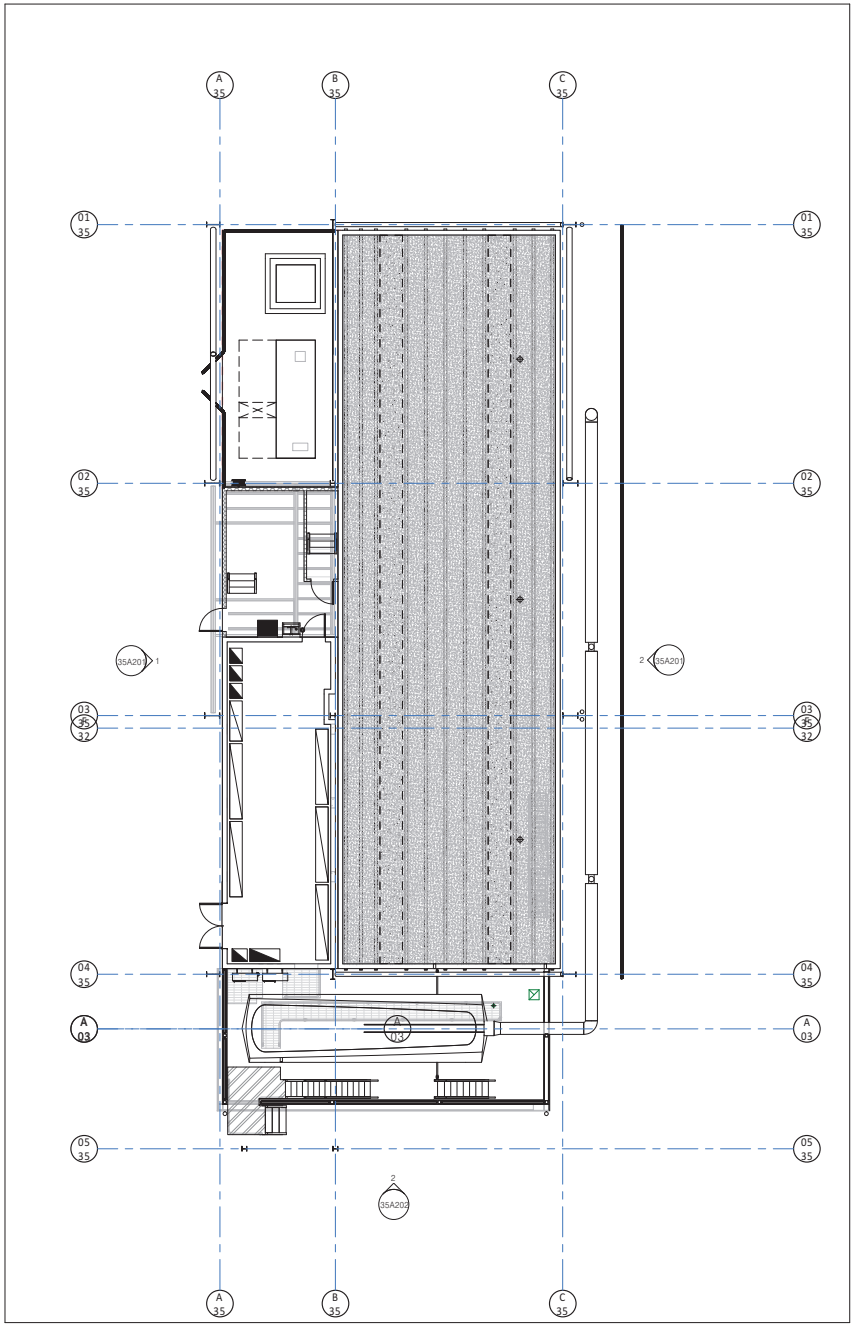

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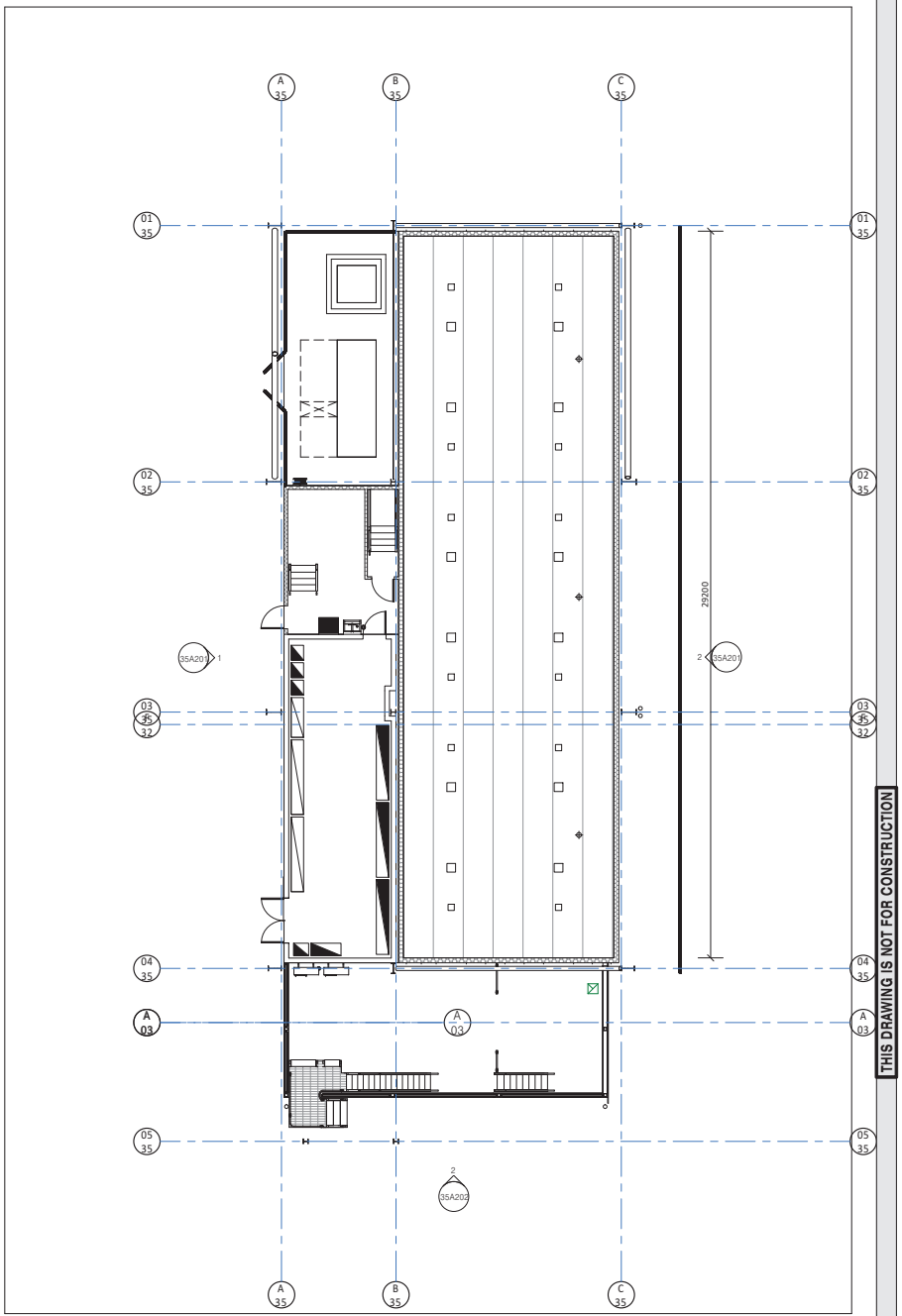

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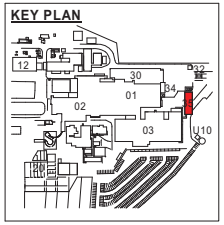

Date	Issue	Amendment	Init
24/09/21	1	ISSUE FOR REVIEW	AJ

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Drawing Title

VENT PIPES, BEAMS, BLOCK WALLS & STRUCTURAL SLAB

Scale

Drawn BC | Date SEPT 2021

Project No. W25813 | Bldg No. 35

Drawing No. 35A011 - 1 | Issue

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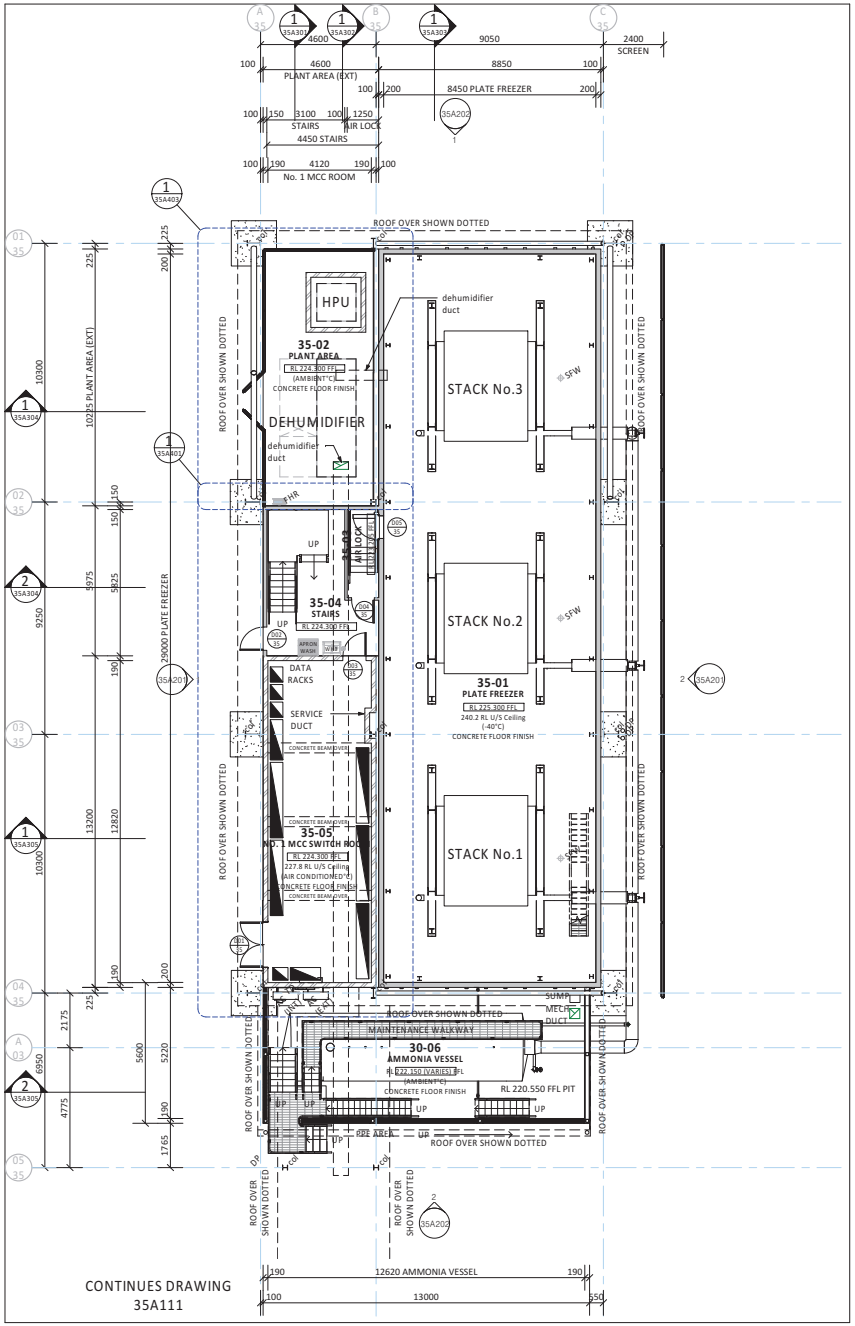
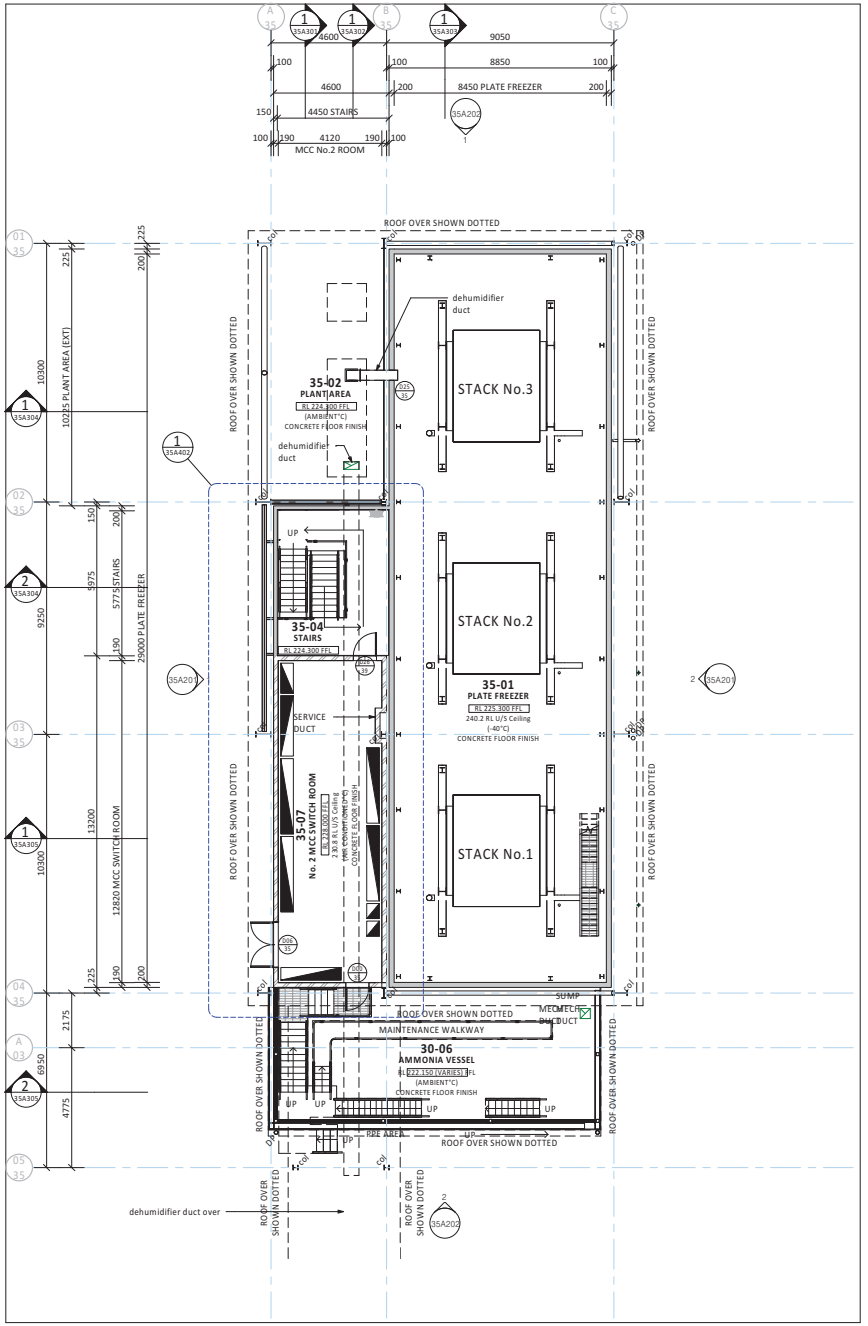
ADVICE◆ DESIGN◆ ENGINEERING◆ CONSTRUCTION

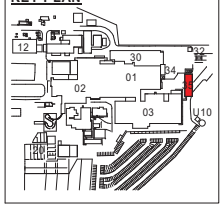


1 GROUND FLOOR PLAN
A1 = 1 : 100



2 UPPER MCC SWITCH ROOM
A0 = 1 : 100

KEY PLAN



NOTE:

- provide zone rated fittings to ammonia vessels area
- all conduits in plate freezer to be stainless steel
- all conduits in non freezer areas to be PVC
- all insulated panel joints must be core to core connection and or foam filled and sealed to prevent green mould forming on external joints
- plate freezer and tunnel walls to be restrained with mushroom nut girt/ wind beam fixings for seismic compliance

Date	Issue	Amendment	Init
24/09/21	7	ISSUE FOR REVIEW	AJ
11/06/21	6	VESSEL AREA REVISED	AJ
10/06/21	5	CONCEPT PHASE CLIENT SUBMISSION	AJ
31/05/21	4	AWNING OVER AMMONIA VESSELS ADDED, BLOCK WORK TO MCC & UNDER PLATE FREEZER STRUCTURAL SLAB SHOWN, GENERAL REVISION	AJ
10/05/21	3	REVISIONS AS PER CLIENT MEETING	AJ
06/05/21	2	GENERAL REVISION	AJ
28/04/21	1	INITIAL ISSUE	AJ

BRISBANE KUALA LUMPUR MELBOURNE SYDNEY TOOWOOMBA
www.wiley.com.au
connect@wiley.com.au
1300 385 988

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Project

TEYS AUSTRALIA - PLATE FREEZER PROJECT
WAGGA WAGGA, NSW

Drawing Title

PLATE FREEZER FLOOR PLANS

Scale	A1 = 1: 100 (A3 = 1: 200) 0 1000 2000 mm
Drawn	AJ
Date	APR 2021
Project No.	W25813
Bldg No.	35
Drawing No.	35A101 - 7
Issue	

NOT FOR CONSTRUCTION

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Plot Date: 24/09/2021 5:15:59 PM

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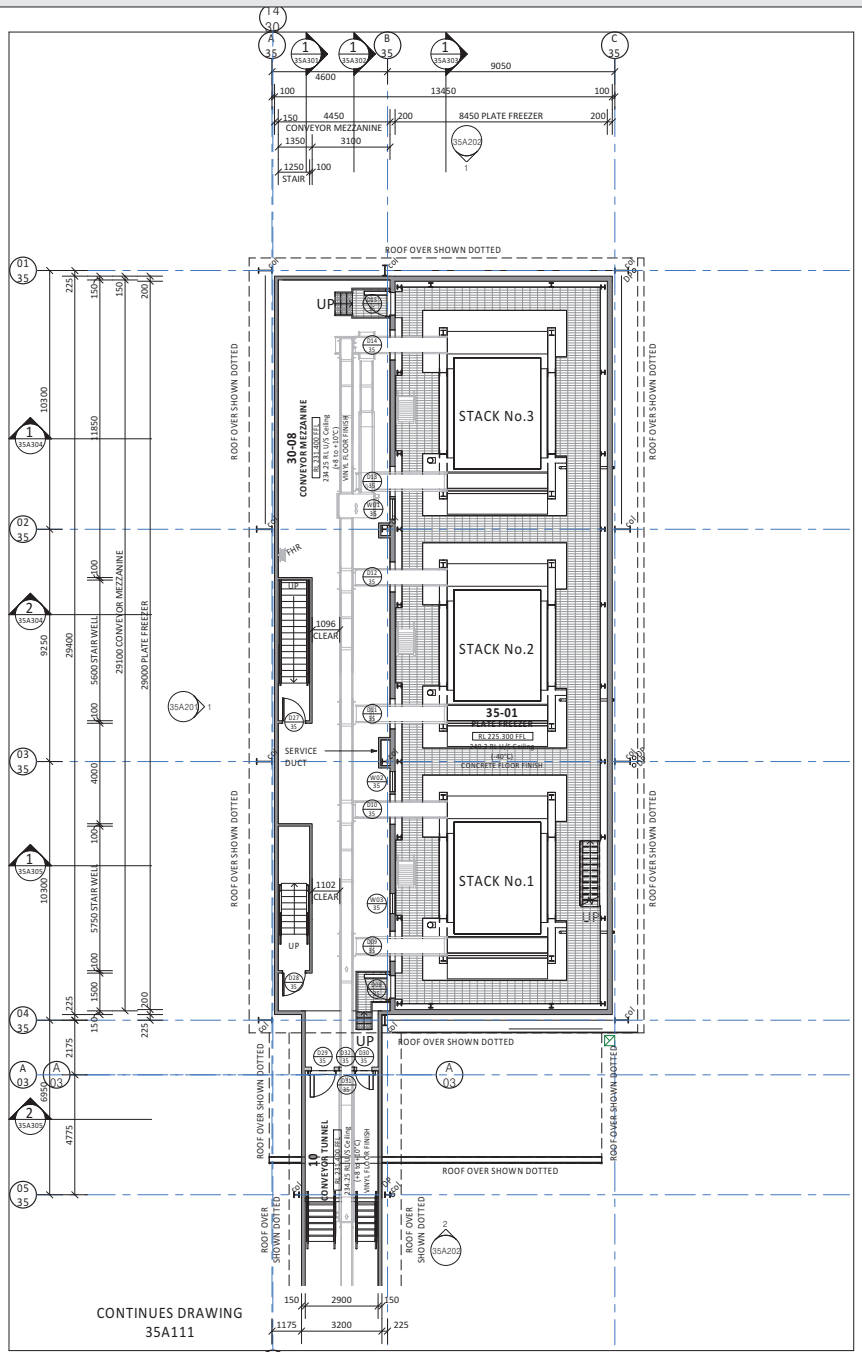
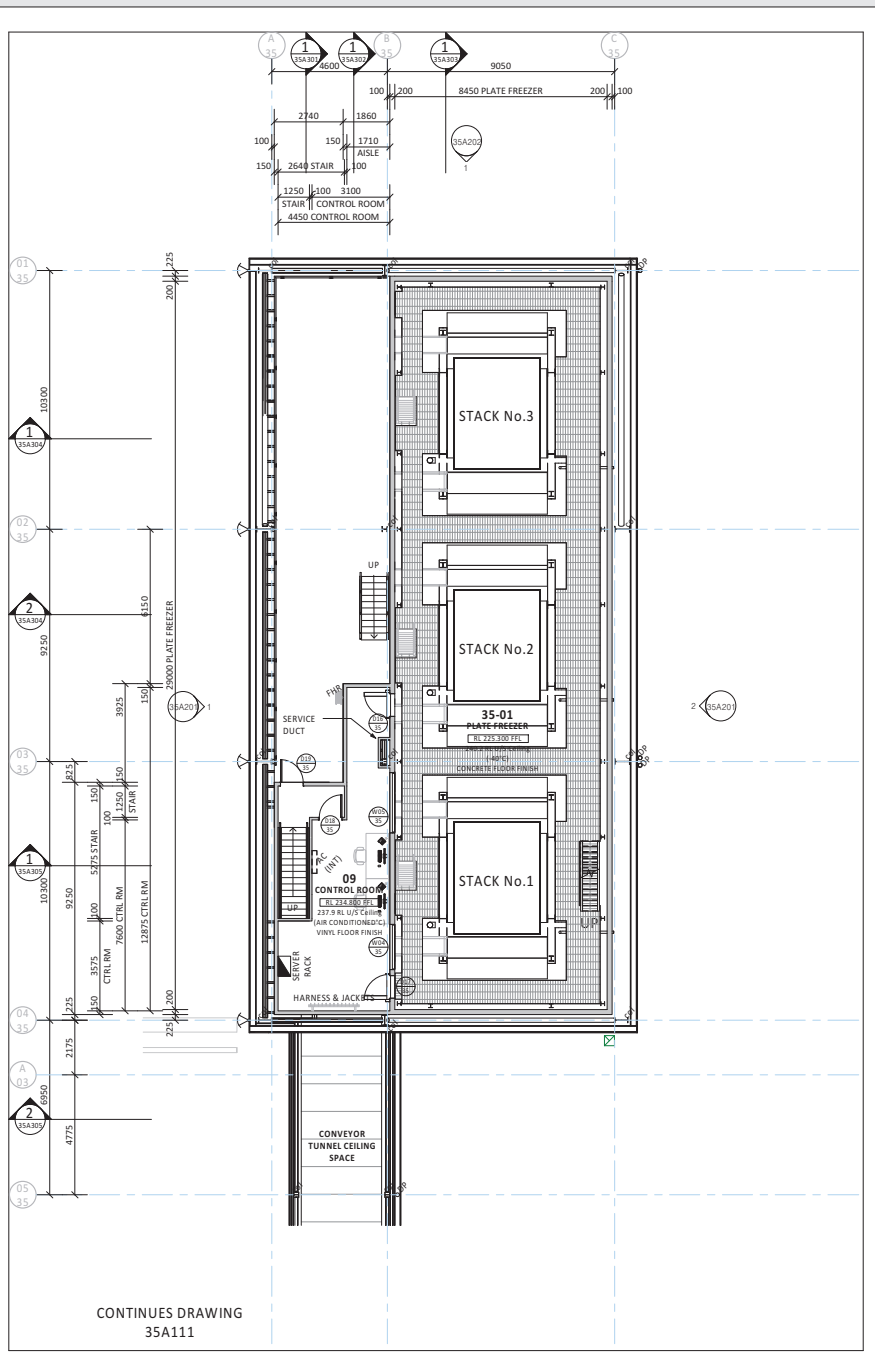
ADVICE◆ DESIGN◆ ENGINEERING◆ CONSTRUCTION



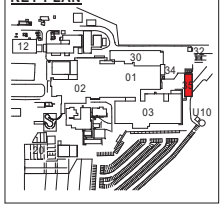
11 CONVEYOR LEVEL PLAN
A1 = 1 : 100



2 CONTROL ROOM LEVEL PLAN
A1 = 1 : 100

THIS DRAWING IS NOT FOR CONSTRUCTION

KEY PLAN



NOTE:
- provide zone rated fittings to ammonia vessels area
- all conduits in plate freezer to be stainless steel
- all conduits in non freezer areas to be PVC
- all insulated panel joints must be core to core connection and or foam filled and sealed to prevent green mould forming on external joints
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Date	Issue	Amendment	Init
24/09/21	8	ISSUE FOR REVIEW	AJ
21/06/21	7	CEILING SPACE ACCESS LADDERS NOW STAIRS	AJ
11/06/21	6	VESSEL AREA REVISED	AJ
10/06/21	5	CONCEPT PHASE CLIENT SUBMISSION	AJ
31/05/21	4	AWNING OVER AMMONIA VESSELS ADDED, BLOCK WORK TO MCC & UNDER PLATE FREEZER STRUCTURAL SLAB SHOWN, GENERAL REVISION	AJ
10/05/21	3	REVISIONS AS PER CLIENT MEETING	AJ
06/05/21	2	GENERAL REVISION	AJ

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www.wiley.com.au
connect@wiley.com.au
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WAGGA WAGGA, NSW

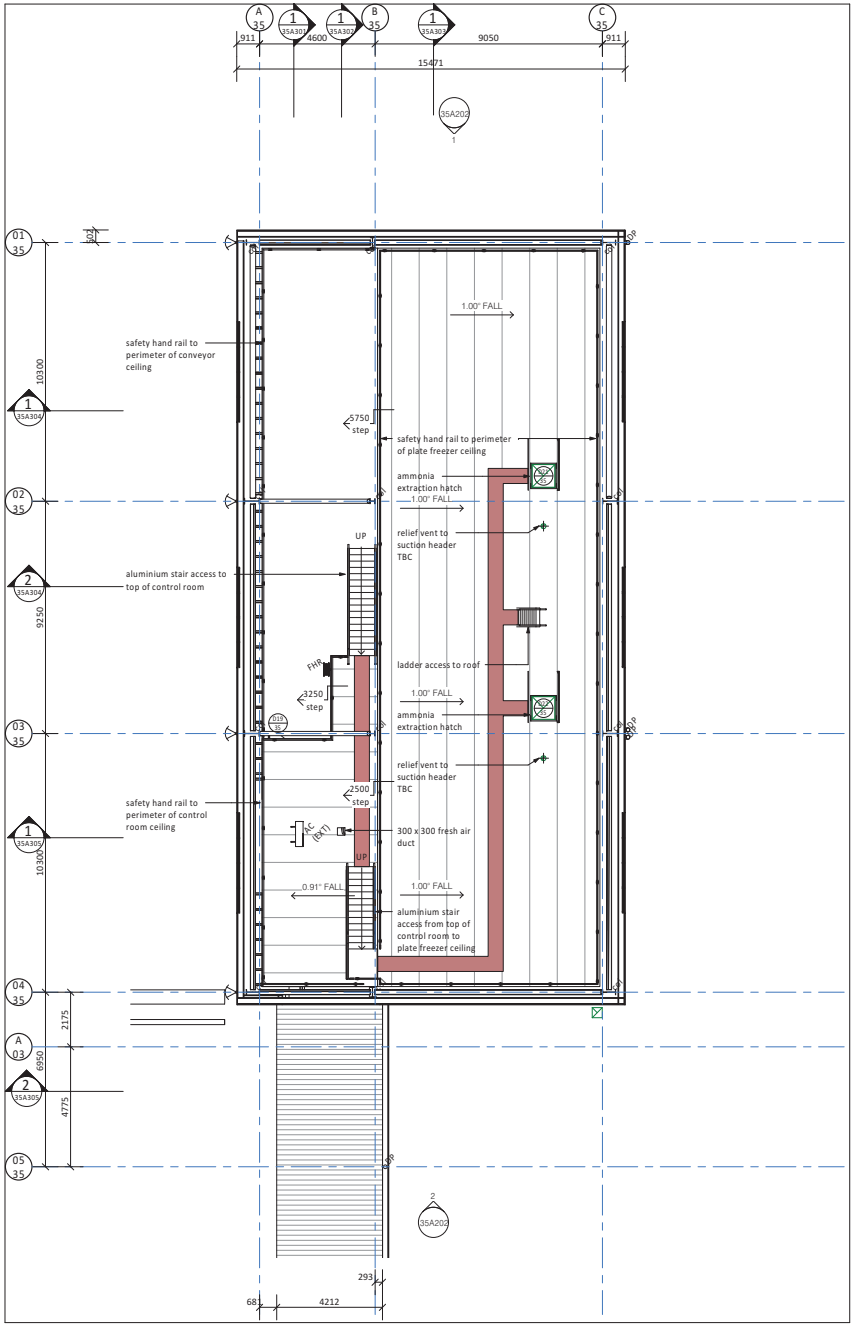
Drawing Title

CONVEYOR FLOOR ROOM & CONTROL ROOM FLOOR PLANS

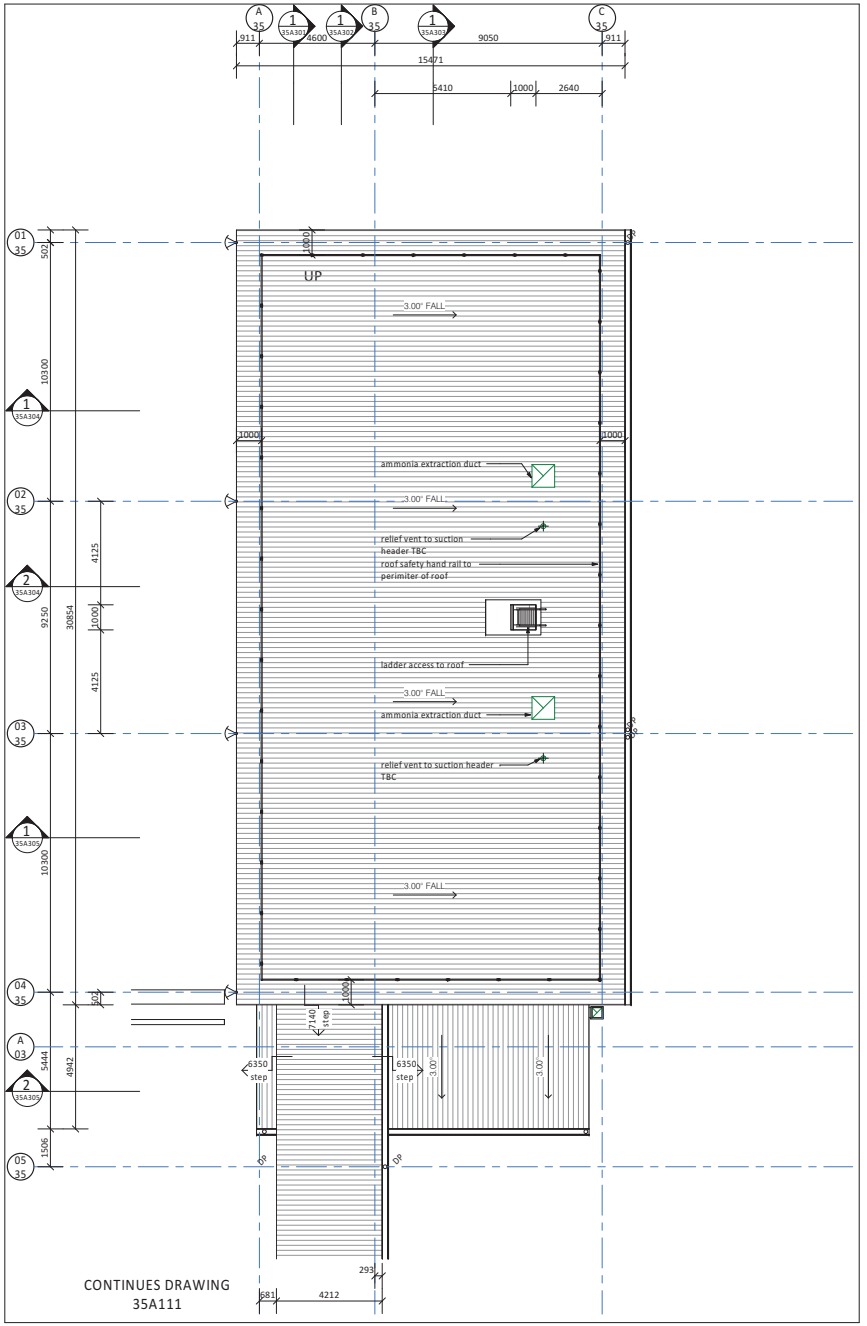
Scale A1 = 1: 100 (A3 = 1: 200) 0 1000 2000 mm
Drawn AJ | Date APR 2021
Project No. W25813 | Bldg No. 35
Drawing No. 35A102 - 8 | Issue
NOT FOR CONSTRUCTION

Plot Date: 24/09/2021 5:18:09 PM

Cad File No :U:\CAD\Revit\WLY Revit Local\W25813-35-Arch_adam.jaroszuk.rvt



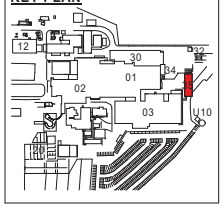
1 TOP OF CEILING PLAN
A1 = 1 : 100



2 ROOF PLAN
A1 = 1 : 100

THIS DRAWING IS NOT FOR CONSTRUCTION

KEY PLAN



NOTE:
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- all conduits in non freezer areas to be PVC
- all insulated panel joints must be core to core connection and or foam filled and sealed to prevent green mould forming on external joints
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Date	Issue	Amendment	Init
24/09/21	1	ISSUE FOR REVIEW	AJ

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TEYS AUSTRALIA - PLATE FREEZER PROJECT
WAGGA WAGGA, NSW

Drawing Title

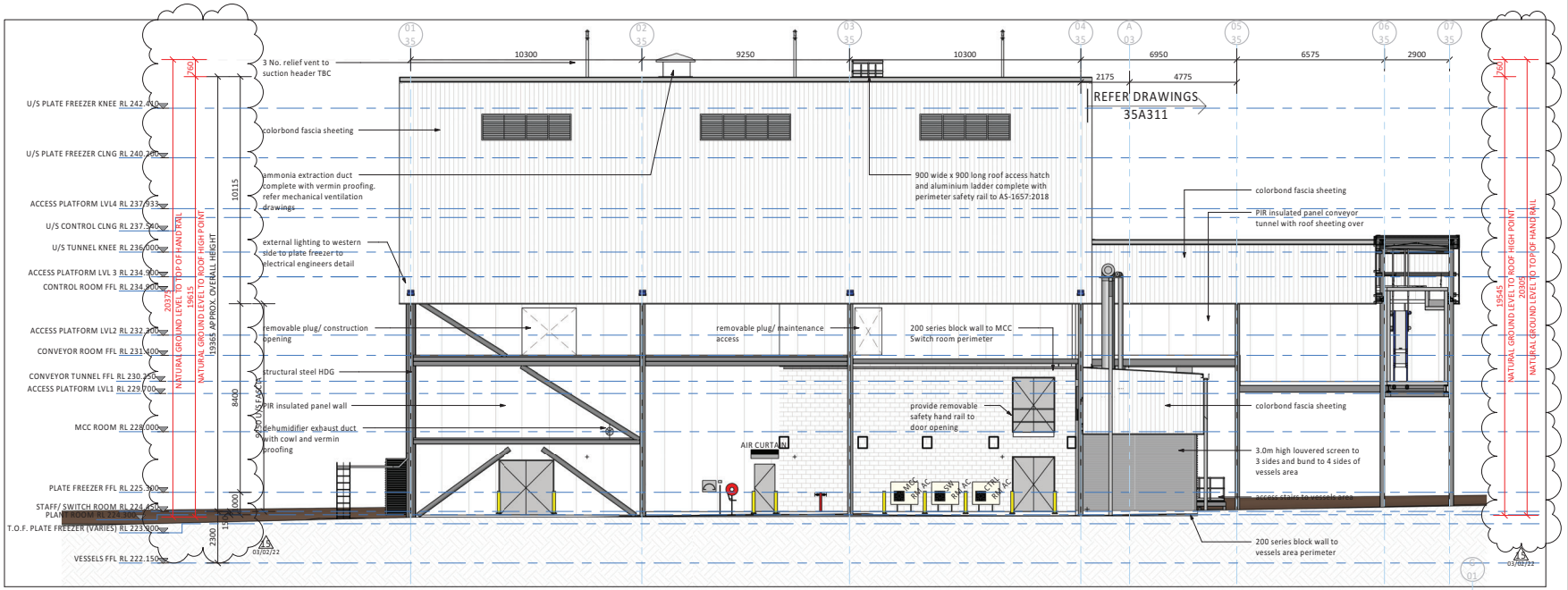
PLATE FREEZER TOP OF CEILING & ROOF PLANS

Scale	A1 = 1: 100 (A3 = 1: 200) 0 1000 2000
Drawn	A.J.
Date	SEPT 2021
Project No.	W25813
Bldg No.	35
Drawing No.	35A103 - 1
Issue	NOT FOR CONSTRUCTION

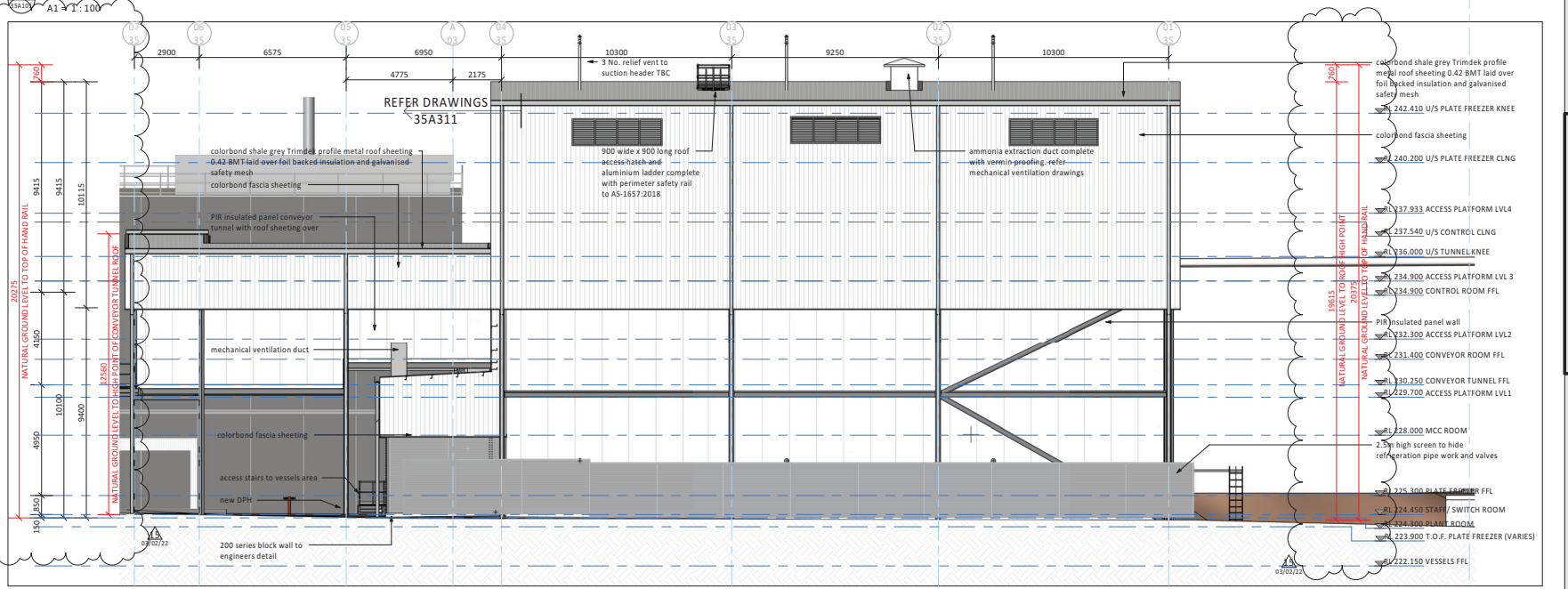
Plot Date: 24/09/2021 5:20:26 PM

Cad File No :U:\CAD\Revit\WLY Revit Local\W25813-35-Arch_adam.jaroszuk.rvt

ADVICE◆ DESIGN◆ ENGINEERING◆ CONSTRUCTION



1 WEST ELEVATION (35A101)
A1 = 1 : 100



2 EAST ELEVATION (35A101)
A1 = 1 : 100

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ORIGINAL IN COLOUR

ADVICE◆ DESIGN◆ ENGINEERING◆ CONSTRUCTION

Date	Issue	Amendment	Init
03/02/22	15	REVISED DA ISSUE	AJ
17/01/22	14	GMP SUBMISSION	SC
12/12/21	13	NOTES REVISED	AJ
25/11/21	12	TENDER ISSUE	AJ
05/11/21	11	NOTES ADDED/ REVISED	AJ
19/10/21	10	FOR CLIENT REVIEW	AJ
06/10/21	9	FOR CLIENT REVIEW	AJ
05/10/21	8	ISSUED TO MPN	AJ
24/09/21	7	ISSUE FOR REVIEW	AJ
11/06/21	6	VESSEL AREA REVISED	AJ
10/06/21	5	CONCEPT PHASE CLIENT SUBMISSION	AJ

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TEYS AUSTRALIA - PLATE FREEZER PROJECT
WAGGA WAGGA, NSW

Drawing Title

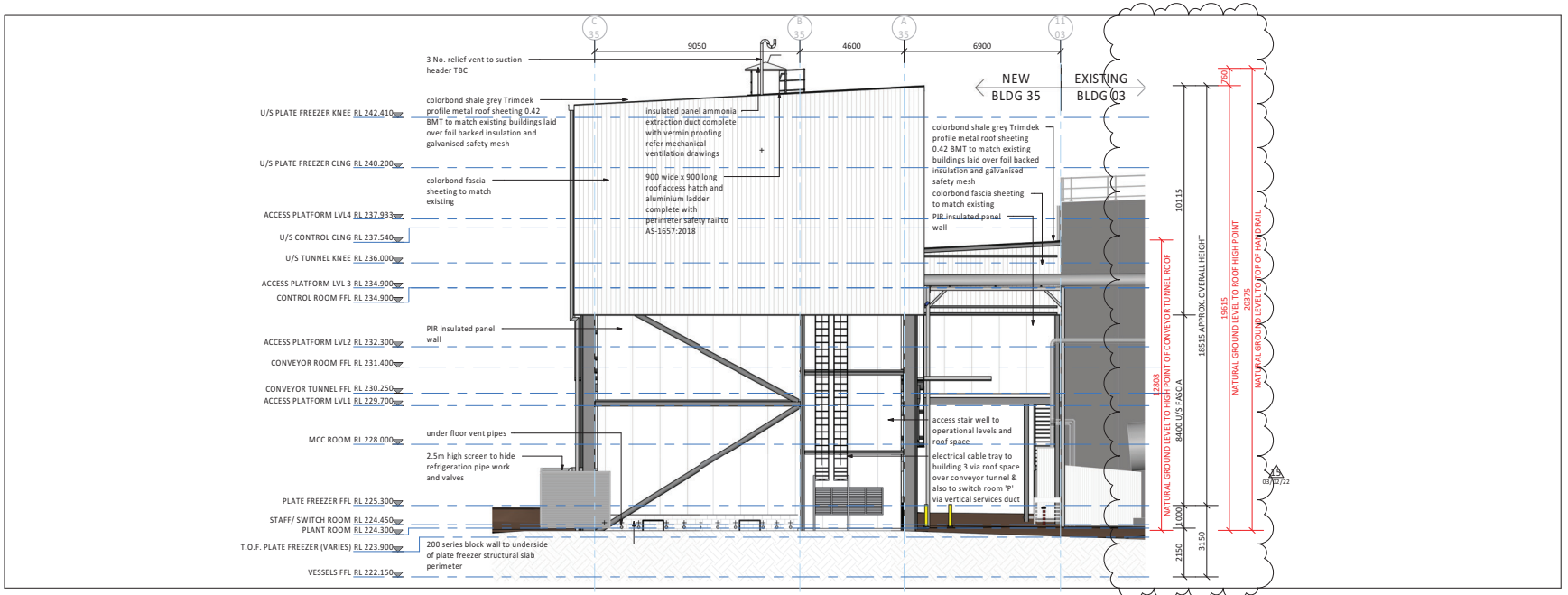
PLATE FREEZER ELEVATIONS - EAST & WEST

Scale A1 = 1: 100 (A3 = 1: 200) 0 1000 2000 mm
Drawn AJ | Date APR 2021
Project No. W25813 | Bldg No. 35
Drawing No. 35A201 | Issue 15

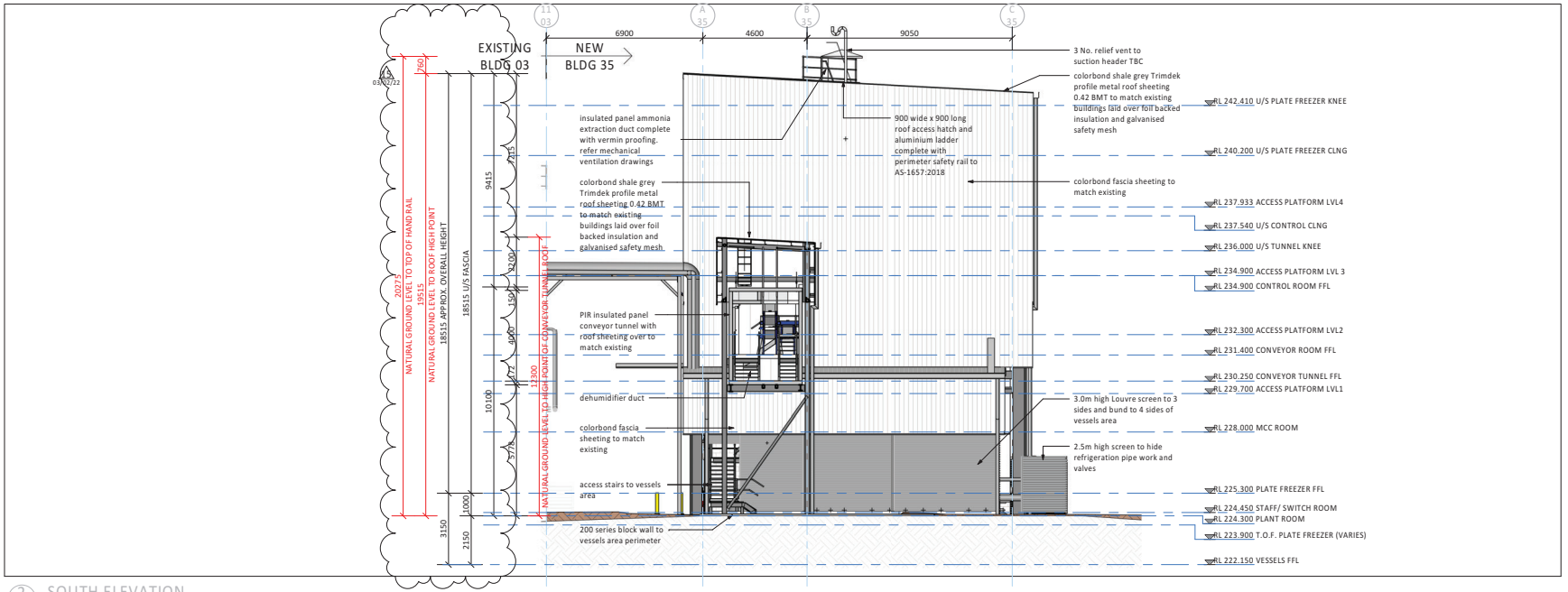
NOT FOR CONSTRUCTION

Plot Date: 9/02/2022 11:44:21 AM

Cad File No :BIM 360://Teys - Wagga - Master Site/W25813-35-ARCH.rvt



1 35A101 NORTH ELEVATION
A1 = 1 : 100



2 35A101 SOUTH ELEVATION
A1 = 1 : 100

ORIGINAL IN COLOUR

ADVICE◆DESIGN◆ENGINEERING◆CONSTRUCTION

Plot Date: 7/02/2022 9:34:12 AM

Cad File No :BIM 360://Teys - Wagga - Master Site/W25813-35-ARCH.rvt

Date	Issue	Amendment	Init
03/02/22	15	REVISED DA ISSUE	AJ
17/01/22	14	GMP SUBMISSION	SC
12/12/21	13	NOTES REVISED	AJ
25/11/21	12	TENDER ISSUE	AJ
05/11/21	11	NOTES ADDED/ REVISED	AJ
19/10/21	10	FOR CLIENT REVIEW	AJ
06/10/21	9	FOR CLIENT REVIEW	AJ
05/10/21	8	ISSUED TO MPN	AJ
24/09/21	7	ISSUE FOR REVIEW	AJ
11/06/21	6	VESSEL AREA REVISED	AJ
10/06/21	5	CONCEPT PHASE CLIENT SUBMISSION	AJ

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TEYS AUSTRALIA - PLATE FREEZER PROJECT
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Drawing Title

PLATE FREEZER ELEVATIONS - NORTH & SOUTH

Scale A1 = 1: 100 (A3 = 1: 200) 0 1000 2000 mm

Drawn AJ | Date APR 2021

Project No. W25813 | Bldg No. 35

Drawing No. 35A202 | Issue 15

NOT FOR CONSTRUCTION

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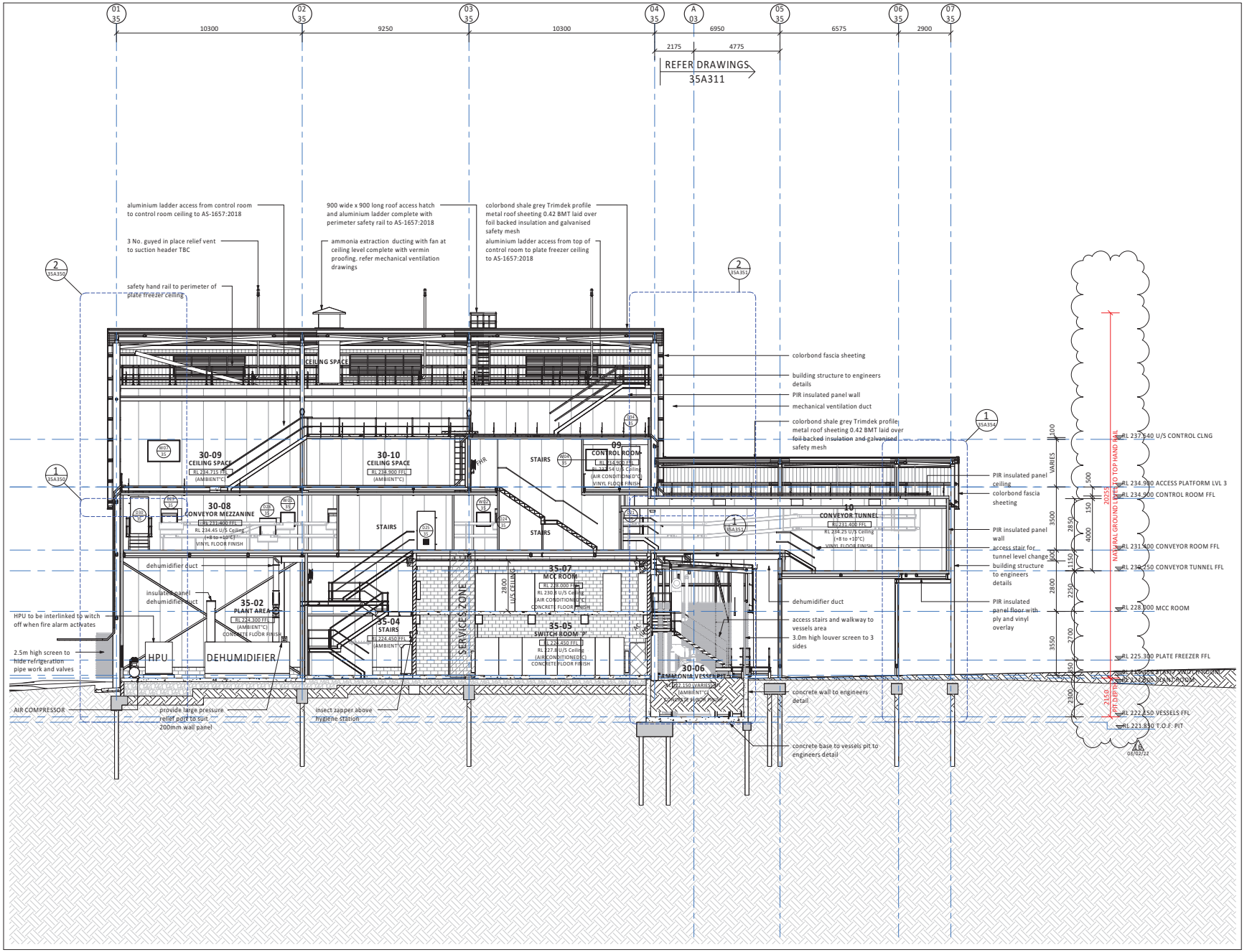

1 SECTION
A1 = 1 : 100

THIS DRAWING IS NOT FOR CONSTRUCTION

Date	Issue	Amendment	Init
03/02/22	16	REVISED DA ISSUE	AJ
17/01/22	15	GMP SUBMISSION	SC
14/12/21	14	FOOTINGS AND DUCT REVISED	AJ
25/11/21	13	TENDER ISSUE	AJ
05/11/21	12	NOTES ADDED/ REVISED	AJ
19/10/21	11	FOR CLIENT REVIEW	AJ
06/10/21	10	FOR CLIENT REVIEW	AJ
05/10/21	9	ISSUED TO MPN	AJ
24/09/21	8	ISSUE FOR REVIEW	AJ
21/06/21	7	CEILING SPACE ACCESS LADDERS NOW STAIRS	AJ
11/06/21	6	VESSEL AREA REVISED	AJ
10/06/21	5	CONCEPT PHASE CLIENT SUBMISSION	AJ

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TEYS AUSTRALIA - PLATE FREEZER PROJECT
WAGGA WAGGA, NSW

Drawing Title

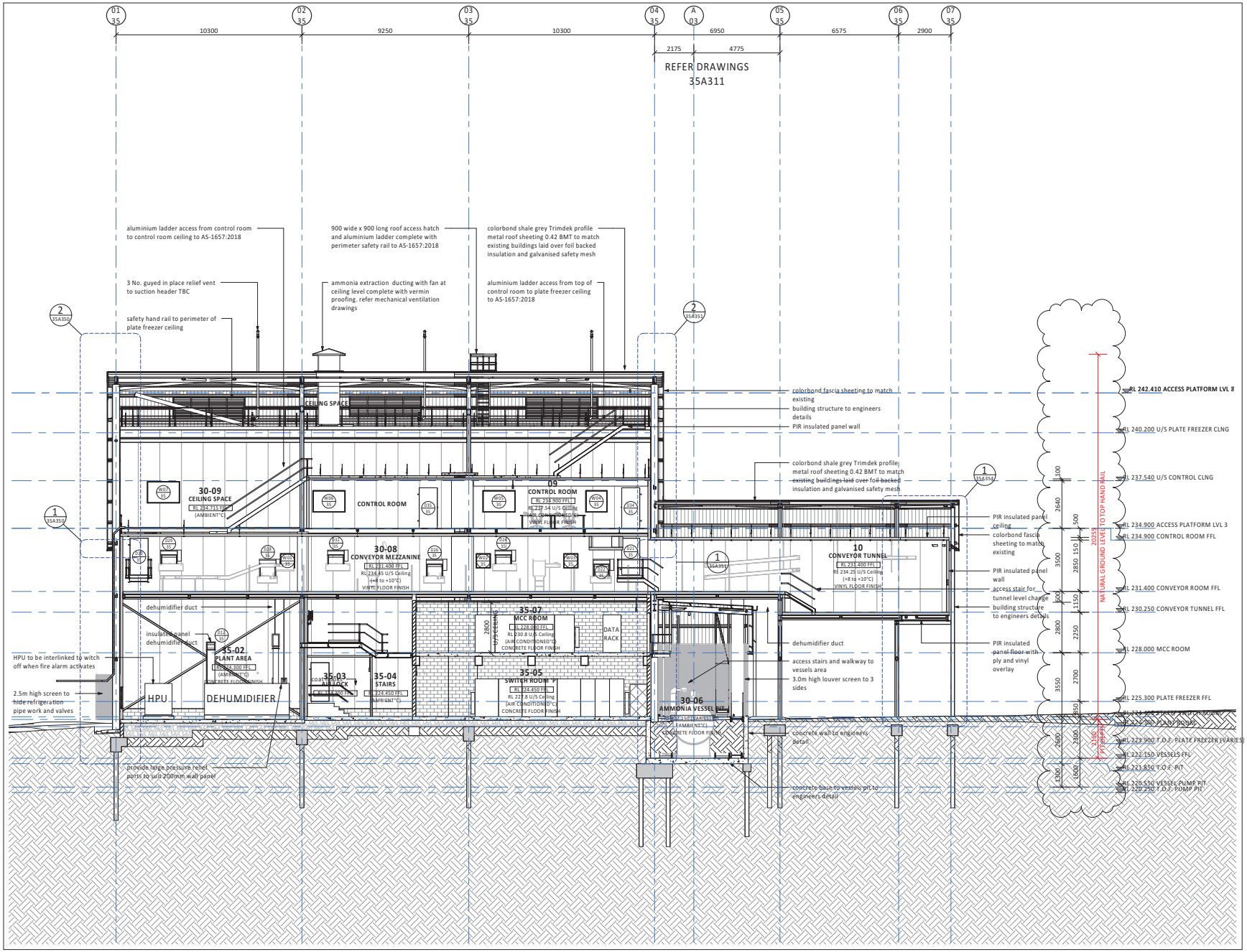
CONVEYOR ROOM SECTION

Scale A1 = 1: 100 (A3 = 1: 200) 0 1000 2000 mm
Drawn AJ Date APR 2021
Project No. W25813 Bldg No. 35
Drawing No. 35A301 - 16 Issue
NOT FOR CONSTRUCTION

Plot Date: 7/02/2022 9:36:14 AM

Cad File No :BIM 360://Teys - Wagga - Master Site/W25813-35-ARCH.rvt

ADVICE◆ DESIGN◆ ENGINEERING◆ CONSTRUCTION



1 SECTION
A1 = 1 : 100

THIS DRAWING IS NOT FOR CONSTRUCTION

ADVICE◆ DESIGN◆ ENGINEERING◆ CONSTRUCTION

Plot Date: 7/02/2022 9:37:24 AM

Cad File No :BIM 360://Teys - Wagga - Master Site/W25813-35-ARCH.rvt

Date	Issue	Amendment	Init
03/02/22	9	REVISED DA ISSUE	AJ
17/01/22	8	GMP SUBMISSION	SC
12/12/21	7	FOOTINGS REVISED	AJ
25/11/21	6	TENDER ISSUE	AJ
05/11/21	5	NOTES ADDED/ REVISED	AJ
19/10/21	4	FOR CLIENT REVIEW	AJ
06/10/21	3	FOR CLIENT REVIEW	AJ
05/10/21	2	ISSUED TO MPN	AJ
24/09/21	1	ISSUE FOR REVIEW	AJ

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Project

TEYS AUSTRALIA - PLATE FREEZER PROJECT
WAGGA WAGGA, NSW

Drawing Title

CONVEYOR ROOM SECTION

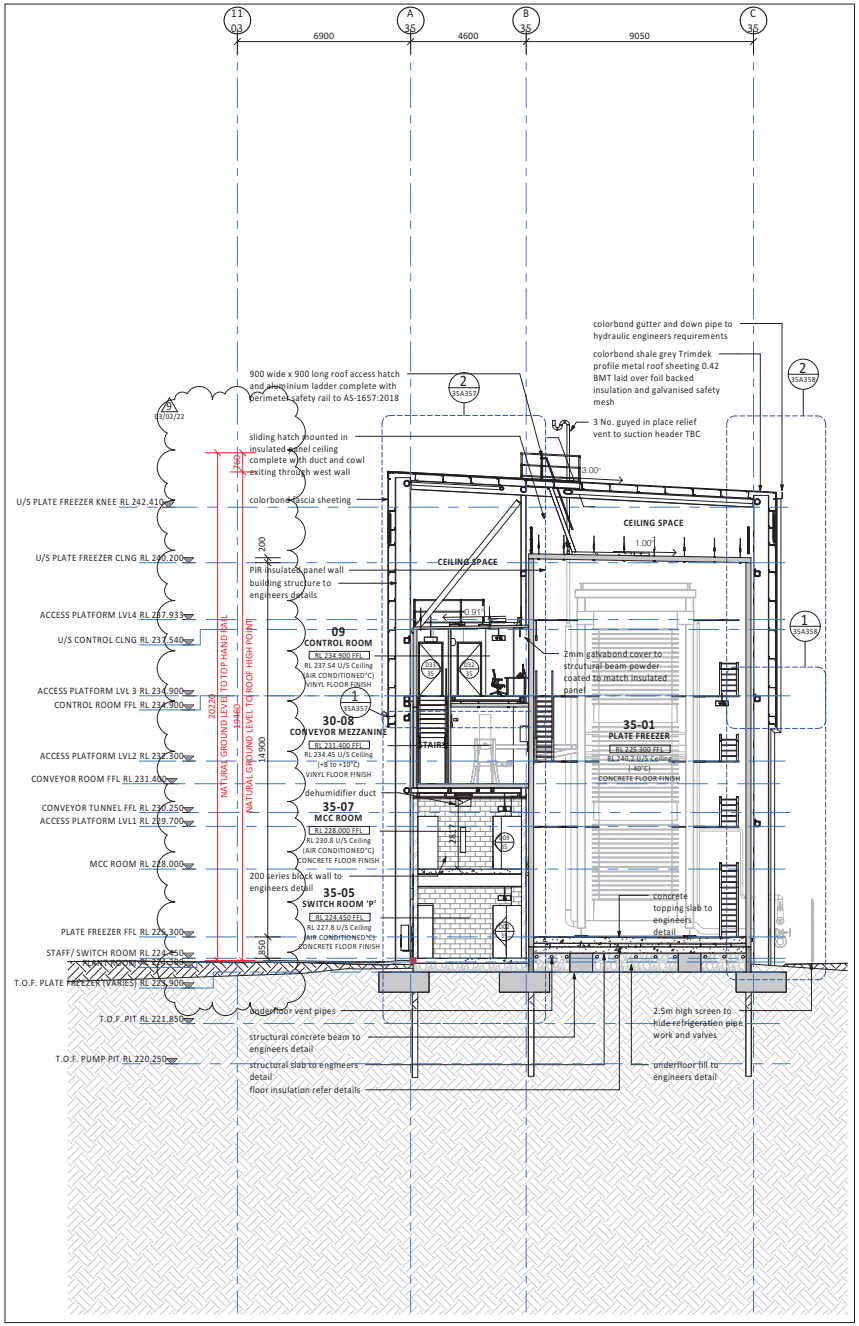
Scale A1 = 1: 100 (A3 = 1: 200) 0 1000 2000 mm

Drawn A.J. | Date SEPT 2021

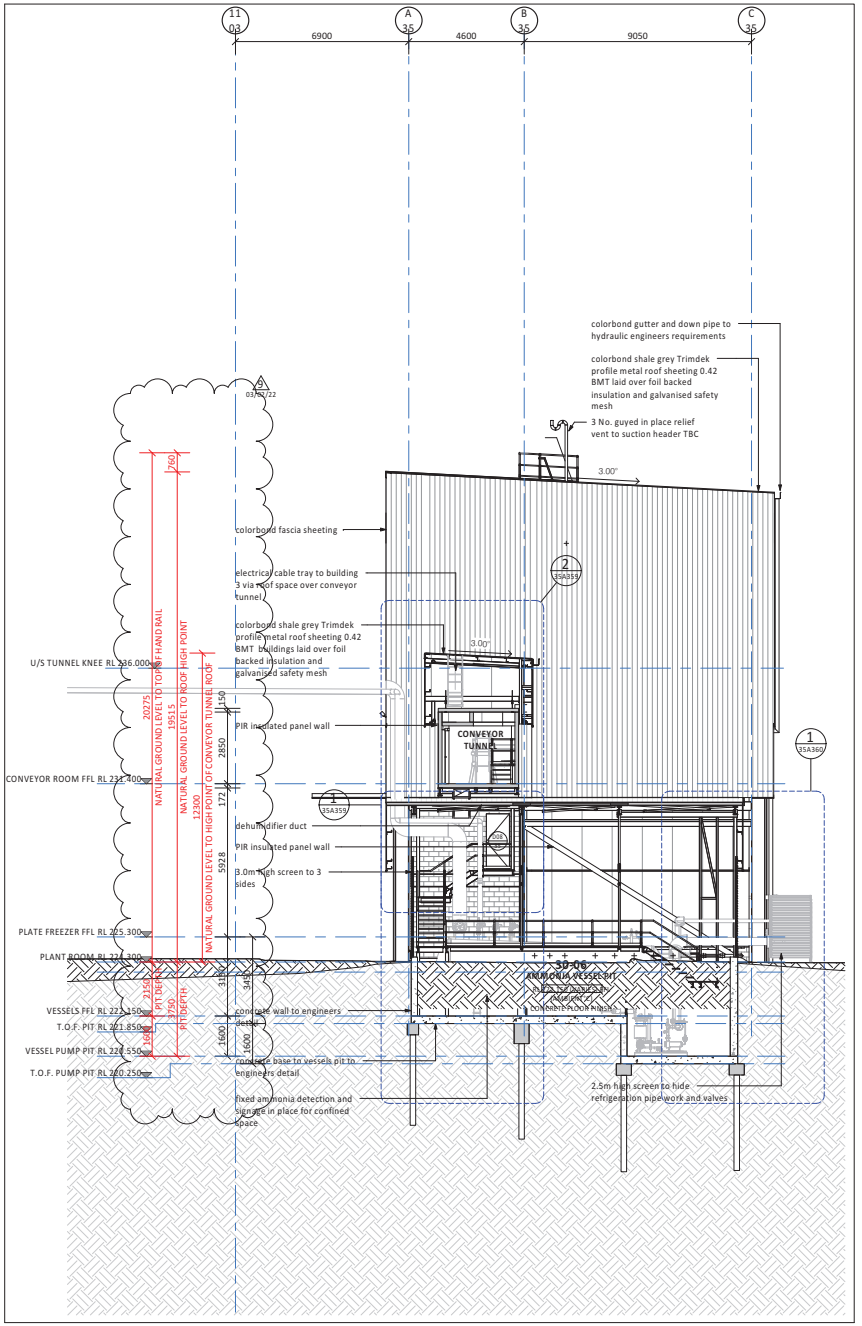
Project No. W25813 | Bldg No. 35

Drawing No. 35A302 - 9 | Issue

NOT FOR CONSTRUCTION



1 SECTION
A1 = 1 : 100



2 SECTION
A1 = 1 : 100

THIS DRAWING IS NOT FOR CONSTRUCTION

Date	Issue	Amendment	Init
03/02/22	9	REVISED DA ISSUE	AJ
17/01/22	8	GMP SUBMISSION	SC
14/12/21	7	NOTES AND DUCT REVISED	AJ
25/11/21	6	TENDER ISSUE	AJ
05/11/21	5	NOTES ADDED/ REVISED	AJ
19/10/21	4	FOR CLIENT REVIEW	AJ
06/10/21	3	FOR CLIENT REVIEW	AJ
05/10/21	2	ISSUED TO MPN	AJ
24/09/21	1	ISSUE FOR REVIEW	AJ

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Project

TEYS AUSTRALIA - PLATE FREEZER PROJECT
WAGGA WAGGA, NSW

Drawing Title

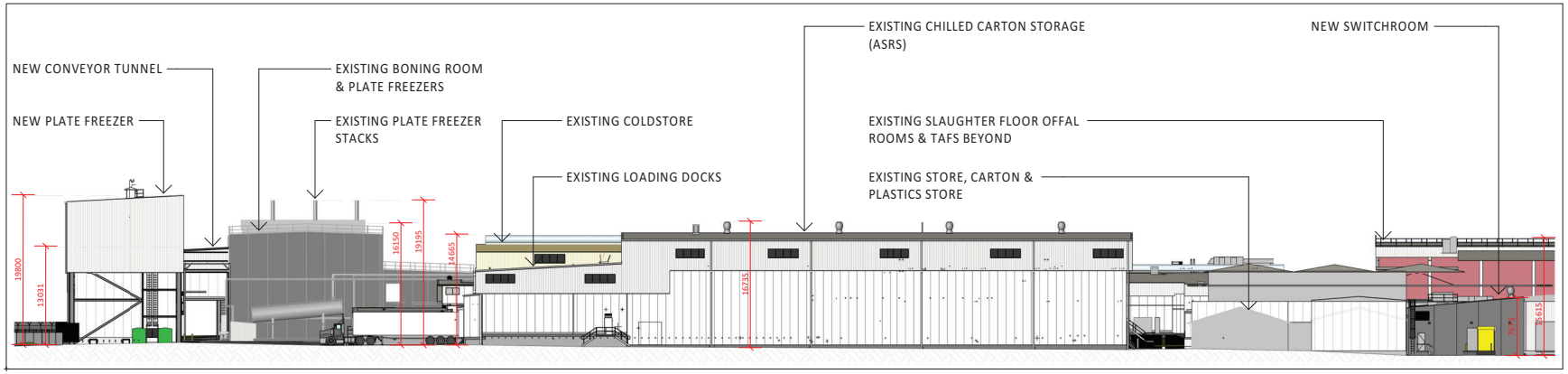
PLATE FREEZER & VESSEL SECTION

Scale	A1 = 1: 100 (A3 = 1: 200) 0 1000 2000
Drawn	AJ
Date	SEPT 2021
Project No.	W25813
Bldg No.	35
Drawing No.	35A305 - 9
Issue	NOT FOR CONSTRUCTION

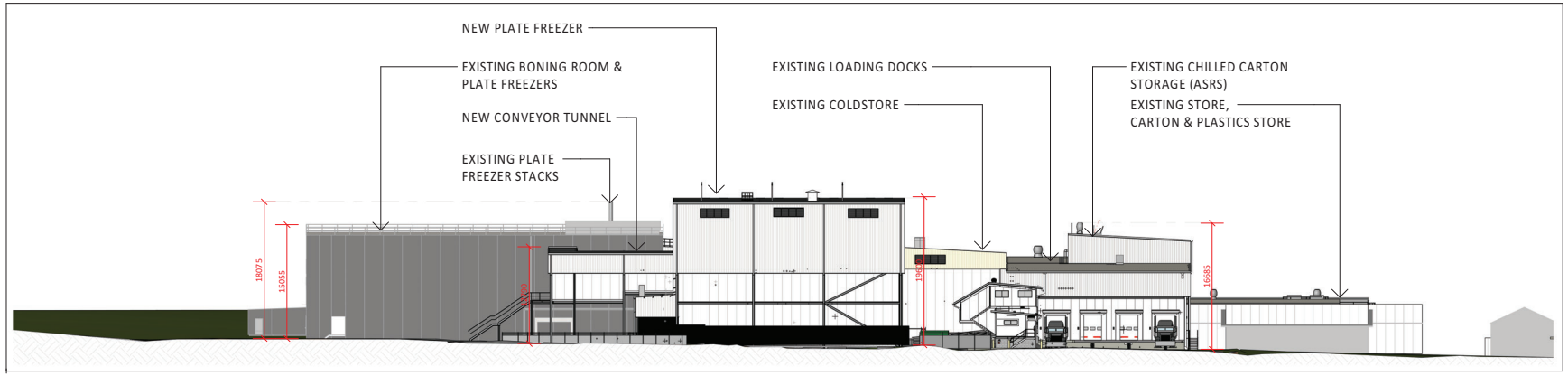
Plot Date: 7/02/2022 9:39:15 AM

Cad File No :BIM 360://Teys - Wagga - Master Site/W25813-35-ARCH.rvt

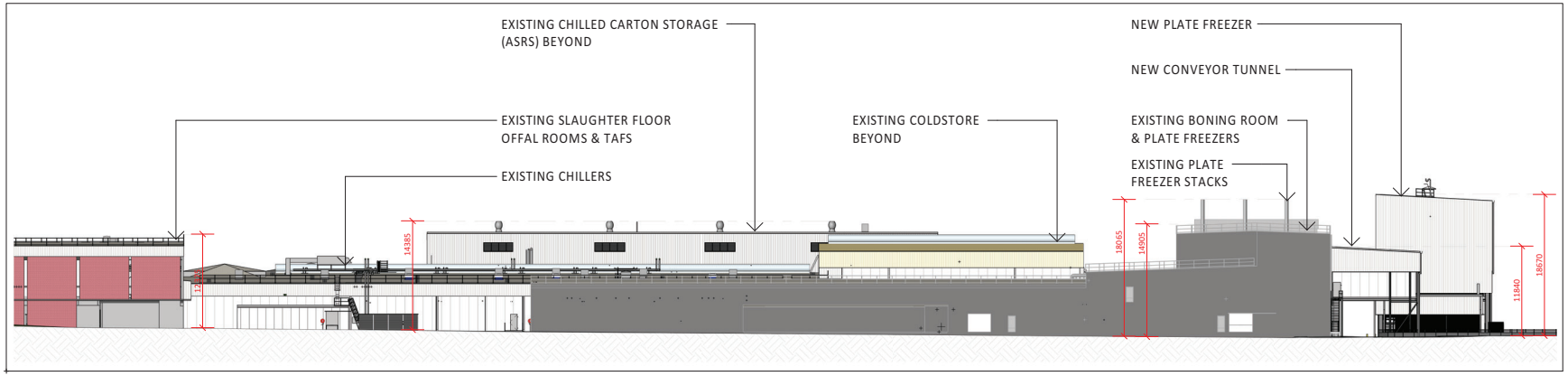
ADVICE◆ DESIGN◆ ENGINEERING◆ CONSTRUCTION



ELEVATION LOOKING SOUTH
NOT TO SCALE



ELEVATION LOOKING WEST
NOT TO SCALE



ELEVATION LOOKING NORTH
NOT TO SCALE

ORIGINAL IN COLOUR

THIS DRAWING IS NOT FOR CONSTRUCTION

Date	Issue	Amendment	Init
03/02/22	1	REVISED DA ISSUE	AJ

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Project
TEYS AUSTRALIA - PLATE FREEZER PROJECT
WAGGA WAGGA, NSW

Drawing Title
SITE ELEVATIONS

Scale	NOT TO SCALE
Drawn	A.J.
Date	FEB 2022
Project No.	W25813
Bldg No.	01
Drawing No.	00A201 - 1
Issue	

NOT FOR CONSTRUCTION

ORIENTATION PLAN
NOT TO SCALE

3D VIEW LOOKING NORTH FROM BYRNES ROAD
NOT TO SCALE

3D VIEW LOOKING SOUTH WEST FROM DAMPIER STREET
NOT TO SCALE

3D VIEW LOOKING WEST FROM BYRNES ROAD
NOT TO SCALE

ORIGINAL IN COLOUR

THIS DRAWING IS NOT FOR CONSTRUCTION

Date	Issue	Amendment	Init
03/02/22	1	REVISED DA ISSUE	AJ

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Project

TEYS AUSTRALIA - PLATE FREEZER PROJECT
WAGGA WAGGA, NSW

Drawing Title

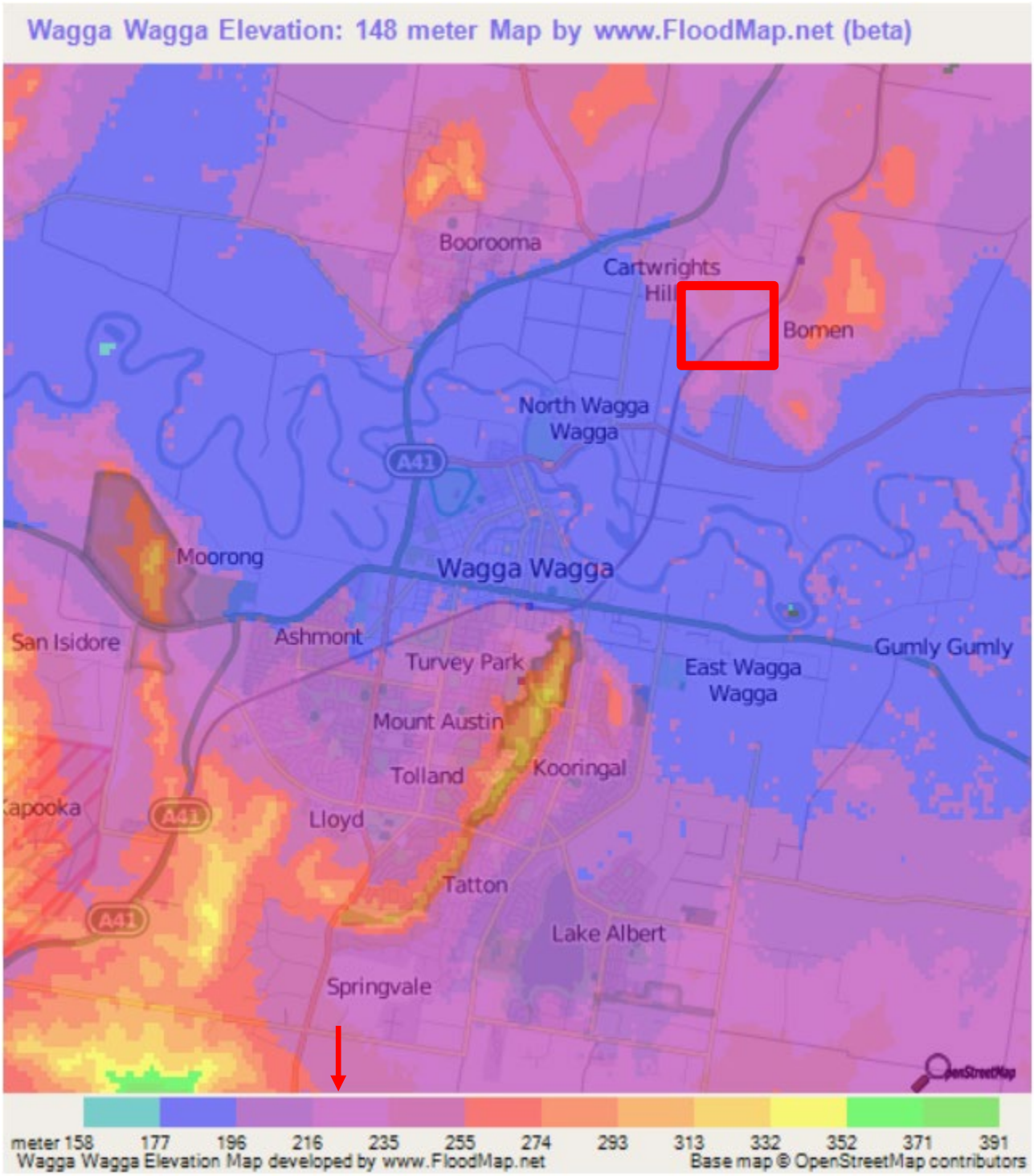
ORIENTATION PLAN AND 3D PERSPECTIVE VIEWS

Scale	NOT TO SCALE
Drawn	AJ
Date	FEB 2022
Project No.	W25813
Bldg No.	01
Drawing No.	00A210 - 1
Issue	

NOT FOR CONSTRUCTION

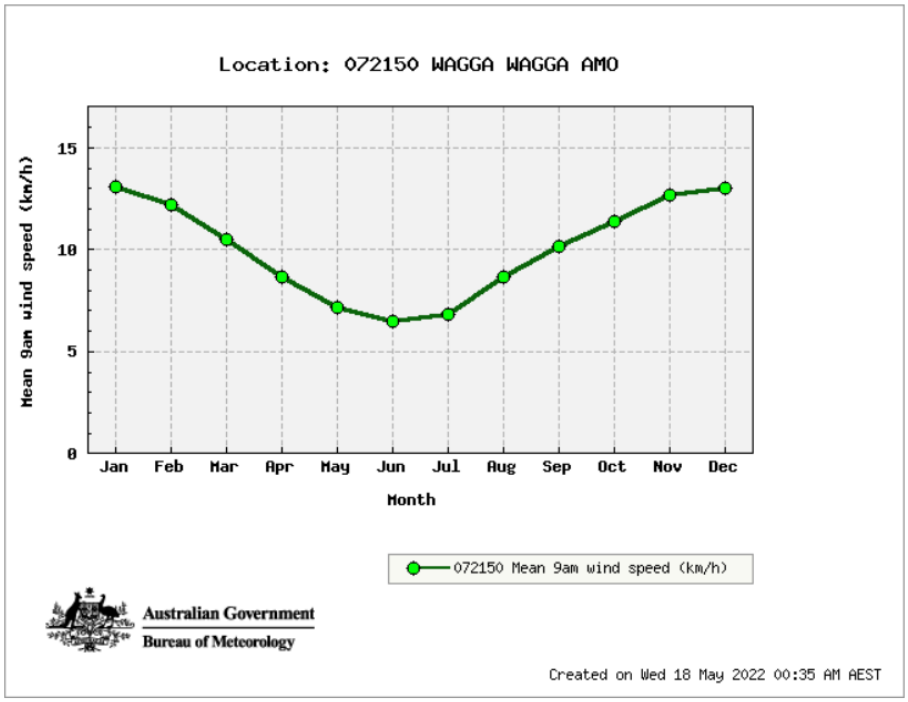
Appendix D Climatic and Site Data

Elevation



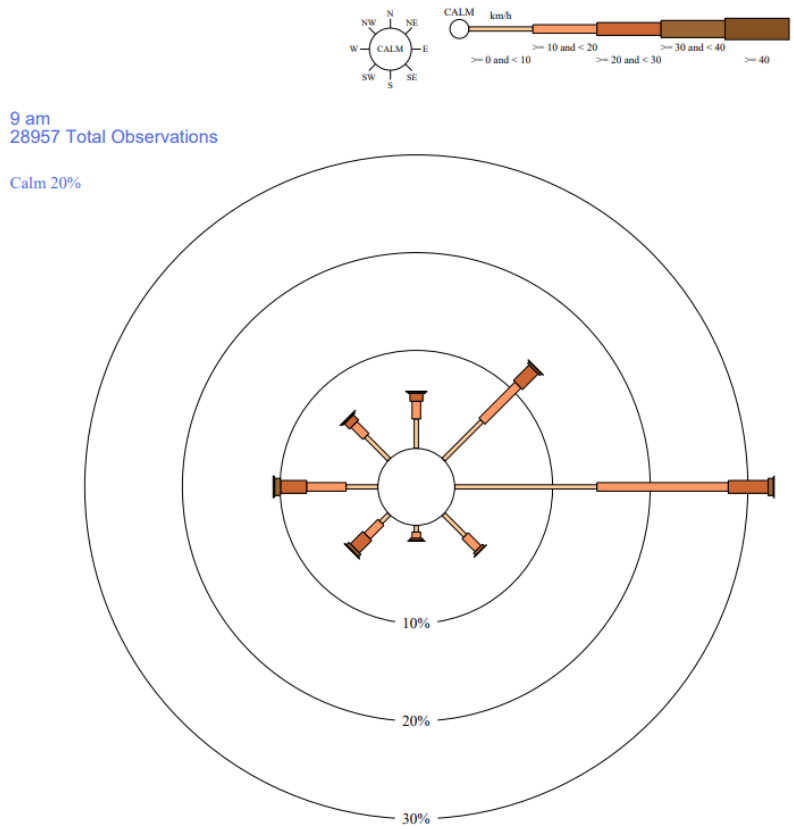
Source: https://www.floodmap.net/Elevation/ElevationMap/?gi=2145110 (2022)

Mean 9am Wind Speed



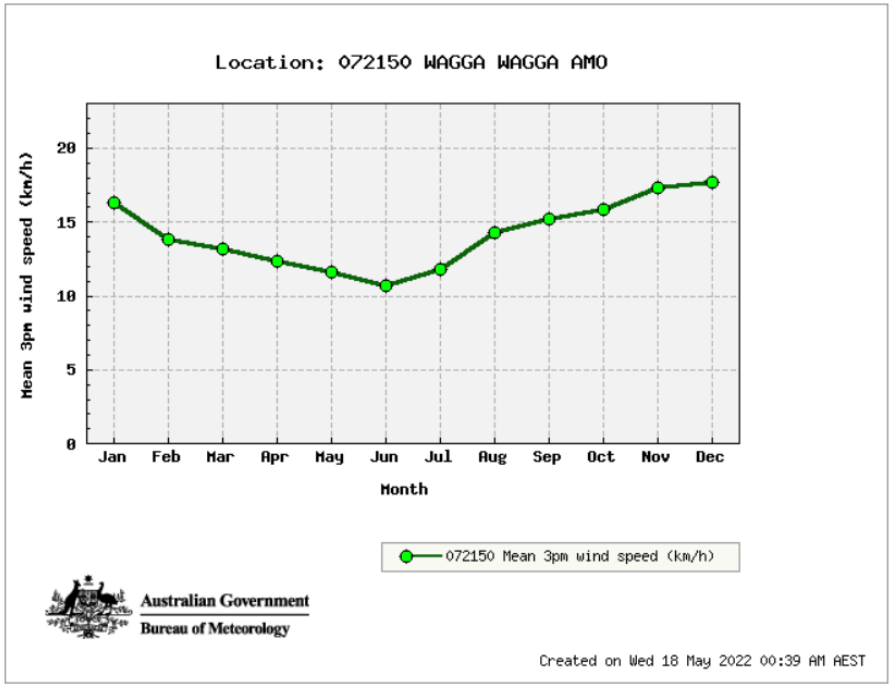
Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean 9am wind speed (km/h) for years 1941 to 2010	13.1	12.2	10.5	8.7	7.2	6.5	6.8	8.7	10.2	11.4	12.7	13.0	10.1	68

9am Wind Direction Rose



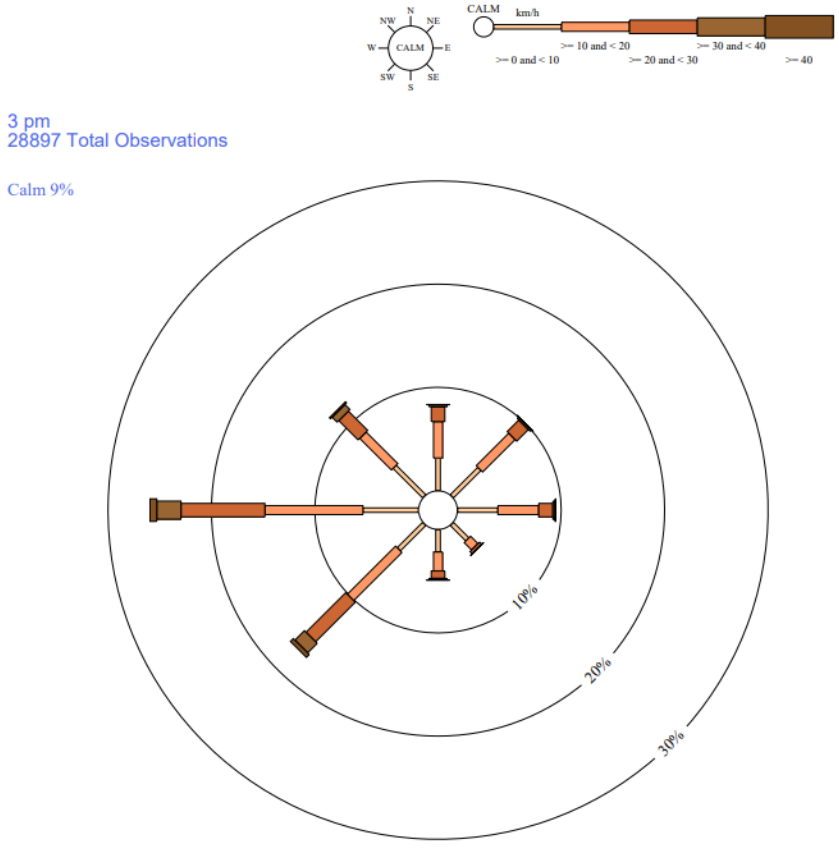
Source: Bureau of Meteorology (2022) / Wagga Wagga AMP, Site Number: 072150

Mean 3pm Wind Speed



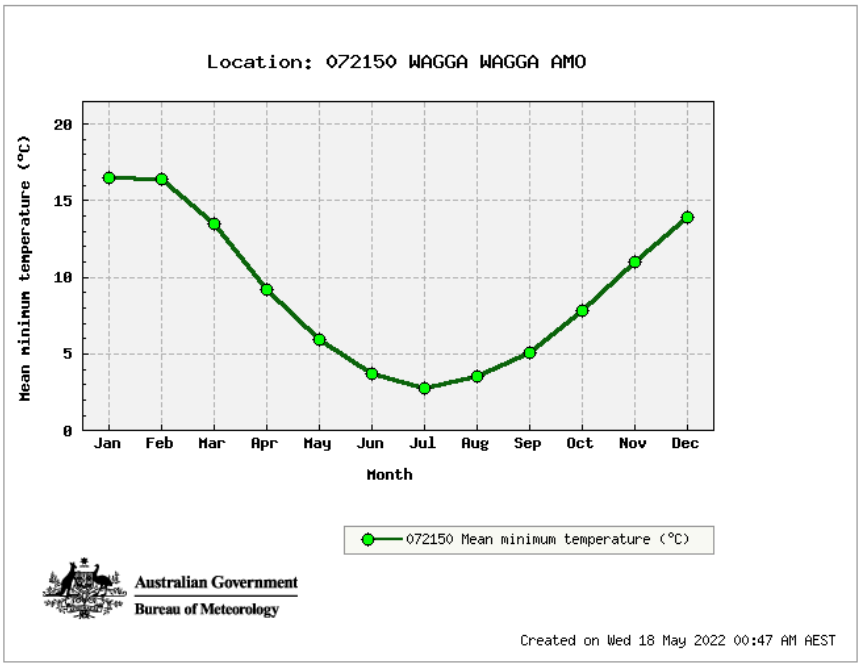
Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean 3pm wind speed (km/h) for years 1941 to 2010	16.3	13.8	13.2	12.4	11.6	10.7	11.8	14.3	15.2	15.9	17.3	17.7	14.2	68

3pm Wind Direction Rose



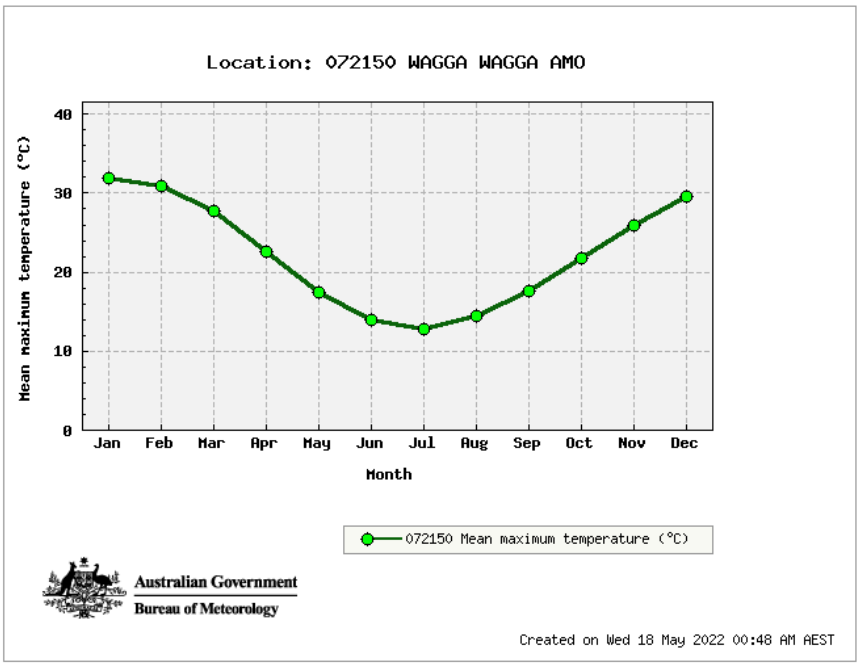
Source: Bureau of Meteorology (2022) / Wagga Wagga AMP, Site Number: 072150

Mean Minimum Temperature



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean minimum temperature (°C) for years 1942 to 2022	16.5	16.4	13.5	9.2	5.9	3.7	2.8	3.5	5.1	7.8	11.0	13.9	9.1	80

Mean Maximum Temperature



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean maximum temperature (°C) for years 1942 to 2022	31.9	30.9	27.7	22.6	17.4	13.9	12.8	14.5	17.7	21.7	25.9	29.6	22.2	80

Source: Bureau of Meteorology (2022) / Wagga Wagga AMP, Site Number: 072150

Appendix E Model Overview: Anhydrous Ammonia

Model Type

Consistent with CDM Smith practice in the past, we determined the impact zones using Areal Locations of Hazardous Atmospheres (ALOHA) program which is the air modelling element of CAMEO, a program suite that assesses the health and safety impacts of emergency releases. It was produced as a joint effort of the US Environmental Protection Agency (US EPA) and the US National

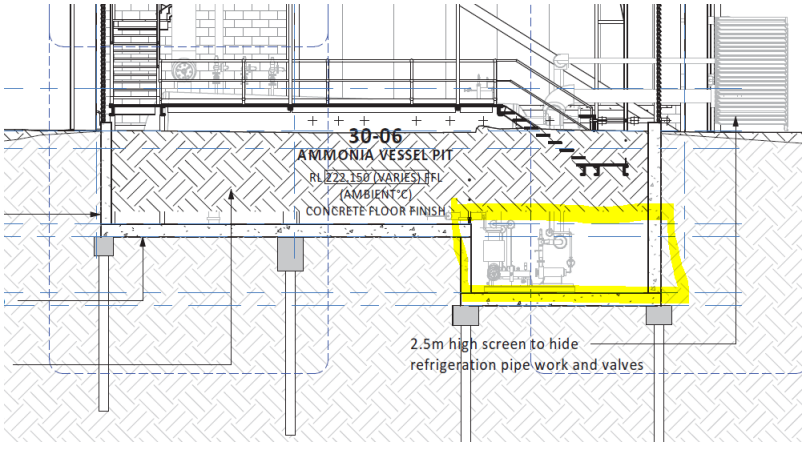
Oceanic and Atmospheric Administration (NOAA). It has been successfully used for decades and is currently in revision 5.4.4. CAMEO is recognised and supported within industry and ALOHA is widely used for the purposes required in this assessment. ALOHA has some limitations when it comes to modelling the dispersion of gas mixtures at stable meteorological conditions and low wind speeds. These shortcomings are more important for modelling toxic exposures, however, for this project two difference climatic conditions have been modelled for each release scenario first using worst case and second using normal weather conditions.

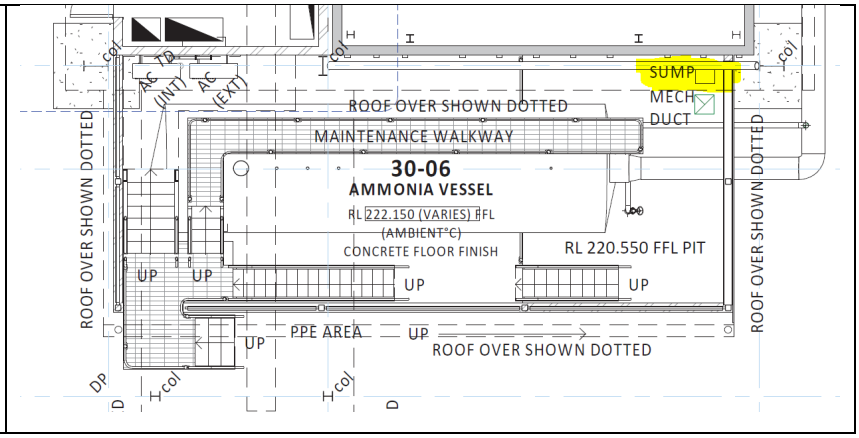
Model Input Rationale

The following table outlines the rationale for key model inputs.

Key Input	**Input Value/Type**	**Rationale**
Scenario 1		
Leak Type	Hole or Rectangle	This scenario assumes a tank puncture from equipment such as a forklift which has a standard fork size of 10.16 cm x 5.08 cm). A circular hole with a diameter of 101.6 mm and a rectangular puncture with 101.6 mm length and width of 50.8 mm was tested. Both result in the same release rate and exposure extent. The UK HSE guide for failure rate and event data use within risk assessments provides guidance on categorisation of release sizes (i.e. major and minor) (hole diameters) for refrigerated pressure vessels (based on data that includes ammonia vessels). Three tank size ranges are provided >12,000 m^3, 12,000 m^3 – 4,000 m^3 and 4,000 – 450 m^3. The ammonia storage tank being installed at the Teys facility has a maximum capacity of 32 m^3 (i.e 14 times smaller than the base range provided in the UK guidance). For the 4,000 – 450 m^3 range the guidance indicates 500 mm is a major and 150 mm is a minor category. Taking a straightforward reduction of hole sizes based on the size of the new ammonia storage vessel we would get approximately 35.7 mm for a major hole and 10.7 mm for a minor hole. Thus, the 101.6 mm hole applied to the modelling is considered appropriate. Separately, in analysis for LPG road tankers TNO (1983) surmises 5 mm diameter hole as a small/minor puncture and 75 mm as a large/major puncture (noting transport tanks are at much greater risk of punctures and 75 mm is considered major in that analysis). These indicative rupture sizes are also utilised by RISO (2005) the National Laboratory of Denmark in their safety assessment of ammonia as a transport fuel. However, their nominal ammonia storage tank is larger than the one proposed at Teys - 44 m^3.
Ammonia Release Form	Gas	Ammonia from storage vessel in a gaseous form assuming puncture or failure occurs above the liquid level.

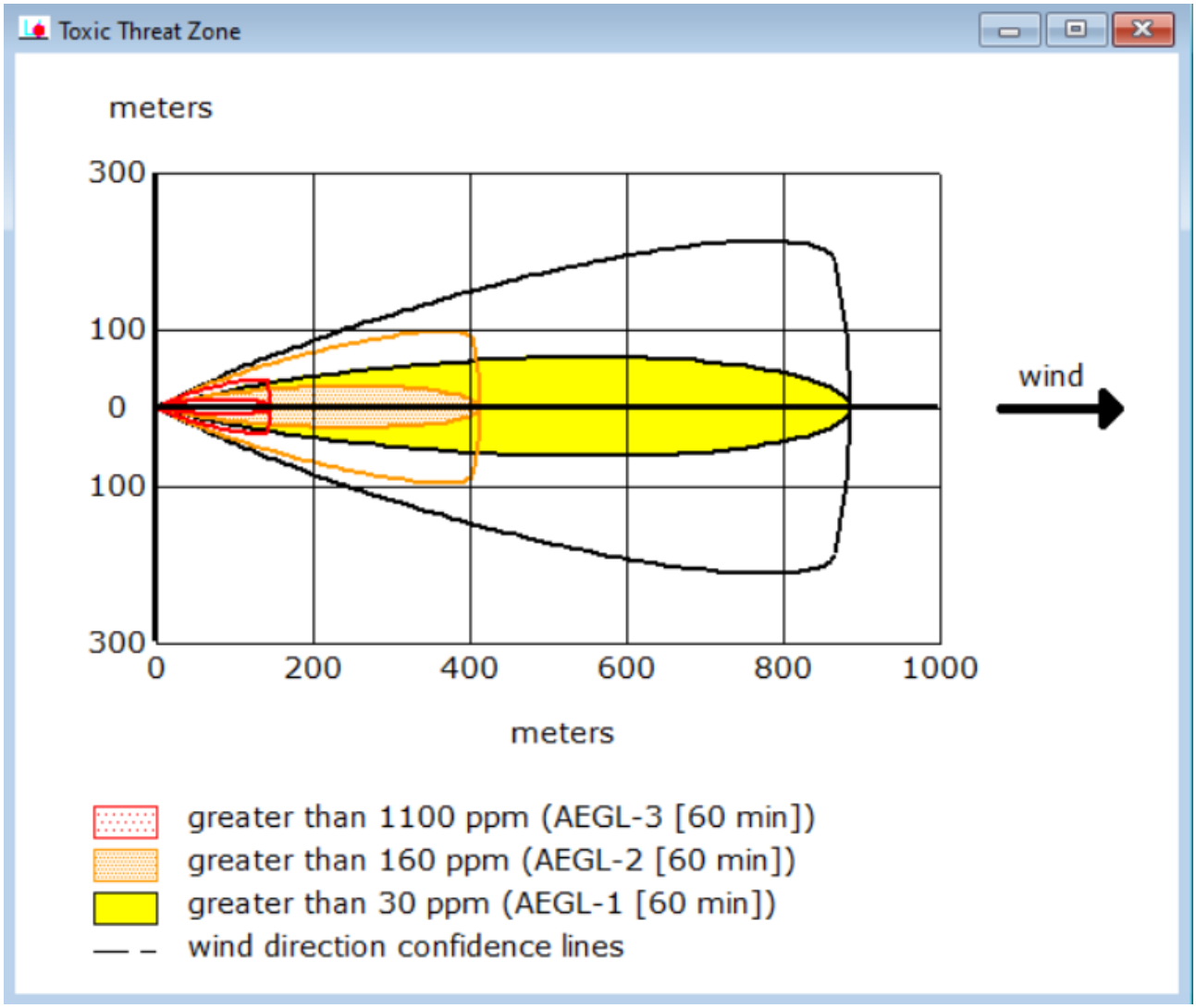
		This is considered as the tank is >50% set within a concrete base and (with exception of major maintenance overhaul – e.g. once per 3-5 years) the liquid level will be lower than the surface level <50%). The model was manipulated to allow for gaseous rather than liquid release. No evaporative puddle forms under this scenario; however, gas can still release from the puncture/failure. At a temperature of -40 degrees f/c within the tank there is very little evaporation of the liquid.
Ground Roughness	Open Country	As per Aloha manual this accounts for open fields and parking lots which are to the east. Lowest roughness value and more conservative threat zone.
Climatic Conditions	Class D and F	Modelling was undertaken for uncommon steady climatic conditions (Stability Class F) and more common (unsteady) weather conditions (Stability Class D). Class F is reflective of a stable atmosphere which tend to suppress vertical updrafts and reduce turbulence intensity, this is the worst-case meteorological condition in a toxic gas release situation. Class D is reflective of the normal or typical weather conditions, these were determined through an analysis of historic Bureau of Meteorology records for the Wagga Wagga Weather Station (Site Number 072150).
Building Type and Surrounds	Single Storied, Sheltered	Vessel Location external to building - ground floor. Sheltered above, on the northern, western and southern sides by building walls. Front is screen only.
Scenario 2		
Leak Type	Hole or Rectangle	This scenario assumes a pipe puncture from equipment such as a forklift which has a standard fork size of 10.16 cm x 5.08 cm) or a failure (e.g. valve). A circular hole with a diameter of 101.6 mm and a rectangular puncture with 101.6 mm length and width of 50.8 mm was tested. Both result in the same release rate and exposure extent.
Ammonia Release Form	Gas	Ammonia from storage vessel in a gaseous form.
Ground Roughness	Open Country	As per Aloha manual this accounts for open fields and parking lots which are to the east. Lowest roughness value and more conservative threat zone.
Climatic Conditions	Class D and F	Modelling was undertaken for uncommon steady climatic conditions (Stability Class F) and more common (unsteady) weather conditions (Stability Class D). Class F is reflective of a stable atmosphere which tend to suppress vertical updrafts and reduce turbulence intensity, this is the worst-case meteorological condition in a toxic gas release situation. Class D is reflective of the normal or typical weather conditions, these were determined through an analysis of historic Bureau of Meteorology records for the Wagga Wagga Weather Station (Site Number 072150).

Building Type and Surrounds	Single Storied, Sheltered	Vessel Location external to building - ground floor. Sheltered above, on the northern, western and southern sides by building walls. Front is screen only.
Scenario 3		
Leak Type	Tank Valve Failure	Accounts for potential liquid leak and puddl in which the tank attached valve or piping suffers a leak that releases ammonia liquid onto the floor of the pit.
Ammonia Release Form	Liquid (two phase)	Partial flashing resulting in vapour/ liquid aerosol which is initially denser than air and slumps to ground close to the release point; gas disperses as denser than air, ground hugging cloud
Ground Roughness	Open Country	As per Aloha manual this accounts for open fields and parking lots which are to the east. Lowest roughness value and more conservative threat zone.
Climatic Conditions	Class D and F	As per Aloha manual this accounts for open fields and parking lots which are to the east. Lowest roughness value and more conservative threat zone.
Puddle Size and Depth	2 m^2 and 2.5 cm	The puddle area and depth is based on a review of the tank floor design which includes a dry sump and sloping of the pit floor to drain into the dry. Liquid ammonia that is released would drain directly to the sump thus reducing both the surface area and depth that would be available for evaporation (see below). Plus there is a mechanical pit further below which would also act to contain a leak and the exposed surface area. Refer to drawing extracts below. Pool spreads to 2 m^2 in diameter and is contained within the vessel pit but drains into the pit dry sump. The surface area is based on the pit floor design and contouring of the pit floor around the tank that directs any liquid release to the sump. The sump is to be covered and thus limits evaporation. 

		 SUMP MECH DUCT ROOF OVER SHOWN DOTTED MAINTENANCE WALKWAY 30-06 AMMONIA VESSEL RL 222.150 (VARIES) FFL (AMBIENT°C) CONCRETE FLOOR FINISH RL 220.550 FFL PIT ROOF OVER SHOWN DOTTED ROOF OVER SHOWN DOTTED UP UP UP UP UP PPE AREA UP ROOF OVER SHOWN DOTTED AC (INT) AC (EXT) Col H I DP D

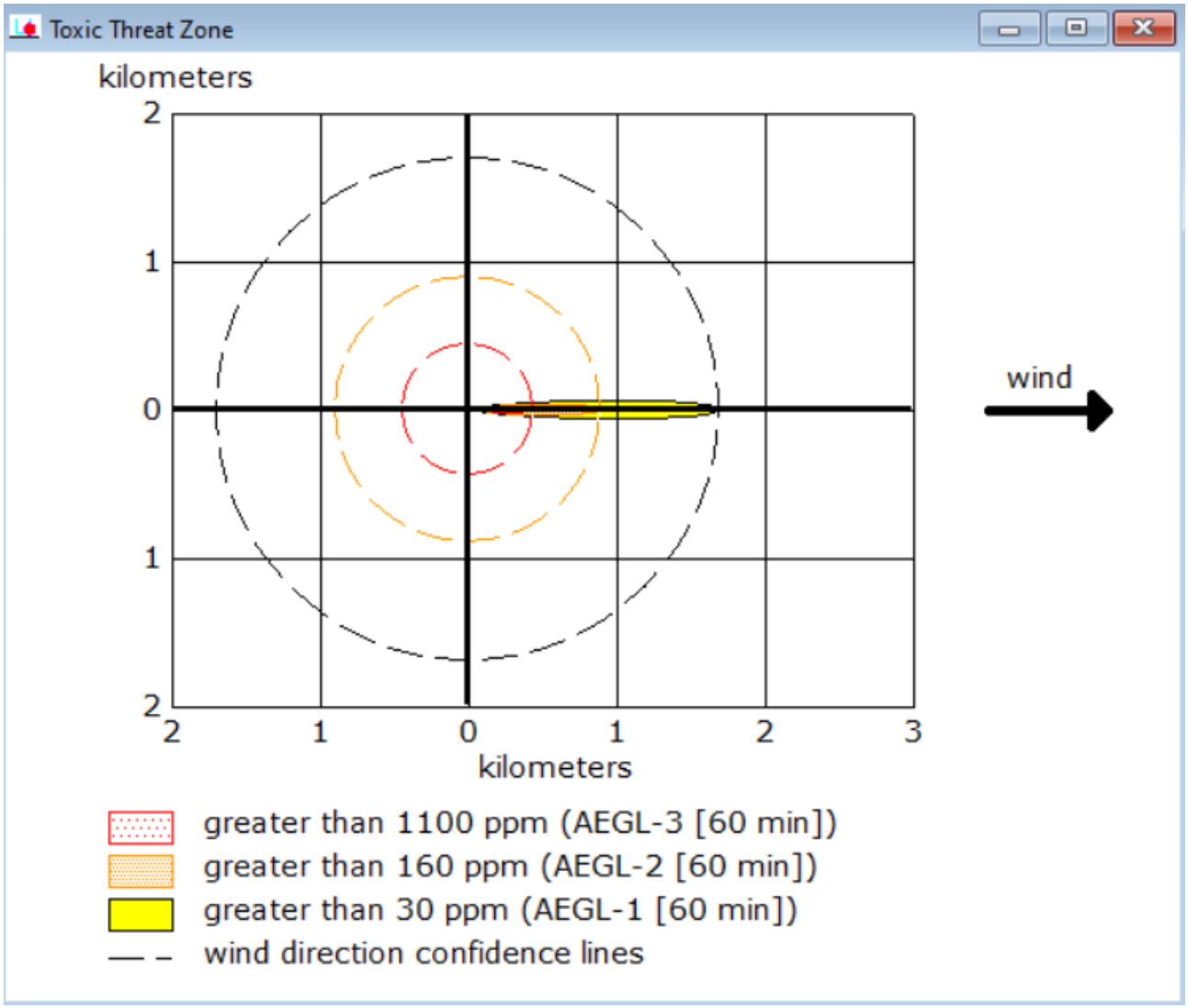
Scenario 1 – Catastrophic Hole in Tank Wall (Normal Conditions)

```
SITE DATA:
  Location: BOMEN, AUSTRALIA
  Building Air Exchanges Per Hour: 0.51 (sheltered single storied)
  Time: May 17, 2022  1100 hours ST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                    Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm      UEL: 280000 ppm
  Ambient Boiling Point: -33.9° C
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 3.95 meters/second from W at 10 meters
  Ground Roughness: open country           Cloud Cover: 5 tenths
  Air Temperature: 22.2° C
  Stability Class: D (user override)
  No Inversion Height                      Relative Humidity: 50%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 2.27 meters               Tank Length: 8 meters
  Tank Volume: 32.4 cubic meters
  Tank contains gas only                   Internal Temperature: -10° C
  Chemical Mass in Tank: 70 kilograms
  Circular Opening Diameter: 10.16 centimeters
  Release Duration: 1 minute
  Max Average Sustained Release Rate: 708 grams/sec
     (averaged over a minute or more)
  Total Amount Released: 42.5 kilograms

THREAT ZONE:
  Model Run: Gaussian
  Red    : 147 meters --- (1100 ppm = AEGL-3 [60 min])
  Orange: 413 meters --- (160 ppm = AEGL-2 [60 min])
  Yellow: 887 meters --- (30 ppm = AEGL-1 [60 min])
```


Toxic Threat Zone
meters
300
100
0
100
300
0
200
400
600
800
1000
meters
wind
greater than 1100 ppm (AEGL-3 [60 min])
greater than 160 ppm (AEGL-2 [60 min])
greater than 30 ppm (AEGL-1 [60 min])
wind direction confidence lines

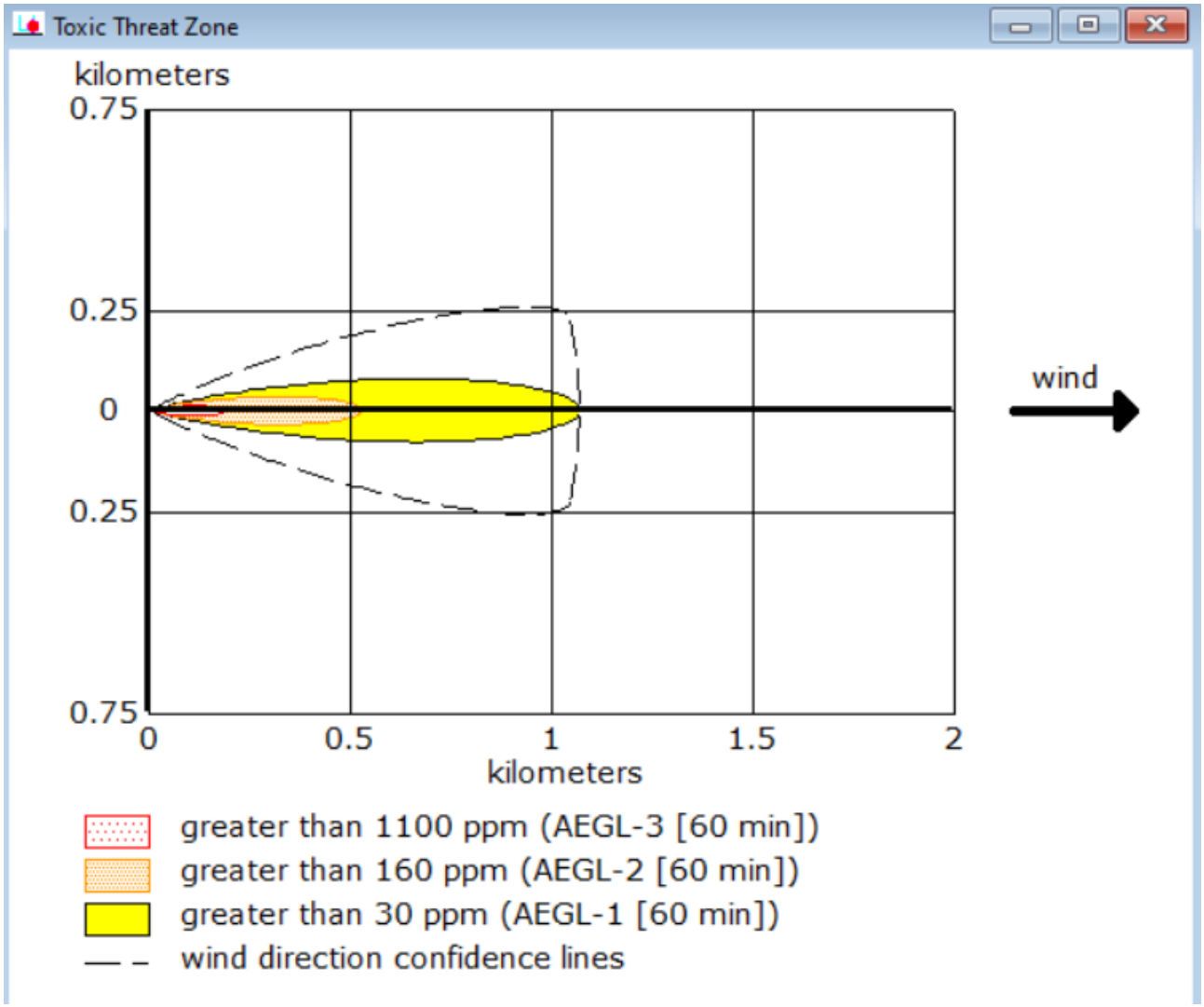
Scenario 1 – Hole in Tank Wall (Worst Case Conditions)

```
SITE DATA:
  Location: BOMEN, AUSTRALIA
  Building Air Exchanges Per Hour: 0.29 (sheltered single storied)
  Time: May 17, 2022  1100 hours ST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                    Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm      UEL: 280000 ppm
  Ambient Boiling Point: -33.9° C
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 1 meters/second from E at 10 meters
  Ground Roughness: open country           Cloud Cover: 5 tenths
  Air Temperature: 27° C
  Stability Class: F (user override)
  No Inversion Height                      Relative Humidity: 50%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 2.27 meters               Tank Length: 8 meters
  Tank Volume: 32.4 cubic meters
  Tank contains gas only                   Internal Temperature: -10° C
  Chemical Mass in Tank: 70 kilograms
  Circular Opening Diameter: 101.6 centimeters
  Release Duration: 1 minute
  Max Average Sustained Release Rate: 708 grams/sec
     (averaged over a minute or more)
  Total Amount Released: 42.5 kilograms

THREAT ZONE:
  Model Run: Gaussian
  Red    : 447 meters --- (1100 ppm = AEGL-3 [60 min])
  Orange: 899 meters --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.7 kilometers --- (30 ppm = AEGL-1 [60 min])
```


Toxic Threat Zone
kilometers
2
1
0
1
2
2
1
0
1
2
3
kilometers
wind
greater than 1100 ppm (AEGL-3 [60 min])
greater than 160 ppm (AEGL-2 [60 min])
greater than 30 ppm (AEGL-1 [60 min])
wind direction confidence lines

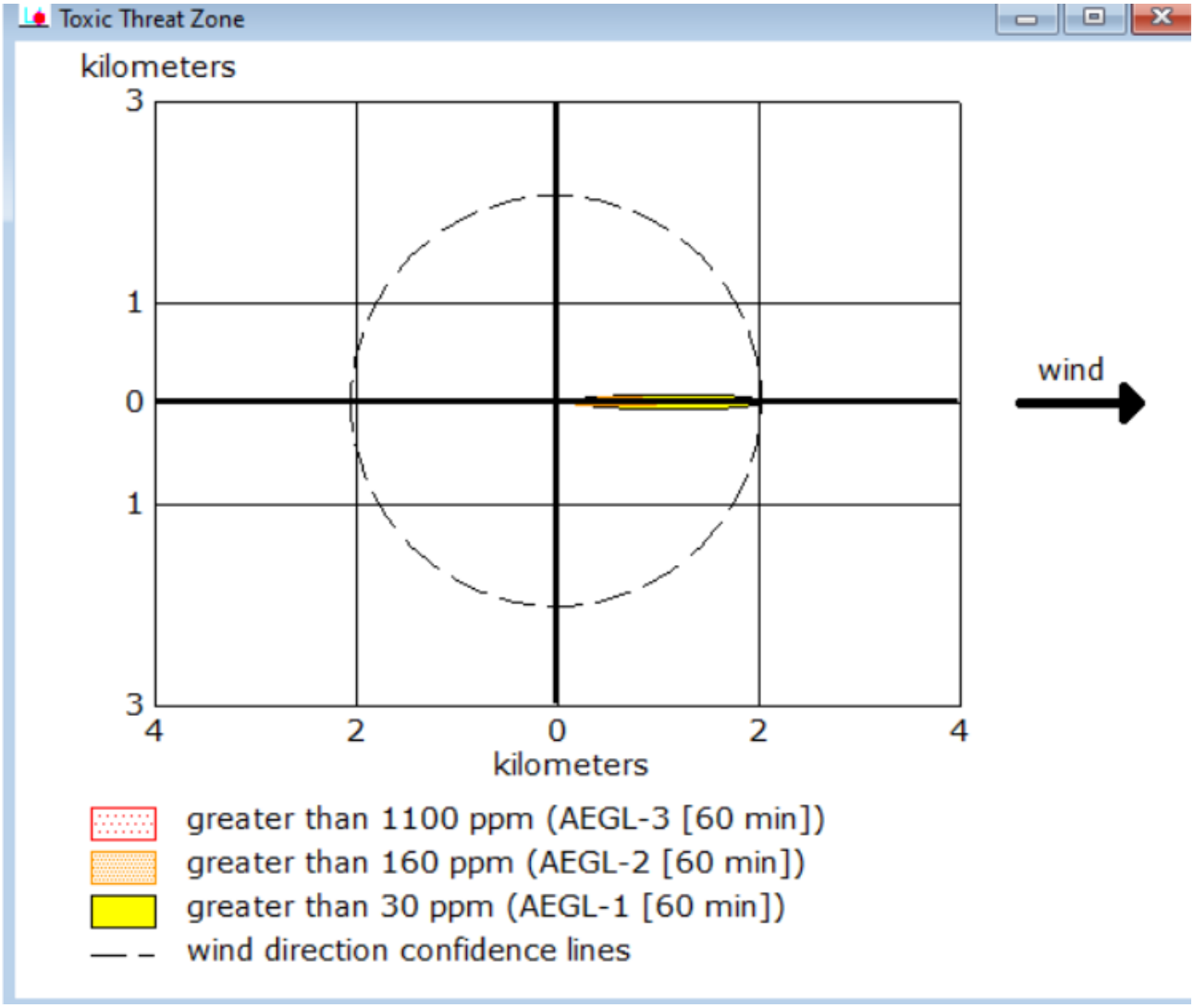
Scenario 2 – High Pressure Pipe Failure (Normal Conditions)

```
CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                    Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm       UEL: 280000 ppm
  Ambient Boiling Point: -33.6° C
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 3.95 meters/second from W at 10 meters
  Ground Roughness: open country           Cloud Cover: 5 tenths
  Air Temperature: 22.2° C
  Stability Class: D (user override)
  No Inversion Height                      Relative Humidity: 50%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 2.75 meters               Tank Length: 8 meters
  Tank Volume: 47.5 cubic meters
  Tank contains gas only                   Internal Temperature: -10° C
  Chemical Mass in Tank: 110 kilograms
  Circular Opening Diameter: 10.16 centimeters
  Release Duration: 1 minute
  Max Average Sustained Release Rate: 1.15 kilograms/sec
     (averaged over a minute or more)
  Total Amount Released: 68.9 kilograms

THREAT ZONE:
  Model Run: Gaussian
  Red    : 190 meters --- (1100 ppm = AEGL-3 [60 min])
  Orange: 527 meters --- (160 ppm = AEGL-2 [60 min])
  Yellow: 1.1 kilometers --- (30 ppm = AEGL-1 [60 min])

THREAT AT POINT:
  Concentration Estimates at the point:
  Downwind: 1010 meters                    Off Centerline: 0 meters
  Max Concentration:
     Outdoor: 35.2 ppm
     Indoor:  0.473 ppm
```


Toxic Threat Zone
kilometers
0.75
0.25
0
0.25
0.75
0
0.5
1
1.5
2
kilometers
wind
greater than 1100 ppm (AEGL-3 [60 min])
greater than 160 ppm (AEGL-2 [60 min])
greater than 30 ppm (AEGL-1 [60 min])
wind direction confidence lines

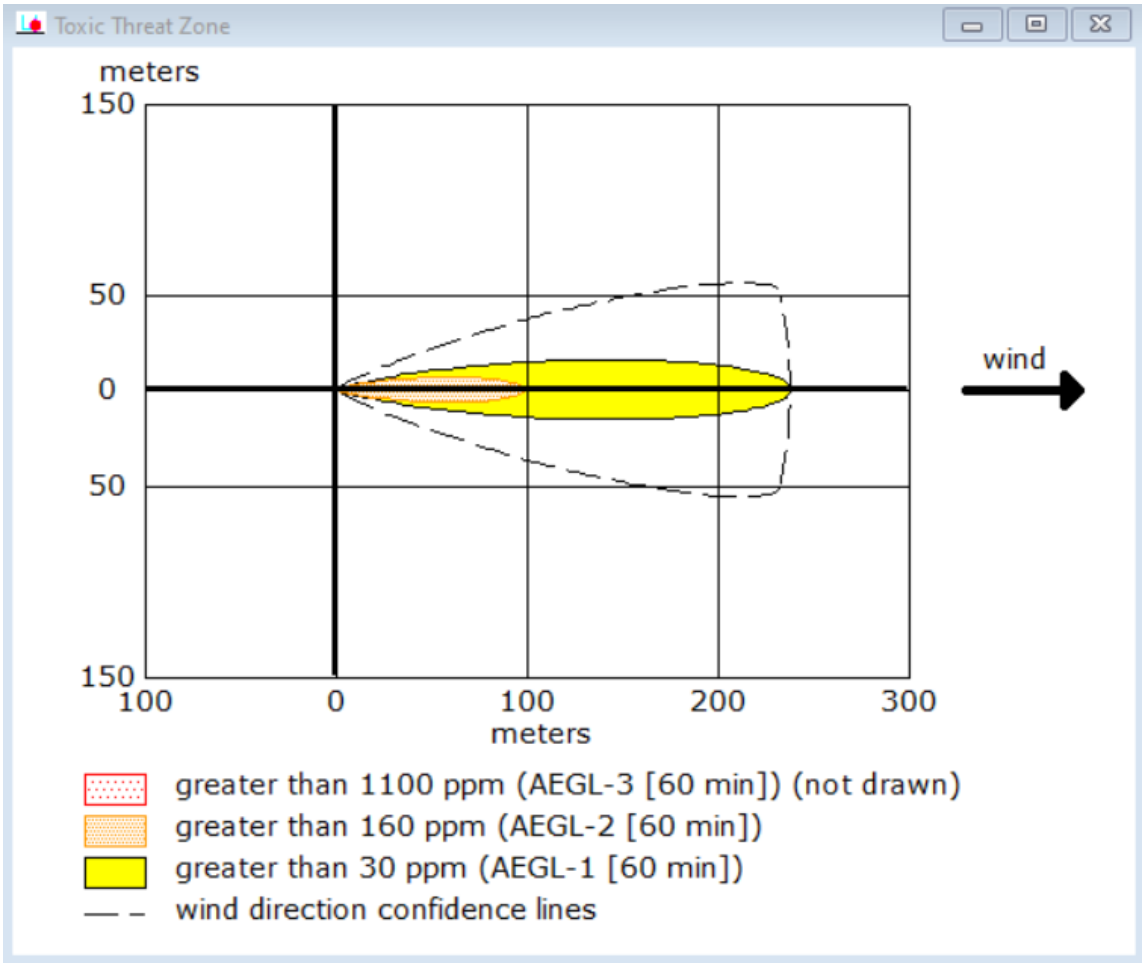
Scenario 2 – High Pressure Pipe Failure (Worst Case Conditions)

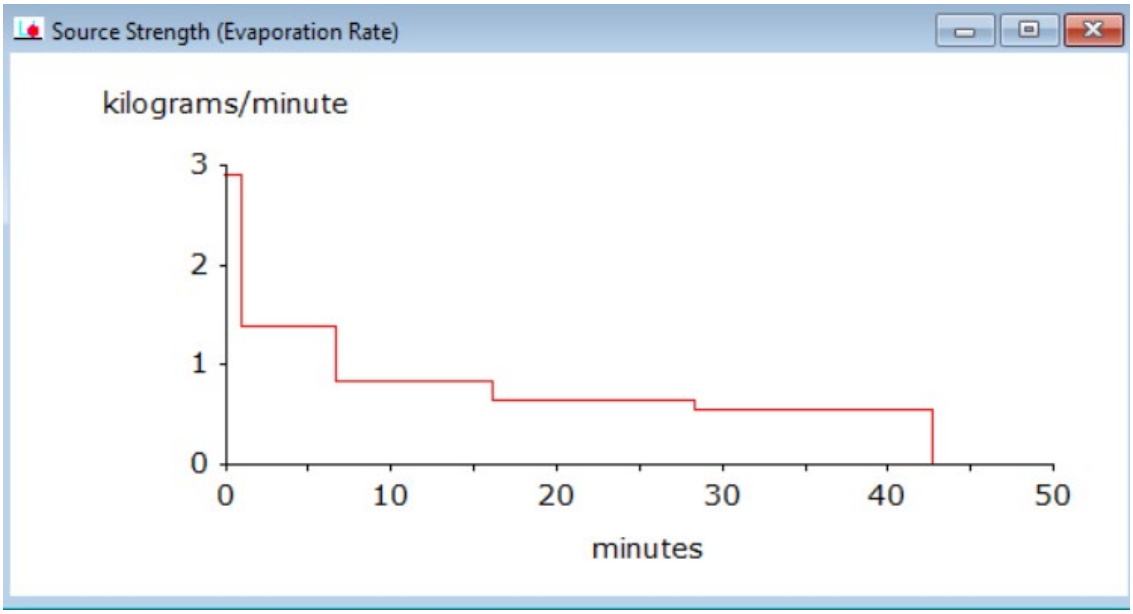
```
SITE DATA:
  Location: BOMEN, AUSTRALIA
  Building Air Exchanges Per Hour: 0.29 (sheltered single storied)
  Time: May 17, 2022  1100 hours ST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                    Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm      UEL: 280000 ppm
  Ambient Boiling Point: -33.6° C
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 1 meters/second from E at 10 meters
  Ground Roughness: open country           Cloud Cover: 5 tenths
  Air Temperature: 27° C
  Stability Class: F (user override)
  No Inversion Height                      Relative Humidity: 50%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 2.75 meters               Tank Length: 8 meters
  Tank Volume: 47.5 cubic meters
  Tank contains gas only                   Internal Temperature: -10° C
  Chemical Mass in Tank: 110 kilograms
  Circular Opening Diameter: 10.16 centimeters
  Release Duration: 1 minute
  Max Average Sustained Release Rate: 1.15 kilograms/sec
     (averaged over a minute or more)
  Total Amount Released: 68.9 kilograms

THREAT ZONE:
  Model Run: Gaussian
  Red    : 532 meters --- (1100 ppm = AEGL-3 [60 min])
  Orange: 1.1 kilometers --- (160 ppm = AEGL-2 [60 min])
  Yellow: 2.1 kilometers --- (30 ppm = AEGL-1 [60 min])
```


Toxic Threat Zone
kilometers
3
1
0
1
3
4
2
0
2
4
kilometers
wind
greater than 1100 ppm (AEGL-3 [60 min])
greater than 160 ppm (AEGL-2 [60 min])
greater than 30 ppm (AEGL-1 [60 min])
wind direction confidence lines

Scenario 3 – Tank Puddle Leak onto Plant Floor (Normal Conditions)

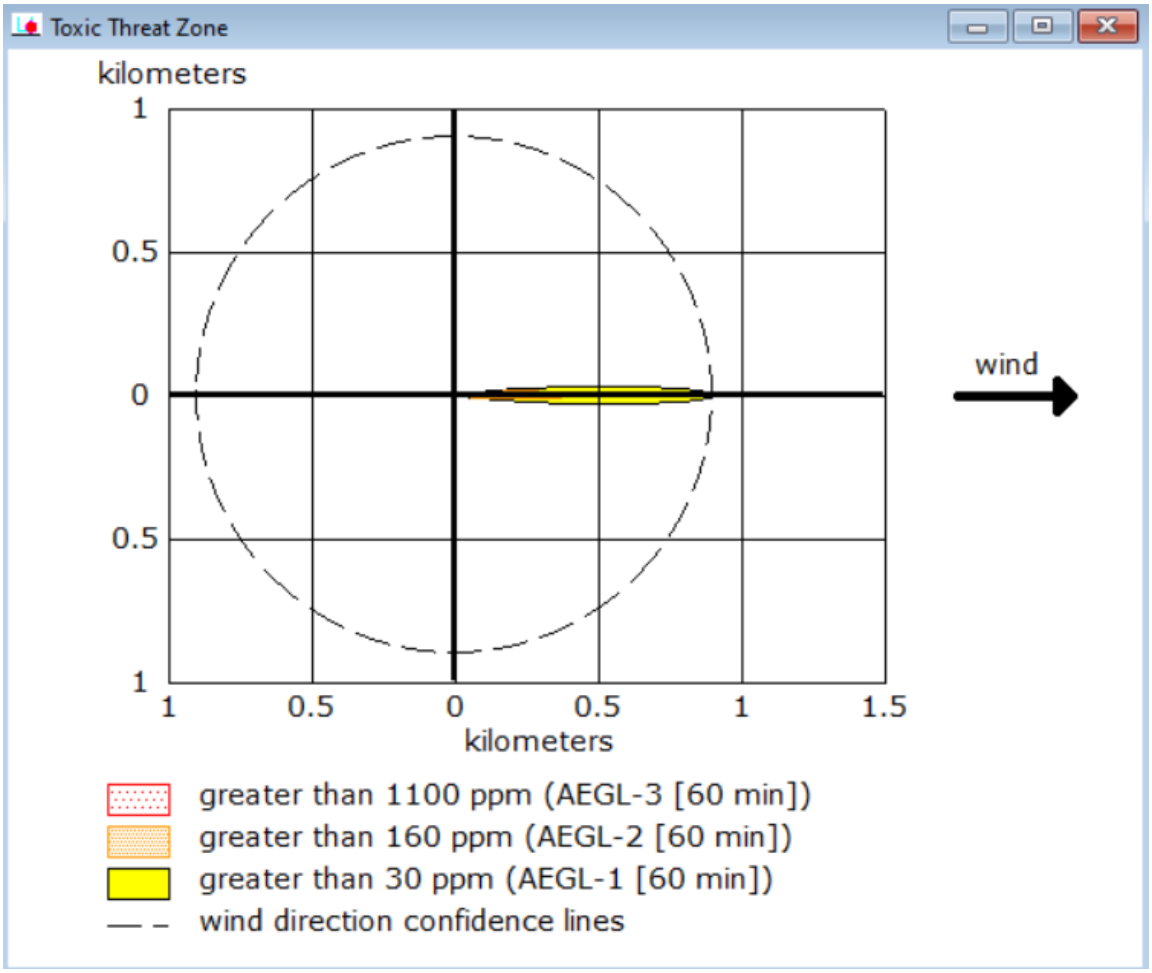
```
SITE DATA:
  Location: BOMEN, AUSTRALIA
  Building Air Exchanges Per Hour: 0.51 (sheltered single storied)
  Time: May 17, 2022  1100 hours ST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                    Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm      UEL: 280000 ppm
  Ambient Boiling Point: -33.6° C
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 3.95 meters/second from W at 10 meters
  Ground Roughness: open country           Cloud Cover: 5 tenths
  Air Temperature: 22.2° C
  Stability Class: D (user override)
  No Inversion Height                      Relative Humidity: 50%

SOURCE STRENGTH:
  Evaporating Puddle (Note: chemical is flammable)
  Puddle Area: 2 square meters
  Average Puddle Depth: 2.5 centimeters
  Ground Type: Concrete                    Ground Temperature: 22.2° C
  Initial Puddle Temperature: -40° C
  Release Duration: 43 minutes
  Max Average Sustained Release Rate: 2.89 kilograms/min
     (averaged over a minute or more)
  Total Amount Released: 34.5 kilograms

THREAT ZONE:
  Model Run: Gaussian
  Red    : 36 meters --- (1100 ppm = AEGL-3 [60 min])
  Note: Threat zone was not drawn because effects of near-field patchiness
     make dispersion predictions less reliable for short distances.
  Orange: 99 meters --- (160 ppm = AEGL-2 [60 min])
  Yellow: 238 meters --- (30 ppm = AEGL-1 [60 min])
```

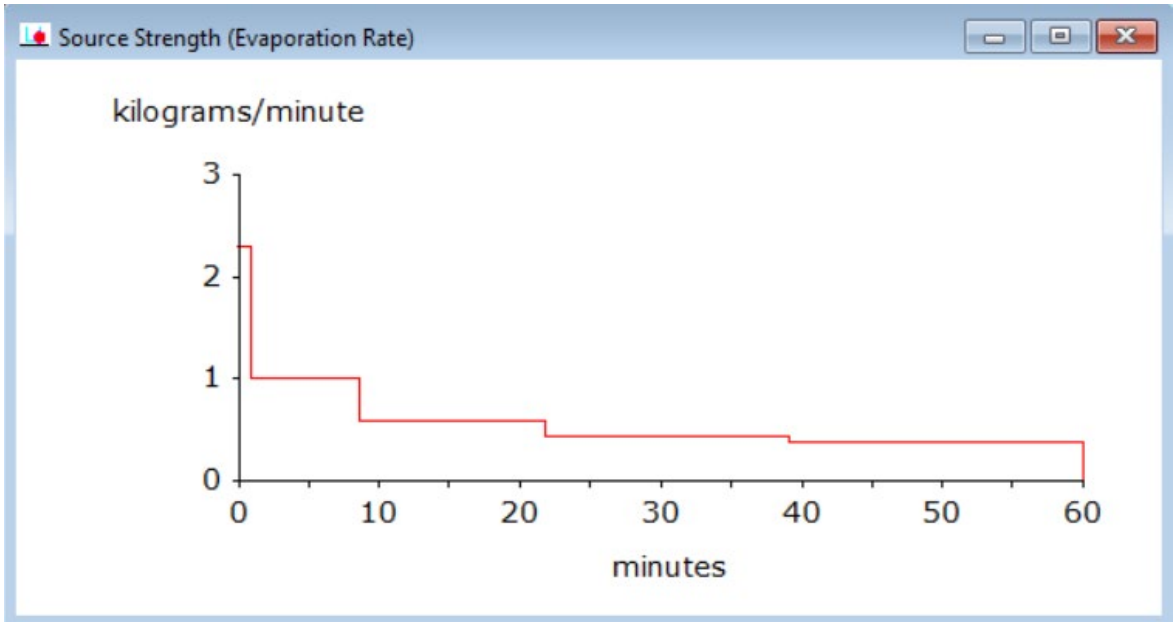

Toxic Threat Zone
meters
150
50
0
50
150
100
0
100
200
300
meters
wind
greater than 1100 ppm (AEGL-3 [60 min]) (not drawn)
greater than 160 ppm (AEGL-2 [60 min])
greater than 30 ppm (AEGL-1 [60 min])
wind direction confidence lines


Source Strength (Evaporation Rate)
kilograms/minute
3
2
1
0
0
10
20
30
40
50
minutes

Scenario 3 – Tank Puddle Leak onto Plant Floor (Worst Case Conditions)

```
SITE DATA:
  Location: BOMEN, AUSTRALIA
  Building Air Exchanges Per Hour: 0.29 (sheltered single storied)
  Time: May 17, 2022  1100 hours ST (user specified)

CHEMICAL DATA:
  Chemical Name: AMMONIA
  CAS Number: 7664-41-7                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -33.6° C
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 1 meters/second from E at 10 meters
  Ground Roughness: open country         Cloud Cover: 5 tenths
  Air Temperature: 27° C
  Stability Class: F (user override)
  No Inversion Height                    Relative Humidity: 50%

SOURCE STRENGTH:
  Evaporating Puddle (Note: chemical is flammable)
  Puddle Area: 2 square meters
  Average Puddle Depth: 2.5 centimeters
  Ground Type: Concrete                  Ground Temperature: 27° C
  Initial Puddle Temperature: -40° C
  Release Duration: ALOHA limited the duration to 1 hour
  Max Average Sustained Release Rate: 2.28 kilograms/min
     (averaged over a minute or more)
  Total Amount Released: 33.3 kilograms

THREAT ZONE:
  Model Run: Gaussian
  Red    : 168 meters --- (1100 ppm = AEGL-3 [60 min])
  Orange: 394 meters --- (160 ppm = AEGL-2 [60 min])
  Yellow: 902 meters --- (30 ppm = AEGL-1 [60 min])
```


Toxic Threat Zone
kilometers
1
0.5
0
0.5
1
1
0.5
0
0.5
1
1.5
kilometers
wind
greater than 1100 ppm (AEGL-3 [60 min])
greater than 160 ppm (AEGL-2 [60 min])
greater than 30 ppm (AEGL-1 [60 min])
wind direction confidence lines


Source Strength (Evaporation Rate)
kilograms/minute
3
2
1
0
0
10
20
30
40
50
60
minutes

Appendix F Standard Safety Data Sheet

Safety Data Sheet

Ammonia

Date of first issue: 27/08/2007 Revised date: 19/12/2016 Supersedes: 08/11/2012 Version: 7.0

SDS reference: AL068

Danger

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Trade name	:	Anhydrous ammonia
SDS no	:	AL068
Chemical description	:	Anhydrous ammonia CAS No : 7664-41-7 EC no : 231-635-3 EC index no : 007-001-00-5
Registration-No.	:	01-2119488876-14
Chemical formula	:	NH3

1.2. Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	:	Industrial and professional. Perform risk assessment prior to use. Test gas/Calibration gas. Laboratory use. Chemical reaction / Synthesis. Use for manufacture of electronic/photovoltaic components. Use as refrigerant. Use for metal treatment. Contact supplier for more information on uses.
Uses advised against	:	Consumer use.

1.3. Details of the supplier of the safety data sheet

Company identification	:	Air Liquide Australia Limited Level 9 / 380 St. Kilda Road 3004 Melbourne VIC Australia +61 3 9697 9888 ALAEnquiries@AirLiquide.com

1.4. Emergency telephone number

Emergency telephone number	:	1800 812 588

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification according to WHS Regulation

Physical hazards	Flammable gases, Category 2	H221
	Gases under pressure : Liquefied gas	H280
Health hazards	Acute toxicity (inhalation:gas) Category 3	H331
	Skin corrosion/irritation, Category 1B	H314
	Serious eye damage/eye irritation, Category 1	H318
Environmental hazards	Hazardous to the aquatic environment — Acute Hazard, Category 1	H400

2.2. Label elements

Classification according to WHS Regulation

Hazard pictograms :

GHS04 GHS05 GHS06 GHS09

Signal word : Danger

Hazard statements : H221 - Flammable gas.
H280 - Contains gas under pressure; may explode if heated.
H331 - Toxic if inhaled.
H400 - Very toxic to aquatic life.
H314 - Causes severe skin burns and eye damage.
EUH071 - Corrosive to the respiratory tract.

Precautionary statements

- Prevention : P273 - Avoid release to the environment.
P260 - Do not breathe gas, vapours.
P280 - Wear protective gloves, protective clothing, eye protection, face protection.
P210 - Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.

- Response : P377 - Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381 - Eliminate all ignition sources if safe to do so.
P303+P361+P353+P315 - IF ON SKIN : (or hair) Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. Get immediate medical advice / attention.
P304+P340+P315 - IF INHALED : Remove victim to fresh air and keep at rest in a position comfortable for breathing. Get immediate medical advice / attention.
P305+P351+P338+P315 - IF IN EYES : Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get immediate medical advice / attention.

- Storage : P403 - Store in a well-ventilated place.
P405 - Store locked up.

2.3. Other hazards

: None.

SECTION 3: Composition/information on ingredients

3.1. Substance

Name	Product identifier	%	Classification according to WHS Regulation
Anhydrous ammonia	(CAS No) 7664-41-7 (EC no) 231-635-3 (EC index no) 007-001-00-5 (Registration-No.) 01-2119488876-14	100	Flam. Gas 2, H221 Press. Gas (Liq.), H280 Acute Tox. 3 (Inhalation:gas), H331 Skin Corr. 1B, H314 Eye Dam. 1, H318 Aquatic Acute 1, H400

Contains no other components or impurities which will influence the classification of the product.

Full text of R-phrases see section 16. Full text of H-statements see section 16.

3.2. Mixture : Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

- Inhalation : Remove victim to uncontaminated area wearing self contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.
- Skin contact : Remove contaminated clothing. Drench affected area with water for at least 15 minutes.
- Eye contact : Immediately flush eyes thoroughly with water for at least 15 minutes.
- Ingestion : Ingestion is not considered a potential route of exposure.

4.2. Most important symptoms and effects, both acute and delayed

: May cause severe chemical burns to skin and cornea. Suitable first-aid treatment should be immediately available. Seek medical advice before using product.
Prolonged exposure to small concentrations may result in pulmonary oedema.
Material is destructive to tissue of the mucuous membranes and upper respiratory tract. Cough, shortness of breath, headache, nausea.
Refer to section 11.

4.3. Indication of any immediate medical attention and special treatment needed

: Treat with corticosteroid spray as soon as possible after inhalation.
Obtain medical assistance.

SECTION 5: Firefighting measures

5.1. Extinguishing media

- Suitable extinguishing media : Water spray or fog.
Foam.
Carbon dioxide.
- Unsuitable extinguishing media : Do not use water jet to extinguish.

5.2. Special hazards arising from the substance or mixture

Specific hazards : Exposure to fire may cause containers to rupture/explode.

Hazardous combustion products : If involved in a fire the following toxic and/or corrosive fumes may be produced by thermal decomposition:
Nitric oxide/nitrogen dioxide.

5.3. Advice for fire-fighters

Specific methods : Use fire control measures appropriate for the surrounding fire. Exposure to fire and heat radiation may cause gas receptacles to rupture. Cool endangered receptacles with water spray jet from a protected position. Prevent water used in emergency cases from entering sewers and drainage systems.
If possible, stop flow of product.
Use water spray or fog to knock down fire fumes if possible.

Do not extinguish a leaking gas flame unless absolutely necessary. Spontaneous/explosive re-ignition may occur. Extinguish any other fire.
Move containers away from the fire area if this can be done without risk.

Special protective equipment for fire fighters : Wear gas tight chemically protective clothing in combination with self contained breathing apparatus.
EN 943-2: Protective clothing against liquid and gaseous chemicals, aerosols and solid particles. Gas-tight chemical protective suits for emergency teams.
Standard EN 137 - Self-contained open-circuit compressed air breathing apparatus with full face mask.

Hazchemcode : 2RE

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

: Try to stop release.
Evacuate area.
Monitor concentration of released product.
Wear gas tight chemically protective clothing in combination with self contained breathing apparatus.
Ensure adequate air ventilation.
Act in accordance with local emergency plan.
Stay upwind.

6.2. Environmental precautions

: Try to stop release.
Reduce vapour with fog or fine water spray.

6.3. Methods and material for containment and cleaning up

: Hose down area with water.
Ventilate area.
Keep area evacuated and free from ignition sources until any spilled liquid has evaporated (ground free from frost).
Wash contaminated equipment or sites of leaks with copious quantities of water.

6.4. Reference to other sections

: See also sections 8 and 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Safe use of the product : The substance must be handled in accordance with good industrial hygiene and safety procedures.
Only experienced and properly instructed persons should handle gases under pressure.
Consider pressure relief device(s) in gas installations.
Ensure the complete gas system was (or is regularily) checked for leaks before use.
Do not smoke while handling product.
Avoid exposure, obtain special instructions before use.
Use only properly specified equipment which is suitable for this product, its supply pressure and temperature. Contact your gas supplier if in doubt.
Installation of a cross purge assembly between the cylinder and the regulator is recommended.
Purge system with dry inert gas (e.g. helium or nitrogen) before gas is introduced and when system is placed out of service.
Avoid suck back of water, acid and alkalis.
Assess the risk of potentially explosive atmospheres and the need for explosion-proof equipment.
Take precautionary measures against static discharge.
Keep away from ignition sources (including static discharges).
Consider the use of only non-sparking tools.
Do not breathe gas.
Avoid release of product into atmosphere.

Safe handling of the gas receptacle : Refer to supplier's container handling instructions.
Do not allow backfeed into the container.
Protect cylinders from physical damage; do not drag, roll, slide or drop.
When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders.
Leave valve protection caps in place until the container has been secured against either a wall or bench or placed in a container stand and is ready for use.
If user experiences any difficulty operating cylinder valve discontinue use and contact supplier.
Never attempt to repair or modify container valves or safety relief devices.
Damaged valves should be reported immediately to the supplier.
Keep container valve outlets clean and free from contaminants particularly oil and water.
Replace valve outlet caps or plugs and container caps where supplied as soon as container is disconnected from equipment.
Close container valve after each use and when empty, even if still connected to equipment.
Never attempt to transfer gases from one cylinder/container to another.
Never use direct flame or electrical heating devices to raise the pressure of a container.
Do not remove or deface labels provided by the supplier for the identification of the cylinder contents.

7.2. Conditions for safe storage, including any incompatibilities

: Observe all regulations and local requirements regarding storage of containers.
Containers should not be stored in conditions likely to encourage corrosion.
Container valve guards or caps should be in place.
Containers should be stored in the vertical position and properly secured to prevent them from falling over.
Stored containers should be periodically checked for general condition and leakage.
Keep container below 50°C in a well ventilated place.
Store containers in location free from fire risk and away from sources of heat and ignition.
Keep away from combustible materials.
Segregate from oxidant gases and other oxidants in store.
All electrical equipment in the storage areas should be compatible with the risk of a potentially explosive atmosphere.

7.3. Specific end use(s)

: None.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Anhydrous ammonia (7664-41-7)		
OEL : Occupational Exposure Limits		
United Kingdom	WEL - LTEL - UK [mg/m³]	18 mg/m³
	WEL - LTEL - UK [ppm]	25 ppm
	WEL - STEL - UK [mg/m³]	25 mg/m³
	WEL - STEL - UK [ppm]	35 ppm

Anhydrous ammonia (7664-41-7)	
DNEL: Derived no effect level (Workers)	
Acute - local effects, inhalation	36 mg/m³
Long-term - local effects, inhalation	14 mg/m³
Acute - systemic effects, dermal	6.8 mg/kg bw/day
Long-term - systemic effects, dermal	6.8 mg/kg bw/day

Anhydrous ammonia (7664-41-7)	
PNEC: Predicted no effect concentration	
Aqua (freshwater)	0.0011 mg/l
Aqua (marine water)	0.0011 mg/l

8.2. Exposure controls

8.2.1. Appropriate engineering controls

: Provide adequate general and local exhaust ventilation.
Product to be handled in a closed system.
Preferably use only permanent leak-tight installations (e.g. welded pipes).
Systems under pressure should be regularly checked for leakages.
Ensure exposure is below occupational exposure limits (where available).
Gas detectors should be used when toxic gases may be released.
Consider work permit system e.g. for maintenance activities.

8.2.2. Individual protection measures, e.g. personal protective equipment

: A risk assessment should be conducted and documented in each work area to assess the risks related to the use of the product and to select the PPE that matches the relevant risk. The following recommendations should be considered:
Protect eyes, face and skin from liquid splashes.
PPE compliant to the recommended EN/ISO standards should be selected.

• Eye/face protection

: Wear safety glasses with side shields.
Wear goggles and a face shield when transfilling or breaking transfer connections.
Standard EN 166 - Personal eye-protection.
Provide readily accessible eye wash stations and safety showers.

• Skin protection

- Hand protection

: Wear working gloves when handling gas containers.
Standard EN 388 - Protective gloves against mechanical risk.
Wear chemically resistant protective gloves.
Standard EN 374 - Protective gloves against chemicals.
Permeation time: minimum >30min short term exposure: material / thickness [mm] Chloroprene rubber (CR) 0,5
Permeation time: minimum >480min long term exposure: material / thickness [mm] Butyl rubber (IIR) 0,7
Consult glove manufacturer´s product information on material suitability and material thickness.
The breakthrough time of the selected gloves must be greater than the intended use period.

- Other

: Consider the use of flame resistant anti-static safety clothing.
Standard EN ISO 14116 - Limited flame spread materials.
Standard EN ISO 1149-5 - Protective clothing: Electrostatic properties.
Wear safety shoes while handling containers.
Standard EN ISO 20345 - Personal protective equipment - Safety footwear.
Keep suitable chemically resistant protective clothing readily available for emergency use.
Standard EN943-1 - Full protective suits against liquid, solid and gaseous chemicals.

• Respiratory protection

: Gas filters may be used if all surrounding conditions e.g. type and concentration of the contaminant(s) and duration of use are known.
Use gas filters and full face mask, where exposure limits may be exceeded for a short-term period, e.g. connecting or disconnecting containers.
Recommended: Filter K (green).
Consult respiratory device supplier´s product information for the selection of the appropriate device.
Gas filters do not protect against oxygen deficiency.
Standard EN 14387 - Gas filter(s), combined filter(s) and full face mask - EN 136.
Keep self contained breathing apparatus readily available for emergency use.
Standard EN 137 - Self-contained open-circuit compressed air breathing apparatus with full face mask.
Self contained breathing apparatus is recommended, where unknown exposure may be expected, e.g. during maintenance activities on installation systems.

• Thermal hazards

: None necessary.

8.2.3. Environmental exposure controls

: Refer to local regulations for restriction of emissions to the atmosphere. See section 13 for specific methods for waste gas treatment.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Appearance

- Physical state at 20°C / 101.3kPa : Gas.
- Colour : Colourless.

Odour	:	Ammoniacal.
Odour threshold	:	Odour threshold is subjective and inadequate to warn of overexposure.
pH value	:	If dissolved in water pH-value will be affected.
Molar mass	:	17 g/mol
Melting point	:	-77.7 °C
Boiling point	:	-33 °C
Flash point	:	Not applicable for gases and gas mixtures.
Critical temperature [°C]	:	132 °C
Evaporation rate (ether=1)	:	Not applicable for gases and gas mixtures.
Flammability range	:	15.4 - 33.6 vol %
Vapour pressure [20°C]	:	8.6 bar(a)
Vapour pressure [50°C]	:	20 bar(a)
Relative density, gas (air=1)	:	0.6
Relative density, liquid (water=1)	:	0.7
Solubility in water	:	517000 mg/l
Partition coefficient n-octanol/water [log Kow]	:	Not applicable for inorganic gases.
Auto-ignition temperature	:	630 °C
Viscosity [20°C]	:	Not applicable.
Explosive Properties	:	Not applicable.
Oxidising Properties	:	None.

9.2. Other information

Other data : None.

SECTION 10: Stability and reactivity

10.1. Reactivity

: No reactivity hazard other than the effects described in sub-sections below.

10.2. Chemical stability

: Stable under normal conditions.

10.3. Possibility of hazardous reactions

: May react violently with oxidants.
Can form explosive mixture with air.

10.4. Conditions to avoid

: Keep away from heat/sparks/open flames/hot surfaces. – No smoking.

10.5. Incompatible materials

: Reacts with water to form corrosive alkalis.
May react violently with acids.
Air, Oxidiser.
For additional information on compatibility refer to ISO 11114.

10.6. Hazardous decomposition products

: Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Inhalation of large amounts leads to bronchospasm, laryngeal oedema and pseudomembrane formation.

LC50 inhalation rat (ppm)	2000 ppm/4h

Skin corrosion/irritation : May cause inflammation of the skin.

Serious eye damage/irritation : Irritation to eyes.

Respiratory or skin sensitisation : No known effects from this product.

Germ cell mutagenicity : No known effects from this product.

Carcinogenicity : No known effects from this product.

Toxic for reproduction : Fertility : No known effects from this product.

Toxic for reproduction : unborn child : No known effects from this product.

STOT-single exposure : May cause inflammation of the respiratory system.

Target organ(s) : Respiratory tract.

STOT-repeated exposure : No known effects from this product.

Aspiration hazard : Not applicable for gases and gas mixtures.

SECTION 12: Ecological information

12.1. Toxicity

Assessment : Very toxic to aquatic life.

12.2. Persistence and degradability

Assessment : The substance is biodegradable. Unlikely to persist.

12.3. Bioaccumulative potential

Assessment : Not expected to bioaccumulate due to the low log Kow (log Kow < 4). Refer to section 9.

12.4. Mobility in soil

Assessment : Because of its high volatility, the product is unlikely to cause ground or water pollution.

12.5. Results of PBT and vPvB assessment

Assessment : Not classified as PBT or vPvB.

12.6. Other adverse effects

: May cause pH changes in aqueous ecological systems.

Effect on ozone layer : None.

Effect on the global warming : No known effects from this product.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Must not be discharged to atmosphere.
Toxic and corrosive gases formed during combustion should be scrubbed before discharge to atmosphere.
Gas may be scrubbed in sulphuric acid solution.
Gas may be scrubbed in water.
Ensure that the emission levels from local regulations or operating permits are not exceeded.
Refer to the EIGA code of practice Doc.30 "Disposal of Gases", downloadable at http://www.eiga.org for more guidance on suitable disposal methods.

List of hazardous waste codes (from Commission Decision 2001/118/EC) : 16 05 04: Gases in pressure containers (including halons) containing dangerous substances.

13.2. Additional information

: None.

SECTION 14: Transport information

14.1. UN number

UN-No. : 1005

14.2. UN proper shipping name

Transport by road/rail (ADG) : AMMONIA, ANHYDROUS

Transport by air (ICAO-TI / IATA-DGR) : AMMONIA, ANHYDROUS

Transport by sea (IMDG) : AMMONIA, ANHYDROUS

14.3. Transport hazard class(es)

Labelling :

2.3 : Toxic gases
8 : Corrosive substances

Environmentally hazardous substances

Transport by road/rail (ADG)

Class : 2
Hazchemcode : 2RE
Hazard identification number : 268
Tunnel Restriction : C/D - Tank carriage : Passage forbidden through tunnels of category C, D and E. Other carriage : Passage forbidden through tunnels of category D and E

Transport by air (ICAO-TI / IATA-DGR)

Class / Div. (Sub. risk(s)) : 2.3 (8)

Transport by sea (IMDG)

Class / Div. (Sub. risk(s)) : 2.3 (8)
Emergency Schedule (EmS) - Fire : F-C
Emergency Schedule (EmS) - Spillage : S-U

14.4. Packing group

Transport by road/rail (ADR/RID) : Not applicable
Transport by air (ICAO-TI / IATA-DGR) : Not applicable
Transport by sea (IMDG) : Not applicable

14.5. Environmental hazards

Transport by road/rail (ADR/RID) : Environmentally hazardous substance / mixture.

Transport by air (ICAO-TI / IATA-DGR) : Environmentally hazardous substance / mixture.

Transport by sea (IMDG) : Marine pollutant

14.6. Special precautions for user

Packing Instruction(s)

Transport by road/rail (ADR/RID) : P200

Transport by air (ICAO-TI / IATA-DGR)

Passenger and Cargo Aircraft : Forbidden

Cargo Aircraft only : Forbidden

Transport by sea (IMDG) : P200

Special transport precautions : Avoid transport on vehicles where the load space is not separated from the driver's compartment.
Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency.
Before transporting product containers:
- Ensure there is adequate ventilation.
- Ensure that containers are firmly secured.
- Ensure cylinder valve is closed and not leaking.
- Ensure valve outlet cap nut or plug (where provided) is correctly fitted.
- Ensure valve protection device (where provided) is correctly fitted.

HAZCHEMCODE : 2RE

14.7. Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

: Not applicable.

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

National regulations

Ensure all national/local regulations are observed.

15.2. Chemical safety assessment

: A CSA has been carried out.

SECTION 16: Other information

Indication of changes : Revised safety data sheet in accordance with commission regulation (EU) No 453/2010.

Training advice : Users of breathing apparatus must be trained. Ensure operators understand the toxicity hazard.

Full text of H-statements

Acute Tox. 3 (Inhalation:gas)	Acute toxicity (inhalation:gas) Category 3
Aquatic Acute 1	Hazardous to the aquatic environment — Acute Hazard, Category 1
Eye Dam. 1	Serious eye damage/eye irritation, Category 1
Flam. Gas 2	Flammable gases, Category 2

Press. Gas (Liq.)	Gases under pressure : Liquefied gas
Skin Corr. 1B	Skin corrosion/irritation, Category 1B
H221	Flammable gas
H280	Contains gas under pressure; may explode if heated
H314	Causes severe skin burns and eye damage
H318	Causes serious eye damage
H331	Toxic if inhaled
H400	Very toxic to aquatic life
EUH071	Corrosive to the respiratory tract
R10	Flammable
R23	Toxic by inhalation
R34	Causes burns
R50	Very toxic to aquatic organisms
C	Corrosive
N	Dangerous for the environment
T	Toxic

DISCLAIMER OF LIABILITY : Before using this product in any new process or experiment, a thorough material compatibility and safety study should be carried out.
Details given in this document are believed to be correct at the time of going to press.
Whilst proper care has been taken in the preparation of this document, no liability for injury or damage resulting from its use can be accepted.

End of document

Appendix G GBI Charge Projection

Charge Projection, by GBI **10/02/2022**

Refrigeration - Ammonia 2 stage 2 temperature LR system **10/05/2022JN REV A**

Liquid accumulators/vessel AS1210 un-fired vessel								Teys registeration not current provided	100% volume	legal 85% volume	normal working level	normal working level
Existing		location	external /internal	type	**OT**	state	installer	Norminal dimensions	m3	m3	m3	tonne ammonia liquid
1	High side (chiller)	ER	internal	Vertical	-10°C		unknown	1.52m dia x 3.0 m long	6.00	5.10	1.70	1.19
2	Intercooler	ER	internal	Vertical	-10°C		unknown	1.2m dia x 3.6 m long	7.50	6.38	2.13	1.49
3	High side - drop out vessel	ER	internal	Vertical	-10°C		unknown	1.2m dia x 3,6 m ?	7.50	6.38	2.13	1.49
4	Low side	ER	internal	Vertical	-40°C		unknown	1.52m dia x 3.05m long	6.00	5.10	1.70	1.19
5	Low side - Plate Freezer	existing PF area	external	Horizontal	-40°C		GBI	1.9m dia x 10.8m long	33.00	28.05	4.68	3.27
5	HP receiver - no 1	ER court yard	external	Horizontal			unknown	0.76m dia x 2.7m long	1.30	1.11	0.37	0.26
6	HP receiver - no 2	ER court yard	external	Horizontal			unknown	0.57m dia x 3.6m long	1.00	0.85	0.28	0.20
7	HP receiver - no 3	ER court yard	external	Horizontal			unknown	1.22m dia x 3.7m long	4.70	4.00	1.33	0.93
	Aircoolers	various	internal	NA			various	nominally5800 kWr				6.09
	condenser plant	ER	external	NA								2.00
	5103 carton Plate freezers	existing PF building	internal	NA				nominally 700kWr PF				18.00
	ammonia P&V	various	internal/ external	NA								3.61
	sundries 5%											1.99
	-	-	-	-	-						Projected Existing Ammonia Charge Jan 2022	41.70
Proposed for 9216 Carton PF project for future				-		-			37.5	31.88	26.25	18.38
8	Add 9216 PF accumulator	new PF area	external	Horizontal	-40°C			2.27.m dia x 8 m TBC	35	29.75	4.96	3.47
9	Add IC vessel	ER	internal	vertical	-10 oC			1.067 m dia x 3m TBC	2.7	2.30	0.77	0.54
	ammonia P&V	various	internal/external									1.50
	add condenser and remove old McNeice	ER	external									-0.30
	sundries 5%											
											Projected add Ammonia Charge for PF	23.58

Appendix H Disclaimer and Limitations

This report has been prepared by CDM Smith Australia Pty Ltd (CDM Smith) for the sole benefit of Teys Australia Southern Properties Pty Ltd for the sole purpose of assessing the hazards and risks associated with the operational activities of the proposed plate freezer/store at 1 Dampier Street, Bomen New South Wales, for the purposes of planning approval.

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