Technical report J

Preliminary hazard analysis

Cleanaway & Macquarie Capital

Western Sydney Energy and Resource Recovery Centre

Preliminary Hazard Analysis

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ARUP

Executive Summary

Background

Cleanaway and Macquarie Capital are jointly developing an energy-from-waste (EfW) facility known as the Western Sydney Energy and Resource Recovery Centre (WSERRC) (the proposal).

The proposal will be designed to thermally treat up to 500,000 tonnes per year of residual Municipal Solid Waste (MSW) and residual Commercial and Industrial (C&I) waste streams that would otherwise be sent to landfill. This process would generate up to 58 megawatts (MW) of base load electricity, some of which would be used to power the facility itself, with the remaining 55MW exported to the grid. The proposal involves the building of all onsite infrastructure needed to support the facility including site utilities, internal roads, weighbridges, parking and hardstand areas, storm water infrastructure, fencing and landscaping.

Arup has been engaged to undertake an Environmental Impact Statement (EIS) as part of the planning process for the EfW facility, and a Preliminary Hazard Analysis (PHA) forms part of the EIS. This PHA has been developed with reference to the NSW Department of Planning, Industry and Environment's (NSW DPIE) Hazardous Industry Planning Advisory Papers (HIPAPs), *Applying SEPP 33* and *Multi-level Risk Assessment*.

Methodology

The level of risk assessment was determined from NSW DPIE's *Multi-level Risk Assessment* and a partially quantitative analysis was carried out. A list of hazardous substances stored and used in the EfW process was compiled and screened according to NSW DPIE's *Applying SEPP 33*. Hazardous products resulting from the process were also identified and the offsite impact analysed.

A Hazard Identification Study (HAZID) with the relevant stakeholders was undertaken on 28 February 2020 and completed 6 March 2020 to help formulate scenarios and causes for the hazardous events to occur. During the analysis of the identified risks, reference was made to the relevant general principles as defined by HIPAP 4 – *Risk Criteria for Land Use Safety Planning*. Recommendations have been made against each of the identified risks to ensure that the residual risks will be reduced So Far As Reasonably Practicable (SFARP).

The PHA incorporates aspects of the air quality and odour report, the traffic and transport report, and the waste report to satisfy the requirements set out by Table 1 of NSW DPIE's *Multi-level Risk Assessment.*

Hazards and Consequences

The hazards identified during the HAZID workshop were assessed in accordance with the level of analysis determined from NSW DPIE's *Multi-level Risk Assessment*. The identified hazards can be found in Table 1 below. The consequences arising from scenarios developed during the workshop process were assessed against risk criteria set out by HIPAP 4 – *Risk Criteria for Land Use Safety Planning*.

Table 1: Determination of hazard analysis

Reference	Identified Hazard
3.2.1	Fire in Tipping Hall
3.2.2	Fire in Waste Bunker
3.2.3	Build-up of Flammable Gas in Waste Bunker
3.2.4	Dust Explosion in Tipping Hall
3.2.5	Formation of Phosphine and Hydrogen in Incinerator Bottom Ash (IBA)
3.2.6	Reaction between Acids and Bases
3.2.7	Sodium Hydroxide
3.2.8	Release of Calcium Hydroxide
3.2.9	Uninterruptible Power Supply (UPS) Batteries Fire/Explosion
3.2.10	Activated Carbon Dust Explosion
3.2.11	Diesel Spill and Bund Fire
3.2.12	Release of Ammonium Hydroxide
3.2.13	Flammable Atmosphere of Ammonium Hydroxide
3.2.14	Interference with Aircraft
3.2.15	Offensive Odour
3.2.16	Release of Flue Gas Treatment residue (FGTr)
3.2.17	Transformer Bund Fire, Explosion

There were five hazards identified where the consequences have the potential to pose offsite risks:

- Formation of Hydrogen in IBA: In the event of a facility shutdown and subsequent hydrogen build-up, the peak overpressure expected at the site boundary has been modelled to be 4.5 kPa. This is below the threshold for fatality as set out in HIPAP 4. Therefore, the risk of this scenario having an offsite impact is negligible.
- Activated Carbon Dust Explosion: In the event of the ignition of a dust cloud within the activated carbon storage silo, the peak overpressure expected at the site boundary has been calculated to be 2.9 kPa. This is below the threshold for injury or fatality as set out in HIPAP 4. Therefore, the risk of this scenario having an offsite impact is negligible.
- Diesel Spill and Bund Fire: In the event of a catastrophic failure and subsequent bund fire of diesel, the heat radiation at the site boundary has been calculated to be 3.8 kW/m^2. This is below the threshold of 4.7 kW/m2 that will cause pain

after 15-20 seconds exposure, and injury (second degree burns) after 30 seconds exposure. Therefore, the risk of this scenario having an offsite impact is negligible.

- Release of Ammonium Hydroxide: In the event of a catastrophic failure of the ammonium hydroxide tank, the worst credible case results in the dispersion of a toxic cloud at the Short-Term Exposure Limit (STEL) of 35ppm at a height of 5m as far as 1075m downwind from the release point. It is noted that the nearest sensitive receptor (a childcare centre) is approximately 1150 m away from the ammonium hydroxide storage area. Given the scale of the warehouses between the Site and the childcare centre there is a negligible risk of injury to sensitive receptors. People working in the industrial warehouses closest to the facility could be exposed to higher doses of ammonia and these have been considered further below.
- Waste Bunker Fire: In the event of the largest possible fire in the waste bunker, the heat radiation at the site boundary has been calculated to be 2.9 kW/m^2. This is below the threshold of 4.7 kW/m2 that will cause pain after 15-20 seconds exposure, and injury (second degree burns) after 30 seconds exposure. At this level, the offsite impact is negligible.

The potential consequences of the ammonium hydroxide dispersion scenario resulted in it being carried forward for frequency analysis. The likelihood has been estimated using a series of conservative assumptions and is orders of magnitude below the risk criteria set out by HIPAP 4. The likelihood of exposure to a toxic cloud above the STEL occurring was estimated to be approximately once every 5 million years. The potential exposure to sensitive receptors at ERPG 1 was estimated to be a once in 35 million years event.

Individual and Societal Risk

The individual risk of fatality is approximately 1.4E-11, which is not only orders of magnitude lower than the risk criteria for industrial areas, which surround the site, but also orders of magnitude lower than the criteria for the most sensitive population groups. It is considered that the risk posed by the facility to an individual is negligible.

The cumulative frequency of a fatality as a result of an uncontrolled release of ammonium hydroxide has been calculated to occur approximately once in 72 billion years. The expected number of people in the industrial warehouse area to the east of the facility has been estimated as 50. In the event of a catastrophic rupture, the potentially lethal dose of 2400 ppm could reach as far as 175 m which could cover an area of approximately 10% of the adjoining site. This could result in 5 fatalities. In the event of a large leak, the potentially lethal dose of 2400 ppm could reach as far as 135 m which could cover an area of approximately 2% of the adjoining site. This could result in 1 fatality. This is the only scenario that has the potential to cause an offsite fatality and has been plotted on an F-N curve below. As can be seen by Figure 1, the risk of a fatality as a result of hazardous substances at the facility is considered to be a negligible risk.

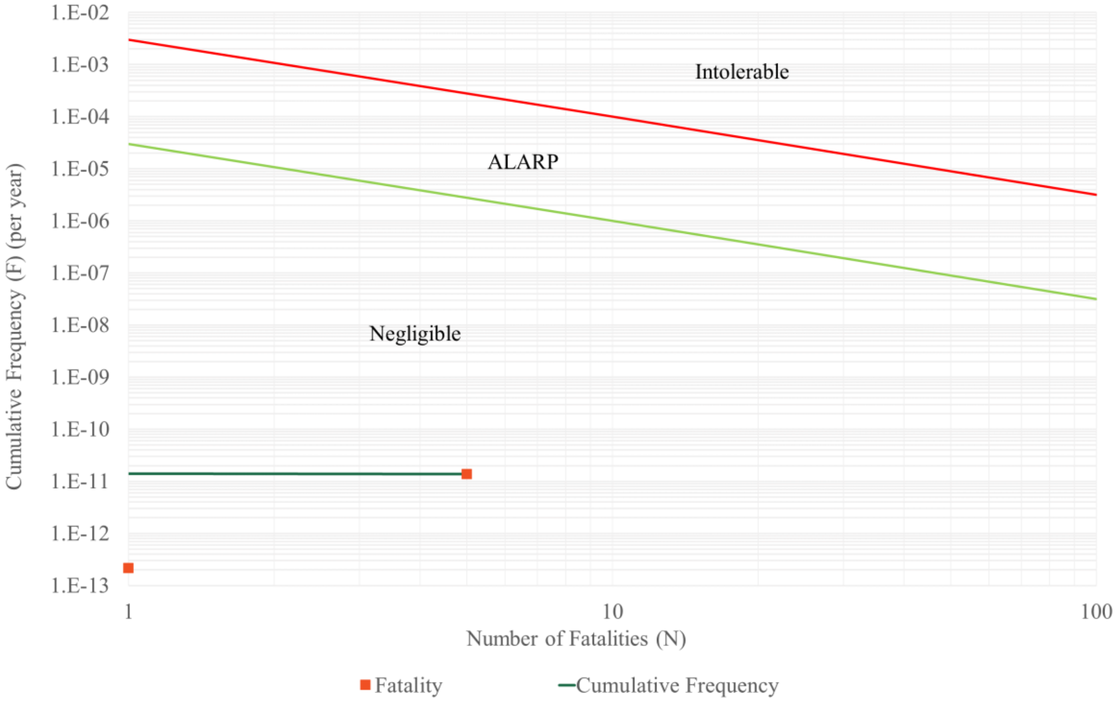

Figure 1: F-N curve for cumulative frequency of fatal risks

Recommendations

The following recommendations have been made regarding the EfW facility:

- Fire detection and suppression systems in both the tipping hall and waste bunker;
- As part of the ongoing management plan, during operation, the facility wide vacuum cleaning system is to be used to reduce the likelihood of dust build-up;
- The ventilation of the IBA shall be sufficient to prevent the building up of hydrogen into an explosive atmosphere. The IBA area shall also have hydrogen gas sensors with alarm set points below the lower flammability limit;
- Acids and bases will be stored in accordance with AS 3780-2008, and in accordance with obligations under Section 5 of Chapter 7 of the Work Health and Safety Regulations 2011;
- Ammonium hydroxide and sodium hydroxide will not be stored in the same bunded area or in compounds that share a common drainage system as per Section 6.3 of AS/NZS 3833-2017;
- The activated carbon storage area is to be zoned in accordance with AS/NZS 60079.10.2-2016 and a Hazard Assessment as outlined in Section 3 of AS/NZS 4745-2012 is to be carried out during the design phase;
- Safe operation and maintenance of Flue Gas Treatment residue (FGTr) transfer systems such as spill management procedures will be implemented to limit failure;
- The storage of diesel is to be designed in accordance with the EPA's guidelines on 'Bunding and Spill Management' and AS 1940-2017, and be contained within a bunded area that can hold the capacity of the diesel storage tank;
- The ammonium hydroxide tanks will be provided with real-time monitoring to identify leaks quickly from the control room. The alarm is to be set below short-term exposure limit (STEL) levels;
- Notification and evacuation procedures are to be developed and included in the emergency plan in the event of a significant release of ammonium hydroxide or other adverse events;
- The site managers are to develop a response plan which is to include coordination with local response organisations such as FRNSW and NSW Ambulance services;
- The stack should be lit in accordance with Chapters 5 and 6 of the Federal Aviation Administration's (FAA) AC 70/7460-1L: *Obstruction Marking and Lighting*; and
- The waste bunker is to be provided with both ceiling level sprinkler and water monitor fire suppression. These are to be fed off separate valves for additional resiliency. The final waste bunker fire safety design is to be developed through an appropriate fire engineering process.

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Environmental Assessment Requirements

The below table lists the Secretary's environmental assessment requirements (SEARs) relevant to Hazard and Risk, and where they are addressed in this report.

Assessment Requirements	**Reference in this technical paper**
Department of Planning and Environments Environmental Assessment Requirements *Section 4.12(8) of the Environmental Planning and Assessment Act 1979, Schedule 2 of the Environmental Planning and Assessment Regulation 2000*	
General Requirements	
The EIS must include a detailed assessment of the key issues specified below, and any other significant issues identified in this risk assessment, which includes: • A description of the existing environment, using sufficient baseline data. • An assessment of the potential impacts of all stages of the development, including any cumulative impacts of the proposed facility with any approved (but not yet constructed) developments, including The Next Generation's proposal for an energy from waste facility at Eastern Creek (currently subject to proceedings in the NSW Land and Environment Court). • A description of the measures that would be implemented to avoid, minimise and if necessary, offset the potential impacts of the development, including proposals for adaptive management and/or contingency plans to manage any significant risks to the environment. A consolidated summary of all the proposed environmental management and monitoring measures, highlighting commitments included in the EIS.	Section 1.1 Section 1.2 Section 5
Hazard and Risk	
A Preliminary Hazard Analysis (PHA) prepared in accordance with the Department's Hazardous Industry Planning Advisory Paper No. 6, 'Hazard Analysis' and Multi-Level Risk Assessment (DoP 2011).	This document
Details of fire/emergency measures and procedures.	Chapter 3 Proposal Description
Detailed contingency measures for any potential incidents or equipment failure or in the event of a shutdown.	Appendix B
Traffic and Transport	
Details of the types of material being transported and whether the material would be classified as dangerous goods under the Australian Dangerous Goods Code.	Section 2.4
Aircraft Safety	
A plume rise assessment in accordance with relevant Civil Aviation Safety Authority guidelines.	Section 3.2.14
Consultation	

<table>
<tr><td>During the preparation of the EIS, you must consult with the relevant local, State or Commonwealth Government authorities, service providers, community groups and affected landowners.

In particular you must consult with:
Blacktown City Council
Fairfield Council
Environment Protection Authority
Department of Primary Industries
Environment, Energy and Science (previously Office of Environment and
Heritage)
Transport for NSW (including Roads and Maritime Services)
NSW Ministry of Health
Western Sydney Local Health District
NSW Fire and Rescue
Department of Planning, Industry and Environment – Water and Natural Resources Access Regulator (previously WaterNSW)
Sydney Water
Endeavour Energy
SafeWork NSW
Western Sydney Airport Corporation
Civil Aviation Safety Authority
Department of Energy and Environment
nearby landowners, businesses and occupiers that may be affected by the proposal.
The EIS must describe the consultation process and the issues raised and identify where the design of the development has been amended in response to these issues. Where amendments have not been made to address an issue, a short explanation should be provided.</td><td>Section 3.2.14
Appendix C
Appendix D
Appendix E</td></tr>
<tr><td colspan="2">Blacktown City Council submission to SEARs request for SSD 10395</td></tr>
<tr><td colspan="2">Overall and General Requirements</td></tr>
<tr><td>The EIS must include a detailed assessment of the key issues specified below, and any other significant issues identified in this risk assessment, which includes:
A description of the existing environment, using sufficient baseline data.
An assessment of the potential impacts of all stages of the development, including any cumulative impacts of the proposed facility with any approved (but not yet constructed) developments, including The Next Generation’s proposal for an energy from waste facility at Eastern Creek (currently subject to proceedings in the NSW Land and Environment Court).
A description of the measures that would be implemented to avoid, minimise and if necessary, offset the potential impacts of the development, including proposals for adaptive management and/or contingency plans to manage any significant risks to the environment.
A consolidated summary of all the proposed environmental management and monitoring measures, highlighting commitments included in the EIS.</td><td>Section 1.1
Section 1.2
Section 5</td></tr>
</table>

Environmental Health Impacts	
Address the impacts the development will have on the environment, including hazardous chemicals, pest control, ventilation, disease outbreaks, quarantine and hygiene protocols for staff and visitors.	Section 4
The relevant Acts, policies and guidelines that need to be addressed include: • Pesticides Act 1999 • Protection of the Environment Operations Act 1997 • Public Health Act 2010 in terms of the Preliminary Hazard Analysis (PHA) — in accordance with the Hazardous Industry Planning Advisory Paper No. 6 — Guidelines for Hazard Analysis and Multi-level Risk Assessment, and details of fire/emergency measures and procedures.	This document
Air Quality	
Address air quality and human health impacts by way of the following: • A quantitative assessment of the potential air quality and odour impacts of the development on surrounding landowners, the locality in general and sensitive receptors under the relevant Environment Protection Authority guidelines. • Details of any pollution control equipment and other impact mitigation measures for fugitive and point source emissions. • Detail contingency plans for any potential incidents or equipment failure during the operation of the project.	Section 3.2.15
Transport and Accessibility (operational)	
Detail the proposed transportation of hazardous goods from the plant.	Section 3.2.16
Built form and urban design	
Consideration of any impact on flight paths.	Section 3.2.14
EPA recommendations for SEARs for the Western Sydney Energy and Resource Recovery Centre (SSD 10395)	
Soils, Contamination and Construction	
Detail contingency plans for any potential incidents during the construction of the facility that may result in environmental harm.	Section 3.1
Hazards and Risk	
Where preliminary screening indicate that the project is potentially hazardous provide a Preliminary Hazard Analysis (PHA) in accordance with *Hazardous Industry Planning Advisory Paper No. 6 — Guidelines for Hazard Analysis* and *Multi-Level Risk Assessment* and or *No 33 Hazardous and Offensive Development and Applying SEPP 33 (DoP, 2011)* with a clear indication of class, quality and location of all dangerous goods and hazardous material associated with the development.	Section 2.3 Section 2.5 Appendix A
Provide details of procedures for the assessment, handling, storage, transport and disposal of all hazardous and dangerous materials used, stored, processed or disposed of at the site, in addition to the requirements for liquid and non-liquid wastes.	Section 2
The containment of liquids shall be in accordance with EPA's guidelines section 'Bunding and Spill Management' at	Section 3.2.11

http://www.epa.nsw.gov.au/mao/bundinqspiII.htm and the most recent versions of the Australian Standards referred to in the Guidelines. Containment should be designed for no-discharge.	Section 3.2.17
Detail fire/emergency measures and procedures.	Chapter 3 Proposal Description
Detail contingency plans for any potential incidents or equipment failure during the operation of the facility that may result in environmental harm.	Appendix B
Transport for NSW SEARs	
General Assessment Requirements	
Details of any likely dangerous goods to be transported on arterial and local roads to and from the site, if any, and the preparation of an incident management strategy, if necessary.	Section 3.2.16

Abbreviations and Glossary

Abbreviations	
AC	Advisory Circular
ADGC	Australian Code for the Transport of Dangerous Goods by Road & Rail
CASA	Civil Aviation Safety Authority
CIV	Capital Investment Value
C&I	Commercial and Industrial
DG	Dangerous Good
DPIE	Department of Planning, Industry and Environment
EfW	Energy from Waste
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FGTr	Flue Gas Treatment residues
HAZID	Hazard Identification Study
HIPAP	Hazardous Industry Planning Advisory Paper
IAEA	International Atomic Energy Agency
IBA	Incinerator Bottom Ash
IPC	Independent Planning Commission
LFL	Lower Flammability Limit
LGA	Local Government Area
MSW	Municipal Solid Waste
MW	Megawatt
NIST	National Institute of Standards and Technology
PG	Packing Group
PHA	Preliminary Hazard Analysis
Proposal (the)	The purpose of the proposal is to build an energy-from-waste (EfW) facility that can generate up to 55 megawatts (MW) (net) of power by thermally treating up to 500,000 tonnes per year of residual municipal solid waste (MSW) and residual commercial and industrial (C&I) waste streams that would otherwise be sent to landfill.
RAAF AIS	Royal Australian Air Force Aeronautical Information Service
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SFARP	So Far As Reasonably Practicable
SRD	State and Regional Development
SSD	State Significant Development
UFL	Upper Flammability Limit
UPS	Uninterruptable Power Supply
UV/IR	Ultraviolet / Infrared
WSA Co	Western Sydney Airport Corporation
WSP	Western Sydney Parklands

1 Introduction

This section introduces the proposal and applicant while describing the purpose and structure of this report.

1.1 Site Description and Surrounding Land Use

Cleanaway and Macquarie Capital are jointly developing an energy-from-waste (EfW) facility known as the Western Sydney Energy and Resource Recovery Centre (WSERRC) (the proposal).

The proposal will be designed to thermally treat up to 500,000 tonnes per year of residual Municipal Solid Waste (MSW) and residual Commercial and Industrial (C&I) waste streams that would otherwise be sent to landfill. This process would generate up to 58 megawatts (MW) of base load electricity some of which would be used to power the facility itself with the remaining 55MW exported to the grid. The proposal involves the building of all onsite infrastructure needed to support the facility including site utilities, internal roads, weighbridges, parking and hardstand areas, storm water infrastructure, fencing and landscaping.

The proposal site is located at 339 Wallgrove Road in Eastern Creek, NSW (Lot 1 DP 1059698) which is in the Blacktown local government area (LGA). The site is in the Wallgrove Precinct of the Western Sydney Parklands (WSP) Plan of Management. The site layout can be found in Figure 2, and in more detail in Appendix A.

The 8.23ha site is divided by a small strip of land not part of the proposal site, resulting in a 2.04ha northern section and a 6.19ha southern section. This dividing strip is part of the adjacent lot and includes a right of carriageway benefitting the proposal site allowing vehicles to move between the two parts of the site. The proposal area will be fully contained in the 6.19ha portion of the site. Works to occur on the 2.04 ha northern section of the site include the clearing of weeds and exotic vegetation within the existing overland flow channel which is confined to the eastern section of this parcel of land. The northern section will also be used temporarily to support construction works. It is not currently expected that any other works will occur on the 2.04 ha northern section of the site as part of this proposal.

The facility will also recover metals from the ash and these metals will be recycled. The facility will include a visitor centre to help educate and inform the community on the circular economy, recycling, resource recovery and the benefits of extracting energy from waste.

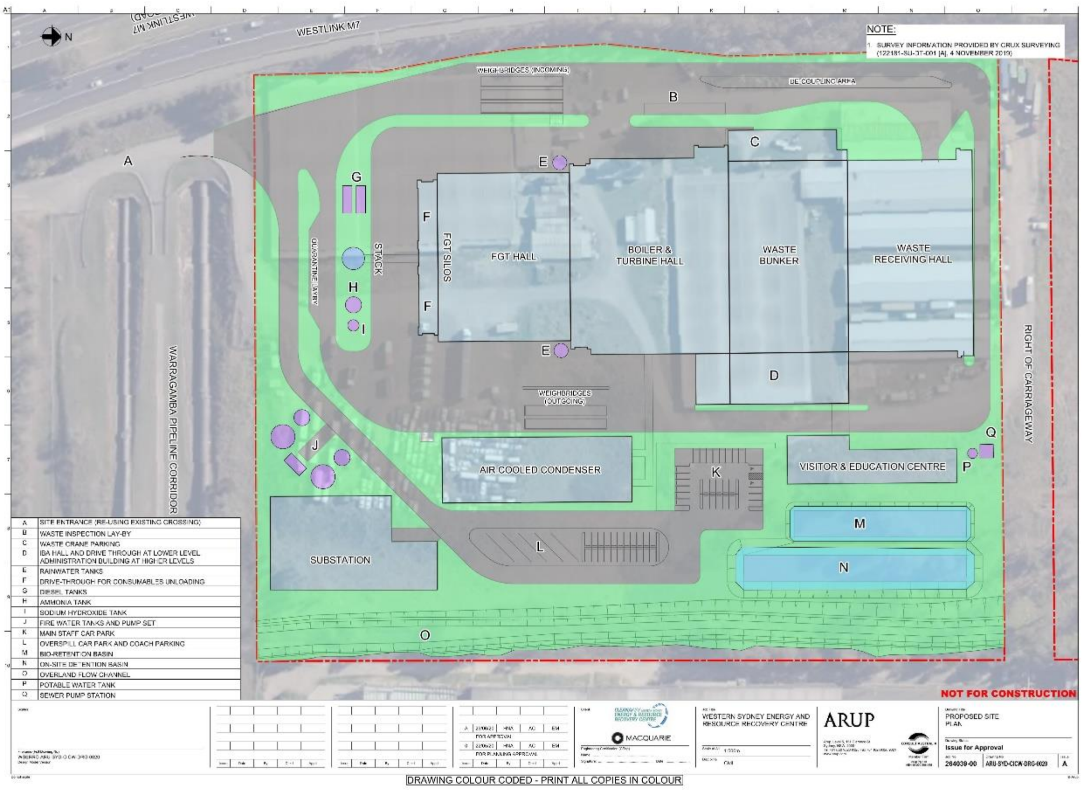

Figure 2: Proposed site layout

The local context can be found in Figure 3 below, and the area immediately surrounding the site is characterised by industrial and transport infrastructure. It should be noted that the Global Renewables waste processing facility borders the site to the east.

The existing site includes buildings associated with a disused poultry facility, which will be cleared from the site prior to starting construction.

The site is bounded by the M7 Motorway to the west with the Eastern Creek industrial area located farther west. The now-closed Eastern Creek landfill site (which still has an operational organics recycling facility component) is located to the north and north-east, with the operational Global Renewables waste management facility located immediately to the east. To the south, the site is bounded by the Warragamba Pipeline Corridor with the Austral Bricks facility located farther south.

The nearest residential area is located around 1 km to the south of the site. The Erskine Park residential area is located around 3.5 km to the west with Minchinbury located around 3 km to the north. Horsley Park Public School is located over 2 km south of the site and a childcare centre is located within the Eastern Creek industrial area approximately 1 km to the west of the site.

The application is categorised as State Significant Development (SSD) as it is electricity generating works with a capital investment value (CIV) greater than $30 million for the purposes of Schedule 1 of the State and Regional Development (SRD) State Environmental Planning Policy (SEPP) (SRD SEPP) 2011. It will be assessed and determined by the Minister for Planning and Public Spaces or the Independent Planning Commission (IPC).

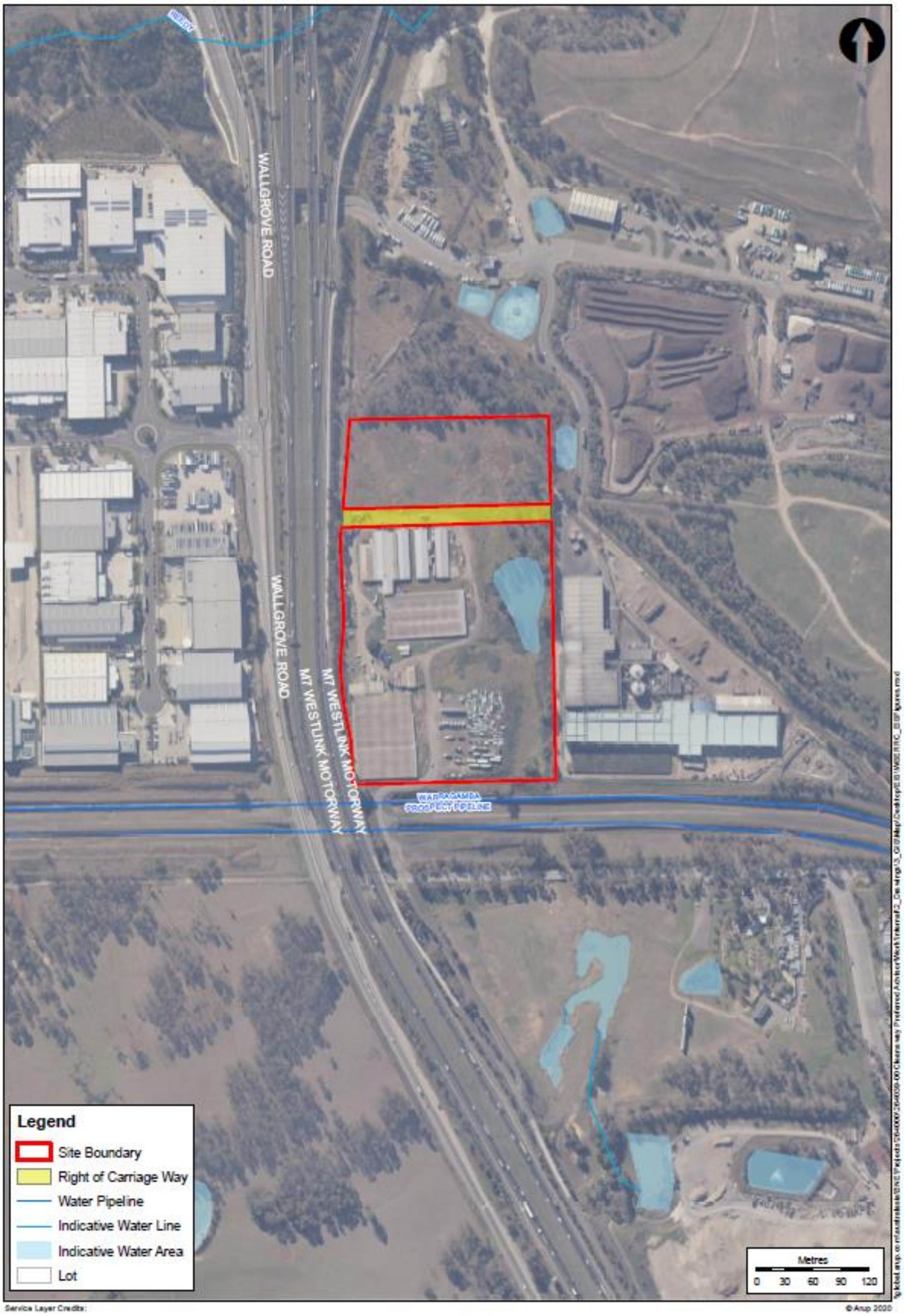

Figure 3: Local context of the proposed facility.

1.2 Operational Processes

The proposed facility will be operational on a 24/7 basis. The key components of a waste boiler system and flue gas treatment system are shown in Figure 4 and Figure 5, respectively.

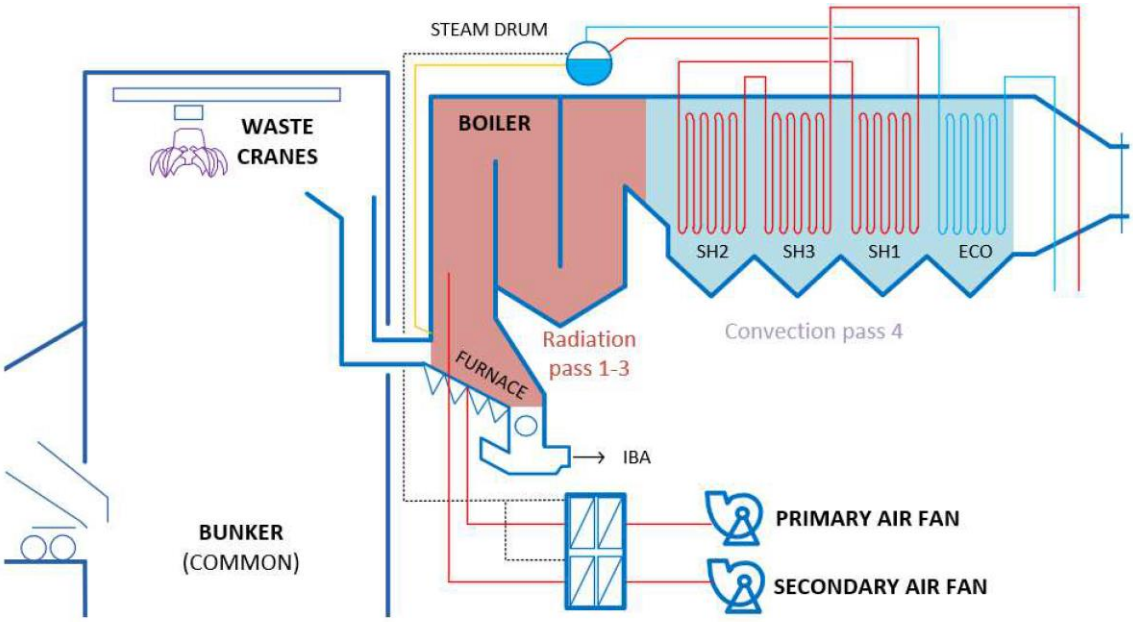

Figure 4: Waste boiler system

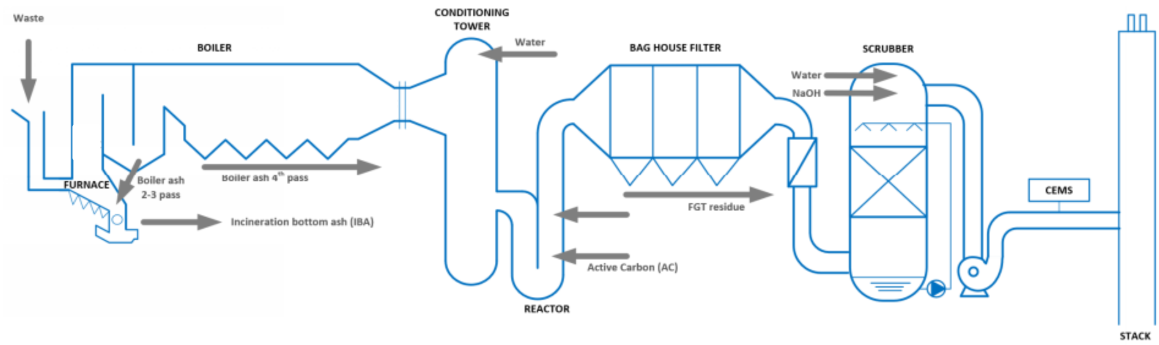

Figure 5: Flue gas treatment system

The steps in the EfW process are described in Table 2 below.

Table 2: Steps in the operational process

Step	Operation	Description
Step 1	Waste deliveries and weighing area (weighbridge)	Waste will be delivered to site by enclosed waste delivery vehicles. The route taken to site will depend on the origin of the waste, however all vehicles would enter the site via the site entrance off the unnamed road (informally, Austral Bricks Road). The vehicles will be weighed on arrival and electronically catalogued, including information on the type and source of waste. Outbound vehicles will also be weighted and electronically catalogued.

Step 2	Waste receival, intake and storage	Waste delivery trucks will drive into the waste receiving hall, through fast acting roller shutter doors, located on the southern elevation of the building. Waste will be unloaded into chutes which convey the waste to the storage bunker. Deliveries can also be diverted to an inspection and quarantine area in the receiving hall if required. Inspections will be carried out periodically as part of the quality assurance process for the incoming waste and in response to any uncertainties about the type and source of the waste identified at the weighbridge. Empty vehicles would exit the receival hall, circulate around the site and exit over the outbound weighbridge back onto the unnamed road. Unsuitable waste would be rejected, and arrangements will be made for its removal to a licenced facility. The weighbridges at the entrance/exit will be used to confirm that rejected waste was taken offsite. Waste feedstock will be temporarily stored in the bunker. The bunker will have sufficient capacity to store approximately five days normal throughput of waste. Bunker grab cranes will mix the waste, then feed it onto a chute to the moving grate furnace. Activities in the reception hall will be monitored by operators in the control room, either directly or by CCTV cameras. The receival hall and bunker would be operated under an inward pressure gradient to contain odour within the building and to draw it into the combustion process.
Step 3	Combustion process	Waste combustion will take place as the waste slowly moves along the furnace grate. The grate will slope away from the waste feed chute. The movement of the grate floor components and the slope of the grate will cause the waste, as it burns, to move forward and downwards from the feed point to the ash discharge point. Movement of the grate floor components will also agitate the waste so that new surfaces will be continuously exposed to the flames. The rate at which the waste moves will be controlled to optimise combustion. The residence time of waste in the furnace will be approximately one hour. The slow movement of the grate allows for waste to 'pre-heat' and dry out prior to full furnace exposure. The main sections of the grate will be air cooled to prevent waste from sintering to equipment. Ash from the combustion process will be discharged into a water bath and then to the bottom ash bunker. Primary combustion air is drawn into the furnace from the waste bunker and reception hall, thus keeping these areas under an inward pressure gradient and preventing the release of odours and dust from these areas to the outside environment. The waste feed rate, the supply of combustion air and the grate speed will be controlled by an advanced combustion control system which will measure flow rate, flue gas oxygen and combustion temperature in order to obtain the best possible operational conditions and maximise steam production.
Step 4 to Step 6	Energy recovery process	Hot flue gases will pass through a heat recovery boiler where they will be gradually cooled while the excess heat is used to produce superheated steam. Cooled flue gases will pass into the flue gas treatment system (Step 8 to Step 11). Superheated steam will drive a conventional turbine to produce electricity. The steam is then condensed in the air-cooled condenser

		and recirculated through the boiler feed pumps as a closed loop system. The net electrical power output is expected to be 55 MW.
Step 7	Ash / residue management	Incinerator Bottom Ash (IBA) from the combustion process will be discharged into a water bath and then to the bottom ash bunker. The final use of the ash is subject to ongoing assessment (e.g. incorporation into construction materials such as road base). Ferrous metals will be recovered from the ash using magnets, and subsequently recycled. Boiler ash and air pollution control residue will be collected and transported off-site to a facility licenced to receive restricted waste.
Step 8 to Step 11	Flue gas treatment (FGT)	The flue gas treatment system includes the following key elements; • Selective Non-Catalytic Reduction for NO_x abatement with ammonia injection (ammonium hydroxide); • Injection of hydrated lime and activated carbon within a reactor tower for abatement of acid gases, heavy metals and other elements; • Bag filter to remove dust and spent abatement chemicals (together the Flue Gas Treatment residues (FGTr)); and, • A wet scrubber with sodium hydroxide injection to further clean the flue gases. Cleaned flue gases would then be sent, via the induced draft fan, to the stack where they would be emitted at speed to support their adequate dispersion. Emissions monitoring equipment will be located in the flue gas duct so that the composition of the flue gas emitted will be the same as that monitored. Further information on emissions monitoring can be found in the Process Description chapter of the EIS.
	Water use	Boiler make-up water, flue gas quenching, and flue gas treatment are the main water users. Water is used to rapidly cool the bottom ash as it leaves the combustion grate. The steam leaving the turbine will be condensed to water in a condenser. The condensate will then be returned to the boiler feed water system.

1.3 Document Purpose

The purpose of this Preliminary Hazard Analysis (PHA) is to achieve the following:

- Identification of all potential hazards and incident scenarios;
- Analysis of the consequences of the incidents on people;
- Analysis of the likelihood (frequency) of such events occurring;
- Quantification of the resultant risk levels (individual risk and societal risk); and
- Comparison of the risk levels with established risk criteria and identification of opportunities for risk reduction.

This process is illustrated and is consistent with the methodology outlined in the NSW Department of Planning, Industry and Environment's (DPIE) Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 – *Hazard Analysis.*

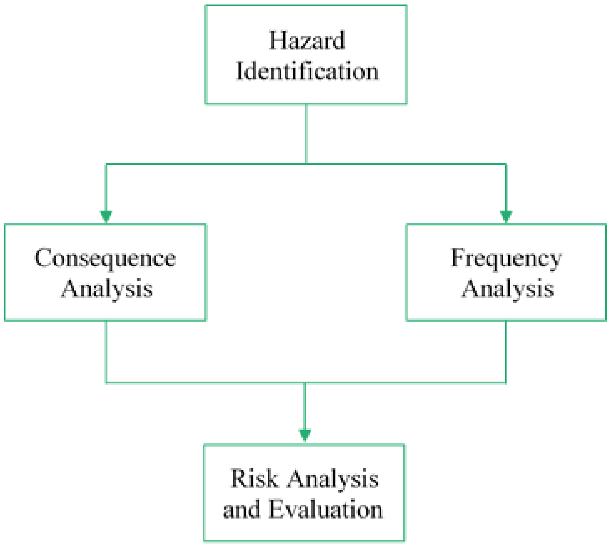

Figure 6: Methodology for a PHA from HIPAP 6

During the analysis of the identified risks, reference was made to the relevant general principles as defined by HIPAP 4 – *Risk Criteria for Land Use Safety Planning* Section 2.4.1:

- The avoidance of all *avoidable* risks;
- The risk from a major hazard should be reduced wherever practicable, even where the likelihood of exposure is low; and
- The effects of significant risks should, wherever possible be contained within the site boundary.

Recommendations have been made against each of the identified risks to ensure that the residual risks will be reduced So Far As Reasonably Practicable (SFARP).

The PHA will incorporate aspects of the air quality report, the traffic and transport report, and the waste report to satisfy the requirements set out in Table 1 of NSW DPIE's *Multi-level Risk Assessment.*

2 Assessment Process

2.1 Introduction

The methodology adopted for the PHA consists of the following steps:

- Step 1: Screening storage and transport of dangerous goods to determine the applicability of State Environmental Planning Policy (SEPP) 33 as shown in Table 3 and Table 4. This includes classification of each potential dangerous good stored at the site, review of the quantities onsite, and transport of the material against SEPP 33 thresholds.
- Step 2: Determining the level of risk assessment required according to NSW DPIE's *Multi-level Risk Assessment*. This step is undertaken to determine the level analysis required for the site, noting that not all sites or risks require a fully quantified approach. The requirement to quantify the risk depends on the potential for offsite impacts to occur and how well their severity and likelihood are understood.
- Step 3: Conducting a risk assessment following the criteria set out by HIPAP 4 – *Risk Criteria for Land Use Safety Planning*. Based on the potentially dangerous goods identified in step one, a risk assessment is undertaken for those scenarios that have potential offsite consequences. This assessment is intended to identify the potential offsite risks and mitigation measures and highlight key parameters for the final hazard assessment.

The risk assessment was carried out following the methodology set out by HIPAP 6 – *Hazard Analysis* shown in Figure 6. A Hazard Identification (HAZID) workshop was used as the primary source of hazard identification, and minutes of the HAZID workshop conducted on 28 February 2020 and completed 6 March 2020 can be found in Appendix B.

2.2 Dangerous Goods Used and Stored at the Facility

Dangerous Goods (DGs) are used at the proposed facility to treat the flue gas before discharge to the atmosphere through the stack. The facility is therefore able to control the level of emissions discharged to the atmosphere within acceptable licence limits. The details of how each dangerous good is used at the facility are detailed below.

2.2.1 Dangerous Goods Used for Flue Gas Cleaning

These DGs are used as part of the flue gas scrubbing system:

- *Ammonium Hydroxide* – used in the Selective Non-Catalytic Reduction (SNCR) process where ammonia is injected into the boiler to reduce nitrogen oxide emissions in the combustion process;
- *Activated Carbon* – added to the flue gas where it absorbs dioxins and furans, gaseous mercury, heavy metals and other components;
- *Calcium Hydroxide* – added to the flue gas where it neutralises acidic components;
- *Hydrochloric Acid* – used in water treatment regeneration; and
- *Sodium Hydroxide* – used within the wet scrubber to reduce acid gases and other flue gas components.

2.2.2 Dangerous Goods for Maintenance / Ongoing Operations

These DGs are necessary to ensure maintenance and continuous operation occur:

- *Acetylene* – necessary for welding repairs during maintenance operations; and
- *Oils* – Hydraulic and lubrication oil are necessary consumables for the ongoing operation and lubrication of the grate, cranes, turbine and other mechanical equipment used at the facility.

2.2.3 By-products

The following DGs may be produced by the EfW process under certain circumstances and require monitoring to ensure they remain at a safe level:

- *Hydrogen* – created from a reaction between Incinerator Bottom Ash (IBA), and the water used to cool IBA and prevent dust generation. This is due to the presence of aluminium and its reaction with regenerated water.
- *Phosphine* – associated with the incineration of phosphorous-rich waste such as bone meal. The formation is slow and is usually avoided through proper ventilation of the IBA storage bays. This is a rare issue and has only been recorded in energy recovery facilities that contain an animal crematorium. This facility does not have an animal crematorium.

2.3 Dangerous Goods Onsite

The Dangerous Goods (DGs) onsite are listed in Table 3 and reviewed in detail in Section 3.2. This table shows the UN number (if relevant), DG class, subsidiary risk, quantities, and screening limits of each DG onsite. The table serves to establish the overall quantity of DGs against the screening limits to identify which DGs at the site exceed the screening quantities of SEPP 33.

Table 3: List of Dangerous Goods and corresponding screening

Dangerous Good	UN Number	Class	Subsidiary Risk	Packing Group	Quantity	Screening limit	Notes
Hydraulic Oil	TBC	3	N/A	III	~1 t	2 t and 3 m from boundary	Below the threshold
Lubrication Oil	TBC	3	N/A	III	~1 t	2 t and 3 m from boundary	Below the threshold
Activated Carbon	1362	4.2	N/A	III	50 t	1 t	Exceeds the threshold
Ammonia (Ammonium Hydroxide, <25% concentration)	2672	8	N/A	III	100 t	50 t	Exceeds the threshold
Propane / Acetylene	1978 / 3374	2.1	N/A	N/A	<100 kg	100 kg	Below the threshold
Phosphine	2199	2.3	2.1	N/A	~350 mg/hr	100 kg	By-product slowly produced by maturation of IBA. Below the threshold.
Hydrogen (gaseous)	1049	2.1	N/A	N/A	~7 kg/hr	100 kg	By-product slowly produced by maturation of IBA. Below the threshold.
Sodium Hydroxide	1823	8	N/A	II	50 t	25 t	Exceeds the threshold
Hydrochloric Acid	1789	8	N/A	II	1 t	25 t	Below the threshold
Flue Gas Treatment residues (FGTr)	2811	6.1	N/A	N/A	360 t	0.5-2.5 t	Exceeds the threshold
Diesel	1202	N/A – not a DG but it is a C1 combustible liquid			140 t	N/A	N/A
Lime (Calcium Hydroxide)	N/A – not a DG				200 t	N/A	N/A

Note that while diesel is not classified as a DG, it is considered to add to the fuel load in the event of a fire, and hence must not be neglected when assessing the site from a DG perspective.

A concept design layout provides details of the storage locations for each of these hazardous goods in Appendix A.

2.4 Dangerous Good Transportation

Table 4: Screening of expected traffic movements by DG class

DG Class	Expected Annual Movements	Threshold Annual Movements	Threshold Exceeded?
2.1	10	>500	No
2.3	0	>100	No
3PGI	10	>500	No
4.2	12-15	>100	No
6.1	750	all	**Yes**
8	150	>500	No

Note that only class 6.1 goods exceed the threshold for annual movements. Class 6.1 goods also exceed the threshold of 2 t loads per truck movement with expected loads of 20 t.

2.5 Applicability of SEPP 33

As can be seen from Table 3, activated carbon, ammonium hydroxide and FGTr all exceed the threshold. Therefore, SEPP 33 applies, the development is to be considered potentially hazardous, and a PHA is required. Furthermore, since class 6.1 goods exceed the threshold in Table 4, SEPP 33 advises that a route evaluation study be carried out in accordance with HIPAP 11 – *Route Selection*.

The potential impact on air quality of the site including odour, is detailed in a separate report attached in Technical Report A: *Air quality and odour impact assessment* of the EIS. The facility requires an Environmental Protection Licence under the Protection of the Environment Operations Act 1997 and is therefore considered potentially offensive. However, as outlined in the executive summary of Technical Report A, the site will meet the requirements of its Environmental Protection Licence and so is not considered to be an offensive industry with respect to odour. In terms of air quality, in cases where monitored emissions may exceed the set limits, mitigation measures such as a full shutdown will be implemented to ensure that the licence requirements are still met. The facility will implement sufficient safeguards and mitigation controls to ensure that emissions will not result in a significant level of offence and is therefore not considered an offensive industry.

2.6 Multi-level Risk Assessment

The NSW DPIE's *Multi-level Risk Assessment* gives the following guidance for determining the appropriate level of risk assessment:

- **Level 1 – qualitative analysis**, primarily based on hazard identification techniques;
- **Level 2 – partially quantitative analysis**, using hazard identification and the focused quantification of key potential offsite risk contributors; and
- **Level 3 – quantitative risk analysis**, based on the full and detailed quantification of risks, consistent with HIPAP 6 – *Hazard Analysis.*

Using Figure 3 and Table 1 of Multi-level Risk Assessment, the required level of analysis necessary can be determined. Following the HAZID workshop held on 28 February 2020 and completed on 6 March 2020, the appropriate level of analysis was determined to be Level 2, as all volumes of the hazardous materials stored are less than those that can be classified by IAEA Table IV(a): *Classification of Substances by Effect Categories* of NSW DPIE's *Multi-level Risk Assessment*. IAEA Table IV(a) allows the maximum effect distance to be estimated given the class and quantity of DG stored.

3 Hazard Identification

In accordance with NSW DPIE's *Multi-level Risk Assessment* and a HAZID workshop held with design team, the level of risk analysis required for each risk was determined as reflected in Table 6. Level 1 of the risk analysis requires a qualitative estimate of risks while a Level 2 risk analysis requires an estimate of risk as well as the quantification of the likelihood of events with significant offsite effects. Through the quantified consequence analysis in Section 4, it was determined that only the dispersion of ammonium hydroxide posed significant offsite consequences. This event was therefore the only event where the likelihood of occurrence was quantified. An additional event of a bund fire was identified as having the potential for moderate offsite risks, the impact but not likelihood of this risk has been quantified in Section 4.

3.1 HAZID

A HAZID workshop was used as the primary source of hazard identification, an example of the process and example hazards can be found in the table below. Minutes of the completed HAZID workshop conducted on 28 February 2020 and completed 6 March 2020 can be found in Appendix B.

Table 5: Example hazards including safeguards and additional recommendations

Project:		WSERRC HAZID			Date:	Friday, 28 February 2020
Node Description:		TIPPING HALL				
Property		Guideword	Cause	Consequence	Safeguard	Recommendations
1	FIRE	WASTE	Waste that has a smouldering load	Fire inside a truck	Assume that entire facility is covered by fire detectors (flame/smoke)	Form of detection is yet to be determined, will be determined in detailed design. Operational response and emergency procedures yet to be determined
2	EXPLOSION	DUST	Very dusty in the tipping hall	Dust explosion	Requirement to do regular cleaning, fire engineers to calculate how much dust is allowed. Access to the girders and hard to reach places to be put in place	Regular cleaning of all level surfaces, avoid horizontal design and regular maintenance of all potential dust build up areas

Based on the HAZID it was identified that the major offsite risks posed by the facility primarily relate to adverse events related to air quality, environment, and transport. While there are a variety of DGs stored onsite which could be subject to fire, explosion, or toxic release, each of the chemicals being stored are well understood materials that are present in a variety of industrial processes. As such specific guidance is available for the appropriate protection of these chemicals from sources such as Australian Standards, International Standards, or insurers guidance. Therefore, this PHA has been carried out in accordance with a Level 2 analysis, as per NSW DPIE's *Multi-level Risk Assessment*.

Furthermore, construction safety is to be assessed by the builder prior to construction beginning. It has not been assessed in this PHA, as hazards faced during construction are not within the scope of a PHA.

Table 6: Determination of hazard analysis

Reference	Identified Hazard
3.2.1	Fire in Tipping Hall
3.2.2	Fire in Waste Bunker
3.2.3	Build-up of Flammable Gas in Waste Bunker
3.2.4	Dust Explosion in Tipping Hall
3.2.5	Formation of Phosphine and Hydrogen in IBA
3.2.6	Reaction between Acids and Bases
3.2.7	Sodium Hydroxide
3.2.8	Release of Calcium Hydroxide
3.2.9	Uninterruptible Power Supply (UPS) Batteries Fire/Explosion
3.2.10	Activated Carbon Dust Explosion
3.2.11	Diesel Spill and Bund Fire
3.2.12	Release of Ammonium Hydroxide
3.2.13	Flammable Atmosphere of Ammonium Hydroxide
3.2.14	Interference with Aircraft
3.2.15	Offensive Odour
3.2.16	Release of Flue Gas Treatment residue
3.2.17	Transformer Bund Fire, Explosion

3.2 Hazard Details & Mitigation

All hazards that had the potential to pose offsite risks were analysed qualitatively as set out by Level 1 of the NSW DPIE's *Multi-level Risk Assessment* and assessed according to the risk criteria set out in HIPAP 4 – *Risk Criteria for Land Use Safety Planning*. Where the qualitative assessment was not sufficient to ensure that there were no offsite risks, the hazard was carried forward for quantitative consequence analysis which can be found in Section 4.

3.2.1 Fire in Tipping Hall

There are multiple scenarios that would result in a fire in the tipping hall or waste bunker. Smouldering waste within a waste truck, a truck breakdown, and a truck crash all have the potential to cause a fire in the tipping hall. The exact controls to mitigate against this event are to be developed as the design progresses. The design shall include:

- Fire detection within the tipping hall e.g. smoke or flame detectors;
- Operational response plans to fires, truck breakdowns, truck on truck, or truck on structure incidents;
- Automatic fire suppression systems;
- Manual fire intervention systems to allow for staff intervention where appropriate; and
- Fire hydrant systems to allow for brigade intervention, noting that fire hydrant coverage is provided throughout the building.

The operation of the area shall consider:

- Implementation of procedures to limit the likelihood of truck collisions;
- Traffic control measures to prevent collisions; and
- Protection of personnel from vehicles (onsite risk).

Based on the above, and that the tipping hall is enclosed, offsite impacts are expected to be unlikely with these mitigation measures in place.

3.2.2 Fire in Waste Bunker

The waste bunker is to be provided with a variety of fire safety systems to serve to identify and control/suppress a potential fire within the space, as well as management and operational working methods to prevent a fire occurring. The primary means of a potential fire occurring in the waste bunker would be from recent hot waste tipped into the bunker and waste left for extended periods which self-heats from decomposition processes. The fire safety systems for the waste bunker are:

- Cameras with thermal sensing equipment (e.g. UV/IR cameras) - these are to be capable of peering into the waste piles to locate hotspots and monitoring in the control room.

- Water monitors (water cannons) to protect the waste bunker piles - these are to have automatic and/or manual means of activation from the control room and are to be integrated with the thermal imaging cameras.
- Ceiling level sprinklers – located far above the waste piles, these may be provided or omitted depending on final design of monitors. The monitors serve as the primary means of firefighting to the waste bunker.
- Fire hydrant coverage for responding fire brigade.

The operations plan shall work with the above systems to prevent waste bunker fires and control them if they break out:

- Control room personnel to monitor thermal imaging cameras.
- Crane operators may elect to select 'hot waste' as the next waste into the process to prevent a fire breaking out.
- Waste selection is to rotate to prevent any waste from spending extended periods (weeks / months) within the bunker undisturbed. This aids in preventing autoignition of waste.

While the waste bunker is provided with a variety of fire prevention, control, and suppression systems, the worst-case consequence scenario for a bunker fire is an uncontrolled fire that has ignited the full surface area of the bunker. The potential for this scenario to have offsite impacts means that it has been carried forward for consequence analysis in Section 4.6.

3.2.3 Build-up of Flammable Gas in Waste Bunker

Through the decomposition of waste, methane and other flammable gas may form in the waste bunker. This can create a hazard if the methane is allowed to build up in pockets above the lower flammable rage for methane in air. The following measures will prevent this from happening:

- Flammable gas will generally form too slowly from decomposition for a flammable atmosphere to develop as a result of the short amount of time that the waste spends in the bunker. The maximum residence time of waste in the bunker will be 5 to 7 days.
- The facility is designed to have a negative pressure so that the furnace draws in air from the tipping hall and waste bunker. This has the benefit of drawing in any methane generated from decomposition directly into the furnace where it can be combusted in a controlled fashion and prevent any build up methane that could lead to unwanted fires (or in the worst case, explosions) in the waste bunker.

The operations will assist in reducing the risk further:

- Waste selection is to rotate to prevent any waste from spending extended periods (weeks / months) within the bunker undisturbed. This aids in preventing autoignition of waste.

- The above rotation is also in the best interest of ongoing operations, as waste which sits for extended periods can become overly compacted.

The above controls have been deemed to be sufficient to mitigate the risk of flammable gas creating an explosive atmosphere inside the waste bunker.

3.2.4 Dust Explosion in Tipping Hall

The large volume of movements of waste within the tipping hall generates dust that can induce a risk of a dust explosion if it is not managed properly. The design for the tipping hall is to consider:

- As part of odour control, the furnace has an air intake through the rear of the tipping hall. Natural and mechanical venting is therefore not possible to reduce the build-up of dust. However, pressure venting in accordance with AS/NZS 4745-2012 and National Fire Protection Agency (NFPA) 68-2018, will be investigated to reduce the impact in the event of a dust explosion.
- Horizontal surfaces are to be avoided where possible.

The operations will assist in reducing the risk further:

- The vacuum cleaning system is to be used to reduce the likelihood of dust build-up.

These mitigation measures are considered sufficient to reduce the risk of a dust explosion in the tipping hall and prevent offsite impacts.

3.2.5 Formation of Phosphine and Hydrogen in IBA

The composition of waste being burned and method of cooling the IBA has the potential to cause both phosphine and hydrogen to form. These are the only known by-products of the IBA cooling process. The low Lower Flammability Limits (LFLs) of both phosphine and hydrogen expose the facility to the possibility of an IBA bunker fire. Each DG is considered separately below:

Phosphine

Phosphine can generally only be expected from rare, phosphorous rich IBA usually resulting from the incineration of phosphorous rich waste such as bone meal.[1] As the facility will not be accepting any animal remains, it is therefore unlikely that phosphine will be present as the by-product in the IBA. Proper ventilation of the bunker area is considered sufficient to mitigate the consequence of any unexplained build-up of phosphine.

[1] *Hjelmar, O. et al., 2013, Hazard Property Classification of High Temperature Waste Materials.*

Hydrogen

Hydrogen can be formed as a reaction between aluminium in the IBA and the alkaline water used to cool the IBA. A study of hydrogen production from IBA sampled from three EfW facilities was used as the basis for understanding the potential for offsite impacts.[2]

The production of hydrogen has been assessed over three stages of its life: IBA bunker, transport from site, and any potential processing. Each of these stages are discussed in further detail below.

The IBA bunker will be designed such that any gases produced by IBA will be drawn into the furnace and incinerated. If this incineration does not occur, such as if the facility is not in operation, then a build-up of hydrogen and subsequent ignition of this cloud could occur. The potential for this ignition to have offsite impacts means that it has been carried forward for consequence analysis.

Hydrogen formed as a by-product of IBA has been known to explode[3] when kept in confined spaces. To mitigate the risk of this scenario, IBA will be transported offsite in open air road tankers. This is considered sufficient to ventilate the IBA to prevent the build-up of hydrogen. Further, the IBA will be wetted as part of the cooling process. This will ensure that there is minimal risk of a spill during transport and any spill during transport is to be immediately cleaned up. As such, the risk of a build-up of hydrogen during transport is considered to be reduced SFARP.

The risk of hydrogen build-up during use of IBA in construction aggregate is not within the scope of this PHA. Before any usage, the IBA will be weathered exposed (outdoors) for a period of time to allow for hydrogen to dissipate. Once the IBA is dry and all aluminium has either reacted or oxidised, the ash can be processed for use in construction aggregate. This process is to take place at another site and is not part of the scope of this PHA.

3.2.6 Reaction between Acids and Bases

It is recommended that acids and bases will be stored in accordance with AS 3780-2008, and in accordance with obligations under Section 5 of Chapter 7 of the Work Health and Safety Regulations 2011. This includes the specific requirements of containing and managing spills under subdivision 2.

The acids and bases yet to be selected that will be stored are primarily for the water treatment. These will be stored in intermediate bulk containers in low quantities not expected to exceed 1t. Sodium hydroxide will be used for flue gas treatment and is

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[2] *Saffarzadeh A. et al, 2015, Aluminium and aluminium alloys in municipal solid waste incineration bottom ash: A potential source for the production of hydrogen gas.*

[3] *Marine Accident Investigation Report, 2017, Gas explosions on general cargo ship Nortrader with 1 person injured, https://www.gov.uk/maib-reports/gas-explosions-on-general-cargo-ship-nortrader-with-1-person-injured, accessed 17 August 2020*

detailed further below in Section 3.2.7. The exact chemicals for water treatment will be selected as the design progresses, and reference to the specific SDS sheets will be done to ensure that incompatible chemicals are not stored in the same bunded area.

3.2.7 Sodium Hydroxide

An online calculation tool[4] developed by the US National Oceanic and Atmospheric Administration (NOAA) was used to calculate the potential reaction between ammonium hydroxide and sodium hydroxide. An interaction between these two substances may generate corrosive products, gas, heat and toxic products. Therefore, these substances are considered to be incompatible and might react dangerously as per AS/NZS 3833-2007. Ammonium hydroxide and sodium hydroxide will not be stored in the same bunded area or in compounds that share a common drainage system as per Section 6.3 of AS/NZS 3833-2017. The bund will at least 100% of the capacity of each tank. Further, the transport of sodium hydroxide to the site is to be within a sealed tanker and transfer into the tank is to be self-contained (through sealed piping).

In the event of a spill from the sodium hydroxide tank the solution would be contained within the bunding. Sodium hydroxide does not form a vapor and therefore remains within the bund rather than dispersing to a vapor cloud. The sodium hydroxide is therefore not expected to pose an offsite risk when in a separate bund that is in accordance with AS/NZS 3833-2007, as it will prevent any potential interaction with water from ammonium hydroxide.

3.2.8 Release of Calcium Hydroxide

While not classified as a DG by the ADGC, a loss of control of calcium hydroxide has the potential to cause injuries as a mass powder substance.[5] It is recommended that calcium hydroxide be stored in a silo and contained so that it is not released into the atmosphere. Storing calcium hydroxide in this way will prevent its release into the environment and limit offsite impacts.

3.2.9 UPS Batteries Fire/Explosion

The site will include UPS batteries as a mitigation measure against power loss and to warrant continuous operation. The battery system shall be either lead acid batteries or lithium-ion batteries, each of which have their own risk. The preliminary risks of each are described below, more detailed analysis will be carried out during the design phase when the battery system is selected.

Lead Acid Batteries: Have the potential to produce hydrogen and can create an explosive atmosphere. It is recommended that the battery room be in a dedicated area,

[4] *National Oceanic and Atmospheric Administration, Database of Hazardous Materials, https://cameochemicals.noaa.gov/, accessed 26 May 2020*
[5] *EPA Ireland, 2018. Incident at Dublin Waste to Energy Ltd, Poolbeg https://www.epa.ie/newsandevents/incidents/recent/name,62419,en.html, accessed 16 March 2020*

properly vented, and designed to ensure hydrogen does not collect and build-up. It is recommended that hydrogen detection equipment be installed in an appropriate position to detect any build up.

Lithium Batteries: The risk associated with lithium batteries is an overloading of the battery and a subsequent fire. It is recommended that standard mitigation and protection measures, including a battery management system, be followed to prevent the overloading of the battery.

3.2.10 Activated Carbon Dust Explosion

A dust explosion as a result of activated carbon is most likely to occur in one of two scenarios; within the storage silo (or in breach of the silo) or when it is being used within the baghouse as part of the flue gas treatment.

Within the reactor section of the flue gas treatment system, the activated carbon is injected with hydrated lime and water to absorb toxins within the flue gas. In order to prevent an explosive atmosphere, the dosing control system is to have a setpoint to avoid excess dust. The injectors and all equipment will be maintained to avoid creating sparks in the process in accordance with the relevant hazardous area classification.

The storage silo for the activated carbon is to be provided with temperature monitoring systems and gas suppression. The gas suppression bottles are to be stored sufficiently far away from the silo to reduce the likelihood of damage in an explosion. The gas suppression must be able to be operated from a safe distance.

From AS/NZS 60079.10.2-2016, there are three zone designations for explosive dust atmospheres. During the design phase the three zones will be assigned to the following areas:

- Zone 20: The inside of the storage silo for activated carbon and any other areas where an explosive dust atmosphere is continuously present.
- Zone 21: The area immediately surrounding the activated carbon storage silo and potential sources of release where an explosive dust atmosphere is likely but not frequently present.
- Zone 22: The area surrounding Zone 21 to the point where an explosive dust atmosphere is not likely to occur in normal operation.

Further, the design of the activated carbon storage area will consider AS/NZS 4745-2012, specifically carrying out a Hazard Assessment as outlined in Section 3 of AS/NZS 4745-2012. During this process, NFPA 68-2018 will be consulted to determine the magnitude of the consequences of a dust explosion.

The exact design of the storage silos and the operational considerations to avoid dust explosions during filling of the silos will be developed as part of the detailed design process.

The potential for offsite impacts involving an explosion of activated carbon means that this scenario has been carried forward for consequence analysis in Section 4.2.

3.2.11 Diesel Spill and Bund Fire

There exists the potential for diesel to be released into the environment through a spillage from the storage area. The storage is to be designed in accordance with AS 1940-2017 and be contained within a bunded area that can hold the capacity of the storage tank. Diesel storage is a common feature of industrial and non-industrial sites with well-defined standards of design. The potential for offsite impacts involving the loss of control of diesel means that this scenario has been carried forward for consequence analysis in Section 4.3.

3.2.12 Release of Ammonium Hydroxide

There exists the potential for ammonium hydroxide to be released into the environment through a spillage from the storage area. In order to limit the likelihood and consequence of an ammonia spill the storage area will be designed in accordance with AS 3780-2008 and be contained within a bunded area that can hold at least 100% of the capacity of the storage tank. In addition to this, the predictable consumption and delivery of ammonium hydroxide allows a leak to be quickly identified. Tanks (or bund sumps) are to be provided with real-time monitoring to identify leaks quickly from the control room. The potential for ammonia dispersion to have an offsite impact means that this scenario has been carried forward for consequence analysis in Section 4.4.

3.2.13 Flammable Atmosphere of Ammonium Hydroxide

One of the potential risks is for ammonia to form a flammable atmosphere. Utilising Henry’s law it is feasible to calculate the % ammonia vapor within the tank vapor space above the liquid ammonia. The calculation, shown below, demonstrates that the concentration of ammonia within the vapour space of the tank would be 22% by volume.

$$
\begin{aligned}
Density &= 0.903\ g/cm^3\ at\ 20°C \\
1L\ of\ ammonium\ hydroxide &= 0.903\ kg\ of\ ammonium\ hydroxide \\
NH_3 &= 0.22575\ kg/L\ of\ ammonium\ hydroxide \\
&= 13.2552\ mol/L\ of\ ammonium\ hydroxide \\
Henry's\ Law H^{cp} &= \frac{c_a}{p} \\
The\ concentration\ of\ NH_3,\ \ c_a &= 13255.24\ mol/m^3 \\
Henry's\ Constant, \qquad H^{cp} &= 0.59\ mol/m^3 Pa \\
Partial\ pressure, \qquad p &= 22466.51\ Pa \\
atm &= 101.125\ kPa \\
\%\ of\ NH_3\ by\ volume\ of\ air &= 22.22\%
\end{aligned}
$$

This value lies within the LFL and ULF limits for ammonia, thus the vapour space is likely to always be flammable and should be classified as Hazardous Area Zone 0. The design of the storage and nearby electrical systems is to consider the potential for ammonia leakage to include appropriate Zone 1 and Zone 2 classifications after study during detailed design.

The above results also match with the consequence modelling in Section 4.4 which found that a major spill incident may result in the LFL being achieved 2-4 m downwind of a spill.

3.2.14 Interference with Aircraft

The site produces a significant heat plume from the stack, this plume may pose risks to passing aircraft, particularly any light aircraft.

In accordance with CASA's Draft AC 139-05 v3.0: *Plume rise assessments*, a request for a plume study through Form 1247: *Application for Operational Assessment of a Proposed Plume Rise* was submitted to CASA to determine if the stack poses any issue with aircraft from local airports.

A summary of the Plume Rise Assessment was received on 28 April 2020 and can be found in Appendix D. The summary states that 'Based on the information presented and assumed, there will not be an infringement of an OLS for Western Sydney Airport. CASA recommends that an Acceptable Level of Safety will be achieved'. The risk of interference with an aircraft from a plume rise is therefore considered to be sufficiently low.

Further, during consultation with CASA the lighting and marking of the stack was raised. In the absence of local guidance, the Federal Aviation Administration's (FAA) AC 70/7460-1L: *Obstruction Marking and Lighting* advises that the stack should be lit in accordance with Chapter 5: *Red Obstruction Light System* and Chapter 6: *Medium-Intensity Flashing White Obstruction Light Systems*.

The National Airports Safeguarding Framework (NASF) Principles and Guidelines C, D and F were consulted as part of the risk assessment process and are described further below:

C – *Managing the Risk of Wildlife Strikes in the Vicinity of Airports*: The site is outside the 13km radius of an airport as a potential risk for wildlife strikes advised by Guideline C. Further, since the entire process is contained inside the facility and waste is not exposed, wildlife attraction is not expected. The site also includes means to contain the potential odours which could attract wildlife. In normal operation the waste hall is kept in a negative pressure as the furnace pulls air in through the waste hall. During shutdown, the waste hall is closed and activated carbon filters are provided to limit odours.

D – *Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation*: Paragraph 21 of Guideline D advises that the RAAF AIS should be notified of any structure 45m or more above ground level, however according to CASA's AC 139-08: *Reporting of tall structures and hazardous plume sources*, Airservices is now responsible for the database of tall structures. This triggered a notification to Airservices Australia via email on 23 April 2020. An Airservices assessment was carried out for Sydney, Bankstown, Camden and Richmond aerodromes, and Westmead Hospital heliport completed on 22 May 2020. It was stated that 'Airservices have no objections to the proposed plume rise at the above location'. Further details can be found in Appendix D.

F – *Managing the Risk of Intrusions into the Protected Airspace of Airports*: Attachment 3 of Guideline F describes the process that should be followed by planning authorities. Western Sydney Airport Corporation (WSA Co) was also notified via email on 23 April 2020 of a potential intrusion into the protected airspace of airports. Consultation with WSA Co on 22 May 2020, included the discussion of this potential intrusion and details received on 28 May 2020 can be found in Appendix E. The obstacle limitation surfaces (OLS) typically defines the lower altitude of an airport's airspace. As illustrated in Figure 7, the OLS Elevation (AHD) is 222.2 m, and the CASA plume rise assessment gives the following AHD levels for select critical velocities:

Table 7: AHD levels for critical plume velocities

AHD level for given velocities (m)		
10.6 m/s	6.1 m/s	4.3 m/s
149	161	177

A plume travelling at 4.3 m/s is usually the lowest velocity required to be considered as intruding on a protected airspace. From Table 7, the plume will not reach 4.3 m/s at the OLS elevation of Western Sydney Airport (WSA). It was therefore determined that the stack and plume would not intrude into the protected airspace of WSA.

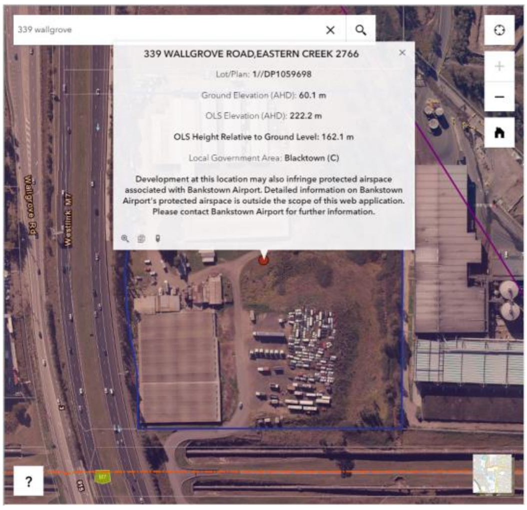

Figure 7: OLS elevation for the proposed site[6].

3.2.15 Offensive Odour

As per SEPP33, the potential for offensive odour can be difficult to simply quantify and the primary means of demonstrating a site does not represent an offense odour is through demonstrating the site is capable of meeting the requirements of the Environmental Protection licence under the Protection of the Environment Operations Act 1997.

The plant is to be provided with a significant number of pollution control systems ranging from simply using an inward pressure gradient for the tipping hall and waste bunker, to advanced flue gas treatment systems to prevent the flue gas from posing an odour or pollution risk to offsite areas.

The potential impact on air quality of the site including odour, is detailed further in a separate report attached in Technical Report A: *Air quality and odour impact assessment* of the EIS. As outlined in the executive summary of this report, the site will meet the requirements of its Environmental Protection licence in normal operation.

3.2.16 Release of Flue Gas Treatment residues (FGTr)

In order to operate, the site requires a significant amount of materials to be brought to and from the site throughout the year. As seen in Table 4, all materials barring the FGTr are below the transportation threshold set within SEPP33.

The FGTr, or air pollution control residue, is part of the residue from the flue gas pollution control system. This residue consists of a variety of elements, heavy metals, and toxins which are taken to an offsite treatment plant. The composition of FGTr

[6] *WSA Co, 2018, OLS tool, https://www.wsaco.com.au/_old/about/airspace-protection-for-western-sydney-airport/2-pages/39-ols-tool, accessed 22 May 2020.*

depends on the incoming waste, however some indicative FGTr compositions from other EfW facilities are shown in Figure 8.

Element	Average mg/kg	25 - 75 % range mg/kg	n 1)
Ca	230,000	180,000 - 280,000	19
Cl	180,000	91,000 - 222,000	23
Si	69,000	51,000 - 92,000	12
Mg	9,400	7,400 - 12,000	16
Fe	12,000	11,000 - 63,000	19
Al	26,000	15,000 - 29,000	27
K	23,000	15,000 - 31,000	18
Na	17,000	12,000 - 20,000	16
Zn	15,000	12,000 - 18,000	28
S	15,000	8,200 - 21,000	18
Pb	5,400	4,100 – 6,300	27
Ti	3,300	2,600 - 4,400	17
Mn	480	280 - 680	19
Ba	540	320 - 660	18
Sn	890	770 - 1,000	15
Cu	710	490 – 860	25

Table 4 Concentration of elements in APCr from different countries. 1) n = number of different samples, Source: IAWG (1997)

Figure 8: Indicative FGTr Composition

Given its composition including heavy metals it has been assumed that the FGTr is a Class 6.1 toxic substance. FGTr is contained onsite within a silo. Sealed vehicles will be used to transport FGTr. At site, the tankers will securely connect to the silo outlet via a hose connection and FGTr will be deposited from the silo into the tanker in a controlled manner.

The most credible scenario for the release of FGTr onsite is a failure of the hose during transfer of the FGTr from the silo to the sealed vehicle. Safe operation and maintenance of systems such as spill management procedures will be implemented to limit failure. This is considered sufficient to reduce the risk of this scenario having an offsite impact SFARP.

Once transferred, the route from site to disposal must be considered. Potential routes the FGTr may take from site have been traced from the site to the treatment facility and to the final landfill. These potential routes are shown in Figure 9, while the final route will be chosen in detailed design. Further, if no routes with acceptable risk levels to sensitive receptors can be found, a different treatment facility may be selected.

Following treatment at the Cleanaway Bulk Hazardous Solid Treatment Facility or similar, it is anticipated that the FGTr will no longer be toxic and can therefore be disposed at the SUEZ Kemps Creek Landfill.

The routes have been chosen to limit the exposure to a potential loss of control of FGTr for sensitive receptors. This balances the number of schools passed and the time spent travelling on roads suited for heavy goods vehicles. These routes comply with the NSW Government guidance on suitable Heavy Goods Vehicle routes in the Greater Sydney Metropolitan Area[7].

[7] *Transport for NSW, 2018, NSW Heavy Vehicle Access Policy Framework*

The potential for an uncontrolled release of FGTr to have offsite impacts means that this scenario has been carried forward for consequence analysis.

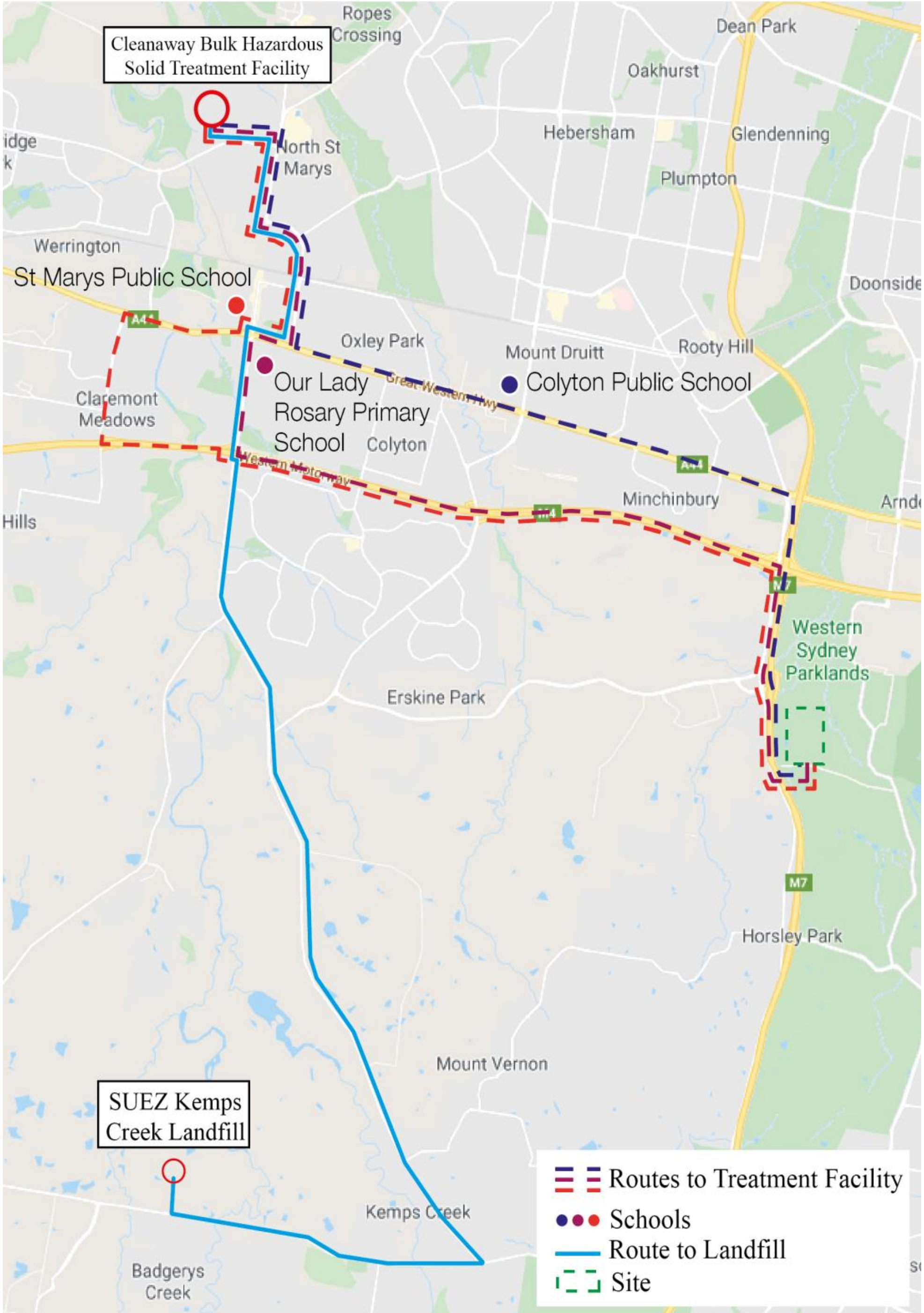

Figure 9: FGTr Transport Route

3.2.17 Transformer Explosion or Bund Fire

As an energy site, the site will include a significant oil-filled transformer which could potentially pose a fire or explosion risk. Transformers are common equipment across many sites with well-defined standards of design. It is considered that complying with the relevant design standards is sufficient to mitigate the risk posed by transformers.

4 Consequence Analysis

The scenarios from Section 3.2 that posed a potential for offsite risks have been carried forward for consequence analysis. Each scenario has been quantitively analysed as set out by Level 2 of the NSW DPIE's *Multi-level Risk Assessment* and assessed according to the risk criteria set out in HIPAP 4 – *Risk Criteria for Land Use Safety Planning.*

4.1 Formation of Hydrogen in IBA

A study of hydrogen production from IBA sampled from three EfW facilities was used as the basis for understanding the potential for offsite impacts.[8] This study provided the volume of hydrogen produced per day per kg of IBA for four samples of IBA from three facilities. Figure 10 below gives the daily generation rate of hydrogen gas from four fractions of IBA from one facility.

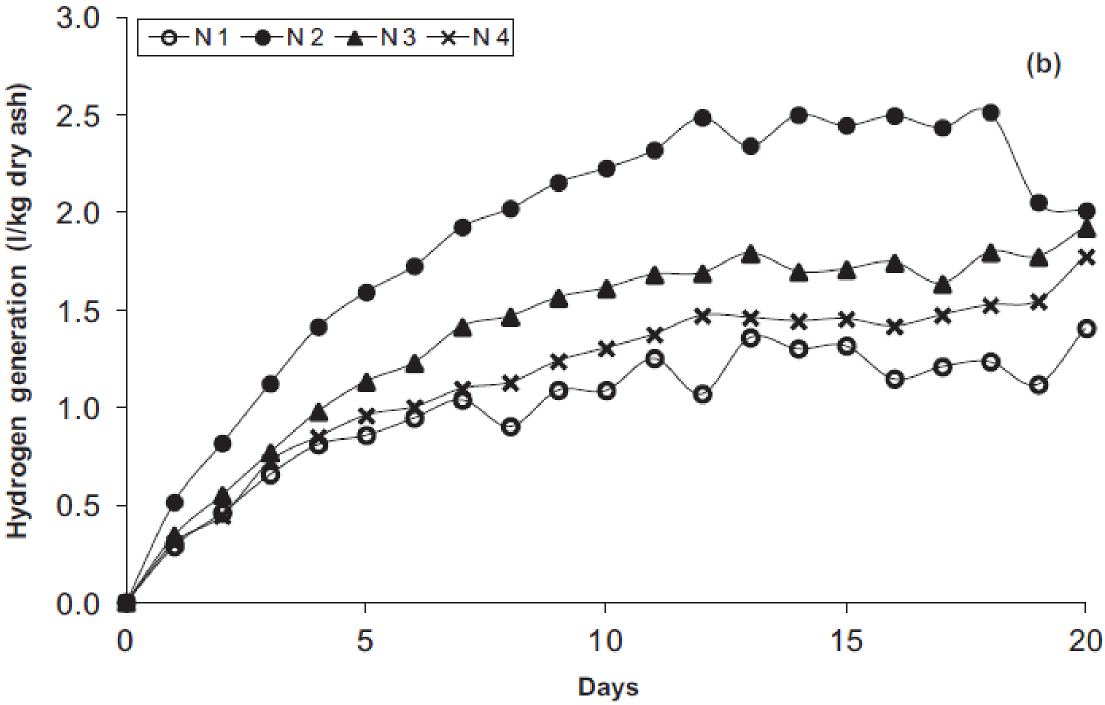

Figure 10: Reproduced Figure 7b) the daily generation rate of hydrogen gas from four fractions of bottom ash residues from source N under agitated condition at 40 °C. Saffarzadeh A., et al.

The curve above was extrapolated for each sample in the study and was approximated by a logarithmic function. This function was found to be in the form $y = a + b \ln{(x + 1)}$ where $a = 0.048$ and $b = 0.234$ are constants, x is the day between 0 and 20, and y is the generation rate of hydrogen for that day. Taking the area under this curve gives the expected hydrogen produced for each day.

[8] *Saffarzadeh A. et al, 2015, Aluminium and aluminium alloys in municipal solid waste incineration bottom ash: A potential source for the production of hydrogen gas.*

Table 3-4 and 3-5 of Chapter 3 of the EIS gives the anticipated amount of IBA produced by the facility. The IBA is expected to spend a maximum of 5 days in the bunker. At the peak rate of waste incineration of 1800 t/day, 306 t of IBA will be produced. Utilising the production rate formula and this daily peak IBA production rate, the total possible hydrogen production is 1006 m^3 over the total 5 days of storage.

The vapour cloud explosion has been modelled for this scenario. Modelling was performed using DNV GL's software package *Phast v8.22*. The bunker is approximately 1800 m^3 and at 25 °C and 1 atm, the volume hydrogen produced is 1,006m^3, and the density of hydrogen is approximately 0.0813 kg/m^3, giving a total of 81.75 kg of fuel. The explosion strength is an input for *Phast* and is a number between 1 and 10 as defined by Table 5.3 of the Dutch Yellow Book: *Methods for the calculation of physical effects*. A conservative explosion strength of 5 was chosen given the confinement of the bunker. Table 8 below gives the model inputs used in *Phast*.

Table 8: Vapour cloud explosion model inputs

Parameter	Value
Material	Hydrogen
Flammable mass in cloud	81.75 kg
Volume of confined source	1800 m^3
Strength of confined source	5

The results of the consequence modelling are presented in Figure 15 below.

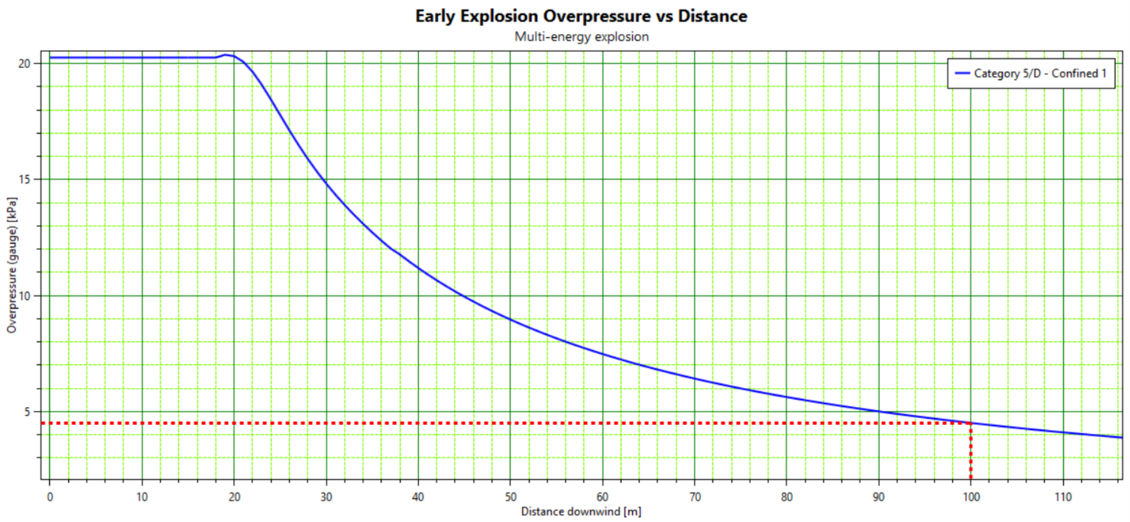

Figure 11: Hydrogen consequence model results

The bunker will at minimum, be provided with ventilation to avoid the build-up of hydrogen when the furnace is unable to incinerate any formed gases. The bunker will be provided with hydrogen gas monitors which are to include alarm set points below the LFL to allow staff to manually activate the ventilation system if required. These controls are considered sufficient to mitigate the risk of this scenario occurring SFARP.

The site boundary is approximately 100 m away. At this distance, the peak explosion overpressure expected is 4.5 kPa. This is below the 7 kPa overpressure set out by HIPAP 4 that is identified as having a probability of injury of 10% and no fatality probability. This scenario has therefore not been carried forward for frequency analysis.

4.2 Activated Carbon Dust Explosion

A dust explosion of the activated carbon dust can occur if there is sufficient dispersion, containment, oxygen and an ignition source. A lower explosive limit of 0.05 kg/m^3 is commonly accepted, while there is not a well-defined upper limit[9]. Empirical tests show that the maximum explosion pressure for an activated carbon dust explosion is reached when the density is approximately 0.25 kg/m^3 [10].

There exists a conservative model that estimates the overpressure at a given distance which has been utilized in this consequence analysis. This does not take into account the different explosibility indices for different dusts. It should be noted that activated carbon is generally considered weakly explosive[11].

The current design indicates that the storage of activated carbon is required to be approximately 130 m^3. The most likely scenario in which activated carbon would be sufficiently dispersed inside the silo, is immediately following a delivery. As such, the scenario has been modelled with 75% of the silo being filled. This would allow for 33 m^3 of air space for activated carbon dispersion. At a dispersion density of 0.25 kg/m^3, this results in 8.25 kg of activated carbon available to participate in an explosion.

Tweeddale's adjusted TNT equivalency method[12] used to model this scenario can be found below and converts the quantity of dust in a cloud to an approximately equivalent quantity of TNT. Table 9 shows the inputs for the model. The quantity of TNT can then be used to calculate the distance to certain peak overpressures. The TNT equivalency equation is shown below:

$$W_{TNT} = \alpha\left(\frac{W_{AC}H_{AC}}{H_{TNT}}\right)$$

Table 9: TNT equivalency model inputs

Parameter		Value
$\boldsymbol{\alpha}$	Explosion efficiency	0.3
$\boldsymbol{W_{AC}}$	Mass of activated carbon in cloud (kg)	8.25
$\boldsymbol{H_{AC}}$	Heat of combustion of activated carbon (kJ/kg)	32,800
$\boldsymbol{H_{TNT}}$	Heat of combustion of TNT (kJ/kg)	4560

[9] *General Carbon Corp., 2017, Activated Carbon Safety Data Sheet.*
[10] *Khalil Y.F., 2013, Experimental investigation of the complex deflagration phenomena of hybrid mixtures of activated carbon dust/hydrogen/air.*
[11] *General Carbon Corp., 2017, Activated Carbon Safety Data Sheet.*
[12] *Tweeddale, H.M., 1993, Hazard Assessment and Reduction.*

The above inputs give an equivalent TNT mass of 17.8 kg. The distances to peak overpressures of interest from Table 7 of HIPAP 4 can be found using the equivalent TNT mass and the following equations:

$$\lambda = \frac{R}{W_{TNT}^{\frac{1}{3}}}$$

$$\log_{10} 10\lambda = 0.082(\log_{10} P)^2 - 0.529 \log_{10} P + 1.526$$

Where λ is the scaled distance, R is the distance of the target from the explosion centre in metres, W_{TNT} is the equivalent TNT mass in kg and P is the explosion peak overpressure in bars. The results are presented in Table 10 below.

Table 10: Explosion overpressure consequences and distances

Explosion Overpressure (kPa)	Effect	Distance from explosion centre (m)
2.9	no effect set out in HIPAP 4	90
3.5	no fatality, very low probability of injury 90% glass breakage	77
7	10% probability of injury, no fatality damage to internal partition and joinery but can be repaired	46
14	house uninhabitable or badly cracked	28
21	20% chance of fatality in a building reinforced structures distort	22
35	house uninhabitable, wagons and plants items overturned, threshold of eardrum damage 50% chance of fatality for a person in a building and 15% chance of fatality for a person in the open	16

The distance from the activated carbon storage silo to the boundary of the site is approximately 90 m. At this distance, a peak of overpressure of 2.9 kPa is expected, which is below the threshold for injury or fatality set out in HIPAP 4. It is therefore anticipated that the risk of this scenario having an offsite impact is negligible and so the likelihood of such an event occurring has not been calculated.

4.3 Diesel Spill and Bund Fire

The potential impact of a catastrophic tank failure followed by initiating event resulting in a bund fire can be modelled to determine the radiation impact at the site boundary. While the details of the tanks and bunding are in development the design thus far considers two, 80 kL diesel tanks within one bund sized to 110% of the largest tank. The bund would be approximately 20 m x 10 m in size, thus if a tank failed and ignited a potential fire of area of 200 m^2 could result.

Utilising a point source model, the radiation to the site boundary from a bund fire can be determined. The equation for a point source mode relies on the distance to the target (site boundary), the total heat release rate of a fire, and the fraction of the energy radiated. This equation is show below:

$$\dot{q}'' = \frac{X_r \dot{Q}}{4\pi R_0^2}$$

In this equation X_r, represents the radiative fraction of the fire, $\dot{Q}$ represents the overall heat release rate of the fire as previously calculated, and R represents the distance to the point of interest, in this case the distance to the site boundary. The distance to the target is taken as 30 m, which is the approximate distance between the proposed bund wall and the nearest site boundary.

The total heat release rate must be calculated, this can be conservatively assumed as the heat release rate per unit area (HRRPUA) across the entire pool area, though it is noted in *Industrial Fire Protection Engineering*[13] that for large pool fire diameters (10 s of meters) the actual mass loss and thus heat release rate per unit area value may reduce due to inefficient mixing. Based on NIST research the HRRPUA for diesel no. 2 is 1,400 kW/m^2, applying this across the entire bund area (20 m x 10 m) results in a maximum catastrophic fire size of 280 MW.

The fraction of the total energy radiated can be taken at 0.35 for some fires, however research by NIST has shown that for large pool fires the soot produced significantly reduces the overall radiated fraction. The following equation from NISTIR 6546: *Thermal Radiation from Large Pool Fires*[14] has been utilised to calculate the radiative fraction:

$$X_r = X_{r\,max}\, e^{-kD}$$

In the above equation D is a calculated diameter of the bund utilising a circular equivalent diameter of 16 m, $X_{r\,max}$ is 0.35 and *k* is 0.05. The circular equivalence calculation and the $X_{r\,max}$ and *k* values are also in accordance with the methodology set out in *Thermal Radiation from Large Pool Fires*. Utilising this equation, the effective emitted radiation fraction from the potential bund fire is 0.157. A summary of the inputs and the calculated results are shown in Table 11.

Table 11: Results of Bund Fire

Parameter	Value	Source
Fire Size (MW)	280	Calculated based on HRRPUA
Radiative Fraction	0.157	Calculated based on diameter
Distance to target (m)	30.5	Preliminary site drawings

[13] *Zalosh, R., 2003, Industrial Fire Protection Engineering*

[14] *National Institute of Standards and Technology U.S. Department of Commerce, 2000, NIST Interagency/Internal Report 6546: Thermal Radiation from Large Pool Fires.*

Radiation at Site Boundary (kW/m^2)	3.8	Calculated Result

The results indicate that up to 3.8 kW/m^2 may be received that the site boundary. At this level, persons may face injury (second degree burns) if they do not immediately move further away from the site however fire spread would not occur.

From Table 6 of HIPAP 4: *Risk Criteria for Land Use Safety Planning*, 4.7 kW/m^2 would cause pain after 15-20 s and injury after 30 s, and 2.1 kW/m^2 could cause pain after 1 minute of exposure. Given that persons would need to stand at the boundary line of an unpopulated area during the bund fire this is considered unlikely.

The Dutch Purple Book: *Guidelines for quantitative risk assessment* provides a method for estimating the probability of death due to heat radiation. The probit function for heat radiation is given by:

$$Pr = -36.38 + 2.56 \ln (Q^{4/3}t)$$

Where Q is the heat radiation in W/m^2, t is the exposure time in seconds limited to a maximum of 20 and Pr is the probit corresponding to a probability of death for someone outdoors P_E. Note that when $Pr = 2.67, P_E = 0.01 \; or \; 1\%$.

Using this probit function, it can be seen that the minimum heat radiation required for a 1% probability of death is approximately 9.8 kW/m^2. As the maximum heat radiation expected at the site boundary is 3.8 kW/m^2, this scenario is not expected to have a fatal impact offsite.

It is further noted that the boundaries nearest the tanks and bund area consist of the entry road and the adjacent highway, neither of which are likely to have occupants outside and exposed. The nearest area that is more likely to have individuals outside and exposed is the warehouses to the west approximately 150 m away. Further there is a topographical difference in height between the bunds and the roadway, this creates an angle that would reduce the radiation received at the roadway. Through compliance with AS 1940-2017, and the low consequence to individual life, the offsite risk of a diesel spill or bund fire is considered sufficiently mitigated and so has not been carried forward for frequency analysis.

4.4 Ammonium Hydroxide Dispersion

The rate at which ammonia gas evolves from a pool of ammonium hydroxide was calculated in order to determine whether the short-term exposure limit (STEL) and the LFL were reached in the event of a catastrophic failure of the storage tank.

An online calculation tool[15] developed by the US National Oceanic and Atmospheric Administration (NOAA) was used to calculate the initial evaporation rate of ammonia

[15] *National Oceanic and Atmospheric Administration, 2003. Evaporation Calculator, http://www2.arnes.si/~gljsentvid10/evap.html, accessed 28 April 2020*

gas. The scenario modelled was based on a catastrophic failure of the tank, resulting in the release of 75 t of ammonium hydroxide.

The parameters used in the model are outline in Table 12, with an ambient temperature of 25 °C and three scenarios with varying wind speeds modelled.

Table 12: Evaporation modelling and calculation input

Parameter		Value
Tank capacity (m^3)		109.89
Tank area (m^2)		34.21
Bund capacity (m^3)		133.94
Bund surface area (m^2)		167.43
Alongwind puddle length (m)		12.94
Crosswind puddle length (m)		12.94
Ambient temperature (°C)		25
Wind speed (m/s)	Scenario 1	1.5
	Scenario 2	5
	Scenario 3	10
Ammonium hydroxide concentration (% w/w)		25

The software tool *Phast* version 8.22 (provided by DNV GL) was used to undertake the consequence modelling. The inputs for these models have been based on the information provided at the current stage of the design process.

The results are presented in Table 13 and consequence contours for Emergency Response Planning Guidelines (ERPGs) levels in Scenario 3 can be found in Figure 12 below, the full dispersion results from *Phast* can be found in Appendix G.

Table 13: Model output

Scenario 1: Wind speed 1.5m/s	
Initial Partial Pressure (Pa)	63000
Initial Evaporation Rate (kg/s)	0.783
Orifice size (mm)	60.6
Maximum Downwind Distance at 35ppm (m)	1250
Maximum Downwind Distance at LFL (160000 ppm) (m)	1.9
Scenario 2: Wind speed 5m/s	
Initial Partial Pressure (Pa)	63000
Initial Evaporation Rate (kg/s)	2.00
Orifice size (mm)	96.85
Maximum Downwind Distance at 35ppm (m)	1025
Maximum Downwind Distance at LFL (160000 ppm) (m)	2.8
Scenario 3: Wind speed 10m/s	

Initial Partial Pressure (Pa)	63000
Initial Evaporation Rate (kg/s)	3.42
Orifice size (mm)	126.65
Maximum Downwind Distance at 35ppm (m)	1080
Maximum Downwind Distance at LFL (160000 ppm) (m)	3.4

The above results demonstrate that in each case the spill release results in an offsite impact with potential societal impacts. In each scenario the short-term exposure limit (STEL) of 35 ppm is exceeded beyond site boundary. This is largely driven by the properties of ammonia which has a low tolerable exposure level and a very high vapour pressure (propensity for gasification). The combination of these mean that in virtually all cases a major ammonia spill, if modelled, will result in offsite risks. This scenario has been carried forward for frequency analysis.

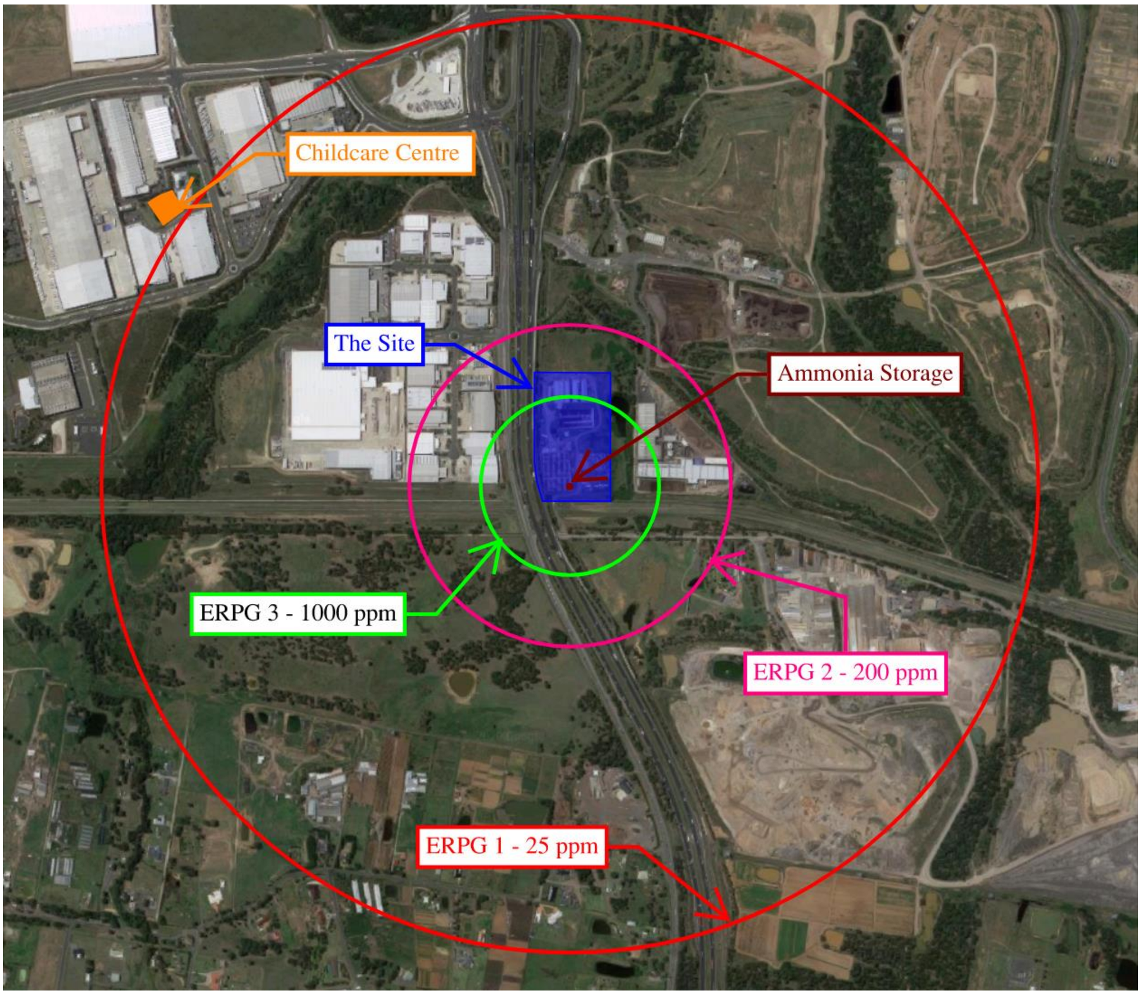

Figure 12: Consequence contours for Scenario 3

The Dutch Purple Book provides a method for estimating the probability of death due to exposure to a toxic cloud. The probit function for ammonia exposure is given by:

$$Pr = -15.6 + \ln(C^2 \times t)$$

Where C is the concentration in mg/m^3, t is the exposure time in minutes limited to 30 and Pr is the probit corresponding to a probability of death for someone outdoors P_E. Note that when $Pr = 2.67, P_E = 0.01\ or\ 1\%$.

The concentration required to have an approximate a P_E of 1% even at 30 minutes of exposure is 2,400 ppm and reaches a maximum distance of 175 m from the ammonium hydroxide storage area. While this concentration does extend beyond the site boundary, satellite imagery shows that there is limited access to areas outdoors that fall into this range. This scenario has been carried forward for frequency analysis.

Motorists on the M7 are within range of dispersion of ammonium hydroxide. For individuals indoors, the Dutch Purple Book gives the probability of death as $0.1 \times P_E$. The maximum concentration that can reach the M7 is approximately 8,000 ppm. At this concentration the probability of death for an individual indoors after 5 minutes of exposure is 0.4%. It is not anticipated that an individual in a car will be exposed to ammonium hydroxide for more than 1 minute due to the nature of a motorway. This scenario has been carried forward for frequency analysis.

While the properties of ammonia give it the potential to create an offsite risk, it is also a commonly utilised chemical in industry with well-defined protection measures.

Scenario 3 was assessed as being the worst case for offsite impact, with the Little Graces Childcare Centre, located approximately 1,150 m away, potentially being affected by a low level of ammonium hydroxide exposure. The childcare centre has been determined as the only sensitive receptor in the vicinity of the site. The controls that will be implemented or are naturally occurring reduce the likelihood of the dispersion of ammonium hydroxide resulting from a large release from reaching the childcare centre. This scenario has been carried forward for frequency analysis.

The tanks are to be provided with real-time monitoring to identify leaks set below STEL levels quickly from the control room. Notification and evacuation procedures are to be developed and included in the emergency plan in the event of a significant release. The site managers are to develop a response plan which is to include coordination with local response organisations such as FRNSW and NSW Ambulance services.

4.5 Release of Flue Gas Treatment Residue

The worst-case scenario for the release of FGTr is as a result of a truck incident that leads to the dispersion of FGTr. Two scenarios were modelled, source sizes of 25 m^2 and 49 m^2, representing approximately half and all of the truck contents spilling respectively. Air dispersion modelling has been undertaken by Todoroski Air Services and is appended in Appendix F. This section summarises the results of the modelling.

The US EPA air dispersion screening model (SCREEN3) was used to determine how far FGTr can realistically disperse under adverse conditions. The modelling results were compared with the US Protective Action Criteria (PAC) for the toxic substances in the

FGTr. The PAC are short-term exposure criteria applied by emergency responders to protect the public from health effects. The PAC-1 criteria adopted in this study represent concentrations at which individuals may experience mild and transient health effects. Note that the PAC-1 criteria are 1-hour averages, however, it has been assumed that the release of any FGTr would be responded to and dust suppression (light sprinkling) applied within 30 minutes. The results of the modelling are presented below.

Table 14: Summary of SCREEN3 results

Parameter	Value	
Area (m^2)	25	50
Emission rate ($g/m^2/s$)	6.82E-06	6.82E-06
Total emission rate (g/s)	1.7E-4	3.4E-4
Distance to maximum concentration (m)	20	21
Maximum concentration (mg/m^3)	0.006	0.010

Table 15: Summary of SCREEN3 results for toxic substances

Pollutant	Maximum concentration (mg/m^3)		PAC-1 (mg/m^3)	% of Criteria[16]
	25m^2 Area	50m^2 Area		
Chloride	4.30E-04	7.25E-04	1.4_{A}[17]	5.18E-02
Sulphate	5.60E-05	9.44E-05	0.013[18]	7.26E-01
Fluoride	1.72E-07	2.89E-07	2.6_{A}[19]	1.11E-05
Mercury (non-volatile)	1.32E-08	2.23E-08	1.5[20]	1.49E-06
Antimony	1.57E-06	2.64E-06	1.5	1.76E-04
Arsenic	1.06E-07	1.79E-07	1.5	1.19E-05
Barium	1.87E-06	3.15E-06	1.5	2.10E-04
Cadmium	4.15E-07	6.99E-07	0.1_{A}[21]	6.99E-04
Chromium	2.13E-07	3.60E-07	1.5	2.40E-05
Cobalt	5.23E-08	8.83E-08	0.18	4.90E-05
Copper	1.52E-06	2.57E-06	3	8.56E-05
Lead	3.58E-06	6.03E-06	0.15	4.02E-03
Manganese	1.59E-06	2.69E-06	3	8.95E-05
Molybdenum	3.40E-08	5.73E-08	30	1.91E-07
Nickel	1.92E-07	3.24E-07	4.5	7.21E-06
Selenium	1.14E-08	1.93E-08	0.6	3.22E-06
Thallium	3.10E-09	5.23E-09	0.06	8.72E-06

[16] Using the maximum concentration from both modelled areas
[17] PAC-1 criterion corresponds to 1-hour AEGL-1 criteria for chlorine
[18] PAC-1 criterion sourced from vanadium sulphate
[19] PAC-1 criterion corresponds to 1-hour AEGL-1 criteria for fluorine
[20] PAC-1 criterion sourced from mercury oxide
[21] PAC-1 criterion corresponds to 1-hour AEGL-1 criteria for cadmium

Tin	9.35E-07	1.58E-06	6	2.63E-05
Vanadium	2.65E-07	4.46E-07	3	1.49E-05
Zinc	2.34E-05	3.94E-05	6	6.57E-04

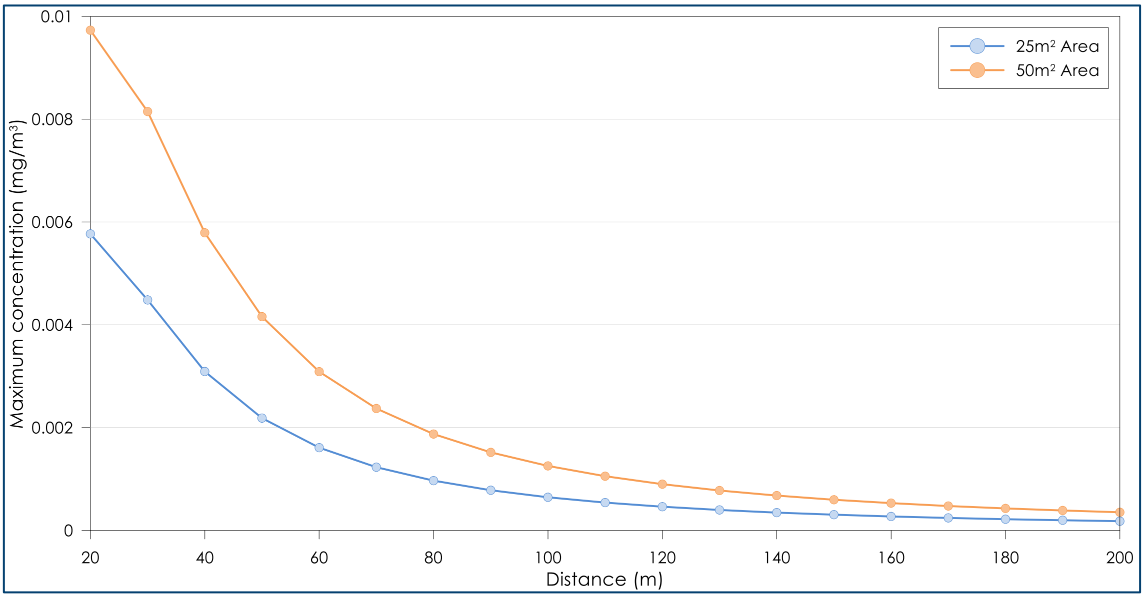

Figure 13: Concentrations of total FGTr at distances

As illustrated by the above results, even with conservative assumptions, the impact to sensitive receptors, even at a distance of 20 m, is expected to be negligible. It is therefore considered that the routes in Figure 14, each being over 20 m away from a sensitive receptor are acceptable at this stage of the design process. The exact route will be chosen later in the design process and will consider community submissions pre-approval and the HIPAP 11 – *Route Selection* study post-approval. As a result of the negligible impact resulting from a release of FGTr, this scenario has not been carried forward for frequency analysis and is considered to be reduced SFARP.

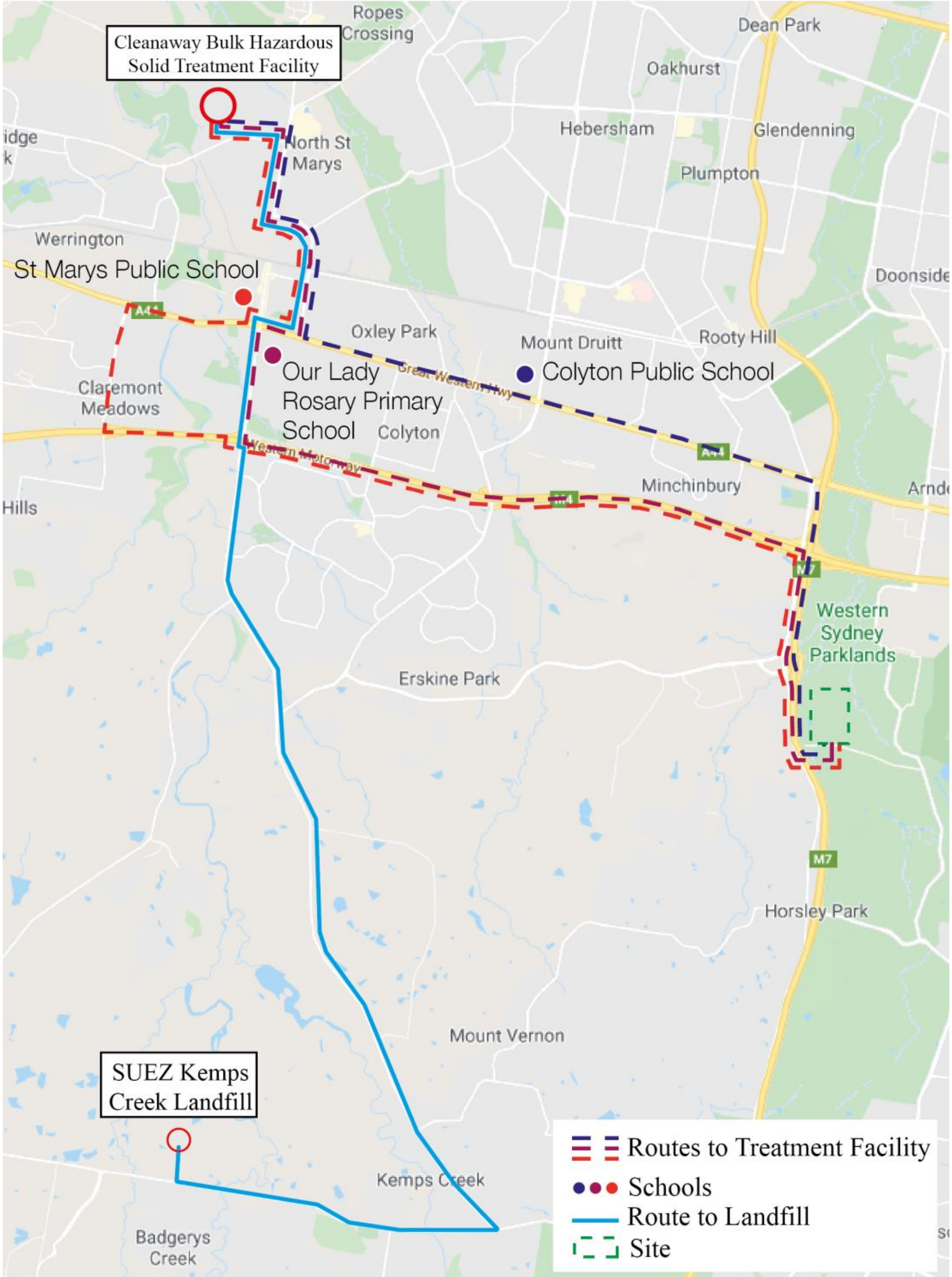

Figure 14: FGTr Transport Route

4.6 Waste Bunker Fire

The single largest fuel load present at the site is the waste within the waste bunker which feeds fuel to the two furnaces. At typical operation the nominal capacity of the waste bunker is 10,500 t of waste. In order to provide additional fuel for operation over holiday periods where the influx of waste may stop for a few days, the maximal capacity of the waste bunker is 17,000 t which can be achieved by closing half of the tipping bays and arranging the waste against them with the overhead cranes.

The worst-case consequence scenario for a bunker fire is an uncontrolled fire that has ignited the full surface area of the bunker. The potential maximum heat release rate from this fire and burn duration have been approximated utilising a heat release rate per unit area (HRRPUA) applied across the exposed surface in both the nominal and maximum capacity modes of the bunker hall. The fire duration has then been calculated based on the fire intensity and the fuel load present, assuming the maximum anticipated heat of combustion (calorific energy) of incoming waste for the facility which is assumed to be 15 MJ/kg.

In order to provide a robust sensitivity assessment, a range of fire intensities, referred to at heat release rate per unit area (HRRPUA) have been utilised. This allows the assessment to identify the peak fire size, which has the most radiation on the boundary but the shortest burn duration, and a potential reduced fire size but longer burn duration. The range of applied values is from 250 kW/m^2 to 750 kW/m^2.

Some testing has been carried out on fire sizes of typical municipal waste by the US Nuclear Regulatory Commission (US NRC) however this has largely been done at a trash bag scale, rather than bunker scale. The testing however did include an adjustment for equivalent fire diameter and resultant HRRPUAs, the tests resulted in a range of HRRPUAs from 200 kW/m^2 to 400 kW/m^2. Notably, these tests were conducted with standardised trash within the bags consisting of plastics, paper, milk cartons, and the like, essentially all combustible materials, and at small scale. The HRRPUA captured in this review incorporate a range of values that include fire intensities above these lab scale tests, providing a more conservative radiant flux at the boundary. The model inputs are shown in Table 16.

Table 16: Model Inputs

Parameter		Value	Sources
Heat of Combustion of Waste		15 MJ/kg	Peak expected calorific value for incoming waste stream
Bunker Area		2070 m^2	Flat area taken from bunker size
Low	HRRPUA	250 kW/m^2	Assumed value
	Fire Size	517.5 MW	Calculated based on HRRPUA
	Duration	137 hours	Calculated based on HRRPUA
Medium	HRRPUA	500 kW/m^2	Assumed value
	Fire Size	1035 MW	Calculated based on HRRPUA
	Duration	68 hours	Calculated based on HRRPUA
High	HRRPUA	750 kW/m^2	Assumed value
	Fire Size	1552.5 MW	Calculated based on HRRPUA
	Duration	46 hours	Calculated based on HRRPUA

The fire size as calculated above, can then be utilised to calculate the potential radiation received at the site boundary. This is done utilising a simple point source radiation calculation as shown below:

$$\dot{q}'' = \frac{X_r \dot{Q}}{4\pi R_0^2}$$

In this equation X_r, represents the radiative fraction of the fire, $\dot{Q}$ represents the overall heat release rate of the fire as previously calculated, and R represents the distance to the point of interest, in this case the distance to the site boundary.

X_r, the radiative fraction, is a vital input to this equation, while little large-scale testing has been undertaken for waste fires, there is significant data on the calculation of X_r for large pool fires. While the waste bunker will not contain a hydrocarbon pool fire, the large potential fire diameters tested and extensive research on pool fires provides a basis for approximation of the radiative fraction for a bunker fire. Generally, it has been found that as diameter increases, due to turbulence, soot, incomplete combustion, and other effects, the radiative fraction of a fire decreases. Research on these pool fires of various fuels has shown that the X_r, which is the radiative fraction of energy emitted, can be calculated based on the following equation:

$$X_r = X_{r\,max}\, e^{-kD}$$

Where $X_{r\,max}$ is 0.35, k is a constant with value 0.05, and D is the fire diameter, or equivalent fire diameter calculated for non-circular fires. However, this equation has not been fit to fires with very large diameters (more than 50 m), as shown in Figure 15 which shows the equation plotted with data points. Therefore, this equation has been applied to the different fire sizes, but also a conservative approach utilising a radiation fraction of 0.1 has also been tested.

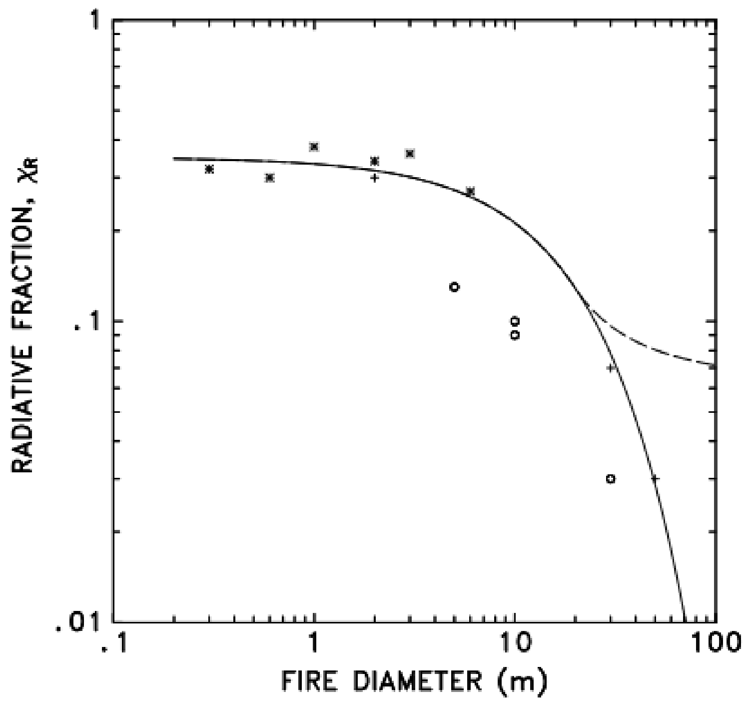

Figure 15: Radiative Fractions for given Fire Diameters

The fire sizes calculated above have been combined with the point source radiation formula above to give the radiative flux expected at the boundary. The results from this calculation can be found in Table 17 below.

Table 17: Radiative flux outputs by fire size

<table>
<tr><th colspan="2">Parameter</th><th>Value</th></tr>
<tr><td colspan="2">Fire Area (m^2)</td><td>2070</td></tr>
<tr><td colspan="2">Equivalent Diameter (m)</td><td>51.3</td></tr>
<tr><td colspan="2">Calculated $\boldsymbol{X_r}$</td><td>0.0269</td></tr>
<tr><td colspan="2">Alternative $\boldsymbol{X_r}$</td><td>0.1</td></tr>
<tr><td colspan="2">Distance to Boundary (m)</td><td>12.94</td></tr>
<tr><td rowspan="3">Radiative Flux at Boundary (kW/m^2)</td><td>Low (250 kW/m^2)</td><td>0.26</td></tr>
<tr><td>Medium (500 kW/m^2)</td><td>0.51</td></tr>
<tr><td>High (750 kW/m^2)</td><td>0.77</td></tr>
<tr><td rowspan="3">Radiative Flux at Boundary for Alternative $\boldsymbol{X_r}$ (kW/m^2)</td><td>Low (250 kW/m^2)</td><td>0.95</td></tr>
<tr><td>Medium (500 kW/m^2)</td><td>1.91</td></tr>
<tr><td>High (750 kW/m^2)</td><td>2.86</td></tr>
</table>

While the worst-case scenario result of 2.9 kW/m^2 provides an approximation of the fire size and duration of a full bunker fire it is important to recognise a number of variables which will impact on the actual fire characteristics. The above calculations assume a simultaneous surface combustion of fuel throughout the bunker, on a flat surface. In reality, some of the waste is stacked, but as a fire burns these stacks are likely to collapse and settle into the bunker, creating a more flat and even surface. The bunker fire would also have a point of origin from which is grows, rather than simultaneously combusting throughout the space.

A real fire within the bunker fire is unlikely to burn at its peak intensity for the entire duration, therefore the actual heat flux at the boundary would vary with time based on the intensity at the moment, and the fuel is likely to be consumed more slowly resulting in a longer, but less intense fire.

The probit function calculated in Section 4.3 illustrates that a heat flux of 2.9 kW/m^2 is not expected to have a fatal offsite impact. The qualitative threat-barrier diagram found in Appendix H shows the active and passive controls present in the waste bunker that will reduce the likelihood of this scenario occurring. Through these controls and the consequence analysis results, the risk of this scenario is considered to be mitigated SFARP and has not been carried forward for frequency analysis.

5 Frequency Analysis

Threat-barrier diagrams (TBDs) are models which demonstrate the interactions between threats, consequences and controls. An example indicative TBD can be found in Figure 16. A quantified TBD has been developed to assess the likelihood of the dispersion of ammonium hydroxide. A qualitative TBD has been developed to illustrate the controls in place to reduce the likelihood of a full bunker fire.

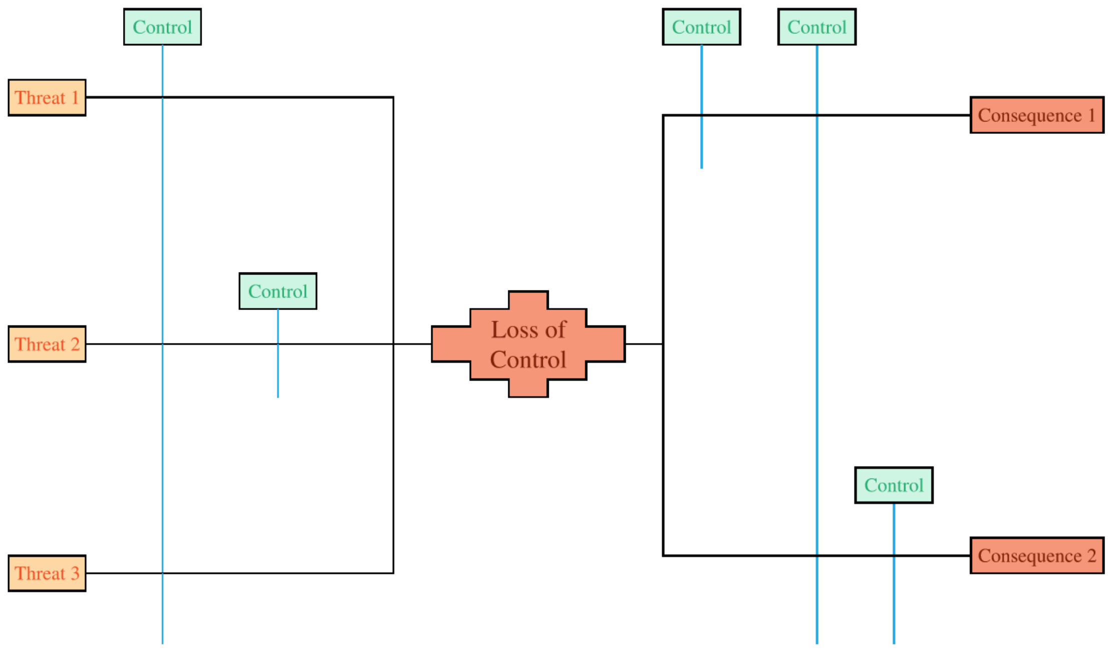

Figure 16: Example Threat-Barrier Diagram

The main elements of a TBD are:

- Threat: a scenario which may lead to a Loss of Control;
- Loss of Control: the moment when control is lost over a threat and a negative consequence may occur;
- Consequence: a potential outcome of a Loss of Control; and
- Control: a precaution which may prevent threat scenarios from leading to a Loss of Control, and a Loss of Control from leading to a consequence.

TBDs may be quantified by estimating the frequency of each threat and the effectiveness of each control. This enable the estimated frequency of the Loss of Control and Subsequent Consequences to be calculated.

Appendix H contains the TBDs for an ammonium hydroxide dispersion and full bunker fire. The results of the ammonium hydroxide TBD are summarised further in Section 5.1, the bunker fire results are not discussed herein as no offsite consequence was calculated.

5.1 Ammonium Hydroxide Dispersion

The potential offsite impacts that a release of ammonium hydroxide could pose have each been considered in the frequency analysis. Failure rates of small and medium atmospheric vessels has been sourced from the UK Health and Safety Executive[22]. Factors such as wind speed, wind direction and probability that an individual is present reduce the likelihood of this event having an offsite impact further. The estimated likelihoods of each impact are presented in Table 18 below. Further information can be found on the relevant TBD in Appendix H.

Table 18: Estimated likelihood of impacts of an ammonium hydroxide dispersion

Potential Impact	Yearly rate of impact	Likelihood
Exposure to STEL	1.9E-7	1 in 5 million years
Childcare centre exposed to ERPG 1	2.8E-8	1 in 35 million years
Fatality outdoors	1.4E-11	1 in 72 billion years

The likelihood has been estimated using a series of conservative assumptions and is orders of magnitude below the risk criteria set out by HIPAP 4. Implementing the measures described in Section 4.4 and the extremely low likelihood of such an event occurring is considered sufficient to lower the risk of this scenario SFARP.

[22] *UK Health and Safety Executive, 2017, Failure Rate and Event Data for use within Risk Assessments*

6 Individual Risk

The individual fatality risk criteria for land use planning near hazardous installations is set out by HIPAP 4:

- Hospitals, schools, childcare facilities, old age housing: 5E-7 per year;
- Residential, hotels, motels, tourist resorts: 1E-6 per year;
- Commercial developments including retail centres, offices and entertainment centres: 5E-6 per year;
- Sporting complexes and active open space: 1E-5 per year; and
- Industrial: 5E-5 per year.

As can be seen by Section 5.1, the individual risk of fatality is approximately 1.4E-11, which is not only orders of magnitude lower than the risk criteria for industrial areas, which surround the site, but also orders of magnitude lower than the criteria for the most sensitive population groups. As the risk of exposure to the STEL of ammonium hydroxide is also lower than the risk criteria for the most sensitive population groups, it is considered that the risk posed by the facility to an individual is negligible.

7 Societal Risk

The cumulative frequency of a fatality as a result of the scenario described in Section 5.1 has been plotted on an F-N curve below. The expected number of people in the industrial warehouse area to the east of the facility has been estimated as 50. In the event of a catastrophic rupture, the potentially lethal dose of 2400 ppm could reach as far as 175 m which could cover an area of approximately 10% of the adjoining site. This could result in 5 fatalities. In the event of a large leak, the potentially lethal dose of 2400 ppm could reach as far as 135 m which could cover an area of approximately 2% of the adjoining site. This could result in 1 fatality. As can be seen by Figure 17, the risk of a fatality as a result of hazardous substances at the facility is considered to be a negligible risk.

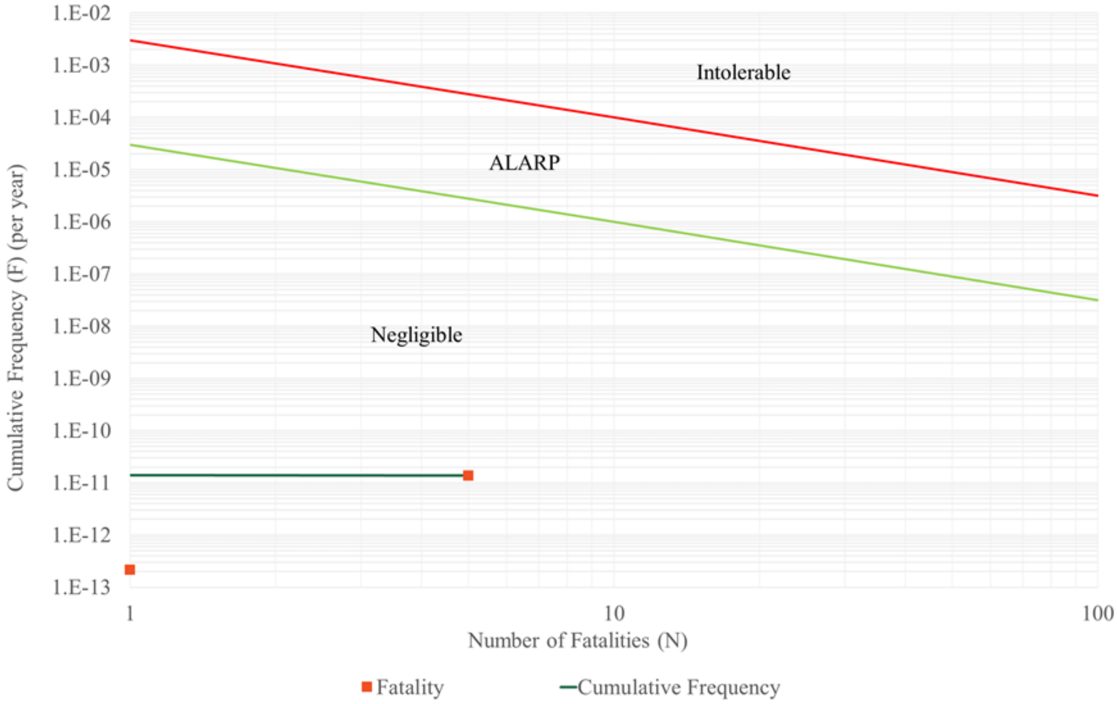

Figure 17: F-N curve for cumulative frequency of fatal risks

The only hazard that has an offsite impact above criteria set out by HIPAP 4 is the release of ammonium hydroxide. As such, it is not expected that there is a risk of accident propagation. The EfW facility is not expected to raise the risk of the site and surrounding land uses.

8 Findings and Recommendations

As demonstrated through the HAZID process, energy from waste facilities are a proven technology with well-known and defined risks. This allows for the hazards posed by the facilities to be readily identified and mitigated against, typically by simply complying with the relevant standards of design for individual systems, goods, and processes.

There were five hazards identified where the consequences have the potential to pose significant offsite risks:

- Formation of Hydrogen in IBA: In the event of a facility shutdown and subsequent hydrogen build-up, the peak overpressure expected at the site boundary has been modelled to be 4.5 kPa. This is below the threshold for fatality as set out in HIPAP 4. Therefore, the risk of this scenario having an offsite impact is negligible.
- Activated Carbon Dust Explosion: In the event of the ignition of a dust cloud within the activated carbon storage silo, the peak overpressure expected at the site boundary has been calculated to be 2.9 kPa. This is below the threshold for injury or fatality as set out in HIPAP 4. Therefore, the risk of this scenario having an offsite impact is negligible.
- Diesel Spill and Bund Fire: In the event of a catastrophic failure and subsequent bund fire of diesel, the heat radiation at the site boundary has been calculated to be 3.8 kW/m^2. This is below the threshold of 4.7 kW/m2 that will cause pain after 15-20 seconds exposure, and injury (second degree burns) after 30 seconds exposure. Therefore, the risk of this scenario having an offsite impact is negligible.
- Release of Ammonium Hydroxide: In the event of a catastrophic failure of the ammonium hydroxide tank, the worst credible case results in the dispersion of a toxic cloud at the Short-Term Exposure Limit (STEL) of 35ppm at a height of 5m as far as 1075m downwind from the release point. It is noted that the nearest sensitive receptor (a childcare centre) is approximately 1150 m away from the ammonium hydroxide storage area. Given the scale of the warehouses between the Site and the childcare centre there is a negligible risk of injury to sensitive receptors. People working in the industrial warehouses closest to the facility could be exposed to higher doses of ammonia and these have been considered further below.
- Waste Bunker Fire: In the event of the largest possible fire in the waste bunker, the heat radiation at the site boundary has been calculated to be 2.9 kW/m^2. This is below the threshold of 4.7 kW/m2 that will cause pain after 15-20 seconds exposure, and injury (second degree burns) after 30 seconds exposure. At this level, the offsite impact is negligible.

The potential consequences of the ammonium hydroxide dispersion scenario resulted in it being carried forward for frequency analysis. The likelihood has been estimated using a series of conservative assumptions and is orders of magnitude below the risk criteria set out by HIPAP 4. The likelihood of exposure to a toxic cloud above the STEL occurring was estimated to be approximately once every 5 million years. The potential exposure to sensitive receptors at ERPG 1 was estimated to be a once in 35 million years event.

The individual risk of fatality is approximately 1.4E-11, which is not only orders of magnitude lower than the risk criteria for industrial areas, which surround the site, but also orders of magnitude lower than the criteria for the most sensitive population groups. It is considered that the risk posed by the facility to an individual is negligible.

The cumulative frequency of a fatality as a result of an uncontrolled release of ammonium hydroxide has been calculated to occur approximately once in 72 billion years. The expected number of people in the industrial warehouse area to the east of the facility has been estimated as 50. In the event of a catastrophic rupture, the potentially lethal dose of 2400 ppm could reach as far as 175 m which could cover an area of approximately 10% of the adjoining site. This could result in 5 fatalities. In the event of a large leak, the potentially lethal dose of 2400 ppm could reach as far as 135 m which could cover an area of approximately 2% of the adjoining site. This could result in 1 fatality. This is the only scenario that has the potential to cause an offsite fatality and has been plotted on an F-N curve below. As can be seen by Figure 18, the risk of a fatality as a result of hazardous substances at the facility is considered to be a negligible risk.

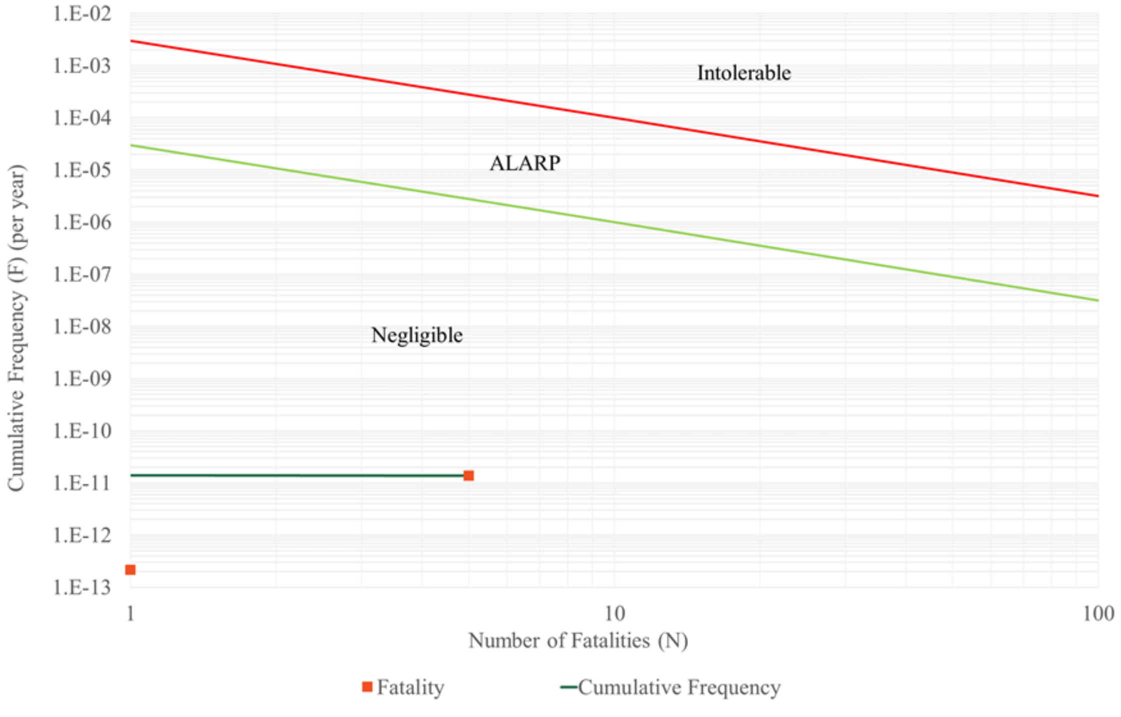

Figure 18: F-N curve for cumulative frequency of fatal risks

In addition to the above, the following recommendations have been made regarding the EfW facility:

- Fire detection and suppression systems in both the tipping hall and waste bunker;
- As part of the ongoing management plan, during operation the facility wide vacuum cleaning system is to be used to reduce the likelihood of dust build-up;
- The ventilation of the IBA shall be sufficient to prevent the building up of hydrogen into an explosive atmosphere. The IBA area shall also have hydrogen gas sensors with alarm set points below the lower flammability limit;
- Acids and bases will be stored in accordance with AS 3780-2008, and in accordance with obligations under Section 5 of Chapter 7 of the Work Health and Safety Regulations 2011;
- Ammonium hydroxide and sodium hydroxide will not be stored in the same bunded area or in compounds that share a common drainage system as per Section 6.3 of AS/NZS 3833-2017;
- The activated carbon storage area is to be zoned in accordance with AS/NZS 60079.10.2-2016 and a Hazard Assessment as outlined in Section 3 of AS/NZS 4745-2012 is to be carried out during the design phase;
- Safe operation and maintenance of FGTr transfer systems such as spill management procedures will be implemented to limit failure;
- The storage of diesel is to be designed in accordance with the EPA's guidelines on 'Bunding and Spill Management' and AS 1940-2017, and be contained within a bunded area that can hold the capacity of the diesel storage tank;
- The ammonium hydroxide tanks will be provided with real-time monitoring to identify leaks quickly from the control room. The alarm is to be set below short-term exposure limit (STEL) levels;
- Notification and evacuation procedures are to be developed and included in the emergency plan in the event of a significant release of ammonium hydroxide;
- The site managers are to develop a response plan which is to include coordination with local response organisations such as FRNSW and NSW Ambulance services;
- The stack should be lit in accordance with Chapters 5 and 6 of the Federal Aviation Administration's (FAA) AC 70/7460-1L: *Obstruction Marking and Lighting*; and
- The waste bunker is to be provided with both ceiling level sprinkler and water monitor fire suppression. These are to be fed off separate valves for additional resiliency. The final waster bunker fire safety design is to be developed through an appropriate fire engineering process.

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Appendix A

Site Layout

A	SITE ENTRANCE (RE-USING EXISTING CROSSING)
B	WASTE INSPECTION LAY-BY
C	WASTE CRANE PARKING
D	IBA HALL AND DRIVE THROUGH AT LOWER LEVEL. ADMINISTRATION BUILDING AT HIGHER LEVELS
E	RAINWATER TANKS
F	DRIVE-THROUGH FOR CONSUMABLES UNLOADING
G	DIESEL TANKS
H	AMMONIA TANK
I	SODIUM HYDROXIDE TANK
J	FIRE WATER TANKS AND PUMP SET
K	MAIN STAFF CAR PARK
L	OVERSPILL CAR PARK AND COACH PARKING
M	BIO-RETENTION BASIN
N	ON-SITE DETENTION BASIN
O	OVERLAND FLOW CHANNEL
P	POTABLE WATER TANK
Q	SEWER PUMP STATION

Scales

Filename (Full Drawing No)
WSERRC-ARU-SYD-CICW-DRG-0020
Design Model Version

Issue	Date	By	Chkd	Appd
A	29/06/20	HNA	AC	EM
	FOR APPROVAL			
0	22/05/20	HNA	AC	EM
	FOR PLANNING APPROVAL			

Client
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MACQUARIE

Engineering Certification (CEng)
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Signature: Date:

Job Title
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Drawing Title
PROPOSED SITE PLAN

Drawing Status
Issue for Approval

Job No 264039-00
Drawing No ARU-SYD-CICW-DRG-0020
Issue A

Do not scale

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Appendix B

HAZID Minutes

Project:	WSERRC HAZID				Date:	Friday, 28 February 2020 and Friday, 6 March 2020
Node Description:	MASTER					ARUP

#	Area	Property	Guideword	Cause	Consequence	Safeguard	Recommendations
1	Tipping Hall	FIRE	WASTE	Waste that has a smouldering load	Fire inside a truck	Entire facility is covered by fire detectors (flame/smoke)	Form of detection is yet to be determined, will be determined in detailed design. Operational response and emergency procedures yet to be determined
2		FIRE	WASTE	Truck breaks down/catches fire	Fire inside a truck	Entire facility is covered by fire detectors (flame/smoke)	Form of detection is yet to be determined, will be determined in detailed design. Operational response and emergency procedures yet to be determined
3		FIRE	BUNKER	Fire in bunker comes back into tipping hall	Fire spread through building	Gates are insufficient to stop fire from coming back from the bunker. Safeguards exist in the bunker to control any fire within the bunker	For design and operation management
4		CRASH	TRUCK	Large amount of movements in tipping hall	Fire inside a truck	Entire facility is covered by fire detectors (flame/smoke)	Form of detection is yet to be determined, will be determined in detailed design. Operational response and emergency procedures yet to be determined
5		WEATHER	HIGH TEMPERATURE	Not a hazard			
6		ODOUR	RELEASE	Odour release into the atmosphere	Offensive odour released	Airflow from external through tipping hall, bunker and furnace creating slight underflow. If process is stopped, there will be an air flow that takes the odour through the activated carbon to treat the odour. Done as much as reasonably possible	Ensure that any leaks that do occur are within environmental limits
7		LIQUID_WASTE	LIQUID WASTE	Spillage that misses the chute	Liquid waste on floor of tipping hall	Slope into bunker, will go into bunker. Street sweeper to clean up. Will be able to empty a truck on the floor and check it. Liquid waste wouldn't be accepted, procedures in place to not accept liquids	Liquid waste not to be accepted by facility
8		BIOLOGICAL_HAZARDS	BIOLOGICAL HAZARDS	General waste characteristics	Biological hazard	Won't be accepting bio waste from hospitals and vet clinics	Bio waste not to be accepted by facility
9		EXPLOSION	DUST	Very dusty in the tipping hall	Dust explosion	Requirement to do regular cleaning, fire engineers to calculate how much dust is allowed. Access to the girders and hard to reach places to be put in place	Regular cleaning of all level surfaces, avoid horizontal design and regular maintenance of all potential dust build up areas
10		CRASH	TRUCK	Fuel spill	Fuel ignites	Fuel will get washed into the bunker	Regular cleaning of floor of tipping hall
11		FIRE	WASTE	Hot ash / disposal of hot waste / self-heating	fire in waste	Thermal detection of waste, full water cannons, bunker is scanned continuously various levels of detection. Each level determines a new action from water cannons. Crane operator/control room will be alerted and can take control of water cannons. Semi-automatic. operators in control room can see high temperature waste and interject and move it into the furnace. Crane operator can also select hot waste as next into the hopper to remove it from bunker.	For further design / operation management

12	Waste Bunker	ODOUR	RELEASE	same as tipping hall	offensive odour	Airflow from external through tipping hall, bunker and furnace creating slight negative pressure. If process is stopped, there will be an air flow that takes the odour through the activated carbon to treat the odour. Done as much as reasonably possible	For further design
13		LIQUID_WASTE	LIQUID WASTE	accumulation of liquid waste	biohazard and process impact	Site does not accept liquid-only waste. Limited liquid accumulating in waste / in incoming waste. Bunker can be drained if necessary	For operations management
14		BIOLOGICAL_HAZARDS	BIOLOGICAL HAZARDS	same as tipping hall	biohazard	Site does not accept any specifically hazardous waste (e.g. medical waste). All waste poses general biohazard risk within site, however bunker is indoors.	For operations management
15		EXPLOSION	DUST	40 000 cubic metres	exploding	operators entering the area will be in space suits, maintenance zones with easy access. Bunker will most likely be classified as a hazardous area, access will be highly controlled	Investigate electrical systems and dust
16		EXPLOSION	ACTIVATED CARBON	filter catches fire	fire	Design to comply with local regulations, NSW regulations, and best practice. May include local suppression if appropriate	For further design
17		FLAMMABLE_GAS	IN WASTE	decomposition of waste	gas catches fire/explodes	Underflow of air pressure would take gas into furnace. Decomposition of waste is too slow compared to its entering into the furnace. The bunker would be emptied in sections so that waste is not kept in the bunker for long enough for decomposition	Establish method of moving waste from bunker to furnace to avoid one section being in the bunker for too long (first in, first out)
18		FLAMMABLE_GAS	IN WASTE	gas canister	explosion in furnace	Furnace is built to accommodate and deal with likely things being in the waste (e.g. BBQ canister)	N/A - part of typical design of furnace
19		LOSS_OF	POWER	power failure	operational continuity	Should not happen as the plant is generating its own power and if there is an issue with that there are backup generators and a UPS battery to cover lag in switching over to the diesel generator	N/A - part of typical design of furnace
20		FIRE	SHREDDER	Shredder shredding items that are flammable		Shredder shouldn't be shredding things that are flammable	Establish a strategy to deal with shredder shredding things and causing a fire
21	Furnace	FLOW	HIGH	backfire from furnace into chute.	Fire from furnace comes back into chute.	Backstop chute with waste. There is also a fire damper inside the chute. Fire damper between bunker and boiler hall. System controls how much waste on the conveyor, ramp feeder into furnace	Cranes have built in weighing devices to control the flow
22		FLOW	ZERO	no flow of waste	reduced burning	Auxiliary burners to stay under legal limits for emissions	For operations management
23		START_UP	START_UP	After a shut down	Emissions requirements will not be met if 850C for 2 seconds is not maintained	Auxiliary burners are can be used until the shutdown is complete. Environmental limits are met with auxiliary burners	For operations management
24		SHUTDOWN	SHUTDOWN	Emergency or planned	Emissions requirements will not be met if 850C for 2 seconds is not happening	Auxiliary burners are used until the start up is complete. Environmental limits can be met with auxiliary burners	For operations management
25		AIR_FLOW	ZERO	Emergency or planned	Gasification of chamber	Burner has own air supply so that gas doesn't build up	For design/operations management
26		LOSS_OF	AMMONIA	Leak in storage or pipes	People exposed to ammonia	Stored outside, run to facility by ammonia pipes, nozzles spray the ammonia water into the process. Mainly an on-site risk as process is indoors.	For operations management.
27		LOSS_OF	AMMONIA	Hose carrying ammonia water snaps	release into environment	Monitoring of emissions, flow rate or other nozzles will be increased so that the nozzle isn't used. Automatic feedback	For operations management.
28		TEMPERATURE	LOW	Burner not running	Would not meet the requirements of 850C for pollution control	Auxiliary burner, continued failing to meet emissions emergency shutdown	For operations management.

29	Horizontal Boiler	LEAK	RADIATION	Radiation brought into facility	Exposure to radiation	All incoming delivery and residue vehicles will go through radiation scanner prior to entering tipping hall. Any vehicle which exceed radiation limits will be quarantined.	For operations management.
30		LEAK	STEAM	Flue gas is extremely corrosive, corrodes the inside of the boiler	Shutdown of line	Temperature sensors. Line will shut down if there is a pipe burst. Regular maintenance to check thickness of pipes to monitor corrosion, aim to replace weak parts before they burst	For operations management.
31		LEAK	WATER	Flue gas is extremely corrosive, corrodes the inside of the boiler	Shutdown of line	Temperature sensors. Line will shut down if there is a pipe burst. Regular maintenance to check thickness of pipes to monitor corrosion, aim to replace weak parts before they burst	For operations management.
32		FEED_CONTROL_/_STEAM_REQUIREMENT	FEED_CONTROL_/_STEAM_REQUIREMENT	No steam	Not enough steam to satisfy environmental requirements	Lines can be reduced to 70% if necessary	For operations management.
33	SNCR	CONCENTRATION	HIGH	Overdosing of ammonia	Ammonia slip (potential release)	Flue gas cleaning scrubber will flush out extra ammonia. If the plants emissions exceeds the environmental limits, plant will shut down	For operations management
34		CONCENTRATION	HIGH	Ammonia needs to be vented	People near venting pipe exposed to ammonia	Keep venting pipe high enough to not affect people	For design and operations management
35		TANK_LEVEL	HIGH	Over delivery of ammonia	Overflow of ammonia	Monitoring the level of ammonia in the tank	Establish a means of monitoring
36		TANK_LEVEL	LOW	Under delivery of ammonia / overuse	Not enough ammonia for FGT	Monitoring the level of ammonia in the tank	Establish a means of monitoring
37	IBA	MATURATION	HYDROGEN	Water reacting with aluminium	Explosion of hydrogen in IBA	Moved out of IBA bunker in under 5 days, venting of the IBA bunker	For operations management
38		MATURATION	PHOSPHINE	Bonemeal in waste producing phosphine	Explosion of phosphine in IBA	Unlikely to have a lot of bonemeal in incoming waste. Does not accept medical, vet waste, or bodies.	For operations management
39		FIRE	IBA	Ignition of IBA	Fire in the bunker	IBA is inert if the process is done properly. Advanced combustion control monitors process.	For operations management
40		EXPLOSION	DUST	Ignition source	Dust generated by IBA process explodes	Process will be fully enclosed, reduced dust generation because of 20% water. Taken offsite to mature for 30 days. IBA is ventilated outside for the 30 days, trailer trucks are open top covered with hood. Dust is inert <3% total organic carbon	For operations management
41		TRANSPORT_INCIDENT	IBA	Accident on road	Dust released into area	Not hazardous chemical, dust is main issue	Transport study
42		LEAK	STEAM	Pipe malfunction	Steam release	Regular maintenance	For design and operations management
43		LOSS_OF	WATER SUPPLY	Pipe / supply malfunction	Overheating of furnace with a loss of water supply	steam can be released above the boiler	For operations management
44		LOSS_OF	WATER SUPPLY	IBA isn't cooled	IBA causes fire/explosion/dust explosion	storage of waste water used for the process can accommodate the cooling of IBA if there is a loss of water supply	Site to be provided with on-site storage of cooling water. On-site supply must at minimum be sufficient for a full shutdown. Recommend redundancy with multiple hours of supply on site.
45		FIRE	BAGHOUSE	Heat from flue gas or external fire source	Fire in baghouse	teflon bags covered by a layer of lime and activated carbon, that becomes APCr. Low/negligable risk of fire/explosion due to the low concentration of activated carbon	For operations management
46		EXPLOSION	ACTIVATED CARBON	storage of activated carbon is an explosion risk	dust explosion	overdose so that there is less activated carbon. Rates to be determined to avoid too much activated carbon. Concentration in flue gas system is very low. Temperature monitoring in the silo, if high temperature is detected, nitrogen is released into the silo (nitrogen blanket)	For operations management
47		LOSS_OF	LIME	Pipe burst	Corrosive irritant released. Spilled from storage	Store in accordance to local requirements	For operations management

48	Flue Gas Treatment	SCRUBBER_LEVEL	HIGH	High scrubber level	leakage of sodium hydroxide	Geert will come back to us with hazards	For operations management
49		LOSS_OF	FGT	pipe burst or leaking valve of FGT residue	uncontrolled release of emissions	continual emissions monitoring would shut the plant down	For operations management
50		STORAGE_OF	APCr	if transportation to APCr silos is out of action there are feed bags that can store the APCr until it can be transported	Small spillage of APCr	will have to be cleaned and transported	For operations management
51		LOSS_OF	CONTROL	Catastrophic failure of feed bags	Catastrophic failure of feed bags	can be shut down individually	For operations management
52		LOSS_OF	POWER	site power failure	site power failure	diesel power generator and UPS can be used to keep the plant running. If plant is kept running, the energy will be lost	For operations management
53		LOSS_OF	ID FAN	ID fan loss	plant will shut down or continued operation	reduncancies on motor to avoid immediate shut down	For operations management
54		FGT_RESIDUE	FGT_RESIDUE	corrosion	Leak in pipe	stainless steel is used, no condensation. May need to use fibreglass after the scrubber	For operations management
55		STACK_EMISSIONS	ABOVE REGULATIONS	release of emmissions	hazardous emissions released	continuously monitored by coninuous emission monitoring systems (CEMS), EU regulations dictate the emission levels	For operations management
56		STORAGE_OF	ACTIVATED CARBON	high temperature in silo	dust explosion	ATEX zone and temperature monitoring/nitrogen coverage. Pneumatic sensors and dosing equipment to be ATEX zone/rated	For operations management
57		SCRUBBER_LEVEL	HIGH	High scrubber level	overflow of scrubber	ph between 5and 6, no risk	For operations management
58		STORAGE_OF	HYDROCHLORIC ACID	Pipe burst	Leakage near equiment and flanges	Distribution in double pipes	For design considerations
59		STORAGE_OF	SODIUM HYDROXIDE	Pipe burst	Leakage near equiment and flanges	Distribution in double pipes	For design considerations
60	Water Treatment	LOSS_OF	CONTROL	Storage of sodium hydroxide and hydrochloric acid together	interaction of acid and base	Ensure required separation distances are met	keep up to code requirements for separation distances. Find out about storage requirements and transportation
61	Transformer	FIRE	BUND	oil filled transformer	transformer explosion	Bunded, will meet required design	consequence modelling of worst case scenario
62	Other	UPS_BATTERIES	UPS_BATTERIES	lead acid batteries	hydrogen production	separate room well ventilated, back up exhaust for the room	hydrogen detection system as well
63		UPS_BATTERIES	UPS_BATTERIES	lithium	overloaded and creating a fire	separate room, with battery management system	Ensure mitigation and protection measures are used
64		STORAGE_OF	LIME	brought in as a powder and blown into the silo, hose bursts	spillage of lime	handling of lime and activated carbon can be done in isolation. It is indoors so it is not released into the atmosphere	lime should be stored indoors to avoid loss of dust
65		STORAGE_OF	ACTIVATED CARBON	brought in as a powder and blown into the silo, hose bursts	Dust explosion	Maintenance of equipment	For operations management
66		STORAGE_OF	ACTIVATED CARBON	explosion from spark / self-heatingg	Explosion / fire	temperature monitoring / nitrogen gas supperssion	For further design and operations management
67		CRASH	AIRCRAFT	heat plume above stack	Aircraft crash	Design and operational management	flag it to Maria and Jade, high risk if the flight path is over the site. Plume rise assessment
68		WEATHER	EXTREME RAINFALL	Extreme rainfall	Flooding	Main EfW facility and visitor centre will be located above the 1 in a 100 year event plus a min 300mm freeboard. Site's stormwater network will be designed in accordance local regulations and will shed overland flows away from the buildings.	For design management
69		WEATHER	WIND	Weather	Damage to facility	designed to the relevant standards	For design management

70	Site	WEATHER	LIGHTENING	extreme weather event	lightning hits stack	local lightning protection regulations, is the BCA enough	Check BCA and identify any additional measures
71		WEATHER	LARGE HAIL	Weather	impact on air cooled condenser	no off site impacts	For design management
72		LOSS_OF	APCR	APCr transportation	Release of APCr into the envrironment	spillage will be in a closed environment when it is onsite	defined dangerous goods route to avoid exposure to sensitive receptors (societal and environmental usually flora that causes issues). Understand the possible routes, and Arup to recommend routes. Client may have their own facility for where the APCr ends up
73		SABOTAGE	SABOTAGE	environmental activists and theft of materials	mostly vocal. Risk during construction if protestor is injured	site is secure outside of hours and has security systems during operations	For operations management
74		FIRE	BUND	100 000m3 of diesel	diesel ignition	not a large risk due to the higher flash point	For design management
75		NOISE	NOISE	Lots of movement and fans in ACC	Offensive noise	limit at site boundary as part of the EIS, noise inside can be controlled. ACC is the noisiest thing outside, couuld use low speed low noise fans in the ACC if necessary. General traffic will be assessed	For design and operations management
76		SEPARATION	TRAFFIC	Traffic in facility close together	Public exposure to waste	separating waste traffic going both ways to avoid staff and visitors	Euan to send through new site layout
77		SEPARATION	TRANSFORMER	transformer	Domino effect for transformers	not yet defined on the site layout, transformers that will be in substation are at risk	explosion walls will be put in as necessary. Design details for fuel loads needs to be given for PHA. Consequence modelling for explosion
78		WEATHER	DUST STORM	dust in the facility	dust explosion	increased maintenance as necessary	For operations management
79		WEATHER	EROSION	Weather	erosion below building	Slopes will be designed in accordance with Australian Standards and will be stabilised where required.	For design and operations management

Appendix C

Summary of CASA Plume Rise Assessment

Australian Government
Civil Aviation Safety Authority

Application for Operational Assessment of a Proposed Plume Rise

Proponent Details

Contact Name	Nick Schutt
Company Name	Cleanaway
Address	Level 2, 9 Help St, Chatswood, NSW 2067 Australia
Phone (BH)	+61 407 713 946
Email Address	nick.schutt@cleanaway.com.au
Date Submitted	23/04/2020
File Reference: (CASA use only)	

Details of the Proposed Facility and Prior Consultation

1. Type of facility	Energy from Waste facility
2. Location of the nearest town (direction and distance)	Horsely Park 2.5km South
3. Location of the facility in latitude and longitude (degrees, minutes, seconds)	33°49'08"S 150°51'13"E
4. Proximity to any other existing or planned facility that generates a plume rise (if known)	Austral Bricks Plants 1, 2 and 3, and the PGH Bricks facility are ~1km, 1.8km, 2.4km, and 2.8km respectively.
5. Distance to the nearest aerodrome or landing area incl. helicopter landing sites	~14 km (Western Sydney Airport) ~16.5 km (Bankstown Airport)
6. Height of the stack or tallest structure at the site above ground level (AGL)	75.6m
7. Elevation of the location of the facility above mean sea level (AMSL)	61.6m
8. Date the facility will commence operation	Estimated 2025
9 A. For single stacks: ▪ Stack exit velocity (metres per second) ▪ Stack exit temperature (degrees Celsius) ▪ Stack radius (metres) ▪ Stack height (metres above ground level)	Between 14.6 and 23.6m/s Between 57.85 and 63.85 degrees Celsius Minimum of 3.5m radius. There are two flues in the stack with 2m diameter each. The two flues are wrapped up into one stack. Stack is min 7m outer diameter. 75.6m

9 B. For multiple stacks please give median, mean and range for each parameter: ▪ Stack separation distance (metres) ▪ Stack exit velocity (metres per second) ▪ Stack exit temperature (degrees Celsius) ▪ Stack radius (metres) ▪ Stack height (metres above ground level)	Not Applicable
9 C. For facilities with multiple configurations please give the parameters for the worst case scenario: ▪ Stack separation distance (metres) ▪ Stack exit velocity (metres per second) ▪ Stack exit temperature (degrees Celsius) ▪ Stack radius (metres) ▪ Stack height (metres above ground level)	Not Applicable
9 D. For facilities with multiple configurations please give the parameters for the normal operating scenario: ▪ Stack separation distance (metres) ▪ Stack exit velocity (metres per second) ▪ Stack exit temperature (degrees Celsius) ▪ Stack radius (metres) ▪ Stack height (metres above ground level)	Not Applicable
10. Details of any prior consultation with: ▪ CASA ▪ Dept of Defence ▪ Aerodrome Operator ▪ Other relevant party	Prior engagement and initial discussion with CASA (David Alder) in 2019 about Western Sydney Airport airspace and the defined OLS and PAN-OPS in relation to the current proposal (SSD-10395).

Submitted By:

Name: Nate Lobel		Signature: [signature]	
Contact Phone:	+61 432 295 521		
Email Address:	nate.lobel@arup.com	Date:	23/04/2020

Air Navigation, Airspace and Aerodromes

File Ref: F18/3018-7

26/04/2020

Nate Lobel
Senior Engineer Fire Engineering
Arup
By Email:
Nate.Lobel@arup.com

Dear Mr. Lobel,

PLUME RISE – ENERGY FROM WASTE FACILITY

CASA has assessed the plume predicted for the proposed stack.

Location:
339 Wallgrove Road, Eastern Creek
33° 49' 08" S
150° 51' 13" E

Aviation Facilities in Vicinity:

Western Sydney Aerodrome: The plume site is approximately 12.8 km north east from the future runway threshold 23 and close to the future runway 05/23 extended centreline.

The Western Sydney Aerodrome operator would be able to advise on the Obstacle Limitation Surfaces (OLS) at the site. A rough estimate is that the critical surface would be the Approach Surface at approximately 223m AHD. (The stack site would be close to the lateral limit of the Outer Horizontal Surface for Western Sydney Aerodrome at approximately 230.5m AHD).

Bankstown Aerodrome: The plume site is 16.5 km north west from the runway threshold 11C and very approximately 1.6 km offset north east from the runway 11C/29C extended centre line. The plume site is outside the lateral limit of the Obstacle Limitation Surfaces.

Plume

Parameters for Proposed Stack:

Number of stacks 1 (refer below)

Stack Separation: refer below

Exit velocity = Between 14.6 and 23.6 m/s

Stack diameter = 2.82m (equivalent area)

Stack height = 75.6m AGL is approximately 137m AHD

Temperature = Between 57.85° C and 63.85° C

The 2 x 2m ø flues within the stack would have an area of 6.28m^2 which is an approximately equivalent diameter of 2.82m.

Using the CASA screening tool, at the worst-case scenario of max temperature and max velocity and 2 flues running at full duty (100% capacity), the plume reduces to:

10.6 m/s at approximately 12m above the stack top or approximately 88m AGL (~149m AHD)

6.1 m/s at approximately 24m above the stack top or approximately 99m AGL (~161m AHD)

4.3 m/s at approximately 40m above the stack top or approximately 116m AGL (~177 AHD)

Discussion

The site is under approach and departure zones. Considering the distance from the Western Sydney Airport, 6.1 m/sec would be an appropriate critical velocity in this case. The proposed plume dissipates to 6.1 m/sec at approximately 161m AHD which is under the approach surface for future Western Sydney runway 23 by approximately 60m.

Based on the information presented and assumed, there will not be an infringement of an OLS for Western Sydney Airport. CASA recommends that an Acceptable Level of Safety will be achieved.

This assessment does not cover potential effects on Instrument Flight Procedures, Communication and Navigation systems, visibility or Air Traffic Management etc which are issues for Airservices Australia to consider. And this assessment only covers plume rise dynamic aspects and does not cover other environmental, town planning or airport planning aspects such as bird control, pollution or noise.

Yours sincerely,

David Alder

David Alder
Aerodrome Engineer

Cc:
kosborne@wsaco.com.au
airport.developments@AirservicesAustralia.com
By Email

Appendix D

Airservices Correspondence

From: Nate Lobel
Sent: Friday, 22 May 2020 10:26 AM
To: Maria Caruda; Michael D'Souza
Subject: FW: Airservices Response: YSSW-MA-003 - Plume Rise, 339 Wallgrove Rd, Eastern Creek [SEC=UNOFFICIAL]

Feedback from AirServices is all positive.

Think we should loop this into the PHA.

Kind Regards,

Nate Lobel
Senior Engineer | Fire Engineering
BSc (ChE) MSc (Fire) MIEAust CPEng NER
***Make flexibility work** – if you receive an email from me outside of normal business hours, it's because I am sending it at a time that suits me. I am not expecting you to read it or reply until your own business hours.*

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From: Airport Developments <Airport.Developments@AirservicesAustralia.com>
Sent: Friday, 22 May 2020 10:23 AM
To: Nate Lobel <Nate.Lobel@arup.com>
Cc: Airspace Protection <Airspace.Protection@casa.gov.au>
Subject: [External] Airservices Response: YSSW-MA-003 - Plume Rise, 339 Wallgrove Rd, Eastern Creek [SEC=UNOFFICIAL]

Hi Nate,

I refer to your request for an Airservices assessment of a **plume rise at 339 Wallgrove Rd, Eastern Creek (33°49'08"S 150°51'13"E).**

Airspace Procedures

With respect to procedures designed by Airservices in accordance with ICAO PANS-OPS and Document 9905, at heights of **137.2m (451ft) and 177m (581ft) AHD** the exhaust stack and the plume rise respectively will not affect any sector or circling altitude, nor any instrument approach or departure procedure at Sydney, Bankstown, Camden and Richmond aerodromes or Westmead Hospital heliport.

The plume rise and exhaust stack will not affect Sydney RTCC.

Note: procedures not designed by Airservices at Sydney, Bankstown, Camden, Richmond aerodromes and Westmead Hospital heliport were not considered in this assessment. The plume rise height was based on a plume rise velocity of 4.3m/s.

Communications/Navigation/Surveillance (CNS) Facilities

This proposal will not adversely impact the performance of any Airservices Precision/Non-Precision Nav Aids, Anemometers, HF/VHF/UHF Comms, A-SMGCS, Radar, PRM, ADS-B, WAM or Satellite/Links.

Summary

Airservices have no objections to the proposed plume rise at the above location.

Kind Regards,

John Graham

WORKING FROM HOME
Airport Development Applications Coordinator
Airservices Australia

t 0439 385 472
e John.Graham@airservicesaustralia.com

From: Airport Developments
Sent: Thursday, 30 April 2020 9:18 AM
To: Nate Lobel <Nate.Lobel@arup.com>
Subject: YSSW-MA-003 - Plume Rise, 339 Wallgrove Rd, Eastern Creek [SEC=UNOFFICIAL]

Hi Nate,

I have received your proposal and commenced the Airservices assessment, which takes approximately 6 weeks for completion.

If you have any questions, please contact the Airport Developments team and quote assessment code: YSSW-MA-003.

Please note that all completed Airservices assessments are also forwarded to CASA.

Kind Regards,

John Graham

WORKING FROM HOME
Airport Development Applications Coordinator
Airservices Australia

t 0439 385 472
e John.Graham@airservicesaustralia.com

From: Nate Lobel <Nate.Lobel@arup.com>
Sent: Thursday, 23 April 2020 4:08 PM
To: CASA OAR <oar@casa.gov.au>; david.alder@casa.gov.au; Airport Developments <Airport.Developments@AirservicesAustralia.com>; kosborne@wsaco.com.au
Cc: Maria Caruda <Maria.Caruda@arup.com>; Michael D'Souza <Michael.DSouza@arup.com>; Nigel Cann <Nigel.Cann@arup.com>
Subject: Plume Rise Assessment - Energy from Waste Facility

Dear All,

Arup is working on behalf of Macquarie Capital and Cleanaway on the EIS for the Western Sydney Energy Resource Recovery Centre (WSERRC) proposed for 339 Wallgrove Road, Eastern Creek (Application number SSD-10395, https://www.planningportal.nsw.gov.au/major-projects/project/25896). The project is currently in the planning and early design phase and we are preparing the EIS for submission in the coming months.

I am leading the Hazard and Risk assessment (Preliminary Hazard Assessment/PHA under SEPP33) which has been identified in the SEARs as one of the key issues to be addressed in the EIS. The SEARs also ask that in preparing the EIS, we consult with relevant agencies, including CASA, AirServices Australia, and WSACo.

The Hazard and Risk assessment (PHA) has noted the following pertaining to each agency:

- The anticipated plume rise has an exit velocity exceeding 6.1m/s and may thus pose a societal or individual risk to aircraft. We have therefore completed Form 1247 (Application for Operational Assessment of a Proposed Plume Rise) and it can be found attached.
- The NASF has been reviewed and guidelines C and D addressed below:
    - C: The site is located outside the 13km radius considered in the risk matrix concerning attracting wildlife in Attachment 1 of Guideline C
    - D: The RAAF AIS should be notified of any structure 45m or more above ground level, however according to CASA AC 139-08 Reporting of tall structures and hazardous plume sources, AirServices is now responsible for the database of tall structures. The stack for the development would be 75m above ground level which triggers this notification.

We would be happy to discuss the assessment with you further to understand any additional requirements not specified in the SEARs of relevance to your agency and to update you on the assessment.

Please let me know if you would like a follow up discussion or any further information.

Kind Regards,

Nate Lobel
Senior Engineer | Fire Engineering
BSc (ChE) MSc (Fire) MIEAust CPEng NER
***Make flexibility work** – if you receive an email from me outside of normal business hours, it's because I am sending it at a time that suits me. I am not expecting you to read it or reply until your own business hours.*

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Appendix E

WSA Co Correspondence

From: Kirk Osborne <kosborne@wsaco.com.au>
Sent: Thursday, 28 May 2020 4:24 PM
To: Michael D'Souza
Cc: Nate Lobel; Brian Cullinane; Maria Caruda
Subject: [External] [DLM=OFFICIAL] RE: WSERRC PHA correspondence with WSA Co

OFFICIAL

Michael

Thanks for sending through the email.

As discussed WSA understands that the SSD application will address the aviation safety and hazard issues noted below. For clarification in relation to the OLS and PANS-OPS, as noted there is no PANS-OPS designed yet for WSA and whilst we think it likely that that the PANS-OPS surface will be at or higher than the OLS levels, this won't be known until the detailed airspace design is completed by the Commonwealth. The currently declared protected airspace for WSA is the OLS.

WSA will review the development application documentation in detail once the application is on public exhibition and will make a formal submission at this time.

Regards

Kirk Osborne
Lead Town Planner | Airport Planning

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kosborne@wsaco.com.au
PO Box 397 Liverpool NSW 1871

Western Sydney Airport

OFFICIAL

From: Michael D'Souza <Michael.DSouza@arup.com>
Sent: Wednesday, 27 May 2020 5:02 PM
To: Kirk Osborne <kosborne@wsaco.com.au>
Cc: Nate Lobel <Nate.Lobel@arup.com>; Brian Cullinane <brian@emeadvisory.com>; Maria Caruda <Maria.Caruda@arup.com>
Subject: WSERRC PHA correspondence with WSA Co

Hello Kirk,

Thanks for your time last week. To confirm our discussion from Friday:

- OLS height at 339 Wallgrove Rd Eastern Creek is 222m. As per the CASA assessment, the plume is expected to reach 4.3m/s at 177 AHD and therefore the stack and plume will not intrude into the protected airspace of WSA. The OLS is in the process of being updated, but this is not expected to significantly change the elevation at the edge of the surface. We also understand that the PANS-OPS to be established will be higher than the OLS.

- How will the facility manage wildlife attraction to avoid bat and bird strikes?
    - The entire process is enclosed with an inward pressure gradient used in the areas where waste is unloaded and kept
    - Activated carbon filters will be used to filter the odour in times of shutdown to reduce the risk of wildlife attraction further
    - Stormwater will be transitioned to underground stormwater detention
    - Boundary planting will replace the current landscaping
- How will the stack be managed from a safety perspective?
    - The stack will be lit in accordance with chapter 5 and 6 of the FAA's Advisory Circular 70/7460-1L: Obstruction Marking and Lighting

If you could confirm that you're satisfied with the above for this early stage and that we've appropriately engaged with you as a stakeholder for this phase of the project it would be much appreciated. We do note obviously the design is still being developed and the PHA will be published as part of the EIS in the coming months.

Please let me know if you have anything you'd like to add to the above, or if you have any further questions.

Kind Regards,

Michael D'Souza
Risk Consultant | Resilience, Security & Risk

Arup
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Appendix F

Flue Gas Treatment Residue Dispersion

TODOROSKI AIR SCIENCES
Suite 2B, 14 Glen Street Eastwood, NSW 2122
Phone: 02 9874 2123
Fax: 02 9874 2125
Email: info@airsciences.com.au
Web: www.airsciences.com.au
ACN: 151 202 765 | ABN: 74 955 076 914

31 August 2020

Rebecca Dixon
Partner
Ashurst Australia
Via email: rebecca.dixon@ashurst.com

DRAFT RE: WSERRC – FGTr dispersion modelling

Dear Rebecca,

Thank you for engaging Todoroski Air Sciences (TAS) to conduct an investigation into the dispersion of flue gas treatment residue (FGTr) following the release from a truck incident offsite.

Methodology

The dispersion of FGTr was estimated using a conservative, screening level model. This involved the use of the US EPA air dispersion screening model (SCREEN3) to determine how far FGTr can realistically disperse under adverse conditions. The modelling included analysis for a full range meteorological conditions to estimate the worst impact on any direction.

Dust emissions were represented by a square area source. Two source sizes were assumed, for an area ranging from 25 square metres (m^2) to $49m^2$ and a source height of 2m, (representing approximately half or all of the truck contents spilling).

The size data for the FGTr indicates that it is predominantly in the size fraction for particulate matter 10 micrometres or less in diameter (PM_{10}), hence the emission rate was calculated assuming a wind erosion emission factor for PM_{10} of 425 kilograms per hectare per year (kg/ha/yr) sourced from the US EPA AP42 Emission Factors (**US EPA 1998**). Generally higher wind speeds correspond with higher emissions but also better dispersion. In this study, high rates of emissions were assumed to occur under all wind conditions (irrespective of the wind conditions which may have nil or low emissions). The emission rate modelled was increased as a cube of the wind speed, and a value equal to the average rate in any hour of the year plus two standard deviations was used. This approach is highly conservative in combination with the conservatism already inherent in the SCREEN3 model.

This study considered the composition of FGTr from the Dublin Energy-from-Waste (EfW) to determine the composition of toxic substances in the FGTr. **Table 1** below presents the composition of toxic substances in the FGTr which have been applied. The modelling results were compared with the US Protective Action Criteria (PAC) for the toxic substances in the FGTr.

The PAC are short-term exposure criteria applied by emergency responders to protect the public from health effects. The PAC-1 criteria adopted in this study represent concentrations at which individuals may experience mild and transient health effects. The PAC levels are based on the corresponding AEGL, ERPG, or TEEL value and give preference to guidelines based on the strongest evidence. Note that the PAC-1 criteria are 1-hour averages, however, it has been assumed that the release of any FGTr would be responded to and dust suppression (light sprinkling) applied within 30 minutes.

Table 1: Composition of toxic substances in the FGTr

Pollutant	Composition of toxic substances (%)
Chloride	14.9
Sulphate	1.94
Fluoride	0.01
Mercury (non volatile)	0.0005
Antimony	0.05
Arsenic	0.0037
Barium	0.06
Cadmium	0.01
Chromium	0.01
Cobalt	0.0018
Copper	0.05
Lead	0.12
Manganese	0.06
Molybdenum	0.0012
Nickel	0.01
Selenium	0.0004
Thallium	0.0001
Tin	0.03
Vanadium	0.01
Zinc	0.81

Results

Table 2 below presents a summary of the maximum concentrations and distance to the maximum impact. The composition of toxic substances in the FGTr have been applied to the maximum concentrations and compared with the PAC-1 criteria in **Table 3.**

Figure 1 below graphically presents the concentration of total FGTr at various distances. Note that the individual toxic substances are a small component of the total level presented.

Table 2: Summary of SCREEN3 results

Parameter	Value	
Area (m^2)	25	50
Emission rate ($g/m^2/s$)	6.82E-06	6.82E-06
distance to maximum impact (m)	20	21
Maximum concentration (mg/m^3)	0.006	0.010

Table 3: Summary of SCREEN3 results for toxic substances

Pollutant	Maximum concentration (mg/m^3)		PAC-1 (mg/m^3)	% of Criteria[1]
	25m^2 Area	50m^2 Area		
Chloride	4.30E-04	7.25E-04	1.4_A[2]	5.18E-02
Sulphate	5.60E-05	9.44E-05	0.013[3]	7.26E-01
Fluoride	1.72E-07	2.89E-07	2.6_A[4]	1.11E-05
Mercury (non volatile)	1.32E-08	2.23E-08	1.5[5]	1.49E-06
Antimony	1.57E-06	2.64E-06	1.5	1.76E-04
Arsenic	1.06E-07	1.79E-07	1.5	1.19E-05
Barium	1.87E-06	3.15E-06	1.5	2.10E-04

Pollutant	Maximum concentration (mg/m^3)		PAC-1 (mg/m^3)	% of Criteria[1]
	25m² Area	50m² Area		
Cadmium	4.15E-07	6.99E-07	$0.1_A{}^6$	6.99E-04
Chromium	2.13E-07	3.60E-07	1.5	2.40E-05
Cobalt	5.23E-08	8.83E-08	0.18	4.90E-05
Copper	1.52E-06	2.57E-06	3	8.56E-05
Lead	3.58E-06	6.03E-06	0.15	4.02E-03
Manganese	1.59E-06	2.69E-06	3	8.95E-05
Molybdenum	3.40E-08	5.73E-08	30	1.91E-07
Nickel	1.92E-07	3.24E-07	4.5	7.21E-06
Selenium	1.14E-08	1.93E-08	0.6	3.22E-06
Thallium	3.10E-09	5.23E-09	0.06	8.72E-06
Tin	9.35E-07	1.58E-06	6	2.63E-05
Vanadium	2.65E-07	4.46E-07	3	1.49E-05
Zinc	2.34E-05	3.94E-05	6	6.57E-04

[1]Using the maximum concentration from both modelled areas.
[2]PAC-1 criterion corresponds to 1-hour AEGL-1 criteria for chlorine.
[3]PAC-1 criterion sourced from vanadium sulphate.
[4]PAC-1 criterion corresponds to 1-hour AEGL-1 criteria for fluorine.
[5]PAC-1 criterion sourced from mercury oxide.
[4]PAC-1 criterion corresponds to 1-hour AEGL-1 criteria for cadmium.

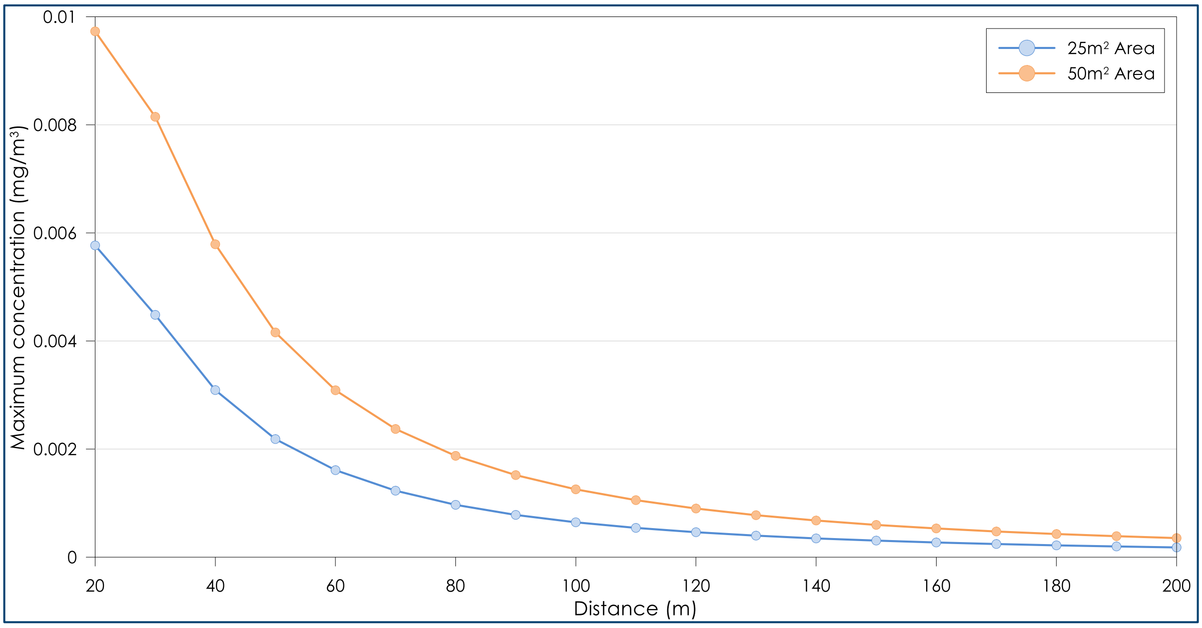


Figure 1: Concentrations of total FGTr at distances

Conclusion

The results show that no impact would occur from any release of FGTr in the event of a truck incident offsite. It is expected that the maximum impact would occur at an approximate distance of 20m and would decrease to negligible levels further away.

The composition of toxic substances in the FGTr was considered and no impacts for these substances was identified compared to the available PAC-1 criteria for the toxic substances.

Please feel free to contact me on any aspect of this analysis.

Yours faithfully,
Todoroski Air Sciences

Ellie McDougall

Aleks Todoroski

References

US EPA (1998)

"AP42: Compilation of Air Emission Factors, Chapter 11.9 Western Surface Coal Mining", United States Environment Protection Authority, October 1998.

Appendix G

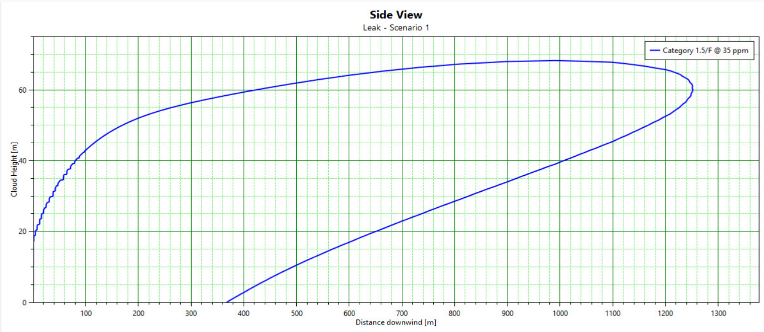
Ammonium Hydroxide Consequence Modelling Contours

Scenario 1

Orifice	60.6	mm
Release	0.783	kg/s

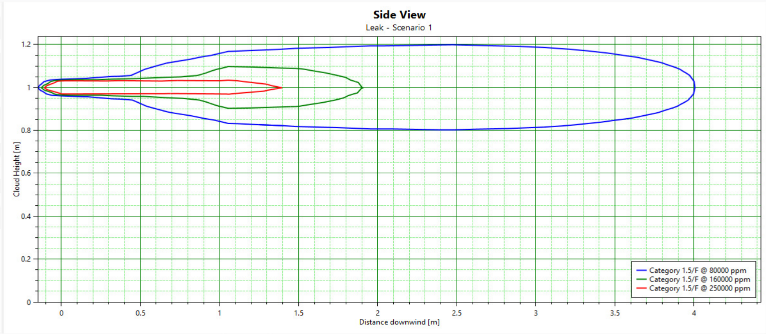
Toxic

Audit Number	804
Averaging time	STEL (900 s)
Equipment	Pressure vessel
Spacing parameter for the grid in the x dimension	0.1
Material	AMMONIA
Material to track	AMMONIA
Offset from Centerline	0 m
Program	Phast 8.22
Scenario	Leak - Scenario 1
View Time	3600 s
Weather	Category 1.5/F
Workspace	PhastConsequence



Flammable

Audit Number	810
Averaging time	Flammable (18.75 s)
Equipment	Pressure vessel
Spacing parameter for the grid in the x dimension	0.1
Material	AMMONIA
Material to track	AMMONIA
Offset from Centerline	0 m
Program	Phast 8.22
Scenario	Leak - Scenario 1
View Time	3600 s
Weather	Category 1.5/F
Workspace	PhastConsequence

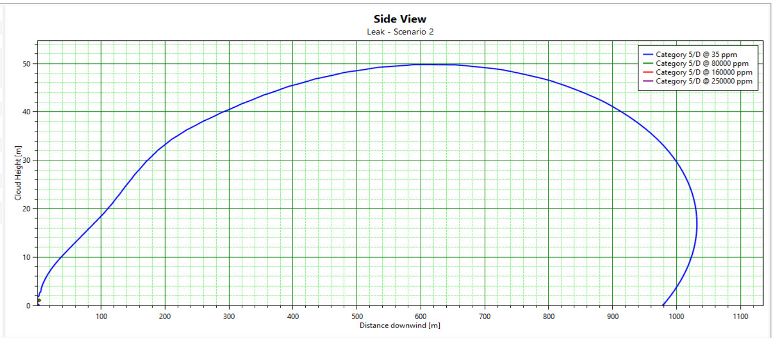


Scenario 2

Orifice	96.85	mm
Release	2.00	kg/s

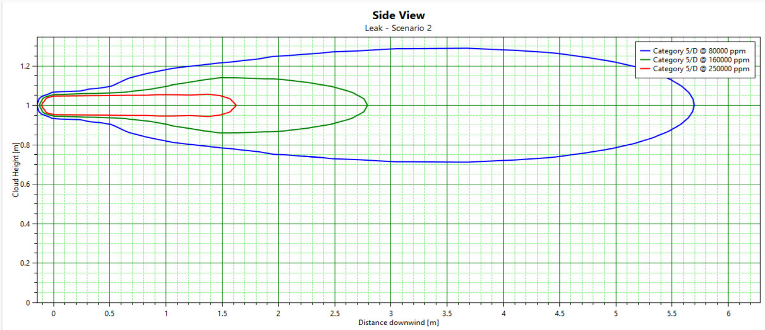
Toxic

Audit Number	804
Averaging time	STEL (900 s)
Equipment	Pressure vessel
Spacing parameter for the grid in the x dimension	0.1
Material	AMMONIA
Material to track	AMMONIA
Offset from Centerline	0 m
Program	Phast 8.22
Scenario	Leak - Scenario 2
View Time	3600 s
Weather	Category 5/D
Workspace	PhastConsequence



Flammable

Audit Number	810
Averaging time	Flammable (18.75 s)
Equipment	Pressure vessel
Spacing parameter for the grid in the x dimension	0.1
Material	AMMONIA
Material to track	AMMONIA
Offset from Centerline	0 m
Program	Phast 8.22
Scenario	Leak - Scenario 2
View Time	3600 s
Weather	Category 5/D
Workspace	PhastConsequence

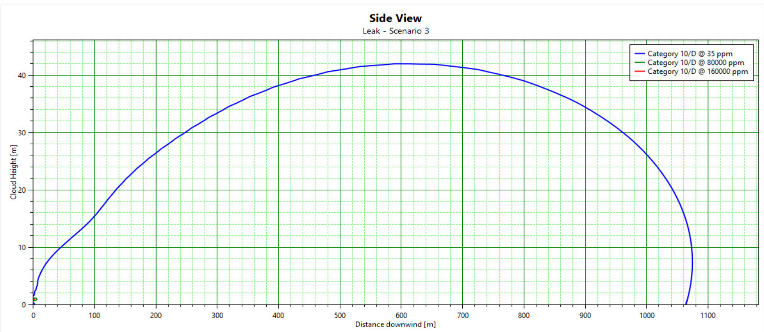


Scenario 3

Orifice	126.65	mm
Release	3.42	kg/s

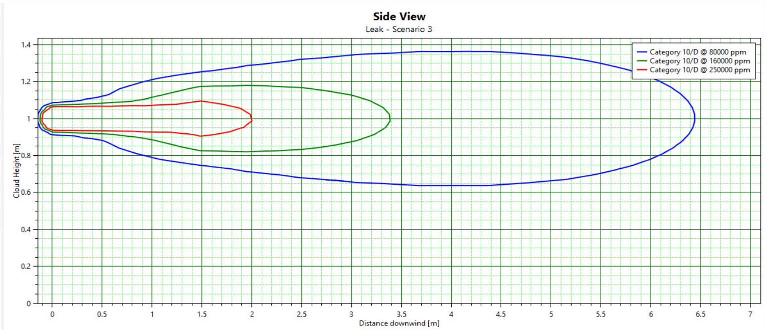
Toxic

Audit Number	804
Averaging time	STEL (900 s)
Equipment	Pressure vessel
Spacing parameter for the grid in the x dimension	0.1
Material	AMMONIA
Material to track	AMMONIA
Offset from Centerline	0 m
Program	Phast 8.22
Scenario	Leak - Scenario 3
View Time	3600 s
Weather	Category 10/D
Workspace	PhastConsequence



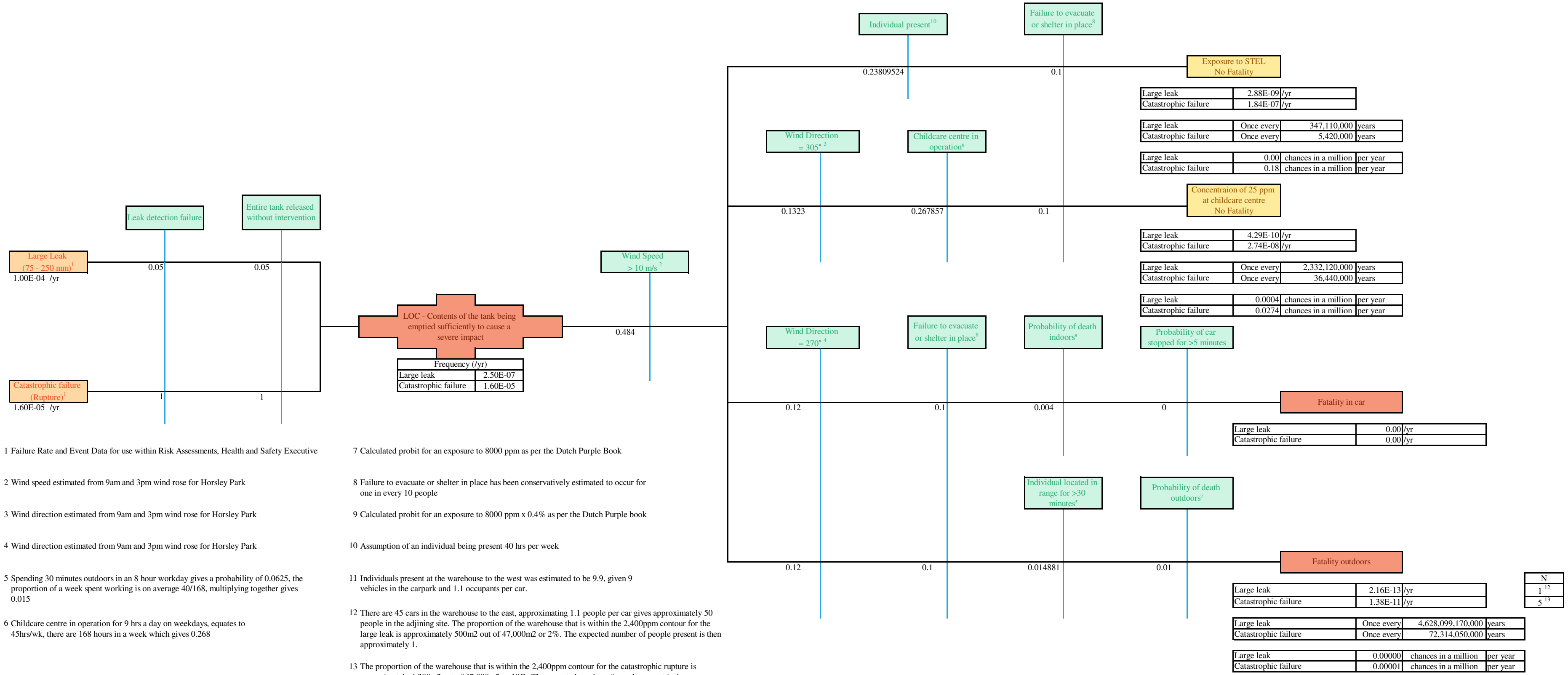
Flammable

Audit Number	810
Averaging time	Flammable (18.75 s)
Equipment	Pressure vessel
Spacing parameter for the grid in the x dimension	0.1
Material	AMMONIA
Material to track	AMMONIA
Offset from Centerline	0 m
Program	Phast 8.22
Scenario	Leak - Scenario 3
View Time	3600 s
Weather	Category 10/D
Workspace	PhastConsequence



Appendix H

TBDs for Consequence Models



Exposure to STEL – No Fatality

Large leak	2.88E-09	/yr
Catastrophic failure	1.84E-07	/yr

Large leak	Once every	347,110,000	years
Catastrophic failure	Once every	5,420,000	years

Large leak	0.00	chances in a million	per year
Catastrophic failure	0.18	chances in a million	per year

Concentraion of 25 ppm at childcare centre – No Fatality

Large leak	4.29E-10	/yr
Catastrophic failure	2.74E-08	/yr

Large leak	Once every	2,332,120,000	years
Catastrophic failure	Once every	36,440,000	years

Large leak	0.0004	chances in a million	per year
Catastrophic failure	0.0274	chances in a million	per year

Fatality in car

Large leak	0.00	/yr
Catastrophic failure	0.00	/yr

Fatality outdoors

Large leak	2.16E-13	/yr
Catastrophic failure	1.38E-11	/yr

N
1 [12]
5 [13]

Large leak	Once every	4,628,099,170,000	years
Catastrophic failure	Once every	72,314,050,000	years

Large leak	0.00000	chances in a million	per year
Catastrophic failure	0.00001	chances in a million	per year

1 Failure Rate and Event Data for use within Risk Assessments, Health and Safety Executive

2 Wind speed estimated from 9am and 3pm wind rose for Horsley Park

3 Wind direction estimated from 9am and 3pm wind rose for Horsley Park

4 Wind direction estimated from 9am and 3pm wind rose for Horsley Park

5 Spending 30 minutes outdoors in an 8 hour workday gives a probability of 0.0625, the proportion of a week spent working is on average 40/168, multiplying together gives 0.015

6 Childcare centre in operation for 9 hrs a day on weekdays, equates to 45hrs/wk, there are 168 hours in a week which gives 0.268

7 Calculated probit for an exposure to 8000 ppm as per the Dutch Purple Book

8 Failure to evacuate or shelter in place has been conservatively estimated to occur for one in every 10 people

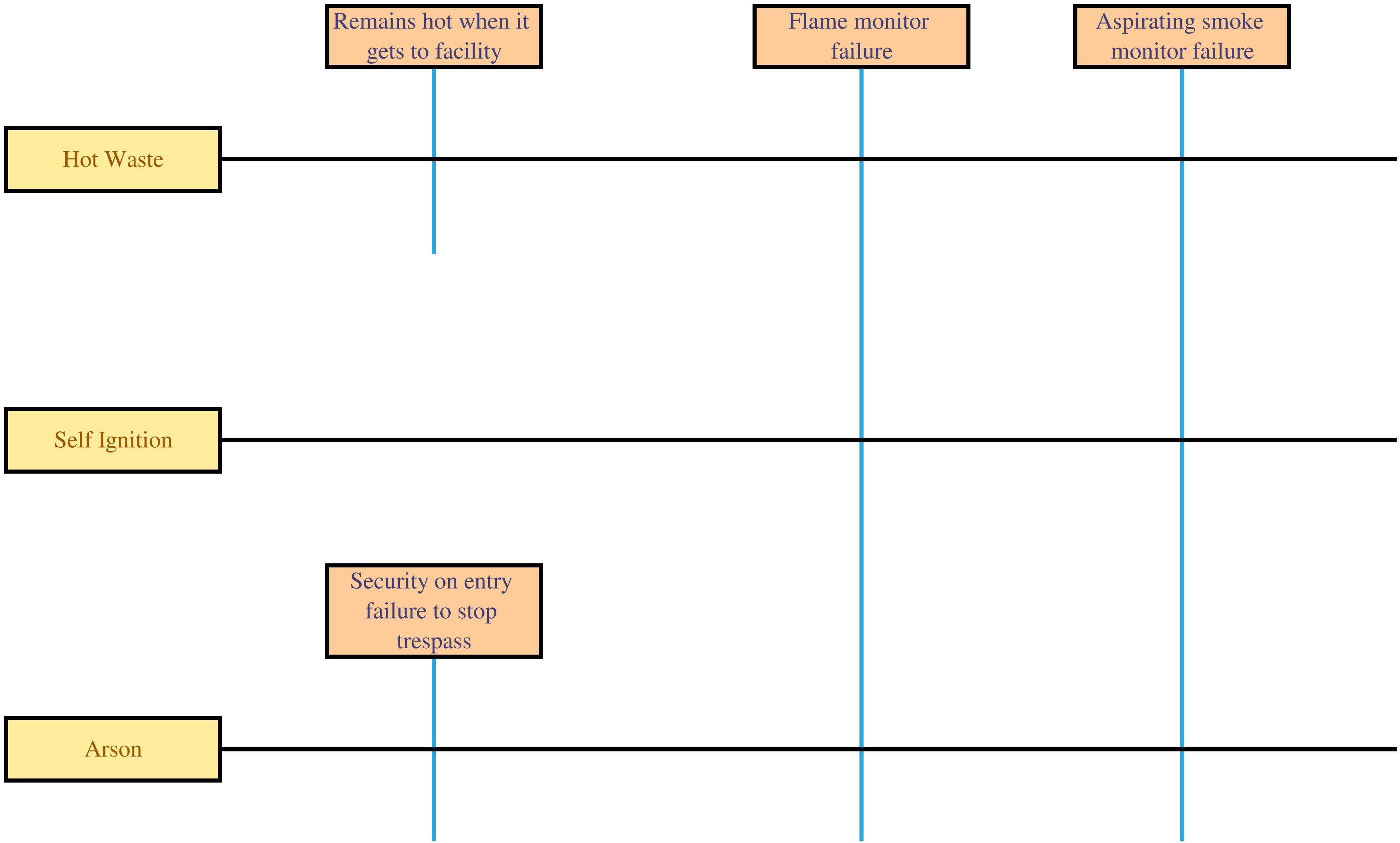
9 Calculated probit for an exposure to 8000 ppm x 0.4% as per the Dutch Purple book

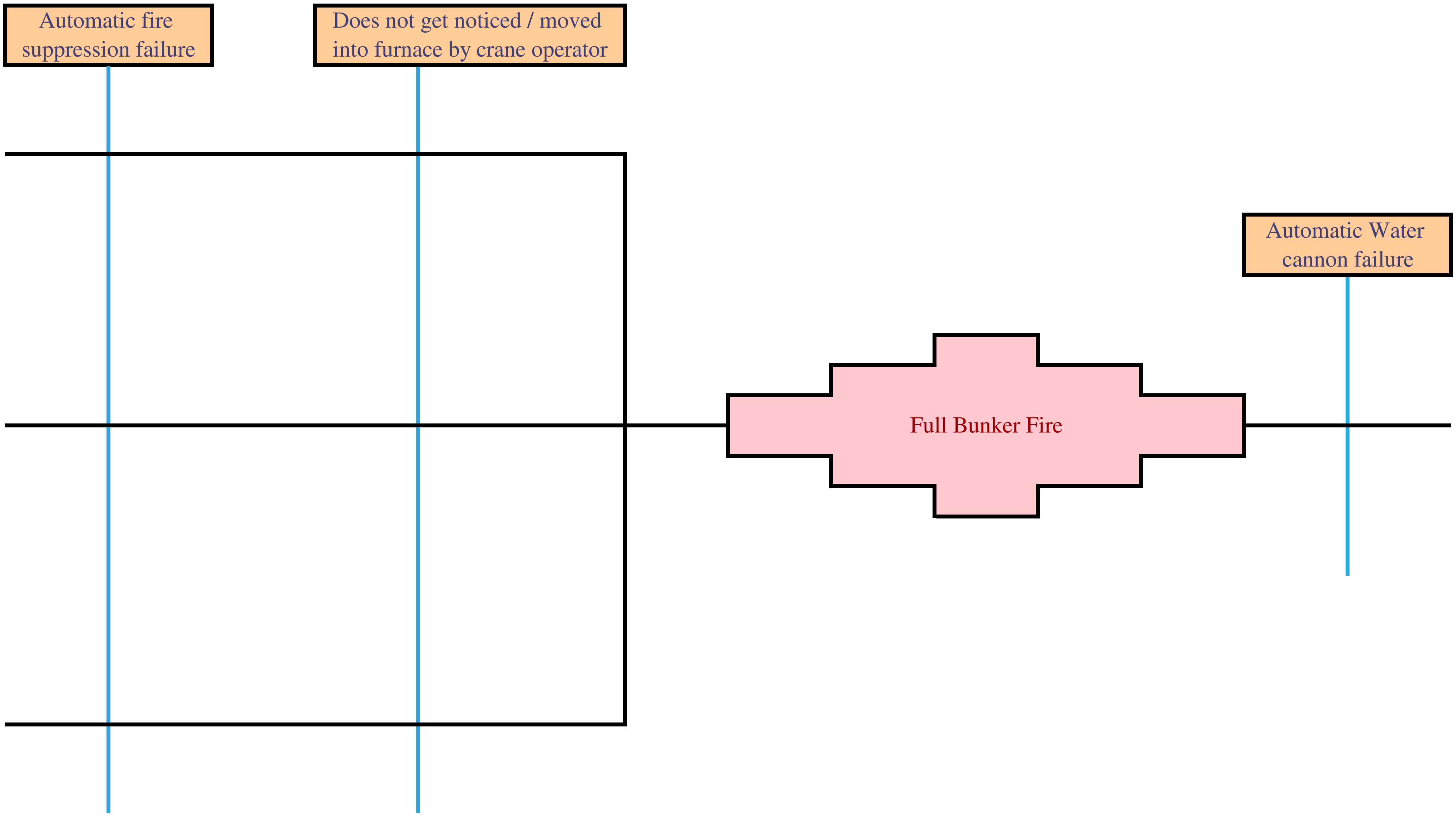
10 Assumption of an individual being present 40 hrs per week

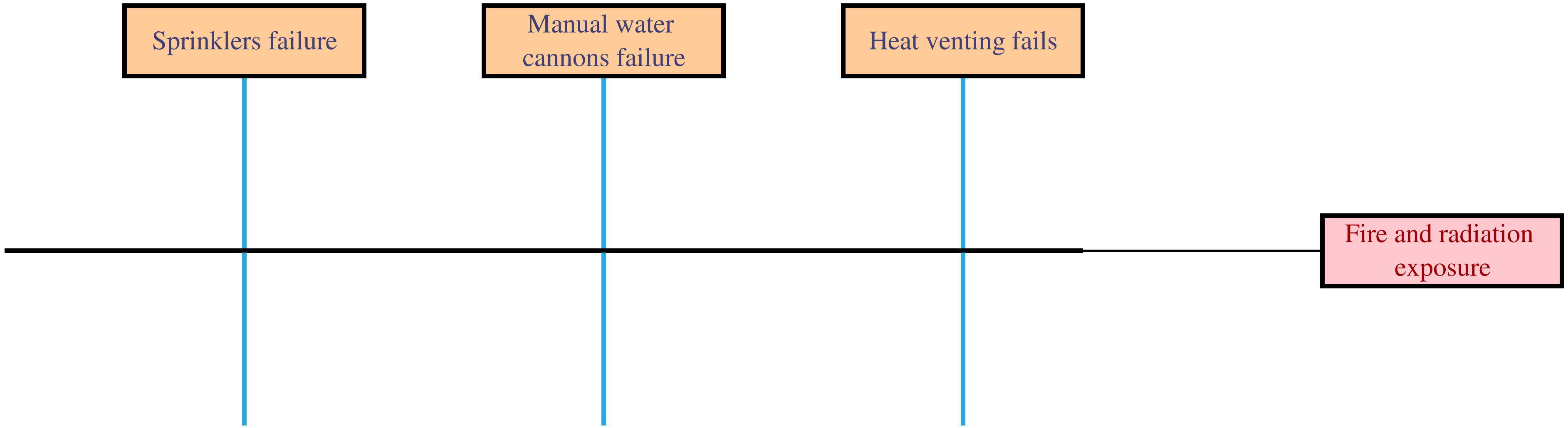
11 Individuals present at the warehouse to the west was estimated to be 9.9, given 9 vehicles in the carpark and 1.1 occupants per car.

12 There are 45 cars in the warehouse to the east, approximating 1.1 people per car gives approximately 50 people in the adjoining site. The proportion of the warehouse that is within the 2,400ppm contour for the large leak is approximately 500m2 out of 47,000m2 or 2%. The expected number of people present is then approximately 1.

13 The proportion of the warehouse that is within the 2,400ppm contour for the catastrophic rupture is approximately 4,300m2 out of 47,000m2 or 10%. The expected number of people present is then approximately 5.


Remains hot when it gets to facility
Flame monitor failure
Aspirating smoke monitor failure
Hot Waste
Self Ignition
Security on entry failure to stop trespass
Arson


Automatic fire suppression failure
Does not get noticed / moved into furnace by crane operator
Automatic Water cannon failure
Full Bunker Fire


Sprinklers failure
Manual water cannons failure
Heat venting fails
Fire and radiation exposure