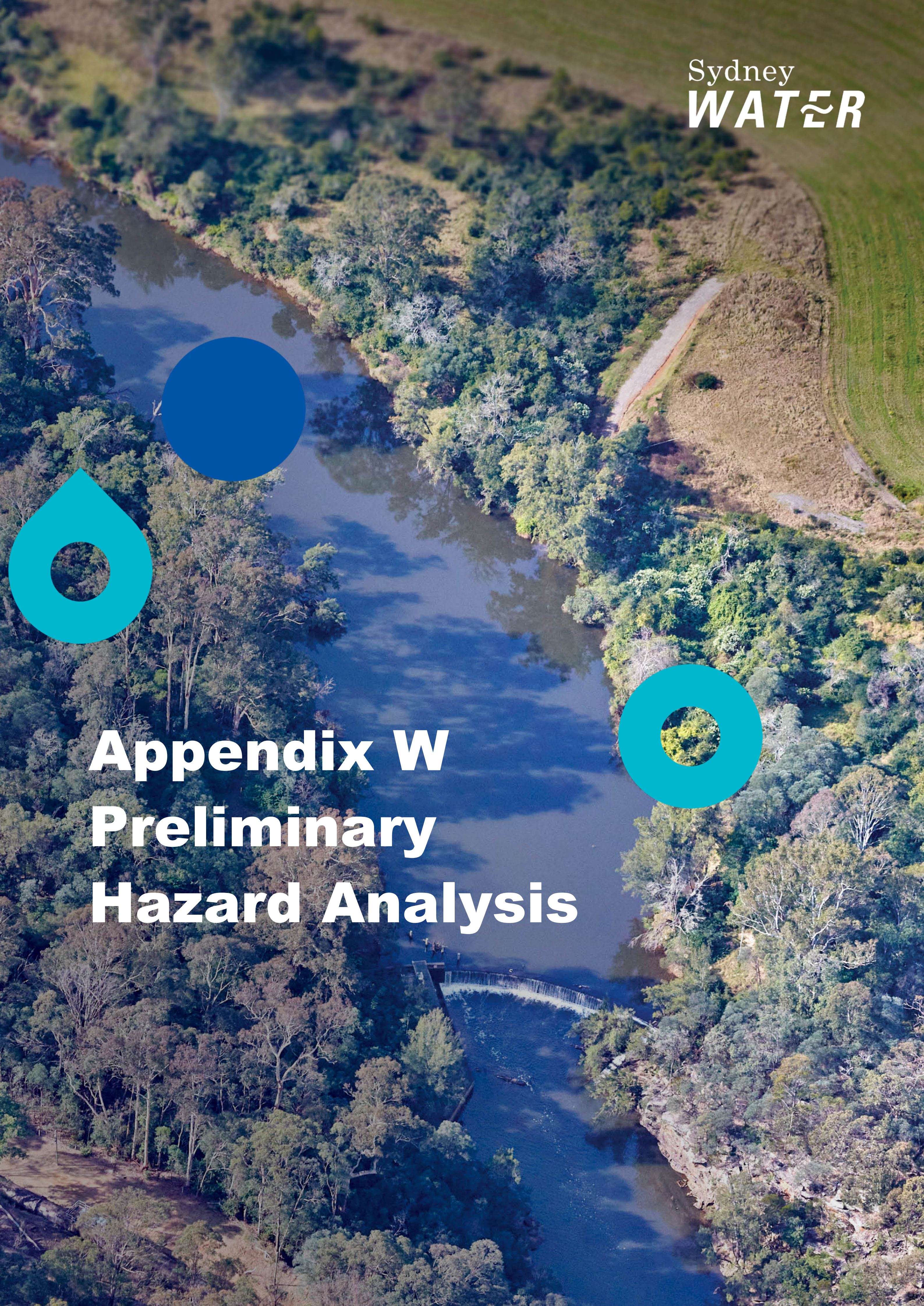

Sydney WATER

# Appendix W Preliminary Hazard Analysis

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# Upper South Creek Advanced Water Recycling Centre

Preliminary Hazard Analysis

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# Table of Contents

**Figures**



**Tables**

# 1 Executive summary

## 1.1 Background

Sydney Water is planning to build and operate new wastewater infrastructure to service the South West and Western Sydney Aerotropolis Growth Areas. The proposed development will include a wastewater treatment plant in Western Sydney, known as the Upper South Creek Advanced Water Recycling Centre (AWRC). Together, this Water Recycling Centre and the associated treated water and brine pipelines, will be known as the ‘project’. The AWRC involves the use of biogeneration of methane. It will also use a variety of dangerous goods and is the subject of this Preliminary Hazard Analysis (PHA). An overview of the location of the proposed infrastructure is provided in Figure 2-1.

## 1.2 Methodology

The Preliminary Hazard Analysis has been prepared in accordance with the guidelines set out by NSW Department of Planning, Industry and Environment’s (DPIE’s) Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 – *Hazard Analysis* [1]. The level of risk assessment was determined from NSW DPIE’s *Multi-level Risk Assessment* [2] and a level 2 – partially quantitative analysis was carried out. A list of hazardous substances stored and used at the facility was compiled and screened according to NSW DPIE’s *Applying SEPP 33* [3]. Hazardous products resulting from the process were also identified and the offsite impact analysed.

Threat-barrier diagrams (TBDs) were developed to help formulate scenarios and causes for the hazardous events to occur. As per 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* [4]. Recommendations have been made against each of the identified hazards to ensure that the residual risks have been reduced So Far as is Reasonably Practicable (SFAIRP) in accordance with *Work Health and Safety Regulations* [5] and to reduce risk wherever practicable in accordance with the principles of HIPAP 4.

## 1.3 Hazards and consequences

It has been identified that the most credible onsite hazards with the potential to cause offsite impacts are the methanol storage area and the digester gas holders. The transport of methanol to the site was also identified as potentially impacting sensitive receptors. The following scenarios were defined:

- methanol storage area: a pool fire following immediate ignition after a LOC of the methanol from the dosing equipment.
- digester gas holders:
  - a vapour cloud explosion (VCE) after a LOC of the methane; and
  - a boiling liquid expanding vapour explosion (BLEVE) following direct flame impingement from a jet fire from another digester gas holder.
- methanol transport:
  - a pool fire after a LOC of the methanol from a tanker accident; and
  - the dispersion of a toxic cloud following a leak from a tanker accident.

A pool fire in the bund of the methanol dosing point was modelled with a heat radiation of 0.8 kW/$m^2$, less than the heat radiation felt by the sun at noon in the summer, being calculated at the boundary of the site.

A VCE as the result of a leak and immediate ignition of the methane from the digester gas holder was modelled with an overpressure of 1.4 kPa, comparable to the pressures felt by a very strong wind that lasts for less than a second, being calculated at the boundary of the site.

A BLEVE as the result of the direct flame impingement from a jet fire from another digester gas holder was modelled with an overpressure of 1.2 kPa, comparable to the pressures felt by a very strong wind that last for less than a second, being calculated at the boundary of the site.

The consequence modelling for all three onsite scenarios demonstrate a negligible offsite impact.

A pool fire on a road adjacent to a sensitive receptor was modelled with a heat radiation of 4.7 kW/$m^2$ extending over the boundary of the sensitive receptor. It should be noted that only a heat radiation of 2.1 kW/$m^2$ was found to extend to an area where an individual could be exposed.

The dispersion of a toxic cloud of methanol vapour was modelled, with the short-term exposure limit (STEL) of 250 ppm extending 100 m from the pool centre. This extends into the boundary of the sensitive receptor, but it is expected that the likelihood of such an incident is extremely low and individuals would be able to shelter-in-place if it did occur.

## 1.4 Recommendations

As a result of the findings above, the following recommendations have been made:

- if methanol is chosen as the final supplemental carbon source:
  - a route evaluation study for the transport of methanol should be completed in accordance with HIPAP 11 – *Route Selection* [6]; and
  - the likelihood of both a pool fire and dispersion of a toxic cloud should be quantified.
- a manifest of the hazardous chemicals exceeding manifest quantities is to be prepared in accordance with Regulation 347 and Schedule 12 of the WHS Regulations.
- the regulator must be notified of hazardous chemicals exceeding manifest quantities in accordance with Regulation 348 of the WHS Regulations.
- an emergency plan is to be prepared for the site and provided to the NSW Fire and Rescue as per the requirements of Regulation 361 of the WHS Regulations.
- the school should be notified as part of the emergency response plan in the event of an emergency involving a methanol tanker near the school.
- outer warning placards regarding quantities of hazardous chemicals should be displayed at any entrance where emergency services may enter the workplace in accordance with Regulation 349 and Schedule 13 of the WHS Regulations.
- placards should be displayed on or near the storage of hazardous chemicals in accordance with Regulation 350 and Schedule 13 of the WHS Regulations.
- citric acid (nor any other acid) will not be stored in the same bunded area as sodium bisulphite.
- the stormwater system should be designed with sufficient capacity to contain the firewater in the event of a fire and retain it until testing confirms it is safe for release.

It should be noted that the future stages of the project being considered have the requisite chemicals sufficiently separated from both Stage 1 chemicals and the site boundary that the conclusions and recommendations made in this PHA are considered adequate for future stages of the project.

# 2 Introduction

## 2.1 Site description

Sydney Water is planning to build and operate new wastewater infrastructure to service the South West and Western Sydney Aerotropolis Growth Areas. The proposed development will include a wastewater treatment plant in Western Sydney, known as the Upper South Creek Advanced Water Recycling Centre (AWRC). Together, this Water Recycling Centre and the associated treated water and brine pipelines, will be known as the 'project'. An overview of the location of the proposed infrastructure is provided in Figure 2-1. Further details of each component of the project are provided below.

### 2.1.1 Advanced Water Recycling Centre

- a wastewater treatment plant with the capacity to treat up to 50 ML of wastewater per day, with ultimate capacity of up to 100ML per day
- the Advanced Water Recycling Centre will produce:
- high-quality treated water suitable for a range of uses including recycling and environmental flows
- renewable energy, including through the capturing of heat for cogeneration
- biosolids suitable for beneficial reuse
- brine, as a by-product of reverse osmosis treatment

### 2.1.2 Treated water pipelines

- a pipeline about 17 km long from the Advanced Water Recycling Centre to the Nepean River at Wallacia Weir, for the release of treated water
- infrastructure from the Advanced Water Recycling Centre to South Creek to release excess treated water and wet weather flows
- a pipeline about five kilometres long from the main treated water pipeline at Wallacia to a location between the Warragamba Dam and Warragamba Weir, to release high-quality treated water to the Warragamba River as environmental flows.

### 2.1.3 Brine pipeline

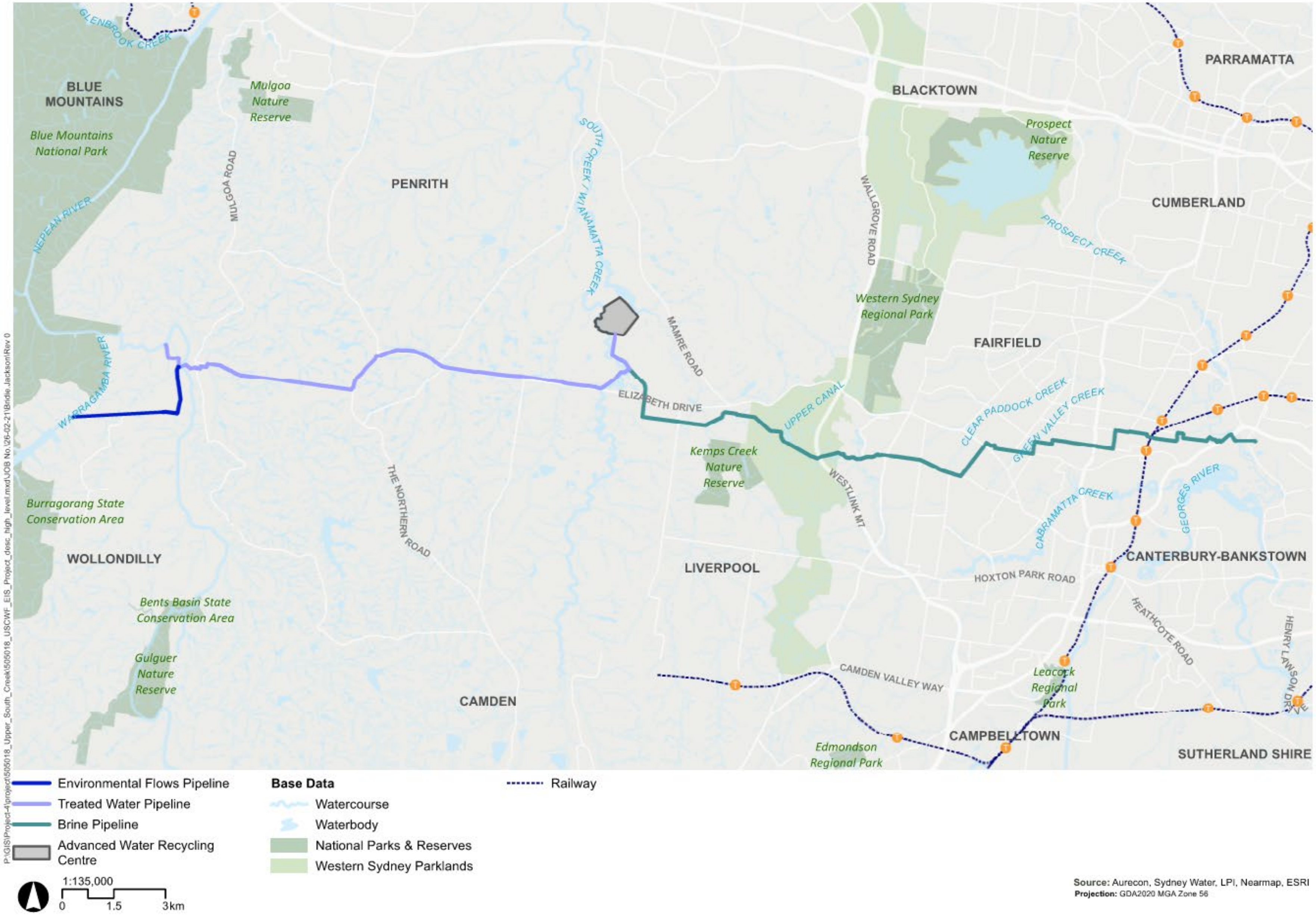
- a pipeline about 24 km long that transfers brine from the Advanced Water Recycling Centre to Lansdowne, in south-west Sydney, where it connects to Sydney Water's existing Malabar wastewater network

Sydney Water is planning to deliver the project in stages, with Stage 1 comprising:

- building and operating the Advanced Water Recycling Centre to treat an average dry weather flow of up to 50ML per day
- building all pipelines to their ultimate capacity, but only operating them to transport and release volumes produced by the Stage 1 Advanced Water Recycling Centre

The timing and scale of future stages will be phased to respond to drivers including population growth rate and the most efficient way for Sydney Water to optimise its wastewater systems.

## Figure 2-1: Project Overview



## 2.2 Surrounding land use

The land surrounding the Water Recycling Centre site is currently zoned for rural purposes. As part of developing the Western Sydney Aerotropolis, this zoning is expected to change over time. The Western Sydney Aerotropolis Plan (Western Sydney Planning Partnership, 2020) indicates the likely future zoning in the vicinity will be for flexible employment south of the Water Recycling Centre site and parkland along the creeks. The Water Recycling Centre site is in the Kemps Creek precinct, which is not currently in the first stage of precincts to be rezoned. This means it may be several years before rezoning occurs in this area.

The Water Recycling Centre site is adjacent to the proposed M12 motorway and Western Metro. The SUEZ Kemps Creek Resource Recovery Park is about 500 m to the south-west. There are existing rural residential and agricultural land uses along Mamre Road and Clifton Avenue to the south and east of the site, with closest dwellings about 300-400 metres from the site. The closest dwellings in the Twin Creeks estate are about 800-900 metres north-west of the site.

The site is situated approximately 2 km from the future Western Sydney Airport and is also potentially beneath the flight path for the future Western Sydney Airport. This means a range of airport safety matters will be relevant for the project such as risk of increasing potential for bird strike and impacts of lighting or reflective surfaces.

## 2.3 Operational process

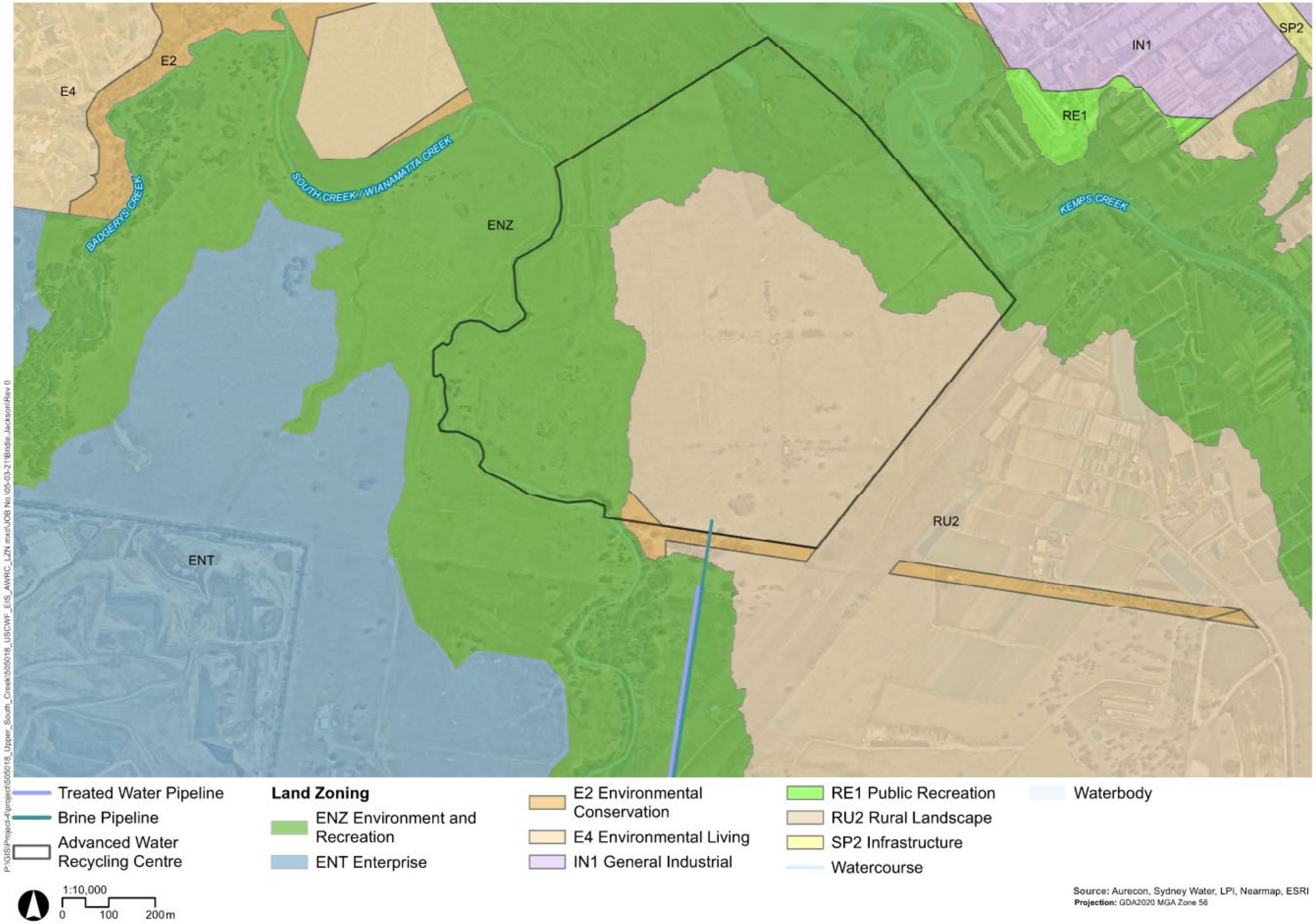
The AWRC will treat up to 100ML/day of wastewater at its ultimate capacity through an advanced tertiary treatment process. The reference design includes:

- inlet works for preliminary treatment
- primary, secondary and tertiary wastewater treatment
- advanced treatment including through reverse osmosis, or similar
- disinfection systems
- biosolids handling facilities
- cogeneration for heat and energy production
- odour control facilities
- infrastructure to South Creek for releases during wet weather
- pumping stations to transfer treated water to the Nepean and Warragamba Rivers, and the brine to the Malabar system.

The incoming mains and flow receival chamber will be sized to treat 100ML/day average dry weather flow to allow for potential future expansion. All other elements of the Stage 1 plant design will be sized to treat 50ML/day average dry weather flow. It should be noted that this PHA has assessed the project for Stage 1, if future stages store certain chemicals closer to the site boundary, the conclusions in this report may change.

This treatment process may be refined or changed during detailed design. The final design will need to demonstrate that environmental impacts are the same or less than assessed in the Environmental Impact Statement (EIS). The acceptable changes that would not affect the conclusions of this report are discussed further in Section 7.

## Figure 2-2: Surrounding land uses



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## 2.4 Secretary's Environmental Assessment Requirements

This report aims to address part of the following Secretary's Environmental Assessment Requirement (SEAR):

51. An assessment of the likely risks of the project to public safety including flood risk, subsidence risks, bushfire risks and the handling and use of dangerous goods.

This report forms the assessment of the likely risks of the project to public safety in the handling and use of dangerous goods. It should be noted that this assessment is only for operational hazards to public safety and does not include hazards occurring at other times of the project such as during construction.

# 3 Methodology

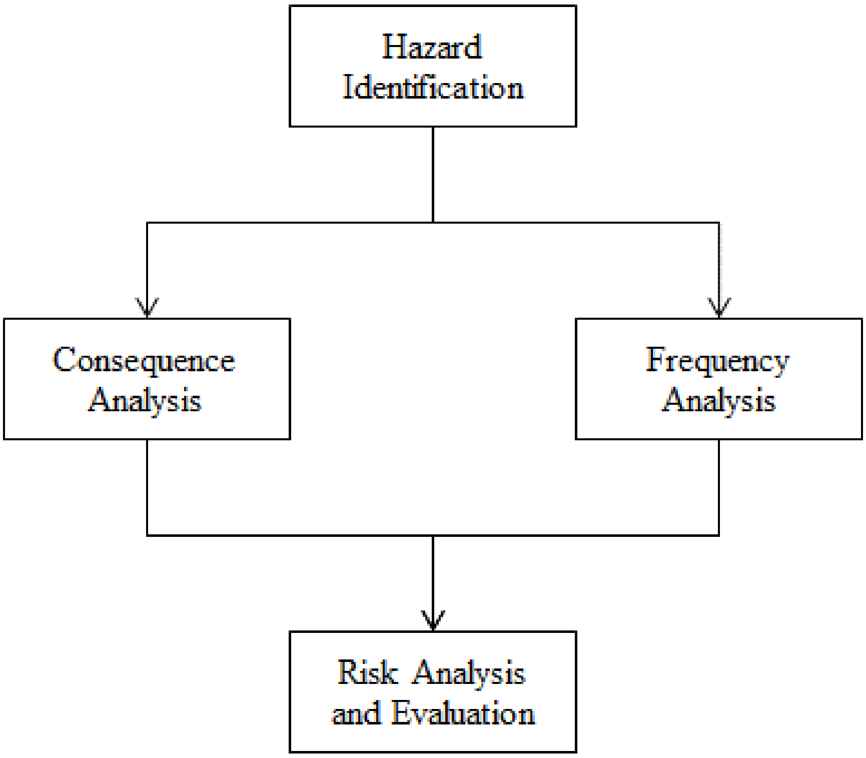
We have been engaged to assess the project against NSW DPIE's *Applying SEPP 33* [3] and if the proposal is found to be potentially hazardous, undertake a Preliminary Hazard Analysis (PHA) for the project.

The PHA has adopted the following specific steps:

1. Screening storage and transport of dangerous goods to determine if the proposal is considered potentially hazardous as set out by NSW DPIE's *Applying SEPP 33* [3], and this is shown in Table 4-2, Table 4-3 and Table 4-4. This includes classification of each potential dangerous good stored at the site in accordance with the National Transport Commission's *Australian Code for the Transport of Dangerous Goods by Road & Rail* (ADGC) [7], review of the quantities on site, and transport of the material against SEPP 33 thresholds.
2. Determining the level of risk assessment required according to NSW DPIE's *Multi-level Risk Assessment* [2]. 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 off-site impacts to occur and how well their severity and likelihood are understood.
3. Conducting a risk assessment according to the level determined above following the criteria set out by HIPAP 4 – *Risk Criteria for Land Use Safety Planning* [4]. Based on the potentially dangerous goods identified in step one, a risk assessment is undertaken to the level identified by Step 2. This assessment is intended to identify the potential offsite risks and mitigation measures.

This process is illustrated in Figure 3-1 below and is consistent with the methodology outlined in HIPAP 6 – *Hazard Analysis* [1].

**Figure 3-1: Methodology for PHA**




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 [4]:

- 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 hazards to ensure that the residual risks have been reduced So Far as is Reasonably Practicable (SFAIRP) in accordance with *Work Health and Safety Regulations* [5] and to reduce risk wherever practicable in accordance with the principles of HIPAP 4 [4].

## 3.1 Step 1: Screening for a potentially hazardous development

*Applying SEPP 33* sets out the process to be followed in order to determine whether the proposal is potentially hazardous and thus requires a PHA. This process is reproduced from *Applying SEPP 33* in Figure 3-2 below and Sections 4.1, 4.2, 4.3 and 4.4 contain the outcomes of this process. As only the AWRC was found to be potentially hazardous from the screening in Section 4.4, SEPP 33 applies to the AWRC and a PHA has been prepared for the AWRC.

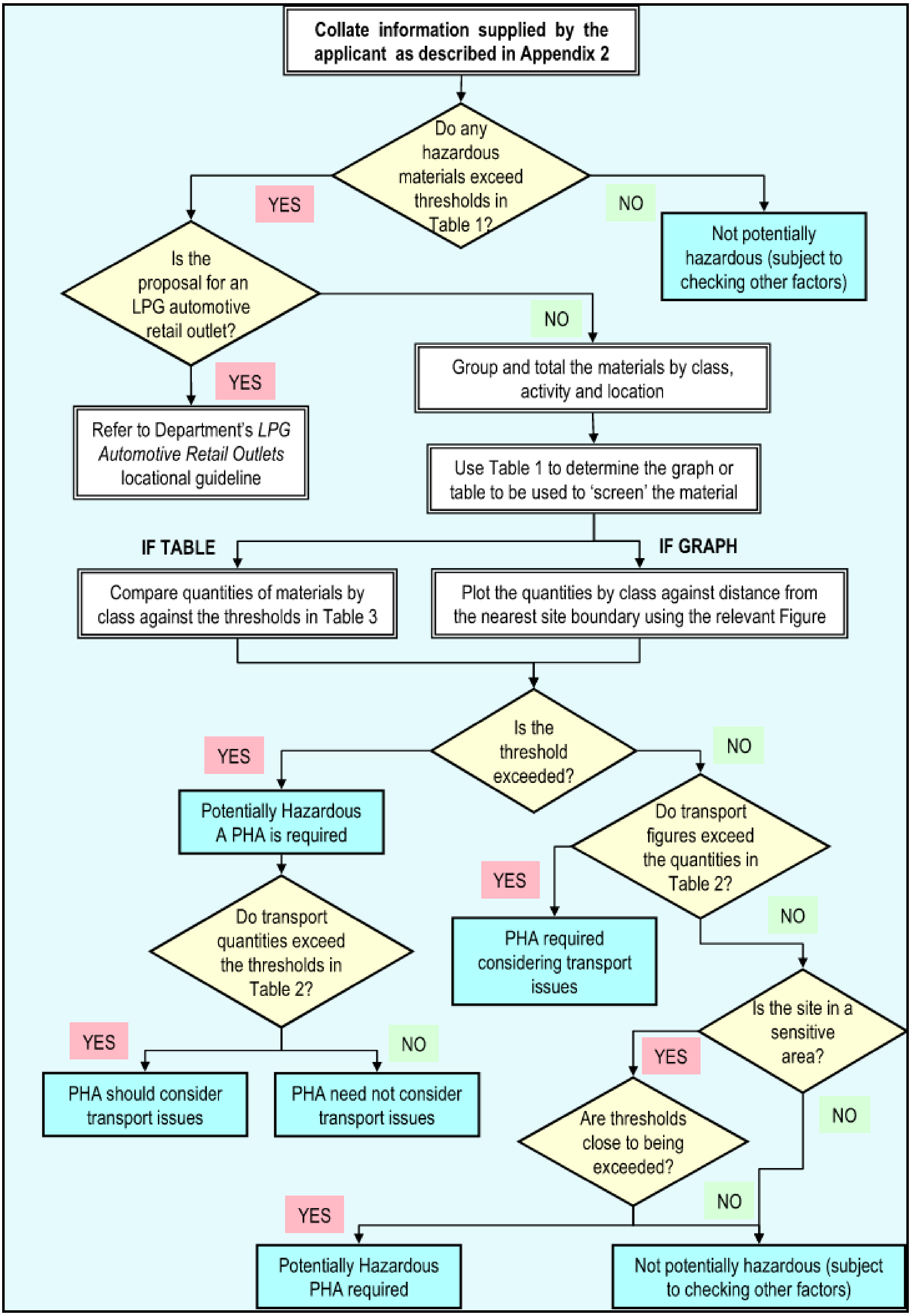
## 3.2 Step 2: Determining the level of risk assessment

The NSW DPIE's *Multi-level Risk Assessment* (MLRA) [2] gives the following guidance for determining the appropriate level of risk assessment required within a PHA:

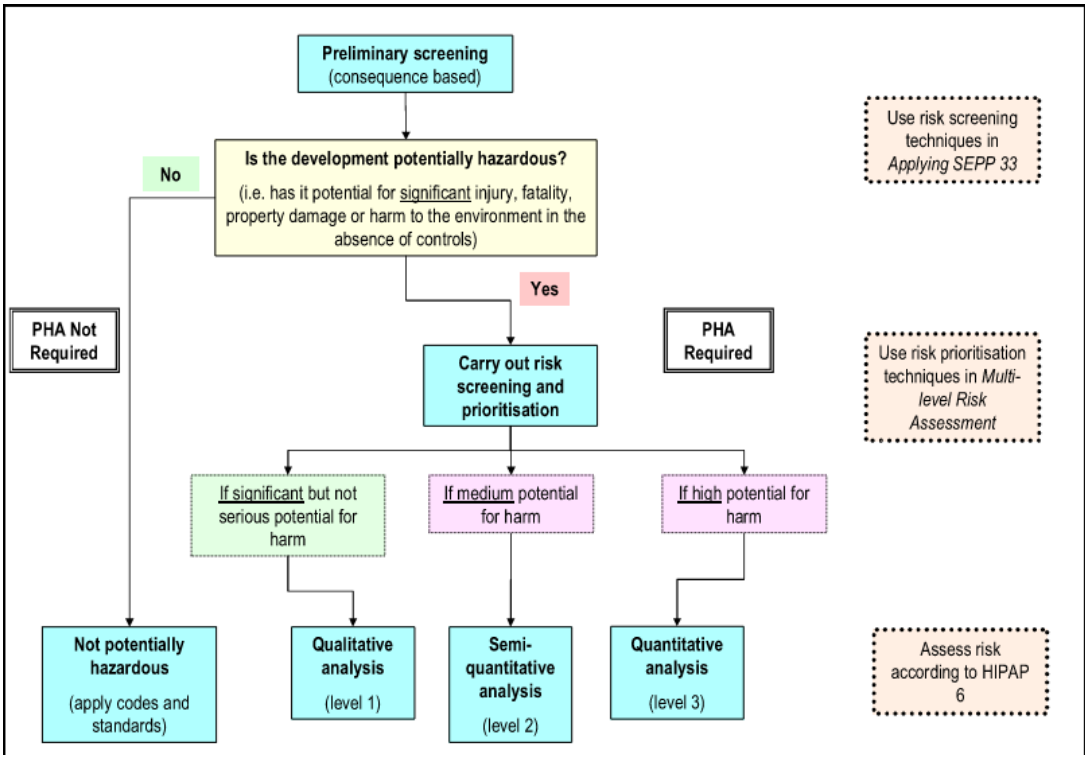
- **Level 1 – qualitative analysis**, primarily based on hazard identification techniques;
- **Level 2 – partially quantitative analysis**, using hazard identification and the focused quantification of key potential off-site risk contributors; and
- **Level 3 – quantitative risk analysis**, based on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

Using Figure 3 and Table 1 of MLRA, reproduced Figure 3-3 and Table 3-1 below, the required level of analysis necessary can be determined. The outcome of this determination is discussed in Section 4.4.

## Figure 3-2: Risk Screening Procedure from *Applying SEPP 33*



### Figure 3-3: The Multi-level Risk Assessment Approach from NSW DPIE's Multi-level Risk




### Assessment

### Table 3-1: Levels of Analysis and Assessment from NSW DPIE's Multi-level Risk Assessment

| Key Elements | Assessment Basis |
| --- | --- |
| **Level 1 – Essentially Qualitative** | |
| • hazard identification using summary diagram, FMEA, fault and event trees, HAZOP etc.<br>• identification of key scenarios and qualitative estimate of risks<br>• comparisons with qualitative criteria.<br>• thorough discussion of protective technical and management measures, including codes and standards | • appropriate methods used for identification<br>• all key scenarios thoroughly examined<br>• realistic estimates of risk<br>• relevant qualitative criteria met<br>• proposed measures appropriate and sufficient<br>• compliance with all relevant codes and standards |
| **Level 2 – Partially Quantitative** | |
| • qualitative elements as for level 1<br>• rigorous quantification of consequences of all events with significant off-site effects<br>• quantification of the likelihood of events with significant off-site consequences<br>• indicative estimate of risk vs. criteria<br>• thorough discussion of technical controls, risk reduction and management measures | • qualitative elements as for level 1<br>• sound consequence methodology used and appropriate failure data used<br>• technical methods and results appropriately documented<br>• relevant criteria shown to be met<br>• appropriate controls and safeguards |

| Key Elements | Assessment Basis |
|---|---|
| **Level 3 – Fully Quantitative** | |
| • qualitative elements as for level 1<br>• comprehensive quantification of significant consequences and their likelihood<br>• evaluation of risk against all relevant criteria<br>• thorough discussion of technical controls, risk reduction and management measures | • qualitative elements as for level 1<br>• sound consequence methodology used<br>• appropriate failure data used<br>• technical methods and results well-documented<br>• all relevant criteria met<br>• ALARP principles followed |

## 3.3 Step 3: Conducting the risk assessment

Given that a PHA is required, the following elements are to be included:

- 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.

Sections 5 and 6 contain the results of this risk assessment.

# 4 Hazard identification

## 4.1 Dangerous goods used and stored at the facility

Dangerous Goods are primarily used at the proposed facility to treat wastewater. The details of how each dangerous good is used at the facility are described in Table 4-1. Each dangerous good has been classified in accordance with the ADGC [7].

**Table 4-1: Dangerous Goods used at the facility**

| Product Name | UN No. | Class | PG | Anticipated Storage Quantity (kL or t) | Description |
|---|---|---|---|---|---|
| Carbon Dioxide | 1013 | 2.2 | N/A | 28 | Used as pH correction |
| Methane | 1971 | 2.1 | N/A | 6,200 | Used for cogeneration |
| Methanol | 1230 | 3, 6.1 | II | 200 | Used as a supplemental carbon source |
| Ferric Chloride | 2582 | 8 | III | 100 | Used for chemical phosphorous removal and biogas odour control |
| Sodium Hydroxide | 1824 | 8 | II | 102 | Used for alkalinity correction and reverse osmosis cleaning in place |
| Sodium Hypochlorite | 1791 | 8 | III | 60 | Used in the membrane bioreactor and the advanced water treatment plant |
| Sodium Bisulphite | 2693 | 8 | III | 8 | Used for de-chlorination |
| Sulphuric Acid | 1830 | 8 | II | 20 | Used as a pH correction |
| Phosphonic Acid (or similar) | N/A | 8 | III | 4 | An antiscalant |

## 4.2 Storage of dangerous goods screening

There are two main areas of the site – near the bioreactors and near the Advanced Water Treatment Plant (AWTP) – that will be used to store dangerous goods. The proposed site layout provides details of these two storage areas in Appendix A. The dangerous goods have been grouped by class and activity and screened according to Section 7 of *Applying SEPP 33* [3]. The details of this screening can be found in Table 4-2 and Table 4-3.

**Table 4-2: Screening for dangerous goods near the bioreactors**

| Dangerous Goods Class | Chemicals | Anticipated Quantity (kL or t) | Threshold | Threshold Exceeded |
|---|---|---|---|---|
| 3 PGII | Methanol | 200[1], 36 m from the site boundary | 10 m from the boundary and sensitive receptors | No |
| 6.1 PGII (subsidiary) | Methanol | 200 | 2.5 tonnes | **Yes** |
| 8 PGII | Ferric Chloride, Sodium Hydroxide, Sodium Hypochlorite, Sodium Bisulphite | 224 | 25 tonnes | **Yes** |

Note that as per Figure 9 of *Applying SEPP 33* [3], the underground storage of 200 kL corresponds to a threshold of approximately 10 m from the boundary and sensitive receptors. Since the methanol storage at this stage of the design is located more than 10 m from the site boundary, the threshold is not exceeded.

**Table 4-3: Screening for dangerous goods near the AWTP**

| Dangerous Goods Class | Chemicals | Anticipated Quantity (kL or t) | Threshold | Threshold Exceeded |
|---|---|---|---|---|
| 2.2 | Carbon Dioxide | 28[2] | N/A | N/A |
| 8 PGII | Sodium Hydroxide<br>Sodium Hypochlorite<br>Sodium Bisulphite<br>Sulphuric Acid<br>Phosphonic Acid | 70 | 25 tonnes | **Yes** |

Note that the 6,200 $m^3$ of methane expected to be produced at the facility exceeds the threshold of 16 $m^3$ set by SEPP 33.

## 4.3 Transportation of dangerous goods screening

The transportation of dangerous goods to and from the site has also been screened according to Section 7 of *Applying SEPP 33* [3]. The details of this screening can be found in Table 4-4.

**Table 4-4: Screening for the transportation of dangerous goods**

| Dangerous Goods Class | Chemicals | Expected Weekly Loads (kL or t) | Expected Annual Movements | Threshold of Annual Movements | Threshold Exceeded |
|---|---|---|---|---|---|
| 2.2 | Carbon Dioxide | 7 | 52 | N/A | N/A |
| 3 PGII | Methanol | 50 | 130 | >750 | No |
| 6.1 | Methanol | 50 | 130 | All | **Yes** |

[1] For class 3 materials only, if storage is underground, the capacity of the tank should be divided by 5 prior to assessing against the screening threshold.
[2] Class 2.2 goods are excluded from risk screening because they are non-flammable, non-toxic gases and are not considered to be potentially hazardous with respect to offsite risk.

| Dangerous Goods Class | Chemicals | Expected Weekly Loads (kL or t) | Expected Annual Movements | Threshold of Annual Movements | Threshold Exceeded |
|---|---|---|---|---|---|
| 8 | Ferric Chloride<br>Sodium Hydroxide<br>Sodium Hypochlorite<br>\|Sodium Bisulphite<br>Sulphuric Acid<br>Phosphonic Acid | 91 | 234 | >500 | No |

Note that class 2.1 goods have not been considered for transport screening as it will be produced onsite. Further, 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.

## 4.4 Applicability of SEPP 33

As can be seen from Table 4-2, dangerous goods classes 6.1 PGII, 8 PGII and 8 PGIII all exceed the threshold. Therefore, SEPP 33 applies, the development is to be considered potentially hazardous, and a PHA is required.

It should be noted that methanol may not be chosen as the final carbon dosing source. If it is chosen as the carbon dosing source, then as it has a subsidiary hazard of class 6.1 dangerous good, it will exceed the thresholds in Table 4-2 and Table 4-4. SEPP 33 advises that a route evaluation study should be completed in accordance with HIPAP 11 – *Route Selection* [6].

The facility requires an Environment Protection Licence under the Protection of the Environment Operations Act 1997 and is therefore considered potentially offensive. However, the site is expected to meet the requirements of its Environment Protection Licence. 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. More detail can be found in the air quality assessment component of the EIS.

As per MLRA [2], the appropriate level of analysis was determined to be Level 2 – partially quantitative due to the potential for offsite impacts arising from the methanol storage area and digester gas holders.

## 4.5 Hazard Identification

A hazard identification study (HAZID) was conducted by Sydney Water on 5 May 2020 and 6 May 2020 and the minutes can be found in Appendix B. The HAZID identified the following hazards for the operation of the facility:

- an explosion in the digester gas holder area; and
- a bushfire impacting the AWRC.

The following hazards have been identified as a result of the SEPP 33 screening conducted above:

- a pool fire in the methanol storage area;
- sensitive receptors exposed to methanol vapour as a result of transport issues;
- the interaction of incompatible dangerous goods stored together;
- the production of dangerous goods from the interaction of chemicals not considered dangerous;
- the release of firewater into the environment; and

- the release of brine into the environment.

These have been qualitatively addressed in Section 5 and if required by MLRA, quantitatively in Section 6 below.

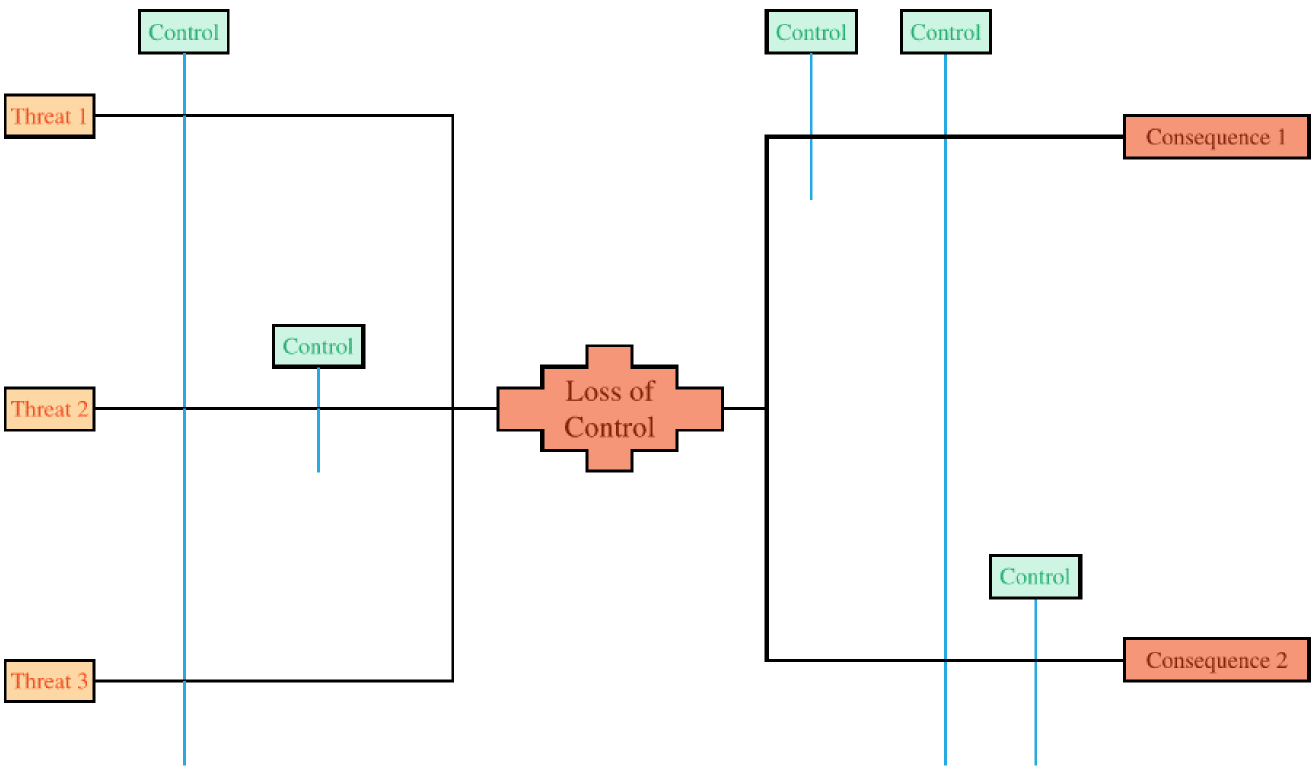
# 5 Qualitative analysis

Following the HAZID and SEPP 33 screening, the hazards that were deemed to pose credible offsite risks were determined. The details of the potential causes and consequences of each identified hazard is described below. If no offsite impacts were anticipated, recommendations were made for the hazard to ensure that the residual risk was reduced SFAIRP by listing relevant design compliance requirements from the relevant Australian Standard. If offsite impacts were anticipated, the hazard was carried forward for consequence analysis in Section 6.

Where necessary, threat-barrier diagrams (TBDs) have been developed to assess the risks of potential fire and explosion scenarios and their potential offsite impacts.

TBDs are models which demonstrate the interactions between threats, consequences and controls. An example TBD is presented in Figure 5-1.

**Figure 5-1: Example threat-barrier diagram (TBD)**




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 enables the estimated frequency of the Loss of Control and subsequent consequences to be calculated.

Appendix C contains the TBDs for a LOC from the methanol storage area, digester gas holders and methanol transport. Note that as there is no fatality risk outside the boundary associated with the events studied, the TBD's have not been quantified.

## 5.1 Pool fire in methanol storage area

Methanol is used at the facility as a supplemental carbon source. It is classified as a class 3 dangerous good with subsidiary class 6.1 and packing group II by the ADGC.

The most credible causes of a LOC from the methanol storage area include corrosion and leaks from the dosing equipment in the dosing area. The consequence scenario from the methanol storage area is a pool fire following immediate ignition after a LOC of the flammable liquid.

The potential for this hazard to pose offsite impacts means that it has been carried forward for consequence analysis. The details of this consequence analysis can be found in Section 6.

## 5.2 Explosion from digester gas holders

Biogas is produced in the digestion process and will be stored in the membrane gas holders fitted above each anaerobic digester. This biogas will primarily be made up of methane, with ferric chloride being used to minimise the concentration of hydrogen sulphide in the biogas. Methane is classified as a class 2.1 dangerous good by the ADGC.

The most credible cause of a LOC from the digester gas holders includes a leak from the gas holders. The consequence scenarios from the digester gas holders are:

- a vapour cloud explosion (VCE) after a LOC of the methane; and
- a boiling liquid expanding vapour explosion (BLEVE) following direct flame impingement from a jet fire from another digester gas holder.

The potential for this hazard to pose offsite impacts means that it has been carried forward for consequence analysis. The details of this consequence analysis can be found in Section 6.

## 5.3 Exposure to methanol from a tanker accident

Methanol is to be transported to the AWRC to be used for carbon dosing. For Stage 1 of the facility operation, on average, 2 deliveries of 20 t trucks are expected per week. It is classified as a class 3 dangerous good with subsidiary class 6.1 and packing group II by the ADGC.

Any transportation of class 6.1 dangerous goods is considered to exceed the threshold, and so this PHA considers transport issues. The most credible cause of a LOC from the transport of methanol is an accident causing a leak in the tanker. The consequence scenarios from this leak are:

- the dispersion of toxic vapour after the vaporisation of a pool of methanol; and
- a pool fire following immediate ignition after a LOC of the flammable liquid.

The potential for this hazard to pose offsite impacts means that it has been carried forward for consequence analysis. The details of this consequence analysis can be found in Section 6.

## 5.4 Interaction between incompatible dangerous goods

The most credible causes of failure leading to the interaction of incompatible dangerous goods include corrosion and leaks from the storage tanks. The interaction between incompatible dangerous goods can credibly lead to reaction products that are corrosive, flammable, or explosive.

To determine the compatibility of the storage chemicals in Table 4-2 and Table 4-3, *CAMEO Chemicals* [8] was utilised. CAMEO Chemicals is a database of hazardous chemical datasheets that emergency responders and planners use to get response recommendations and predict hazards i.e. explosions or toxic fumes. CAMEO Chemicals was developed by the United States' National Oceanic and Atmospheric Administration's Office of Response and Restoration.

Table 5-1 and Table 5-2 below provides an overview of the reactivity predictions of dangerous goods stored near the bioreactors and AWTP, respectively.

**Table 5-1: Compatibility of chemicals stored near bioreactors**

| | Ferric chloride, solution | | | |
|---|---|---|---|---|
| Sodium hydroxide solution | Incompatible | Sodium hydroxide solution | | |
| Sodium hypochlorite | Incompatible | Incompatible | Sodium hypochlorite | |
| Sodium bisulphite solution | Incompatible | Caution | Incompatible | Sodium bisulphite solution |
| Methanol | Caution | Incompatible | Incompatible | Compatible |

**Table 5-2: Compatibility of chemicals stored near AWTP**

| | Carbon dioxide | | | |
|---|---|---|---|---|
| Sodium bisulphite solution | Incompatible | Sodium bisulphite solution | | |
| Sodium hydroxide solution | Incompatible | Caution | Sodium hydroxide solution | |
| Sodium hypochlorite | Caution | Incompatible | Incompatible | Sodium hypochlorite |
| Sulfuric acid | Incompatible | Incompatible | Incompatible | Incompatible |

It is recommended that class 8 substances in the above tables will be stored in accordance with AS 3780-2008: *The storage and handling of corrosive substances* [9], and in accordance with obligations under division 5 of chapter 7 of the Work Health and Safety (WHS) Regulations 2011 [5]. This includes the specific requirements of containing and managing spills under subdivision 2. Incompatible chemicals are not to be stored in the same bunded area.

The measures outlined above are considered sufficient to reduce the residual risk of this hazard SFAIRP.

## 5.5 Goods not classified as dangerous goods by the ADGC

There are goods stored onsite that, while not classified as dangerous goods by the ADGC, may produce dangerous goods if they come in contact with other dangerous goods stored onsite, similar to the scenario described above. For example, citric acid is not classified as a dangerous good by the ADGC. Despite this, citric acid can react with sodium bisulphite (SBS) to produce sulphur dioxide, a toxic gas. It is therefore recommended that citric acid (and all other acids listed in this document) be stored at least 5m away from the SBS storage tank or stored in a separate bunded area (AS3780-2008 clause 5.3.3(a)).

Additionally, the product to be used as an antiscalant has not been confirmed at the time of writing. If it is classified as a dangerous good, it will most likely be a class 8 and will require similar separation requirements as defined in Section 5.4.

The measures outlined above are considered sufficient to reduce the residual risk of this hazard SFAIRP.

## 5.6 Release of firewater into the environment

The total first flush storage volume for Stage 1 is currently estimated to be 500 $m^3$ across 2 separate drainage areas of the site. Following a fire event that requires extinguishing, the firewater has the potential to be released into the environment without being controlled. The stormwater design for the site is still in progress. There is a first flush system which is sized to capture the first 10mm rainfall runoff of all hardstand areas on site during a rain event and return it to the head of the works.

To mitigate this hazard, the stormwater system should be designed with sufficient capacity to contain the firewater in the event of a fire and retain it until testing confirms it is safe for release.

## 5.7 Bushfire impacts on the facility

The location of the proposed site is deemed to be 'bushfire prone' and is required to comply with the aims and objectives of NSW Rural Fire Services document *Planning for Bush Fire Protection* [10]. The Bushfire Constraints and Opportunities Assessment (ref. 201323) completed for the facility states that the proposed AWRC can meet the general aims and objectives of Sections 1 and 8 of the *Planning for Bush Fire Protection* [10] and is therefore bushfire compliant.

## 5.8 Release of brine into the environment

The AWRC will produce a brine solution as a by-product of the advanced treatment process. The brine will be pumped by the transfer pump station via the brine pipeline for release into the existing Malabar wastewater network at Lansvale. There exists the possibility that a leak in the pipeline could lead to the release of brine into the environment and cause human injury. The indicative composition of the brine has been estimated using Reverse Osmosis System Analysis (ROSA) software and the $10^{th}$, $50^{th}$ and $90^{th}$ percentiles are presented in Table 5-3 below.

**Table 5-3: Indicative brine results from mass balance of ROSA results**

| Analyte Name | | Units | Percentile | | |
|---|---|---|---|---|---|
| | | | 10th | 50th | 90th |
| **Ammonia** | NH4+ + NH3 | *mg/L* | 0.28 | 0.40 | 0.81 |
| **Potassium** | K | *mg/L* | 75 | 75 | 89 |
| **Sodium** | Na | *mg/L* | 537 | 537 | 634 |
| **Magnesium** | Mg | *mg/L* | 61 | 61 | 64 |
| **Calcium** | Ca | *mg/L* | 90 | 90 | 96 |
| **Strontium** | Sr | *mg/L* | 0.32 | 0.34 | 0.37 |
| **Carbonate (part of alkalinity measure)** | CO3 | *mg/L* | 1.7 | 2.3 | 3.8 |
| **Bi-carbonate (part of alkalinity measure)** | HCO3 | *mg/L* | 331 | 361 | 452 |
| **Nitrate** | NO3 | *mg/L* | 4.9 | 6.7 | 18.7 |
| **Chlorine** | Cl | *mg/L* | 804 | 823 | 854 |
| Fluoride | F | *mg/L* | 2.8 | 2.8 | 2.9 |
| Sulphate | SO4 | *mg/L* | 283 | 283 | 377 |
| **Silicon dioxide** | SiO2 | *mg/L* | 24 | 24 | 27 |
| **Boron** | Boron | *mg/L* | 0.13 | 0.13 | 0.13 |
| **Carbon dioxide** | CO2 | *mg/L* | 9.6 | 10.2 | 12.1 |
| **Total dissolved solids** | TDS | *mg/L* | 2235 | 2248 | 2622 |
| **"Power of hydrogen"** | pH | *pH units* | 7.5 | 7.6 | 7.7 |

The estimated composition of the brine shows that a release from the pipeline is very unlikely to create toxic, fire or explosion risks. As such it is considered unlikely that a release of brine into the environment would have any impact on humans.

Furthermore, there are both design and operational measures in place to either prevent pipeline failure or leakage, and detect and fix the failure in the event that it occurs. These are discussed in more detail in Project Options and Project Description sections of the EIS.

As it is not considered likely that a release of brine into the environment will have any human impacts, this hazard has not been assessed further.

## 5.9 Work Health and Safety Regulations 2011

Section 7.1 of the WHS Regulations sets out the requirements for the use, handling, and storage of hazardous chemicals at a workplace. Specifically, this report assesses requirements for exceeding manifest and placard quantities found in Division 3 and 4 of Section 7.1, respectively.

Table 5-4 below shows the manifest and placard quantities set out by Schedule 11 of the WHS Regulations. It also contains screening for each chemical classified as hazardous by Schedule 11 stored onsite against the thresholds.

**Table 5-4: Placard and manifest quantities of hazardous chemicals**

| Description of Hazardous Chemical | | Placard Quantity | Manifest Quantity | Applicable Chemicals | Anticipated Quantity | Exceeds Placard Quantity | Exceeds Manifest Quantity |
|---|---|---|---|---|---|---|---|
| Gases under pressure | not specified elsewhere | 1,000 L | 10,000 L | Carbon dioxide | 28,000 kg | Yes | Yes |
| Flammable liquids | category 2 | 250 L | 2,500 L | Methanol | 200,000 L | Yes | Yes |
| Acute toxicity | category 3 | 1,000 L/kg | 10,000 L/kg | Methanol | 200,000 L | Yes | Yes |
| Skin corrosion | category 1A | 50 L/kg | 500 L/kg | Sodium hydroxide | 102,000 L | Yes | Yes |
| | | | | Sulphuric acid | 20,000 L | Yes | Yes |
| Skin corrosion | category 1B | 250 L/kg | 2,500 L/kg | Ferric chloride | 100,000 L | Yes | Yes |
| | | | | Sodium hypochlorite | 60,000 L | Yes | Yes |
| Corrosive to metals | category 1 | 1,000 L/kg | 10,000 L/kg | Ferric chloride | 100,000 L | Yes | Yes |
| | | | | Sodium hydroxide | 102,000 L | Yes | Yes |
| | | | | Sulphuric acid | 20,000 L | Yes | Yes |

### 5.9.1 Manifest Quantities

Table 5-4 shows that each of the hazardous chemicals exceed the manifest quantities of the WHS Regulations. As such, the following recommendations have been made:

- a manifest of the chemicals in the above table is to be prepared in accordance with Regulation 347 and Schedule 12 of the WHS Regulations.
- the regulator must be notified in accordance with Regulation 348 of the WHS Regulations.
- an emergency plan is to be prepared for the site and provided to the NSW Fire and Rescue as per the requirements of Regulation 361 and Division 4 of Part 3.2 of the WHS Regulations.

### 5.9.2 Placard Quantities

Division 4 of the WHS Regulations states that outer warning placards and placards are to be displayed if placard quantities are exceeded. Table 5-4 above shows that each of the hazardous chemicals exceed the placard quantities of the WHS Regulations. As such the following recommendations have been made:

- outer warning placards should be displayed at any entrance where emergency services may enter the workplace in accordance with Regulation 349 and Schedule 13 of the WHS Regulations.
- placards should be displayed on or near the storage of hazardous chemicals in accordance with Regulation 350 and Schedule 13 of the WHS Regulations.

# 6 Consequence analysis

Consequence modelling has been carried out for the hazards identified as potentially having offsite impacts in Section 5:

- methanol storage area: a pool fire following immediate ignition after a LOC of the methanol from the dosing equipment.
- digester gas holders:
- a vapour cloud explosion (VCE) after a LOC of the methane; and
- a boiling liquid expanding vapour explosion (BLEVE) following direct flame impingement from a jet fire from another digester gas holder.
- methanol transport:
- a pool fire after a LOC of the methanol from a tanker accident; and
- the dispersion of a toxic cloud following a leak from a tanker accident.

The results of the modelling undertaken has been assessed against the consequence criteria set out in HIPAP 4 [4] shown below. Modelling was performed using DNV GL's process hazard analysis software package *Phast v8.*22 – widely accepted as industry best practice. The details of this consequence modelling are described further below.

## 6.1 Consequence criteria

### Heat flux radiation

The heat radiation generated from a fire event is a potential hazard to the surrounding population. The consequences of heat radiation levels are provided in HIPAP 4 [4] and are reproduced in Table 6-1.

**Table 6-1: Heat radiation consequences**

| Radiation ($kW/m^2$) | Effect |
|---|---|
| 1.2 | • received from the sun at noon in summer |
| 2.1 | • minimum to cause pain after 1 minute |
| 4.7 | • will cause pain in 15-20 seconds and injury after 30 seconds |
| 12.6 | • significant chance of fatality for extended exposure, high chance of injury<br>• causes the temperature of wood to rise to a point where it can be ignited by a naked flame after a long exposure<br>• thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure |
| 23 | • likely fatality for extended exposure and chance of fatality for instantaneous exposure<br>• spontaneous ignition of wood after long exposure<br>• unprotected steel will reach thermal stress temperatures which can cause failure<br>• pressure vessel needs to be relieved or failure will occur |
| 35 | • significant chance of fatality for instantaneous exposure<br>• cellulosic material will pilot ignite within one minute of exposure |

### Explosion overpressure

The overpressure generated from an explosion event is a potential hazard to the surrounding population. The consequences of explosion overpressure levels are provided in HIPAP 4 [4] and are reproduced in Table 6-2.

**Table 6-2: Explosion overpressure consequences**

| Overpressure (kPa) | Effect |
|---|---|
| 3.5 | • no fatality, very low probability of injury<br>• 90% glass breakage |
| 7 | • 10% probability of injury, no fatality<br>• damage to internal partition and joinery but can be repaired |
| 14 | • house uninhabitable or badly cracked |
| 21 | • 20% chance of fatality in a building<br>• reinforced structures distort |
| 35 | • house uninhabitable<br>• wagons and plants items overturned<br>• threshold of eardrum damage<br>• 50% chance of fatality for a person in a building and 15% chance of fatality for a person in the open |

### Toxic exposure

The short-term exposure limit (STEL) of a toxic substance is the acceptable exposure over 15 minutes. STELs for common toxic substances are defined by Safe Work Australia's *Workplace Exposure Standard for Airborne Contaminants* [11]. The STEL of a substance aligns with HIPAP 4's [4] minimum risk criteria for toxic gas exposure.

## 6.2 Consequence Scenarios

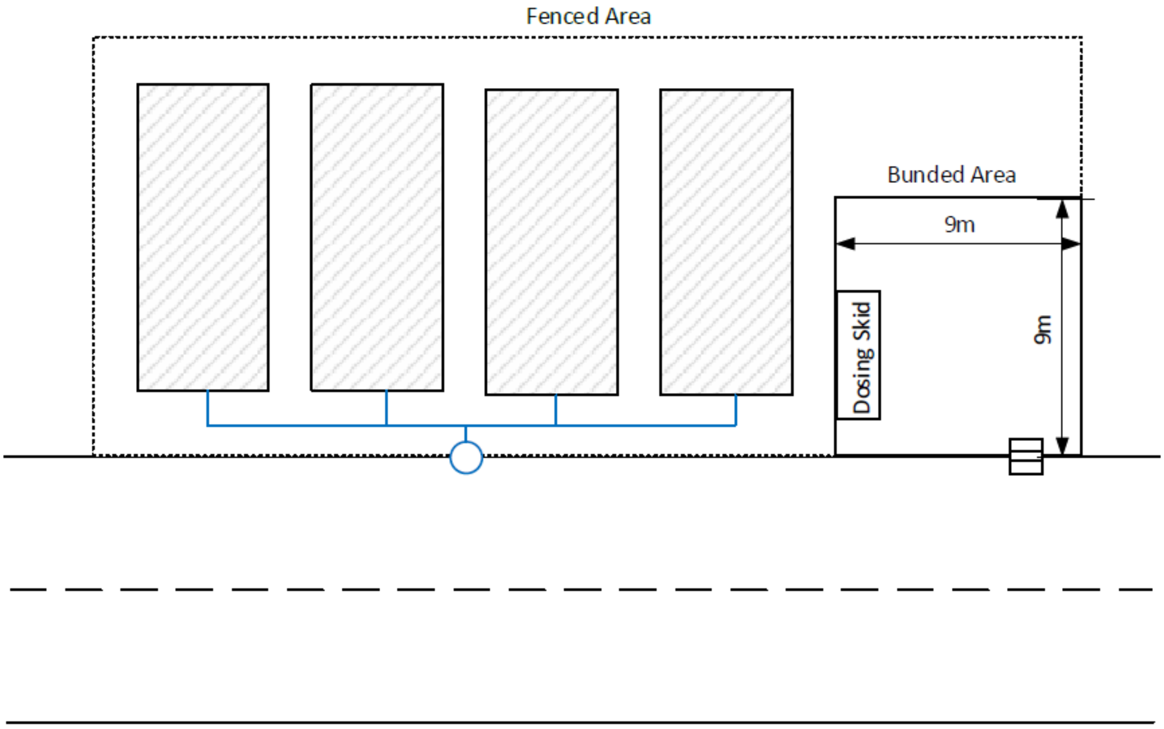
### 6.2.1 Pool fire in methanol storage area

The scenario upon which the model was based is a pool of methanol forming as a result of a leak from the dosing equipment. The pool fire consequence modelling tool in *Phast* was used to model this scenario. The 9m×9m bund in Figure 6-1 was converted to a circular bund of equivalent radius. Inputs used for the model can be found in Table 6-3.

**Table 6-3: Input parameters for pool fire**

| Parameter | Value |
|---|---|
| Material | Methanol |
| Pool diameter | 10.16 m |
| Elevation of radiation effects | 1 m |

**Figure 6-1: Methanol dosing area**




## 6.2.2 Explosion from digester gas holders

### 6.2.2.1 Vapour cloud explosion

The scenario upon which the model was based is a cloud of methane and air in the optimal stoichiometric ratio for combustion forming in the digester gas holder area. A cloud of this nature could credibly form as the result of a catastrophic failure of the gas holder.

The digester gas holder area has a volume of approximately 4,500 $m^3$, with a cloud height of 5 m being assumed. A 4,500 $m^3$ cloud containing a methane-air mixture in the optimal stoichiometric ratio for combustion was defined in *Phast*. This ratio is an output from *Phast* and defines the case for what the highest explosion overpressures will be, in the event of a deflagration.

The optimal stoichiometric ratio of methane to air is 1:23.9. Therefore, a 4,500 $m^3$ cloud of methane in its optimal stoichiometric ratio with air contains 1631.1 kg of fuel.

The Multi-Energy method in *Phast* was used to model the explosion behaviour. One of the parameters used in this method is the 'explosion strength', which is a number between 1 and 10, and is used to define the equation used in the calculations. Due to the low confinement of the considered area, an explosion strength of 3 was deemed most appropriate for the situation.

Inputs used for the model can be found in Table 6-4.

**Table 6-4: Input parameters for vapour cloud explosion**

| Parameter | Value |
|---|---|
| Material | Methane |
| Flammable mass in cloud | 559.5 kg |
| Volume of confined source | 4500 m3 |

| Parameter | Value |
|---|---|
| Strength of confined source | 3 |

#### 6.2.2.2 Boiling liquid expanding vapour explosion

The scenario upon which the model was based is a jet fire from a gas holder impinging on another causing a boiling liquid expanding vapour explosion (BLEVE). This scenario could credibly form as a result of a leak from the digester gas holder.

A methane tank pressurised at 4.1 kPa with a volume of 1,600 m$^3$ was defined in *Phast*. The BLEVE blast method was used to model the explosion behaviour. The input parameters can be found in Table 6-5 below.

**Table 6-5: Input parameters for BLEVE model**

| Parameter | Value |
|---|---|
| Material | Methane |
| Diameter | 16 m |
| Length | 8 m |
| Temperature | 25 ℃ |
| Pressure (gauge) | 4.1 kPa |

### 6.2.3 Exposure to methanol from a tanker accident

If chosen as a carbon supplement, methanol is likely to be transported to the AWRC from a supplier in Ingleburn, NSW. From satellite review, the route that minimises exposure to sensitive receptors passes a small school on the corner of Elizabeth Dr and Duff Rd, Cecil Park, NSW. Figure 6-2 below shows the school and adjacency to the likely transport route. The following analysis has been conducted with this sensitive receptor forming the basis of the model.

**Figure 6-2: School near methanol transport route**


### 6.2.3.1 Pool fire

The scenario upon which the model was based is a pool of methanol forming as a result of a leak from the tanker transporting methanol. The pool fire consequence modelling tool in *Phast* was used to model this scenario. A pool diameter of 20 m was deemed to be most appropriate for the scenario given the natural drainage on either side of the road. Inputs used for the model can be found in Table 6-6 below.

**Table 6-6: Input parameters for pool fire model**

| Parameter | Value |
|---|---|
| Material | Methanol |
| Pool diameter | 20 m |
| Elevation of radiation effects | 1 m |

### 6.2.3.2 Dispersion of toxic cloud

The scenario upon which the model was based is the vaporisation of a pool of methanol as a result of a leak from the tanker transporting methanol. A tank carrying 20 t of methanol and a pool of 20 m in diameter was defined in *Phast*. The dispersion method was used to model the dispersion of this cloud. The STEL of methanol is 250 ppm and is therefore the concentration of interest in this scenario. The input parameters used for the model can be found in Table 6-7 below.

**Table 6-7: Input parameters for dispersion model**

| Parameter | Value |
|---|---|
| Material | Methanol |
| Mass inventory | 20 t |
| Temperature | 25 ℃ |
| Pressure (gauge) | 101.325 kPa |
| Orifice diameter | 8 mm |

| Parameter | Value |
|---|---|
| Elevation | 1 m |
| Concentration of interest | 250 ppm |

## 6.3 Consequence Results

### 6.3.1 Pool fire in methanol storage area

The results of the consequence modelling are presented in Figure 6-3. The distances from the pool fire centre to the heat flux radiation levels for a pool fire from the methanol storage area are presented in Table 6-8. This is represented by impact contours on the site layout in Figure 6-4 below.

**Figure 6-3: Pool fire heat radiation vs distance**

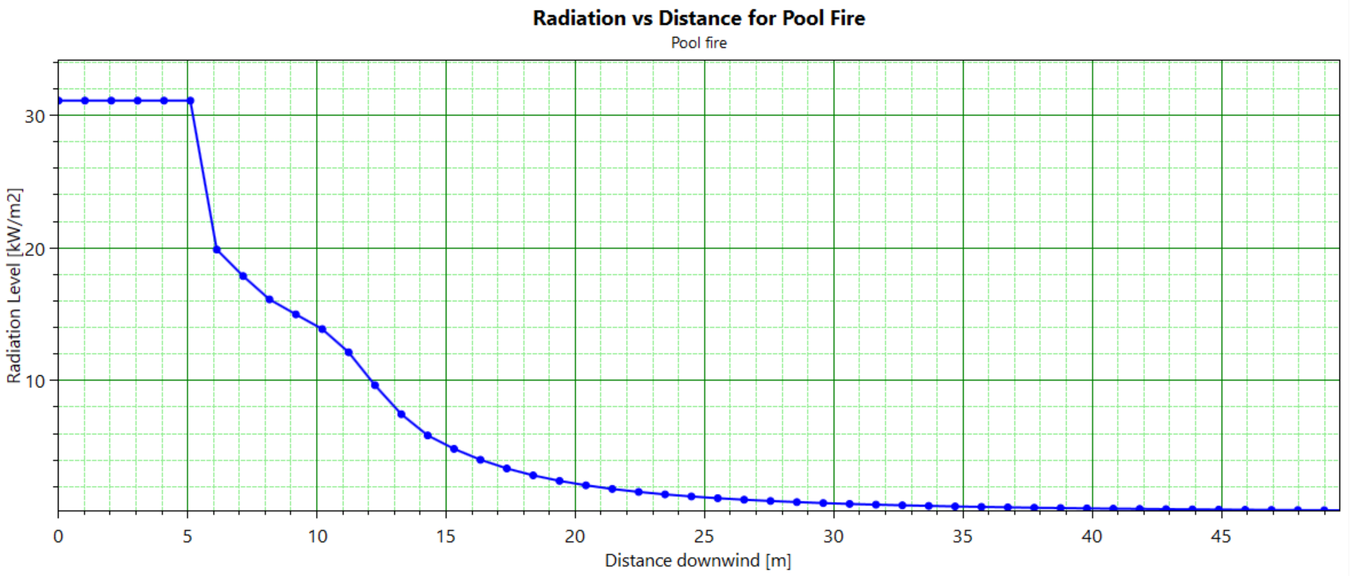
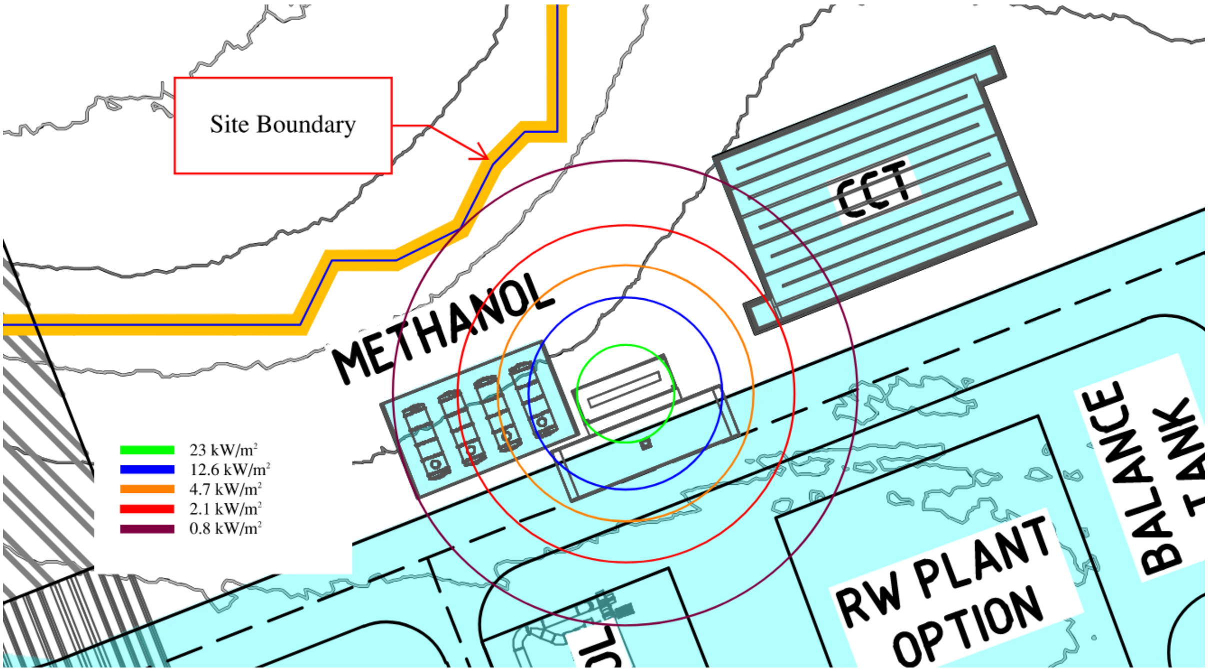



**Table 6-8: Methanol storage area – pool fire heat radiation contours**

| Distance from pool fire centre to heat radiation level (m) | | | | |
|---|---|---|---|---|
| 35 kW/m$^2$ | 23 kW/m$^2$ | 12.6 kW/m$^2$ | 4.7 kW/m$^2$ | 2.1 kW/m$^2$ |
| N/A | 7 | 12 | 16 | 21 |

**Figure 6-4: Impact contours on site layout**




The site layout as at the time of writing shows the methanol storage area at least 29 m from the site boundary. At this distance, the expected heat radiation is approximately 0.8 kW/m$^2$. It is anticipated therefore, that the offsite impacts of a pool fire following immediate ignition after a LOC of the flammable liquid will be negligible and that there is no offsite fatality risk.

## 6.3.2 Explosion from digester gas holders

### 6.3.2.1 Vapour cloud explosion

The results of the consequence modelling are presented in Figure 6-5. These results represented by impact contours on the site layout in Figure 6-6 below.

**Figure 6-5: VCE overpressure vs distance**

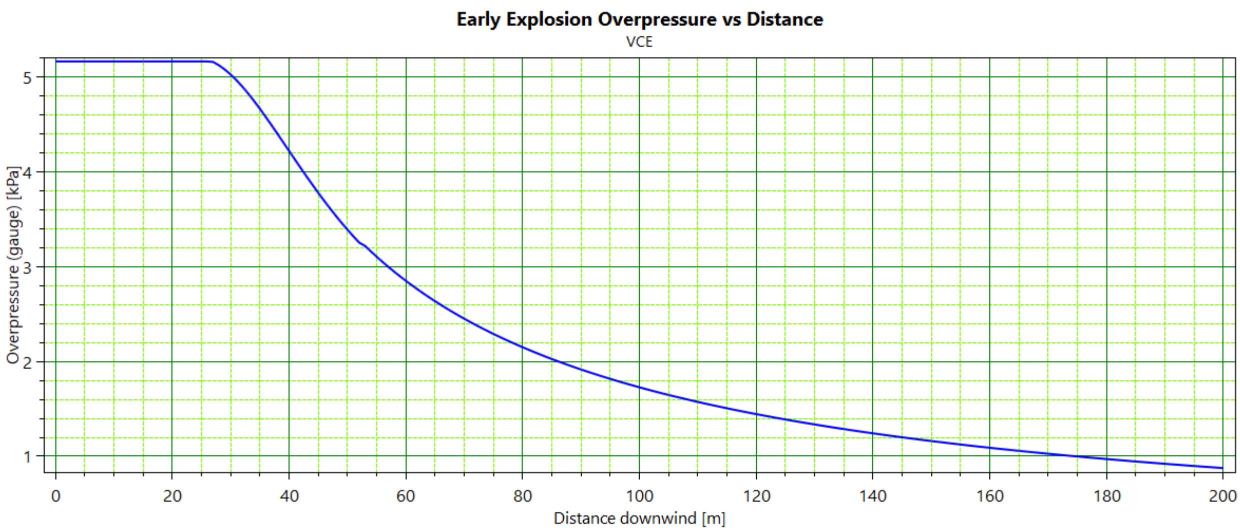
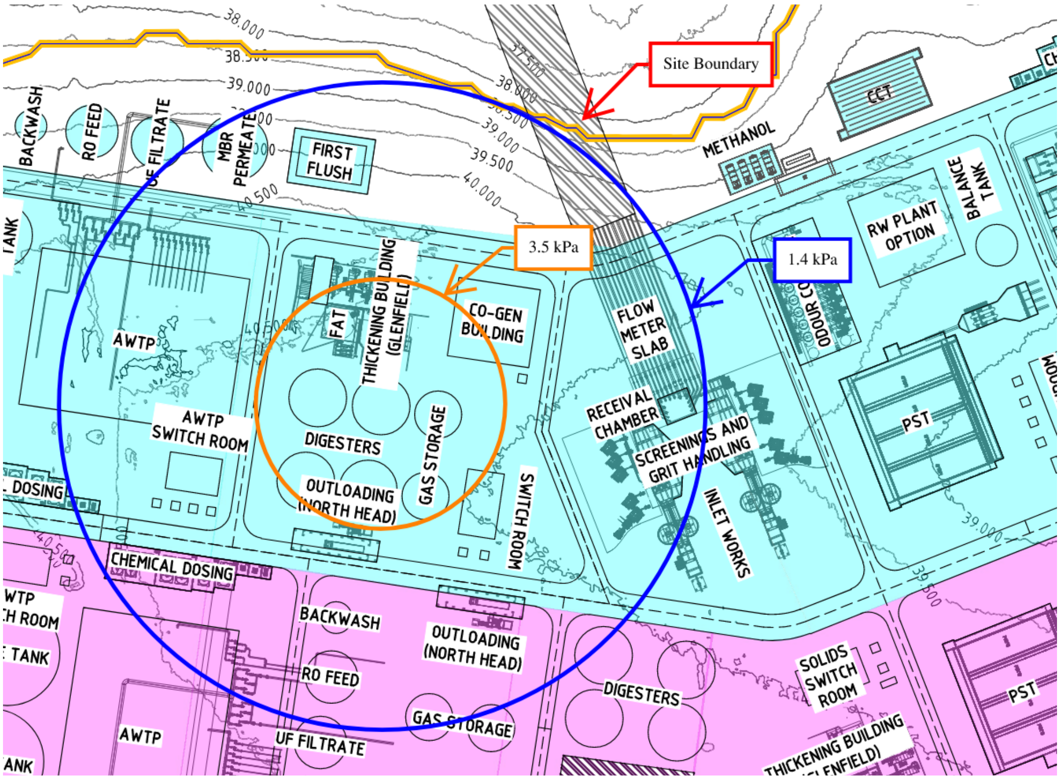


**Figure 6-6: Impact contours for VCE model**

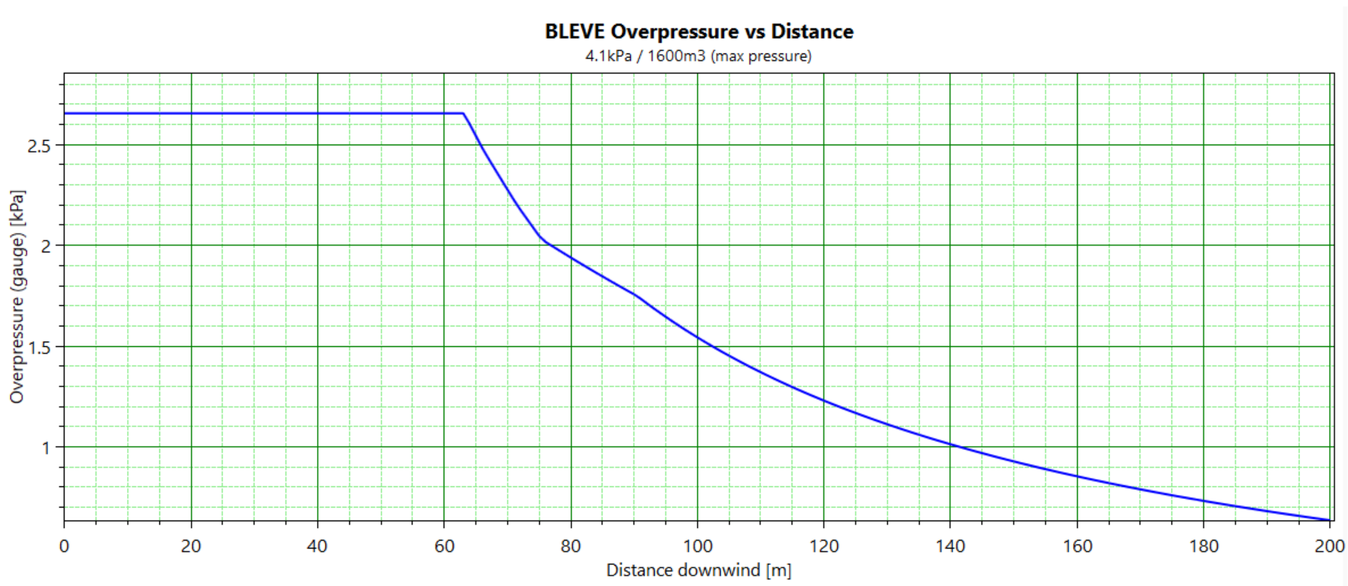



The site layout as at the time of writing shows the digester gas holders at least 124 m from the site boundary. At this distance, the overpressure is 1.4 kPa, which is comparable to the force of a very strong wind. It is anticipated therefore, that the offsite impacts of a VCE following a LOC of methane from the digester gas holders will be negligible and that there is no offsite fatality risk.

### 6.3.2.2 Boiling liquid expanding vapour explosion

The results of the consequence modelling are presented in Figure 6-7.

**Figure 6-7: BLEVE overpressure vs distance**



The site layout as at the time of writing shows the digester gas holders at least 124 m from the site boundary. At this distance, the overpressure is 1.2 kPa, which is comparable to the force of a very strong wind over a very short duration. It is anticipated therefore, that the offsite impacts of a BLEVE following a jet fire impingement from the digester gas holders will be negligible and that there is no offsite fatality risk.

### 6.3.3 Exposure to methanol from a tanker accident

#### 6.3.3.1 Pool fire

The results of the consequence modelling are presented in Figure 6-8. The distances from the pool fire centre to the heat flux radiation levels of interest are presented in Table 6-9. This is represented by impact contours on the site layout in Figure 6-9 below.

**Figure 6-8: Pool fire heat radiation vs distance**

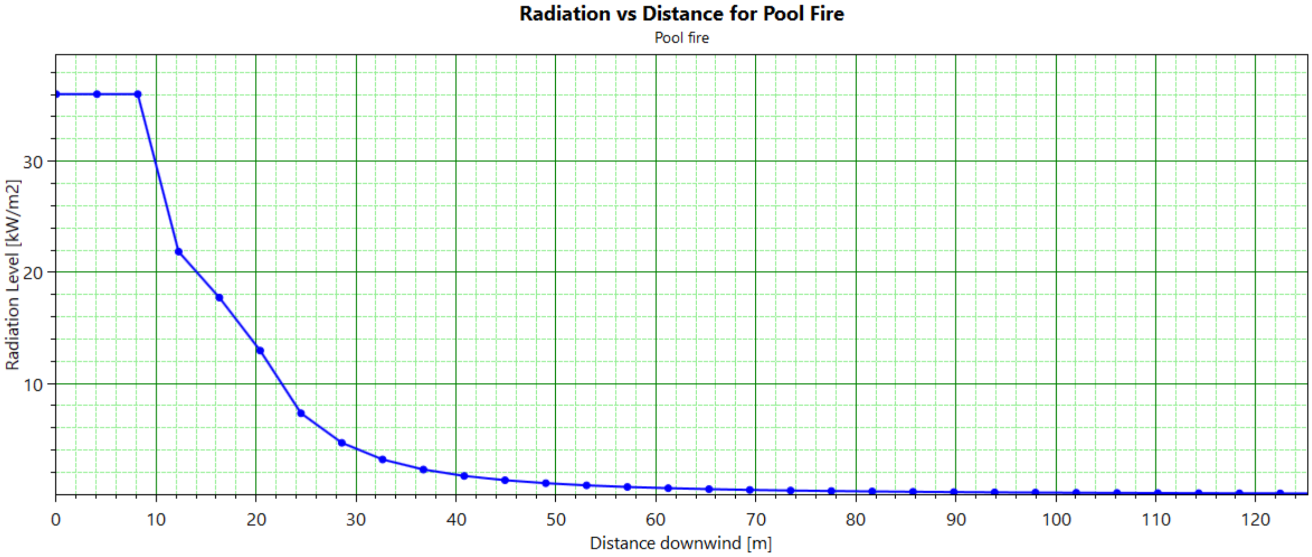



**Table 6-9: Methanol transportation – pool fire heat radiation contours**

| Distance from pool fire centre to heat radiation level (m) | | | | |
|---|---|---|---|---|
| 35 kW/m² | 23 kW/m² | 12.6 kW/m² | 4.7 kW/m² | 2.1 kW/m² |
| N/A | 13 | 19 | 28 | 33 |

**Figure 6-9: Impact contours for pool fire model**


While the impact contours for 2.1 kW/$m^2$ and 4.7 kW/$m^2$ do extend past the site boundary of the school, only the 2.1 kW/$m^2$ contour reaches an area where an individual could be exposed. Furthermore, HIPAP 4 [4] guidance states that exposure to 4.7 kW/$m^2$ is an appropriate lower bound for injury. This exposure should not exceed more than 50 chances in a million per year.

As illustrated in the methanol transport pool fire TBD in Appendix C, there are multiple naturally occurring controls that are ordinarily in place to reduce the likelihood of such a scenario occurring. These may include:

- The accident occurring near the school or other sensitive receptor.
- The accident being extreme enough to cause a failure of the tank.
- The pool of methanol ignites.
- There are sensitive receptors outside and close enough to the pool fire to be affected.

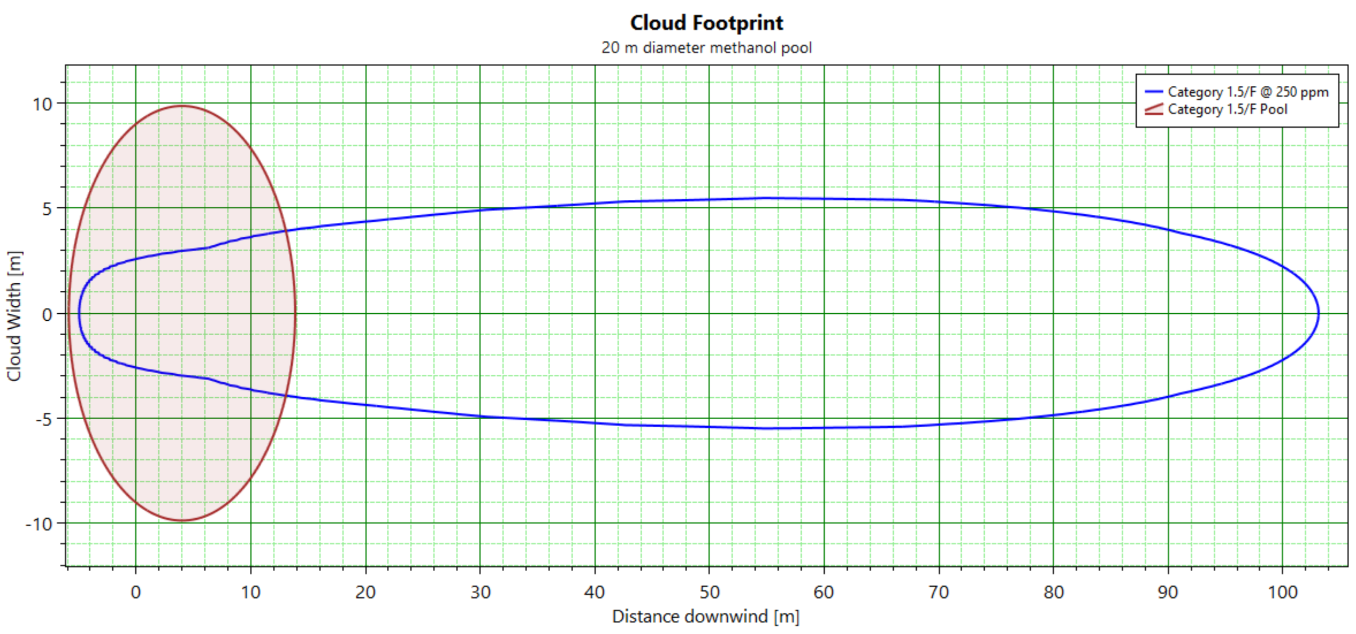
This is not an exhaustive list, but all controls would all have to fail concurrently for this scenario to occur. It is considered that the likelihood of a pool fire resulting from a leak of methanol following an accident involving the methanol transport adjacent to a sensitive receptor is extremely low.

It is recommended that if methanol is chosen as the supplemental carbon source, the likelihood of this event is to be quantified and a route evaluation study in accordance with HIPAP 11 [6] be undertaken. Additionally, the school should be notified as part of the emergency response plan in the event of an emergency involving a methanol tanker near the school.

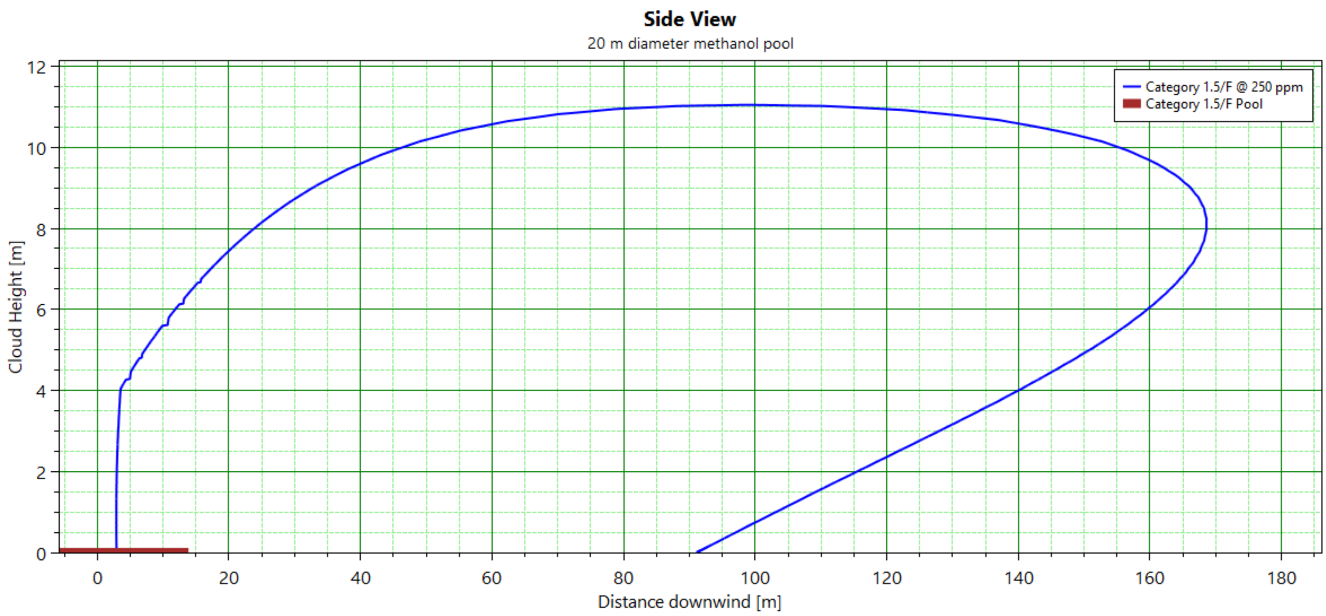
#### 6.3.3.2 Dispersion of toxic cloud

The results of the consequence modelling are presented in Figure 6-10 and Figure 6-11. The possible dispersion contour is presented in Figure 6-12.

## Figure 6-10: Footprint of methanol dispersion




## Figure 6-11: Side view of methanol dispersion



### Figure 6-12: Dispersion contour at 250 ppm


While this cloud does extend past the site boundary of the school, it is expected that individuals will be able to shelter indoors before being exposed to the STEL. Furthermore, as illustrated in the methanol transport dispersion TBD in Appendix C, there are multiple naturally occurring controls that are ordinarily in place to reduce the likelihood of such a scenario occurring. These may include:

- The accident occurring near the school or other sensitive receptor.
- The accident being extreme enough to cause a failure of the tank.
- The pool of methanol vaporises and does not ignite.
- The wind is strong enough and in the right direction to disperse the cloud towards sensitive receptors.
- There are sensitive receptors outside and close enough to the STEL contour to be affected.

This is not an exhaustive list, but all controls would all have to fail concurrently for this scenario to occur. It is considered that the likelihood of the dispersion of methanol resulting from a leak following an accident involving the methanol transport adjacent to a sensitive receptor is extremely low.

In accordance with HIPAP 4 [4], this event should not have a probability of occurrence more than 10 chances in a million per year.

It is recommended that if methanol is chosen as the supplemental carbon source, the likelihood of this event is to be quantified and a route evaluation study in accordance with HIPAP 11 [6] be undertaken. Additionally, the school should be notified as part of the emergency response plan in the event of an emergency involving a methanol tanker near the school.

# 7 Acceptability of design changes

As the design of the AWRC has not been finalised, there are a number of design parameters that may change before the construction of the site. It is important to understand the potential changes that could be effected while maintaining the negligible levels of risk demonstrated by this PHA.

The following guidance gives conservative separation distances and distances to the site boundary for hazardous chemicals deemed to have potential offsite consequences:

- the bunded methanol dosing point should be at least 20 m from the site boundary;
- the digester gas holders should be at least 30 m from the site boundary to ensure that a bushfire will not cause a vapour cloud explosion; and
- chemical storage of flammable and explosive material for future stages of the development are to be at least 50 m from the current flammable and explosive storage to prevent any knock-on events.

The distances stated above have been chosen as sufficiently conservative, in-line with the relevant general principles set out by HIPAP 4 [4]:

- 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.

It should be noted that the future stages of the project being considered have the requisite chemicals sufficiently separated from both Stage 1 chemicals and the site boundary that the conclusions and recommendations made in this PHA are considered adequate for future stages of the project.

# 8 Findings

It has been identified that the most credible onsite hazards with the potential to cause offsite impacts are the methanol storage area and the digester gas holders. The transport of methanol to the site was also identified as potentially impacting sensitive receptors. The following scenarios were defined:

- methanol storage area: a pool fire following immediate ignition after a LOC of the methanol from the dosing equipment.
- digester gas holders:
  - a vapour cloud explosion (VCE) after a LOC of the methane; and
  - a boiling liquid expanding vapour explosion (BLEVE) following direct flame impingement from a jet fire from another digester gas holder.
- methanol transport:
  - a pool fire after a LOC of the methanol from a tanker accident; and
  - the dispersion of a toxic cloud following a leak from a tanker accident.

A pool fire in the bund of the dosing point was modelled with a heat radiation of 0.8 kW/m$^2$, less than the heat radiation felt by the sun at noon in the summer, being calculated at the boundary of the site.

A VCE as the result of a leak and immediate ignition of the methane from the digester gas holder was modelled with an overpressure of 1.4 kPa, comparable to the pressures felt by a very strong wind, being calculated at the boundary of the site.

A BLEVE as the result of the direct flame impingement from a jet fire from another digester gas holder was modelled with an overpressure of 1.2 kPa, comparable to the pressures felt by a very strong wind, being calculated at the boundary of the site.

A pool fire on a road adjacent to a sensitive receptor was modelled with a heat radiation of 4.7 kW/m$^2$ extending over the boundary of the sensitive receptor. It should be noted that only a heat radiation of 2.1 kW/m$^2$ was found to extend to an area where an individual could be exposed.

The dispersion of a toxic cloud of methanol vapour was modelled, with the STEL of 250 ppm extending 100 m from the pool centre. This extends into the boundary of the sensitive receptor, but it is expected that the likelihood of such an incident is extremely low and individuals would be able to shelter-in-place if it did occur.

The consequence modelling for all three scenarios demonstrate a negligible offsite impact and that there is no offsite fatality risk.

# 9 Recommendations

As a result of the findings above, the following recommendations have been made:

### Table 9-1: Hazards and mitigation effectiveness

| Project specific mitigation measures | | |
|---|---|---|
| **Potential impact** | **Mitigation measure** | **Impact significance following mitigation** |
| Release of methanol near sensitive receptor | If methanol is chosen as the final supplemental carbon source:<br>A route evaluation study for the transport of methanol should be completed in accordance with HIPAP 11 – *Route Selection* [6]; and<br>The likelihood of both a pool fire and dispersion of a toxic cloud should be quantified. | Medium |
| Interaction between incompatible dangerous goods | Class 8 substances 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 [5].<br>Citric acid (nor any other acid) will not be stored in the same bunded area as sodium bisulphite. | Low |
| Compliance with Work Health and Safety Regulations | A manifest of the hazardous chemicals exceeding manifest quantities is to be prepared in accordance with Regulation 347 and Schedule 12 of the WHS Regulations.<br>The regulator must be notified of hazardous chemicals exceeding manifest quantities in accordance with Regulation 348 of the WHS Regulations.<br>An emergency plan is to be prepared for the site and provided to the NSW Fire and Rescue as per the requirements of Regulation 361 of the WHS Regulations.<br>The school should be notified as part of the emergency response plan in the event of an emergency involving a methanol tanker near the school.<br>Outer warning placards regarding quantities of hazardous chemicals should be displayed at any entrance where emergency services may enter the workplace in accordance with Regulation 349 and Schedule 13 of the WHS Regulations.<br>Placards should be displayed on or near the storage of hazardous chemicals in accordance with Regulation 350 and Schedule 13 of the WHS Regulations. | Low |
| Release of firewater into the environment | The stormwater system should be designed with sufficient capacity to contain the firewater in the event of a fire and retain it until testing confirms it is safe for release. | Low |

It should be noted that the future stages of the project being considered have the requisite chemicals sufficiently separated from both Stage 1 chemicals and the site boundary that the conclusions and recommendations made in this PHA are considered adequate for future stages of the project.

# 10 Bibliography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[10] NSW Rural Fire Service, *Planning for Bush Fire Protection,* 2019.

[11] Safe Work Australia, *Workplace Exposure Standards for Airborne Contaminants,* 2013.

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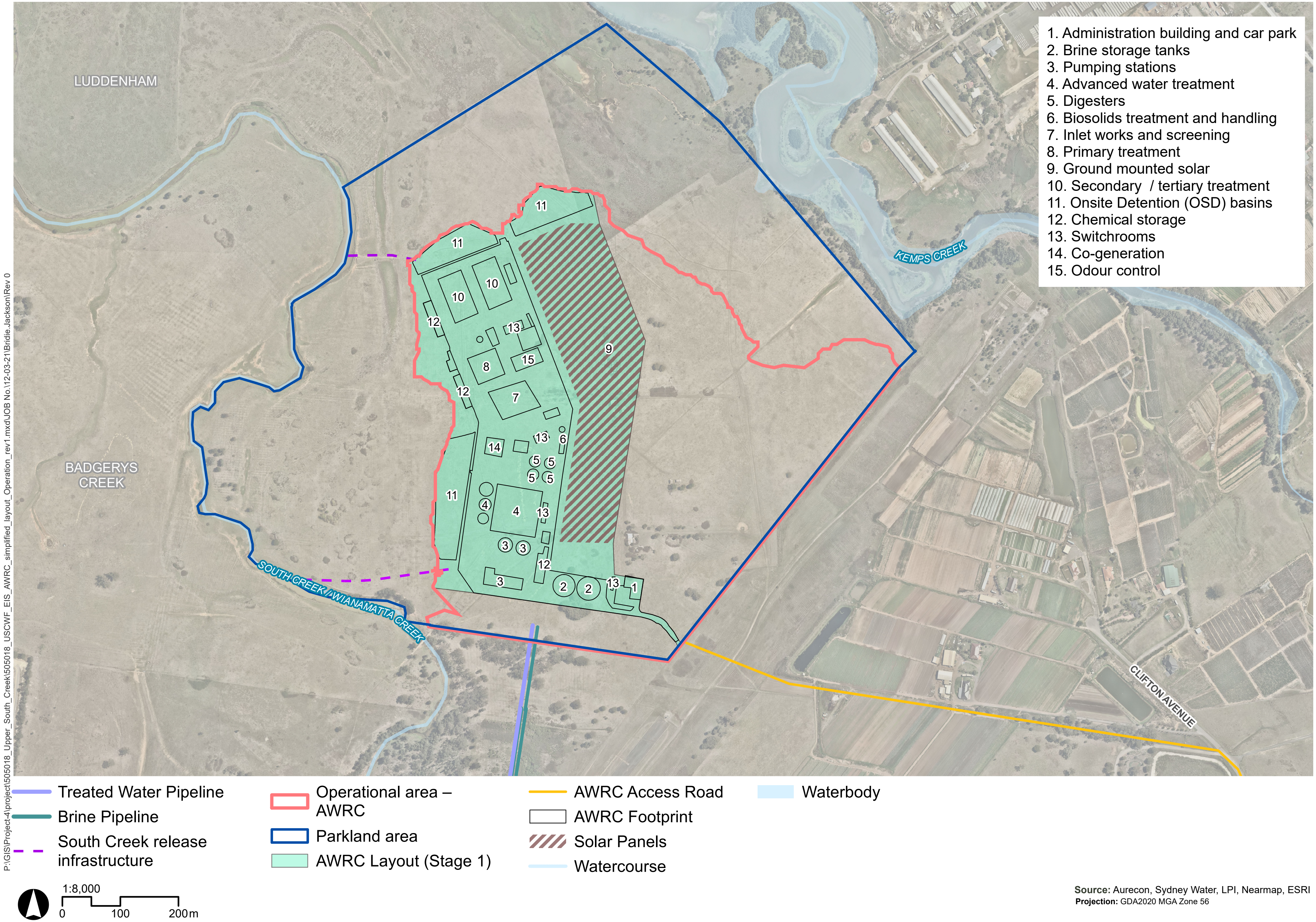
# 11 Glossary and abbreviations

| | |
|---|---|
| ADGC | Australian Code for the Transport of Dangerous Goods by Road & Rail |
| AWRC | Upper South Creek Advanced Water Recycling Centre |
| AWTP | Advanced Water Treatment Plant |
| BLEVE | Boiling Liquid Expanding Vapour Explosion |
| DPIE | Department of Planning, Industry and Environment |
| EIS | Environmental Impact Statement |
| HAZID | Hazard Identification Study |
| HIPAP | Hazardous Industry Planning Advisory Paper |
| LOC | Loss of Containment |
| MLRA | Multi-level Risk Assessment |
| PHA | Preliminary Hazard Analysis |
| ROSA | Reverse Osmosis System Analysis |
| SBS | Sodium Bisulphite |
| SEAR | Secretary’s Environmental Assessment Requirement |
| SEPP | State Environmental Protection Policy |
| SFAIRP | So Far as is Reasonably Practicable |
| STEL | Short-term Exposure Limit |
| TBD | Threat-Barrier Diagram |
| VCE | Vapour Cloud Explosion |
| WHS | Work Health and Safety |

# Appendix A Proposed Site Layout



1. Administration building and car park
2. Brine storage tanks
3. Pumping stations
4. Advanced water treatment
5. Digesters
6. Biosolids treatment and handling
7. Inlet works and screening
8. Primary treatment
9. Ground mounted solar
10. Secondary / tertiary treatment
11. Onsite Detention (OSD) basins
12. Chemical storage
13. Switchrooms
14. Co-generation
15. Odour control
LUDDENHAM
BADGERYS CREEK
KEMPS CREEK
SOUTH CREEK / WIANAMATTA CREEK
CLIFTON AVENUE
Treated Water Pipeline
Brine Pipeline
South Creek release infrastructure
Operational area – AWRC
Parkland area
AWRC Layout (Stage 1)
AWRC Access Road
AWRC Footprint
Solar Panels
Watercourse
Waterbody
1:8,000
0 100 200m
Source: Aurecon, Sydney Water, LPI, Nearmap, ESRI
Projection: GDA2020 MGA Zone 56
P:\GIS\Project-4\project\505018_Upper_South_Creek\505018_USCWF_EIS_AWRC_simplified_layout_Operation_rev1.mxd\JOB No.\12-03-21\Bridie.Jackson\Rev 0

# Appendix B Hazard Identification Study Minutes

| | |
|---|---|
| PROJECT NUMBER | **20036007** |
| PROJECT NAME | **USC AWRC** |
| PROJECT DESCRIPTION | **Waste Water Treatment Plant** |
| PROJECT MANAGER | **Matthew Dignam** |
| DESIGN MANAGER | **Nigel Vivian** |

| COMPULSORY READING/ RELEVANT INFORMATION | | Description |
|---|---|---|
| safe work australia | Safe Work Australia - Safe Design of Structures Code of Practice | This model Code of Practice has been developed to provide practical guidance to persons conducting a business or undertaking who design structures that will be used, or could reasonably be expected to be used, as a workplace. This includes architects, building designers and engineers.<br><br>This Code is also relevant for anyone making decisions that influence the design outcome, such as clients, developers and builders. |
| NSW GOVERNMENT WorkCover | CHAIR Safety in Design Tool | A useful document summarising the CHAIR process, including examples and the list of guidewords. |
| Sydney WATER | Sydney Water Safety in Design Procedure | iConnect link (will only work when accessed from Sydney Water computers) |

## SAFETY IN DESIGN METHODOLOGY GUIDE

1. There are several types of SiD reviews available to the project team.
2. The type of review/s to be undertaken depends upon the Level of Design and Discipline Involvement.
3. The designers shall select the most appropriate SiD reviews to mitigate the risks associated with the project.
4. Below are examples of these categories and various SiD methodologies that could be used.

| LEVEL OF DESIGN | | | | |
|---|---|---|---|---|
| **PROCUREMENT SUPPORT**<br>Technical authoring / equipment specification based on SWC Specifications | **MINOR MAINTENANCE ACTIVITIES**<br>Minor equipment replacement or remediation | **CONCEPT DESIGN**<br>Conceptual design only | **DETAILED DESIGN**<br>Detailed design only | **DEMOLITION**<br>Any works involving demolition or decommissioning |
| **POSSIBLE SID METHODOLOGY** | | | | |
| NOT APPLICABLE | HIDRA | HIDRA<br>CHAIR 1<br>HAZOP<br>CHAZOP<br>FMECA | HIDRA<br>CHAIR 2<br>CHAIR 3<br>HAZOP<br>CHAZOP<br>FMECA | HIDRA<br>CHAIR 2 |

**HAZOP RECORD SHEET**

# HAZOP
# HAZARD & OPERABILITY STUDY

| | |
|---|---|
| **DATE OF REVIEW** | **05/05/2020** |
| **PROJECT NUMBER** | **20036007** |
| **PROJECT NAME** | **Upper South Creek** |
| **PROJECT DESCRIPTION** | **Waste Water Treatment Plant** |
| **Project Manager: Matthew Dignam** | |
| **Design Lead: Nigel Vivian** | |

| Reference Drawings/Documents |
|---|
| |

| No. | Guideword | Risk Issue | Causes | Consequences | Safeguards | ACTION Description | ACTION Person Responsible | ACTION Date Due | DISCUSSION NOTES - Not all specifally HAZARD However recorded in the relevant section for context. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | | LINES | | | | | |
| *E.g.* | *High Flow / High Level* | | | | | | | | |
| **1.** | **Influent Recieval Chamber** | | | | | | | | |
| 1.1 | Flow/Level | High flow from network: | Comms failure with pump stations from SCADA to IICATS | High flows to plant could cause discharge of primary treated effluent | There is a level sensor influent chamber and a physical high level switch that is planned to connect to icaats to limit upstream pumping station. Screenings is designed for 6ADWF and PST fo 3 ADWF, so should be a manageable occurance. There is a plan to automate back to network, but even if that fails there is a flow path. Considered further at the PST and bioreactor. | | | | Potentially 2 flow meters on lines (one at pump station). High flow from network - all pumped flow will overflow at plant without automation back to network. Do we need an isolation valve to each inlet works? Low flow -potential for screenings depostion. |
| | | grit deposit | flow flow oversized chamber | maintance in a critical chamber | benching to outlet | Optimise the size of the chamber. | MR | 80% | |
| 1.2 | Pressure | | | | | | | | |
| 1.3 | Temperature | | | | | | | | |
| 1.4 | Changes in composition/concentration | | | | | | | | |
| 1.5 | Plant items | | | | | | | | |
| 1.6 | Instruments | | | | | | | | Location of LTX important so not impacted by turbulence - note |
| 1.7 | Services Required | | | | | | | | Ventillation - need to get air velocities and changes correct. Washwater required and backup in event of no MBR. |
| 1.8 | Materials of Constrsuction | | | | | | | | Need a liner on exposed concrete |
| 1.9 | Breakdown/failure | | | | | | | | Need access to flowmeters for maintenance, given number of RM and limited space |
| **2.** | **Screenings and Grit Removal** | | | | | | | | |
| 2.1 | Flow/Level | | | | | | | | |
| 2.2 | Pressure | | | | | | | | |
| 2.3 | Temperature | | | | | | | | |
| 2.4 | Changes in composition/concentration | | | | | | | | |
| 2.5 | Plant items | operator unable to rack manual screen | Too many screenings, difficult operation | screen through to process. | | Review the need to a mechanical bypass screen. | | | Bypass screen should be mechanical due to operability and health and safety concerns of manual screens. If we want mechanical screens, we need to include it in the reference design. Keep channel shallow and provide access to openings for manual raking if this is a manually raked screen. |
| 2.6 | Instruments | | | | | | | | |
| 2.7 | Services Required | | | | | | | | |
| 2.8 | Materials of Constrsuction | | | | | | | | |
| 2.9 | Breakdown/failure | no process path under critical failure | power or control failure | unscreened sewage to process and to outfall. | dual power feed and dual control networks | | | | Power failure at wet weather - UPS on the bypass mechanical screen. There is an issue with power outage and wet weather event. Backup mechanical would have to have own power source e.g UPS, generators. Do not have permenantly installed generators at USC, but do have double feeders. Having non mechanical primaries makes this a lower risk. We will have to consider for Spec and maybe add a caveat for hand raked screens. Or can we get rid of manual screens all together for bypass? |
| **3.** | **Vortex Grit Capture** | | | | | | | | |
| 3.1 | Flow/Level | | | | | | | | Grit tanks have 150% process capacity, so there is the opportunity to take one offline. |
| 3.2 | Pressure | | | | | | | | |
| 3.3 | Temperature | | | | | | | | |
| 3.4 | Changes in composition/concentration | | | | | | | | |
| 3.5 | Plant items | | | | | Specs for grit removal process to be prescriptive around performance guarantees | MR | 100% | Update pump pipework - one pump per classifier per grit chamber **REFER TO 5.5** |
| 3.6 | Instruments | | | | | | | | During the VE workshop there was a proposal for using ultrasonic flowmeters instead of mag flow. They are currently used in LSC. We often need a level control downstream of the grit traps to prevent draining during low flows. Flumes are needed for level control elements. Some brands (smith and loveless) have a level control weir installed as part of tank itself. Smith and loveless have high removal rates. We should write the tech spec with requirements to guarantee removal rate, knowing only S+L can ensure this. We can write the grit spec to ensure high levels of grit capture to protect downstream plant. Flow mearuement also has to be considered along with maintaining high removal in grit traps. Need a FSL on grit pumps. |
| 3.7 | Services Required | | | | | | | | |
| 3.8 | Materials of Constrsuction | | | | | | | | |
| 3.9 | Breakdown/failure | | | | | | | | |
| **4** | **Inlet works screenings handling** | | | | | | | | |
| 4.1 | Flow/Level | | | | | | | | |
| 4.2 | Pressure | | | | | | | | |
| 4.3 | Temperature | | | | | | | | |
| 4.4 | Changes in composition/concentration | | | | | | | | |
| 4.5 | Plant items | | | | | | | | |
| 4.6 | Instruments | | | | | | | | |

# HAZOP RECORD SHEET

| No. | Guideword | Risk Issue | Causes | Consequences | Safeguards | ACTION | | | DISCUSSION NOTES - Not all specifally HAZARD However recorded in the relevant section for context. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Description | Person Responsible | Date Due | |
| 4.7 | Services Required | | | | | | | | |
| 4.8 | Materials of Constrsuction | | | | | | | | |
| 4.9 | Breakdown/failure | | | | | | | | |
| **5.** | **Grit washing and outloading** | | | | | | | | |
| 5.1 | Flow/Level | | | | | | | | |
| 5.2 | Pressure | | | | | | | | |
| 5.3 | Temperature | | | | | | | | |
| 5.4 | Changes in composition/concentration | | | | | | | | |
| 5.5 | Plant items | blockage of pipework | Tee's in grit pipe | loss process units | | dedicated pipes from grip pumps to classifiers. | SC | 80% | Each grit tank works with a classifier. It has no functionality of crossover pipework for maintenance. We need to update the P&ID. No common header for grit pumps, each grit trap has two grit pumps to two classifiers. |
| 5.6 | Instruments | | | | | | | | |
| 5.7 | Services Required | | | | | | | | |
| 5.8 | Materials of Constrsuction | | | | | | | | |
| 5.9 | Breakdown/failure | | | | | | | | |
| **6.** | **PST Flow Distribution** | | | | | | | | |
| 6.1 | Flow/Level | Setting of solids in inlet channel | low velocity | grit in inlet channel / maintainance | | taper channel to prove an increased velocity at ends of cahnnel where flow in the lowest. | MR | 100% | Shape of channel changing in cross section depending on flow at various points (wider in cenre, narrower towards PSTs). If you are relying on penstock/launders to control flow split, might end up with differential flows in tanks. At st marys, flow split was more controlled by inlet valve to get split over the weir. Not an ideal way to control levels relative to a weir. Also issue with solids settling in channel. need to consider shaping and depth of channel. Avoid aeration in channel because of maintenance issues. |
| 6.2 | Pressure | | | | | | | | |
| 6.3 | Temperature | | | | | | | | |
| 6.4 | Changes in composition/concentration | Scum in feed channel | no method of removal | scum build up - maintenance | | Need to add penstock or similar that can open to allow scum to pass through to PST. | SC | 80% | Need to consider scum in inlet channel. LSC has higher level penstock to allow scum through to get rid of it. |
| 6.5 | Plant items | | | | | | | | Mixers could also help with ferric dosing |
| 6.6 | Instruments | | | | | | | | |
| 6.7 | Services Required | | | | | | | | Consider reverse direction valves at back of tank for backfilling with PE during maintenance, releasing from channel height. |
| 6.8 | Materials of Constrsuction | | | | | | | | Spec should include usual consideration about corrosion concrete coating etc. |
| 6.9 | Breakdown/failure | | | | | | | | |
| **7** | **PST Tanks** | | | | | | | | |
| 7.1 | Flow/Level | Low flow | Block pipes | ineffective scum or sludge removal | | add rodding points or hot sludge flush - however not designing to this level of detail. | | | Issue with getting scum to flow through the lines. May be issues with cleaning and rodding scum lines and the potential for sludge lines blocking with fats, oils and grease. |
| 7.2 | Pressure | | | | | | | | |
| 7.3 | Temperature | | | | | | | | |
| 7.4 | Changes in composition/concentration | Scum | | | | add level detection | | | |
| 7.5 | Plant items | sludge build up in the PST | ineffective sludge draw of due to wide PSTs and single draw point | process issues and desludgeing | | add additoinal extraction pooint | SC | 80% | For tanks this wide, can use cross scraper to push sludge across width to one end, but that adds more maintenance. We cannot have single sludge drawoff from a 12m wide sludge hopper. |
| 7.6 | Instruments | | | | | | | | Need torque switches on drives, particularly for bottom scraper. Limit switches for flight direction. WSH for drives.<br>Need sludge blanket level detector. Consider multiple sludge hoppers. |
| 7.7 | Services Required | | | | | | | | Need spray water for scum, hose points for wash down |
| 7.8 | Materials of Constrsuction | | | | | | | | |
| 7.9 | Breakdown/failure | | | | | | | | |
| **8** | **Fine Screens** | | | | | | | | |
| 8.1 | Flow/Level | Screenings pump block | Ragging | Increased maintance | Pump Selection - vaughn chopper pumps | | | | 3x50% process capacity, 2 duty, 1 standby<br>Consider pump types for screenings |
| 8.2 | Pressure | | | | | | | | |
| 8.3 | Temperature | | | | | | | | |
| 8.4 | Changes in composition/concentration | | | | | | | | |
| 8.5 | Plant items | | | | | | | | Getting screenings to common screenings handling. Currently sluice -> wet well -> submersible pumps. Are submersible pumps the best? Could end up with screenings stuck on pump wires/supports or blocking the suction of pumps. May need a chopper pump and configured dry mounted. Connect RE to sluice. |
| 8.6 | Instruments | | | | | | | | |
| 8.7 | Services Required | | | | | | | | |
| 8.8 | Materials of Constrsuction | | | | | | | | |
| 8.9 | Breakdown/failure | Flooding of bioreactor | failure of isolation | environmental / health / safety concerns | power back up, multiple penstocks | | | | Power fail scenario: We have a dual power feed with half of bioreactor on each. With the loss of one feed, we will have half bioreactor capacity so only 1.5ADWF. Varying capacity to bioreactor has issues with static weir. In event of power fail, we will use penstocks combined with level in bioreactor. If increase in bioreactor level, penstocks will close to prevent level, forcing more flow to overflow weir. Alternatively, could be a valve on the line between the PST and screen chamber (plug valve). Would be expensive and would very rarely operate. We have 2 sets of penstocks for reliability. We need to decide how to balance screens so two could be off one feeder and one off another. Would have enough control to be able to have only 1 screen operating when losing a feeder. Need to make it clear in control logic/spec about uneven equipment over 2 feeders and the different response. Overflow on PST sized for 4.5ADWF. In event where we lost feed, need to manage full flow to plant. Storm weir controlled by penstocks. As a 3rd level of backup, control link with network. Need to consider cost of separate feeder vs cost of 6ADWF bypass. Wouldn't necessarily need backup generator. If we lose power from outside of fence, can feed the plant from other feed supply. |
| **9** | **CCT and Dechlorination** | | | | | | | | |
| 9.1 | Flow/Level | Flooding of CCT | power fail in peak storm condition | environmental / health / safety concerns | | Increase capacity of CCT to ensure 4.5 ADWF can be passed through from PST to outfall | MR | 80% | Hydraulically sized to take 4.5ADWF. We have a contingency for power fail during storm. From a process perspective, should it be sized to 3 or 4.5? Probably need to size for the 3, because 4.5 requires too many failure scenarios. Could have v notch to extend weir. Note west camden CCT had the last section ~10% for dechlorination to prevent discharge to creek. Sodium bisulphite line can be moved to last pass of CCT. |
| 9.2 | Pressure | | | | | | | | |
| 9.3 | Temperature | | | | | | | | |

# HAZOP RECORD SHEET

| No. | Guideword | Risk Issue | Causes | Consequences | Safeguards | ACTION Description | ACTION Person Responsible | ACTION Date Due | DISCUSSION NOTES - Not all specifally HAZARD However recorded in the relevant section for context. |
|---|---|---|---|---|---|---|---|---|---|
| 9.4 | Changes in composition/concentration | SBS no fully mixed in prior to discharge | Dosed downstream of CCT weir | effect on ecology in creek | There is a very long discharge path through pipes and channel. There will be plenty of mixing | | | | SBS dose point - potentially use final pass for contact time |
| 9.5 | Plant items | | | | | | | | Number of turns/baffling up to supplier. Consdier CCT cleaning, need drains. |
| 9.6 | Instruments | | | | | | | | |
| 9.7 | Services Required | | | | | | | | |
| 9.8 | Materials of Constrsuction | | | | | | | | |
| 9.9 | Breakdown/failure | | | | | | | | |
| **10** | **Bioreactor** | | | | | | | | |
| 10.1 | Flow/Level | Need stopboards for tank isolations e.g. risk of power outage/stop pumping membranes causing backflow into reactor. Need to isolate downstream end. | Membrane tank offline and RAS pump fails | Flow pass backwards to Membrane tanks. | | Allow for stopboards on the membrane outlet weirs. | SC | 80% | There is no hydraulic bypass to membrane. Is there a risk of overflowing bioreactors? We arent actually pumping into bioreactor, so at a certain level it will flow upstream. We need to check hydrualics. Could have weir/chmaber at end of MBR feed channel connected to stormwater, to ensure gravity feed out. However would be overflowing mixed liquor. Considered making bioreactors tall enough to make it overflow PST weir, but that would have been too tall. Hydrualic break on weirs to bioreactors, so theoretically overflow shouldnt go back to screens. Need to consider network controls, if there is a high level in bioreactor shutoff feed to plant. Fine screens upstream of bioreactor will shut if mixed liquour channel is high high, which is another protection. High level switch on every biroeactor would be another layer of protection. Note that layout and levels could change in detailed design. Need to document seuqence of events that results in this critical scenario, would require multiple failures. |
| 10.2 | Pressure | | | | | | | | |
| 10.3 | Temperature | | | | | | | | |
| 10.4 | Changes in composition/concentration | scum build up in bioreactor | insufficient flow velocity to push scum to MLR channel | maintenance activities | | Check MLR & RAS rates and check velocities or provide sprays | MR | 80% | Design for scum transfer down the bioreactor and sprays to get it over the end weir and towards the MBR. Currently have sprays in ML channel. Variable COD load/composition potential high as may be predominantly industrial. |
| 10.5 | Plant items | | | | | | | | |
| 10.6 | Instruments | Bioreactor flooding in power fail | penstock don't close | environmental / health / safety concerns | | Allow for back up instruments to detect high level | SC | 80% | Level instruments for power failure scenario: level control is in downstream membrane tanks feed channels. Duty/standby LTX and LSHH to shut inlet penstocks as failsafe - all instruments and penstocks to be connected to UPS. Need to have something in spec on preferred instruments to ensure enough spares etc. Location of ammonia probe should be such that it can control aeration DO. |
| 10.7 | Services Required | | | | | | | | |
| 10.8 | Materials of Constrsuction | | | | | | | | |
| 10.9 | Breakdown/failure | Flooding of membrane tanks | RAS pumps stop / fail | environmental / health / safety concerns | Mebrane tank wall same height as bioreactor. | | | | If membrane permeate or RAS pumps stop, chambers fill up and stop flow through bioreactors. Do we hant high level switch on each biroeactor to shut off feed penstock? Bioreactor has large HGL but we can consider it. |
| **11** | **Mixed Liquor Channel** | | | | | | | | |
| 11.1 | Flow/Level | | | | | | | | |
| 11.2 | Pressure | | | | | | | | |
| 11.3 | Temperature | | | | | | | | |
| 11.4 | Changes in composition/concentration | | | | | | | | |
| 11.5 | Plant items | Can't remove scum | Fixed weir on the scum weir. | only remove scum and very speciifc flow rates. | | Consider modulating weir. | MR | 80% | Scum removal: shown as fixed weir, but might have different level. Can make scum removal slightly submerged bellmouth. Can make scum lines primary wasting method -> surface wasting (as used in north head MBR). Want to make scum valves modulated and connect to wasting line. |
| 11.6 | Instruments | | | | | | | | Need high level switch and alarm - **refer to 10.1** |
| 11.7 | Services Required | | | | | | | | |
| 11.8 | Materials of Constrsuction | | | | | | | | |
| 11.9 | Breakdown/failure | | | | | | | | |
| **12** | **Bioreactor Aeration Chamber** | | | | | | | | |
| 12.1 | Flow/Level | | | | | | | | Plenty of turndown for blowers for commissioning loads and flows. Need NRV on each blower. |
| 12.2 | Pressure | | | | | | | | |
| 12.3 | Temperature | | | | | | | | |
| 12.4 | Changes in composition/concentration | | | | | | | | |
| 12.5 | Plant items | | | | | | | | |
| 12.6 | Instruments | | | | | | | | |
| 12.7 | Services Required | | | | | | | | |
| 12.8 | Materials of Constrsuction | | | | | | | | |
| 12.9 | Breakdown/failure | | | | | | | | |
| **13** | **MBR Tank** | | | | | | | | |
| 13.1 | Flow/Level | | | | | | | | Low-level entry to MBR tank |
| 13.2 | Pressure | | | | | | | | |
| 13.3 | Temperature | | | | | | | | |
| 13.4 | Changes in composition/concentration | Air in pipe | air not efffectly removed by eductor | pump don't provide correct flow rate | | Eductor should be moved upstream of the backpulse pipework due to needing to be located at high point of permate pipework | SC | 80% | |
| 13.5 | Plant items | | | | | | | | |
| 13.6 | Instruments | | | | | | | | What area are we using to level control pumps? If we use a small channel, level will change a lot. - using the ML channel |
| 13.7 | Services Required | | | | | | | | |
| 13.8 | Materials of Constrsuction | | | | | | | | |
| 13.9 | Breakdown/failure | | | | | | | | If we lose 2 bioreactors on a power feeder, we will only have 1 RAS return, so that membrane zone could fill up quickly. Can be picked up with level controls. **REFER TO 10.9** |
| **14** | **MBR Tanks** | | | | | | | | |
| 14.1 | Flow/Level | | | | | | | | |
| 14.2 | Pressure | | | | | | | | |
| 14.3 | Temperature | | | | | | | | |
| 14.4 | Changes in composition/concentration | | | | | | | | |
| 14.5 | Plant items | | | | | | | | |
| 14.6 | Instruments | | | | | | | | |
| 14.7 | Services Required | | | | | | | | |
| 14.8 | Materials of Constrsuction | | | | | | | | |
| 14.9 | Breakdown/failure | | | | | | | | |
| **15** | **RAS Pump Station** | | | | | | | | |
| 15.1 | Flow/Level | | | | | | | | Weir into each of chambers to split flow equally, RAS pumps will pump to set flow with trim based on level control. Because volume of bioreactors is quite large there will be a lag. Likely that membrane suppliers will edit this. |
| 15.2 | Pressure | | | | | | | | |

# HAZOP RECORD SHEET

| No. | Guideword | Risk Issue | Causes | Consequences | Safeguards | ACTION | | | DISCUSSION NOTES - Not all specifally HAZARD However recorded in the relevant section for context. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Description | Person Responsible | Date Due | |
| 15.3 | Temperature | | | | | | | | |
| 15.4 | Changes in composition/concentration | | | | | | | | No major issues with solids settling, as chambers are small and recycle constant |
| 15.5 | Plant items | | | | | | | | |
| 15.6 | Instruments | | | | | | | | Each chamber has level instrumentation. |
| 15.7 | Services Required | | | | | | | | |
| 15.8 | Materials of Constrsuction | | | | | | | | |
| 15.9 | Breakdown/failure | | | | | | | | |
| **16** | **MBR Backpulse Pumps** | | | | | | | | |
| 16.1 | Flow/Level | | | | | | | | |
| 16.2 | Pressure | | | | | | | | |
| 16.3 | Temperature | | | | | | | | |
| 16.4 | Changes in composition/concentration | Spray with hazardous water | None disinfected RE spray | operators health | | Check if it is a health issue. | AR | 80%] | Draw RE from this balance tank rather than AWTP? Closer to sources for things such as screens sprays. Check with RW team if RE being used for sprays requires disinfection. |
| 16.5 | Changes in composition/concentration | chemical in RE | Chemical residual left in backwash line | RE could have chemical residual | | | | | CIP chemicals need to go into each of individual MBR lines. Might have tank doing CIP while backpulse is happening. Don't want to backpulse chemicals. Might want backpulse line to be downstream going to each tank, so only dosing chemicals into chosen membrane, not all of them. Because of the size of the lines, there is a big pipe. Chemicals could sit in pipe and possibly wash into other units. Move dosing much closer to tank (directly into tank or in line just before tank). Membrane suppliers probably have this figured out. |
| 16.6 | Plant items | | | | | | | | |
| 16.7 | Instruments | | | | | | | | |
| 16.8 | Services Required | | | | | | | | |
| 16.9 | Materials of Constrsuction | | | | | | | | |
| 16.1O | Breakdown/failure | | | | | | | | |
| **17** | **MBR Tank Drain Pumps** | | | | | | | | |
| 17.1 | Flow/Level | | | | | | | | VE: Might be able to get rid of one pump and create common standby. Do we need something off common main to pump ML back to ML channel? In spec, need discussion on speed of pump back to chemical waste tank. Need minimum and max return rate. |
| 17.2 | Pressure | | | | | | | | |
| 17.3 | Temperature | | | | | | | | |
| 17.4 | Changes in composition/concentration | | | | | | | | Chemical waste tank: No neutralisation. Currently have 10% of UF. But if dry weather and no UF, might need to neutralise. Need to have clear guidance on RE quality. Line to return mixed liquor back to front end of mixed liquor channel during draindown for CIP. **Refer to 16.4** |
| 17.5 | Plant items | | | | | | | | |
| 17.6 | Instruments | | | | | | | | |
| 17.7 | Services Required | | | | | | | | |
| 17.8 | Materials of Constrsuction | | | | | | | | |
| 17.9 | Breakdown/failure | | | | | | | | |
| **18** | **MBR Air Scour Blowers** | | | | | | | | |
| 18.1 | Flow/Level | Reverse flow | no NRVs on blowers | damage to blowers | | Add NRVs to blower discahrge | SC | 80% | NRVs on blower lines |
| 18.2 | Pressure | | | | | | | | |
| 18.3 | Temperature | | | | | | | | |
| 18.4 | Changes in composition/concentration | | | | | | | | |
| 18.5 | Plant items | | | | | | | | |
| 18.6 | Instruments | | | | | | | | |
| 18.7 | Services Required | | | | | | | | |
| 18.8 | Materials of Constrsuction | | | | | | | | |
| | Breakdown/failure | | | | | | | | |
| | | | | **GENERAL DISCUSSION** | | | | | |
| 0.1 | | | | | | | | | |
| 0.2 | | | | | | | | | |
| 0.3 | | | | | | | | | |
| 0.4 | | | | | | | | | |
| 0.5 | | | | | | | | | |

# ATTENDEE_HAZOP1 (L) REGISTER

Sydney WATER

| | | | |
|---|---|---|---|
| **PROJECT NUMBER** | **20036007** | **Date of Review** | **5/05/2020 (AM)** |
| **PROJECT NAME** | **Upper South Creek Water Factory** | **Location** | **Online (MS Teams/Mural)** |
| **PROJECT DESCRIPTION** | **Reference Design for new water recycling fa** | **Review** | **HAZOP1 - Liquids Stream** |
| **Project Manager: Nigel Vivian** | | | |
| **Design Manager: Mark Rush** | | | |

| Company | Name | Position | Email | Phone |
|---|---|---|---|---|
| Planning Partner | Azaria Rahardjo | Design - Treatment | [redacted] | |
| SWC | Eizac Chee | PE | [redacted] | |
| SWC | Hannah Lockie | Planning | [redacted] | |
| Planning Partner | Ivona Maric | Facilitator | [redacted] | |
| SWC | Jason Sylvester | SWC Treatment | [redacted] | |
| Planning Partner | Julian Briggs | Reviewer | [redacted] | |
| Planning Partner | Justing Van Den Bogaardt | Design - Mechanical | [redacted] | |
| SWC | Karu Karunahararaj | DM PM | [redacted] | |
| Planning Partner | Mark Rush | Design Manager | [redacted] | |
| Planning Partner | Martina Kempys | Design - Treatment | [redacted] | |
| Planning Partner | Navid Majlessi | Electrical | [redacted] | |
| SWC | Nigel Vivian | Design Manager | [redacted] | |
| Planning Partner | Patrick Schnelle | Design - Treatment | [redacted] | |
| Planning Partner | Raymond Faure | Design - Treatment | [redacted] | |
| SWC | Rebecca Lowrie | SWC Treatment | [redacted] | |

**HAZOP RECORD SHEET**

# HAZOP
# HAZARD & OPERABILITY STUDY

| | |
|---|---|
| **DATE OF REVIEW** | **05/05/2020** |
| **PROJECT NUMBER** | **20036007** |
| **PROJECT NAME** | **Upper South Creek** |
| **PROJECT DESCRIPTION** | **Waste Water Treatment Plant** |
| **Project Manager: Matthew Dignam** | |
| **Design Lead: Nigel Vivian** | |

| Reference Drawings/Documents |
|---|
| |

| No. | Guideword | Risk Issue | Causes | Consequences | Safeguards | ACTION | | | DISCUSSION NOTES - Not all specifally HAZARD However recorded in the relevant section for context. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Description | Person Responsible | Date Due | |
| | | | | | | | | | |
| LINES | | | | | | | | | |
| *E.g.* | *High Flow / High Level* | | | | | | | | |
| **1.** | **Primary Sludge Pumps** | | | | | | | | |
| 1.1 | Flow/Level | no flow from primary pumps | FOG | pump performance / maintaintance | | Refer to text. Rodding points to be added. Not designing to that level of detail. | | | Currently single line. Is there value in providing 2 lines? Consider in detailed design. Do we need hot sludge return to sludge feed pumps? Parallel line from digesters that brings hot sludge into suction lines of primary sludge pumps, close to PST hoppers. Pumps back through the system. Run for ~ half an hour a day to break down fat deposits. However, USC is likely to run at lower sludge concentration than typical. Would that contribute to significant blockages or is fat blockage more closely related to temperature? Thinner sludge is less likley to drop fats and greases out of pipes due to higher pump velocity. It still might be an issue. |
| 1.2 | Pressure | | | | | | | | |
| 1.3 | Temperature | | | | | | | | |
| 1.4 | Changes in composition/concentration | | | | | | | | |
| 1.5 | Plant items | | | | | | | | Consideration in detailed design for 2 primary sludge lines |
| 1.6 | Instruments | instrument signal failure | cleaning of density meters | ploss of process control | | Not designing to that level of detail. | | | Issues with keeping sludge density metres clean. Al Kapocious is a good contact. Should be focused on in tender and spec. Need to consider access/bypass in cost. Close consideration should be paid to how it is specified. |
| 1.7 | Services Required | | | | | | | | |
| 1.8 | Materials of Constrsuction | | | | | | | | |
| 1.9 | Breakdown/failure | | | | | | | | |
| **2.** | **Primary Scum Pumps** | | | | | | | | |
| 2.1 | Flow/Level | | | | | | | | Do we need dedicated scum pumping system or do we use raw sludge pumps? i.e. valve to empty scum hopper into sludge pumps. Currently in use at glenfield, liverpool and cronulla. Need to consider hopper configuration. Consider suction line length, potential problem with pumping if common pumps (around 20-30m suction length). |
| 2.2 | Pressure | | | | | | | | |
| 2.3 | Temperature | | | | | | | | |
| 2.4 | Changes in composition/concentration | | | | | | | | |
| 2.5 | Plant items | Scum not removed | scum suction line blocked due to long suction line | maintainance | | Consider number of scum removal points or combining scum with wasting | SC | 80% | How many scum pumps per PSTs? Need to consider suction length of pumps. Check suction conditions on scum pumps or consider doubling pumps so we have a set per pair of tanks. |
| 2.6 | Instruments | | | | | | | | |
| 2.7 | Services Required | Scum not removed | caked on surface | maintainance | | RE sprays | SC | 80% | Will need RE flushing. Have RE sprays at PSTs that feed into scum trough that feed scum pumps. Do we want an RE feed upstream of pump for dedicated flow for flushing? |
| 2.8 | Materials of Constrsuction | | | | | | | | |
| 2.9 | Breakdown/failure | | | | | | | | |
| **3.** | **WAS and Secondary Pump Station** | | | | | | | | |
| 3.1 | Flow/Level | | | | | | | | Surface wasting to remove need of ML scum pumps? Will create common WAS with foam and scum in it, which will get pumped to RDT. No major process issue with scum in RDT. With this size of plant wasting continuously, will be pulling scum off continuosly, so significant surface scum doesnt form. For surface wasting can use floating weir style of bellmouth below water level with sprays to help capture foam. **Also refer to bioreactor section.** |
| 3.2 | Pressure | | | | | | | | |
| 3.3 | Temperature | | | | | | | | |
| 3.4 | Changes in composition/concentration | | | | | | | | |
| 3.5 | Plant items | | | | | | | | |
| 3.6 | Instruments | | | | | | | | |
| 3.7 | Services Required | | | | | | | | |
| 3.8 | Materials of Constrsuction | | | | | | | | |
| 3.9 | Breakdown/failure | | | | | | | | |
| **4** | **WAS Thickening** | | | | | | | | |
| 4.1 | Flow/Level | | | | | | | | |
| 4.2 | Pressure | | | | | | | | |
| 4.3 | Temperature | | | | | | | | |
| 4.4 | Changes in composition/concentration | | | | | | | | |
| 4.5 | Plant items | | | | | | | | |
| 4.6 | Instruments | | | | | | | | |
| 4.7 | Services Required | | | | | | | | |
| 4.8 | Materials of Constrsuction | | | | | | | | |

# HAZOP RECORD SHEET

| No. | Guideword | Risk Issue | Causes | Consequences | Safeguards | ACTION Description | ACTION Person Responsible | ACTION Date Due | DISCUSSION NOTES - Not all specifally HAZARD However recorded in the relevant section for context. |
|---|---|---|---|---|---|---|---|---|---|
| 4.9 | Breakdown/failure | failure of the flock tank and there is a loss of thickening, | critical component | critical maintainence activity - loss of process function | | refer to text. | | | Can we isolate flow to one of two RDTs at floc tank? If not, have to stop both units. Can decide in detailed design e.g. 2 feed pumps, 2 floc tanks. Note there is a full common standby unit. Need to consider cost saving. Can ask contractor to price during tender negotiations. Can add preferred equipment to spec, for contractors to have to convince if they have a better option. Discussion about RDT vs varipond. Consider alternatives for discussion at tender. Add knife gate valve to allow for isolation. Common outlet pump and hopper typical for G3 megaduo. |
| **5.** | **Recuperative Thickening** | | | | | | | | |
| 5.1 | Flow/Level | | | | | | | | |
| 5.2 | Pressure | | | | | | | | |
| 5.3 | Temperature | | | | | | | | |
| 5.4 | Changes in composition/concentration | | | | | | | | |
| 5.5 | Plant items | | | | | | | | |
| 5.6 | Instruments | critcal failure items | lack of isolation | loss of process due to failure of single items | | Add valves to isolate RDT. | | | Add valves on these P&IDs to WAS RDT P&ID |
| 5.7 | Services Required | | | | | | | | |
| 5.8 | Materials of Constrsuction | | | | | | | | |
| 5.9 | Breakdown/failure | | | | | | | | |
| **6.** | **Digester Feed Blending Tank** | | | | | | | | |
| 6.1 | Flow/Level | spill from top of digester | pumped feed and no overflow | environmental and health and safety | | add in over flow pipe from digesters to sump. May need additional pump station | SC / MR | 80% | Update for surface wasting/combined WAS and Scum. Can we provide an overflow i.e. to fill and spill pump station or overflow pipe to plant sewer? Fill and spill PS not too far away, but do we want to but raw sludge in there? Or even overflow pipe to the ground, into first flush sump. Also,tank may have suction problems in pumps. Would want pumps mounted underneath tank. Tanks where we have tanks mounted off the side we often end up with suction problems, which limits sludge thickness. Opportunity to remove feed blending tank and pump straight to digesters. Consider pump suction from cone bottom of tank. |
| 6.2 | Pressure | | | | | | | | |
| 6.3 | Temperature | | | | | | | | |
| 6.4 | Changes in composition/concentration | | | | | | | | Issues with struvite if too much mixing inside tank. Turbines should be below water level of tank. Might not be an issue this far upstream because ammonia concentration is too low. Manage turbulence and alkalinity stripping by ensuring feed and mixing lines return below operating level. Note |
| 6.5 | Plant items | | | | | | | | Drain lines? Drain the tank using the pumps. Might want backup drain upstream of pumps. Create cover P&ID on general assumptions on pumps e.g. all suction pumps have drain lines, rodding points on sludge lines, etc. |
| 6.6 | Instruments | | | | | | | | Consider DTX |
| 6.7 | Services Required | | | | | | | | |
| 6.8 | Materials of Constrsuction | | | | | | | | |
| 6.9 | Breakdown/failure | | | | | | | | Emergency overflow - to nearby plant sewer or fill and spill PS. TBD **REFER TO 6.1** |
| **7** | **Digesters** | | | | | | | | |
| 7.1 | Flow/Level | | | | | | | | |
| 7.2 | Pressure | | | | | | | | |
| 7.3 | Temperature | | | | | | | | |
| 7.4 | Changes in composition/concentration | | | | | | | | |
| 7.5 | Plant items | | | | | | | | Pump mixing: don't have sludge screens and cannot use North head style mixer with biogas dome. St marys P&IDs has digester with roof gas covers. Can go with cheaper sludge mixing, but will need sludge screens. Best to stay with what he have now. |
| 7.6 | Instruments | | | | | | | | |
| 7.7 | Services Required | | | | | | | | |
| 7.8 | Materials of Constrsuction | | | | | | | | |
| 7.9 | Breakdown/failure | | | | | | | | |
| **8** | **Fill and Spill** | | | | | | | | |
| 8.1 | Flow/Level | exceed capacity of digester | momentum from recop process | overfill | | Consider additional capacity | AR | 80% | If stopping recup pumps, momentum from levels in digesters could continue to spill for a while after stop pumping. Need to have enough capacity for this. Can be a note for detailed design. Consider drawing recup feed directly from secondary digesters. |
| 8.2 | Pressure | | | | | | | | |
| 8.3 | Temperature | | | | | | | | |
| 8.4 | Changes in composition/concentration | | | | | | | | |
| 8.5 | Plant items | | | | | | | | |
| 8.6 | Instruments | | | | | | | | |
| 8.7 | Services Required | | | | | | | | |
| 8.8 | Materials of Constrsuction | | | | | | | | |
| 8.9 | Breakdown/failure | | | | | | | | |
| **9** | **Recuperative Thickening Feed** | | | | | | | | |
| 9.1 | Flow/Level | | | | | | | | |
| 9.2 | Pressure | | | | | | | | |
| 9.3 | Temperature | | | | | | | | |
| 9.4 | Changes in composition/concentration | | | | | | | | |
| 9.5 | Plant items | | | | | | | | |
| 9.6 | Instruments | | | | | | | | |
| 9.7 | Services Required | | | | | | | | |
| 9.8 | Materials of Constrsuction | | | | | | | | |
| 9.9 | Breakdown/failure | | | | | | | | |
| **10** | **Recuperative thickening RDT** | | | | | | | | |
| 10.1 | Flow/Level | | | | | Add valves | SC | 80% | Recup thicken has bypass unlike WAS |
| 10.2 | Pressure | | | | | | | | |
| 10.3 | Temperature | | | | | | | | |
| 10.4 | Changes in composition/concentration | | | | | | | | |
| 10.5 | Plant items | | | | | | | | |
| 10.6 | Instruments | | | | | | | | |
| 10.7 | Services Required | | | | | | | | |
| 10.8 | Materials of Constrsuction | | | | | | | | |
| 10.9 | Breakdown/failure | | | | | | | | |
| **11** | **Standby Thickening RDT** | | | | | | | | |
| 11.1 | Flow/Level | | | | | | SC | 80% | Consider upstream isolation |

# HAZOP RECORD SHEET

| No. | Guideword | Risk Issue | Causes | Consequences | Safeguards | ACTION | | | DISCUSSION NOTES - Not all specifally HAZARD However recorded in the relevant section for context. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Description | Person Responsible | Date Due | |
| 11.2 | Pressure | | | | | | | | |
| 11.3 | Temperature | | | | | | | | |
| 11.4 | Changes in composition/concentration | | | | | | | | |
| 11.5 | Plant items | | | | | | | | |
| 11.6 | Instruments | | | | | | | | |
| 11.7 | Services Required | | | | | | | | |
| 11.8 | Materials of Constrsuction | | | | | | | | |
| 11.9 | Breakdown/failure | | | | | | | | |
| **12** | **Hot Water Recir Pumps** | | | | | | | | |
| 12.1 | Flow/Level | | | | | | SC | 80% | Check against St Mary's IFC P&IDs for all requirements. |
| 12.2 | Pressure | | | | | | | | |
| 12.3 | Temperature | | | | | | | | |
| 12.4 | Changes in composition/concentration | | | | | | | | |
| 12.5 | Plant items | | | | | | | | |
| 12.6 | Instruments | | | | | | | | |
| 12.7 | Services Required | | | | | | | | |
| 12.8 | Materials of Construction | | | | | | | | |
| 12.9 | Breakdown/failure | | | | | | | | |
| **13** | **Digester Heating and Cooling Supply** | | | | | | | | |
| 13.1 | Flow/Level | | | | | | | | |
| 13.2 | Pressure | | | | | | | | |
| 13.3 | Temperature | | | | | | | | |
| 13.4 | Changes in composition/concentration | | | | | | | | |
| 13.5 | Plant items | | | | | | | | |
| 13.6 | Instruments | | | | | | | | |
| 13.7 | Services Required | | | | | | | | |
| 13.8 | Materials of Construction | | | | | | | | |
| 13.9 | Breakdown/failure | | | | | | | | |
| **14** | **BFW Preheating Hot Water Supply** | | | | | | | | |
| 14.1 | Flow/Level | | | | | | SC | 80% | GENERAL: fix up titles, remove BFW (not using boilers) |
| 14.2 | Pressure | | | | | | | | |
| 14.3 | Temperature | | | | | | | | |
| 14.4 | Changes in composition/concentration | | | | | | | | |
| 14.5 | Plant items | | | | | | | | |
| 14.6 | Instruments | | | | | | | | |
| 14.7 | Services Required | | | | | | | | |
| 14.8 | Materials of Construction | | | | | | | | |
| 14.9 | Breakdown/failure | | | | | | | | |
| **15** | **Composite Steam Boiler** | | | | | | | | |
| 15.1 | Flow/Level | | | | | | | | |
| 15.2 | Pressure | | | | | | | | |
| 15.3 | Temperature | | | | | | | | |
| 15.4 | Changes in composition/concentration | | | | | | | | |
| 15.5 | Plant items | | | | | | | | |
| 15.6 | Instruments | | | | | | | | |
| 15.7 | Services Required | | | | | | | | |
| 15.8 | Materials of Construction | | | | | | | | |
| 15.9 | Breakdown/failure | | | | | | | | |
| **16** | **Hot Water Expansion Tank** | | | | | | | | |
| 16.1 | Flow/Level | | | | | | | | |
| 16.2 | Pressure | | | | | | | | |
| 16.3 | Temperature | | | | | | | | |
| 16.4 | Changes in composition/concentration | | | | | | | | |
| 16.5 | Plant items | | | | | | | | |
| 16.6 | Instruments | | | | | | | | |
| 16.7 | Services Required | | | | | | | | |
| 16.8 | Materials of Construction | | | | | | | | |
| 16.9 | Breakdown/failure | | | | | | | | |
| **17** | **Digester Gas Holders** | | | | | | | | |
| 17.1 | Flow/Level | | | | | | | | |
| 17.2 | Pressure | equipment damage / gas to environment | over pressurerisation | health and safety | | | | | |
| 17.3 | Temperature | | | | | | | | |
| 17.4 | Changes in composition/concentration | | | | | | | | |
| 17.5 | Plant items | | | | | | | | |
| 17.6 | Instruments | | | | | | | | |
| 17.7 | Services Required | Explosion | Bushfire / ember attack | loss of life | deluge system if requried from bushfire assessment | | | | Bushfire analysis: deluge?. Power failure: biogas needs to be flared to WGB if over pressure. |
| 17.8 | Materials of Construction | | | | | | | | |
| 17.9 | Breakdown/failure | | | | | | | | |
| **18** | **Biogas Blowers** | | | | | | | | |
| 18.1 | Flow/Level | | | | | | | | |
| 18.2 | Pressure | | | | | | | | |
| 18.3 | Temperature | | | | | | | | |
| 18.4 | Changes in composition/concentration | | | | | | | | |
| 18.5 | Plant items | | | | | | | | |
| 18.6 | Instruments | | | | | | | | |

## HAZOP RECORD SHEET

| No. | Guideword | Risk Issue | Causes | Consequences | Safeguards | ACTION | | | DISCUSSION NOTES - Not all specifally HAZARD However recorded in the relevant section for context. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Description | Person Responsible | Date Due | |
| 18.7 | Services Required | | | | | | | | |
| 18.8 | Materials of Construction | | | | | | | | |
| 18.9 | Breakdown/failure | | | | | | SC | 80% | Move connection to WGB upstream of biogas blowers. |
| **19** | **Biogas Distribution Header** | | | | | | | | |
| 19.1 | Flow/Level | | | | | | | | |
| 19.2 | Pressure | | | | | | | | |
| 19.3 | Temperature | | | | | | | | |
| 19.4 | Changes in composition/concentration | | | | | | | | Check if chiller is required. Refer to North Head P&IDs. Methane analyser - also consider other analysers (H2S, CO2) if biogas cleaning provided. |
| 19.5 | Plant items | | | | | | | | |
| 19.6 | Instruments | | | | | | | | |
| 19.7 | Services Required | | | | | | | | |
| 19.8 | Materials of Construction | | | | | | | | |
| 19.9 | Breakdown/failure | | | | | | | | |
| **20** | **Cogen Engines** | | | | | | | | |
| 20.1 | Flow/Level | | | | | | | | |
| 20.2 | Pressure | | | | | | | | |
| 20.3 | Temperature | | | | | | | | |
| 20.4 | Changes in composition/concentration | | | | | | | | Methane analyser? Often included in cogen package. If we include gas cleaning will also needs CO2 and H2S analysers. Do we need condensate removal/chiller? |
| 20.5 | Plant items | | | | | | | | |
| 20.6 | Instruments | | | | | | | | |
| 20.7 | Services Required | | | | | | | | |
| 20.8 | Materials of Construction | | | | | | | | |
| 20.9 | Breakdown/failure | | | | | | | | |
| **21** | **Waste Gas Burner** | | | | | | | | |
| 21.1 | Flow/Level | | | | | | | | |
| 21.2 | Pressure | | | | | | | | |
| 21.3 | Temperature | | | | | | | | |
| 21.4 | Changes in composition/concentration | | | | | | | | |
| 21.5 | Plant items | | | | | | | | |
| 21.6 | Instruments | | | | | | | | |
| 21.7 | Services Required | | | | | | | | |
| 21.8 | Materials of Construction | | | | | | | | |
| 21.9 | Breakdown/failure | | | | | | | | Power failure: what happens? Fans would be off and biogas would be kept inside membrane gas holders. Would shut off biogas supply to utilisation points and keep gas inside gas holders. If overpressurised, released by flame arrester/PRV. Needs to be preferentially burnt through waste gas burner. High pressure should push gas to WGB. |
| **22** | **Lube Oil** | | | | | | | | |
| 18.1 | Flow/Level | | | | | | | | |
| 18.2 | Pressure | | | | | | | | |
| 18.3 | Temperature | | | | | | | | |
| 18.4 | Changes in composition/concentration | | | | | | | | |
| 18.5 | Plant items | | | | | | | | |
| 18.6 | Instruments | | | | | | | | |
| 18.7 | Services Required | | | | | | | | |
| 18.8 | Materials of Construction | | | | | | | | |
| 18.9 | Breakdown/failure | | | | | | | | |
| **23** | **Dewaterign FAT and Centrifuge Feed Pumps** | | | | | | | | |
| 18.1 | Flow/Level | | | | | | | | Need overflows/vents/odour control connection |
| 18.2 | Pressure | | | | | | | | |
| 18.3 | Temperature | | | | | | | | |
| 18.4 | Changes in composition/concentration | | | | | | | | Detailed designer needs to consider struvite formation potential in design of tank entries, mixing system. Pump suction needs to be close to tank, slower speed pumps preferred. |
| 18.5 | Plant items | | | | | | | | Add in odour control |
| 18.6 | Instruments | | | | | | | | |
| 18.7 | Services Required | | | | | | | | |
| 18.8 | Materials of Construction | | | | | | | | |
| 18.9 | Breakdown/failure | | | | | | | | Include overflows/venting |
| **24** | **Centrifuge** | | | | | | | | |
| 18.1 | Flow/Level | | | | | | | | Unit sizing: SW wants to run smaller units unattended. Discussions of sizing have already been made in dewatering program. Consider providing buffer tank for centrate to return to this tank at night. |
| 18.2 | Pressure | | | | | | | | |
| 18.3 | Temperature | | | | | | | | |
| 18.4 | Changes in composition/concentration | | | | | | | | Add in RE connections and jetting lines at top of centrate lines for struvite mitigation if required. |
| 18.5 | Plant items | | | | | | | | |
| 18.6 | Instruments | | | | | | | | |
| 18.7 | Services Required | | | | | | | | |
| 18.8 | Materials of Construction | | | | | | | | |
| 18.9 | Breakdown/failure | | | | | | | | |
| **25** | **Recycle Return PS** | | | | | | | | |
| 18.1 | Flow/Level | | | | | | | | Consider overflow location |
| 18.2 | Pressure | | | | | | | | |
| 18.3 | Temperature | | | | | | | | |
| 18.4 | Changes in composition/concentration | | | | | | | | Add RE in case of struvite. Extend feed lines below operating level to minimize turbulence. |
| 18.5 | Plant items | | | | | | | | |
| 18.6 | Instruments | | | | | | | | |

## HAZOP RECORD SHEET

| No. | Guideword | Risk Issue | Causes | Consequences | Safeguards | ACTION | | | DISCUSSION NOTES - Not all specifally HAZARD However recorded in the relevant section for context. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Description | Person Responsible | Date Due | |
| 18.7 | Services Required | | | | | | | | |
| 18.8 | Materials of Construction | | | | | | | | |
| 18.9 | Breakdown/failure | | | | | | | | |
| **27** | **Biosolids Silos** | | | | | | | | |
| 18.1 | Flow/Level | | | | | | | | |
| 18.2 | Pressure | | | | | | | | |
| 18.3 | Temperature | | | | | | | | |
| 18.4 | Changes in composition/concentration | | | | | | | | |
| 18.5 | Plant items | | | | | | | | |
| 18.6 | Instruments | | | | | | | | |
| 18.7 | Services Required | | | | | | | | |
| 18.8 | Materials of Construction | | | | | | | | |
| 18.9 | Breakdown/failure | | | | | | | | |
| **28** | **Biosolids Outloading** | | | | | | | | |
| 18.1 | Flow/Level | | | | | | | | |
| 18.2 | Pressure | | | | | | | | |
| 18.3 | Temperature | | | | | | | | |
| 18.4 | Changes in composition/concentration | | | | | | | | |
| 18.5 | Plant items | | | | | | | | |
| 18.6 | Instruments | | | | | | | | |
| 18.7 | Services Required | | | | | | | | Building needs to fully contain truck. Needs hose points, drains, odour control venting |
| 18.8 | Materials of Construction | | | | | | | | |
| 18.9 | Breakdown/failure | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | **GENERAL DISCUSSION** | | | | | | | | |
| 0.1 | Which version of st marys p&ids are we using? 100% or IFC? Will confirm | | | | | | | | |
| 0.2 | | | | | | | | | |
| 0.3 | | | | | | | | | |
| 0.4 | | | | | | | | | |
| 0.5 | | | | | | | | | |

Sydney WATER

| | | | |
|---|---|---|---|
| **PROJECT NUMBER** | **20036007** | **Date of Review** | **5/05/2020 (PM)** |
| **PROJECT NAME** | **Upper South Creek Water Factory** | **Location** | **Online (MS Teams/Mural)** |
| **PROJECT DESCRIPTION** | **Reference Design for new water recycling fa** | **Review** | **HAZOP1 - Solids Stream** |
| **Project Manager: Nigel Vivian** | | | |
| **Design Manager: Mark Rush** | | | |

| Company | Name | Position | Email | Phone |
|---|---|---|---|---|
| Planning Partner | Azaria Rahardjo | Design - Treatment | [redacted] | |
| SWC | Hannah Lockie | Planning | [redacted] | |
| Planning Partner | Ivona Maric | Facilitator | [redacted] | |
| SWC | Jason Sylvester | SWC Treatment | [redacted] | |
| Planning Partner | Julian Briggs | Reviewer | [redacted] | |
| Planning Partner | Justin Van Den Bogaardt | Design - Mechanical | [redacted] | |
| SWC | Karu Karunahararaj | DM PM | [redacted] | |
| Planning Partner | Mark Rush | Design Manager | [redacted] | |
| Planning Partner | Martina Kempys | Design - Treatment | [redacted] | |
| Planning Partner | Navid Majlessi | Electrical | [redacted] | |
| SWC | Nigel Vivian | Design Manager | [redacted] | |
| Planning Partner | Patrick Schnelle | Design - Treatment | [redacted] | |
| Planning Partner | Raymond Faure | Design - Treatment | [redacted] | |
| SWC | Rebecca Lowrie | SWC Treatment | [redacted] | |
| Planning Partner | Sam Corben | Design - Treatment | [redacted] | |

# HAZOP
# HAZARD & OPERABILITY STUDY

| | |
|---|---|
| DATE OF REVIEW | 06/05/2020 |

| | |
|---|---|
| PROJECT NUMBER | 20036007 |
| PROJECT NAME | Upper South Creek |
| PROJECT DESCRIPTION | Waste Water Treatment Plant |
| Project Manager: Matthew Dignam | |
| Design Lead: Nigel Vivian | |

| Reference Drawings/Documents |
|---|
| |

| No. | Guideword | Risk Issue | Causes | Consequences | Safeguards | ACTION | | | DISCUSSION NOTES - Not all specifally HAZARD However recorded in the relevant section for context. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Description | Person Responsible | Date Due | |
| | | | | | | | | | |
| LINES | | | | | | | | | |
| *E.g.* | *High Flow / High Level* | | | | | | | | |
| **1.** | **Effluent Storage Tanks** | | | | | | | | |
| 1.1 | Flow/Level | frequent stop starts of pumps | large pumps with limited turn down. | Operational issues or large feed tanks. | | Review need for smaller pumps | SK | 80% | Low turndown in PS resulted in large balance tank. If we change pumps, might be able to reduce balance volume. Especially if we leave space for storage addition later on. Tradeoff between volume and number of pumps. Detailed designer might look in closer detail. Decision changes around likelyhood of growth slowdown. Would prefer to cater for less flow in the first instance. |
| 1.2 | Pressure | | | | | | | | |
| 1.3 | Temperature | | | | | | | | |
| 1.4 | Changes in composition/concentration | | | | | | | | |
| 1.5 | Plant items | | | | | | | | |
| 1.6 | Instruments | | | | | Include 2 sets on instruments in transsfer tank. | SC | 80% | Dupllication of instruments for IICATS and SCADA |
| 1.7 | Services Required | | | | | | | | |
| 1.8 | Materials of Constrsuction | | | | | | | | |
| 1.9 | Breakdown/failure | | | | | | | | |
| **2.** | **Treated Water Transfer Pumping Station** | | | | | | | | |
| 2.1 | Flow/Level | Reverse flow | 2 discharges from one main with isolation on one discharge. | air in line, may affect the pump head | | Review discharge design | | | Could we have backflow from the eflows discharge? Might need motorised valves. If we have motorised valves on both lines, if we can fully close the lines off, can have flowmeter on common line. Include drainage valves and scour valves. Included in pipeline drawings but not on P&ID. On this P&ID we are showing manual isolation valves on pumps. Normal operation would mean standby pumps rely on NRV to stop backflow through pump. Operation pressure of rising main if going to warragamba is ~13 bar. What pressure do we rely on NRV to stop backflow and at what point do we consider a motorised valve on the discharge? Someone like Milan could answer because we have stations with similar pressure head. Zane recalls them not having motorised valves, just usign NRV. Motorised valves close and open slowly, causing pressure issues. Check valves are pretty reliable. Can have maintenance issues with NRVs. Misaki to chase up. Note from Milan: "The isolating valves of this size shown on the P&ID need to be actuated, both suction and discharge.Fixed speed pumps also have delivery control valves (DCVs) upstream of their non-return valves (NRV) for starting and stopping. These are not normally required for variable speed pumps. Eg. we don't have them at the desal WP0369 at Kurnell. However, considering the size and potentially high pressures at this WPS, I would recommend to have DCVs here. They should be metal seated double or triple offset butterfly valves, relatively low cost compared to the total. |
| 2.2 | Pressure | | | | | | | | |
| 2.3 | Temperature | | | | | | | | |
| 2.4 | Changes in composition/concentration | | | | | | | | 2 phase flow with air and water |
| 2.5 | Plant items | Are there suffitcient duty pumps for maintenance and breakdowns | Pumps design for future duty, initally not all installed. | Loss of pumping ability | | Review number of pumps. | SK | 80% | Do we have enough duties for breakdowns? Duty/duty/standby/assist seems fairly reasonable. At the moment have 2 pumps doing 50ML and 3 pumps doing 100ML. Standby comes from design review. Is one additional duty pump going to cover the double flow? Yes the current 2 pumps are running lower for the lower flow. The pumps are chosen so that they dont have to be changed to different pumps between stage 1 and 2. Why are we putting in pumps to do 170 ML right away? It's not doing 170ML right away. Stage 1 always has a standby. It could do 170 ML to run all units at same time. Stage 2 adds another standby pump. Need to consider if stage 1 has less than 50 ML. To reduce costs, we will remove 1 pump. SHould be fine as long as we have a standby unit. Will be asking contractors to give price for smaller capacity. Need to document what the capacity would be for just duty/standby. Need to leave space in pumping station for another pump. Spec to include a table for different flows at different stages. Could potentially upsize line sizes in first 2 streams and leave 3rd and 4th as potential future augmentation. Misaki to look in to that. |
| 2.6 | Instruments | | | | | | | | |
| 2.7 | Services Required | | | | | | | | |
| 2.8 | Materials of Constrsuction | | | | | | | | |
| 2.9 | Breakdown/failure | | | | | | | | |
| **3.** | **Brine Storage Tanks** | | | | | | | | |
| 3.1 | Flow/Level | | | | | | | | |
| 3.2 | Pressure | | | | | | | | |
| 3.3 | Temperature | | | | | | | | |
| 3.4 | Changes in composition/concentration | | | | | | | | |
| 3.5 | Plant items | | | | | | SC | 80% | Probably no need for actuation on connecting tanks but allows flexibility. Add drain lines on tanks. |
| 3.6 | Instruments | | | | | | SC | 80% | Do we need double instruments on each tank? Motorised valves controlled by IICATS. Do we want motorised valve or manual valve? If motorised want open shut position switches. |
| 3.7 | Services Required | | | | | | | | |
| 3.8 | Materials of Constrsuction | | | | | | | | |
| 3.9 | Breakdown/failure | PS failure | Power outage | Loss of pumping ability | Dual power feed | | | | Power to PS fed from water factory HV. Is it active dual feed or a split feed? Can do either at PS. Capacity of feeders will be sized to run full PS. With power outages, do we need a surge vessel? Milan will do surge and water hammer analysis. Good to include upfront for costs, rather than add it later. Discussed in VE. For 80% design, will know mititgation methods. Will coordinate with electircal. |

## HAZOP RECORD SHEET

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|---|---|---|---|---|---|---|---|---|---|
| **4** | **Brine Transfer PS** | | | | | | | | |
| 4.1 | Flow/Level | pumping brine when NGRS is at capacity | Loss of control | Unplanned overflow from NGRS, overwhelming Malabar | | Consider control and back up systems. | SK | 80% | Pump station interlocked with level instrument and regime controls in NGRS. If we pump brine back to NGRS after stormflow, might take more than 3 days for NGRS to be back to normal. Need more controls on brine pump. As soon as there are level issues in NGRS, triggers shutdown on brine pumps or AWTP. Have to consider holistic setpoints before discharge to NGRS and restart brine production. Need to consider whole system and what is feeding it. Currently modelling. Upgrades needed in Malabar system. Controls needed in first instance, and then changes to those controlled based on malabar system thresholds and overflows. |
| | | Feeding brine when NGRS is at capacity | pipe emptying after the pumps have shut down | Unplanned overflow from NGRS, overwhelming Malabar | | Consider control valve at end of brine transfer line | SK | 80% | Approx 25% of pipeline is pressurised rising main, rest is gravity flow. Pumping head of about 80m. Switching on pumping station doesn't mean flow stops in NGRS. Need a control valve close at discharge point to stop these flows. |
| 4.2 | Pressure | | | | | | | | |
| 4.3 | Temperature | | | | | | | | |
| 4.4 | Changes in composition/concentration | | | | | | | | |
| 4.5 | Plant items | | | | | | | | |
| 4.6 | Instruments | | | | | | SK | 80% | Will brine controls be on IICATS? Pump station and brine are IICATS controlled. At the moment the system is controlled by roberts road sensors. Will these be linking to plant control? Intention is to have a duplication of these level instruments feeding to plant scada. Easier to have duplication of instruments after discussion at quakers. Discussing if PS is scada or iicats controlled. Another meeting with IICATS on friday, will discuss then. Cahors and roberts rd are significantly downstream of USC flow. Need to know what delays to apply to downstream sensors. From cotnractors POV they will build pump station and set up controls. Need to allow for sufficient cost for programming. Dont need to work out exact timing and sequencing now. Do need input on if it will impact how often we will shut down RO system for EIS. Hannah to send out report for feedback. St Marys has similar brine transfer, might look at their information. |
| 4.7 | Services Required | | | | | | | | |
| 4.8 | Materials of Construction | corrosion from brine | pumping brine | increased failures | Brine not concentrated enough to create corrosion concern | | | | Material of valve/fittings/pumps: will brine trigger high rate of failure? Do we need special coating? Generall don't encounter materials issues until a higher TDS. Misaki will check with material specialists and suppliers |
| 4.9 | Breakdown/failure | | | | | | | | PS to be interlocked with NGRS regime change and control systems. |
| **5.** | **AWTP Balance Tank** | | | | | | | | |
| 5.1 | Flow/Level | | | | | | | | After VE: Might reduce to one line entering tank |
| 5.2 | Pressure | | | | | | | | |
| 5.3 | Temperature | | | | | | | | |
| 5.4 | Changes in composition/concentration | | | | | | | | |
| 5.5 | Plant items | | | | | | | | Consider moving the takeoff for RE PS upstream to ensure RE continuity. Provide an MBR permeate to RO feed tank bypass **REFER to 6.1** |
| 5.6 | Instruments | | | | | | | | |
| 5.7 | Services Required | | | | | | | | RE continuity depending on which tank **REFER to 6.1** |
| 5.8 | Materials of Constrsuction | | | | | | | | |
| 5.9 | Breakdown/failure | no ability to feed the RO | MBR or RO feed tank under maintenance | none-compliant discharge until tank back on line | | Consider bypass around critical tanks | SC | 80% | For maintenance, do we have to shut down and drain other tanks? Might need to install valve. Do we want a redundant tank as a standby? Hannah to investigate what happens at other plants. At the moment, MBR only pumps to MBR balance. If you took that tank offline, you couldnt use the bioreactor. probably value in bypassing that thank to RO feed so could go straight to RO during planned shutdown. Could then take UF and MBR tank offline. If we put isolation valve between 2 tanks, could just feed UF effluent to transfer pump station. If we take MBR permeate directly to RO, can take 2 tanks offline. But will lose balance volume. DO we want to be able to run the RO when taking that tank offline? We don't really need that ability, only if we need to do actual maintenance on tanks. |
| **6.** | **UF Filtrate and RO Tanks** | | | | | | | | |
| 6.1 | Flow/Level | No RE | RE drawn from inline process tank which has been used emptied by process. | screens and other critical equipment fail. | | Ensure the tank has slightly greater volume to allow voluem for RE. | | | Need to maintainn enough water in one of these tanks to feed RE e.g. screenings sprays. |
| 6.2 | Pressure | | | | | | | | |
| 6.3 | Temperature | | | | | | | | |
| 6.4 | Changes in composition/concentration | | | | | | | | |
| 6.5 | Plant items | | | | | | | | Flexibility around drawing to RO from UF filtrate. **REFER TO POINT 5.9** |
| 6.6 | Instruments | | | | | | | | |
| 6.7 | Services Required | | | | | | | | |
| 6.8 | Materials of Constrsuction | | | | | | | | Should we be able to isolate these tanks? **REFER TO POINT 5.9** |
| 6.9 | Breakdown/failure | | | | | | | | Consider complete bypass of all AWTP tanks from MBR line directly to RO feed tank. Consider the risk of RO feed tank needing to be taken offllne for maintenance. **REFER TO POINT 5.9** |
| **7** | **Wet Weather and CCT** | | | | | | | | |
| 7.1 | Flow/Level | | | | | | | | |
| 7.2 | Pressure | | | | | | | | |
| 7.3 | Temperature | | | | | | | | |
| 7.4 | Changes in composition/concentration | | | | | | | | |
| 7.5 | Plant items | | | | | | | | |
| 7.6 | Instruments | | | | | | | | |
| 7.7 | Services Required | | | | | | | | |
| 7.8 | Materials of Constrsuction | | | | | | | | |
| 7.9 | Breakdown/failure | | | | | | | | |
| **8** | **UF Feed Pumps** | | | | | | | | |
| 8.1 | Flow/Level | | | | | | | | |
| 8.2 | Pressure | | | | | | | | |
| 8.3 | Temperature | | | | | | | | |

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| | | | | | | Description | Person Responsible | Date Due | |
| 8.4 | Changes in composition/concentration | | | | | | | | |
| 8.5 | Plant items | | | | | | | | |
| 8.6 | Instruments | | | | | | | | |
| 8.7 | Services Required | | | | | | | | |
| 8.8 | Materials of Constrsuction | | | | | | | | |
| 8.9 | Breakdown/failure | | | | | | | | |
| **9** | **UF Trains** | | | | | | | | |
| 9.1 | Flow/Level | | | | | | | | |
| 9.2 | Pressure | | | | | | | | |
| 9.3 | Temperature | | | | | | | | |
| 9.4 | Changes in composition/concentration | | | | | | | | |
| 9.5 | Plant items | | | | | | | | |
| 9.6 | Instruments | | | | | | | | |
| 9.7 | Services Required | | | | | | | | |
| 9.8 | Materials of Constrsuction | | | | | | | | |
| 9.9 | Breakdown/failure | | | | | | | | |
| **9** | **UF Backwash Skids** | | | | | | | | |
| 9.1 | Flow/Level | | | | | | | | |
| 9.2 | Pressure | | | | | | | | |
| 9.3 | Temperature | | | | | | | | |
| 9.4 | Changes in composition/concentration | | | | | | | | |
| 9.5 | Plant items | | | | | | | | |
| 9.6 | Instruments | High temp | high ambient temp | Damage to membranes | | Add temperature sensor to air flow | SC | 80% | |
| 9.7 | Services Required | | | | | | | | |
| 9.8 | Materials of Constrsuction | | | | | | | | |
| 9.9 | Breakdown/failure | | | | | | | | |
| 10.9 | Breakdown/failure | | | | | | | | |
| **11** | **RO Permeate Tank** | | | | | | | | |
| 11.1 | Flow/Level | | | | | | | | How are we managing returning off spec water to tank? Don't have hard spec requirements to meet with this water, so long as it passes license requirements. Typically, WWTPs don't return off spec to head of plant, just discharge it. Probably more for if you want to tune things during start up e.g. when starting up chemical dosing systems and want to stabilise pH. This is more relelvant if doing potable water reusue, not a major concern now. Don't need a return system for RO. Is there a need for a return to head of works to stabilise dosing system? Try to look at recycle from a comissioning POV, look for an appropriate return. |
| 11.2 | Pressure | | | | | | | | |
| 11.3 | Temperature | | | | | | | | |
| 11.4 | Changes in composition/concentration | | | | | | | | |
| 11.5 | Plant items | | | | | | | | |
| 11.6 | Instruments | | | | | | | | |
| 11.7 | Services Required | | | | | | | | |
| 11.8 | Materials of Constrsuction | | | | | | | | |
| 11.9 | Breakdown/failure | | | | | | | | |
| **12** | **Reminieralisation** | | | | | | | | |
| 12.1 | Flow/Level | | | | | | SC | 80% | Add blank connection for opportunity for flow recycling for potable reuse? Find a recycle point further up in the plant. If we add lime and get too high pH, we might need a recirc to control it. Further discussion to be had. Add it as a VE opportunity. Will need to consider size of recir pipework. |
| 12.2 | Pressure | | | | | | | | |
| 12.3 | Temperature | | | | | | | | |
| 12.4 | Changes in composition/concentration | | | | | | | | |
| 12.5 | Plant items | | | | | | | | |
| 12.6 | Instruments | | | | | | | | |
| 12.7 | Services Required | | | | | | | | |
| 12.8 | Materials of Construction | | | | | | | | |
| 12.9 | Breakdown/failure | | | | | | | | |
| **13** | **Chemicals** | | | | | | | | |
| 13.1 | Flow/Level | | | | | | | | NOTE: Most chemical P&IDs from other detailed design that have been through full HAZOP |
| 13.2 | Pressure | | | | | | | | |
| 13.3 | Temperature | | | | | | | | |
| 13.4 | Changes in composition/concentration | | | | | | | | |
| 13.5 | Plant items | | | | | | | | |
| 13.6 | Instruments | | | | | | | | |
| 13.7 | Services Required | | | | | | | | |
| 13.8 | Materials of Construction | | | | | | | | |
| 13.9 | Breakdown/failure | | | | | | | | |
| **14** | **Odour** | | | | | | | | |
| 14.1 | Flow/Level | | | | | | | | Opportuntiy for optimising volumes of flow (From VE) |
| 14.2 | Pressure | | | | | | | | |
| 14.3 | Temperature | | | | | | | | |
| 14.4 | Changes in composition/concentration | | | | | | | | |
| 14.5 | Plant items | | | | | | | | |
| 14.6 | Instruments | | | | | | | | |
| 14.7 | Services Required | | | | | | | | |
| 14.8 | Materials of Construction | | | | | | | | |
| 14.9 | Breakdown/failure | | | | | | | | |
| **15** | **Plant Auxiliaries** | | | | | | | | |
| 15.1 | Flow/Level | | | | | | | | |
| 15.2 | Pressure | | | | | | | | |

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| | | | | | | Description | Person Responsible | Date Due | |
| 15.3 | Temperature | | | | | | | | |
| 15.4 | Changes in composition/concentration | | | | | | | | |
| 15.5 | Plant items | | | | | | | | |
| 15.6 | Instruments | | | | | | | | |
| 15.7 | Services Required | | | | | | | | |
| 15.8 | Materials of Construction | | | | | | | | |
| 15.9 | Breakdown/failure | | | | | | | | |
| GENERAL DISCUSSION | | | | | | | | | |
| 0.1 | AWTP flows: 2 scenarios: 1 where we don't get e flows approved, would need to consider where we only build pipe as far as nepean. Might not need to consider for HAZOP as simpler mode, just validate that there is nothing else we need to consider. There was discussion around 1.3 RO being e flow. We only get credit for what they will release from the dam anyway, which will be increasing with more variability. With the eflows, there will be a signal coming in guiding the production of RO water. Given the additonal pumping cost, you would only pump there if you get the credit. From an energy POV would prefer to discharge at nepean. This would be the basis of our approval. | | | | | | | | |
| 0.2 | Environmentally they wouldn't accept uf treated water to discharge to warragamba. To count as an eflow it would need to be RO water. Once we start shandying effluent with UF filtrate we discharge to nepean until that event has passed and we are back to full RO. | | | | | | | | |
| 0.3 | Question about brine line: storage tank holds 3 days production at 1.3. In major stormflow, will 3 days be sufficient? NO, we would have to shut down AWTP. First we will fill up AWTP storage over the first few days, in some events you have to go beyond that and stop the AWTP and just do tertiary treated water. You would still have the UF running. Assuming you had less than 1.7AWDF, all flows get MBR+UF and go to nepean. Modelling done to see how often this would occur. Could occur in 1:5 year flood. If flows were ine xcess of 1.7AWDF, pump station wouldnt be able to get them to nepean, excess MBR water would go to south creek. In these extreme events, would have higher phosphorus loads leaving the plant | | | | | | | | |
| 0.4 | | | | | | | | | |
| 0.5 | | | | | | | | | |

Sydney WATER

| | | | |
|---|---|---|---|
| **PROJECT NUMBER** | **20036007** | **Date of Review** | **6/05/2020 (AM)** |
| **PROJECT NAME** | **Upper South Creek Water Factory** | **Location** | **Online (MS Teams/Mural)** |
| **PROJECT DESCRIPTION** | **Reference Design for new water recycling fa** | **Review** | **HAZOP1 - AWTP & Transfer PS** |
| **Project Manager: Nigel Vivian** | | | |
| **Design Manager: Mark Rush** | | | |

| Company | Name | Position | Email | Phone |
|---|---|---|---|---|
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| SWC | David Cantlon | Operations | [redacted] | |
| SWC | Eizac Chee | PE | [redacted] | |
| SWC | Hannah Lockie | Planning | [redacted] | |
| Planning Partner | Ivona Maric | Facilitator | [redacted] | |
| Planning Partner | Julian Briggs | Reviewer | [redacted] | |
| Planning Partner | Julian Briggs | Reviewer | [redacted] | |
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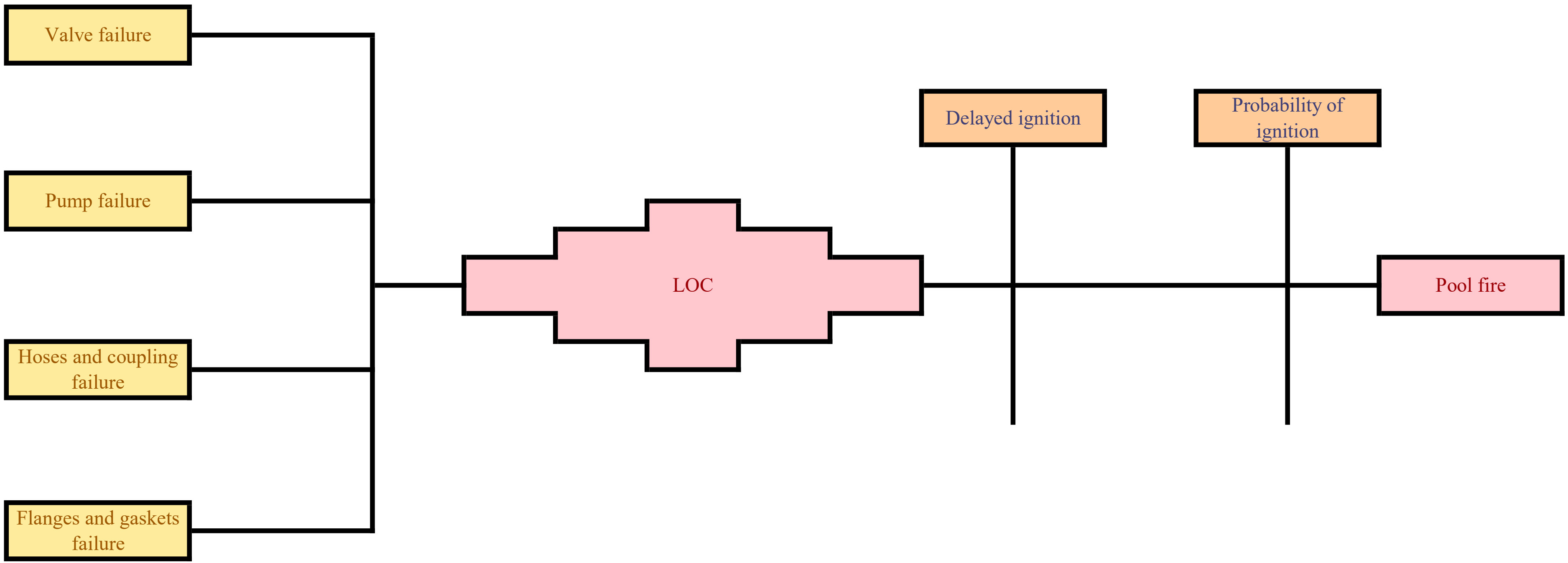
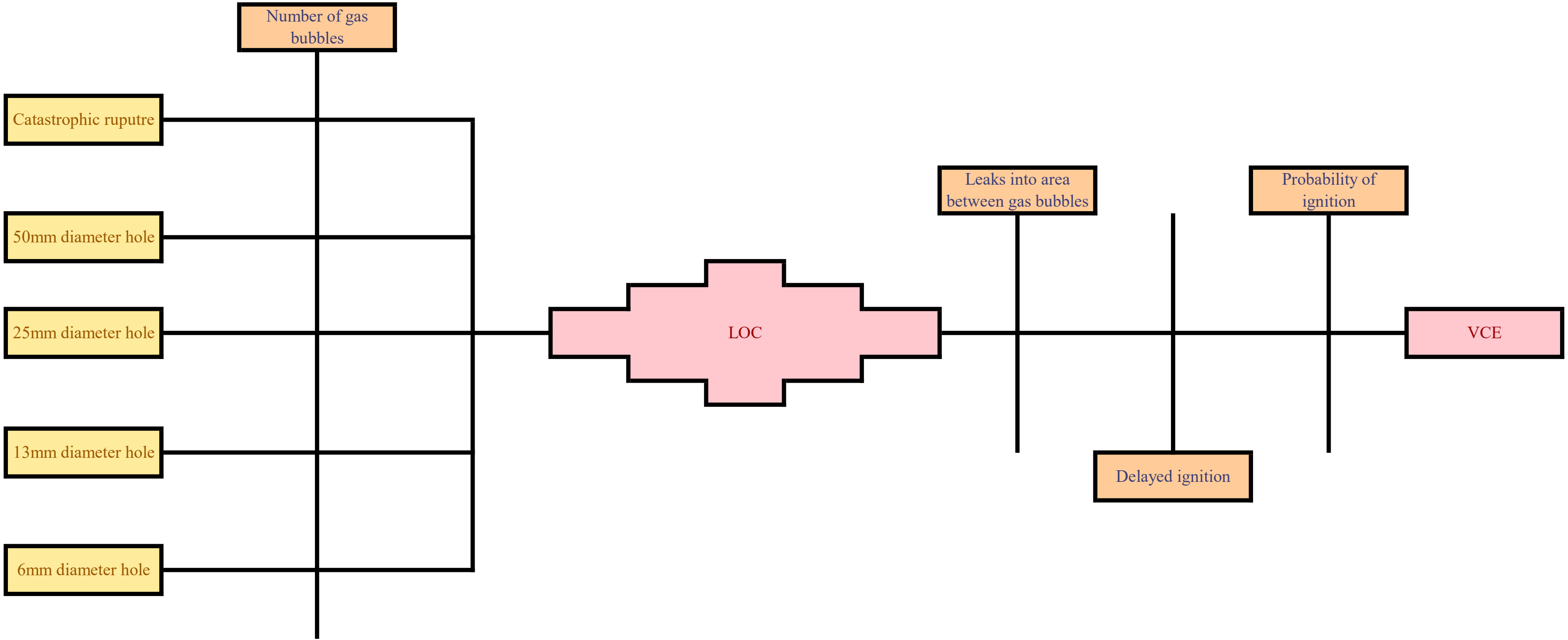
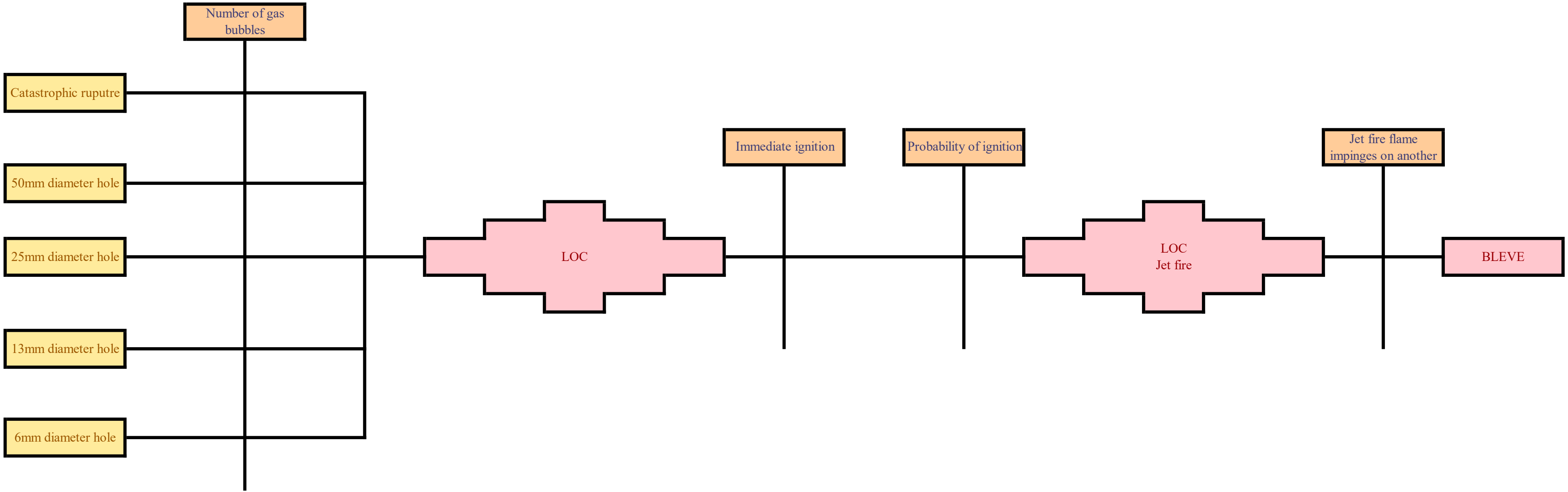
| SWC | Karu Karunahararaj | DM PM | [redacted] | |
| SWC | Leighton Cramp | IICATS | [redacted] | |
| Planning Partner | Martina Kempys | Design - Treatment | [redacted] | |
| SWC | Milan Rubcic | UD&E - Pump Stations | [redacted] | |
| Planning Partner | Misaki Nakamura | Design - PS | [redacted] | |
| Planning Partner | Navid Majlessi | Electrical | [redacted] | |

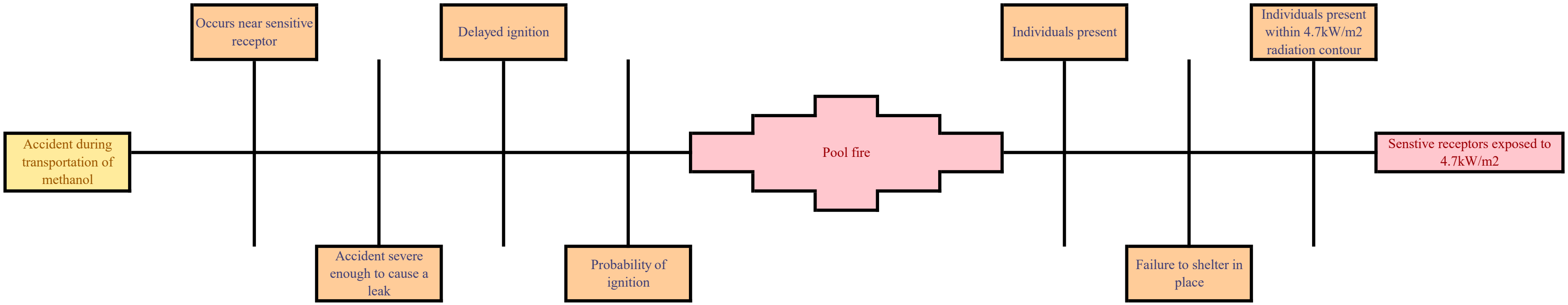
# Appendix C Threat-Barrier Diagrams

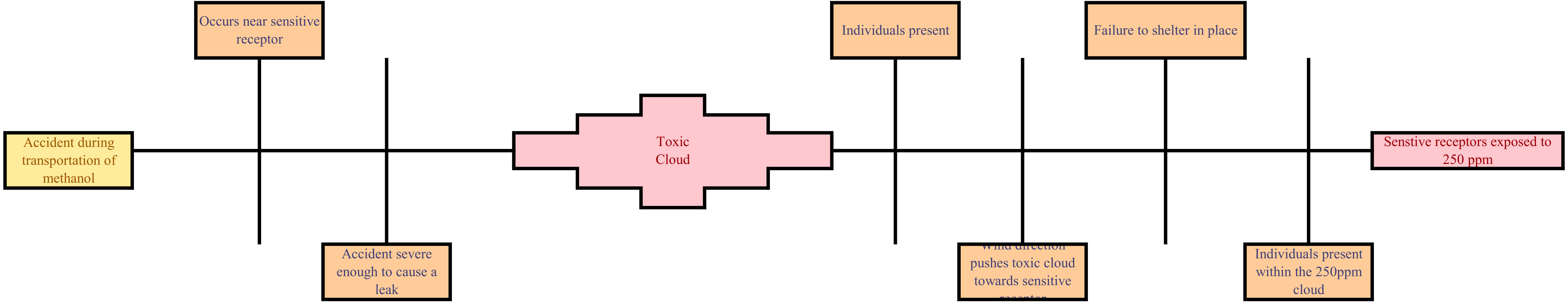

Valve failure
Pump failure
Hoses and coupling failure
Flanges and gaskets failure
LOC
Delayed ignition
Probability of ignition
Pool fire



Number of gas bubbles
Catastrophic ruputre
50mm diameter hole
25mm diameter hole
13mm diameter hole
6mm diameter hole
LOC
Leaks into area between gas bubbles
Delayed ignition
Probability of ignition
VCE


Number of gas bubbles
Catastrophic ruputre
50mm diameter hole
25mm diameter hole
13mm diameter hole
6mm diameter hole
LOC
Immediate ignition
Probability of ignition
LOC
Jet fire
Jet fire flame impinges on another
BLEVE


Accident during transportation of methanol
Occurs near sensitive receptor
Accident severe enough to cause a leak
Delayed ignition
Probability of ignition
Pool fire
Individuals present
Failure to shelter in place
Individuals present within 4.7kW/m2 radiation contour
Senstive receptors exposed to 4.7kW/m2


Accident during transportation of methanol
Occurs near sensitive receptor
Accident severe enough to cause a leak
Toxic Cloud
Individuals present
pushes toxic cloud
towards sensitive
Failure to shelter in place
Individuals present within the 250ppm cloud
Senstive receptors exposed to 250 ppm