Appendix 13

Hazard Identification and Risk Assessment

Hazard Identification and Risk Assessment for

Resource Recovery Centre, Ringaskiddy

***Prepared for*:**

Indaver

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Contents

1 INTRODUCTION

1.1 Background

This report sets out the findings of a Hazard Identification and Risk Assessment (HAZID&RA) exercise for a proposed resource recovery centre at Ringaskiddy. We have previously conducted similar assessments for a proposed development at this site. For the initial assessments (in 2001 and 2008), the design and scope of the facility was larger than the new plan, and incorporated a wider range of waste materials and included a wider range of activities. One of the implications of this was that the COMAH Regulations[1] applied to the planned developments at that time. However, the current proposal involves a smaller scope of development and it does not incorporate some of the elements from the previous design (e.g. a bulk storage tank farm for waste solvents or a waste drum storage area). This means that the number of hazards at the site and the associated risks presented by the activity, have been greatly reduced when compared with the previous assessments. It also means that the COMAH Regulations no longer apply to the proposed facility.

Nonetheless the decision was taken to reassess the risks presented by the facility to human health and to the environment using the same criteria as were applied for previous assessments. This formal risk assessment exercise plays a key role for Indaver in demonstrating that the risks presented by the facility can be considered to be As Low As Reasonably Practicable (ALARP).

The COMAH Regulations do not apply because as the quantities of hazardous materials at the site will be below the thresholds set out under the legislation. Appendix 5 of this report contains an assessment of the expected composition of the flue gas residues. This exercise was conducted to determine whether the concentrations of contaminants in the ash would be sufficient for the entire ash residue stream to require classification as Hazardous to the Aquatic Environment.

Nevertheless there are several materials that will be stored and handled at the site which could give rise to an accident scenario presenting a risk to human health or the environment and so this report sets out the findings of the risk assessment exercise that was conducted by Indaver.

1.2 Description of Site

Indaver proposes to develop a Resource Recovery Centre in Ringaskiddy in County Cork for the treatment of household, commercial and industrial, hazardous and non-hazardous waste. The proposed development, the Ringaskiddy Resource Recovery Centre will use robust and proven technology to process up to 240,000 tonnes per annum of residual waste. Energy and other useful materials will be recovered from this residual waste, which is currently landfilled or exported. The facility will produce approximately 21 megawatts of electricity.

Included in the proposed development is an upgrade of the local road (L2545) adjacent to the Indaver site to alleviate local flooding issues along the road. In addition, the proposed development will include beach nourishment along the eastern boundary of the Indaver site that will address local coastal erosion issues. Finally, the ground levels of the western portion of the Indaver site will be raised.

A copy of the site layout drawing is shown as Figure 1-1. Further layout drawings to show the site in more detail are shown in Appendix 1.

[1] Previously SI 74 of 2006 (Seveso II), since replaced by SI 209 of 2015 (Seveso III)

The site for the Ringaskiddy Resource Recovery Centre is situated at the north-eastern corner of the Ringaskiddy peninsula and occupies an area of approximately 12 hectares. Figure 1-2 shows the location of the facility and the surrounding area.

Figure 1-1: Site Layout

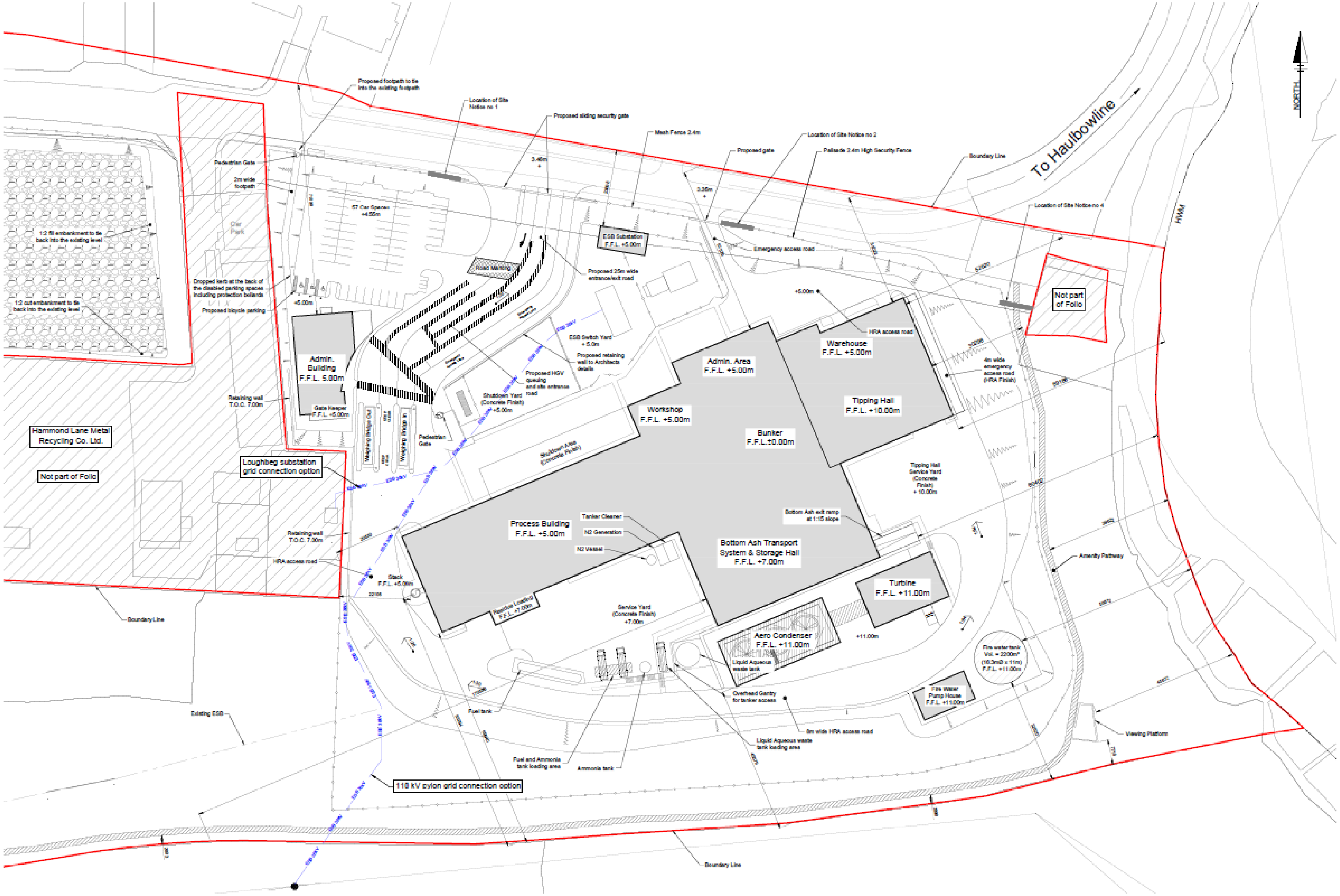


Figure 1-2: Location of Indaver Site (© OpenStreetMap contributors)

1.3 Description of Surroundings

1.3.1 Neighbouring Land Use

The proposed site is located to the east of Ringaskiddy village. The other developments in the vicinity of the Indaver site are described here.

There is a metal reclamation works at Hammond Lane, which is located directly to the west of the proposed Indaver facility. Due to the proximity of this site to the proposed development, the HAZID&RA Team gave consideration to the potential risk that an incident at the metal reclamation works could act as an initiator to an accident scenario at the Indaver establishment.

Apart from the Hammond Lane site, the next nearest building to the Indaver site at which there is industrial/commercial activity is a warehousing operation (Yara Ireland) located immediately to the northwest of the Indaver site. There is also the National Maritime College of Ireland site, which is adjacent to this warehousing facility.

There are a number of COMAH establishments in the vicinity of the planned development at Ringaskiddy, as follows:

- Pfizer – Pharma (API) – upper tier
- Sterling – Pharma (API) – upper tier
- Carbon Chemical Group – Chemical suppliers – lower tier
- Thermofisher – Pharma – upper tier
- Hovione – Pharma – lower tier

The closest of these sites to Indaver is the Hovione establishment, which is located c.800 m from the planned Indaver facility. The consequence modelling shows that there is no risk that an accident at Indaver could present any risk to any of these COMAH establishments.

We do not have details of the Consultation Distances that have been established around these existing establishments; in the event that the Indaver site falls within this range of any of these Seveso sites, the operators will be required to provide Indaver with an information package on the hazards presented by their establishment. However the separation distances are too large for an accident at any of these facilities to present any risk of domino effects or escalation effects to Indaver.

1.3.2 Geology and Hydrogeology

Referring to the Geological Survey of Ireland (GSI) website[2], we have obtained details of the geology and hydrogeology of the site and surrounding area. The details are shown in Figure 1-3, Figure 1-4 and Figure 1-5 on the following pages.

The bedrock immediately under the site is identified on the GSI website as "Flaser-bedded sandstone & mudstone" and "dark muddy limestone, shale".

The aquifer immediately under the site is identified as locally important, with bedrock that is moderately productive only in local zones. There are also some karstified areas in the wider vicinity

[2] http://www.gsi.ie/

of the site. The aquifer under the site is shown as extremely vulnerable, with the area to the south of the site identified as comprising rock near surface or karst.

Figure 1-3: Details of the Bedrock in the Vicinity of the Indaver Site (© Geological Survey of Ireland)

Figure 1-4: Details of Aquifer Classification in Vicinity of the Indaver Site (© Geological Survey of Ireland)

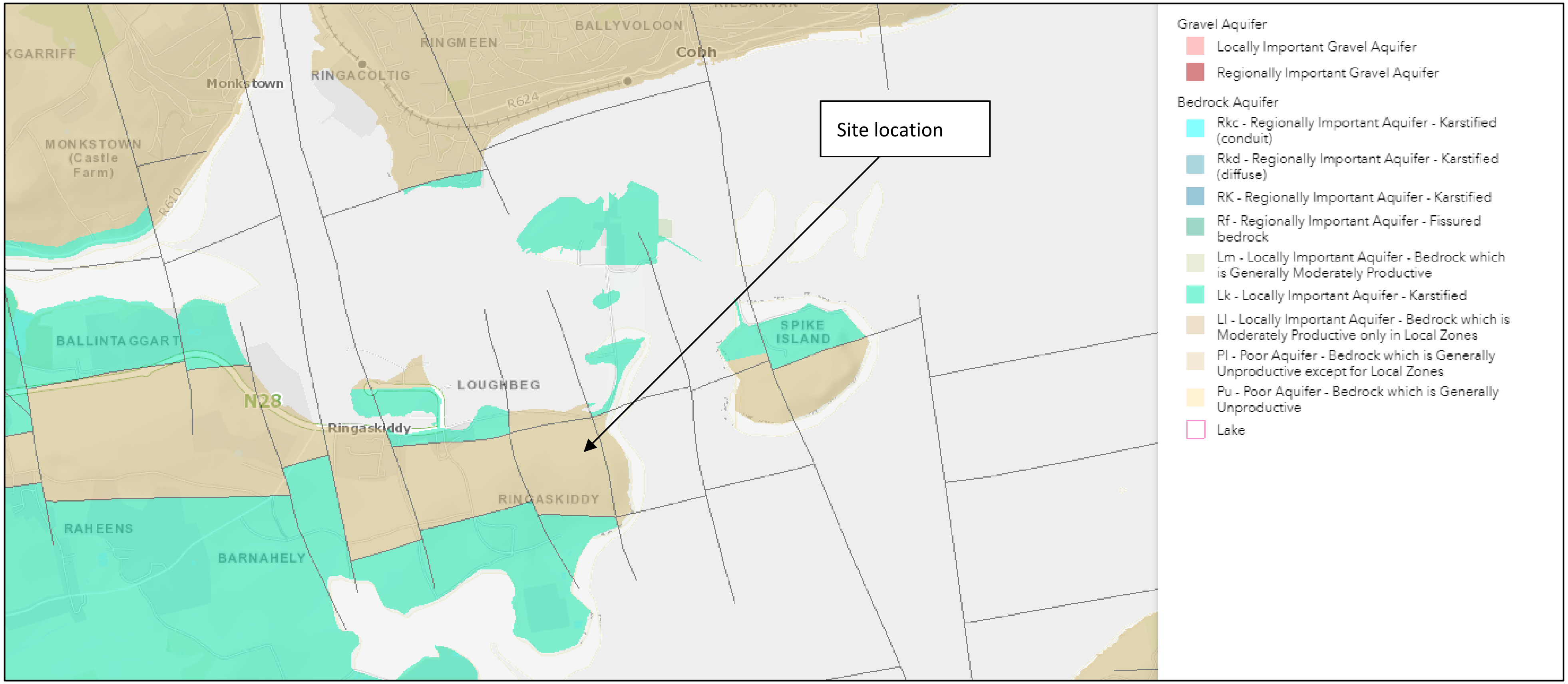
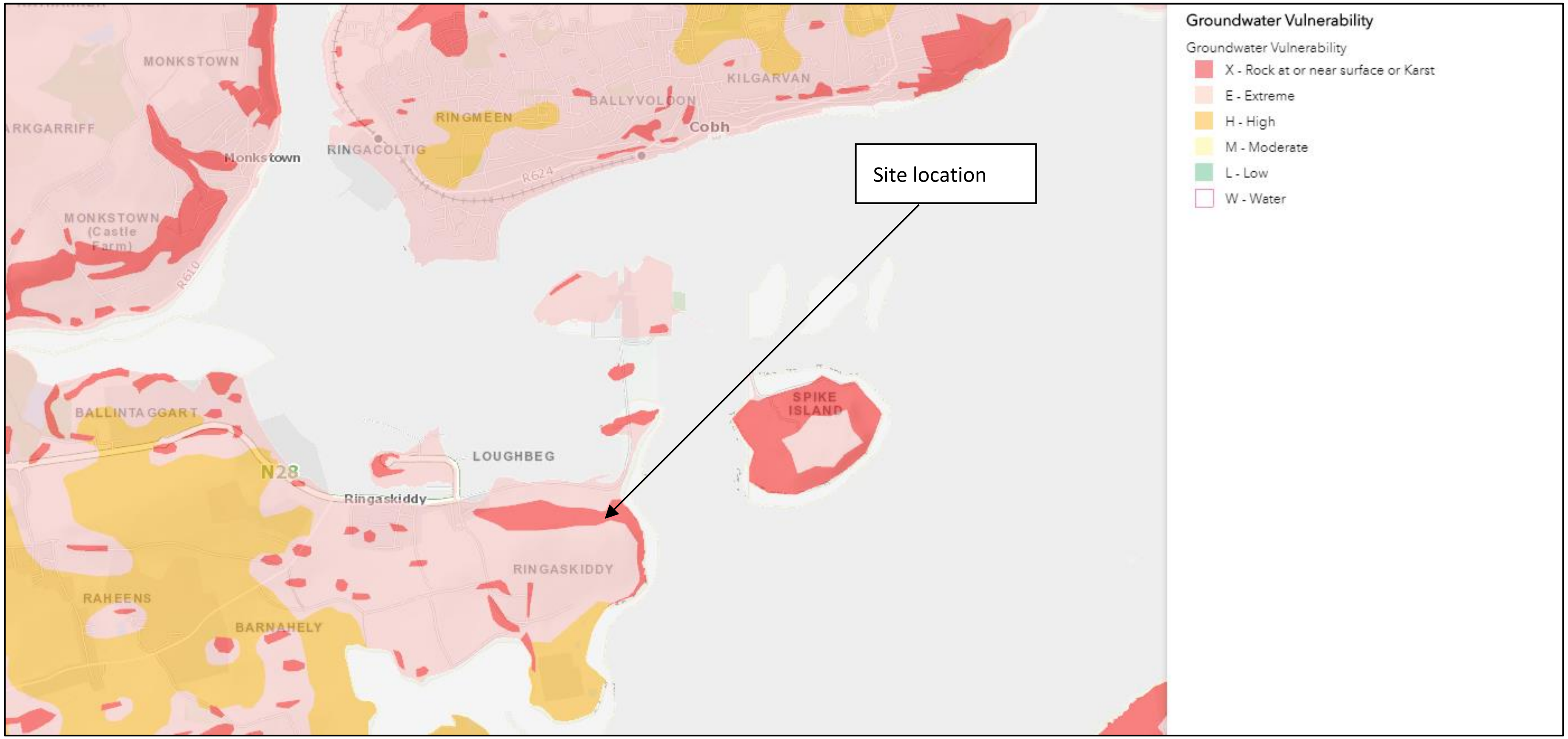


Figure 1-5: Details of Aquifer Vulnerability in Vicinity of the Indaver Site (© Geological Survey of Ireland)



1.3.3 Flora and Fauna

There are several protected sites in the vicinity of the proposed development. These are as shown in Figure 1-6 and Table 1-1.

Table 1-1: Protected Sites (NPWS)

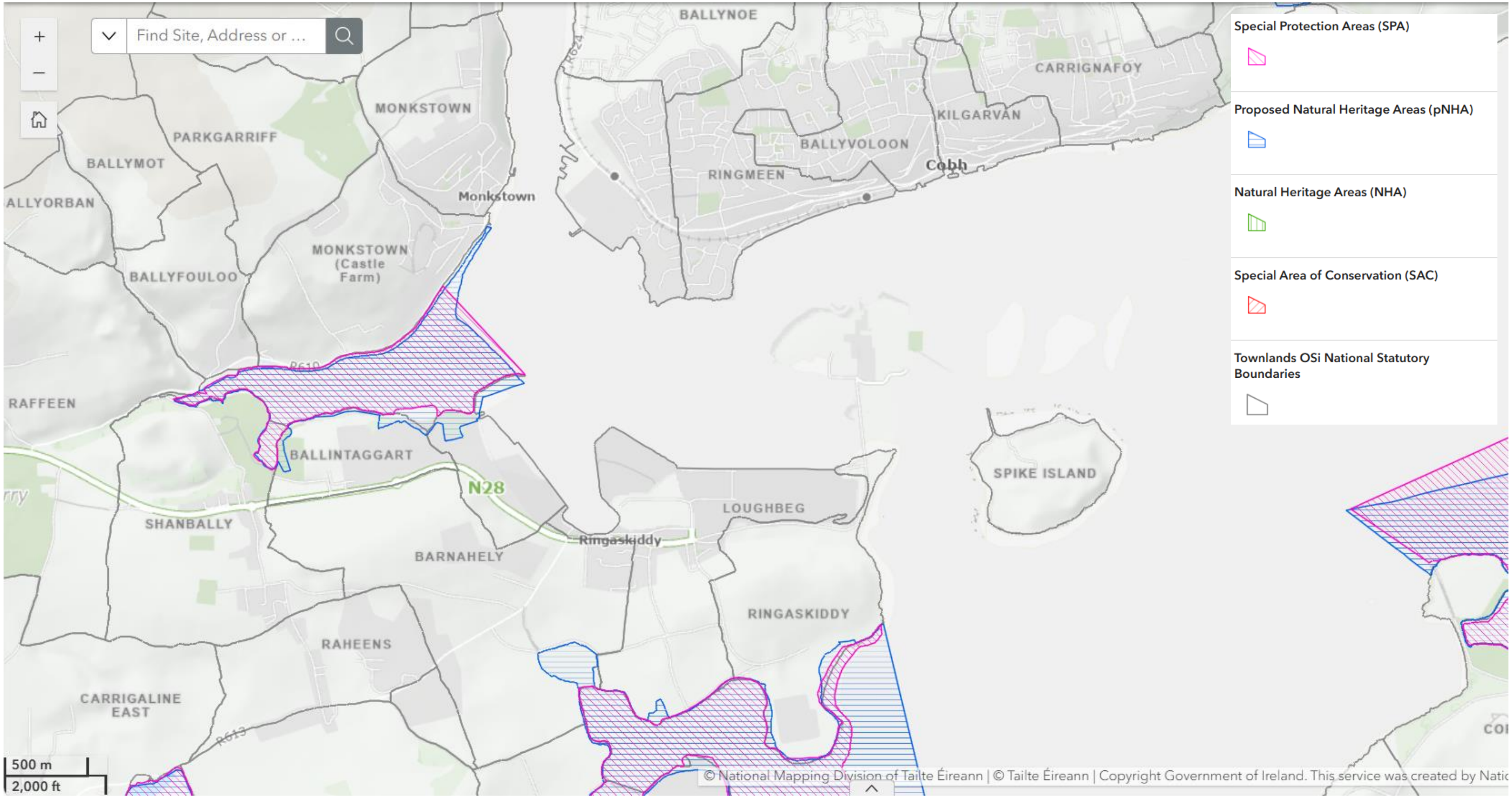
Site Code	Site Name		
004030	Cork Harbour	SPA	There are several areas of Cork Harbour which are designated as SPA, including at Monkstown, Lough Beg and Whitegate Bay

There are also several proposed natural heritage areas (pNHA) in the vicinity of the site, which are not shown on the map.

- 001979: Monkstown Creek pNHA: West of site (between Ballintaggart and Monkstown).
- 001066: Lough Beg (Cork). South of site (south of Ringaskiddy).
- 001084: Whitegate Bay. East of site (at Whitegate).
- 001987: Cushkinny Marsh. Northeast of site (at Cushkinny).

None of these protected sites lie in the immediate vicinity of the proposed Indaver site.

Figure 1-6: Protected Sites in the Vicinity of the Indaver Development



1.3.4 Watercourses (Tides and Currents)

Cork Harbour is an important and attractive water body with many beneficial uses. The harbour, a drowned river valley, is the tidal estuary of the River Lee and extends about 20 km from Cork City to the open sea. In simple terms, the upper harbour estuary widens uniformly in the direction of the open sea and the tidal currents move simply up and down the estuary as the tide ebbs and flows.

According to the Admiralty Chart, the tidal data for Cobh and Ringaskiddy are as shown in Table 1-2.

Table 1-2: Tidal Data for Cobh and Ringaskiddy

Location	Lat N	Long W	Heights in metres above datum				Datum and Remarks
			MHWS	MHWN	MLWN	MLWS	
Cobh	51°51’	8°18’	4.1	3.2	1.3	0.4	0.13 m above OD (Dublin)
Ringskiddy	51°50’	8°19’	4.2	3.3	1.4	0.5	0.13 m above OD (Dublin)

1.3.5 Weather Conditions

For the purposes of the risk assessment exercise detailed in this report, the meteorological parameters of most interest are ambient temperature, wind speed, atmospheric stability and rainfall. High ambient temperatures lead to increased evaporation rates from spilled materials. Low wind speeds and high atmospheric stability lead to reduced dispersion of a release, allowing higher concentrations to accumulate in the atmosphere. High wind speeds on the other hand can give rise to high angles of flame tilt in the event of a pool fire.

Cork Airport is the closest weather monitoring station to the site and weather data for this station was obtained from Met Éireann for the period 1991 to 2020, which is the latest 30-year period reported on by Met Éireann. This is shown in Table 1-3 overleaf.

The temperature data shows that the average daily maximum temperature varies from 8.2°C in January to 18.6°C in July. The highest temperature recorded at the station over the 30-year reporting period was 27.8°C.

Wind speed and atmospheric stability are strongly interrelated. Greater atmospheric stability is found at low wind speeds and only certain combinations of wind speed and stability can occur. The data shows an average wind speed of 9.8 knots or 5.04 m/s.

Table 1-3: Cork Airport Weather Data, 1991 – 2020 (Met Éireann)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
TEMPERATURE (degrees Celsius)													
mean daily max	8.2	8.5	9.8	12	14.6	17	18.6	18.4	16.5	13.3	10.3	8.7	13
mean daily min	3.2	3.2	3.9	5.3	7.6	10.1	11.7	11.6	10.2	8	5.3	3.8	7
mean temperature	5.7	5.8	6.8	8.6	11.1	13.6	15.2	15	13.4	10.6	7.8	6.2	10
absolute max.	16.1	14.5	18.8	21.1	23.6	27.2	26.7	27.8	24.5	21.1	15.9	13.9	27.8
min. maximum	-0.3	-1.9	-1.3	4.1	8.5	10.5	12.6	13.8	10.2	6	0.6	-3.1	-3.1
max. minimum	10.5	10.6	10.8	11.3	14.4	16.6	17.5	18	17	15.5	13	11.5	18
absolute min.	-5.6	-4.7	-7	-2.4	0.1	4.1	6.2	5.4	3	-1	-3.3	-7.2	-7.2
mean num. of days with air frost	3.8	3.5	2.3	0.9	0	0	0	0	0	0.2	1	2.8	14.5
mean num. of days with ground frost	12.7	11.8	10.7	6.8	2.4	0.2	0	0.1	0.5	2.4	6.8	11.2	65.6
mean 5cm soil	4.5	4.5	5.9	8.9	12.5	15.6	16.7	15.9	13.4	9.9	6.7	5.2	10
mean 10cm soil	4.9	4.9	5.9	8.2	11.5	14.4	15.7	15.2	13.1	10	7.2	5.6	9.7
mean 20cm soil	5.7	5.7	6.6	8.7	11.5	14.3	15.7	15.5	13.9	11.1	8.3	6.5	10.3
RELATIVE HUMIDITY (%)													
mean at 0900UTC	91.1	90.5	88.3	83.3	81.3	80.9	83.5	86.1	89.1	90.7	91.4	91.3	87.3
mean at 1500UTC	84.4	79.9	75.8	72.3	71.7	71.5	73.7	73.6	76.3	80.4	83.9	86.5	77.5
SUNSHINE (hours)													
mean daily duration	2	2.6	3.6	5.4	6.2	6.1	5.3	5.1	4.3	3.2	2.5	1.8	4
greatest daily duration	8.5	10	11.5	13.8	15.5	16	15.3	14.4	12.1	10.3	8.8	7.6	16

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
mean num. of days with no sun	9.8	6.7	5.7	3.1	2.4	2.3	2.2	2.4	3.4	6.5	7.8	11.4	63.7
RAINFALL (mm)													
mean monthly total	131.3	97.2	91.5	86.5	80.8	83.3	87.2	94.6	92	131.2	127	136.6	1239
greatest daily total	39.3	39.0	55.2	37.7	34.9	51.3	73.2	59.0	58.9	52.1	47.9	61.4	73.2
mean num. of days with >= 0.2mm	21.3	18.4	18.3	16.8	15.9	14.6	16.9	16.9	17	19.9	20.8	21.4	218.2
mean num. of days with >= 1.0mm	16.7	13.7	13.4	12.3	12	10.1	11.9	12.2	11.9	15.1	15.6	16.8	161.7
mean num. of days with >= 5.0mm	9.1	6.8	5.7	5.8	5.3	5.6	5.7	5.5	5.8	7.8	7.9	8.7	79.7
WIND (knots)													
mean monthly speed	10.9	11	10.5	9.8	9.4	8.9	8.5	8.5	8.8	9.7	10.2	10.8	9.8
max. gust	71	70	65	63	53	49	47	58	51	74	66	80	80
max. mean 10-minute speed	44	50	42	41	34	33	29	45	35	47	46	56	56
mean num. of days with gales	1.3	0.8	0.6	0.3	0	0	0	0.1	0.1	0.4	0.6	1	5.1
WEATHER (mean no. of days with..)													
snow or sleet	2.6	2.5	1.7	0.4	0	0	0	0	0	0	0.3	1.9	9.5
snow lying at 0900UTC	0.3	0.4	0.5	0.1	0	0	0	0	0	0	0	0.4	1.8
hail	1	1.1	1.2	1.5	0.5	0.2	0.1	0	0.1	0.3	0.1	0.4	6.5
thunder	0.3	0.1	0	0.1	0.6	0.4	0.6	0.4	0	0.4	0.1	0.1	3.2
fog	8.6	7.2	8.5	7.8	8	7.3	8.5	9.2	8.3	8.5	7.5	8.5	97.8

1.3.6 Listed Buildings and Monuments

Figure 1-7 is a map of the site and surroundings, taken from the Archaeological Survey of Ireland's website[3]. There are three monuments shown on this map, one in close proximity to the site and two located in the wider surrounding area, as follows. The red circles indicate sites included in the Sites and Monuments Records (SMR), while blue indicates entries from the National Inventory of Architectural Heritage (NIAH).

The SMR sites are as follows:

CO087-053---- : Martello tower : RINGASKIDDY

On highest point of Ringaskiddy promontory, overlooking Cork Harbour. Circular tower (diam. 15.5m E-W; 10.9m N-S; H 12.1m) with flattened profile to N and S; enclosed by dry fosse (Wth 4.6m; D 3.1m); within circular enclosure (diam. 100m) marked by ordnance stones. Built of coursed limestone ashlar. Door at 1st floor level on E side closed by iron door; access to interior not gained. Enlarged window opes, at 1st floor level, to N, S and W show an attempt at conversion. Largest of Cork Harbour Martellos; it was under construction 1813-15 (Kerrigan 1978, 148; Enoch 1975, 30). The above description is derived from the published 'Archaeological Inventory of County Cork. Volume 2: East and South Cork' (Dublin: Stationery Office, 1994). In certain instances the entries have been revised and updated in the light of recent research.

CO087-161---- : Midden : RINGASKIDDY

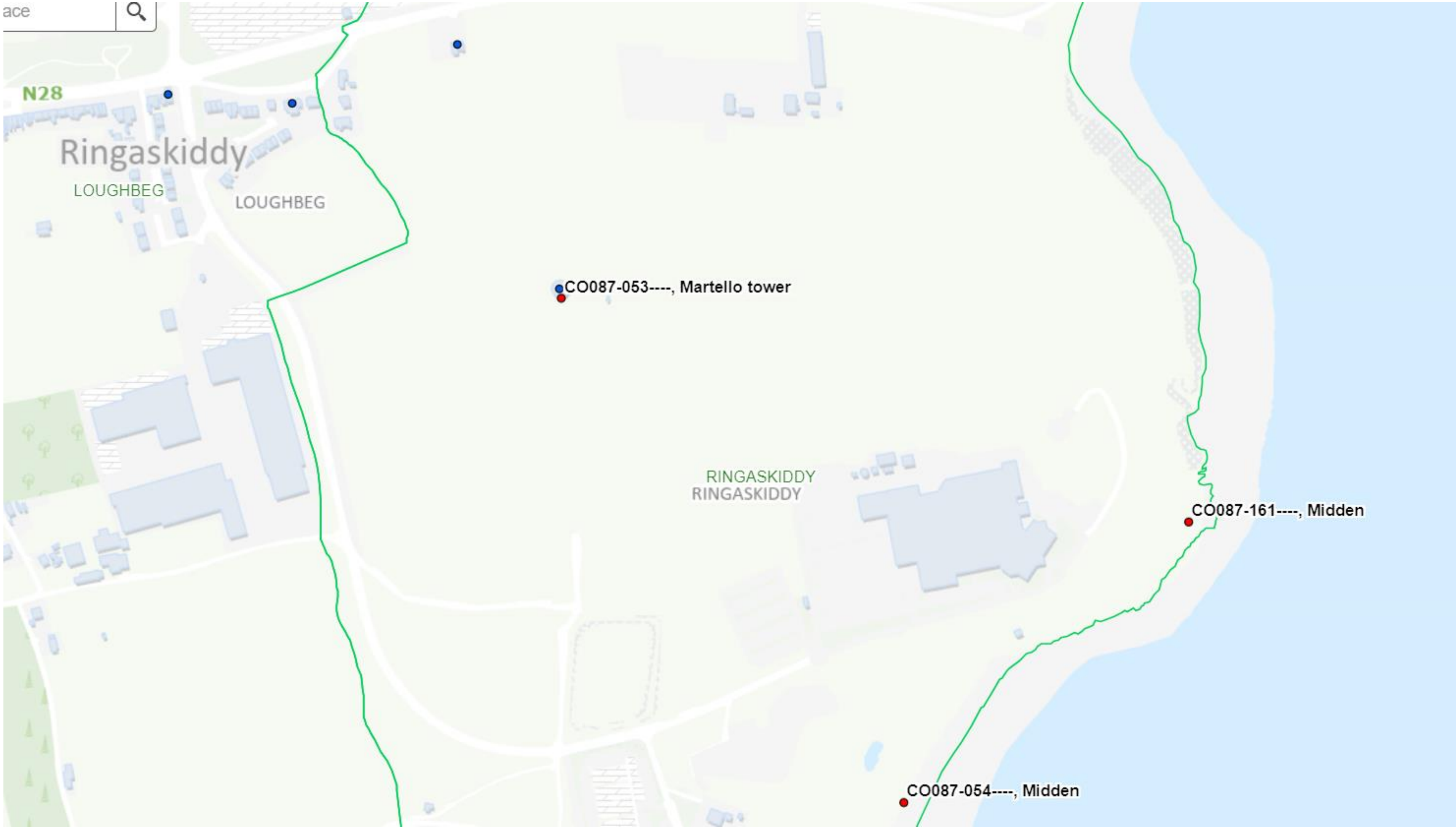
The Archaeological Survey of Ireland (ASI) is in the process of providing information on all monuments on The Historic Environment Viewer (HEV). Currently the information for this record has not been uploaded. To access available information for research purposes please make an appointment in advance with the Archive Unit (open Fridays 10.00 am – 5.00 pm), Department of Culture, Heritage and the Gaeltacht, The Custom House, Dublin 1 D01W6XO or email nmarchive@chg.gov.ie.

CO087-054---- : Midden : RINGASKIDDY

On beach at Curlane Bank. Narrow lens of midden material extends for 30m N-S along shoreline just above high tide mark and measures 0.1m in thickness. Deposit contains cockles, limpets and winkles with some oyster and razor shells. Large scatter of shells (c. 100m E-W) on beach at low tide level. The above description is derived from the published 'Archaeological Inventory of County Cork. Volume 2: East and South Cork' (Dublin: Stationery Office, 1994). In certain instances the entries have been revised and updated in the light of recent research.

[3] http://webgis.archaeology.ie/NationalMonuments/FlexViewer/

Figure 1-7: Location of National Monuments in Vicinity of Site (Historic Environment Viewer)



The Martello Tower is located southwest of the site footprint.

In addition to the three monuments (shown in red in Figure 1-7), there are also three buildings of architectural heritage in the vicinity of the development (shown in blue on the map). These are:

- Reg. No. 20987046. Ring House, Ringaskiddy, Co. Cork.
- Reg. No. 20987045. Rock Cottage.
- Reg. No. 20987044. Ringaskiddy Oratory.

2 HAZARD IDENTIFICATION AND RISK ASSESSMENT

2.1 Risk Assessment Methodology

A formal Hazard Identification & Risk Assessment exercise (HAZID&RA) was carried out to identify potential accident scenarios that could arise at each area of the site where dangerous substances are stored or handled. Each scenario was assessed using the HAZID&RA methodology to determine its likelihood of occurrence and the severity of impact to people and the environment if it did occur. This approach gives a semi-quantitative assessment of the overall level of risk associated with each accident scenario identified by the HAZID&RA Team. The Team took account of any relevant prevention or mitigation measures in place when assessing the risks associated with each scenario.

Each scenario was assigned a semi-quantitative Risk Rating, based on the findings of this analysis. The Risk Ratings were then compared with the various criteria established in the risk assessment methodology to determine the significance of the risks associated with each scenario. This approach allowed Indaver to prioritise attention on the scenarios presenting the highest risk and to ensure that all necessary measures would be in place to prevent accidents occurring and to limit the consequences of any such accidents for human health and the environment.

The methodology used is based on a technique outlined in Annex D of BS 8800: 1996, Guide to Occupational Health and Safety Management Systems. Similar risk assessment techniques have also been outlined by the IChemE[4] and the US Naval Weapons Centre's Practical Risk Analysis for Safety Management. It is described in more detail in the following sub-sections. A flowchart to illustrate this methodology is included in Appendix 2.

2.1.1 HAZID&RA Team

The HAZID&RA Team comprised the following personnel:

- Conor Jones: Regional Engineering Manager, Indaver
- Luke Schumm: International Graduate, Indaver
- Thomas Leonard Senior Partner, Byrne Ó Cléirigh

The Team members between them have appropriate training in hazard identification, risk assessment and consequence analysis and had knowledge of the complete range of operations that will be conducted on the site.

They also drew upon specialist input from other members at Indaver and at BÓC where required.

[4] Institute of Chemical Engineers Course, Practical Quantitative Hazard Assessment, 1985

2.1.2 Areas Assessed

The resource recovery centre was sub-divided into the following areas, each of which was assessed in turn by the HAZID&RA Team:

- Bunker
- Furnace
- Boiler
- Flue Gas Cooling Section Water Quench [no MAH]
- Activated Carbon Silo
- Bag House
- Flue Gas Residue Storage
- Flue Gas Cooling Section (water quench / heat exchanger) [No MAH]
- ID Fan [no MAH]
- Stack [no MAH]
- Water treatment plant, chemical storage (IBCs of aqueous HCl and NaOH)
- Piperacks
- General storage area (fuel oil, aqueous waste, aqueous ammonia)

These areas represent the various locations at the site where dangerous substances are stored or handled and which were considered as potentially presenting a risk of a significant accident scenario. Following the assessment of the HAZID&RA Team, not all of these areas were found to present a credible risk of an accident scenario. Further details of the assessment can be obtained from the HAZID&RA Worksheets in Appendix 3, which shows the initiating event – end event combinations for the various major accident scenarios identified for each installation.

2.1.3 Accident Scenarios

Each area was assessed in detail by the HAZID&RA Team. For each area the Team identified the various accident scenarios, or end events, that could arise and noted them in the HAZID&RA Worksheets. This process involved cataloguing all the potential scenarios that could occur for each area; each scenario was described and an assessment made of the potential consequences that could result. A copy of the Worksheet is included in Appendix 3.

2.1.4 Assessment of Severity Ratings

Each scenario was assigned two Severity Ratings with values between 1 and 5, in accordance with the criteria set out in Table 2-1. The first Severity Rating was used to characterise the potential impacts to people, while the second Severity Rating was used to characterise the potential impacts to the environment.

Table 2-1: Severity Ratings for Accident Scenarios

Severity Rating	Category Description	Health & Safety		Environmental Impact
		On-Site	Off-Site	
0	Negligible	None	None	None
1	Minor	Minor injury	None	None
2	Appreciable	Multiple injuries with return to work	Discomfort	Discoloration of water or air
3	Severe	Major permanent disability	Some hospitalisation for screening	Minor short term damage to adjacent land or water courses
4	Very Severe	Single fatality	Minor injuries	Significant short term damage or minor long term damage requiring clean up action
5	Catastrophic	Multiple fatalities	Major injuries or fatalities	Major incident with significant loss of species or habitat

When assessing impacts to health & safety, consideration is given to both on-site and off-site impacts, based on the descriptors shown above, in order to determine the appropriate Severity Rating.

2.1.5 Identification of Initiating Events

Once the various accident scenarios for a particular area have been identified and Severity Ratings assigned to each, the HAZID&RA Team then examined the various initiating events which could potentially give rise to each scenario and the details were set out in the Risk Assessment Register (RAR) sheet. The potential initiating events which were considered included, inter alia, mechanical failure, human error, control equipment failure, as well as external events such as lightning strike or domino effects from an external event. A copy of the RAR worksheets is included in Appendix 3.

2.1.6 Assessment of Frequency Ratings

Each scenario (based on the combination of End Event and Initiating Event) was assigned a Frequency Rating using the HAZID&RA methodology. Table 2-2 shows the criteria used when assigning Frequency Ratings for each scenario.

Table 2-2: Frequency Ratings for Accident Scenarios

Frequency Rating	Descriptor	Frequency Range per Annum
1	Virtually Impossible	$< 1 \times 10^{-8}$
2	Improbable	1×10^{-8} to 1×10^{-5}
3	Unlikely	1×10^{-5} to 1×10^{-3}
4	Infrequent	1×10^{-3} to 0.1
5	Occasional	0.1 to 10
6	Frequent	> 10

The following sources of information were referred to when assigning Frequency Ratings to the various scenarios:

- Literature review: Published figures of generic data, including those developed by the Dutch Committee for the Prevention of Disasters' Guidelines for Quantitative Risk Assessment (the Purple Book) and industry specific studies. Historical data of this type encompasses all relevant contributory aspects including the reliability of equipment, human factors, operational methods, quality of construction, inspection, maintenance, operation, surrounding environment etc.
- Operational conditions: The HAZID&RA Team explicitly accounted for the planned level of activity at the site and on the site layout (e.g. deliveries per annum of material, lengths of unbunded pipeline sections, etc.). The potential risk of knock-on effects from adjacent establishments or other external factors was also considered.
- Professional judgement: The Team members, between them, had appropriate training in hazard identification, risk assessment and consequence analysis and had knowledge of the complete range of operations on site.

2.1.7 Calculation of Risk Rating

The HAZID&RA Team calculated numerical Risk Ratings for each scenario identified in the course of the exercise using the following equations:

$$R_H = S_H \times L$$
$$R_E = S_E \times L$$

Where: R_H is the overall Risk Rating with respect to health and safety for a scenario
R_E is the overall Risk Rating with respect to the environment for a scenario
S_H is the Severity Rating with respect to health and safety for an end event
S_E is the Severity Rating with respect to the environment for an end event
L is the Likelihood Rating for a specific initiating event – end event combination

The Risk Ratings for each scenario were assessed using a matrix, as set out in Table 2-3.

Table 2-3: Matrix of Risk Ratings

Risk Rating		Severity				
		1	2	3	4	5
Frequency	1	1 - Trivial	2 - Trivial	3 - Trivial	4 - Trivial	5 - Minor
	2	2 - Trivial	4 - Trivial	6 - Minor	8 - Minor	10 - Moderate
	3	3 - Trivial	6 - Minor	9 - Moderate	12 - Substantial	15 - Priority
	4	4 - Trivial	8 - Minor	12 - Substantial	16 - Priority	20 - Priority
	5	5 - Minor	10 - Moderate	15 - Priority	20 - Priority	25 - Priority
	6	6 - Minor	12 - Substantial	18 - Priority	24 - Priority	30 - Priority

A Risk Reduction Register (RRR) was then completed for each scenario on the back of this assessment. This was used to set out any specific scenarios or locations at the site where the HAZID&RA Team identified or recommended additional risk reduction or mitigation measures. When making these recommendations, consideration was given to the risk level associated with each scenario using the criteria set out above.

The findings of the Hazard Identification & Risk Assessment (HAZID&RA) exercise are discussed in more detail in the following sub-sections and copies of the HAZID&RA Worksheets are included in Appendix 3.

Table 2-4: Significance of Risk Ratings

Risk Rating	Risk Level	Action and Timescale
≤ 4	Trivial	Generally no action is required for scenarios with such low risk levels and if so there would be no need for detailed working to demonstrate ALARP (i.e. are As Low As Reasonably Practicable).
5 to 8	Minor	No additional controls are required in most cases. Consideration may be given to a more cost-effective solution or improvement that imposes no additional cost burden. Monitoring is required to ensure that controls are maintained.
9 to 11	Moderate	Efforts should be made to reduce the risk, but the cost of prevention should be carefully measured and limited. Risk reduction measures should be implemented within a defined time period. Where a moderate risk is associated with a scenario whose consequences are in the category of Very Severe or Catastrophic (Severity Rating 4 or 5) further assessments may be necessary to establish more precisely the likelihood of harm as a basis for determining the need for improved control measures.
12 to 14	Substantial	The activity should not be started unless it can be verified that all necessary measures have been identified to minimise the risk. Considerable resources may have to be allocated to reduce the risk. Where the risk involves a current activity, urgent action should be taken.
≥ 15	Priority	The activity should not be started or continued until the risk has been reduced. If it is not possible to reduce risk, even with unlimited resources, this activity must be prohibited.

2.2 Human Factors

The possibility of human error was considered throughout the various areas covered by the risk assessment exercise.

For all transfers of materials at the site, there will be procedural controls in place to supplement the technical controls that are designed to prevent accidents, including loss of containment of hazardous materials, from occurring.

All deliveries or movements of waste will be controlled by ensuring that they are carried out in accordance with documented Standard Operating Procedures and are carried out by trained personnel.

The layout of the site is also designed with the following considerations with respect to the locations of occupied buildings and the arrangements where operators must use or handle dangerous substances.

- The provision of good separation distances between occupied buildings and hazardous areas / dangerous substances. There will also be a site plan in place which shows the emergency escape routes and assembly points.
- The layout will be designed to minimise the risk of uncontrolled sources of ignition from reaching hazardous areas. This will include ATEX zoning of the site, where required, and the use of suitable (Ex-rated) equipment in zoned areas.
- Where an operator's activities involve the use or handling of dangerous substances, they will be provided with training on the tasks to be carried out as well as with information on the hazards associated with the materials involved. Personnel will also be provided with appropriate PPE for the tasks being carried out.
- For any instances in which an operator is required to provide direct intervention in the event of abnormal operating conditions and/or a developing accident scenario, they will be provided with the necessary training to do so (Emergency Response Team members).

In each case the roles to be taken by personnel will be documented. Operators who are required to carry out these response plans receive training to ensure that they are fully aware of the steps to be carried out in response to an accident or incident and also that they are fully aware of the hazards and risks associated with the relevant plant or equipment. They will also be provided with appropriate PPE to assist them in carrying out their required tasks.

Indaver will also ensure that there are appropriate staffing levels at the site at all times to ensure safe operating and to implement emergency response measures, where necessary.

2.3 Criteria for Eliminating Scenarios from the Risk Assessment

The HAZID&RA methodology used for this report involves the systematic assessment of all scenarios identified by the HAZID&RA Team, which includes events which are considered to have very low probability of occurrence. Table 2-2 shows that any scenario identified which was found to have a frequency of occurrence of less than 10^{-5} per annum would be assigned a Likelihood Rating of 2. In other words, the methodology allows for extremely remote events to be included in the risk assessment exercise.

It can be seen in Table 2-4 that highly remote events with potentially catastrophic consequences are considered to present a Medium Risk rather than a Low one. This means that these scenarios are examined further, particularly with respect to determining the potential impacts arising from such an event. This means that Indaver would need to consider implementing further risk reduction measures for these scenarios if the HAZIRD&RA Team found it necessary or desirable to do so.

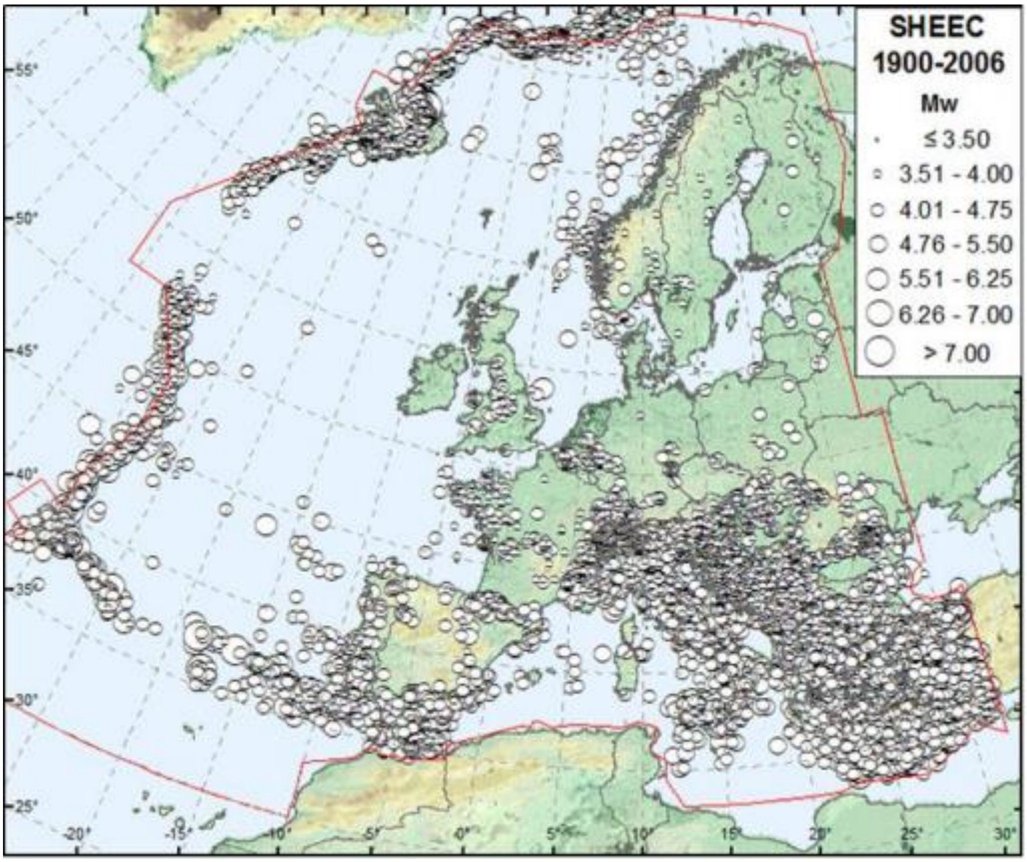
2.4 External Impacts / Off Site Risks

2.4.1 Earthquake

The level of seismic activity in Ireland is very low[5] . The School of Cosmic Physics, which has had a seismic network in operation in Ireland since 1978, has indicated that there is nothing to suggest that this will change in the coming millennia.

The *Seismic Hazard Harmonization in Europe* (SHARE) project, comprising eighteen European partner institutions, has compiled two European Earthquake Catalogues, one for the period 1000 to 1899, and one for the period 1900 to 2006, which show the locations of seismic events across Europe. The map for the period 1900 to 2006 is shown in Figure 2-1. This shows that there is relatively little seismic activity in Ireland.

Figure 2-1: SHARE European Earthquake Catalogue (1900 to 2006)



The SHARE project has also developed a European Seismic Hazard Map, shown in Figure 2-2. The map shows the peak horizontal ground acceleration (measured in ‘g’ – gravitational acceleration) predicted to be reached or exceeded with a 10% probability in 50 years. This corresponds to the average recurrence of such ground motions every 475 years, as prescribed by the national building codes in Europe for standard buildings. Low hazard areas (PGA ≤ 0.1 g) are coloured in blue-green,

[5] *Seismic Hazard in Ireland*, Jacob, W.B. (1993), Dublin Institute for Advanced Studies, School of Cosmic Physics, Geophysics Section

moderate hazard areas in yellow-orange and high hazard areas (PGA > 0.25 g) in red. As can be seen from Figure 2-2, Ireland is a low hazard area.

Figure 2-2: European Seismic Hazard Map

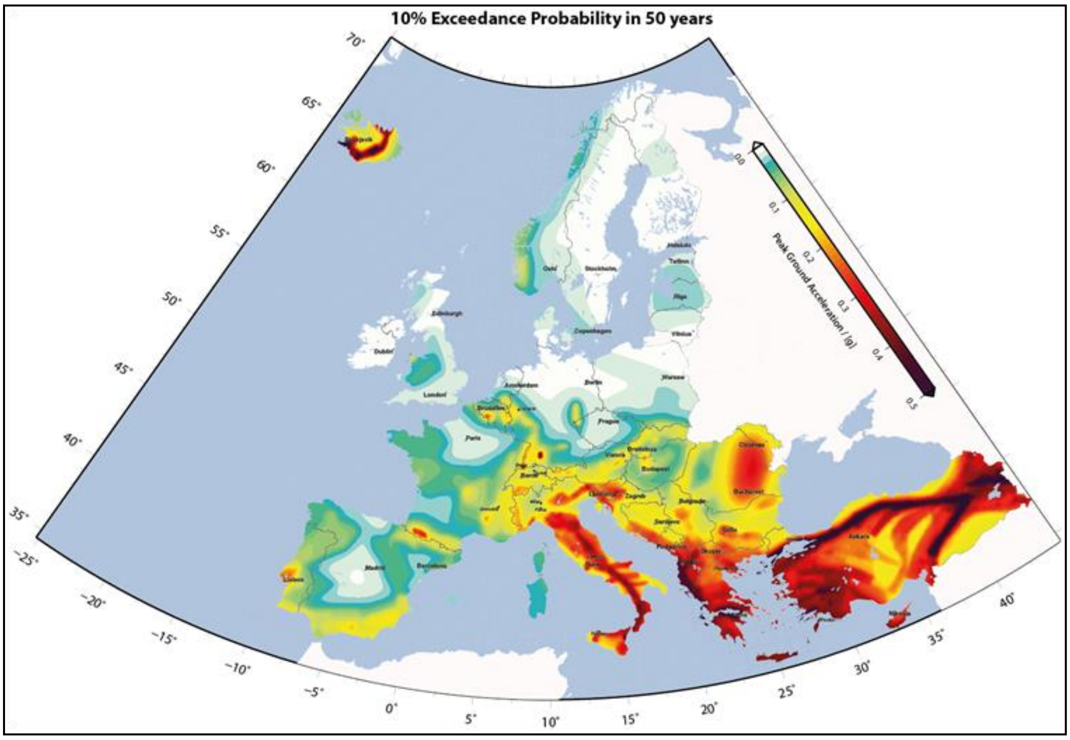


Figure 2-3: Seismic Hazard for Ireland

On the basis of the extremely low seismic hazard in Ireland, earthquakes have been eliminated as sources of credible Major Accident Scenarios at the Zoetis site.

2.4.2 Flooding

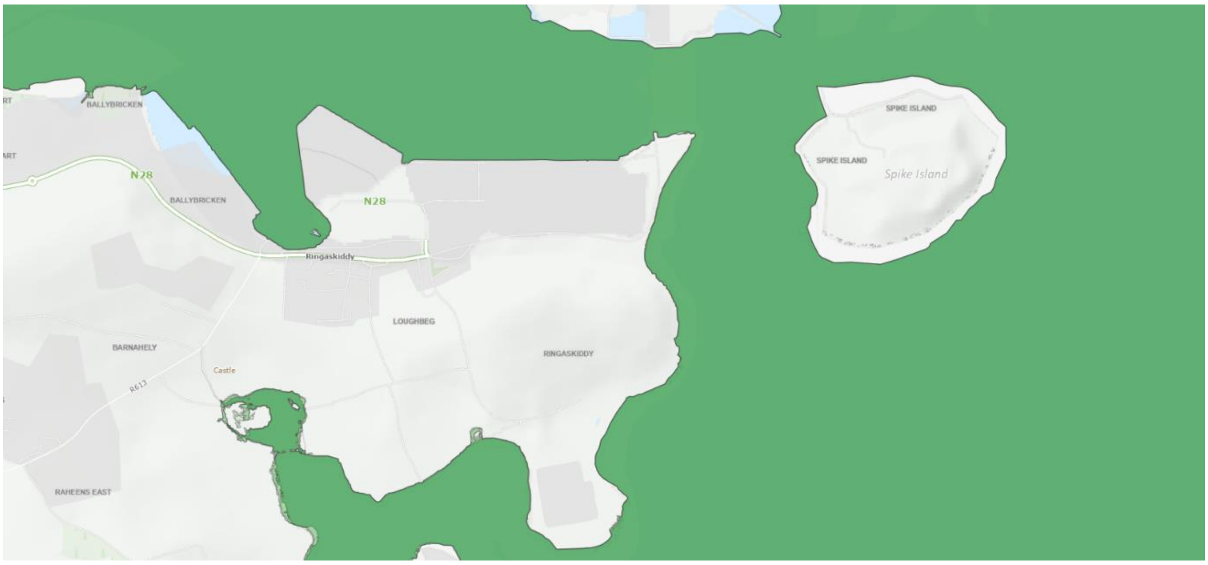
There is no credible risk of an accident occurring at the Ringaskiddy site as a result of a flooding event. Even in the worst-case rainfall event, the highest quantity of rainfall that could fall onto a bund area would be 73.2 mm in 24-hours, based on the rainfall data shown in Table 1-3. Any build-up of water in the bunds could therefore be easily managed by Indaver operators by allowing the rainwater to drain via oil-water separators, in accordance with normal operating procedures at the site.

Indaver will also upgrade the road drainage network in the vicinity of the site in order to further protect against flood risk. A flood study was conducted as part of the planning application process. It was found that flooding has previously occurred in the vicinity of the site, as there was inadequate drainage on the road network. However, upgrade works will be conducted on the L2545 road are part of the proposed development, including improvement of the drainage systems in order to mitigate against future flood risks. The ground at the site will have a finished floor level of at least 5 m above ordnance datum, which is greater than the observed tidal range.

Based on the above it was considered that there was no credible risk of a major accident scenario associated with flooding at the site.

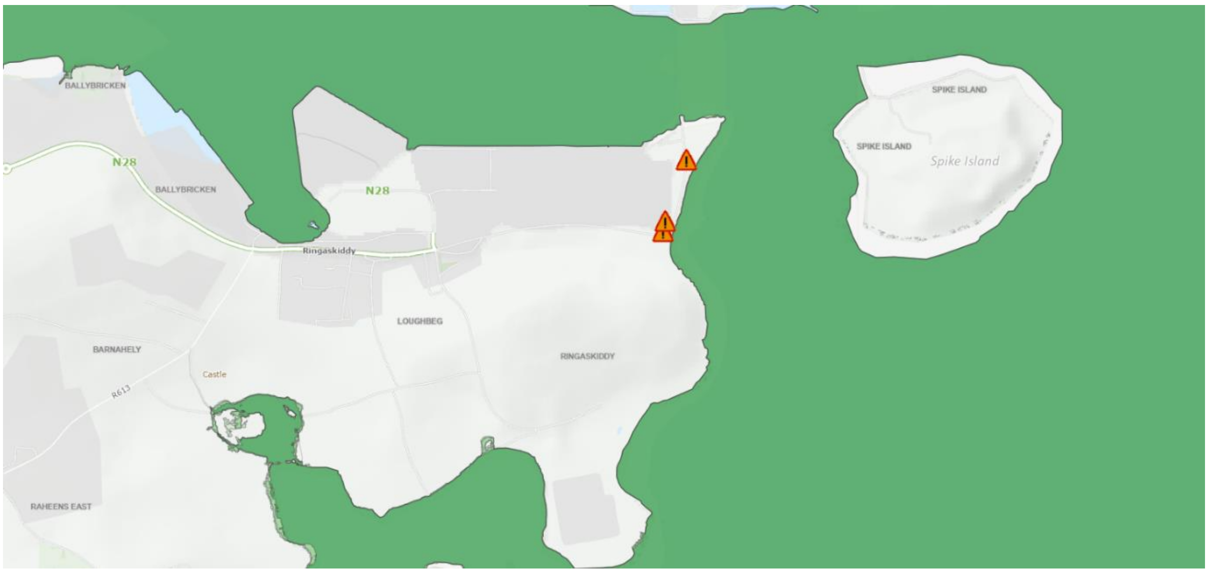
The risk of coastal erosion, and the measures that will be put in place to mitigate against it, are discussed in Section 13.5 of the EIS. The assessment found that there would be no risk from coastal erosion on the proposed development after 30 years. There could be a risk of an impact on a small section of the proposed development after 40 years, but this would be confined only to the amenity walkway and viewing platform located outside the of the security fence line. However, even allowing for the conservative assumptions used to predict the rate of erosion, the facility itself will not be impacted by coastal erosion after 40 years. Based on these findings it was considered that there is no credible accident scenario at the site resulting from coastal erosion effects.

Figure 2-4: OPW Flood Map



This shows the extents of the river flood extents, coastal flood extents and fluvial flood extents. Due to the location, the flood zones shown are all coastal zones. This shows the extends of the High, Medium and Low risk zones. There is no inland encroachment of flood zones to the Indaver site or to the vicinity of the Indaver site.

Figure 2-5: OPW flood events



The map of past flood events shows three incidents to the north east of the site, all close to the shoreline, occurring in 2004 and 2014.

Table 2-5: Flood events in vicinity of site

Ref	Flood Event	Record Type	Source	Comments
Flood summary (ID-1364)	Paddys Block, Ringaskiddy, Co. Cork Oct 2004	Dated Flood - 26/10/2004	Low lying land	-
Flood Summary (ID-12085)	Flooding at Ringaskiddy, Co. Cork on 3rd February 2014	Dated Flood - 03/02/2014	Null	Shown as two discrete points on the map.

The following additional details are provided for the Ringaskiddy flood event ID-12085: High Tides and Strong Winds. The flooding was in the Lee Catchment. Flooding caused by a combination of south-easterly winds and high tides. From Monday morning 03rd February to Tuesday evening 04th February 2014. Flood water extended approx. 60 m from car park at end of local road (L2545) and was approximately 13 - 15 inches deep.

2.4.3 Power Failure

There are no accident scenarios identified at the site which would be associated with a power failure. If a power failure occurred to a key item of plant or equipment at the same time as potentially hazardous materials were being delivered to the site (e.g. a delivery of aqueous ammonia to the storage tank), the transfer would be halted for the duration of the loss of power event.

The site will have a UPS system and emergency diesel generator to provide power in the event of a power cut. This means that Indaver would retain the facility to activate the fire protection systems in the event of a disruption to the electrical supply to the site.

If a power failure occurred to a key item of plant or equipment at the same time as potentially hazardous materials were being delivered to the site (e.g. a delivery of aqueous ammonia to the storage tank), the transfer would be halted for the duration of the loss of power event.

The plant will also have the capability to operate in “Island” mode, i.e. disconnected from the grid but generating and using its own power.

Based on the controls that will be in place it was considered that there was no credible risk of a major accident scenario associated with a power failure to the site.

2.4.4 Aircraft Impact

The closest airport to the Ringaskiddy site is Cork Airport, which is located at a distance of c.13 km from the proposed development. Figure 2-6 shows the plot of the Public Safety Zone (PSZ) for this airport. This is taken from report[6] by ERM (Environmental Resources Management) Ireland Ltd, which was commissioned by the Department of Transport and the Department of the Environment and Local Government.

[6] Public Safety Zones: Cork, Dublin and Shannon Airports, ERM, June 2003 (Draft) on behalf of Department of Transport and Department of Environment & Local Government.

The aim of these PSZs was to protect people on the ground from the risk of an aircraft crash by using land use planning controls on developments in the vicinity of airports. Essentially a PSZ is used to prevent inappropriate use of land where the risk to people is the greatest.

The report for Cork Airport shows 5 no. maps, as follows:

- Cork Airport-Proposed PSZs
- Cork Airport-Proposed PSZs, Main Runway 17-35 (North End 17)
- Cork Airport-Proposed PSZs, Main Runway 17-35 (South End 35)
- Cork Airport-Proposed PSZs, Cross Runway 7-25 (West End 7)
- Cork Airport-Proposed PSZs, Cross Runway 7-25 (East End 25)

The first of these maps illustrates the extents of these zones and is reproduced here as Figure 2-6.

Figure 2-6: Public Safety Zone (PSZ) for Cork Airport (ERM)

Figure 3.1 Cork Airport - Proposed Public Safety Zones

Based on Ordnance Survey Ireland Permit No. 7643. © Ordnance Survey Ireland & Government of Ireland

The plot shows that the PSZ runs in a north-south direction. The proposed development at Ringaskiddy is located to the east of the airport, just outside the range of the map shown. As such the development is comfortably outside of the PSZ contour. The risk of an aircraft impacting the proposed Ringaskiddy development is therefore considered to be extremely remote.

2.4.5 Helicopter impact from Haulbowline Naval Base activities

During the oral hearing held in May 2016, concerns were raised about the increased risk of helicopter accidents due to the presence of the stack of the proposed development and the potential of the plume to interfere with helicopter engine functionality. Information was provided at the oral hearing to address these concerns but subsequently An Bord Pleanála (ABP) sent a request for further information (RFI) to Indaver in March 2017 requesting further details on how the presence of proposed development might prevent/hinder helicopter operations at the naval base. Indaver responded to this request in May 2017.

In October 2017 Indaver responded to a request from ABP to comment on submissions made by third parties post May 2017. The response confirmed that any impact of the plume from the proposed development would be confined to less than 14 m from the tip of the stack. On reviewing the submissions, the Inspector's report (document ref 04.PA0045) concluded that there is nothing based on the information submitted to indicate that the development would impact on low gradient flight paths on take-off from or landing on the naval base. It also concluded that there is nothing to indicate that air emissions would impact on aircraft outside of the radius of 150 m, which was identified as a necessary distance of safety by the Department of Defence.

Based on these considerations, the risk from helicopter impact to the site was considered to be negligible.

2.4.6 High Wind Speeds

All buildings at the site have been designed and will be constructed in conformance with the national building guidelines. Met Éireann has published[7] showing the estimated maximum gust speeds reported in Ireland. These wind speeds may be used as the design speeds for wind loading on buildings using code CP3. Typical maximum gust speeds for Ireland range up to 50 m/s depending on the location of the site. The data in Table 1-3 shows that the maximum gust speed at Cork Airport during the 30-year period from 1990 to 2020 was 80 knots (41.2 m/s).

The Department of Geography in NUIC indicated that when considering the risk of tornadoes, the probability that one will touch down at a particular location in Ireland is very low.

The possible impacts of high winds are taken into consideration when planning for crane work on the site. Crane lifting is prohibited during periods of high wind speed. Notwithstanding this, crane and crane load impacts on areas in which dangerous substances are handled – as a result of mechanical failure and / or human error – are considered as credible initiating events for Major Accident Scenarios at the site.

No credible accident scenario resulting from high wind loading was included as an initiating event by the HAZID&RA Team.

[7] Weather Extreme Records for Ireland - Met Éireann - The Irish Meteorological Service

2.4.7 Extremes in Ambient Temperature

From the temperature data in Table 1-3, the highest ambient temperature at the site (based on a 30-year return period) would be of the order of 27.8°C. There are no scenarios envisioned in which high ambient temperatures could give rise to an accident scenario at the site.

The site will be provided with a fire-fighting water main to supply a network of hydrants and water cannons. This will be designed to meet the necessary standards and the requirements of the Fire Certificate and those of the insurance company. The ring main will be under ground and any chambers for hydrants will be insulated and heat traced, the underground ring main will surface inside the building and in areas such as the tipping hall and bunker the internal ring main will be insulated.

As a result no credible accident scenario resulting from extremes in ambient temperature was included as an initiating event by the HAZID&RA Team.

2.4.8 Lightning Strike

The UK Met Office has operated a lightning location network since 1987 (in its current form known as ATDnet), which allows for the detection of lightning activity across Europe and in turn the development of maps showing the density of lightning strikes. A 2014 research paper[8] analysed the data from the network and produced the lightning flash density map shown in Figure 2-7. This shows that, in general, Ireland is an area of relatively low lightning activity, with the paper noting that:

> *Over the UK, Ireland and Scandinavia the densities are generally lower than the rest of Europe. Some of the lowest densities are observed over the Atlantic, North Sea and Baltic Sea.*

A separate, volunteer organisation also operates a series of lightning monitoring stations across Europe (Blitzortung)[9] , with the data that is collected also used to generate lightning density maps. The lightning density map for Ireland and the UK for 2015 is shown in Figure 2-7. This also shows that Ireland is, in general, an area of low lightning activity.

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[8] G. Anderson & D Klugman, 2014*, A European lightning density analysis using 5 years of ATDnet data*

[9] http://www.lightningmaps.org/blitzortung/europe/

Figure 2-7: Annual detected lightning flash intensity (2008-2012)

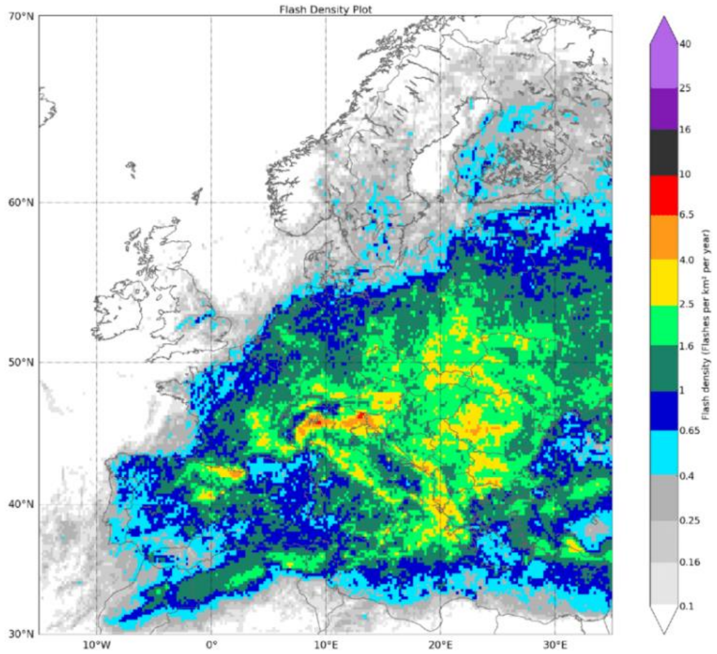
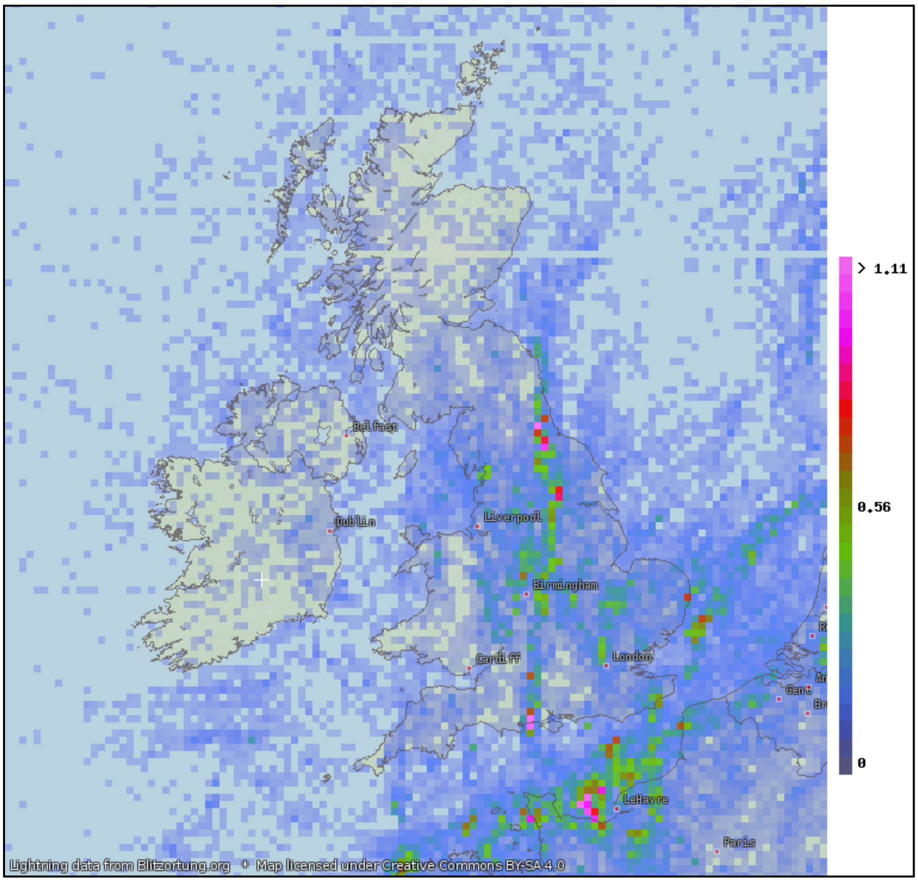


Figure 2-8: Lightning mean stroke density (strokes/km²)



Referring to guidance from the UK HSE, it advises that the use of BS 62305 is the expected standard for lightning protection at hazardous industries[10]. The HSE states that the likelihood of a major accident being initiated by a lightning strike at a well-designed and maintained hazardous installation is, therefore, low so Inspectors must act proportionately to focus on those major hazard installations where reasonably foreseeable risk remains.

In other guidance, the UK HSE notes that the probability of an accident arising as a result of lightning strike at a typical facility involved in the storage of flammable liquids is extremely remote, with a probability of 1×10^{-7} per annum[11].

All areas of the site which are used for the storage and handling of dangerous substances will be assessed in accordance with (IS) EN 62305] and a lightning protection system has been installed which has been designed and installed in accordance with same.

Based on the measures that will be in place and on the guidance from the UK HSE, it was considered that the risk that a lightning strike could initiate a major accident was negligible.

2.4.9 Off Site Initiating Events

Hammond Lane

The only credible off-risk identified by the HAZID&RA Team which could potentially give rise to an impact at the Ringaskiddy site is in the event of a fire at the adjacent Hammond Lane facility. This site is located immediately to the west of the proposed development.

The HAZID&RA Team considered the potential for a fire to occur at the Hammond Lane site. The main stock piles of material at the site comprise light scrap metal / car shred and so present little fire hazard. Car tyres are removed prior to arrival on site. There are also some smaller stockpiles, comprising foam from car seats and other plastic materials from cars, which would present a more credible potential for fire. In the event of a fire arising in one of these stockpiles, this would require an emergency response to be implemented at the Hammond Lane site. The Emergency Response Team at Indaver would mobilise in such a scenario, to review whether any actions should be taken at the site, but it is not envisaged that any fire scenario arising at Hammond Lane would present any risk of escalation / domino effects to the Indaver facility.

DePuy Wind Energy

The HAZID&RA Team also considered the potential risk to the site posed by the DePuy Wind Energy Project to the south of the Indaver site footprint. This comprises wind turbine, with a hub height of 99 m and a turbine radius of 50.5 m, giving a tip height of 149.5 m. This turbine is located c.300 m distance from Indaver and so there is no risk of impact to the Indaver facility in the event of a tower collapsing.

[10] http://www.hse.gov.uk/foi/internalops/og/og-00044.htm

[11] http://www.hse.gov.uk/comah/sraghfl/highly-flammable-liquids.pdf

Further examination was conducted to determine if there could be the potential for impact to Indaver in the event of catastrophic failure of a turbine blade when rotating at high speed. The UK HSE's Research Report 968 (RR968)[12] provides more detail on this topic.

The HSE's report refers to various California County ordinances which suggest setback distances for wind turbines of between 1.25 and 3 times the overall turbine height, depending on the location. The document also reviews various studies and methodologies that have been developed to assess the risks presented by wind turbines. One such study included a risk assessment methodology for ice throw from turbine blades, from which a safety threshold of 200-250 m from any wind turbine was proposed. Another study proposed a methodology to estimate the risks to people and properties from a fragment of a wind turbine, considering both drag and lift effects. This concluded that the probabilities of striking a fixed target is less than 10^{-7} per year per turbine and the risk to a person is less than 10^{-9} per year per turbine. However, the HSE noted that many of these studies were limited by omitting the wind turbine's size from the calculations.

The HSE's assessment, based on a comparable turbine size, produced a series of graphs showing the probability of impact for various failure scenarios. These are reproduced here are Figure 2-9. The plots show that the risk of impact tends to generally increase as the size of the blade fragment decreases.

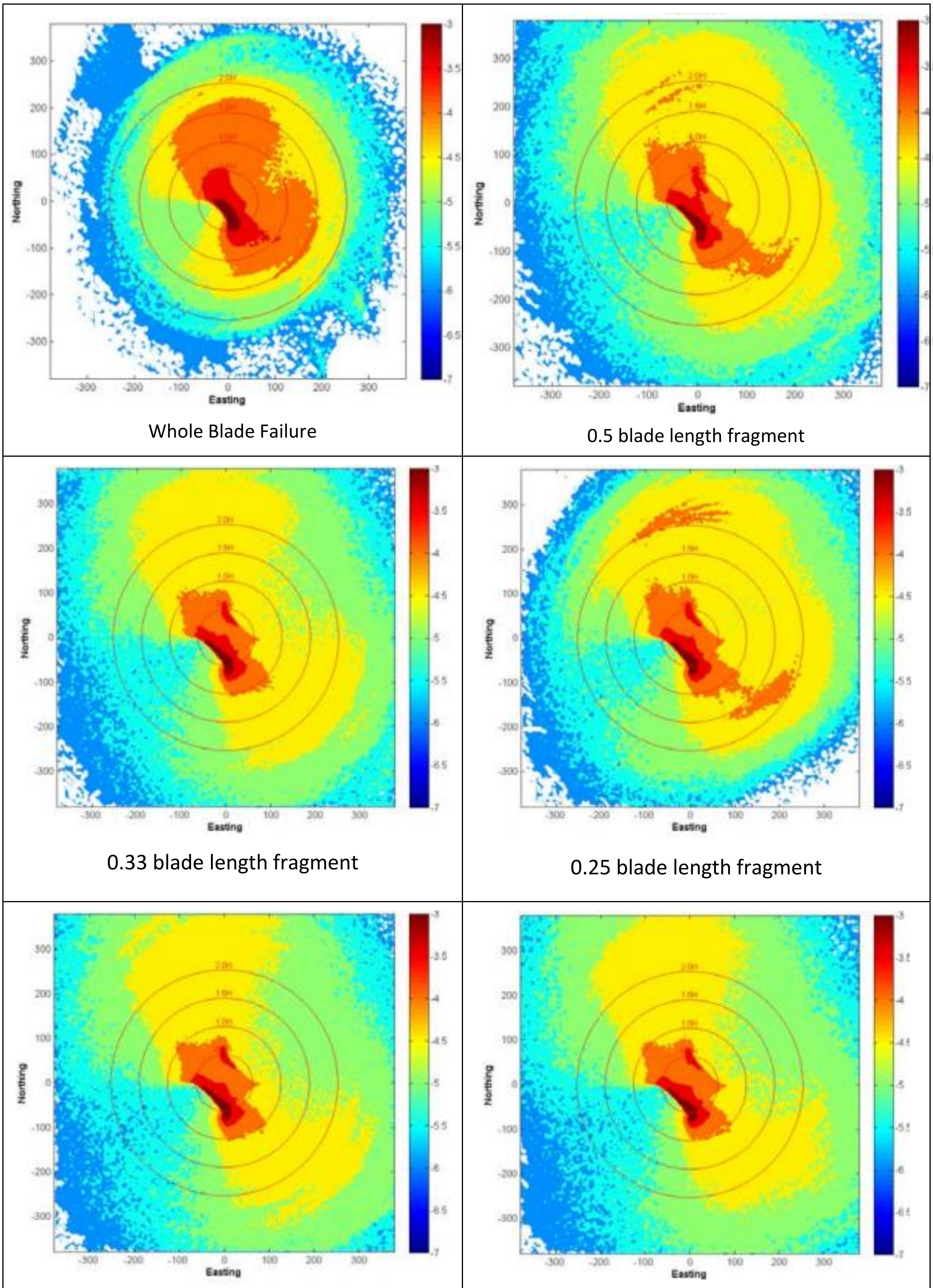
The focus of the HSE's assessment was on locations within 2.0 x H (i.e. twice the hub height) of the turbine. By comparison, the closest point at the Indaver site is at 3 x H from the turbine and the majority of the site is much further then this (in excess of 5 x H at the far end of the site). Nevertheless we have referred to this data in order to extrapolate the risks at greater distances in order to estimate the risk presented to the Indaver site.

These plots show what are referred to as conditional Location Specific Individual risks (LSIR), where the condition is that the failure has already occurred. These show the estimated probability that a 5 x 5 m receptor would be impacted if failure of the turbine did occur. Based on our review of the six figures above, we have conservatively estimated the probability of impact at a typical location at the Indaver site to be of the order of 2.4×10^{-6} per incident.

This figure must be scaled up to account for the much larger footprint of the Indaver site where dangerous substances are stored and handled. The modified value works out as 3.8×10^{-3} per incident.

[12] "Study and development of a methodology for the estimation of the risk and harm to persons from wind turbines", UK HSE

Figure 2-9: Location Specific Risks in the Event of Blade Turbine Failure (UK HSE RR 9680)



Whole Blade Failure

0.5 blade length fragment

0.33 blade length fragment

0.25 blade length fragment

0.20 blade length fragment

0.10 blade length fragment

The level of risk is then calculated by multiplying the probability of impact by the probability of blade turbine failure. The HSE's report states that the probability of major failure of a turbine in this manner is in the range from 10^{-3} per annum to 10^{-4} per annum.

Based on this conservative assessment of the HSE's data, the probability of a fragment of a wind turbine blade is estimated to be in the range 3.8 x 10^{-7} per annum to 3.8 x 10^{-6} per annum, i.e. it is conservatively estimated to be of the order of one in one million per annum.

Based on the above, there is good separation distance between the wind turbine and Indaver's facility. Although the potential risk of impact to the facility to the site cannot be completely ruled out, the probability of the site being impacted by a turbine blade is extremely remote.

2.5 Suitability of Information Used

Due to the range of materials stored at the site, the HAZID&RA Team examined scenarios involving flammable risks (fires and explosions), risks of acute toxic exposure to people and risks of spills to the environment.

When assessing the impacts of accident scenarios to people in the vicinity, a consequence modelling exercise was carried out, using a range of pre-determined endpoints. Some of the endpoints used are also of relevance for emergency response planning.

2.5.1 Consequence Modelling – Thermal Radiation Endpoints

The following thermal radiation and thermal dose endpoints were used for this assessment.

- 4 kW/m^2: Sufficient to cause pain to persons exposed if unable to reach cover within 20 seconds. However, with appropriate protective clothing, emergency response actions lasting several minutes may be undertaken. The distance to this heat flux level is often used by fire responders when determining the limiting distance at which personnel can be deployed.
- 6.3 kW/m^2: This is the heat flux reported by the Chemical Industries Association (CIA)[13] as a maximum level to which an emergency exit should be exposed.
- 8 kW/m^2: This is the threshold value reported in EI19[14] at which protective cooling water may be required to prevent escalation of a fire event to exposed items of plant and equipment.
- 12.7 kW/m^2: This level of thermal radiation is noted in the HSA's LUP guidance as the level at which the fire could spread to a building in the event of sustained fire attack.
- 25.6 kW/m^2: This level of thermal radiation is noted in the HSA's LUP guidance as the level at which the fire could rapidly spread to a building in the event of fire attack.

[13] "Guidance for the location and design of occupied buildings on chemical manufacturing sites" 2010 (Chemical Industries Association)

[14] "Model Code of Safe Practice Part 19: Fire precautions at petroleum refineries and bulk storage installations" (Energy Institute)

2.5.2 Consequence Modelling – Explosion Overpressures

The following overpressure endpoints were used for this assessment:

- 30 mbar: Glass breakage.
- 50 mbar: 1% lethality risk to people in portacabins or typical residential buildings.
- 100 mbar: 1% lethality risk to people in typical office buildings.
- 168 mbar: 1% lethality risk to people outdoors.
- 600 mbar: Significant damage to plant and equipment; previously used by the HSA for determining the extent of the Inner Zone, when adopting a consequence-based approach to zoning.

There is no factoring for exposure time in the case of explosion scenarios as they are effectively instantaneous events.

2.5.3 Consequence Modelling – Acute Toxic Exposure

For scenarios involving a release of materials classed as acutely toxic to people, the impacts of exposure were calculated by reference to the Probit function, which takes the following form, as set out in the HSA's Land Use Planning guidance document:

$$Probit = a + b \times ln(C^n \times t)$$

Where a, b and n are material-specific values, taken from published data, C is the exposure concentration (the units will depend on the literature source used for determining a, b and n, but will be either mg/m^3 or ppm) and t is the exposure time in minutes.

The Probit function can then be used to directly calculate the risk to people exposed and express them as a probability of lethal impacts in the surrounding area, using the following equation:

$$Probability = \frac{1}{\sqrt{2\pi}} \int_{u=-\infty}^{u=Y-5} exp\left(-\frac{u^2}{2}\right) du$$

Where u is an integration variable.

In the cases of any materials for which Probit data was not available, reference was made to the UK HSE guidance "Assessment of the Dangerous Toxic Load (DTL) for Specified Level of Toxicity (SLOT) and Significant Likelihood of Death (SLOD)". The UK HSE has published data for a wide range of materials on the dose exposure (i.e. the concentration and the exposure time) that would correspond to both the SLOT (1% lethality) and the SLOD (50% lethality).

In addition to consideration of toxic doses, each scenario was also modelled to the AEGL-2 endpoint Acute Exposure Guideline Level), which is used for emergency response purposes. This threshold was determined by the US EPA as the "airborne concentration of a substance above which is it predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape. For any materials for which AEGL endpoint data was not available, then reference was made instead to alternate endpoints, such as the AEGL-2[15] endpoint established by the US EPA and which is widely used for emergency response purposes.

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[15] Acute Exposure Guideline Level 2 – this is defined by the US EPA as the airborne concentration (expressed as ppm or mg/m3) of a substance above which it is predicted that the general population, including susceptible

2.5.4 Assessment of Impacts – Releases to the Aquatic Environment

There are a number of materials that will be stored and handled at the Ringaskiddy development which are classed as Toxic to the Environment.

The bunker will be used to store large quantities of incoming waste. As the bunker waste is solid, a spill of material (e.g. during a delivery to the site) is not mobile and so would be easily recoverable. Furthermore, in the event of a fire in this area, the bunker would retain the fire-fighting water applied to the waste. Indaver will also conduct a fire water retention study for the site.

The primary environment hazard arises not from the bunker material but rather from the residue that is formed at the back end of the process, which can contain elevated concentrations of various heavy metals. We have examined the properties of the waste residue in order to determine the appropriate hazard classification. The assessment in Appendix 5 shows that the Seveso Regulations do not apply to this waste but nonetheless it is environmentally hazardous.

The other potentially environmentally hazardous materials of note are fuel oil and ammonia:

- Fuel oil: 80 m^3 capacity tank
- Aqueous Ammonia (24.9%)

These tanks will be of double skinned construction to protect against the risk of catastrophic tank failure.

Any spills outside of bunded areas would be collected in the surface drainage systems at the site. The outfall from the site is fitted with an oil water separator to protect against elevated concentrations of oil in the surface water discharge. In the event of a spill of water soluble materials, Indaver can shut down the outfall and divert to a dedicated retention tank. This will be done automatically by fitting a TOC, conductivity and pH meter on the line, which will shut down the outfall when necessary. There will also be a switch which can be activated by Indaver personnel to manually shut down the outfall.

The significance of environmental releases was assessed by reference to the Chemical and Downstream Oil Industries Forum's (CDOIF) *Guideline Environmental Risk Tolerability for COMAH Establishments*, which provides a framework and screening methodology for assessing the impacts of environmental releases.

2.5.5 Weather Data

The range of weather conditions that were examined for the purposes of the consequence modelling work that was conducted in support of the HAZID&RA exercise depended on the type of scenario being considered, as follows:

- <u>Fire scenarios</u>: the consequence modelling exercise for the fire scenarios covered in this report use wind speeds of 5 m/s (to represent the impacts during normal weather conditions) and 10 m/s (to represent the impacts in high wind speeds, which can give rise to flame tilt).

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individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

- Explosion scenarios: any scenarios involving the evolution and dispersion of vapour to atmosphere were modelled in D5 weather conditions (5 m/s wind speed and normal levels of atmospheric stability) and F2 weather conditions (2 m/s and calm weather conditions).
- Toxic releases: any scenarios involving the release of toxic materials to atmosphere were modelled in D5 weather conditions (5 m/s wind speed and normal levels of atmospheric stability) and F2 weather conditions (2 m/s wind speed and calm weather conditions).

In each case, the approach was to model the scenario in normal weather conditions, which would be more likely to prevail at the time of an accident, and also in worst-case conditions (in other words, low wind speeds and calm atmospheric conditions for toxic releases and high wind speeds for fires).

2.6 Credible Scenario Trail

2.6.1 Review of Accident Scenarios

The approach used to carry out the risk assessment exercise is described in Section 2.1. The resulting HAZID&RA worksheets are included in Appendix 3. These comprise the Accident Scenario sheets (AS), which describe the various end events that were identified for the site, and the Risk Assessment Register (RAR) and Risk Reduction Register (RRR), which identifies the various initiating events which could give rise to an accident and calculates the overall risk associated with each scenario. These worksheets also provide details of the various protection and mitigation measures that will be in place at the site, as well as any additional measures recommended in the course of the HAZID&RA exercise.

This exercise covered the full range of accident scenarios examined for each of the areas listed in Section 2.1.2 of this report.

In total the HAZID&RA exercise covered a total of 111 accident scenarios, many of which were slight variations of other scenarios. Of these, a small subset of representative worst-case scenarios was identified for further assessment. These scenarios were primarily selected on the basis of their Risk Ratings, but additional consideration was also given to potentially catastrophic events. The scenarios selected for more detailed consideration were as follows:

- Bunker fires
- Explosion of LPG cylinder at furnace
- Loss of containment of aqueous HCl from IBC
- Loss of containment of fuel oil
- Loss of containment of aqueous ammonia
- Fire following loss of containment of aqueous solvent waste mixture
- Loss of containment of dangerous substances from pipelines (various)

2.7 Detailed Subset of Accident Scenarios

This section of the report describes the sub-set of accident scenarios that was selected for more detailed analysis. These represent the credible worst-case scenarios that could arise at the Ringaskiddy facility. These scenarios have been selected for detailed discussion as they represent the worst-case events at the various locations that were examined.

2.7.1 Bunker Fire

Smoke Plume

The risk assessment team examined a number of different bunker fire scenarios, ranging from a spot fire in the waste bunker area up to a fully developed bunker fire. Although the Seveso Regulations do not apply to the waste material within the bunker, nonetheless a fire in this area could give rise to a variety of potentially hazardous products of combustion. Based on previous discussions with the HSA at the time of the 2008 report and on the findings of the subsequent 2015 HAZID&RA review, the primary hazard associated with a bunker fire of this type is the potential formation and emission to atmosphere of dioxins in the smoke plume, although there could also be other products of combustion in the emission.

The bunker will typically comprise c.4,000 tonnes of waste, based on a design calorific value of 9.6 MJ/kg, although it will have the capacity to accommodate up to 6,000 tonnes. The dimensions of the bunker are 18.2 m × 40.5 m.

Based on the analysis of the HAZID&RA Team, there are three categories of bunker fire examined:

- Minor fire – smouldering due to contaminants such as hot ashes in the incoming waste stream. In this scenario, Indaver can respond by using the grab crane to load the portion of smouldering waste to the hopper feeding the furnace. It is conservatively assumed that up to 1 tonne of waste could be burned in the bunker area for this scenario.
- Intermediate fire – this is a larger fire scenario requiring the implementation of Indaver's fire-fighting response to extinguish the fire. It is assumed that up to 50 tonnes of waste could be consumed in this case.
- Fully developed fire – if the initial fire-fighting response fails to deal with the scenario the fire could escalate to become a fully developed scenario. In this case the full inventory of waste in the bunker area (between 4,000 and 6,000 tonnes) is consumed.

A more detailed description of the approach used for the consequence modelling exercise for these potential bunker fire scenarios is included in Appendix 6.

Thermal Radiation

In addition to the potentially hazardous effects from the smoke plume arising from a bunker fire, there would also be significant thermal radiation to the surrounding area once the fire became fully developed. The software package that was used for this exercise does not include data on the burning rate and surface emissive power for the waste in the bunker and so a surrogate material was selected. The impacts of this scenario were modelled as a pool fire with a surface area equal to the cross-sectional area of the bunker. Decane was selected as a surrogate material, as a longer chain hydrocarbon compound. This is considered to be conservative for the purposes of determining heat fluxes as Decane will burn at a higher rate and with a higher intensity than would the material in the bunker.

2.7.2 Loss of Containment of aqueous Ammonia or Hydrochloric Acid

There are several loss of containment events identified in the HAZID&RA worksheets. The primary such scenarios are as follows:

- Loss of containment of aqueous Ammonia from transfer pipeline. The flow rate in the transfer line is 0.4 m^3/hr. In the event of a major release (guillotine failure) Indaver personnel will be able to detect the loss of containment and to take the necessary measures to shut down the transfer. For the purposes of this assessment a response time of 15 minutes has been assumed. This is a conservative assumption when calculating the quantity of Ammonia that would be released in this scenario as, if the pipeline was to fail in this manner, the pumps would not be able to maintain the pressure in the line. In order to calculate the total quantity released in this period, we multiplied the flow rate by the response time and applied a factor of 2 to allow for additional material lost due to the reduced resistance against which the pump would be operating and for residual material in the line after the pumping ceased. The total volume spilled in this scenario is calculated to be 0.2 m^3.
- Full loss of containment from aqueous Ammonia tank. This is an extremely remote event as the ammonia tank will be a double-skinned tank. The tank will also be protected against impacts by elevating it on a plinth and by installing bollards to protect against impact. However, the HAZID&RA team did not rule out the possibility of the tank being damaged due to mechanical impact. In this scenario the full inventory of the tank could be released (i.e. up to 80 m^3 of aqueous ammonia). The area to which the ammonia would spill in this scenario is comprised of concrete hard standing and graded towards an aco channel which is routed to the surface water network. As such, while the resulting pool could cover a large area, as per the consequence modelling results later in this report, it would not remain in place for a long duration. Once collected in the surface water network, the spill would be routed to a forecourt separator which can be used to retain spill, rather than allowing it to discharge off site.
- Loss of containment during delivery of aqueous ammonia (rupture of transfer hose). This scenario involves a much higher flow rate than a release from a pipeline (40 m^3/hr). However, as the operation is manned locally, there is a much more rapid response time (taken to be 1 to 2 minutes). In this case a factor of 1.5 was also applied to allow for the increase in flow rate following failure of the hose line. The total quantity released in this scenario is 2 m^3.
- Loss of containment of HCl from IBC: HCl will be stored on site in a bunded IBC. For this scenario the full inventory of 1 m^3 is released into the bund tray that the IBC is housed in.
- Damage to side of IBC resulting in jet release of HCl outside of bund. This scenario involves a gradual release of HCl outside of the bund tray due to overjetting. The total quantity released in this case will be the full inventory of the container above the hole height. The resulting pool of liquid will increase in size, giving an increase in HCl evaporation rate over time. As an upper limit to this scenario the maximum evaporation rate of Hydrogen Chloride gas to atmosphere will be determined by the maximum release rate of HCl within the liquid solution being released from the hole in the container.
- Damage to IBC during delivery. This is the worst-case event for the HCl container. It is assumed that the full 1 m^3 inventory is released to an unbunded area.

The loss of containment of an aqueous solution of these materials can give rise to the evolution of potentially toxic gas (Ammonia or Hydrogen Chloride). In each case we have modelled the evolution of gas from the liquid spill, based on the dimensions of the pool formed, the weather conditions (D5 or F2) and the properties of the material spilled.

2.7.3 Fire following Loss of Containment of Aqueous Waste

The aqueous waste stream at Indaver will comprise a variety of different materials, although the bulk of the mixture will comprise water (>70%). This will reduce the flammability of the mixture as the dilution effect will act to reduce the flash point. Nevertheless depending on the mixture of materials involved, this mixture could present a flammable hazard and so the HAZID&RA Team identified the potential risk of a pool fire scenario arising following a loss of containment.

Aqueous waste will be brought on site by bulk tanker. These vehicles will park in a paved area and the waste will be transferred to the aqueous waste tank, from which the stream can be fed into the furnace.

Aqueous waste will be transferred from the storage tank by pipeline at a rate of 2 m^3/hr. In the event of guillotine failure of the line to the aqueous waste tank, it is judged that Indaver would be able to take action to shut down the transfer within 15 minutes, during which time a quantity of up to 0.5 m^3 would be pumped. A factor of 2 has been applied to this figure, to account for the increased flow rate that could arise in the event of guillotine line failure, as well as residual material in the pipeline, giving a total release quantity of 1 m^3 in this scenario. This would be released to an unbunded area. However, it should be noted that this is a paved area which will drain to a 2 m^3 holding tank which in turn discharges to the surface water drainage network at the site. These measures help to reduce the potential atmospheric impacts from the release. For a spill of this quantity over flat ground, it could spread to a representative pool thickness of 10 mm, giving a total pool area of 100 m^2.

2.7.4 Loss of containment of dangerous substances to the aquatic environment

In addition to assessing the risks to human health, we have also assessed the impacts and associated risks for a release of environmentally hazardous materials to the aquatic environment. The worst-case scenarios were identified as follows:

- Loss of containment of aqueous ammonia to drainage system
- Fire at site and discharge of contaminated firefighting water to the drainage system

For any release of ammonia, Section 2.7.2 describes the controls that are in place to collect the spill. As noted in that section, any such release would find its way to the drainage system and could find its way offsite via the effluent discharge. However, there is a holding tank to collect the runoff from the site prior to reaching the outfall. Indaver will monitor the flow into and out of the tank for pH, TOC and conductivity and so would be able to rapidly detect a release and will automatically stop releasing from the site. An operator could also close the valve on the outfall from the holding tank and prevent it from escaping offsite. This means that for a release of ammonia to escape and present a risk to the marine environment, one of the loss of containment events identified in Section 2.7.2 must occur combined with failure of Indaver to detect the release and shut down the valve on the discharge line from the site.

The environmental risks associated with a major fire event at the site will be protected against by the provision of appropriate retention capacity to deal with a major fire event. Indaver will carry out a firewater retention study in accordance with the EPA's guidance, to ensure that there are appropriate measures in place to intercept a release of firewater runoff and that there is sufficient retention capacity to hold this material onsite.

2.8 Consequence Assessment

The consequence modelling results for the various scenarios described above are set out in this section.

2.8.1 Bunker Fires

Dioxin Emissions from Bunker Fire – Human Health

The modelling exercise for the impacts of the dioxin emissions from a bunker fire are described in Appendix 6. The focus of this aspect of the assessment is to examine the combined dose that could be experienced over the course of the fire event, as follows:

- Initial phase with smouldering waste: this is characterised by lower emission rates but also has a less buoyant smoke plume
- Intermediate phase: this involves a fire in the bunker, but one which is extinguished before it can become fully developed.
- Fully developed fire: this involves a fire in the full inventory in the bunker. It is characterised by higher emission rates but it also has a higher buoyancy smoke plume which helps to reduce ground level impacts.

Each phase is progressively less likely to occur, due to the controls and response plans that Indaver will have in place for a fire in the bunker, but the combined impacts of all three phases have been examined.

Table 2-6 sets out the findings of the expected maximum contribution to dioxin intake to the closest vulnerable receptors to the site – the closest residences at Ringaskiddy, the adjacent Hammond Lane facility, the DePuy Wind Energy Project and the National Maritime College of Ireland.

Table 2-6: Impacts of Potential Dioxin Intake (combined risk from all Bunker Fire Scenarios)

Parameter	Ringaskiddy	Hammond Lane	De Puy	Maritime College	Haulbowline Recreational Park
Dist. from Bunker (m)	650 m	125 m	350 m	250 m	1,000 m
Average intake (µg/day)	6.03×10^{-9}	7.55×10^{-8}	1.60×10^{-8}	2.72×10^{-8}	3.01×10^{-9}
Body weight (kg)	70	70	70	70	70
Average Intake (µg/day per kg)	8.62×10^{-11}	1.08×10^{-9}	2.28×10^{-10}	3.88×10^{-10}	4.30×10^{-11}
Average Intake (pg/day per kg)	8.62×10^{-5}	1.08×10^{-3}	2.28×10^{-4}	3.88×10^{-4}	4.30×10^{-5}
Safety Margin compared with TDI	11,604	927	4,377	2,578	23,238

This shows that there is a very wide margin of safety between the expected dioxin intake to people at these locations when compared with the WHO's Tolerable Daily Intake (TDI) for lifetime exposure of 1-4 pg/kg/day (taken as 1 pg/kg/day for the purposes of this calculation). As such the overall exposure to dioxins in the surrounding area as a result of the Indaver facility would be very low (several orders of magnitude less than the overall TDI established by WHO).

The closest Protected Site to the Indaver facility is Lough Beg, which is part of the Cork Harbour SPA and is also a pNHA. This is located c.500 m from the facility. Applying the same calculations as used in Table 2-6, the resulting factor of safety works out as 7,690, based on the WHO criteria for human health.

Dioxin Emissions from Bunker Fire – Environmental Impacts

At the time of the previous risk assessment, in 2008, Indaver arranged for a study to be conducted by AWN to predict the increase in soil PCDD/F (Polychlorinated Dibenzo Dioxin and Polychlorinated Dibenzo Furan) concentrations as a result of potential fire scenarios at the Ringaskiddy facility.

Based on the results of this assessment, the increase in soil PCDDD/F concentrations over a 30-year period was calculated to be 0.0001337 ng I-TEQ/kg, applying an assumption of one small fire (1-tonne) per annum, and 0.0004445 ng I-TEQ/kg, applying an assumption of two 50-tonne fires over the 30-year period. These were very conservative assumptions when compared with Indaver's operational experience at other plants.

Based on this approach the total contribution to soil concentrations within the zone of influence (a 20 km radius around the site) was calculated to be 0.000577 ng I-TEQ/kg. This was found to be significantly lower (two orders of magnitude) than the lowest background soil concentration measured in the Ringaskiddy area, which was 0.052 ng I-TEQ/kg (measured at the Indaver site in 2015).

Based on this assessment, the calculated values for the PCDD/F contribution made by the Indaver facility were found to be insignificant.

While the assessment shows that the contribution made by the Indaver facility to the existing dioxin levels in the soil would be negligible, it is also important to check the significance of the existing dioxin levels. The EPA conducts regular surveys of dioxin levels and we have examined the most recent such study.

The EPA's survey involved an assessment of the concentrations of dioxin in cows' milk for various locations throughout Ireland. The EPA has noted that, given that the primary mechanism for dioxins to enter the food chain is through atmospheric dispersion, cows' milk is considered to be a particularly suitable matrix for assessing their presence in the environment, since cows tend to graze over relatively large areas and these compounds will, if present, concentrate in the fat content of the milk.

The EPA study comprised a wide range of stations around the country, including at Ringaskiddy. The results for Ringaskiddy, for the period from 2013 to 2023, showed a maximum dioxin concentration of 0.23 pg WHO-TEQ/g.

These results were in line with the historical data from previous EPA surveys. The dioxin concentrations in the samples were found to be well below the EU limit for milk and milk products (2.5 pg WHO-TEQ/g). The results of the EPA's survey also compared favourably with those taken from a random selection of similar studies in the EU and other countries.

The low impact on soil dioxin levels predicted by AWN, and the findings of the EPA's surveys, support the conclusion that there will be no impact of significance to the soils and/or the food chain from dioxins released in the event of accidental fires in the solid waste bunker at Indaver.

Thermal Radiation from Bunker Fire

In addition to the potential impacts of the smoke plume, a fire scenario at the bunker could also give rise to significant levels of thermal radiation to the surrounding area. In the case of the first two fire scenarios considered here, the structure of the bunker building would remain intact or largely intact and so the impacts to the surrounding area would be minor.

The bunker has a floor area of 737 m^2. In the event of a fire in the bunker, the impacts to the surrounding area will be minimised due to the concrete walls that surround it. The worst-case impacts to the surrounding area would arise in the event of a fire when the bunker is filled to the maximum operating level with waste. In this scenario, the top of the waste would be at an elevation of 25 m above ground level. The top of the concrete wall would be a further 4.46 m above this. The modelling results reflect the impacts to the surroundings, based on the shielding effects at the base of the flame. We note that the surrounding landscape to the south of the site is higher than the base of the bunker and so we have modelled the impacts of this event with the base of the fire at 15 m above ground level and with the top of the concrete wall at 19.46 m above ground level.

The consequence modelling results for this scenario are shown in Table 2-7.

Table 2-7: Consequence Modelling – Thermal Radiation from Fully Developed Bunker Fire

	Small Fire	Intermediate Fire	Full Bunker Fire
Area	55 m^2	370 m^2	737 m^2
Hazard distances			
…25.6 kW/m^2	-	-	
…12.7 kW/m^2	-	9 m	-
…8 kW/m^2	-	26 m	27 m
…6.3 kW/m^2	-	31 m	36 m
…4 kW/m^2	10 m	42 m	49 m

All distances are expressed as distances from the edge of the fire (or edge of the bunker).

The elevation of the fire, and the shielding effect of the concrete walls, means that the resulting ground level impacts are reduced and so many of the endpoints which we have modelled to, do not arise.

The nearest trees will be at a distance of approximately 70 m from the bunker, to the south of the proposed development. Even allowing for the high elevation of the ground in this direction, the maximum levels of thermal radiation at this distance would be less than 4 kW/m^2. This scenario would therefore not present an escalation hazard to the trees.

Each of the off-site receptors examined previously (Ringaskiddy, Hammond Lane, DePuy and the Maritime College) are comfortably outside of the hazard distances reported in Table 2-7. The closest off-site receptor is the Hammond Lane site. At its closest point, the distance from the flame front following a fire in bunker area to the boundary of the Hammond Lane site is over 100 m. At this distance the resulting heat fluxes would be much less than 4 kW/m^2 and there would be negligible impacts at Hammond Lane. The model results also show that the maximum level of thermal radiation to the nearest roadway would be 3.8 KW/m^2. As such there is no risk of adverse impacts to any off-site receptors arising from the thermal radiation emitted in this scenario.

When assessing the likelihood and impacts from this scenario, the risk assessment team noted a range of controls that will be implemented to mitigate the risks from this scenario. These measures include controls governing all stages of the activities relating to the bunker, including:

- Training of operators.
- Use of documented SOPs to ensure that activities are carried out in a prescribed manner.
- Inspection of material before it is admitted to the bunker.
- Controls to protect against initiation of a fire at the bunker.
- Fixed fire protection systems to enable Indaver to extinguish a fire at the bunker.

These measures are discussed in more detail in Section 2.9.

2.8.2 Loss of Containment of aqueous Ammonia or Hydrochloric Acid

The consequence modelling results for the loss of containment events described above involving aqueous Ammonia are shown in Table 2-8.

Table 2-8: Consequence Modelling for Aqueous Ammonia Releases

Parameter	Loss of containment from Pipeline		Loss of containment from Tank		*Loss of containment during delivery*	
Weather	D5	F2	D5	F2	*D5*	*F2*
Pool Area (m^2)	20	20	940	940	200	200
Distance to AEGL-2	51 m	117 m	443 m	1,400 m	160 m	535 m
Distance to 1% lethality	-	-	92 m	220 m	26 m	72 m
Distance to 50% lethality	-	-	34m	62 m	-	-

"-"in the table indicates that the model did not generate this concentration at any location downwind from the release. However, it should be noted that there would be elevated concentrations directly above the liquid surface.

The primary point to note in this instance is the relatively long hazard distances that are generated following a major release from the ammonia tank. Consideration should be given to these hazard distances when implementing any emergency response efforts to a major release scenario.

The closest off-site receptor is at Hammond Lane. At its closest point the site boundary at Hammond Lane lies within c.100 m of the Ammonia tank. As such, there is the potential for the 1% concentration to extend as far as the eastern boundary of Hammond Lane in the absolute worst case scenario (i.e. full loss of containment from the ammonia tank, in calm atmospheric conditions and with the wind blowing in an unfavourable direction). The impacts of this scenario can be mitigated by having people evacuate the area or taking shelter. Indaver will develop its emergency response arrangements to include provision for alerting Hammond Lane in the event of a release.

The results indicate that there is no risk of lethal impacts at any of the other off-site receptors (Ringaskiddy, DePuy or the Maritime College), even in the worst-case scenario.

Using the AEGL-2 concentrations rather than the lethality exposure levels result in longer hazard distances, as would be expected. In this case the results show that the AEGL-2 concentration could extend to several off-site receptors, again depending on the atmospheric conditions and wind direction. In this case there is no significant risk of lethal effects, but persons downwind following a major release should either remain indoors or evacuate the area in order to protect against exposure effects.

The scenario involving a full loss of contents from the Ammonia tank was identified as the worst-case scenario in terms of Severity Rating in the HAZID&RA exercise. However, the HAZID&RA Team found this scenario to have a low probability of occurrence (Frequency Rating), due to the controls in place, which include:

- The ammonia tank is of double-skinned construction.
- Provision of leak detection between skins to allow Indaver to detect any instances of a leak within the inner skin of the tank.
- Impact protection barriers at the tank.
- Speed limit on site.
- Preventative Maintenance regime to ensure tank integrity.
- Drainage system to collect spills in the vicinity of the ammonia tank.

The consequence modelling results for the loss of containment events described above involving aqueous Hydrochloric Acid are shown in Table 2-9.

Table 2-9: Consequence Modelling for Aqueous Hydrochloric Acid Releases

Parameter	Release from IBC to Bund		Full Release of IBC to unbunded area	
Weather	D5	F2	D5	F2
Pool Area (m^2)	1.44	1.44	100	100
Distance to AEGL-2	< 10m	< 10m	33 m	125 m
Distance to 1% lethality	-	-	-	-
Distance to 50% lethality	-	-	-	-

"-"in the table indicates that the model did not generate this concentration at any location downwind from the release. However, it should be noted that there would be elevated concentrations directly above the liquid surface.

The results show that none of these release scenarios would give rise to any adverse impacts at the off-site receptors.

The control measures to protect against these scenarios are discussed in more detail in Section 2.9.

2.8.3 Fire following loss of containment of Aqueous Waste

The consequence modelling results for this scenario are shown in Table 2-10. This scenario was modelled using Toluene and using Methanol to represent the impacts of the fire event. By modelling the impacts of this event as a pure solvent, the results are conservative when compared with the lower burning rates that would arise in the event of an aqueous solvent release.

Table 2-10: Consequence Modelling – Fire of Aqueous Waste

Parameter	Toluene	Methanol
Distance to 25.6 kW/m^2	4 m	9 m
Distance to 12.7 kW/m^2	10 m	11 m
Distance to 8 kW/m^2	14 m	13 m
Distance to 6.3 kW/m^2	17 m	14 m
Distance to 4 kW/m^2	21 m	17 m

The results show that none of these fire scenarios would give rise to any adverse impacts at the off-site receptors.

The control measures to protect against this scenario are discussed in more detail in Section 2.9.

2.8.4 Loss of containment of dangerous substances to the aquatic environment

Overview

The Chemical and Downstream Oil Industries Forum's (CDOIF) *Guideline Environmental Risk Tolerability for COMAH Establishments*, which provides a framework and screening methodology for assessing the impacts of environmental releases. The CDOIF provides guidance on the process for identifying and examining potential MATTE scenarios, based on the following steps.

1. Understand the types of environmental receptor.
2. Determine the MATTE thresholds that apply to the receptors.
3. Evaluate the risk from the establishment to the receptors.
4. Determine whether a Cost-Benefit-Analysis is required.
5. If required, conduct a CBA to support the demonstration of ALARP.
6. Complete the Environmental Risk Assessment.

The thresholds for considering whether an environmental incident qualifies as a MATTE are expressed in terms of both the potential *extent & severity* of damage and the *duration of harm*, both of which must be satisfied for the scenario to be considered as a potential MATTE. The thresholds for the *extent & severity* of damage are summarised in Table 2-11 and for the *duration of harm* are summarised in Table 2-12.

Table 2-11: Thresholds for extent and severity of environmental damage

Area	Status	Threshold
Designated Area	Site of special scientific interest (SSSI) National nature reserve (NNR)	• Greater than 0.5 ha or 10% of the area of the site adversely affected (whichever is the lesser, subject to a lower limit of 0.25ha) • Greater than 10% of a designated linear feature of the site adversely affected • Greater than 10% of a particular habitat or population of individual species adversely affected (Population refers to the known or estimated population at the site, and individual species named in the designation, not the national population. For other species refer to table 10 of the DETR guidance)
	Special area of conservation (SAC), Special protection area (SPA) Ramsar sites	• Greater than 0.5 ha or 5% of the area of the site adversely affected (whichever is the lesser, subject to a lower limit of 0.25ha) • Greater than 5% of a designated linear feature of the site adversely affected; or • Greater than 5% of a particular habitat or population of individual species adversely affected
	Environmentally sensitivity area (ESA), Area of outstanding natural beauty (AONB) Local nature reserve (LNR), Nitrate sensitive area (NSA)	• Greater than 10% or 10 ha seriously damaged, whichever is the lesser
	Scarce habitat	• Damage to 10% of the area of the habitat or 2 ha, whichever is the lesser
Widespread habitat	Non-designated land	• Contamination of 10 ha or more of land which, for two growing seasons or more, prevents growing of crops or the grazing of domestic animals or renders the area inaccessible to the public because of possible skin contact with dangerous substances • Contamination of 10 ha or more of vacant land for three years or more
	Non-designated water	• Contamination of aquatic habitat (freshwater or marine) which prevents fishing or aquaculture or renders it inaccessible to the public

Area	Status	Threshold
Groundwater	Groundwater body - Source of Public or Private Drinking Water	• Interruption of public or private drinking water supplied from a ground or surface water source, where: (persons affected x duration in hours {at least two hours}) > 1,000
	Groundwater body – non-Drinking Water Source	• 1 ha or more of a groundwater body where the Water Framework Directive (WFD) status has been lowered
	Other Groundwater (outside of groundwater bodies)	Not applicable.
Soil or Sediment	Sediment	• DETR guidance refers to a change in overlying water quality - thus sediment should be considered a pathway and the MATTE threshold to consider is the one for the relevant overlying water or particular species
	Soil	• Contamination of 10 ha or more of land which, for two growing seasons or more, prevents growing of crops or the grazing of domestic animals or renders the area inaccessible to the public because of possible skin contact with dangerous substances • Contamination of 10 ha or more of land by substances, preparations, organisms or micro-organisms that results in a significant risk of adverse effects on human health
	Land that is already contaminated	• Dependent on whether the potential MATTE will alter the management of the existing contamination.
Built environment	Grade 1/Category A listed buildings, scheduled ancient monuments, conservation areas	• Damage to the built environment such that its designation of importance is withdrawn
	Other built heritage types (e.g. Grade 2 listed buildings	• MATTE definitions for widespread habitats (land, water) apply.
Particular species	-	• 1% or more of the population • 5% or more of the plant ground cover
Marine	-	• 2 ha or more of contamination to the littoral or sub-littoral zone • 100 ha or more of open sea benthic community • 100 or more dead sea birds (500 or more gulls); • 5 or more dead/significantly impaired sea mammals

Area	Status	Threshold
Freshwater and estuarine habitats	-	• The chemical or ecological status given by the Water Framework Directive (WFD) has been lowered by one class for more than 2km of a watercourse; • 10% or greater of the area (for estuaries and ponds, reservoirs and lakes); or, • 2 ha or more of the area for estuaries or ponds, reservoirs and lakes, or • Interruption of public or private drinking water supply, where: (persons affected x duration in hours {at least two hours}) > 1,000

Table 2-12: Thresholds for duration of harm

Duration	Short Term Note 1	Medium Term	Long Term	Very Long Term
Harm Duration Category	1	2	3	4
Land	≤ 3 years	> 3 years or > 2 growing seasons for agricultural land	> 20 years	> 50 years
Surface Water (all except public or private drinking water source)	≤ 1 year	> 1 year	> 10 years	> 20 years
Groundwater Body or Surface Water (public or private drinking water source)	N/A	Harm affecting non public drinking water source.	Harm affecting public drinking water source or SPZ.	N/A
Built Environment	Can be repaired in < 3 years, such that its designation can be reinstated	Can be repaired in > 3 years, such that its designation can be reinstated	Feature destroyed, cannot be rebuilt, all features except world heritage site	Feature destroyed, cannot be rebuilt, world heritage site

Note 1: Harm with such short recovery is not considered a MATTE.

When assessing the potential duration of a release of oil to the environment, a spill of oil to water would have a relatively short duration of impact. However, where the spill reaches a coastline, the potential duration can be much greater. ITOPF Technical Information Paper 13 *Effects of Oil Pollution on the Marine Environment* provides an indication of the recovery periods for different habitats, where recovery is defined as the point at which the habitat is functioning normally. The indicative recovery times for various habitats are shown in Table 2-13.

Table 2-13: Indicative recovery periods for oiled habitats

Habitat	Recovery period
Plankton	Weeks / months
Sand beaches	1 – 2 years
Exposed rocky shores	1 – 3 years
Sheltered rocky shores	1 – 5 years
Saltmarsh	3 – 5 years
Mangroves	10 years and greater

Based on the above, a release of oil to the bay could give rise to damage of the order of up to 5 years. This is therefore a duration of medium term (2) on the CDOIF scale.

In the case of an ammonia release, this would be fully soluble in water and so would not have the same potential for fouling of shorelines that would arise from an oil spill. However, it is conservatively assumed that the release could give rise to environmental damage which would take several years to recover. A release of this material is therefore also considered to be medium term (2) on the CDOIF scale.

Table 4.3 of the CDOIF guidance provides a matrix for deriving the receptor tolerability for MATTEs, based on severity of harm, the duration of harm and the probability of occurrence. The matrix is replicated below in Figure 2-10.

Figure 2-10: Method and matrix for deriving receptor tolerability for MATTEs (source: CDOIF)

Severity of Harm	Harm Duration Category 1	2	3	4
4		C	D	D
3		B	C	D
2		A	B	C
1	Sub-MATTE Harm			

Frequency at which the CDOIF consequence level is reached or exceeded	Frequency per receptor per establishment per year	
	Intolerable (greater than)	Broadly Acceptable (less than)
A	1.0 E-02	1.0 E-04
B	1.0 E-03	1.0 E-05
C	1.0 E-04	1.0 E-06
D	1.0 E-05	1.0 E-07

Major Accident to the Environment (MATTE)

In carrying out the HAZID for the proposed development by Indaver, the following scenarios were identified as the representative worst-case scenarios involving a loss of containment to the marine environment. These have been examined against the CDOIF MATTE criteria.

- Loss of containment from fuel oil tank
- Loss of containment from ammonia tank
- Loss of containment during ammonia delivery
- Major fire at site with release of contaminated firefighting water runoff

Both fuel oil and ammonia are classed as dangerous to the aquatic environment.

A release of fuel oil to water will tend to float on the surface and spread out. The components are generally poorly soluble in water, but the most soluble will dissolve and be dispersed, with the remaining oil subject to a number of loss processes. The oil will typically undergo one or more of a variety of natural processes that may act to reduce the severity of a spill or to accelerate the decomposition of the spilled oil. However, it can also present a hazard of fouling. Given the size of the tank, and the proximity of the site to the coast, a loss of containment is considered as a potential MATTE. A severity rating of 2 and a duration of 2 is assigned, making this a Type A MATTE on the CDOIF scale.

The worst-case loss of containment event for fuel oil would involve a release of the full contents of the storage tank, which has a capacity of 60 m^3 and is double-skinned construction. The aqueous ammonia tank is also double-skinned, with a capacity of 80 m^3.

The HSA's LUP guidance identifies a series of loss of containment events and assigns probabilities of occurrence for each. This is set out in Table 2-4.

Table 2-14: LOC for double containment atmospheric storage tanks (Table 54 from HSA's LUP guidance)

LOC scenario	Frequency	Consequence
Instantaneous failure of primary container and outer shell	1.25×10^{-8} per annum	Release of the entire contents
Instantaneous failure of primary container	5×10^{-8} per annum	Release of the entire contents into the intact outer shell
Failure of the primary container and outer shell	1.25×10^{-8} per annum	Release of the entire contents in 10 minutes in a continuous and constant stream
Failure of the primary container	5×10^{-8} per annum	Release of the entire contents in 10 minutes in a continuous and constant stream into the intact outer shell
Failure of the primary container	1×10^{-4} per annum	Continuous release from a hole with an effective diameter of 10 mm into the intact outer shell

Of these events, only two of them would release in a release to the drainage system, i.e. the first and third entry on the table. The combined probability of occurrence for these events is 2.5×10^{-8} per annum. For either of these events to give rise to significant impacts to the aquatic environment, it would need to find a pathway to escape offsite via the drainage system. The drainage system discharges via an interceptor and is routed to a holding tank. The inlet and outlet of the tank is monitored for TOC, conductivity and for pH, enabling Indaver to rapidly detect a release of ammonia to the drainage and to prevent it escaping offsite.

Given the very low probability, the risk associated with the storage tank is considered to be broadly acceptable.

A major release could also arise in the event of a loss of containment during a road tanker delivery. It is anticipated that the fuel oil usage at the site will be of the order of 240 tonnes per annum. This will require 16 tanker deliveries per annum. It is assumed that tankers will be present at the bay for 2 hours per delivery, i.e. 32 hours per annum. Each delivery is assumed to take 1 hour.

The following events are described in the HSA guidance:

- Instantaneous failure of road tanker: 1×10^{-5} per annum
- Failure of tanker over 10 minutes: 5×10^{-7} per annum

- Rupture of transfer hose: 4×10^{-6} per annum
- Leak from transfer hose: 4×10^{-5} per annum

The first three of these events could give rise to a major release. The combined probability of these three events is calculated to be 6.4×10^{-5} per annum. This figure arises primarily from the contribution of the scenario involving a rupture of a transfer hose.

As noted above, the drainage system discharges via an interceptor and is routed to a holding tank. The inlet and outlet of the tank is monitored for TOC and for pH, enabling Indaver to rapidly detect a release of ammonia to the drainage and to prevent it escaping offsite. The probability of failure on demand of this system is conservatively estimated to be 0.1. The probability of a release offsite is therefore calculated to be 6.4×10^{-6} per annum. The risk of this scenario is therefore broadly acceptable.

There will be 38 deliveries of ammonia per annum. Using a similar approach to that described above for the fuel oil tankers, the probability of a major release from an aqueous ammonia tanker is calculated to be 1.52×10^{-4} per annum and the probability of a major release escaping offsite is calculated to be 1.52×10^{-5} per annum. The risk of this scenario is therefore broadly acceptable.

The risks associated with a release of contaminated firefighting water will be mitigated by the provision of appropriate fire-water retention facilities at the site. It is noted that the primary fire hazard (and the largest fire-fighting scenario) arises at the bunker. This will be fitted with water cannons and a fixed deluge system to combat a fire in this area. The bunker will also be sized to completely retain any firefighting water applied in this area. Indaver will also carry out a firewater retention study, in accordance the EPA’s guidance, to ensure that there is appropriate provision for collecting firefighting water at other areas of the site and ensuring that this does not find a pathway to escape offsite.

2.9 Demonstration of ALARP

A total of 111 scenarios was examined in the HAZID&RA exercise, 108 of which were found to present credible accident hazards. These scenarios were assessed and a Severity Rating and Frequency Rating assigned to each, in accordance with the methodology described previously in this report.

The distribution of risk ratings based on risks to human health and to the environment are summarised in Table 2-15 and Table 2-16.

Table 2-15: Frequency Distribution of Risk Ratings (Human Health)

	Severity				
Frequency	**1**	**2**	**3**	**4**	**5**
1	0	0	0	0	0
2	10	17	9	0	2
3	28	23	9	0	0
4	4	3	1	0	0
5	0	1	0	0	0
6	0	0	0	0	0

Table 2-16: Frequency Distribution of Risk Ratings (Environment)

	Severity				
Frequency	**1**	**2**	**3**	**4**	**5**
1	0	0	0	0	0
2	7	25	6	0	0
3	17	42	1	0	0
4	3	5	1	0	0
5	1	0	0	0	0
6	0	0	0	0	0

Based on the findings of the HAZID&RA exercise, there were no scenarios identified which presented a Priority Risk and there was one scenario which presented a Substantial Risk, which was the bunker fire scenario. This scenario received a Severity Rating of 3 for both Human Health and for the Environment and a Likelihood Rating of 4.

The risk associated with this scenario was considered by the HAZID&RA Team to be ALARP, due to the variety of measures that will be in place to protect against a fire scenario, either by reducing the likelihood of occurrence or mitigating the impacts if it did occur. These are listed below:

- All process activities at the site, including receipt and handling of materials at the bunker, will be carried out by trained operators. Indaver will develop standard operating procedures (SOPs) to governing how these activities are carried out.
- Indaver will conduct a visual inspection of waste as it is unloaded at the bunker. This inspection will be carried out by a trained operator. For new customers, loads will be emptied out in the tipping hall area and examined in more detail prior to admittance to the bunker.
- A fire damper will be fitted, which will close in the event of a fire initiating at the bunker. This measure will ensure that there will be no air supply to the boiler from the bunker area under these circumstances.
- The bunker will be a concrete structure and will be compartmentalised (1-hour fire rating). This measure will help to mitigate against the risk of this scenario by limiting the rate at which a fire can develop in this area.
- Fire wrapping will be installed on cables at the bunker, to ensure continued function in the event of a fire developing.
- Indaver will operate a hot work permitting system at the site, to control ignition sources.
- Where practicable, when maintenance works are required, equipment will be taken outside of the bunker for these works.
- The nature of the activity carried out at the site means that there is a quick throughput of material at the bunker (typical residence time of 4 -5 days). This means that waste is not left to settle within the bunker for a long period of time.

- Indaver will also implement a Bunker Management Programme. This will be carried out once or twice per year, prior to shutdown periods. Indaver will lower the bunker level to bring the inventory to low level (as far as practicable). This, in conjunction with the quick turnaround of material in the bunker (4 – 5 days residence time), will help to avoid a situation where a waste batch is allowed to sit in the bunker for a long period of time.
- Indaver will install UV/IR detectors in the bunker and at the hopper. These detectors will enable early detection in the event of smouldering waste in the bunker. If practicable and safe to do so, Indaver can load this waste directly to the hopper and then add more waste on top to smother it. This is done at other sites in accordance with a documented procedure and this same procedure will be implemented at Ringaskiddy.
- A dedicated deluge system will be installed above the hopper.
- At the time of the 2015 HAZID&RA review it was noted that Indaver had implemented a monitoring programme at another of their sites, to study the potential for methane formation due to anaerobic digestion of waste in the bunker at that site. This study has since been completed and has found that the methane levels are very low during operations and rise to levels of up to 400 ppm during shutdowns, when there is no primary air extraction at the bunker. This concentration does not present a fire hazard. Indaver will install LEL detectors at the bunker at the Ringaskiddy site, so that similar monitoring can be carried out there also.
- Indaver will install 4 no. fixed water cannons at the bunker, which will provide the facility to douse spot fires. This measure will allow Indaver to respond to a developing fire scenario, allowing the operator the facility to extinguish the event before it becomes fully developed. This allows the fire to be extinguished rapidly and with relatively low volumes of water when compared with a fully developed fire.
- Indaver will also install a sprinkler system in the bunker, back up to the water cannons. The sprinkler system will be designed to deluge the bunker with water, sufficient to extinguish a fully developed fire. As such, even in the worst-case fire scenario the policy is one of extinguishment and not one of controlled burn down.
- A 250 mm high stop block or kerb will be installed at the bunker to protect against the risk of a trailer falling into the bunker when unloading waste.
- The bunker will be designed to act as fire water retention facility, to prevent the risk of fire-fighting water that is applied at the bunker subsequently escaping off site as contaminated run-off.

Furthermore, Indaver will conduct a fire water retention study for the site in order to ensure that there is adequate provision to retain fire-fighting water applied at the site.

These measures govern all stages of the potential development of this scenario. The measures will protect against the conditions arising under which a fire could occur, they will enable rapid detection and response at the early stages in the event that a fire scenario developing, they will enable extinguishment of the fire even in the event of escalation to a fully developed fire scenario, and protect against the risk of environmental contamination from fire-fighting run off.

With these measures in place, the HAZID&RA team found that Indaver would have all necessary measures to in place at the bunker, throughout all phases of the operation. As such the risks associated with this scenario were considered to be ALARP (as low as reasonably practicable).

The HAZID&RA worksheets also document an extensive series of controls to reduce the risks from the other scenarios covered in the risk assessment. These are summarised below.

Control Measures at Furnace

- Designed in accordance with EN 12952. Based on observations at other sites, the furnace can accommodate instances where unsuitable waste makes its way into the bunker without sustaining damage.
- Oxygen monitoring, with interlocks on the supply to ensure excess oxygen and protect against incomplete combustion.
- Preventative maintenance on induced draft (ID) fan.
- Vibration detection on ID fan.
- Design of plant and selection of appropriate materials of construction to protect against the risk of slag accumulation on the walls of the furnace.
- Periodic cleaning of furnace as part of the preventative maintenance programme.
- Purge step is carried out on start-up of burners.
- Interlocks in place to prevent oil flow to furnace when burners are not firing.
- Furnace in contained building to retain spills.
- UV/IR detection system and sprinkler system at burners.
- Flame scanners on system - would also activate shutdown if burners do not fire within timeframe.
- Pressure gauge at burner with interlocks.
- Welded pipe with flanged connection to furnace.
- Furnace is insulated with cladding, no external ignition source.

Control Measures at Boiler

- Process control system to monitor temperature; automatic control system linked to temperature monitors.
- Measurements for ammonia slip at the stack.
- Automatic purge control sequence before boiler is fired.
- Daily shift walks, including visual inspection of pipes.
- Fire detection system
- Fire protection sprinkler system

Control Measures at Bag House / Flue Gas Residue Storage

- Impact protection in place
- Restricted vehicle access
- Process controls to detect pressure drop, with alarm.
- Process controls with temperature detection.
- Process controls with weight detection.
- Silos designed to recognised standard/specification (designed for external use but housed internally)

- Visual inspection of silos (daily shift walks).

Control Measures at HCl Storage

- UN approved containers / packaging for materials; caged IBCs to protect against loss of containment due to impact.
- Bunded IBCs to retain a spill from the primary containment.
- Investigations / follow up if supplier provides faulty or damaged IBC.

Control Measures at Piperacks

- Piping designed to recognised standard / specification (piperacks welded / flanged at ends).
- Visual inspection of pipes (daily shift walks)
- Impact protection barriers along potentially exposed sections of pipeline.
- Maximum height warning signs at piperack crossovers.
- Pipelines pressure tested to 1.5 times operating pressure
- Pressure relief valve at pump.

Control Measures at General Storage Area

- Design of tanks incorporating measures to protect against siphoning of the tank contents (e.g. a hole in pipeline at top point on tank outlet or a check valve) in the event of line failure.
- Carbon steel construction of fuel supply line to furnace; no flanged connections, all welded (CE certified).
- Impact protection on storage tanks.
- Double skinned tanks, with leak detection between skins to detect a leak in the primary containment layer (fuel oil, ammonia).
- Deliveries to the tanks are manned activities carried out by trained operators.
- Transfer hoses are inspected by trained operators prior to delivery being made.
- Visual inspection of tankers prior to acceptance on site.
- Overfill protection system on storage tanks (level gauging, level switches).
- Personal protective equipment (PPE) for operators involved in carrying out deliveries, where required.
- Contents of aqueous waste tank are diluted (>70% water), thereby reducing the fire hazard.

Other Control Measures (general, site-wide measures)

In addition, the various controls identified above at the various installations around the site, the HAZID&RA Team noted the following controls which will provide protection against risks across multiple areas at the site.

- All operators will be trained in the tasks they must carry out, with periodic refresher training as required.
- Documented SOPs for carrying out activities on site.
- Trained fitters for carrying out maintenance works.
- Regular site inspection.
- Formalised preventative maintenance program on site (SAP).
- Lock out, tag out procedure when carrying out maintenance works on plant. Permit to work sign off by authorised party.
- Vessels, piping designed to recognised standard/specification.
- Indaver personnel conduct screening / assessing of deliveries to site.
- Speed limit / traffic management controls.
- Oil water separator on drains.
- ATEX zoning.
- Control of ignition sources on site.
- Fire-fighting system - hoses, extinguishers.
- Fire-fighting systems / water main and water cannons.
- Spill kits.
- Emergency response team.

3 CONCLUSIONS

Based on the findings of this risk assessment exercise it is considered that with the control measures that will be put in place at the site, as detailed in the HAZID&RA worksheets in Appendix 3 and the additional measures listed in Appendix 4, the risks associated with accident scenarios at the Indaver facility at Ringaskiddy will be reduced to ALARP (As Low As Reasonably Practicable).

Appendix 1: Site Drawings

NOTE:
- DO NOT SCALE. USE FIGURED DIMENSIONS ONLY
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT SPECIFICATIONS AND DRAWINGS.
- ALL DIMENSIONS TO BE CHECKED ON SITE.
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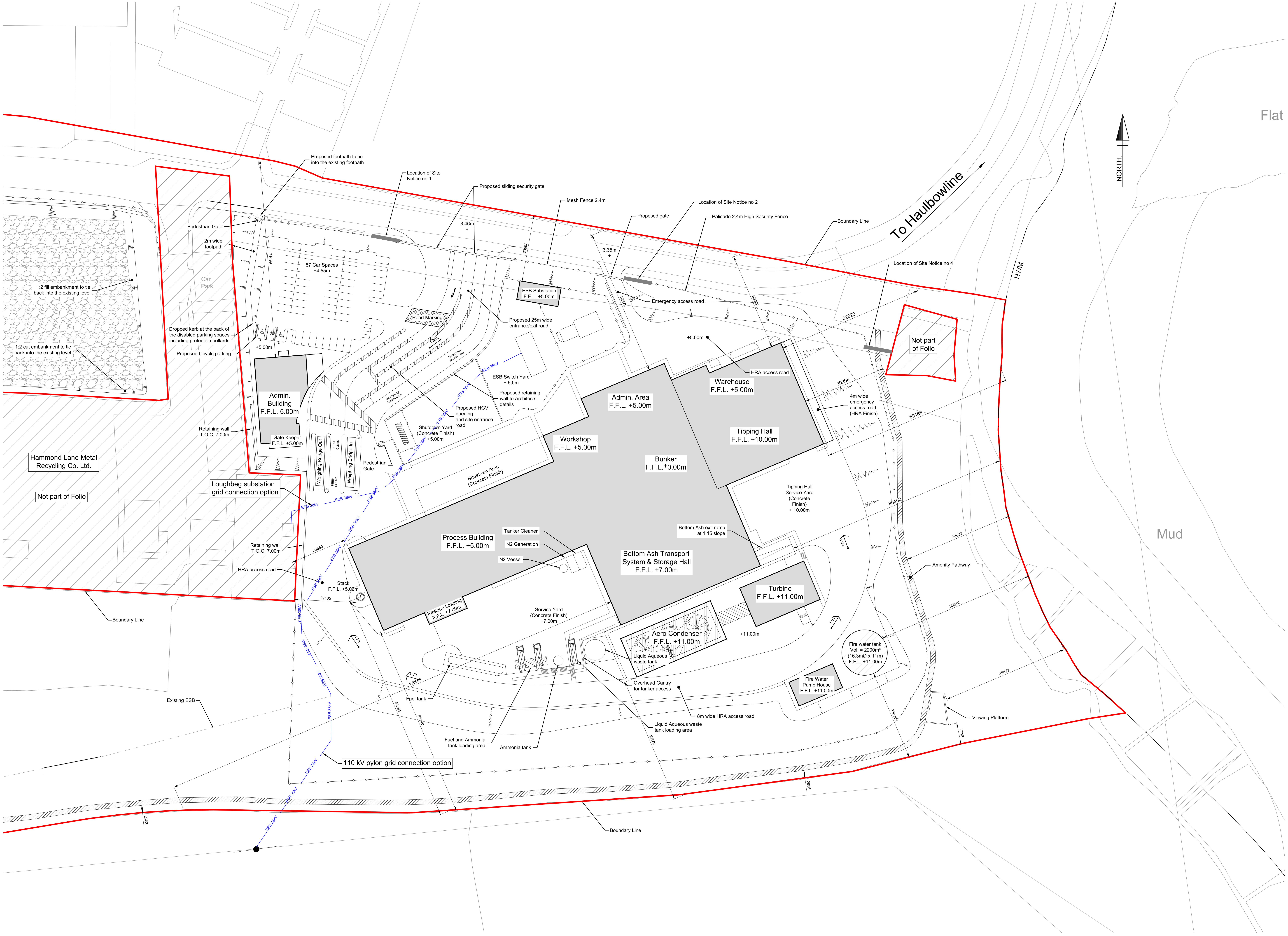

PROPOSED SITE LAYOUT PLAN

(SCALE 1:500 @A0)

LEGEND:

- LOCATION OF SITE NOTICE
- AREA TO WHICH APPLICATION RELATES OUTLINED IN RED
- +7.00m SITE PROPOSED LEVELS
- F.F.L. +7.00m FLOOR FINISHED LEVELS

FOR DRAINAGE DETAILS REFER TO ENGINEERING DRAWINGS

FOR ROAD DETAILS REFER TO ENGINEERING DRAWINGS

FOR SACRIFICIAL MATERIAL DETAILS REFER TO ENGINEERING DRAWINGS

FOR LANDSCAPE DETAILS REFER TO LANDSCAPE ARCHITECTS DRAWINGS

FOR SERVICE DIVERTIONS DETAILS REFER TO ENGINEERING DRAWINGS

DRAWING BASED ON THE FOLLOWING O.S MAP INFORMATION

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Digital Landscape Model (DLM)

Publisher / Source:
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File Format:
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Autodesk AutoCAD (DWG_R2013)

File Name:
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Clip Extent / Area of Interest (AOI):
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Projection= IRENET95_Irish_Transverse_Mercator

Centre Point Coordinates:
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Reference Index:
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1:1,000 | 6472-19
1:2,500 | 6472-C
1:2,500 | 6511-B
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RINGASKIDDY RESOURCE RECOVERY CENTRE INDAVER RINGASKIDDY, CO.CORK				PROPOSED SITE LAYOUT PLAN	
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1:2,500 | 6472-C
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PROPOSED COMPOSITE SITE LAYOUT PLAN

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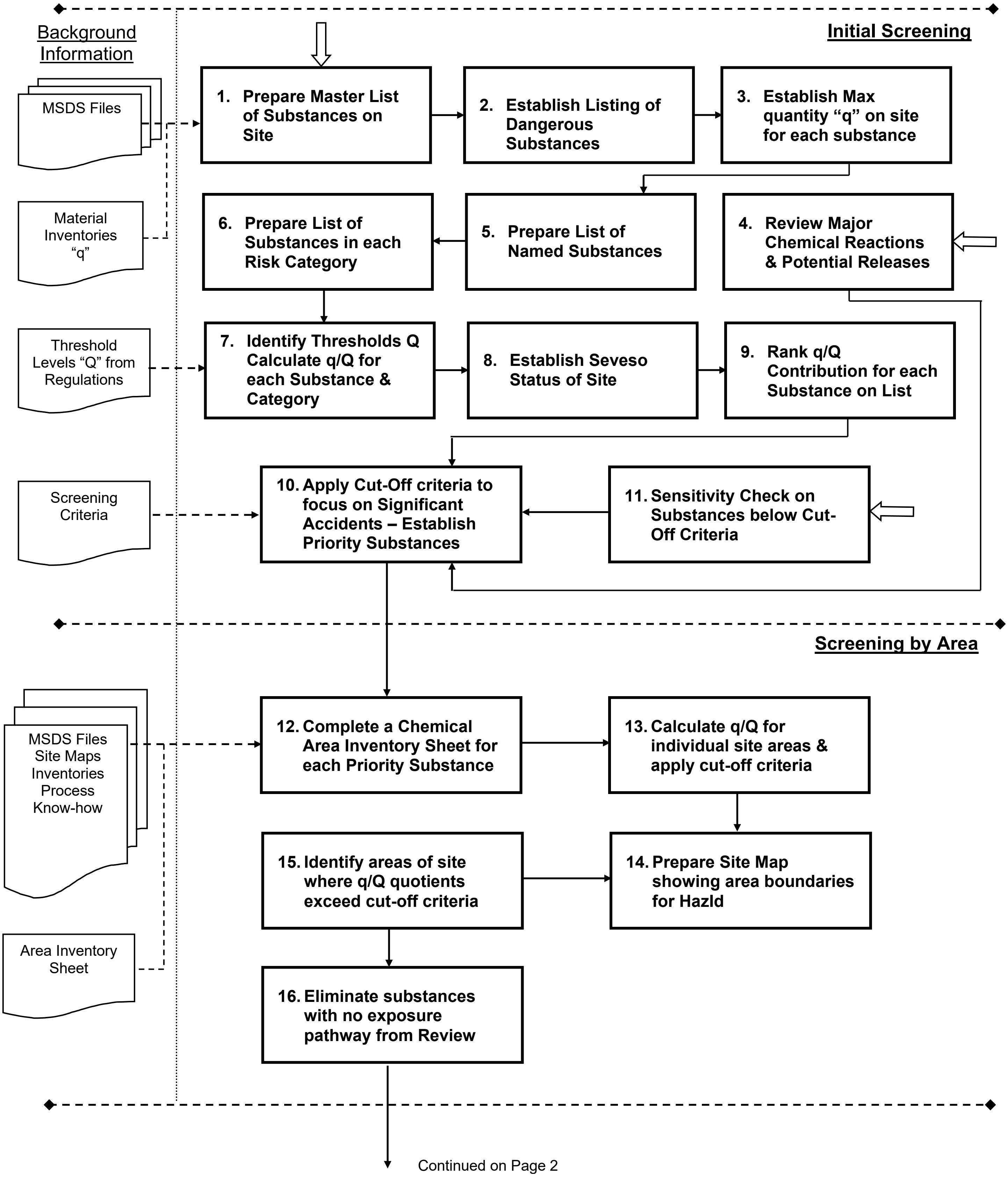
Appendix 2 – HAZID&RA Flow Chart



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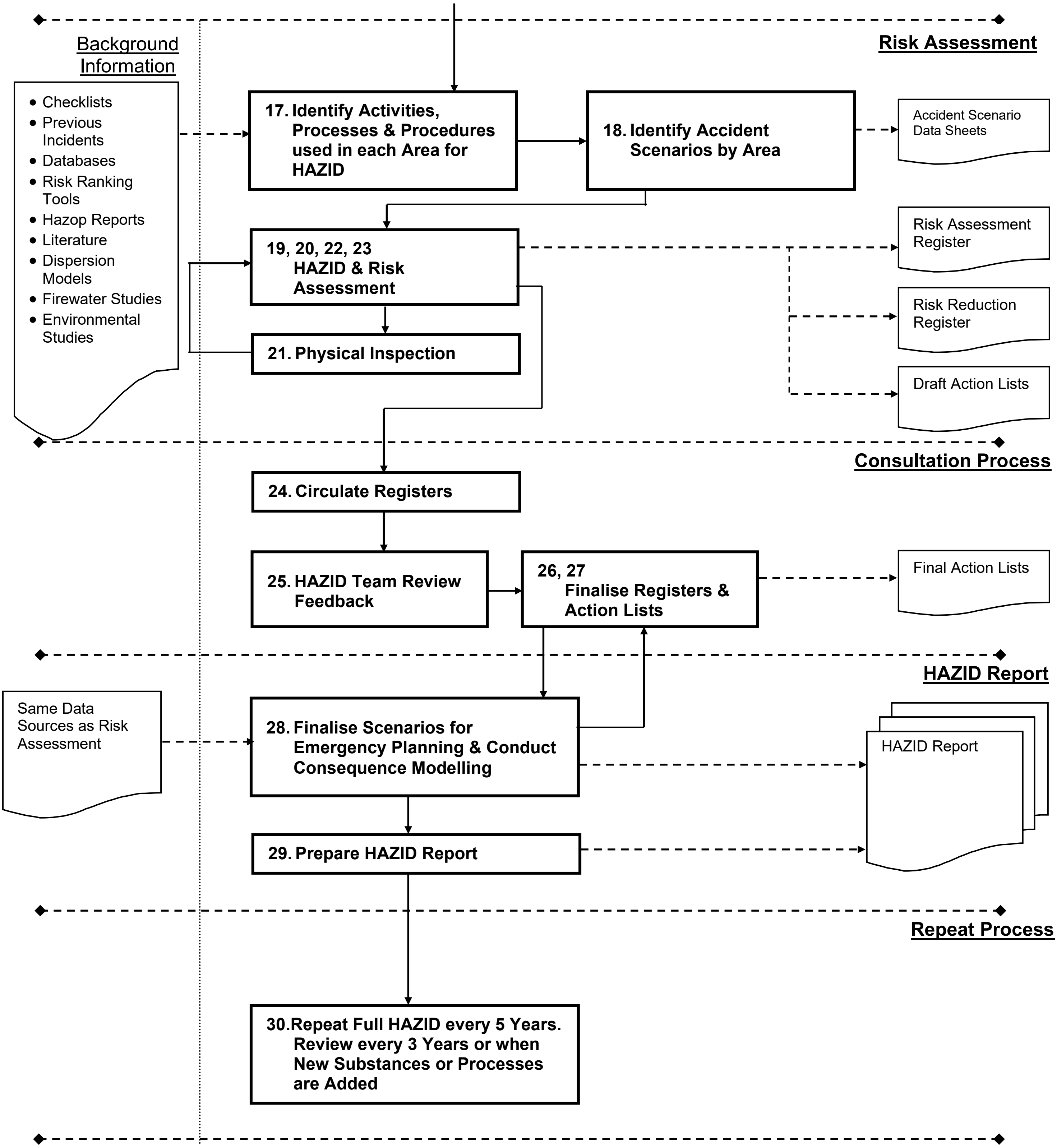
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Risk Assessment
Checklists
Previous Incidents
Databases
Risk Ranking Tools
Hazop Reports
Literature
Dispersion Models
Firewater Studies
Environmental Studies
17. Identify Activities, Processes & Procedures used in each Area for HAZID
18. Identify Accident Scenarios by Area
Accident Scenario Data Sheets
19, 20, 22, 23 HAZID & Risk Assessment
Risk Assessment Register
Risk Reduction Register
21. Physical Inspection
Draft Action Lists
Consultation Process
24. Circulate Registers
25. HAZID Team Review Feedback
26, 27 Finalise Registers & Action Lists
Final Action Lists
HAZID Report
Same Data Sources as Risk Assessment
28. Finalise Scenarios for Emergency Planning & Conduct Consequence Modelling
HAZID Report
29. Prepare HAZID Report
Repeat Process
30.Repeat Full HAZID every 5 Years. Review every 3 Years or when New Substances or Processes are Added

Accident Scenario Data Sheet (ASDS)												
Area												
ID	**Name**	**Date**	**Rev**	**Completed By**		**End Event Ref No.**	**Generic Category of End Event**	**Details of End Event**	**Consequence Description**	**Environ-mental Receptor**	**Severity (Health & Safety)**	**Severity (Environ-mental)**
02	Bunker	Jun-25	2.0	HazId Team	**01**	**2 - 1**	Fire (combustible solids)	Spot Fire in waste bunker area -	Spot smoking - in Bunker, HCl, smoke, some dioxins may be formed. Sucked into boiler as combustion air. Evacuation of drivers / operators in delivery area.	Air	2	1
02	Bunker	Jun-25	2.0	HazId Team	**02**	**2 - 2**	Fire (combustible solids)	Escalation of spot fire to larger scale (intermediate bunker fire)	As above, but with greater emission of potentially toxic combustion products	Air	2	2
02	Bunker	Jun-25	2.0	HazId Team	**03**	**2 - 3**	Fire (combustible solids)	Fully developed Bunker Fire	As above, but with greater emission of potentially toxic combustion products Potential escalation / knock on effects to other areas of site.	Air	3	3
02	Bunker	Jun-25	2.0	HazId Team	**04**	**2 - 4**	Fire (combustible solids)	Fire in Hopper	Similar consequences to 2-1 above. Possibility of spreading back to bunker	Air	2	1
02	Bunker	Jun-25	2.0	HazId Team	**05**	**2 - 5**	Fire (combustible solids)	Explosion at Hopper	Gas cylinder (e.g. LPG) makes it through to waste pusher where it crushed. Explosion resulting in waste being blown back out of hopper. Damage to furnace.	Air	2	2
04	Furnace	Jun-25	2.0	HazId Team	**01**	**4 - 1**	Explosion (flammable substance)	Explosion in furnace	Overpressure leading to explosion. Refractory damage	Air	2	2
04	Furnace	Jun-25	2.0	HazId Team	**02**	**4 - 2**	Gaseous (toxic) release	Flue gases back into boiler house building as a result of overpressure in the system	Potential for inhalation of flue gases if someone is in vicinity at the time (SO_2 exposure)	Air	3	2
04	Furnace	Jun-25	2.0	HazId Team	**03**	**4 - 3**	Liquid (toxic) release	Loss of containment from Fuel Oil Supply at Furnace Start up	Spill to building. Contained within building and routed to u/g water tank	Surface water	1	2
04	Furnace	Jun-25	2.0	HazId Team	**04**	**4 - 4**	Fire (flammable liquid / gas)	Loss of containment from Fuel Oil Supply at Furnace Start up - with ignition - not credible (high flash point liquid)	n.a.	None	0	0
04	Furnace	Jun-25	2.0	HazId Team	**05**	**4 - 5**	Liquid (toxic) release	Loss of containment from liquid waste supply to furnace	Spill to building. Contained within building	Surface water	1	2
04	Furnace	Jun-25	2.0	HazId Team	**06**	**4 - 6**	Liquid (toxic) release	Loss of containment from liquid waste supply to furnace - with ignition	Fire within building. Risk of damage to plant. Firewater run off	Surface Water, Air	3	2
07	Boiler	Jun-25	2.0	HazId Team	**01**	**7 - 1**	Gaseous (toxic) release	Ammonia slip (Incorrect temperature, excess volume)	Possible exceedance of licence due to high ammonia emissions to atmosphere	Air	0	1

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ID	Name											
07	Boiler	Jun-25	2.0	HazId Team	**02**	**7 - 2**	Liquid (toxic) release	Collection of oil below grate due to non firing of burners during startup	Oil collection below waste pit (on concrete floor), would be retained and collected - not a major accident scenario		0	0
07	Boiler	Jun-25	2.0	HazId Team	**03**	**7 - 3**	Fire	Fire below grate due to ignition of oil pool. Scenario 7.2 without cleanup of oil before second firing of burners	Smoke plume inside building, equipment damage.	Air	2	1
07	Boiler	Jun-25	2.0	HazId Team	**04**	**7 - 4**	Liquid (toxic) release	Leak of oil at flanged connection to burner	Spill of oil to drip tray inside building	Surface water	1	1
07	Boiler	Jun-25	2.0	HazId Team	**05**	**7 - 5**	Fire	Leak of oil at flanged connection to burner - with ignition	Small pool fire within drip tray	Surface water	2	1
07	Boiler	Jun-25	2.0	HazId Team	**06**	**7 - 6**	Liquid (toxic) release	Complete failure at flange connection, spill of oil	Spill to ground. Retained within building.	Surface water	1	2
11	Flue Gas Cooling Section Water Quench	Jun-25	2.0	HazId Team	**01**	**11 - 1**	No MAH identified in this area. Flue gas in chamber - water & lime					
12	Activated Carbon Silo	Jun-25	2.0	HazId Team	**01**	**12 - 1**	Fire	Fire at activated carbon silo	Damage to plant and equipment in the immediate vicinity	Air	2	2
13	Bag House	Jun-25	2.0	HazId Team	**01**	**13 - 1**	Solid (toxic) release	Release of ash residue from bag filters	Accumulation of residue on floor Release of residue dust cloud through vents/open doorways	Groundwater, surface water	1	1
13a	Flue Gas Residue Storage	Jun-25	2.0	HazId Team	**01**	**13a - 1**	Solid (toxic) release	Release of ash residue from storage silos (2 No. silos - with a capacity of up to 540m3 between the two)	Accumulation of residue on floor Release of residue dust cloud through vents/open doorways	Groundwater, surface water	1	2
14	Flue Gas Cooling Section	Jun-25	2.0	HazId Team	**01**	**14 - 1**	No MAH identified in this area.					
16	ID Fan	Jun-25	2.0	HazId Team	**01**	**16 - 1**	No MAH identified in this area.					
19	Stack	Jun-25	2.0	HazId Team	**01**	**19 - 1**	No MAH identified in this area.					

Accident Scenario Data Sheet (ASDS)													
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ID	Name											
44	Water treatment plant - Chemical storage	Jun-25	2.0	HazId Team	**01**	**44 - 1**	Liquid (toxic) release	Loss of containment of HCl from IBC to bund tray	Spill held within bund. Evolution of toxic vapour to atmosphere	Surface Water, Air	2	2
44	Water treatment plant - Chemical storage	Jun-25	2.0	HazId Team	**02**	**44 - 2**	Liquid (toxic) release	Rupture of IBC of HCl and release to outside bund	Spill to ground. Collected in internal drainage system (leading to dirty water pit). Evolution of toxic vapour to atmosphere	Surface Water, Air	3	2
44	Water treatment plant - Chemical storage	Jun-25	2.0	HazId Team	**03**	**44 - 3**	Liquid (toxic) release	Loss of containment of HCl during IBC delivery	Loss of containment of 1m3 of HCl (30%) to unbunded area.	Surface Water, Air	3	2
44	Water treatment plant - Chemical storage	Jun-25	2.0	HazId Team	**04**	**44 - 4**	Liquid (toxic) release	Loss of containment of NaOH from IBC to bund tray	Spill held within bund. Evolution of toxic vapour to atmosphere	Surface Water, Air	1	1
44	Water treatment plant - Chemical storage	Jun-25	2.0	HazId Team	**05**	**44 - 5**	Liquid (toxic) release	Rupture of IBC of NaOH and release to outside bund	Spill to ground. Collected in internal drainage system (leading to dirty water pit). Evolution of toxic vapour to atmosphere	Surface Water, Air	2	2
44	Water treatment plant - Chemical storage	Jun-25	2.0	HazId Team	**06**	**44 - 6**	Liquid (toxic) release	Loss of containment of NaOH during IBC delivery	Loss of containment of 1m3 to unbunded area.	Surface Water, Air	2	2
102	Piperacks	Jun-25	2.0	HazId Team	**01**	**102 - 1**	Liquid (toxic) release	Leak of fuel oil from pipeline	Release of oil to ground collected in surface water drainage system. May be diverted to surface/firewater retention tank	Surface water, groundwater	1	1
102	Piperacks	Jun-25	2.0	HazId Team	**02**	**102 - 2**	Liquid (toxic) release	Rupture of fuel oil pipeline	Release of oil to ground collected in surface water drainage system. Diverted to surface/firewater retention tank	Surface water, groundwater	1	2
102	Piperacks	Jun-25	2.0	HazId Team	**03**	**102 - 3**	Liquid (toxic) release	Leak of ammonia solution from pipeline	Release of ammonia to ground collected in surface water drainage system. May be diverted to surface/firewater retention tank	Surface water, groundwater	2	2
102	Piperacks	Jun-25	2.0	HazId Team	**04**	**102 - 4**	Liquid (toxic) release	Rupture of ammonia solution pipeline	Release of ammonia to ground collected in surface water drainage system. Diverted to surface/firewater retention tank	Surface water, groundwater	3	2
102	Piperacks	Jun-25	2.0	HazId Team	**05**	**102 - 5**	Fire (flammable liquid / gas)	Leak of aqueous waste from pipeline	Spill giving rise to pool fire. Spill collected in surface water drainage along with fire fighting water	Surface water, groundwater	1	1
102	Piperacks	Jun-25	2.0	HazId Team	**06**	**102 - 6**	Fire (flammable liquid / gas)	Rupture of aqueous waste pipeline	Spill giving rise to pool fire. Spill collected in surface water drainage along with fire fighting water	Surface water, groundwater	2	2

Accident Scenario Data Sheet (ASDS)												
Area		Date	Rev	Completed By		End Event Ref No.	Generic Category of End Event	Details of End Event	Consequence Description	Environ-mental Receptor	Severity (Health & Safety)	Severity (Environ-mental)
ID	Name											
104	General Storage Area	Jun-25	2.0	HazId Team	**01**	**104 - 1**	Liquid (toxic) release	Loss of containment from fuel oil tank connection (pipeline)	Spill of fuel to ground. Collected in drainage system.	Surface water	1	2
104	General Storage Area	Jun-25	2.0	HazId Team	**02**	**104 - 2**	Liquid (toxic) release	Rupture of fuel oil tank	Loss of full tank contents to bund	Surface water	1	2
104	General Storage Area	Jun-25	2.0	HazId Team	**03**	**104 - 3**	Liquid (toxic) release	Loss of containment of fuel oil tank during road tanker delivery	Spill of fuel to ground. Collected in drainage system.	Surface water	1	2
104	General Storage Area	Jun-25	2.0	HazId Team	**04**	**104 - 4**	Liquid (toxic) release	Loss of containment from aqueous Ammonia tank connection (pipeline)	Spill to ground. Collected in drainage system. Evolution of toxic vapour to atmosphere	Surface Water, Air	2	2
104	General Storage Area	Jun-25	2.0	HazId Team	**05**	**104 - 5**	Liquid (toxic) release	Rupture of aqueous Ammonia tank	Loss of full tank contents to ground. Evolution of toxic vapour to atmosphere. Potential risk to operator if in vicinity. Potential emergency response implications off site.	Surface Water, Air	5	3
104	General Storage Area	Jun-25	2.0	HazId Team	**06**	**104 - 6**	Liquid (toxic) release	Loss of containment of aqueous ammonia during road tanker delivery	Loss of containment of of Ammonia to unbunded area delivery rate of 40m3/hr). Operator responds and shuts down transfer within 1-2 minutes	Surface Water, Air	3	2
104	General Storage Area	Jun-25	2.0	HazId Team	**07**	**104 - 7**	Liquid (toxic) release	Loss of containment from aqueous waste tank connection (pipeline)	Loss of containment of dilute solution to ground - collected in surface drainage system	Surface water	1	2
104	General Storage Area	Jun-25	2.0	HazId Team	**08**	**104 - 8**	Fire (flammable liquid / gas)	Loss of containment from aqueous waste tank connection (pipeline) - with ignition	Spill giving rise to pool fire. Spill collected in surface water drainage along with fire fighting water	Surface water	2	2
104	General Storage Area	Jun-25	2.0	HazId Team	**09**	**104 - 9**	Liquid (toxic) release	Rupture of aqueous waste tank	Spill of fuel to ground. Collected in drainage system.	Surface water	1	2
104	General Storage Area	Jun-25	2.0	HazId Team	**10**	**104 - 10**	Fire (flammable liquid / gas)	Rupture of aqueous waste tank - with ignition	Spill giving rise to pool fire. Spill collected in surface water drainage along with fire fighting water	Surface water	3	2
104	General Storage Area	Jun-25	2.0	HazId Team	**11**	**104 - 11**	Fire (flammable liquid / gas)	Loss of containment of aqueous waste during road tanker delivery	Spill giving rise to pool fire. Spill collected in surface water drainage along with fire fighting water	Surface water	1	2
104	General Storage Area	Jun-25	2.0	HazId Team	**12**	**104 - 12**	Fire (flammable liquid / gas)	Loss of containment of aqueous waste during road tanker delivery - with ignition	Spill giving rise to pool fire. Spill collected in surface water drainage along with fire fighting water	Surface water	2	2

Area		Description of Activity	Description of Initiating Event	End Event Ref No.	Severity (Health & Safety)	Severity (Environ-mental)	Frequency	Risk Rating (Health & Safety)	Risk Rating (Environ-mental)	Description of Activity	Description of Initiating Event	End Event Ref No.	Risk Rating (Health & Safety)	Risk Rating (Environ-mental)	Measures in Place	Additional Measures
ID	Name				S	SE	F									
2	Bunker	Waste receipt	Waste arrives on site smouldering in truck	2 - 1	2	1	4	8	4	**Waste receipt**	**Waste arrives on site smouldering in truck**	2 - 1	8	4	- If fire is detected in bunker, the fire damper will close and air to boiler will be taken from elsewhere. - Bunker is concrete structure and is compartmentalised (1 hr fire rating).. - Visual inspection of waste as it is unloaded. - IR smoke detection and thermal imaging - Fire wrapping of cables to ensure continued function during fire event. - Fire protection systems in Bunker. - Crane driver monitors the bunker. - Water cannons to extinguish spot fires.	
2	Bunker	Maintenance	Ignition due to hot works or similar activities in area	2 - 1	2	1	3	6	3	**Maintenance**	**Ignition due to hot works or similar activities in area**	2 - 1	6	3	- Hot work permitting system. - Trained operators. - Where practicable, equipment is taken outside of the bunker for maintenance works. - Fire protection systems in Bunker. - Crane driver monitors the bunker. - Water cannons to extinguish spot fires.	
2	Bunker	Waste receipt	Heating due to self-combustion of organic fraction in the waste	2 - 1	2	1	5	10	5	**Waste receipt**	**Heating due to self-combustion of organic fraction in the waste**	2 - 1	10	5	- Relatively quick throughput, waste is not left to settle for long period of time. - Bunker Management Programme - once or twice per year, prior to shutdown periods, the bunker inventory is brought to low level (as far as practicable) to avoid situation where a waste batch is allowed sit for long period of time. - Would be evident due to smoke formation as well as UV/IR detectors in the bunker. If smouldering waste is detected it is loaded directly to hopper and more waste is then dumped on top to smother it. - 4 x Fixed water cannons in place to douse spot fires. - Sprinkler system on roof as back up.	
2	Bunker	Waste receipt	Trailer falls into bunker. Loss of containment of high temperature fuel, with ignition	2 - 1	2	1	2	4	2	**Waste receipt**	**Trailer falls into bunker. Loss of containment of high temperature fuel, with ignition**	2 - 1	4	2	- Barrier in place. - SOP / safety induction / trained drivers. - Driver activities are supervised by Indaver operator - Water cannons to extinguish spot fires.	
2	Bunker	Waste receipt	Container of flammable material in bunker, damaged by grab when collecting from bunker	2 - 1	2	1	3	6	3	**Waste receipt**	**Container of flammable material in bunker, damaged by grab when collecting from bunker**	2 - 1	6	3	- Visual inspection of waste in tipping hall. - LEL detector in bunker - Water cannons to extinguish spot fires.	
2	Bunker	Waste receipt	Methane formation due to anaerobic digestion in waste	2 - 1	2	1	3	6	3	**Waste receipt**	**Methane formation due to anaerobic digestion in waste**	2 - 1	6	3	- LEL detector in bunker - Fire protection systems in Bunker. - Crane driver monitors the bunker. - Water cannons to extinguish spot fires.	Indaver are conducting an investigation of the atmospheric conditions in the bunker in Meath to see if there is any CH4 formation - in particular when process is stopped.
2	Bunker	Waste receipt	Waste arrives on site smouldering in truck	2 - 2	2	2	3	6	6	**Waste receipt**	**Waste arrives on site smouldering in truck**	2 - 2	6	6	- UV/IR detectors - If fire is detected in bunker, the fire damper will close and air to boiler will be taken from elsewhere. - Bunker is concrete structure and is compartmentalised (1 hr fire rating).. - Visual inspection of waste as it is unloaded. Fire wrapping of cables to ensure continued function during fire event. - Fire protection systems in Bunker.	

Area ID	Name	Description of Activity	Description of Initiating Event	End Event Ref No.	Severity (Health & Safety) S	Severity (Environ-mental) SE	Frequency F	Risk Rating (Health & Safety)	Risk Rating (Environ-mental)	Description of Activity	Description of Initiating Event	End Event Ref No.	Risk Rating (Health & Safety)	Risk Rating (Environ-mental)	Measures in Place	Additional Measures
2	**Bunker**	Maintenance	Ignition due to hot works or similar activities in area	**2 - 2**	**2**	**2**	**2**	**4**	**4**	**Maintenance**	**Ignition due to hot works or similar activities in area**	**2 - 2**	**4**	**4**	- Hot work permitting system. - Trained operators. - Where practicable, equipment is taken outside of the bunker for maintenance works. - UV/IR detectors - Fire protection systems	
2	**Bunker**	Waste receipt	Heating due to self-combustion of organic fraction in the waste	**2 - 2**	**2**	**2**	**4**	**8**	**8**	**Waste receipt**	**Heating due to self-combustion of organic fraction in the waste**	**2 - 2**	**8**	**8**	- Relatively quick throughput, waste is not left to settle for long period of time. Bunker Management Programme - once or twice per year, prior to shutdown periods, the bunker inventory is brought to low level (as far as practicable) to avoid situation where a waste batch is allowed sit for long period of time. - Would be evident due to smoke formation as well as UV/IR detectors in the bunker. If smouldering waste is detected it is loaded directly to hopper and more waste is then dumped on top to smother it. - 4 x Fixed water cannons in place to douse spot fires. - Sprinkler system on roof as back up.	
2	**Bunker**	Waste receipt	Trailer falls into bunker. Loss of containment of high temperature fuel, with ignition	**2 - 2**	**2**	**2**	**2**	**4**	**4**	**Waste receipt**	**Trailer falls into bunker. Loss of containment of high temperature fuel, with ignition**	**2 - 2**	**4**	**4**	- Barrier in place. - SOP - UV/IR detectors	
2	**Bunker**	Waste receipt	Container of flammable material in bunker, damaged by grab when collecting from bunker	**2 - 2**	**2**	**2**	**2**	**4**	**4**	**Waste receipt**	**Container of flammable material in bunker, damaged by grab when collecting from bunker**	**2 - 2**	**4**	**4**	- Visual inspection of waste in tipping hall. - LEL detector in bunker	
2	**Bunker**	Waste receipt	Methane formation due to anaerobic digestion in waste	**2 - 2**	**2**	**2**	**2**	**4**	**4**	**Waste receipt**	**Methane formation due to anaerobic digestion in waste**	**2 - 2**	**4**	**4**	- LEL detector in bunker	Indaver are conducting an investigation of the atmospheric conditions in the bunker in Meath to see if there is any CH4 formation - in particular when process is stopped.
2	**Bunker**	Waste receipt	Waste arrives on site smouldering in truck	**2 - 3**	**3**	**3**	**3**	**9**	**9**	**Waste receipt**	**Waste arrives on site smouldering in truck**	**2 - 3**	**9**	**9**	- UV/IR detectors. - If fire is detected in bunker, the fire damper will close and air to boiler will be taken from elsewhere. - Bunker is concrete structure and is compartmentalised (1 hr fire rating).. Visual inspection of waste as it is unloaded. - Fire wrapping of cables to ensure continued function during fire event. - Fire protection systems in Bunker. - Water cannons to extinguish spot fires.	FWR study to be conducted to confirm that bunker has capacity to retain the fire fighting water applied in this scenario
2	**Bunker**	Maintenance	Ignition due to hot works or similar activities in area	**2 - 3**	**3**	**3**	**2**	**6**	**6**	**Maintenance**	**Ignition due to hot works or similar activities in area**	**2 - 3**	**6**	**6**	- Hot work permitting system. - Trained operators. - Where practicable, equipment is taken outside of the bunker for maintenance works. - Water cannons to extinguish spot fires.	

Area ID	Name	Description of Activity	Description of Initiating Event	End Event Ref No.	Severity (Health & Safety) S	Severity (Environ-mental) SE	Frequency F	Risk Rating (Health & Safety)	Risk Rating (Environ-mental)	Description of Activity	Description of Initiating Event	End Event Ref No.	Risk Rating (Health & Safety)	Risk Rating (Environ-mental)	Measures in Place	Additional Measures
2	**Bunker**	Waste receipt	Heating due to self-combustion of organic fraction in the waste	**2 - 3**	**3**	**3**	**4**	**12**	**12**	**Waste receipt**	**Heating due to self-combustion of organic fraction in the waste**	**2 - 3**	**12**	**12**	- Relatively quick throughput, waste is not left to settle for long period of time. - Bunker Management Programme - once or twice per year, prior to shutdown periods, the bunker inventory is brought to low level (as far as practicable) to avoid situation where a waste batch is allowed sit for long period of time. - Would be evident due to smoke formation as well as UV/IR detectors in the bunker. If smouldering waste is detected it is loaded directly to hopper and more waste is then dumped on top to smother it. - 4 x Fixed water cannons in place to douse spot fires. - Sprinkler system on roof as back up.	
2	**Bunker**	Waste receipt	Trailer falls into bunker. Loss of containment of high temperature fuel, with ignition	**2 - 3**	**3**	**3**	**2**	**6**	**6**	**Waste receipt**	**Trailer falls into bunker. Loss of containment of high temperature fuel, with ignition**	**2 - 3**	**6**	**6**	- Barrier in place. - SOP - Water cannons to extinguish spot fires.	
2	**Bunker**	Waste receipt	Container of flammable material in bunker, damaged by grab when collecting from bunker	**2 - 3**	**3**	**3**	**2**	**6**	**6**	**Waste receipt**	**Container of flammable material in bunker, damaged by grab when collecting from bunker**	**2 - 3**	**6**	**6**	- Visual inspection of waste in tipping hall. - LEL detector in bunker - Water cannons to extinguish spot fires.	
2	**Bunker**	Waste receipt	Methane formation due to anaerobic digestion in waste	**2 - 3**	**3**	**3**	**2**	**6**	**6**	**Waste receipt**	**Methane formation due to anaerobic digestion in waste**	**2 - 3**	**6**	**6**	- LEL detector in bunker - Water cannons to extinguish spot fires.	
2	**Bunker**	Waste processing	Smouldering material dumped into hopper in error	**2 - 4**	**2**	**1**	**3**	**6**	**3**	**Waste processing**	**Smouldering material dumped into hopper in error**	**2 - 4**	**6**	**3**	- Control to protect against initiating event as described in Scenario 2 - 1. - UV/IR at hopper. - Procedure for handling smouldering waste in bunker is to pick it up and place in the hopper, then cover with other waste to extinguish - Fire protection systems - dedicated deluge system above hopper.	
2	**Bunker**	Waste processing	Smouldering material dumped into hopper and not adequately smothered with more waste afterwards	**2 - 4**	**2**	**1**	**3**	**6**	**3**	**Waste processing**	**Smouldering material dumped into hopper and not adequately smothered with more waste afterwards**	**2 - 4**	**6**	**3**	- Trained operators. - Documented procedure in place to respond to this scenario by smothering the smouldering material with more waste.	
2	**Bunker**	Waste processing	LPG cylinder in waste stream. Dropped into hopper and then crushed by the waste pusher	**2 - 5**	**2**	**2**	**3**	**6**	**6**	**Waste processing**	**LPG cylinder in waste stream. Dropped into hopper and then crushed by the waste pusher**	**2 - 5**	**6**	**6**	- Customer segregation at source. - Visual inspection prior to acceptance. - For new customers, load is dumped on floor in receipt area and examined in more detail before admitting into the bunker - Robust construction; would contain/withstand the impacts of the event to mitigate impacts to surroundings	Indaver review of customer approval procedure for screening of waste streams
4	**Furnace**	Waste processing	LPG cylinder in waste stream. Makes its way to furnace and ruptures due to high temperatures	**4 - 1**	**2**	**2**	**3**	**6**	**6**	**Waste processing**	**LPG cylinder in waste stream. Makes its way to furnace and ruptures due to high temperatures**	**4 - 1**	**6**	**6**	System designed in accordance with EN 12952. Experience at other sites indicates that the system can withstand this scenario without sustaining damage.	Indaver to review customer approval procedure for screening of waste streams
4	**Furnace**	Waste processing	Emergency shutdown, combustion on grate, continues to emit CO. Or waste smouldering to generate CO. If not flushed before restart then can generate explosion on restart.	**4 - 1**	**2**	**2**	**3**	**6**	**6**	**Waste processing**	**Emergency shutdown, combustion on grate, continues to emit CO. Or waste smouldering to generate CO. If not flushed before restart then can generate explosion on restart.**	**4 - 1**	**6**	**6**	Interlocks on O2 level to ensure excess oxygen. Monitoring for CO at stack. Purge of system before restart	

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4	**Furnace**	Waste processing	Control loop pressure transmitter (set point -2mbar) goes out of action. Overpressure leading to induction fan failure, combustion continues. Flue gases back into building	**4 - 2**	**3**	**2**	**3**	**9**	**6**	**Waste processing**	**Control loop pressure transmitter (set point -2mbar) goes out of action. Overpressure leading to induction fan failure, combustion continues. Flue gases back into building**	**4 - 2**	**9**	**6**	Preventative Maintenance on ID fan. Vibration detection on fan.	
4	**Furnace**	Waste processing	Slag accumulation on furnace walls - drops off and impacts grate. Sudden impact of hot slag on water lock gives rise to overpressure with release of flue gases - not credible due to appropriate material selection to prevent slag accumulation in the first place	**4 - 2**	**3**	**2**	**0**	**0**	**0**	**Waste processing**	**Slag accumulation on furnace walls - drops off and impacts grate. Sudden impact of hot slag on water lock gives rise to overpressure with release of flue gases - not credible due to appropriate material selection to prevent slag accumulation in the first place**	**4 - 2**	**0**	**0**	Appropriate selection of refractory materials for wall to protect against risk of slag accumulation. Cleaning once per year.	
4	**Furnace**	Combustion	Oil to furnace without burners activated. Oil passes through grate and is collected inside building	**4 - 3**	**1**	**2**	**3**	**3**	**6**	**Combustion**	**Oil to furnace without burners activated. Oil passes through grate and is collected inside building**	**4 - 3**	**3**	**6**	Purge step is carried out on start up of burners. Interlocks to prevent oil flow when burners are not firing. Contained building with u/g tank to retain spills. Drainage system to collect larger spills. UV/IR and sprinkler system at burners. Flame scanners on system - would also activate shutdown if burners do not fire within timeframe.	
4	**Furnace**	Combustion	Failure of pipeline resulting in leak. Spill is collected inside building or in surface water drains	**4 - 3**	**1**	**2**	**3**	**3**	**6**	**Combustion**	**Failure of pipeline resulting in leak. Spill is collected inside building or in surface water drains**	**4 - 3**	**3**	**6**	PM schedule. The pipeline enters the building on a piperack at high level - it runs in channels (protected against impact). Trained operators of forklifts and other vehicles onsite. Materials of construction appropriate for the chemicals conveyed within the pipelines. Oil water separator on drains. Valve on drainage outlet - can be remotely activated to prevent a release escaping offsite. Pressure gauge at burner would detect major loss of containment and activate interlocks.	
4	**Furnace**		Not credible	**4 - 4**	**0**	**0**					**Not credible**	**4 - 4**				
4	**Furnace**	Combustion	Liquid waste is sent to furnace in error where furnace is not heated	**4 - 5**	**1**	**2**	**3**	**3**	**6**	**Combustion**	**Liquid waste is sent to furnace in error where furnace is not heated**	**4 - 5**	**3**	**6**	Spill kits. Drainage / bund tray to restrict size of spill. SOP with trained operator. Interlocks on the temperature to protect against any waste feed being introduced when the furnace is not heated up.	
4	**Furnace**	Combustion	Failure of pipeline resulting in leak. Spill is collected inside building or in surface water drains	**4 - 5**	**1**	**2**	**3**	**3**	**6**	**Combustion**	**Failure of pipeline resulting in leak. Spill is collected inside building or in surface water drains**	**4 - 5**	**3**	**6**	Use of appropriate materials of construction Welded pipe with flanged connection at entry to furnace	
4	**Furnace**	Combustion	Failure of pipeline resulting in leak. Spill is collected inside building or in surface water drains - with ignition	**4 - 6**	**3**	**2**	**2**	**6**	**4**	**Combustion**	**Failure of pipeline resulting in leak. Spill is collected inside building or in surface water drains - with ignition**	**4 - 6**	**6**	**4**	ATEX Zoning / Ex rated equipment. Furnace is insulated with cladding, no external ignition source. Fire fighting system - hoses, extinguishers. Shift operators are trained in fire-fighting ERT team on site	

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ID	Name				S	SE	F									
7	Boiler	Injection of ammonia	Failure of process controls - too much ammonia / incorrect chamber temperature	7 - 1	0	1	4	0	4	Injection of ammonia	Failure of process controls - too much ammonia / incorrect chamber temperature	7 - 1	0	4	Process control monitor temperature. Automatic control system linked to temperature monitors. Measurements for ammonia slip at the stack (use of high accuracy temperature measurements and profiles across the boiler to control temperature - this reduces the requirement to dose with ammonia to manage Nox emissions).	
7	Boiler	Oil firing	Oil sent to chamber without ignition & not purged prior to firing chamber again	7 - 3	2	1	3	6	3	Oil firing	Oil sent to chamber without ignition & not purged prior to firing chamber again	7 - 3	6	3	Infrequent firing from cold. Automatic purge control sequence programme SOP for startup with trained operators	
7	Boiler	Post Combustion process	Operator error - not securing flange connection following maintenance works	7 - 4	1	1	4	4	4	Post Combustion process	Operator error - not securing flange connection following maintenance works	7 - 4	4	4	Trained fitters Lock out tag out for PM works	
7	Boiler	Post Combustion process	Mechanical failure of flange	7 - 4	1	1	3	3	3	Post Combustion process	Mechanical failure of flange	7 - 4	3	3	Piping designed to recognised standard/specification. Visual inspection of pipes (daily shift walks) Preventative maintenance program (SAP)	
7	Boiler	Post Combustion process	Operator error - not securing flange connection following maintenance works	7 - 5	2	1	3	6	3	Post Combustion process	Operator error - not securing flange connection following maintenance works	7 - 5	6	3	Trained fitters Lock out tag out for PM works Control of ignition sources	
7	Boiler	Post Combustion process	Mechanical failure of flange	7 - 5	2	1	2	4	2	Post Combustion process	Mechanical failure of flange	7 - 5	4	2	Piping designed to recognised standard/specification. Visual inspection of pipes (daily shift walks) Preventative maintenance program (SAP) Control of ignition sources	
7	Boiler	Post Combustion process	Operator error - not securing flange connection following maintenance works	7 - 6	1	2	4	4	8	Post Combustion process	Operator error - not securing flange connection following maintenance works	7 - 6	4	8	Lock out, tag out procedure. Permit to work sign off by authorised party Trained fitters	
7	Boiler	Post Combustion process	Mechanical failure of flange	7 - 6	1	2	3	3	6	Post Combustion process	Mechanical failure of flange	7 - 6	3	6	Piping designed to recognised standard/specification Visual inspection of pipes (daily shift walks) Preventative maintenance program (SAP)	
12	Activated Carbon Silo	Emissions treatment	Wet material unloaded to silo	12 - 1	2	2	3	6	6	Emissions treatment	Wet material unloaded to silo	12 - 1	6	6	Nitrogen blanketing to protect against flammable atmospheres - activated automatically by temperature monitoring in silo	
13	Bag House	Operation of bag house	Major mechanical damage to bag house due to impact	13 - 1	1	1	3	3	3	Operation of bag house	Major mechanical damage to bag house due to impact	13 - 1	3	3	Impact protection. Housed inside a building, protection against released material being dispersed downwind. Restricted vehicle access. Trained operators. Process controls to detect pressure drops. Alarms. CEMS monitoring of flue gas stream. Redundancy of filters - can continue operations while damaged compartment is isolated and replaced.	

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13	**Bag House**	Operation of bag house	Mechanical failure	**13 - 1**	**1**	**1**	**3**	**3**	**3**	**Operation of bag house**	**Mechanical failure**	**13 - 1**	**3**	**3**	Housed inside a building, protection against released material being dispersed downwind. Process controls to detect pressure drops. Alarms. CEMS monitoring of flue gas stream. Redundancy of filters - can continue operations while damaged compartment is isolated and replaced.	
13	**Bag House**	Maintenance	Hatch opened in error or maintenance error	**13 - 1**	**1**	**1**	**3**	**3**	**3**	**Maintenance**	**Hatch opened in error or maintenance error**	**13 - 1**	**3**	**3**	Housed inside a building, protection against released material being dispersed downwind. Restricted vehicle access. Trained operators. Process controls to detect pressure drops. CEMS monitoring of flue gas stream. Redundancy of filters - can continue operations while damaged compartment is isolated and replaced.	
13a	**Flue Gas Residue Storage**	Storage of residue	Major mechanical damage to silo(s) due to impact	**13a - 1**	**1**	**2**	**3**	**3**	**6**	**Storage of residue**	**Major mechanical damage to silo(s) due to impact**	**13a - 1**	**3**	**6**	Impact protection on concrete feet Inside a building with restricted vehicle access Trained operators Process controls - temperature/weight detection	
13a	**Flue Gas Residue Storage**	Storage of residue	Catastrophic failure of silo	**13a - 1**	**1**	**2**	**2**	**2**	**4**	**Storage of residue**	**Catastrophic failure of silo**	**13a - 1**	**2**	**4**	Silos designed to recognised standard/specification (designed for external use, housed internally) Materials of construction. Visual inspection of silos (daily shift walks) Preventative maintenance program (SAP)	
44	**Water treatment plant - Chemical storage**	HCl storage	Corrosive/wear & tear causing leak	**44 - 1**	**2**	**2**	**2**	**4**	**4**	**HCl storage**	**Corrosive/wear & tear causing leak**	**44 - 1**	**4**	**4**	UN approved containers / packaging for materials. Bunded IBCs Regular site inspection (as above) Screening / assessing deliveries to site Investigations / follow up if supplier provides faulty IBC	
44	**Water treatment plant - Chemical storage**	HCl storage	Leak at outlet/tap	**44 - 1**	**2**	**2**	**3**	**6**	**6**	**HCl storage**	**Leak at outlet/tap**	**44 - 1**	**6**	**6**	as above Trained operators	
44	**Water treatment plant - Chemical storage**	HCl storage	Mechanical impact	**44 - 1**	**2**	**2**	**3**	**6**	**6**	**HCl storage**	**Mechanical impact**	**44 - 1**	**6**	**6**	Speed limit / traffic management controls on site. Trained operators Permit to work system Caged IBCs	
44	**Water treatment plant - Chemical storage**	HCl storage	Mechanical impact	**44 - 2**	**3**	**2**	**3**	**9**	**6**	**HCl storage**	**Mechanical impact**	**44 - 2**	**9**	**6**	Speed limit / traffic management controls on site. Trained operators Permit to work system Caged IBCs	

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44	**Water treatment plant - Chemical storage**	HCl storage	Catastrophic failure	**44 - 2**	**3**	**2**	**2**	**6**	**4**	**HCl storage**	**Catastrophic failure**	**44 - 2**	**6**	**4**	UN approved containers / packaging for materials. Bunded IBCs Regular site inspection (as above) Screening / assessing deliveries to site Investigations / follow up if supplier provides faulty IBC	
44	**Water treatment plant - Chemical storage**	Delivery of HCl IBC	Mechanical impact	**44 - 3**	**3**	**2**	**3**	**9**	**6**	**Delivery of HCl IBC**	**Mechanical impact**	**44 - 3**	**9**	**6**	Speed limit / traffic management controls on site. Trained operators Caged IBCs	Indaver operator to check for seal on the tap of the IBC prior to acceptance when arriving on site
44	**Water treatment plant - Chemical storage**	Delivery of HCl IBC	Operator drops IBC	**44 - 3**	**3**	**2**	**2**	**6**	**4**	**Delivery of HCl IBC**	**Operator drops IBC**	**44 - 3**	**6**	**4**	Speed limit / traffic management controls on site. Trained operators Caged IBCs	Indaver to conduct checks of HAZCHEM / ADR training of drivers supplying materials to the site
44	**Water treatment plant - Chemical storage**	NaOH storage	Corrosive/wear & tear causing leak	**44 - 4**	**1**	**1**	**2**	**2**	**2**	**NaOH storage**	**Corrosive/wear & tear causing leak**	**44 - 4**	**2**	**2**	UN approved containers / packaging for materials. Bunded IBCs Regular site inspection (as above) Screening / assessing deliveries to site Investigations / follow up if supplier provides faulty IBC	
44	**Water treatment plant - Chemical storage**	NaOH storage	Leak at outlet/tap	**44 - 4**	**1**	**1**	**3**	**3**	**3**	**NaOH storage**	**Leak at outlet/tap**	**44 - 4**	**3**	**3**	as above Trained operators	
44	**Water treatment plant - Chemical storage**	NaOH storage	Mechanical impact	**44 - 4**	**1**	**1**	**3**	**3**	**3**	**NaOH storage**	**Mechanical impact**	**44 - 4**	**3**	**3**	Speed limit / traffic management controls on site. Trained operators Permit to work system Caged IBCs	
44	**Water treatment plant - Chemical storage**	NaOH storage	Mechanical impact	**44 - 5**	**2**	**2**	**3**	**6**	**6**	**NaOH storage**	**Mechanical impact**	**44 - 5**	**6**	**6**	Speed limit / traffic management controls on site. Trained operators Permit to work system Caged IBCs	
44	**Water treatment plant - Chemical storage**	NaOH storage	Catastrophic failure	**44 - 5**	**2**	**2**	**2**	**4**	**4**	**NaOH storage**	**Catastrophic failure**	**44 - 5**	**4**	**4**	UN approved containers / packaging for materials. Bunded IBCs Regular site inspection (as above) Screening / assessing deliveries to site Investigations / follow up if supplier provides faulty IBC	
44	**Water treatment plant - Chemical storage**	Delivery of NaOH IBC	Mechanical impact	**44 - 6**	**2**	**2**	**3**	**6**	**6**	**Delivery of NaOH IBC**	**Mechanical impact**	**44 - 6**	**6**	**6**	Speed limit / traffic management controls on site. Trained operators Caged IBCs	Indaver operator to check for seal on the tap of the IBC prior to acceptance when arriving on site
44	**Water treatment plant - Chemical storage**	Delivery of NaOH IBC	Operator drops IBC	**44 - 6**	**2**	**2**	**2**	**4**	**4**	**Delivery of NaOH IBC**	**Operator drops IBC**	**44 - 6**	**4**	**4**	Speed limit / traffic management controls on site. Trained operators Caged IBCs	Indaver to conduct checks of HAZCHEM / ADR training of drivers supplying materials to the site

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102	**Piperacks**	Transfer of fuel oil by pipeline	Wear & tear / corrosion	**102 - 1**	**1**	**1**	**3**	**3**	**3**	**Transfer of fuel oil by pipeline**	**Wear & tear / corrosion**	**102 - 1**	**3**	**3**	Piping designed to recognised standard/specification (piperacks welded / flanged at end) Visual inspection of pipes (daily shift walks) Preventative maintenance program (SAP)	
102	**Piperacks**	Transfer of fuel oil by pipeline	Mechanical Impact	**102 - 1**	**1**	**1**	**3**	**3**	**3**	**Transfer of fuel oil by pipeline**	**Mechanical Impact**	**102 - 1**	**3**	**3**	Speed limit / traffic management controls on site. Trained operators Line from tank is taken directly to piperack Maximum height warning signs at piperack crossovers	
102	**Piperacks**	Transfer of fuel oil by pipeline	Overpressure due to blockage in line	**102 - 1**	**1**	**1**	**2**	**2**	**2**	**Transfer of fuel oil by pipeline**	**Overpressure due to blockage in line**	**102 - 1**	**2**	**2**	Pressure relief valve at pump Pipe lines pressure tested to 1.5 times operating pressure (standard for lines throughout the site)	
102	**Piperacks**	Transfer of fuel oil by pipeline	Maintenance error resulting in release at flanged connection	**102 - 1**	**1**	**1**	**3**	**3**	**3**	**Transfer of fuel oil by pipeline**	**Maintenance error resulting in release at flanged connection**	**102 - 1**	**3**	**3**	PM with lock out / tag out. Trained operators. Drainage system to collect spills	
102	**Piperacks**	Transfer of fuel oil by pipeline	Mechanical Impact	**102 - 2**	**1**	**2**	**3**	**3**	**6**	**Transfer of fuel oil by pipeline**	**Mechanical Impact**	**102 - 2**	**3**	**6**	Speed limit / traffic management controls on site. Trained operators Line from tank is taken directly to piperack Maximum height warning signs at piperack crossovers Oil spills from lines would be captured in the drainage system - to interceptor before surface water holding tank. TOC monitoring on inflow and outflow of the holding tank	
102	**Piperacks**	Transfer of fuel oil by pipeline	Catastrophic Failure	**102 - 2**	**1**	**2**	**3**	**3**	**6**	**Transfer of fuel oil by pipeline**	**Catastrophic Failure**	**102 - 2**	**3**	**6**	Piping designed to recognised standard/specification (pipes welded / flanged at end) Materials of construction. Visual inspection of pipes (daily shift walks) Preventative maintenance program (SAP)	
102	**Piperacks**	Transfer of fuel oil by pipeline	Maintenance error resulting in release at flanged connection	**102 - 2**	**1**	**2**	**3**	**3**	**6**	**Transfer of fuel oil by pipeline**	**Maintenance error resulting in release at flanged connection**	**102 - 2**	**3**	**6**	PM with lock out / tag out. Trained operators. Drainage system to collect spills	
102	**Piperacks**	Transfer of ammonia by pipeline	Wear & tear / corrosive	**102 - 3**	**2**	**2**	**3**	**6**	**6**	**Transfer of ammonia by pipeline**	**Wear & tear / corrosive**	**102 - 3**	**6**	**6**	Piping designed to recognised standard/specification (piperacks welded / flanged at end, stainless steel pipeline for ammonia) Visual inspection of pipes (daily shift walks) Preventative maintenance program (SAP) Automatic detection in the event of loss of ammonia flow to lances, with shutdown. Spill collection in drainage system and routed to holding tank. pH monitoring on inflow and outflow of holding tank	

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102	**Piperacks**	Transfer of ammonia by pipeline	Mechanical Impact	**102 - 3**	**2**	**2**	**3**	**6**	**6**	**Transfer of ammonia by pipeline**	**Mechanical Impact**	**102 - 3**	**6**	**6**	Speed limit / traffic management controls on site. Trained operators Protection barriers Maximum height warning signs at piperack crossovers	
102	**Piperacks**	Transfer of ammonia by pipeline	Overpressure due to blockage in line	**102 - 3**	**2**	**2**	**2**	**4**	**4**	**Transfer of ammonia by pipeline**	**Overpressure due to blockage in line**	**102 - 3**	**4**	**4**	Pressure relief valve at pump Pipe lines pressure tested to 1.5 times operating pressure	
102	**Piperacks**	Transfer of ammonia by pipeline	Maintenance error resulting in release at flanged connection	**102 - 3**	**2**	**2**	**3**	**6**	**6**	**Transfer of ammonia by pipeline**	**Maintenance error resulting in release at flanged connection**	**102 - 3**	**6**	**6**	PM with lock out / tag out. Trained operators. Drainage system to collect spills	
102	**Piperacks**	Transfer of ammonia by pipeline	Mechanical Impact	**102 - 4**	**3**	**2**	**3**	**9**	**6**	**Transfer of ammonia by pipeline**	**Mechanical Impact**	**102 - 4**	**9**	**6**	Speed limit / traffic management controls on site. Trained operators Protection barriers Maximum height warning signs at piperack crossovers	
102	**Piperacks**	Transfer of ammonia by pipeline	Catastrophic Failure	**102 - 4**	**3**	**2**	**3**	**9**	**6**	**Transfer of ammonia by pipeline**	**Catastrophic Failure**	**102 - 4**	**9**	**6**	Piping designed to recognised standard/specification (piperacks welded / flanged at end) Visual inspection of pipes (daily shift walks) Preventative maintenance program (SAP)	
102	**Piperacks**	Transfer of ammonia by pipeline	Maintenance error resulting in release at flanged connection	**102 - 4**	**3**	**2**	**3**	**9**	**6**	**Transfer of ammonia by pipeline**	**Maintenance error resulting in release at flanged connection**	**102 - 4**	**9**	**6**	PM with lock out / tag out. Trained operators. Drainage system to collect spills	

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102	**Piperacks**	Transfer of aqueous waste by pipeline	Wear & tear / corrosive	**102 - 5**	**1**	**1**	**2**	**2**	**2**	**Transfer of aqueous waste by pipeline**	**Wear & tear / corrosive**	**102 - 5**	**2**	**2**	Controls to prevent loss of containment as per 102-3 Control on ignition sources (Permit to Work) Fire fighting systems / water main Spill kits ERT team	
102	**Piperacks**	Transfer of aqueous waste by pipeline	Mechanical Impact	**102 - 5**	**1**	**1**	**2**	**2**	**2**	**Transfer of aqueous waste by pipeline**	**Mechanical Impact**	**102 - 5**	**2**	**2**	Controls to prevent loss of containment as per 102-3 Control on ignition sources (Permit to Work) Fire fighting systems / water main Spill kits ERT team	
102	**Piperacks**	Transfer of aqueous waste by pipeline	Overpressure due to blockage in line	**102 - 5**	**1**	**1**	**2**	**2**	**2**	**Transfer of aqueous waste by pipeline**	**Overpressure due to blockage in line**	**102 - 5**	**2**	**2**	Controls to prevent loss of containment as per 102-3 Control on ignition sources (Permit to Work) Fire fighting systems / water main Spill kits ERT team	
102	**Piperacks**	Transfer of aqueous waste by pipeline	Maintenance error resulting in release at flanged connection	**102 - 5**	**1**	**1**	**3**	**3**	**3**	**Transfer of aqueous waste by pipeline**	**Maintenance error resulting in release at flanged connection**	**102 - 5**	**3**	**3**	PM with lock out / tag out. Trained operators. Drainage system to collect spills	
102	**Piperacks**	Transfer of aqueous waste by pipeline	Mechanical Impact	**102 - 6**	**2**	**2**	**2**	**4**	**4**	**Transfer of aqueous waste by pipeline**	**Mechanical Impact**	**102 - 6**	**4**	**4**	Controls to prevent loss of containment as per 102-4 Control on ignition sources (Permit to Work) Fire fighting systems / water main Spill kits ERT team	
102	**Piperacks**	Transfer of aqueous waste by pipeline	Catastrophic Failure	**102 - 6**	**2**	**2**	**2**	**4**	**4**	**Transfer of aqueous waste by pipeline**	**Catastrophic Failure**	**102 - 6**	**4**	**4**	as above	
102	**Piperacks**	Transfer of aqueous waste by pipeline	Maintenance error resulting in release at flanged connection	**102 - 6**	**2**	**2**	**3**	**6**	**6**	**Transfer of aqueous waste by pipeline**	**Maintenance error resulting in release at flanged connection**	**102 - 6**	**6**	**6**	PM with lock out / tag out. Trained operators. Drainage system to collect spills	
104	**General Storage Area**	Fuel oil supply to Furnace	Impact to line	**104 - 1**	**1**	**2**	**4**	**4**	**8**	**Fuel oil supply to Furnace**	**Impact to line**	**104 - 1**	**4**	**8**	CE certified equipment.	Design to incorporate measure to protect against siphoning of the tank contents (e.g. a hole in pipeline at top point on tank outlet or a check valve) in the event of line failure.
104	**General Storage Area**	Fuel oil supply to Furnace	Corrosion /erosion of line	**104 - 1**	**1**	**2**	**3**	**3**	**6**	**Fuel oil supply to Furnace**	**Corrosion /erosion of line**	**104 - 1**	**3**	**6**	No flange connections on pipeline. Carbon steel line and tank. PM regime on site.	
104	**General Storage Area**	Fuel oil supply to Furnace	Maintenance error, line breaking	**104 - 1**	**1**	**2**	**3**	**3**	**6**	**Fuel oil supply to Furnace**	**Maintenance error, line breaking**	**104 - 1**	**3**	**6**	Permit to work system for maintenance. Trained operators	
104	**General Storage Area**	Fuel Oil storage	Mechanical impact to tank	**104 - 2**	**1**	**2**	**2**	**2**	**4**	**Fuel Oil storage**	**Mechanical impact to tank**	**104 - 2**	**2**	**4**	Impact protection on tank. Speed limit on site. Trained operators. Tanker deliveries are controlled and supervised under PTW Spill collected in drainage system - routed to interceptor and holding tank	
104	**General Storage Area**	Fuel Oil storage	Mechanical failure	**104 - 2**	**1**	**2**	**3**	**3**	**6**	**Fuel Oil storage**	**Mechanical failure**	**104 - 2**	**3**	**6**	PM regime. Double skinned tank with leak detection.	
104	**General Storage Area**	Fuel Oil delivery	Failure of transfer hose	**104 - 3**	**1**	**2**	**3**	**3**	**6**	**Fuel Oil delivery**	**Failure of transfer hose**	**104 - 3**	**3**	**6**	Trained operators. Supervised (PTW) activity. Hose inspection prior to use	

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104	**General Storage Area**	Fuel Oil delivery	Road tanker in poor condition - corrosion	**104 - 3**	**1**	**2**	**2**	**2**	**4**	**Fuel Oil delivery**	**Road tanker in poor condition - corrosion**	**104 - 3**	**2**	**4**	Approved contractors. Visual inspection of tankers prior to acceptance on site	
104	**General Storage Area**	Fuel Oil delivery	Overfilling of tank	**104 - 3**	**1**	**2**	**3**	**3**	**6**	**Fuel Oil delivery**	**Overfilling of tank**	**104 - 3**	**3**	**6**	Overfill protection systems in place (gauging, level switches etc.) Hi and hihi alarm	Level reading to be provided locally and at control system.
104	**General Storage Area**	Ammonia to SNCR for scrubbing	Impact to line	**104 - 4**	**2**	**2**	**4**	**8**	**8**	**Ammonia to SNCR for scrubbing**	**Impact to line**	**104 - 4**	**8**	**8**	Speed limit / traffic management controls on site. Trained operators Protection barriers Maximum height warning signs at piperack crossovers	Design to incorporate measure to protect against siphoning of the tank contents (e.g. a hole in pipeline at top point on tank outlet or a check valve) in the event of line failure.
104	**General Storage Area**	Ammonia to SNCR for scrubbing	Corrosion /erosion of line	**104 - 4**	**2**	**2**	**3**	**6**	**6**	**Ammonia to SNCR for scrubbing**	**Corrosion /erosion of line**	**104 - 4**	**6**	**6**	No flange connections on line. Stainless steel line. PM regime on site.	
104	**General Storage Area**	Ammonia to SNCR for scrubbing	Maintenance error, line breaking	**104 - 4**	**2**	**2**	**3**	**6**	**6**	**Ammonia to SNCR for scrubbing**	**Maintenance error, line breaking**	**104 - 4**	**6**	**6**	Permit to work system for maintenance. Trained operators	
104	**General Storage Area**	Ammonia storage	Mechanical impact to tank	**104 - 5**	**5**	**3**	**2**	**10**	**6**	**Ammonia storage**	**Mechanical impact to tank**	**104 - 5**	**10**	**6**	Impact protection. Speed limit on site. Trained operators.	
104	**General Storage Area**	Ammonia storage	Catastrophic failure of tank	**104 - 5**	**5**	**3**	**2**	**10**	**6**	**Ammonia storage**	**Catastrophic failure of tank**	**104 - 5**	**10**	**6**	PM regime Double skinned Leak detection between skins on all double skinned tanks	
104	**General Storage Area**	Ammonia delivery	Failure of transfer hose	**104 - 6**	**3**	**2**	**3**	**9**	**6**	**Ammonia delivery**	**Failure of transfer hose**	**104 - 6**	**9**	**6**	Trained operators. Manned activity. Hose inspection prior to use	PPE for delivery drivers
104	**General Storage Area**	Ammonia delivery	Road tanker in poor condition - corrosion	**104 - 6**	**3**	**2**	**2**	**6**	**4**	**Ammonia delivery**	**Road tanker in poor condition - corrosion**	**104 - 6**	**6**	**4**	Visual inspection of tankers prior to acceptance on site Approved contractor	
104	**General Storage Area**	Ammonia delivery	Overfilling of tank	**104 - 6**	**3**	**2**	**3**	**9**	**6**	**Ammonia delivery**	**Overfilling of tank**	**104 - 6**	**9**	**6**	Overfill protection systems (gauging, level switches etc)	
104	**General Storage Area**	Operation of aqueous waste tank	Impact to line	**104 - 7**	**1**	**2**	**4**	**4**	**8**	**Operation of aqueous waste tank**	**Impact to line**	**104 - 7**	**4**	**8**	Speed limit / traffic management controls on site. Trained operators Protection barriers Maximum height warning signs at piperack crossovers	Design to incorporate measure to protect against siphoning of the tank contents (e.g. a hole in pipeline at top point on tank outlet or a check valve) in the event of line failure.
104	**General Storage Area**	Operation of aqueous waste tank	Corrosion /erosion of line	**104 - 7**	**1**	**2**	**3**	**3**	**6**	**Operation of aqueous waste tank**	**Corrosion /erosion of line**	**104 - 7**	**3**	**6**	No flange connections, all welded. Stainless steel line. PM regime on site.	
104	**General Storage Area**	Operation of aqueous waste tank	Maintenance error, line breaking	**104 - 7**	**1**	**2**	**3**	**3**	**6**	**Operation of aqueous waste tank**	**Maintenance error, line breaking**	**104 - 7**	**3**	**6**	Permit to work system for maintenance. Trained operators	
104	**General Storage Area**	Operation of aqueous waste tank	Impact to line	**104 - 8**	**2**	**2**	**3**	**6**	**6**	**Operation of aqueous waste tank**	**Impact to line**	**104 - 8**	**6**	**6**	Controls to protect against loss of containment, as described in 104-7. Dilute waste stream (>70% water), which reduces fire hazard. Fire fighting / fire protection systems on site.	
104	**General Storage Area**	Operation of aqueous waste tank	Corrosion /erosion of line	**104 - 8**	**2**	**2**	**2**	**4**	**4**	**Operation of aqueous waste tank**	**Corrosion /erosion of line**	**104 - 8**	**4**	**4**	No flange connections, all welded. Stainless steel line. PM regime on site.	
104	**General Storage Area**	Operation of aqueous waste tank	Maintenance error, line breaking	**104 - 8**	**2**	**2**	**2**	**4**	**4**	**Operation of aqueous waste tank**	**Maintenance error, line breaking**	**104 - 8**	**4**	**4**	Permit to work system for maintenance. Trained operators	
104	**General Storage Area**	Operation of aqueous waste tank	Mechanical impact to tank	**104 - 9**	**1**	**2**	**2**	**2**	**4**	**Operation of aqueous waste tank**	**Mechanical impact to tank**	**104 - 9**	**2**	**4**	Impact protection. Speed limit on site. Trained operators.	

Area ID	Name	Description of Activity	Description of Initiating Event	End Event Ref No.	Severity (Health & Safety) S	Severity (Environ-mental) SE	Frequency F	Risk Rating (Health & Safety)	Risk Rating (Environ-mental)	Description of Activity	Description of Initiating Event	End Event Ref No.	Risk Rating (Health & Safety)	Risk Rating (Environ-mental)	Measures in Place	Additional Measures
104	General Storage Area	Operation of aqueous waste tank	Catastrophic failure of tank - not credible as double skinned	104 - 9	1	2	0	0	0	Operation of aqueous waste tank	Catastrophic failure of tank - not credible as double skinned	104 - 9	0	0	PM regime Double skinned Leak detection between skins on all double skinned tanks	
104	General Storage Area	Operation of aqueous waste tank	Mechanical impact to tank	104 - 10	3	2	2	6	4	Operation of aqueous waste tank	Mechanical impact to tank	104 - 10	6	4	Controls to protect against loss of containment, as described in 104-9. Dilute waste stream (>70% water), which reduces fire hazard. Fire fighting / fire protection systems on site.	
104	General Storage Area	Operation of aqueous waste tank	Catastrophic failure of tank - not credible as double skinned	104 - 10	3	2	0	0	0	Operation of aqueous waste tank	Catastrophic failure of tank - not credible as double skinned	104 - 10	0	0	-	
104	General Storage Area	Operation of aqueous waste tank	Wear & tear / corrosive	104 - 11	1	2	3	3	6	Operation of aqueous waste tank	Wear & tear / corrosive	104 - 11	3	6	Trained operators. Manned activity. Hose inspection prior to use	
104	General Storage Area	Operation of aqueous waste tank	Mechanical Impact	104 - 11	1	2	3	3	6	Operation of aqueous waste tank	Mechanical Impact	104 - 11	3	6	Visual inspection of tankers prior to acceptance on site	
104	General Storage Area	Operation of aqueous waste tank	Overpressure due to blockage in line	104 - 11	1	2	2	2	4	Operation of aqueous waste tank	Overpressure due to blockage in line	104 - 11	2	4	Overfill protection systems (gauging, level switches etc)	
104	General Storage Area	Operation of aqueous waste tank	Wear & tear / corrosive	104 - 12	2	2	2	4	4	Operation of aqueous waste tank	Wear & tear / corrosive	104 - 12	4	4	Controls to protect against loss of containment, as described in 104-11. Dilute waste stream (>70% water), which reduces fire hazard. Fire fighting / fire protection systems on site.	
104	General Storage Area	Operation of aqueous waste tank	Mechanical Impact	104 - 12	2	2	2	4	4	Operation of aqueous waste tank	Mechanical Impact	104 - 12	4	4	Visual inspection of tankers prior to acceptance on site	
104	General Storage Area	Operation of aqueous waste tank	Overpressure due to blockage in line	104 - 12	2	2	2	4	4	Operation of aqueous waste tank	Overpressure due to blockage in line	104 - 12	4	4	Overfill protection systems (gauging, level switches etc)	

Appendix 4: Recommendations Arising from HAZID&RA Exercise

The HAZID Team made the following recommendations for the Indaver facility at Ringaskiddy:

1. Indaver are conducting an investigation of the atmospheric conditions in the bunker in Meath to determine the extent of any gas formation in the waste and to determine what gases are being formed, if any, in particular when process is stopped and ventilation is switched off. The findings of this assessment should also be reviewed in the context of the Ringaksiddy site to see if there is a potential hazard here also.

2. Conduct a fire water retention study for the site. This will be conducted in accordance with the EPA guidelines for fire water retention studies in order to protect against the risk of contaminated run-off water being released to the environment in the event of a major fire at the site. This review will also determine the required flow rates and foam stocks required to adequately deal with the fire scenario in the course of the emergency response, which will allow Indaver to determine the adequacy of the fire protection systems for the site.

3. Review the customer approval procedure for screening of incoming waste streams to ensure that there are appropriate checks for unsuitable waste being fed to the hopper (for example, an LPG cylinder in the waste stream).

4. Indaver operator to check for seal on the tap of IBCs prior to acceptance when arriving on site.

5. Indaver to conduct checks of HAZCHEM / ADR training of drivers supplying materials to the site.

6. Design to incorporate measure to protect against siphoning of tank contents (e.g. a hole in pipeline at top point on tank outlet or a check valve) in the event of line failure.

7. Level reading on fuel tank to be provided locally and on the control system.

8. Indaver to review the arrangements for the provision of personal protective equipment (PPE) for drivers / operators engaged in the delivery of aqueous Ammonia to site. Suitable respiratory protection should be provided (by reference to the Safety Data Sheet) to ensure that the personnel are protected from inhalation of toxic gas in the event of a major release.

9. Indaver to review procedures for emergency response. This will be done to confirm whether there is a documented procedure to instruct operators on how to assess the risks associated with smouldering material present in the bunker. This should provide instructions to the operator on determining when it would be appropriate to use the crane to load this material into the hopper and when this could not be done and the fire fighting systems should be deployed.

A full list of the measures that will be put in place at the Indaver facility (aside from these specific measures identified in the course of the HAZID&RA meeting) is contained within the HAZID&RA Worksheets in Appendix 3.

Appendix 5: Assessment of Flue Gas Residue and Boiler Ash

1 Introduction

This note sets out the findings of an assessment conducted by Byrne Ó Cléirigh (BÓC) of the boiler ash and flue gas residue at Indaver's site to determine the hazardous properties of these streams and to determine if there could be any potential implications for the site to qualify under the COMAH Regulations (SI 290 of 2015).

Hazardous ash residue contains heavy metals which, if present in sufficiently high concentrations, would result in the material becoming classed as Hazardous to the Aquatic Environment and thereby qualifying under Schedule 1 of the COMAH Regulations.

2 Background

As the Ringaskiddy facility is not yet built, there are no samples of ash available to assess. We have therefore referred to data from Indaver's Carranstown site, which treats a similar waste stream and using a similar technology to the one planned at Ringaskiddy.

There are two distinct ash residue streams under consideration – flue gas residue and boiler ash. We have analysed the data for both streams to determine the metals content in each. This data is summarised in Table 1.

The data collected by Indaver represents approximately 100 samples, collected over a period of over 10 years. It was noted for this calculation that these ash / residue streams are not homogenous and do not have consistent characteristics that would apply throughout the c.150 tonnes of boiler ash that may be present on site at any one time. The calculations are therefore based on average values from the data.

Table 1: Metals content in waste streams

Metal	Boiler Ash	Flue Gas
Aluminium	5.424%	0.804%
Arsenic	0.005%	0.004%
Barium	0.036%	0.022%
Bromine	0.035%	0.167%
Calcium	21.452%	34.722%
Cadmium	0.005%	0.011%
Cobalt	0.006%	0.001%
Copper	0.049%	0.034%
Chromium	0.015%	0.004%
Iron	2.127%	0.460%
Potassium	2.648%	2.763%
Manganese	0.120%	0.026%
Molybdenum	0.003%	0.001%
Nickel	0.018%	0.003%
Lead	0.104%	0.108%
Antimony	0.059%	0.038%
Selenium	0.000%	0.000%
Tin	0.030%	0.027%
Thallium	0.001%	0.000%
Vanadium	0.030%	0.005%
Zinc	0.611%	0.605%
Mercury	0.000%	0.001%

3 Classification of Residue

To determine the appropriate hazard classification of these streams, we have referred to the Classification Labelling and Packaging (CLP) Regulation[1], which is the basis for determining whether a material qualifies under COMAH. It also describes the approach to determine the hazard classification for a mixture or preparation containing multiple hazardous constituents.

[1] Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification labelling and packaging of substances and mixtures

Referring to the CLP Regulation, many of the heavy metals identified in flue gas and boiler ash residues are capable of forming compounds that are classed as environmentally hazardous. From the point of view of the COMAH Regulations, the following hazard statements are of interest.

Table 2: Environmental Hazard Statements with corresponding entries in Schedule 1 of COMAH

Hazard Statement	Schedule 1 under COMAH
H400: very toxic to aquatic life	Acute Category 1
H410: very toxic to aquatic life with long lasting effects	Chronic Category 1
H411: toxic to aquatic life with long lasting effects	Chronic Category 2

The rules for determining the appropriate classification for a mixture containing constituents that present these hazards are set out in Table 4.1.1 and Table 4.1.2 of the CLP Regulation, which we reproduce here as Table 3 and Table 4.

Table 3: Classification of a mixture for acute hazards, based on summation of classified components (Table 4.1.1 of CLP)

Sum of Components Classified as	Mixture is Classified as
Acute Category 1 × M* ≥ 25%	Acute Category 1

* The M-factor is a multiplying factor which may be applied where there are mixtures containing highly toxic components. This is discussed in more detail below

Table 4: Classification of a mixture for chronic (long term) hazards, based on a summation of classified components (Table 4.1.2 of CLP)

Sum of Components Classified as	Mixture is Classified as
Chronic Category 1 × M* ≥ 25%	Chronic Category 1
(M × 10 × Chronic Category 1) + Chronic Category 2 ≥ 25%	Chronic Category 2
(M × 100 × Chronic Category 1) + (10 × Chronic Category 2) + Chronic Category 3 ≥ 25%	Chronic Category 3
Chronic Category 1 + Chronic Category 2 + Chronic Category 3 + Chronic Category 4 ≥ 25%	Chronic Category 4

If the entire mixture is classed as Acute Category 1, or as Chronic Category 1 or 2, then it qualifies under Schedule 1 of the COMAH Regulations. Referring to these tables, it is clear that the determination of the status of the residues will depend on the quantities and on the relative toxicities of the various components present.

The data on the residues shows the heavy metal contents of the various streams. In reality, these metals are present as metallic compounds, primarily as metal oxides. We have conducted an assessment of the hazardous properties of the compounds formed by these metals, to determine the appropriate hazard classifications in each case.

Table 5: Overview of Classifications of Compounds containing Heavy Metals (CLP Regulation)

Compound	Hazard Statements	Environmentally Hazardous	M-Factors
Aluminium Oxide	-		
Arsenic Oxide	H350, H300, H314, H400, H410	Cat1	
Barium Oxide	H271, H301, H314, H318		
Bromine Note1	H400	Cat1	
Calcium Oxide	H335, H315, H318		
Cadmium Oxide	H350, H341, H361fd, H330, H372, H400, H410	Cat1	
Cobalt Oxide	H302, H317, H400, H410	Cat1	M=10
Copper Oxide	H302, H410 H400, H410	Cat1	Acute M=100 Chronic M=10
Chromium Oxide	H250 H350, H340, H330, H312, H301, H335, H372, H314, H334, H317, H410	Cat1	
Iron Oxide	-		
Potassium Oxide	H314, H318		
Manganese Dioxide	H332, H302		
Molybdenum Oxide	H351, H319, H335		
Nickel Oxide	H350i, H372, H317, H413	Cat4	
Lead Oxide	H360, H332, H302, H373, H410	Cat1	
Antimony Oxide	H332, H302, H411	Cat2	
Selenium Oxide	H330, H301, H373, H314, H318, H400, H410	Cat1	
Tin Oxide	-		
Thallium Oxide	H300, H330, H373, H411	Cat2	
Vanadium Oxide	H350, H341, H361fd, H362, H330, H301, H335, H372, H411	Cat2	
Zinc Oxide	H400, H410	Cat1	
Mercury Oxide (HgO)	H300, H310, H330, H373, H400, H410	Cat1	

Note: Although bromine can form an oxide, this material is not stable. It is assumed that any bromine-containing compounds present similar environmental hazards as bromine (H400). We have scaled up the bromine content by a factor of 2 when calculating the quantity of such hazardous bromine compounds in the mix.

4 Assessment of Flue Gas Residue / Boiler Ash Samples

Using the approach described under the CLP Regulation, we have examined the results for each sample collected from the flue gas residue in turn to determine if any of the following hazard classifications would apply to the waste as a whole:

- Acute Category 1 to aquatic environment
- Chronic Category 1 to aquatic environment
- Chronic Category 2 to aquatic environment

Table 6: Assessment of Boiler Ash Samples

Compound	Content	Acute 1	Chronic1	Chronic2
Aluminium oxide	10.248%	0.000%	0.000%	0.000%
Diarsenic trioxide	0.006%	0.006%	0.006%	0.063%
Barium oxide	0.040%	0.000%	0.000%	0.000%
Bromine	0.069%	0.069%	0.000%	0.000%
Calcium oxide	30.015%	0.000%	0.000%	0.000%
Cadmium oxide	0.006%	0.006%	0.006%	0.056%
Cobalt oxide	0.008%	0.077%	0.077%	0.765%
Copper oxide	0.061%	6.110%	0.611%	6.110%
Chromium oxide	0.022%	0.000%	0.022%	0.217%
Iron Oxide	2.736%	0.000%	0.000%	0.000%
Dipotassium oxide	0.000%	0.000%	0.000%	0.000%
Manganese oxide	0.190%	0.000%	0.000%	0.000%
Molybdenum trioxide	0.005%	0.000%	0.000%	0.000%
Nickel oxide	0.023%	0.000%	0.000%	0.000%
Lead oxide	0.112%	0.000%	0.112%	1.123%
Antimony oxide	0.071%	0.000%	0.000%	0.071%
Selenium dioxide	0.001%	0.001%	0.001%	0.005%
Tin oxide	0.038%	0.000%	0.000%	0.000%
Dithallium trioxide	0.001%	0.000%	0.000%	0.001%
Vanadium oxide	0.053%	0.000%	0.000%	0.053%
Zinc oxide	0.761%	0.761%	0.761%	7.610%
Mercury monoxide	0.000%	0.000%	0.000%	0.000%
Total		**7.0%**	**1.6%**	**16.1%**

The quantity of the metal oxides in each case is calculated based on the monitoring data for pure metals and scaling the value up to reflect the ratio of the molecular weight of each compound with the metal content. In each case, the combined sum of the components is less than 25%. This means that the concentrations of these components are below the threshold for one of these classifications to apply to the boiler ash waste stream. This stream therefore does not qualify under Schedule 1 of the COMAH Regulations.

We conducted a similar assessment on the flue gas residue stream. The results are shown in Table 7

Table 7: Assessment of flue gas residue samples

Compound	Content	Acute 1	Chronic1	Chronic2
Aluminium oxide	1.519%	0.000%	0.000%	0.000%
Diarsenic trioxide	0.005%	0.005%	0.005%	0.047%
Barium oxide	0.024%	0.000%	0.000%	0.000%
Bromine	0.333%	0.333%	0.000%	0.000%
Calcium oxide	48.584%	0.000%	0.000%	0.000%
Cadmium oxide	0.012%	0.012%	0.012%	0.124%
Cobalt oxide	0.002%	0.016%	0.016%	0.156%
Copper oxide	0.043%	4.310%	0.431%	4.310%
Chromium oxide	0.005%	0.000%	0.005%	0.054%
Iron Oxide	0.592%	0.000%	0.000%	0.000%
Dipotassium oxide	0.000%	0.000%	0.000%	0.000%
Manganese oxide	0.042%	0.000%	0.000%	0.000%
Molybdenum trioxide	0.001%	0.000%	0.000%	0.000%
Nickel oxide	0.004%	0.000%	0.000%	0.000%
Lead oxide	0.117%	0.000%	0.117%	1.166%
Antimony oxide	0.045%	0.000%	0.000%	0.045%
Selenium dioxide	0.001%	0.001%	0.001%	0.007%
Tin oxide	0.034%	0.000%	0.000%	0.000%
Dithallium trioxide	0.000%	0.000%	0.000%	0.000%
Vanadium oxide	0.009%	0.000%	0.000%	0.009%
Zinc oxide	0.753%	0.753%	0.753%	7.532%
Mercury monoxide	0.001%	0.001%	0.001%	0.006%
Total		**5.4%**	**1.3%**	**13.5%**

5 Conclusions

Based on these results, the heavy metal content in the flue gas residue and in the boiler ash samples collected by Indaver are below the thresholds to qualify these waste streams under the COMAH Regulations. We have applied the criteria from the CLP Regulation (see Table 3 and Table 4) to determine the aggregate values for acute category 1 and for chronic category 1 or 2 hazards. In each case the aggregate value is less than 25%, indicating that these classifications do not apply to the waste mixtures. This in turn indicates that the mixtures do not qualify under Schedule 1 of the COMAH Regulations and so do not qualify as COMAH substances.

Based on the above data, neither the flue gas residue nor the boiler ash qualifies under the COMAH Regulations. It should be borne in mind that these findings are based on an analysis of analogous waste collected from another Indaver site. Indaver will conduct a similar programme of monitoring of the waste streams at Ringaskiddy to ensure that these findings remain valid for the site once it is in operation.

Appendix 6: Consequence Modelling for Fires in Bunker Area

1 Introduction

The purpose of this Appendix is to determine the impacts associated with an accidental fire in the solid waste bunker area of the Indaver facility at Ringaskiddy and examine the potential impacts to the surrounding area.

The Hazard Identification and Risk Assessment (HAZID&RA) Team identified a fire in this location as a credible accident scenario. The primary hazards for a fire in this location are the potential impacts associated with products of combustion.

The waste bunker has dimensions of 18.2 m × 40.5 m and will typically store c.4,000 tonnes of waste, with a capacity to store up to 6,000 tonnes.

2 Overview of Fire Scenarios

Indaver's operational experience is that smouldering of the incoming wastes can occasionally occur e.g. by hot ashes in dustbins. The normal response in such cases is that the crane operator would remove any smouldering material using the grab crane and load it into the hopper feeding the furnace, where it would be burned under controlled conditions. The grab crane has the capacity to lift approximately 3 cubic metres of waste, equivalent to 1.2 tonnes, at one time. This response would help to protect against escalation of the fire event. Nonetheless, the HAZID&RA team considered the possibility that a fire could escalate to larger sizes. The fire scenarios that have been examined for the bunker area are as follows:

- Fire of 1 tonne of waste. This involves smouldering of the waste rather than a major fire event and it is conservatively assumed that up to 1 tonnes could be consumed in this scenario.
- Fire in bunker, extinguished by the fixed fire protection systems. This is a more remote event, which would involve failure of the initial response using the grab crane but the fire is extinguished by the fire protection systems at the bunker area. Based on the properties of the waste and the anticipated spread of fire in this instance, it is estimated that the fire could continue for a maximum of 2 hours, with up to 26.7 tonnes of waste being burned in this scenario.
- Full bunker fire. This is the most unlikely fire scenario at the bunker, requiring failure of both the initial response and of the fire protection systems. It is assumed for the purposes of this assessment that if the fire escalates to this extent that it would no longer be practicable to extinguish it and instead the response would be to allow it to burn down while focus of the fire-fighting efforts would be to protect nearby plant and equipment.

3 Emissions from a Bunker Fire

In mass emission terms, the primary emissions in the smoke plume in the event of a fire in the bunker would be by-products of combustion as a result of the Carbon, Chlorine and Sulphur content of the waste. The waste in the bunker will comprise 30-35% water and 65-70% solids. Of this solids content, it will comprise c.80% Carbon, 0.4% Chlorine and 0.1% Sulphur.

3.1 Rate of Burning

Based on Indaver's operational experience at other facilities involved in the storage and handling of similar waste streams, the average calorific value of this waste is expected to be 9.6 MJ/kg.

In the initial stages of a fire in the bunker, this would involve a slow smouldering burn within the waste stream. Based on previous assessments, a representative burning rate of 1 tonne of waste being consumed within 30 minutes was used for this scenario. This slow burn would result in a correspondingly low emission rate to atmosphere. However, it is also expected that the resulting smoke plume would have lower buoyancy and there would be less plume rise than for a fully developed fire.

In the event that the scenario escalates into a fully developed fire, the rate of burning will be determined by the properties of the waste and (in the worst case scenario) by the dimensions of the bunker.

The Yellow Book[1] provides data on typical burning rates for a variety of materials. We have extracted the data for a selection of these materials in Table 1. We have also included details of the energy content of these materials, for reference.

Table 1: Data on Burning Rates and Energy Content of Fuels

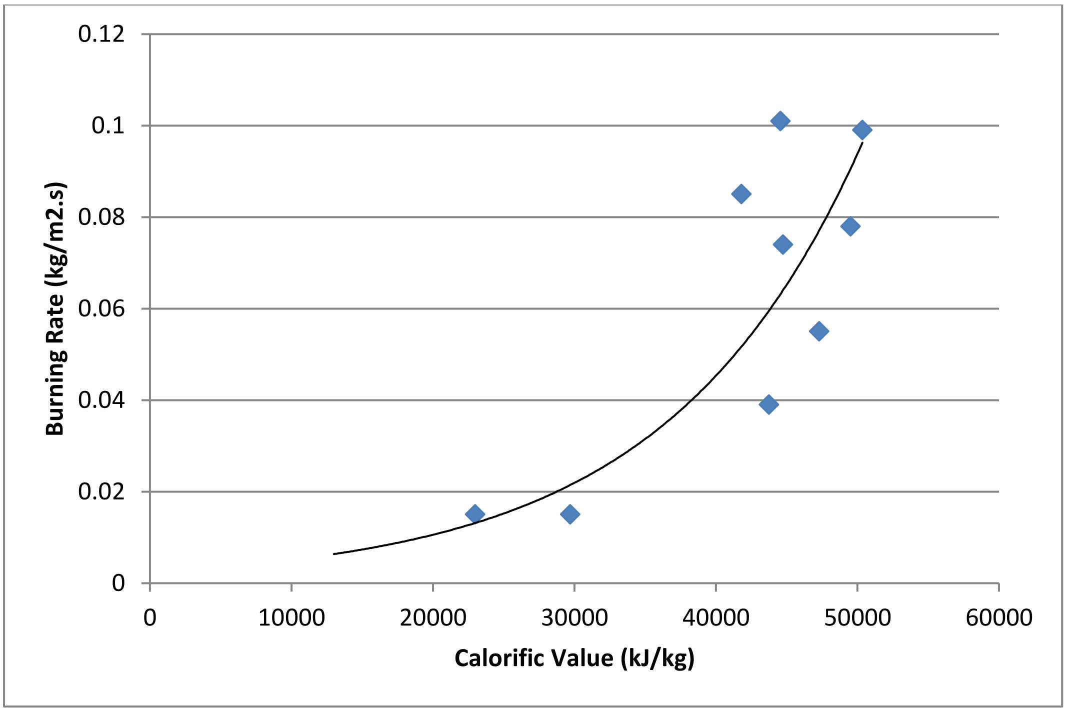
Fuel	Calorific Value (kJ/kg)	Rate of Burning (kg/m^2.s))
Propane	50,350	0.099
Butane	49,510	0.078
Hexane	44,752	0.074
Heptane	44,566	0.101
Benzene	41,800	0.085
Gasoline	47,300	0.055
Kerosene	43,750	0.039
Methanol	23,000	0.015
Ethanol	29,700	0.015

Figure 1 shows a plot of Burning Rate vs. Calorific values for these materials. This indicates that there is a relationship between the two parameters and we have added a best-fit line to this data.

Applying this assessment to the bunker waste, which has a calorific value of 9,600 kJ/kg, this would give a rate of burning of 0.005 kg/m^2.s. However we are conscious that this assessment involves extrapolation outside of the data range and so in order to ensure a conservative approach, we have doubled this figure to determine a maximum burning rate of 0.01 kg/m^2.s. This works out as a slightly lower burning rate for an equivalently sized pool of methanol or ethanol.

[1] "Methods for the calculation of physical effects due to releases of hazardous materials (liquids and gases)"

Figure 1: Plot of Burning Rate vs. Energy Content



The surface area of the bunker is 18.2 m × 40.5 m = 737 m^2. Based on the calculations shown above, this means that the maximum burning rate in the bunker would be of the order of 0.45 tonnes per minute, or 26.7 tonnes per hour. This rate of burning would only arise where the fire is fully developed and covers the full areas of the bunker. For a typical inventory of 4,000 tonnes these results indicate that a fully developed bunker fire could continue for c.6 days and in the event that the bunker was filled to capacity at 6,000 tonnes, it could continue for over a week.

For the intermediate fire scenario, i.e. where the fire escalates beyond the initial smouldering phase but has not spread to the full extent of the bunker area, we have applied a burning rate of 50% of the calculated maximum value.

The details of the three fire scenarios are summarised in Table 2.

Table 2: Burning Rates for different Fire Scenarios at the Bunker

Parameter	Minor Fire, Smouldering Waste in Bunker	Intermediate Fire, extinguished by Emergency Response	Fully Developed Bunker Fire
Total quantity of waste burned (tonnes)	1	26.7	4,000
Rate of burning (t/hr)	2	13.4	26.7

For the purposes of this assessment we have also made the following assumptions about the smoke plume. For a scenario involving a smouldering 1 tonne fire, the resulting smoke plume would exhibit low thermal buoyancy as the fire would be in the early stages of development. A temperature of 50°C was used for modelling the impacts of this scenario.

For the more developed bunker fire scenarios, the temperature of the gases would be much higher. A figure of 300°C has been used for the smoke plume from the intermediate fire and 500°C for the fully developed fire.

3.2 By Products of Combustion of Carbon, Chlorine and Sulphur

The bunker waste will comprise up to 65% solid matter. This solid fraction will typically comprise c.80% Carbon, 0.4% Chlorine and 0.1% Sulphur, by weight. In other words, for every tonne of waste burned, there would be 0.52 tonne Carbon, 0.0026 tonne Chlorine and 0.0007 tonne Sulphur consumed.

Referring to the HSA's guidance document for Land Use Planning (LUP) provides conversion factors for the purposes of calculating combustion products from a fire. The relevant details are summarised below:

- Carbon Monoxide (CO): 9.7% C to CO[2]
- Hydrogen Chloride (HCl): 100% Cl to HCl
- Sulphur Dioxide (SO_2): 100% S to SO_2

This approach is based on the HSA's 2010 LUP guidance. The more recently issued LUP guidance in 2023 discounts the contribution that carbon products make to the smoke plume. However, we have included them in this analysis to ensure that a conservative approach is adopted to the analysis.

There would also be Carbon Dioxide formed in the fire, but the toxic impacts of this component of the smoke plume would be negligible when compared with the Carbon Monoxide emission.

On this basis, we have calculated the emission rates to atmosphere for these products of combustion for the three fire scenarios identified for the bunker. These are set out in Table 3.

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[2] The vast majority of the carbon consumed in the fire would form CO_2. However, it is conservatively assumed that a relatively high fraction of the carbon could experience incomplete combustion and give rise to CO formation.

Table 3: Emission Rates of Products of Combustion for Bunker Fire Scenarios

Parameter	Minor Fire, Smouldering Waste in Bunker	Intermediate Fire, extinguished by Emergency Response	Fully Developed Bunker Fire
Rate of burning (t/hr)	2	13.4	26.7
Emission rates			
Carbon Monoxide	0.065 kg/s	0.438 kg/s	0.873 kg/s
Hydrogen Chloride	0.0015 kg/s	0.0099 kg/s	0.0199 kg/s
Sulphur Dioxide	0.0007 kg/s	0.0048 kg/s	0.0097 kg/s

To assess the impacts of these emissions on the surrounding area, we have used the Probit function which is used to determine the relationship between dose exposure and potential lethal effects (see main report for more details on this function). The scenarios have been modelled to determine the maximum hazard distances to the AEGL-2 endpoint[3] and to a 1% lethality dosage level.

These model runs were conducted using AERSCREEN, a software package developed by the USEPA. This software is used to model the impacts of the release in order to calculate the worst case impacts at distance, based on worst case weather conditions.

It should be noted that it is possible that there would be no emissions to atmosphere for the smaller fire scenarios as the Reception Hall is kept under negative pressure. Combustion air for the incinerators is drawn into the process via the reception hall in order to suppress odours. As such it is possible that the smoke plume arising from the fire would be drawn into the incinerator and treated in the abatement system, which includes filters. As such this assessment has been conducted on a conservative basis.

3.2.1 Carbon Monoxide

The model results for the Carbon Monoxide emissions are shown in Figure 2. This plot shows how the concentration profile varies with distance for each of the fire scenarios. Comparing the results, the impacts to the surrounding area are broadly comparable in the case of the minor fire and the intermediate fire. The impacts are less significant in the case of the fully developed fire due to the high plume buoyancy that arises in this scenario.

The maximum concentrations in the immediate vicinity of the fire tend to arise in conditions of high wind speed, as this can give rise to grounding of potentially buoyant plumes. However at longer distances, the worst case impacts arise in calm conditions. As mentioned above, the model determines the worst case impacts at each distance, based on worst case weather conditions.

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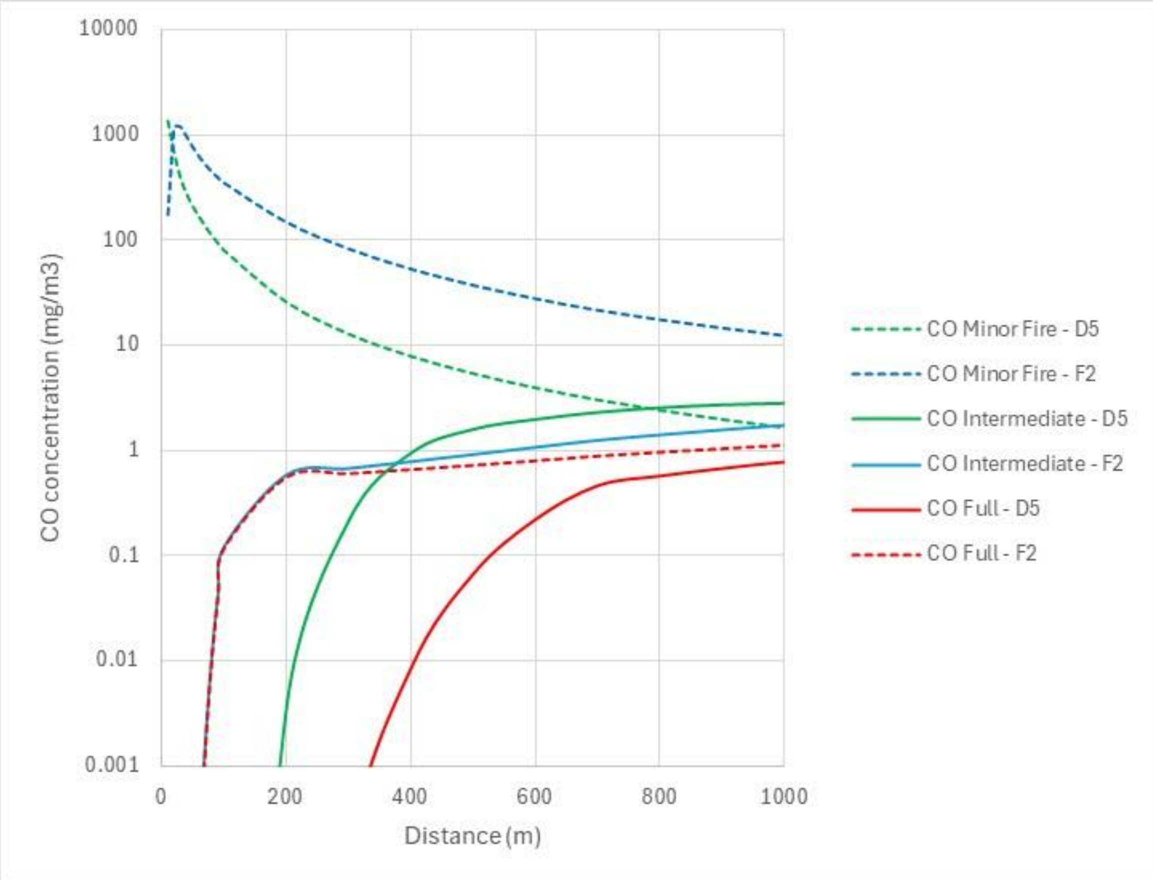
[3] Acute Exposure Guideline Level 2 – this is defined by the US EPA as the airborne concentration (expressed as ppm or mg/m3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

Figure 2: Consequence Modelling Results – Atmospheric Dispersion of CO following Bunker Fire



The 60-minute AEGL-2 concentration for CO is 83 ppm or 96.600 mg/m^3. Referring to the model results for these fires, the maximum distances to this endpoint are as follows:

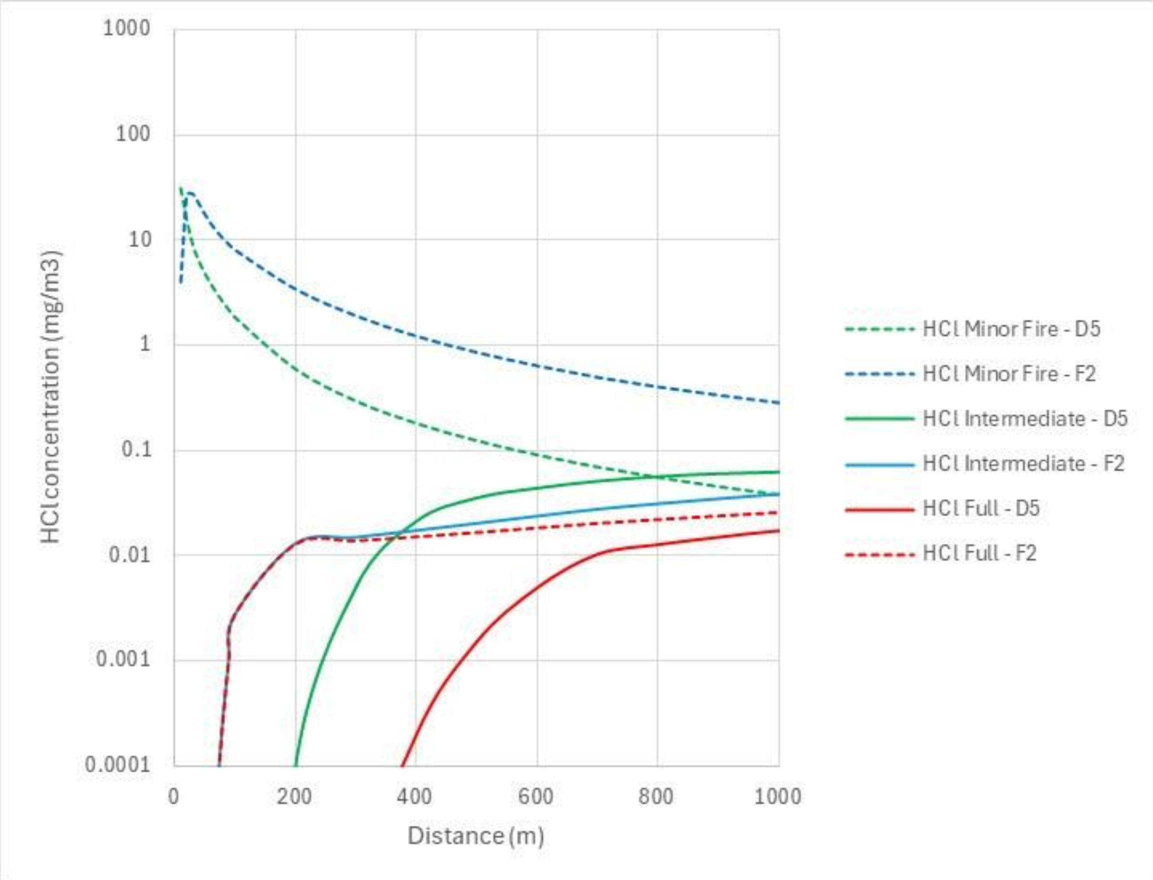
- Small Fire: 280 m
- Intermediate Fire: n.a. this concentration is not reached at any downwind receptor
- Major Fire: n.a. this concentration is not reached at any downwind receptor

Assessing the results using the Probit function to determine the potential for lethal effects from CO exposure, the results show that the 1% Dangerous Dose could be experienced in the immediate vicinity of the fire only. At these ranges the impacts of the event are dominated by the thermal radiation effects. The dangerous dose would not extend to any other buildings on site nor to any off-site locations.

3.2.2 Hydrogen Chloride

The consequence modelling results for Hydrogen Chloride emissions from the bunker fire are shown in Figure 3.

Figure 3: Consequence Modelling Results – Atmospheric Dispersion of HCl following Bunker Fire

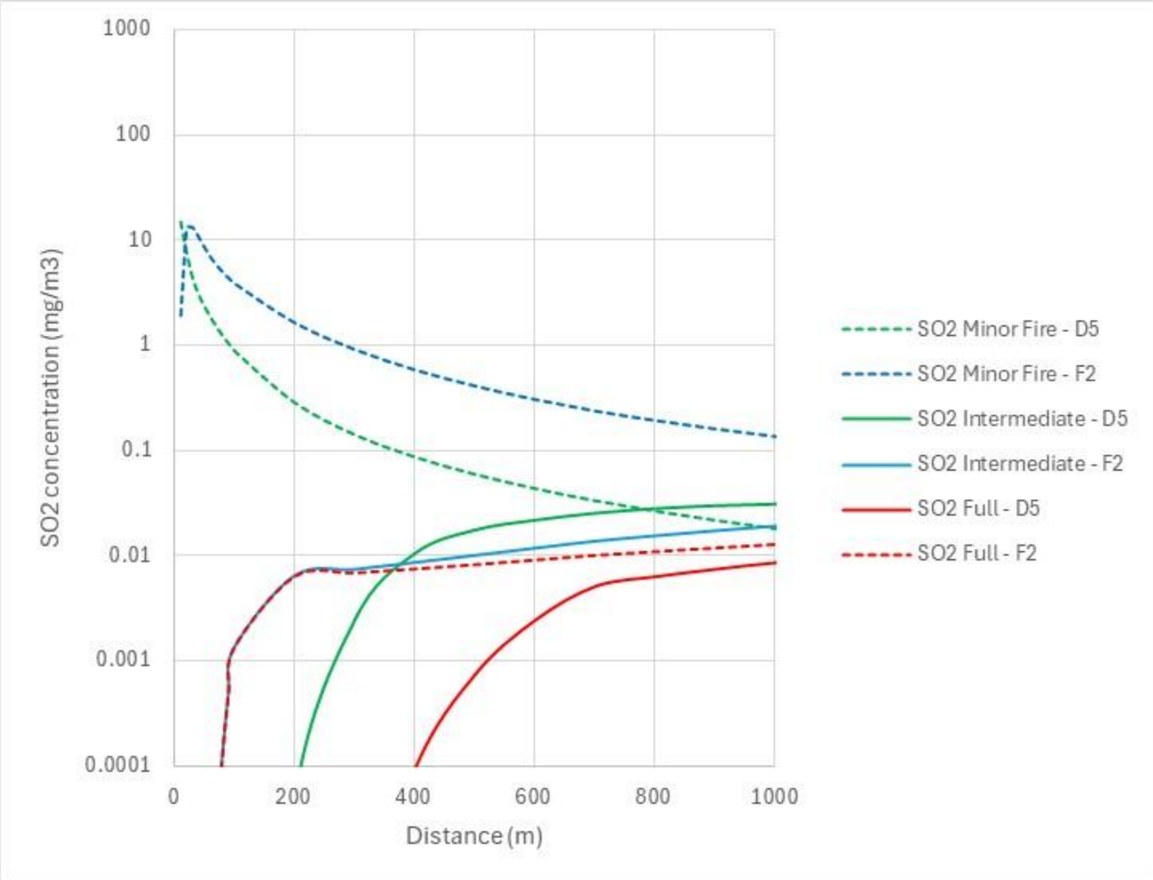


The AEGL-2 concentration for HCl is 22 ppm or 33 mg/m^3. This concentration is reached at a maximum distance of 30 m downwind from the fire.

3.2.3 Sulphur Dioxide

The consequence modelling results for Sulphur Dioxide emissions from the bunker fire are shown in Figure 4.

Figure 4: Consequence Modelling Results – Atmospheric Dispersion of SO_2 following Bunker Fire



The AEGL-2 concentration for SO_2 is 0.75 ppm or 2 mg/m^3. Referring to the model results for these fires, the maximum distances to this endpoint are as follows:

- Small Fire: 180 m
- Intermediate Fire: n.a. this concentration is not reached at any downwind receptor
- Major Fire: n.a. this concentration is not reached at any downwind receptor

Using the probit function, the results show that there is no risk of exposure to a dangerous dose of HCl from this scenario at any buildings in the surrounding area, either on site or off site.