Appendix 19A

Technical Land Use Plan (TLUP) Assessment

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Land Use Planning and Significant Modifications Risk Assessment for T-4 OCGT Development at Tarbert

***Prepared for*:**

SSE Generation

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Byrne Ó Cléirigh, 30a Westland Square, Pearse Street, Dublin 2, D02 PN76, Ireland.
Telephone: + 353 – 1 – **6770733**. Facsimile: + 353 – 1 – **6770729**. Email: **Admin@boc.ie**. Web: **www.boc.ie**

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Contents

1 Introduction

This report sets out the risk assessment for the proposed development of new infrastructure to support an Open Cycle Gas Turbine (OCGT) at SSE's Tarbert Power Station. The site is an establishment under the *Chemicals Act (Control of Major Accident Hazards Involving Dangerous Substances) Regulations*, 2015 (the COMAH Regulations[1]). As such, there is an onus on SSE to ensure that all necessary measures are in place to prevent major accidents occurring and to mitigate the impacts if a major accident does occur.

To support the planning application for this Proposed Development in the context of the COMAH Regulations, SSE requested Byrne Ó Cléirigh (BÓC) to carry out a risk assessment. This report describes our assessment of the major accident risks and our conclusions as to the change in on-site and off-site risk associated with the development.

As this is a development at an existing establishment, we have also assessed the significance of the findings using the HSA's "*Guidance on 'Significant Modifications' Under the COMAH Regulations*".

This assessment has been carried out by Thomas Leonard BE MEngSc CEng MIEI. Thomas Leonard is a Partner at BÓC, with over 25 years' experience in providing consultancy support in the areas of environmental protection and in safety & risk management.

2 Planning Context

2.1 Planning and Development Regulations

Part 11 of the *Planning and Development Regulations*, as amended, sets out the requirements for planning applications relating to developments subject to the COMAH legislation. Section 137(1) of the Planning and Development Regulations requires that a planning authority notifies the Health & Safety Authority (HSA) where:

> *(a) a planning authority receives a planning application relating to the provision of, or modifications to, an establishment, and, in the authority's opinion, the development would be relevant to the risk or consequences of a major accident*

The Proposed Development falls within the scope of Section 137(1)(a) of the Planning and Development Regulations.

2.2 Control of Major Accident Hazard Regulations

The COMAH Regulations place an obligation on operators of establishments that store, handle or process dangerous substances above certain thresholds to *take all necessary measures to prevent major accidents and to limit the consequences for human health and the environment*. Under the COMAH Regulations, an establishment can qualify as upper tier or lower tier, depending on the inventory of dangerous substances; sites that store, handle or process dangerous substances below a certain threshold do not qualify as establishments under the COMAH Regulations.

The types of dangerous substance that contribute to an establishment's inventory include flammable substances, toxic substances, and substances that are hazardous to the aquatic environment. The types of establishment that may fall within the scope of the COMAH Regulations

[1] The COMAH Regulations implemented Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances in Ireland

(depending on their inventories) include oil storage & distribution sites, liquefied petroleum gas storage & distribution sites, pharmaceutical plants, and sites that manufacture and / or store certain types of fertiliser.

Under Part 7 of the COMAH Regulations, the HSA, as the Central Competent Authority, can provide technical advice to a planning authority on developments of, or in the vicinity of, COMAH establishments, as follows:

> *24(2) The Central Competent Authority shall provide technical advice in response to a notice sent by a planning authority under Part 11 of the Planning and Development Regulations 2001 (SI No. 600 of 2001), requesting technical advice on the effects of a proposed development on the risk or consequences of a major accident in relation to the following types of developments…*
>
> *(a) the siting and development of new establishments;*
>
> *(b) modifications to establishments…* [which could have significant consequences for major accident hazards…]*;*
>
> *(c) new developments including transport routes, locations of public use and residential areas in the vicinity of establishments, where the siting, modifications or developments may be the source of, or increase the risk or consequences of, a major accident*.

Based upon the examination of the Proposed Development and the requirements of both the Planning and Development Regulations and the COMAH Regulations, we understand that the Planning Authority may request advice from the HSA in its consideration of the planning application. This report is prepared to assist the authorities in their consideration of this development.

To assist operators and developers in understanding the process and criteria that the HSA uses with respect to land use planning decision making, the HSA has produced guidance for land use planning (LUP) risk assessments[2]. This includes guidance on the types of major accident that could arise at a variety of establishments, as well as the risk-based criteria that the HSA uses to determine the acceptability or otherwise of the risks. The risk assessment in this report has been conducted in accordance with the LUP Guidance, to ensure that the approach reflects the good practice expectations of the HSA.

3 Description of Development

The proposed development will be carried out at the existing SSE establishment at Tarbert. An area of land at the north of this site has been marked out for the development of an OCGT and associated support infrastructure. The layout is illustrated in Appendix 1.

The closest COMAH establishment to the SSE Power Station is the Mainland Tank Farm, to the west of the SSE site. This is operated by the National Oil Reserves Agency (NORA). These two sites already form a 'domino group' under COMAH and there are regular meetings and exchanges of information between management of both sites, to ensure that all relevant parties are aware of the major accident hazards presented by the neighbouring site.

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[2] *Guidance on Technical Land Use Planning Advice for Planning Authorities and COMAH Establishment Operators.*

The proposed development comprises the following hazardous installations:

- Oil storage tank
- Road tanker unloading area
- Pipeline connections between tank and OCGT
- OCGT
- LPG storage
- Sodium hypochlorite storage
- Ammonium hydroxide storage

4 METHODOLOGY

To assist the Planning Authority and the Health & Safety Authority in their consideration of the Proposed Development, BÓC carried out this risk assessment in accordance with the HSA's LUP guidance.

4.1 Assessment Criteria

4.1.1 Individual Risk

The criteria against which the level of individual risk is assessed are based on the LUP Guidance and the use of a three-zone system shown in Table 1.

Table 1: LUP Zones for Individual Risk

Zone	Description
Inner zone	Risk of fatality of 1×10^{-5} per year, (1 in 100,000 years)
Middle zone	Risk of fatality of 1×10^{-6} per year (1 in 1 million years)
Outer zone	Risk of fatality of 1×10^{-7} per year (1 in 10 million years)

These three zones have been determined for the Proposed Development based on the probabilities of the scenarios arising and on the results from the consequence modelling.

The risks are calculated using the consequence modelling results and probability data for the various major accident scenarios identified in this report. The impacts of each scenario are assessed for people indoors and for people outdoors. It is assumed that people in the surrounding area are indoors 90% of the time and outdoors 10% of the time, in accordance with the HSA guidance.

4.1.2 Societal Risk

The societal risk has been assessed by means of the Expectation Value (EV) for the establishment and the surrounding environment. The EV aggregates the risks from all scenarios covered in this assessment, based on the total population at the Site and in the surrounding area, and aggregates them to calculate a single value to represent the overall risk level. It is defined as:

$$EV = \Delta R_{cpm} \times N$$

Where ΔR is the increase in risk presented to people by the Proposed Development (expressed as chances per million) and N is the number of people exposed to this increase in risk.

4.2 Development Sensitivity Levels

The HSA provides advice to the planning authorities, in accordance with the COMAH Regulations, using a similar system to that applied by the Health & Safety Executive in the UK (UK HSE). Different types of development are categorised under one of four sensitivity levels (Level 1 to Level 4). The HSA provides its advice to planning authorities in the form 'advises against' or 'does not advise against' depending on which zone the development lies within, as shown in Table 2 (a tick indicating 'do not advise against' and a cross indicating 'advise against').

Table 2: HSA Matrix for Land Use Planning Advice

Sensitivity Level	Individual Risk Zone		
	Inner Zone	Middle Zone	Outer Zone
Level 1	✓	✓	✓
Level 2	×	✓	✓
Level 3	×	×	✓
Level 4	×	×	×

The levels shown in this table refer to Sensitivity Levels for populations at, or in the vicinity of a COMAH establishment. Depending on the nature of a development, and on the numbers of people present, the HSA will classify the Sensitivity Level using a scale of 1 to 4. As the Sensitivity Level increases, so too do the levels of restrictions that would be placed on where they would be permitted. For example, if a development is classed as Sensitivity Level 2, then the HSA would advise against its development in the Inner Zone but would not advise against its development in the Middle or Outer Zone, whereas for a development which is Sensitivity Level 4 the HSA would advise against its development in any of the LUP zones.

Appendix 2 of the LUP Guidance sets out the approach in more detail but, in outline, the criteria are shown below.

Sensitivity Level 1: People at work; car parks

Developments in this category can be accommodated inside any of the LUP zones around a COMAH establishment. Examples in the LUP Guidance include offices, factories, warehouses, haulage depots, farm buildings, non-retail markets, builders' yards, car parks, lock-up garages.

Workplaces may be classed as Sensitivity Level 2 if they are high density developments. They may be classed as level 3 where they are specifically for people with disabilities.

Sensitivity Level 2: Developments for use by the general public

Developments in this category can be accommodated inside the middle zone or the outer zone. The categories of development which fall under this heading are housing, hotel / holiday accommodation, transport links, indoor use by the public and outdoor use by the public.

As with workplaces, there is scope for developments to have a different sensitivity level on the basis of the density of development. For example, a small housing development consisting of one or two dwelling units would be Sensitivity Level 1, while a high density development with more than 40 dwelling units per hectare would be Sensitivity Level 3.

Similarly, while a transport link is Sensitivity Level 2, estate roads and access roads are Sensitivity Level 1.

Sensitivity Level 3: Developments for use by vulnerable people

Developments in this category can be accommodated inside the outer zone. Examples in the LUP Guidance include hospitals, nursing homes, schools and creches.

In each case there is a size threshold and so if a school, hospital, creche etc. exceeds a certain size level then it is classed as Sensitivity Level 4.

Sensitivity Level 4: Very large and sensitive developments

Developments in this category cannot be accommodated inside any of the LUP zones. Examples in the LUP Guidance include institutional accommodation and very large outdoor use by the general public (e.g. theme parks, sports stadia, markets etc where there could be more than 1,000 people present).

4.3 Consequence Modelling

This section of the report sets out the conditions under which each of the major accident scenarios identified in this report has been modelled. Further details of how these scenarios were identified in accordance with the LUP guidance are provided in Section 5 of this report.

4.3.1 Wind Speed

For toxic releases, a wind speed of 5 m/s was used to model scenarios under average atmospheric conditions (Pasquill Stability Category D), while a wind speed of 2 m/s was used to model scenarios under calm conditions (Pasquill Stability Category F). These two combinations are used to determine the hazard distances for any release scenario resulting in hazardous gas or vapour being released to atmosphere. They represent typical conditions (D5) and worst-case conditions (F2), in accordance with the LUP Guidance.

For fire scenarios, the heat radiation to the surrounding area was modelled using 5 m/s and 10 m/s wind speeds. The higher wind speed will give rise to a greater degree of flame tilt and so will result in higher heat fluxes in the immediate vicinity of the fire.

4.3.2 Temperature

All materials associated with the new development will be stored and handled at ambient temperatures, unless stated otherwise.

4.3.3 Height of Release

Unless stated otherwise, all releases occur at ground level.

5 Major Accident Scenarios

5.1 Summary

The LUP guidance sets out the types of scenario to be considered as part of a COMAH land use planning assessment. The installations at the Proposed Development which are identified as having the potential to give rise to a major accident are as follows:

- Loss of containment of HVO from bulk storage tank
- Loss of containment from road tanker
- Loss of containment from transfer pipeline
- Fire / explosion at OCGT
- Loss of containment of sodium hypochlorite solution
- Loss of containment of ammonium hydroxide

5.2 Loss of Containment from Bulk Storage

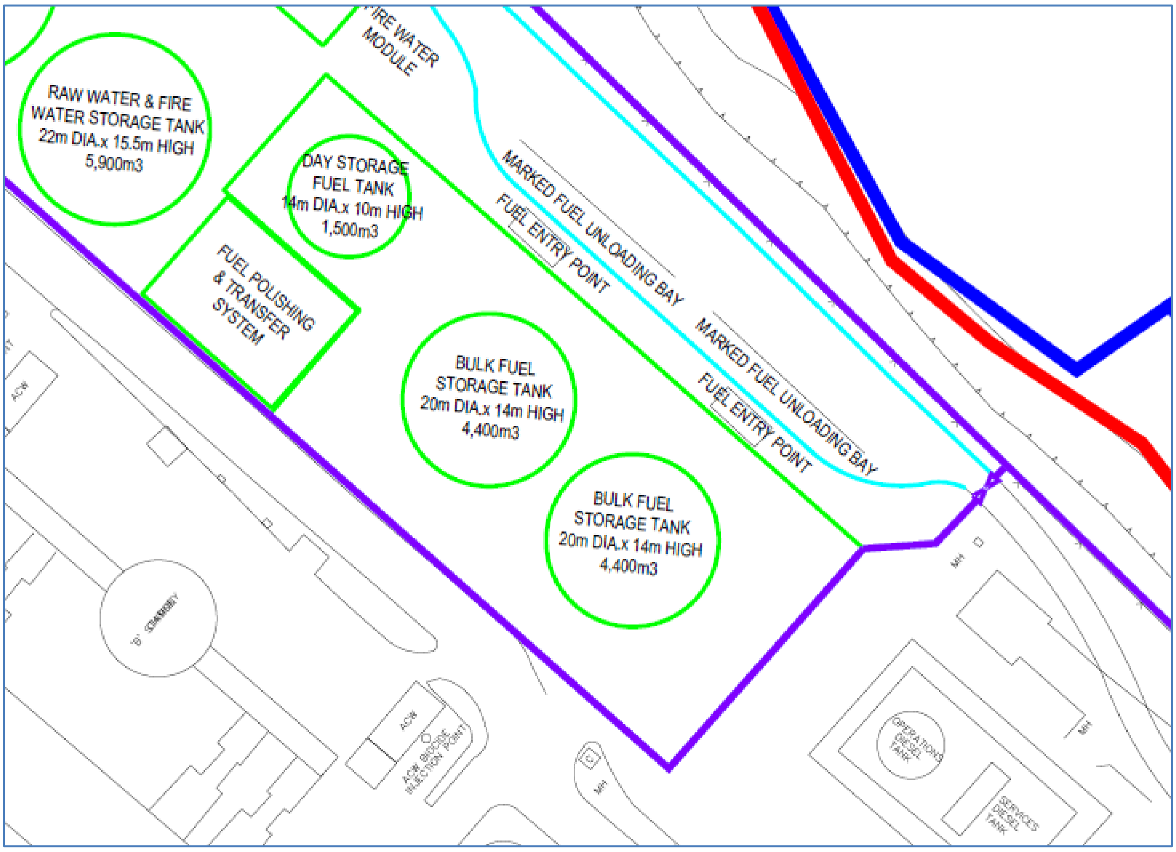
HVO is a diesel-like fuel that can be produced from vegetable oil rather than from fossil resources. Referring to the safety data sheet (SDS), the following hazard statements apply to HVO:

- H226: Flammable liquid and vapour
- H304: May be fatal if swallowed and enters airways
- EUH066: Repeated exposure may cause skin dryness and cracking

It is the H226 statement that qualifies this as COMAH substance. The flash point of HVO is 65°C. This is higher than the threshold of 55°C from the CLP Regulation. However, the CLP Regulation also states that gas oils, diesel and light heating oils with a flash point between 55°C and 75°C may be regarded as flammable (H226).

The bulk storage comprises 2 no. bulk fuel tanks and 1 no. day storage tank, all within a common bund. This is illustrated in Figure 1.

Figure 1: HVO Bulk Storage



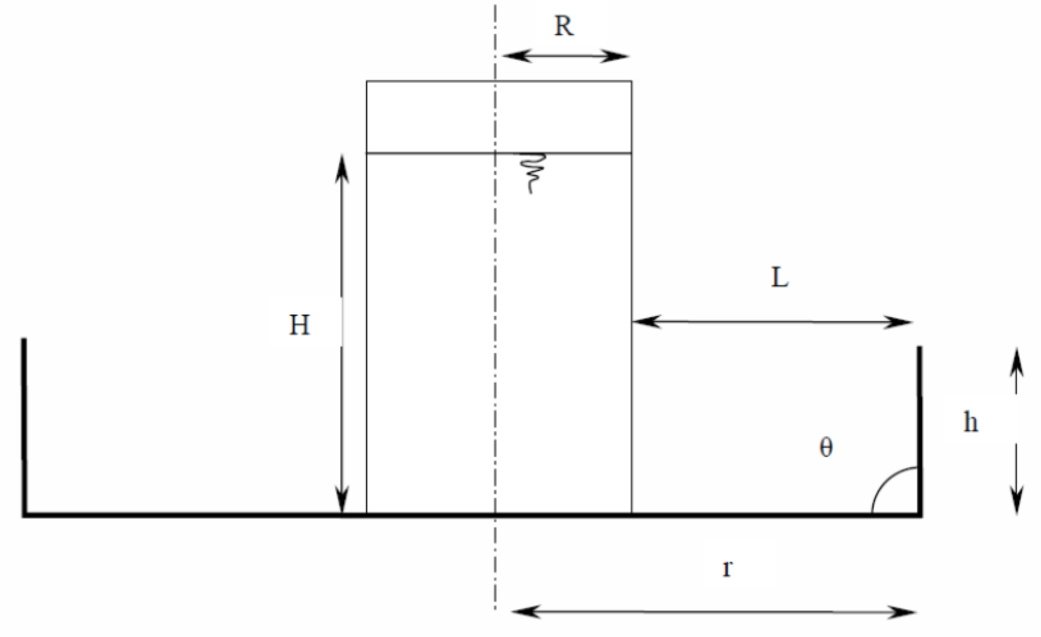
The HSA's guidance advises that, for bulk storage of flammable liquids, the risk assessment should consider three types of loss of containment event:

- Instantaneous failure of storage tank: 5×10^{-6} per tank per year. In this scenario the full contents of the tank are released immediately.
- Failure over 10 minutes: 5×10^{-6} per tank per year. In this scenario the full contents of the tank are released over a period of 10 minutes.
- 10 mm pipe leak over 30 minutes: 1×10^{-4} per tank per year. In this scenario a portion of the tank's contents are released.

For the second and third of these scenarios, the released material would be retained in the bund. However, for the first scenario (instantaneous failure), the momentum of the released material can result in overtopping of the bund wall. The worst-case overtopping event is calculated using the equation from the UK HSE Research Report RR755, "*Validation of the Shallow Water model "SPLOT" against experimental data on bund overtopping*".

The fraction of material that could overtop a bund wall in the event of catastrophic tank failure was calculated by reference to the OVERTOP routine, developed by the UK HSE. The main dimensions used for this calculation are illustrated in Figure 2.

Figure 2: Key tank and bund dimensions for calculation of bund overtopping fraction



The OVERTOP routine is summarised using the following correlation, which has been derived by Liverpool John Moores University (LJMU) on behalf of the UK HSE as a best-fit to a range of laboratory scale tests.

Overtopping Fraction = 1.0255 – 0.1886 (r/H) – 2.9951 (h/H) + 0.3842 (R/H)
+ 0.0140 (r/H)2 + 2.7535 (h/H)2 – 0.0637 (R/H)2
–0.0005 (r/H)3 – 0.8595 (h/H)3

The equation calculates the amount of material that could overtop the bund wall based on worst case conditions, i.e. that the tank is full at the time, failure is instantaneous and the direction of failure is such that the released material impacts the closest bund wall at right angles.

The bund wall height is 2.9 m, to enable the bund to meet the 110% and the 25% rule.

The results of this calculation are shown in Table 3.

Table 3: Calculation of maximum overtopping fraction for catastrophic tank failure

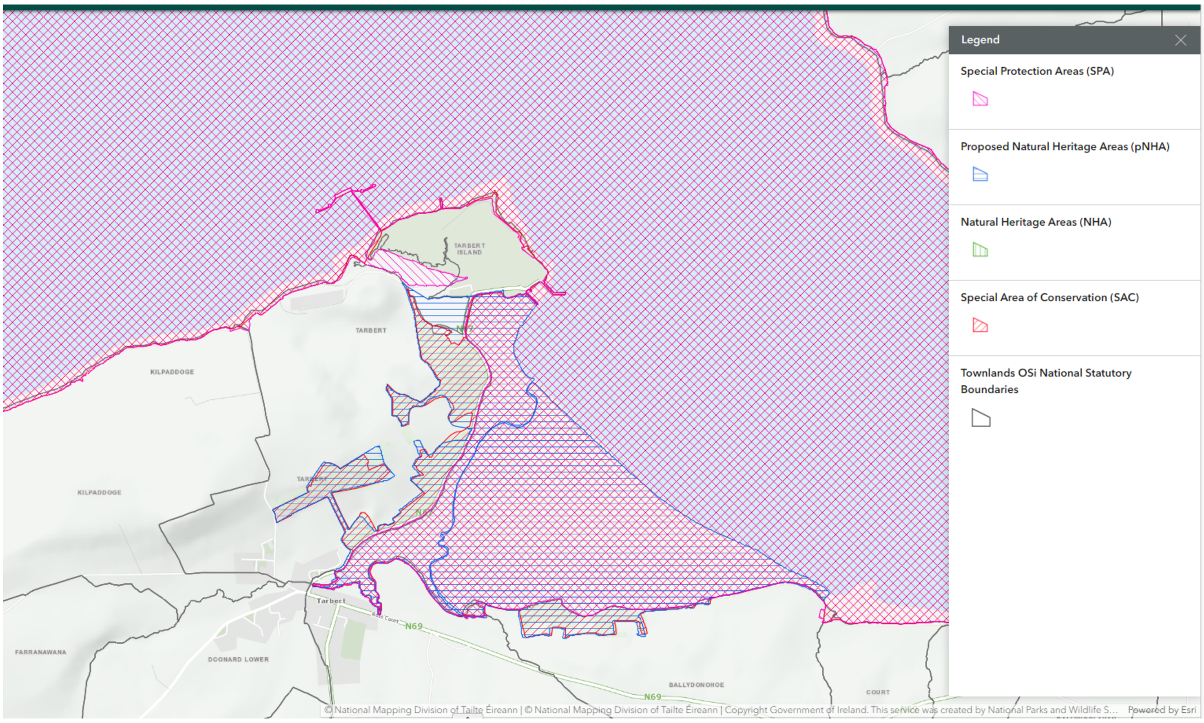
Incident tank	Max operating level	Tank Diameter	Shell – Bund distance	Bund height	Overtopping	Overtopping
Bulk Fuel Tank (2 no.)	14 m	20 m	7 m	2.9 m	55%	2,411 m^3
Day Storage Tank	10 m	14 m	2 m	2.9 m	45%	687 m^3

The calculation shows the maximum overtopping volume in each case. The worst case overtopping event would involve a release of just over 2,400 m^3 of HVO as a result of overtopping the wall.

The severity of the environmental impact following such a release is dependent on whether the overtopping material can find a pathway to escape offsite. The area surrounding the tank farm will be gravelled.

The location of the proposed development is close to the Shannon Estuary. This comprises several Protect Sites, as shown on the National Parks and Wildlife Services (NPWS) website. This is illustrated in Figure 3.

Figure 3: Protected Sites (source NPWS website)



This shows that a major release to the estuary could impact one or more of the following Protected Sites:

- Lower River Shannon SAC (Site Code 002165)
- River Shannon and River Fergus Estuaries SPA (Site Code 004077)
- Tarbert Bay pNHA (Site Code 001386)

The significance of the environmental impacts following a release to the Shannon has been assessed using the approach set out in the Chemical and Downstream Oil Industry Forum (CDOIF)[3] Guidance. This is in accordance with the approach described in the HSA's guidance. This 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.

[3] CDOIF Chemical and Downstream Oil Industries Forum Guideline Environmental Risk Tolerability for COMAH Establishments (v2.0)

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 4 and for the *duration of harm* are summarised in Table 5.

Table 4: Thresholds for extent and severity of environmental damage

Area	Status	Threshold
Designated Area	SSSI 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)
	SACs, SPAs 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
	ESAs, AONBs LNRs, NSAs	• 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 2 km 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 5: 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 6.

Table 6: 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

The maximum quantity that could escape the bund area would be up to 2,411 m^3, based on catastrophic failure of one of the bulk fuel tanks. The released material would be collected in the drainage system and/or in the gravelled areas nearby. The worst-case impacts would arise where the material finds its way to soil / groundwater via a gravelled area. Due to the proximity of the site to the coastline, it is conservatively assumed that this release could then find its way to the estuary, in the worst case.

When compared with petroleum products such as diesel or kerosene, HVO is not classed as environmentally hazardous and the SDS shows that there are no environmentally hazardous statements that apply to it. However, it is conservatively assumed that, for a release to the Shannon SAC this would do damage to more than 0.5 ha and so this meets the threshold to be classed as a MATTE under the CDOIF scale. As such it is assigned a rating of Severe (2) on the CDOIF scale.

The duration of harm for oil contamination of water would be relatively short-lived. However, based on ITOPF data, the duration of harm for oil contamination of a sheltered rocky shoreline is between 1-5 years and for marshlands is 3-5 years. This equates to Medium (2) on the CDOIF scale. It is conservatively assumed that any harm caused by HVO would be similarly persistent.

This scenario is therefore conservatively considered to be a type A MATTE. The CDOIF scale is shown in Figure 4.

Figure 4: CDOIF Risk Assessment Matrix

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

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

The probability of occurrence for catastrophic tank failure and bund wall overtopping is calculated to be 1.5×10^{-5} per annum, based on there being three tanks in service. This is less than the broadly acceptable figure of 10^{-4} per annum for a type A MATTE on the CDOIF scale. The risk associated with this scenario is therefore broadly acceptable.

It was noted that the risks associated with catastrophic tank failure would be reduced by the provision of a double-skin containment tank. A cost-benefit analysis was therefore carried out to determine if implementing such a measure would be justifiable. Based on the costs associated with installing the proposed tanks, it is estimated that the incremental cost of installing double-skin tanks instead would be an increment of the order of €1,000,000.

The probability of catastrophic failure of a single-skin tank is given as 5×10^{-6} per tank per annum in the HSA's guidance. With three tanks in service, this works out as a probability of 1.5×10^{-5} per annum. By contrast, the probability of catastrophic failure of a double-skin tank is 1.25×10^{-8} per tank per annum. With three tanks in service, this works out as a probability of 3.75×10^{-8} per annum. To ensure that we have adopted a conservative approach to this assessment by assuming that implementing the additional measure would eliminate the risk.

For the purposes of this calculation, a project lifetime of 25 years is assumed. This means that the probability of an overtopping event at any time over that 25-year period would be 0.000375 over the project lifetime, based on single-skin tanks. On this basis, the costs associated with the environmental damage from a release offsite would have to be of the order of €2.6 billion to be considered proportionate to the €1,000,000 cost of installing double-skin tanks.

When assessing the damages associated with a major environmental release, there is data available for calculating the costs /damages for releases to the marine environment, e.g. using data published by the International Oil Pollution Compensation Fund (IOPC) has been in place in various formats since 1971, during which time it has been involved in over 150 incidents of varying sizes all over the world. This approach has been used for the risk assessments for SSE's sites at Great Island and at Tarbert. The costs associated with the environmental damages for releases of comparable quantities of petroleum products to the volumes calculated here would be of the order of €10,000,000. These are for releases to harbours or bays, where there are Protected Sites (NHAs, SPAs, SACs) in close proximity. Assuming that the damages resulting from a release at Tarbert would be comparable to these, despite the relative lack of Protected Sites in the vicinity of the proposed development, this would mean that the disproportion factor associated with installing double-skin tanks for the HVO storage would be of the order of 2,670.

Referring to the UK HSE's guidance, *Reducing Risks Protecting People* (R2P2), where a risk is intolerable, then additional measures must be implemented. However, the concept of 'gross disproportion' applies to implanting additional measures for other scenarios, where these measures are not reasonably practicable. Similarly, the HSA's guidance for significant modifications advises that it may be relatively straightforward in soe cases to demonstrate that further risk reduction is not reasonably practicable (or not justifiable) where there are no identifiable technical measures that could be implemented or where the identified measures are clearly disproportionate to the benefit to be gained.

In the case of the bund overtopping event, the risks associated with a major release to the environment were found to be broadly acceptable, based on the CDOIF approach. As such, the costs associated with replacing the two proposed tanks with double-skin tanks are found to be grossly disproportionate.

The HSA's LUP guidance advises that ignition probabilities for Category 3 substances (such as HVO) are zero. Fire and explosion events are not considered for Category 3 substances, unless they are co-located in the same bund as Category 1 or Category 2 substances, in which case they could be modelled as Category 1 or Category 2 substances. There are no Category 1 or 2 substances in the HVO bund.

The HSA's guidance further advises that failure to retain spilled material on-site means that prevention of ignition will no longer be within the control of the operator of an establishment and therefore the approach outlined above, in relation to ignition probability, does not apply and pool fires do have to be modelled. Operators generally do not have control of areas outside the establishment, so an overtop pool running off-site could give rise to a fire event.

In the event of catastrophic tank failure at the Tarbert site, the overtopping material would be collected in the site drainage system. There is no scenario where an unbunded pool of liquid migrates offsite as a result of this event, resulting in a surface spill which could potentially be ignited. As such, the probability of ignition following a release of HVO is zero.

5.3 Road Tanker

The supply of HVO to the site will be by road tanker. The expected annual usage at the OCGT will require 5,110 tankers per annum.

Referring to the LUP Guidance, the following loss of containment events apply:

- Instantaneous failure: 1×10^{-5} per annum.
- Failure over 10 minutes: 5×10^{-7} per annum.
- Rupture of loading / unloading hose: 4×10^{-6} per hour of activity.
- Leak from loading / unloading hose (10%): 4×10^{-5} per hour of activity.

The first two of these scenarios are expressed on a per annum basis. As road tankers will only be present on site some of the time, these must be adjusted downwards to reflect the activity level at the Proposed Development. The second two of these scenarios are expressed on a per hour basis. These figures must be adjusted upwards to reflect the actual number of hours per annum that transfers will take place.

In all of the above scenarios, the loss of containment event would only have the potential to give rise to environmental damage if the release could also find a pathway to escape off site. However, in each case the release would be to a dedicated kerbed area, designed to retain the spill. As such the release would only escape off site if there was a further failure of the operator to correctly manage the drainage system and to discharge the release.

The worst-case scenario of this type would involve a catastrophic failure event of a tanker when making a delivery. We note that tankers are typically compartmented tankers, where each compartment contains approx. 6 to 7 m^3. If it is conservatively assumed that the catastrophic failure event involves the full tanker contents of 36 m^3, this would still be a minor event when compared with the overtopping event and would not be sufficient to give rise to a MATTE on the CDOIF scale.

Based on the above considerations, the road tanker unloading area does not present a risk of a MATTE, based on the CDOIF scale, and the associated environmental risk from a major accident is broadly acceptable, based on the HSA's criteria.

5.4 HVO Pipeline

HVO will be transferred at the Site, e.g. from the road loading area to the tank farm, and from the tank farm to the OCGT, via pipelines. There will be approximately 70 m of 6" diameter lines. The loss of containment events for these lines are as follows:

- Rupture of pipeline
- Leak from pipeline, with an effective diameter of 10% of the nominal diameter

In the event of a loss of containment from a pipeline section with HVO in it but where the pumps are not operating and a transfer is not taking place, the quantity released is taken as the capacity of that pipeline. The pipeline will be fitted with a control valve to ensure that it is only the volume in the line that is released. This approach is conservatively applied for leaks as well as for guillotine failures. The maximum volume that would be released from a pipeline in these scenarios would be up to 1.28 m^3.

In the event of a loss of containment while a transfer is taking place, the quantity released would be larger. The volume in this case would be equal to the quantity in the line, plus the quantity released during the transfer.

The normal flowrate in the line is approx. 128 m^3/hr, at a pressure of 4 bar. In the event of guillotine line failure the release rate is taken to be 192 m^3/hr, i.e. 50% higher than the normal pumping rate, due to the lack of back-pressure. In the event of a leak in the line (10% diameter) the release rate is calculated to be 0.0032 m^3/s, or 11.4 m^3/hr.

A 20-minute response time is applied for the scenarios involving line rupture during a transfer.

- Leak from pipeline, when product is in the line but the pumps are not operating. The total quantity released is the volume of liquid released is the volume of the pipeline, i.e. 1.28 m^3.
- Rupture of pipeline, when product is in the line but the pumps are not operating. The total quantity released is the volume of liquid released is the volume of the pipeline, i.e. 1.28 m^3.
- Leak from pipeline, when pump is operating. The total quantity released is the volume of liquid released is the volume lost over 20 minutes of pumping plus the volume in the line, i.e. 5.1 m^3.
- Rupture of pipeline, when pump is operating. The total quantity released is the volume of liquid released is the volume lost over 20 minutes of pumping plus the volume in the line, i.e. 65.3 m^3.

These loss of containment events are much smaller than the overtopping event discussed in Section 5.2. Furthermore there will be additional protective measures in place to further protect against environmental damage following a release from the pipeline. If the loss of containment occurs from the pipeline within the bund area, it will be retained within the bund, as would be the case following a leak from the tank. If the loss of containment is from a section of pipeline between the bund and the OCGT, this may be either to the site drainage system or may find its way to ground / ground water. The quantities of material involved would not be sufficient to give rise to sufficient severity and duration of harm to register as a MATTE on the CDOIF scale.

Based on the above, there is no significant risk of a MATTE as a result of loss of containment from the HVO pipeline.

5.5 LPG Storage

LPG will be stored on site in a 10 m^3 tank. A variety of loss of containment events was identified for the storage tank, based on the HSA's LUP guidance. These are shown in Table 7.

Table 7: Loss of containment events and major accident scenarios for LPG tank

LOC scenario	Frequency (yr-1)	Consequence	Frequency
Instantaneous failure	5×10^{-7}	BLEVE / Fireball	3.5×10^{-7}
		VCE	6×10^{-8}
		Flash Fire	9×10^{-8}
Continuous leak over 10 minutes	5×10^{-7}	Jet Fire	3.5×10^{-7}
		VCE	6×10^{-8}
		Flash Fire	9×10^{-8}
10mm pipe leak over 30 minutes	1×10^{-5}	Jet Fire	7×10^{-6}
		VCE	1.2×10^{-6}
		Flash Fire	1.8×10^{-6}

The table shows that for a given loss of containment event there is more than one potential outcome. Each outcome has been modelled.

The LUP guidance also identifies a range of loss of containment events for road tanker units. The events are set out in Table 8.

Table 8: Loss of containment events and major accident scenarios for LPG road tankers

Instantaneous failure	5×10^{-7}	BLEVE / Fireball	2×10^{-7}
		VCE	1.2×10^{-7}
		Flash Fire	1.8×10^{-7}
Loss of entire contents through largest connection	5×10^{-7}	Jet Fire	5×10^{-8}
		VCE	1.8×10^{-7}
		Flash Fire	2.7×10^{-7}

The above frequencies are adjusted for the proportion of the year that the laden road transport unit is present. Based on projected operations, there will be 130 m^3 of LPG per annum. This is modelled as 7 no. deliveries per annum using 20 m^3 tankers. Each delivery is assumed to take 1 hour.

The guidance also identifies further risks associated with loading / unloading of LPG.

- Rupture of transfer hose: 4×10^{-6} per hour
- Leak from transfer hose at 10% of diameter: 4×10^{-6} per hour
- BLEVE of tanker (hot): 5.8×10^{-10} per hour

The consequence modelling results for these scenarios (LPG tank and LPG tanker) are set out in the following tables.

Table 9: Consequence modelling of BLEVE events (LPG tank and LPG tanker)

Scenario	BLEVE of LPG tank	BLEVE of LPG tanker
Duration	8.09 s	11.79 s
Endpoints		
…37.5 kW/m^2	105 m	163 m
…25.6 kW/m^2	133 m	198 m
…12.7 kW/m^2	196 m	292 m
…6.3 kW/m^2	280 m	422 m
…4 kW/m^2	350 m	529 m

Table 10: Jet Fires following loss of containment from LPG tank

Scenario	10- minute release horizontal	10- minute release vertical	10- mm release horizontal	10- mm release vertical
Endpoints				
…25.6 kW/m^2	51 m	25 m	22 m	11 m
…12.7 kW/m^2	57 m	33 m	24 m	14 m
…8 kW/m^2	62 m	41 m	26 m	17 m
…6.3 kW/m^2	64 m	45 m	28 m	19 m
…4 kW/m^2	71 m	54 m	30 m	22 m

Table 11: Jet Fires following loss of containment from LPG tanker

	Largest connection	Rupture of hose	Leak from hose
Endpoints			
…25.6 kW/m^2	31 m	31 m	4 m
…12.7 kW/m^2	41 m	41 m	4.5 m
…8 kW/m^2	49 m	49 m	5.5 m
…6.3 kW/m^2	55 m	55 m	6 m
…4 kW/m^2	65 m	65 m	7.5 m

Table 12: Flash Fires and VCEs following loss of containment from LPG tank

Scenario	Instantaneous release D5	Instantaneous release F2	10 min release, horiz D5	10 min release, horiz F2	10 min release, vert D5	10 min release, vert F2	10 mm release, horiz D5	10 mm release, horiz F2	10 mm release, vert D5	10 mm release, vert F2
Length of cloud	146 m	157 m	39 m	97 m	37 m	-	16 m	33 m	-	-
Width of cloud	89 m	101 m	7 m	42 m	7 m	-	10 m	6 m	-	-
...600 mbar	55 m	56 m	17 m	35 m	9 m	-	7 m	14 m	-	-
...140 mbar	149 m	151 m	47 m	95 m	24 m	-	19 m	38 m	-	-
...70 mbar	258 m	261 m	81 m	165 m	42 m	-	33 m	67 m	-	-
...30 mbar	548 m	554 m	172 m	351 m	90 m	-	71 m	142 m	-	-

Table 13: Flash Fires and VCEs following loss of containment from LPG tanker

	Instantaneous release D5	Instantaneous release F2	Largest connection, horiz D5	Largest connection, horiz F2	Rupture of hose D5	Rupture of hose F2	Leak from hose D5	Leak from hose F2
Length of cloud	208 m	291 m	36 m	86 m	36 m	88 m	3 m	7 m
Width of cloud	178 m	283 m	5 m	23 m	5 m	23 m	2 m	10 m
...600 mbar	88 m	79 m	11 m	21 m	11 m	21 m	2.5 m	4.5 m
...140 mbar	236 m	211 m	31 m	55 m	31 m	55 m	7 m	12 m
...70 mbar	412 m	368 m	53 m	97 m	53 m	97 m	12 m	21 m
...30 mbar	878 m	785 m	113 m	205 m	113 m	205 m	25 m	44 m

- Indicates that the model did not generate overpressures for these events

5.6 OCGT

The enclosure has dimensions of 40 m × 50 m × 30 m, or a total enclosed volume of 60,000 m^3. The worst case scenario for a release of high flashpoint material such as HVO into a large space such as this is a fire event. For modelling purposes, a worst case scenario involving a fire over an area of 40 m × 50 m or 2,000 m^2 is assumed. The consequence modelling is set out in Table 14.

Table 14: Major Pool fire at OCGT

Endpoint	Distance 5 m/s wind	Distance 10 m/s wind
25.6 kW/m^2	39 m	43 m
12.7 kW/m^2	50 m	57 m
8 kW/m^2	63 m	71 m
6.3 kW/m^2	69 m	77 m
4 kW/m^2	84 m	90 m

Distances are expressed as distances from the centre of the fire event.

5.7 Sodium Hypochlorite

Storage of aqueous sodium hypochlorite solution will be in a bunded tank with a capacity of 1,600 litres. This material is classed as environmentally hazardous (H400 – *very toxic to aquatic life* and H410 – *very toxic to aquatic life with long lasting effects*). The primary hazard associated with a release from this tank is therefore in the event that the release finds a way to escape offsite to groundwater or surface water as a result of an unbunded release.

This will be stored in a tank of 1.5 m diameter and 1 m in height. This will be housed in a bund with dimensions of 2 m by 2 m and with a bund wall height of 1 m. Applying the overtopping equation described in Section 5.2, there would be no overtopping of the bund wall in the event of catastrophic failure of this tank.

Due to the small size of the tank, and the design of the bund in which it will be housed, there is no significant environmental risk following a loss of containment of sodium hypochlorite, even in the event of catastrophic mechanical failure of the storage tank.

5.8 Ammonium Hydroxide

This is an aqueous solution of ammonia. It will be stored in a horizontal storage tank, 5 m in length and 2.5 m diameter, giving a capacity of 24.5 m^3. It will be housed in a bund.

The aqueous ammonia solution, at a concentration of 24.5%, is not classed as acutely toxic to human health under Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures ('CLP Regulation'). However, in the event of a loss of containment to the bund, the resulting pool of liquid could evaporate, resulting in a release of ammonia to atmosphere. We have therefore included this as a scenario in the risk assessment.

The tank will be located within a bund, with dimensions 6 m × 6 m × 1.5 m. The area of the bund is therefore 36 m^2. The following representative loss of containment events are identified, from the LUP guidance:

- Instantaneous failure: 5 × 10^{-6} per annum
- Failure over 10 minutes: 5 × 10^{-6} per annum
- 10 mm pipe leak over 10 minutes: 1 × 10^{-4} per annum

For a major release (loss of full tank contents within 10 minutes or catastrophic failure), the release would fill the bund. Although a portion of the tank would still jut above the liquid surface, it is conservatively assumed that the full bund area of 36 m^2 would be available for evaporation.

In the event of a leak, the resulting pool of liquid would accumulate in the base of the bund. The area for evaporation would be reduced in this case, as the horizontal tank occupies much of the bund and would sit above the liquid. The area for evaporation in this case is taken to be 26 m^2.

The consequence modelling results are set out in Table 15.

Table 15: Consequence modelling of ammonia releases

	Leak from tank, normal atmospheric conditions	Leak from tank, calm atmospheric conditions	Major release from tank, normal atmospheric conditions	Major release from tank, calm atmospheric conditions
Material	Ammonia (24.5%)	Ammonia (24.5%)	Ammonia (24.5%)	Ammonia (24.5%)
Area	26 m^2	26 m^2	36 m^2	36 m^2
Weather	D5	F2	D5	F2
Evaporation rate	8.39 kg/min	3.39 kg/min	11.3 kg/min	4.58 kg/min
Dist. to 1% lethality	34 m	117 m	39 m	134 m

The distances to 1% lethality are based on the atmospheric dispersion modelling results for each event and assuming that someone would be exposed to the resulting maximum concentration for 30 minutes. This reflects the impacts to someone who is outdoors at the time. For people indoors, the attenuating effects of the building are taken into account, based on 2.5 air changes per hour (ach) in normal atmospheric conditions and on 2 ach in calm conditions, in accordance with the HSA guidance.

6 RISK ASSESSMENT

Combining the various major accident scenarios modelled in Section 5, with the probability of occurrence for each, we have developed a risk contour plot to show the extents of the inner zone, middle zone and outer zone around the proposed development.

Figure 5: LUP Risk Contour Plot

The plot is also included as Appendix 1 to this report. It shows the extents of the Inner, Middle and Outer Zones, in accordance with the LUP Guidance. The contours are primarily confined within the Site footprint.

The primary exposure to these risks will be to operators at the site. It is expected that there will be between 7 and 10 personnel on site during normal working hours. These will be based in the Admin Building, although they will occasionally enter other buildings at the site. For the purposes of this assessment we have calculated their exposure on the basis that an operator would periodically be based in the Demin Water Plant building or the Fuel Polishing Building, i.e. that 10 people present on site during normal hours, based in the Admin Building (the upper end of the expected range) and that these operators may also be present at one or other of these buildings for 1 hour per week each.

Outside of normal working hours, a maximum of 3 people are expected to be present on site (nigh-times, weekends).

The risks to this population are calculated using the Expectation Value (EV). This is calculated as follows:

$$EV = \Delta R_{cpm} \times N$$

Where ΔR_{cpm} is the increased risk presented to human health (expressed as chances per million) and N is the number of people exposed to that risk. The EV calculation is set out in Table 16.

Table 16: Expectation Value

	Admin Building normal hours	Demin Water Plant	Fuel Polishing	Admin Building evening/nigh	Admin Building weekends
Location-based risk	3.04×10^{-7}	5.30×10^{-5}	1.69×10^{-6}	3.04×10^{-7}	3.04×10^{-7}
No. people	10	10	10	4	4
Occupancy	0.25	0.006	0.006	0.464	0.286
Risk Exposure (cpm)	0.076	0.315	0.01	0.002	0.087
EV	0.76	2.21	0.07	0.57	0.35

Combining the risks from each of the elements in the table, the two EV works out as 3.95.

Referring to the HSA's LUP guidance, the total off-site EV should not exceed the criterion upper limit EV of 10,000. Between EVs of 100 and 10,000, it should be demonstrated that all practicable efforts have been made to reduce the risk to a level that is as low as reasonably practicable (above a developmental EV level of 450, an FN curve will be required as part of the demonstration). The significant modifications guidance also states that where the EV is below a threshold of 450, there is no requirement for a full societal risk assessment for the proposed modification.

The calculated EV for the proposed development is much lower than the LUP or significant modifications thresholds.

7 CONCLUSIONS

7.1 Land Use Planning Criteria

The proposed development meets the HSA criteria for land use planning:

- Examining the populations exposed to the risk contours generated by the new plant, they are all employees of SSE and are classed as Sensitivity Level 1. These can be accommodated within the Inner Zone established by the risk contours. As such, all populations exposed to risks from the new plant are in accordance with the criteria from the HSA's risk matrix (as shown in Table 2).
- The risks satisfy the criteria for new establishments, i.e. no members of the public would be exposed to risks of more than 10^{-6} per annum and no person at an off-site work location would be exposed to a risk of more than 5×10^{-6} per annum.
- The EV is lower than the 100 to 10,000 range cited in the guidance.

Based on the above, the HSA's LUP advice would be that the Authority does not advise against the development.

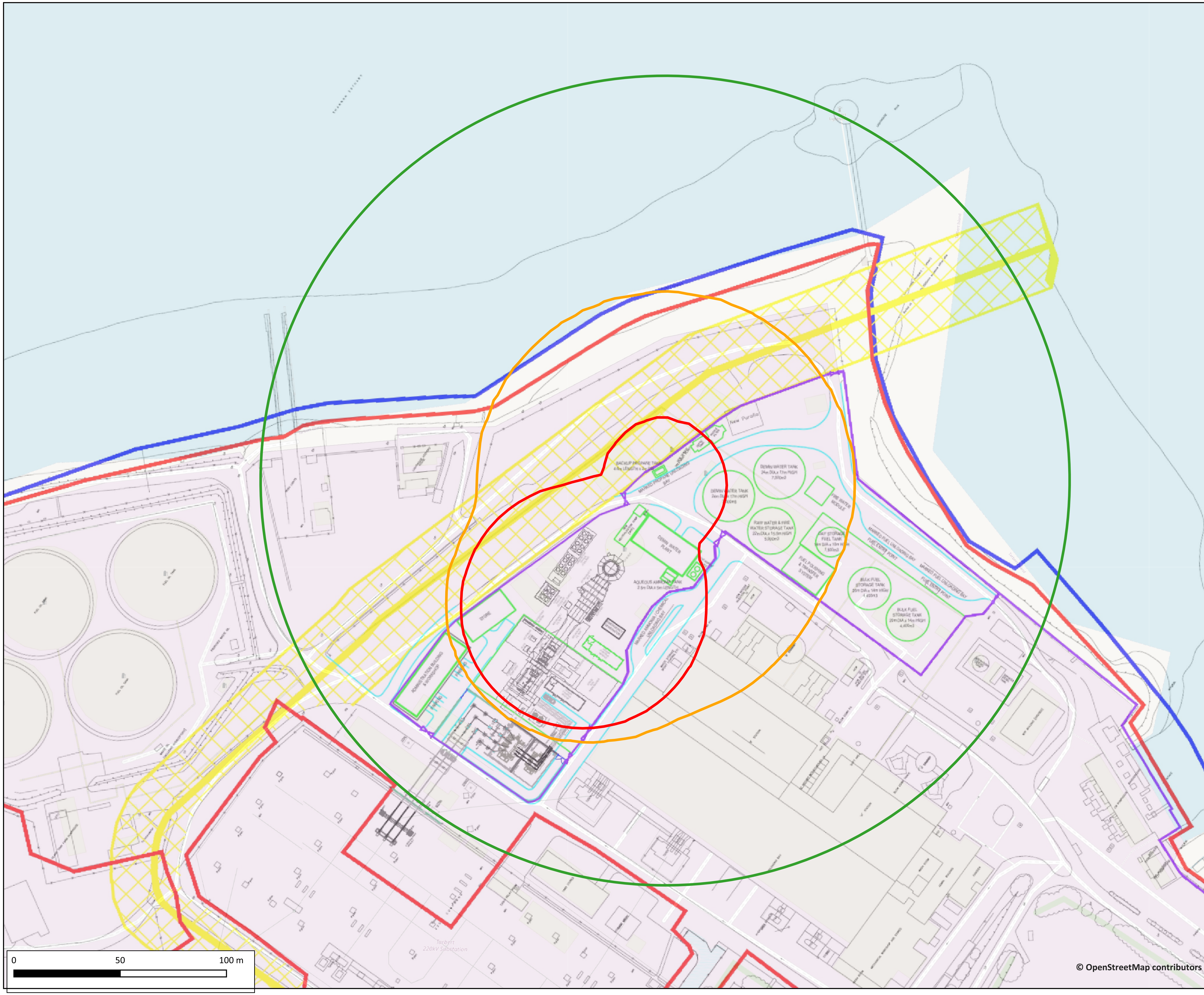
7.2 Significant Modifications Criteria

The proposed development meets the HSA criteria for significant modifications:

- The level of individual risk presented to each operator on site is less than 10^{-6} per annum, which is broadly acceptable, based on the HSA criteria.
- The risks associated with a major environmental release are also broadly acceptable, based on the CDOIF methodology.
- The EV is less than the threshold of 450 from the significant modifications guidance.

Based on the above, the risks associated with the development are broadly acceptable. Referring to the significant modifications guidance, a completed copy of Appendix 3 from the guidance will be maintained on file by SSE, as part of the management of change record.

APPENDIX 1: RISK CONTOUR PLOT



Legend

Risk Contours

- 1 x 10E-7
- 1 x 10E-6
- 1 x 10E-5

N

BYRNE Ó CLÉIRIGH
ENGINEERS CONSULTANTS

Byrne Ó Cléirigh Ltd.

30A Westland Square
Pearse Street, Dublin 2, D02 PN76, Ireland
t: 353 1 677 0733 | f: +353 1 677 0729 | e: info@boc.ie
www.boc.ie

Client	SSE Generation
Project	Land Use Planning
Title	Risk Contours
Scale	1:1615
FBS	483.07.02
	Appendix 1