AECOM

Shannon Technology and Energy Park (STEP) Power Plant

Appendix A2.4: Quantitative Risk Assessment and MATTE

Shannon LNG Limited

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Shannon Technology Energy Park (STEP) Power Plant Land Use Planning

Quantitative Risk Assessment (QRA) – Power Plant

Report Information

Shannon Technology Energy Park (STEP) Power Plant Land Use Planning: Quantitative Risk Assessment (QRA) – Power Plant		
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	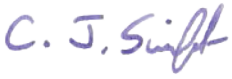	P.P. 
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List of Abbreviations

AGI	Above Ground Installation
BESS	Battery Energy Storage System
BLEVE	Boiling Liquid Expanding Vapour Explosion
CCA	Central Competent Authority
CCGT	Combined Cycle gas Turbine
CHP	Combined Heat and Power
COMAH	Control of Major Accident Hazards
cpm	Chances per million (years)
EV	Expectation Value
GNI	Gas Networks Ireland
HRSG	Heat Recovery Steam Generator
HSA	Health and Safety Authority
LFL	Lower Flammability Limit
LNG	Liquified Natural Gas
LOC	Loss Of Containment
LPG	Liquefied Petroleum Gas
LUP	Land Use Planning
QRA	Quantitative Risk Assessment
RNG	Renewable natural gas
SEP	Surface Emissive Power
SDS	Safety Data Sheet
STEP	Shannon Technology Energy Park
TLUP	Technical Land-Use Planning
UDM	Unified Dispersion Model
VCE	Vapour Cloud Explosion

Executive Summary

New Fortress Energy plans to construct a 600 MW power plant on Tarbert Ballylongford Landbank in the Kerry County Council Development Plant 2022-2028.

The STEP Power Plant consist of:

- A power plant, with different trains, with a total production capacity of 600 MW;
- Liquid fuel storage as power plant backup for production and the facilities needed to receive it; and,
- An above Ground Installation (AGI) accommodating valves and control equipment to receive the natural gas from pipeline.

The Irish Health and Safety Authority (HSA) is the statutory body providing technical land-use planning (TLUP) advice in Ireland, which it does at the request of a planning authority. Its policy on TLUP under the Seveso-III Directive [1] is presented in the document Guidance on technical land-use planning advice for planning authorities and COMAH establishment operators [2]. This document provides a clear guidance for the elaboration of a QRA for land use planning, defining scenario frequencies and modelling parameters, with emphasis in a risk-based approach. It identifies sector types and explains for each sector, the nature of accidents that will be considered, along with the scientific approach to estimate the likelihood of those accidents occurring. This enables lines of equal risk (isorisk contours) to be drawn on a map of the establishment and the surrounding area, defining three risk zones. Subsequently, based on the risk level, more or less intensive / extensive developments are allowed, with a decreasing likelihood of being advised against undertaking such developments as the risk decreases across the zones. The QRA conducted according to the HSA guidelines.

The QRA evaluates risk zones surrounding and due to the power plant and the diesel storage. With this aim, a comprehensive quantitative risk assessment (QRA) of the proposed Shannon Technology and Energy Park (STEP) 600 MW Power generation Combined Cycle Gas Turbine (CCGT) plant and the diesel storage unit has been conducted. The QRA has used the suite of models incorporated into the DNV SAFETI software (version 8.9). SAFETI is a comprehensive hazard and risk analysis software tool for all stages of design and operation.

The QRA evaluates risk to personnel associate with release from:

- The diesel storage unit;
- The AGI;
- The onsite piping; and,
- The power generation Combined Cycle gas Turbine (CCGT) Plant.

The following risks are evaluated:

- Individual risk of fatality contours;
- The individual risk at the nearest residential property;
- Societal risk FN curves for members of the public; and,
- The Societal risk Expectation Value (EV) for members of the public.

The conclusions drawn from the results are as follows:

- Comparing the QRA results against land use planning criteria shows there are no incompatible land uses in any of the three LUP zones;
- The individual risk at the nearest residential property is negligible;
- The societal risk has not been calculated as none of the populated areas are in the scope of the risk curves;
- The Expectation Value for members of the public is 0, as no lethality is expected in the populated areas near to the site.

1 Introduction

1.1 Project Background

New Fortress Energy plans to construct a 600 MW power plant on Tarbert Ballylongford Landbank in the Kerry County Council Development Plant 2022-2028.

The STEP Power Plant consist of:

- A power plant, with different trains, with a total production capacity of 600 MW;
- Liquid fuel storage as power plant backup for production and the facilities needed to receive it;
- An above Ground Installation (AGI) accommodating valves and control equipment to receive the natural gas from pipeline; and,

1.2 Objectives and Scope

This QRA evaluates risk to personnel (on-site and off-site) in relation to the power plant, the AGI and the diesel storage unit. The QRA was conducted in accordance with HSA guidelines, focusing solely on land-use considerations.

1.3 Location and Surroundings

As stated above, STEP is planned for the south bank of the Shannon estuary between Tarbert and Ballylongford in County Kerry, Ireland; this location is shown in Figure 1 (marked in red).

The STEP is to be located on a circa 603-acre site on the Shannon Estuary at Ralappane, between Tarbert and Ballylongford in Co. Kerry and accessed off the existing L-1010 (Coast Road).

The *Kerry County Development Plan 2022-2028* has zoned the site ‘Industry’ as part of the Tarbert/Ballylongford Land Bank, and more specifically for marine related industry and compatible industries requiring deep water access.

Figure 2 provides an overview of the site.

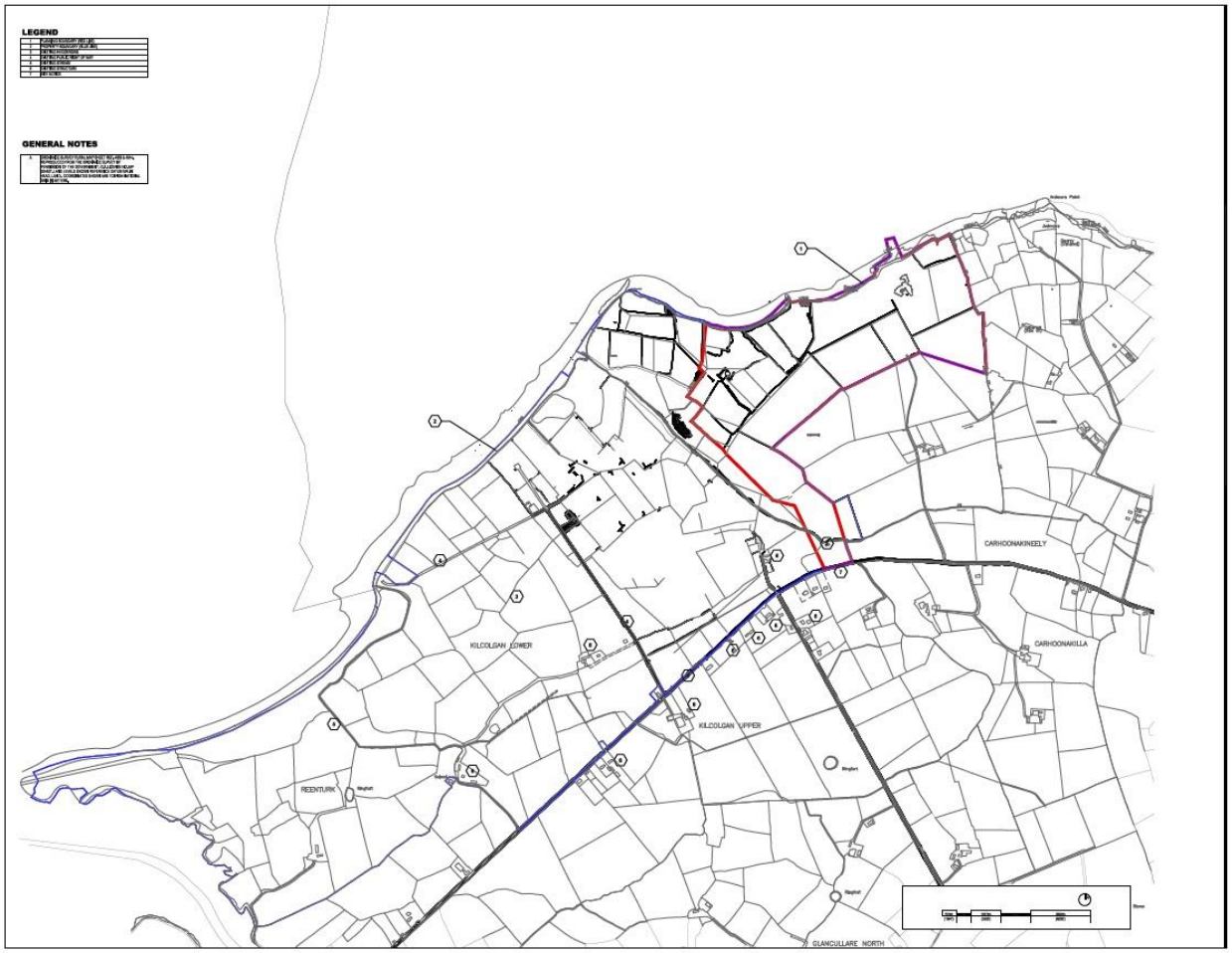


Figure 1 Site Location

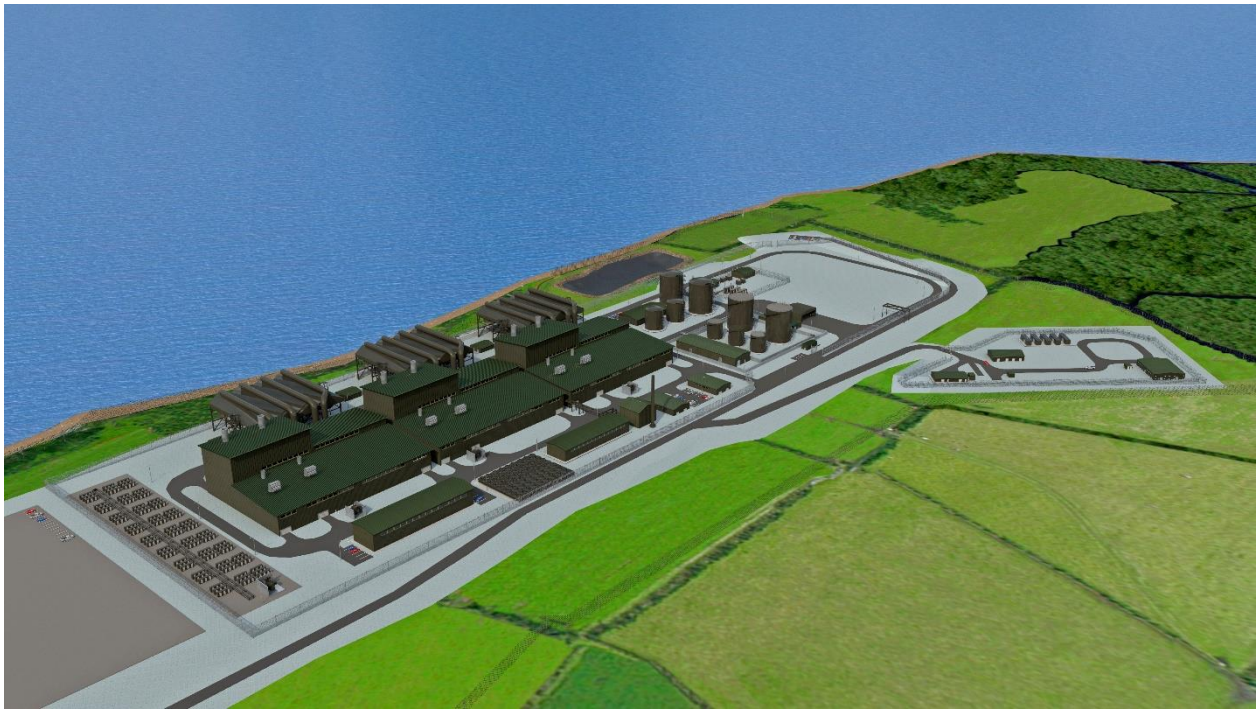


Figure 2 Proposed Site Overview

The location offers the following:

- A large unoccupied landbank on the coast which is zoned for industrial purposes adjacent to the foreshore;
- Access to high-capacity gas transmission system that can receive up to 800 mmscf/d;
- The ability to get a high voltage export grid connection offer within the generation capacity shortfall time window[1]; and
- Access to high-capacity electricity grid (220 kV or higher) that can export 600 MW without undue system constraint.

1.4 Site Summary

1.4.1 Power Plant

The proposed Power Plant will comprise of:

- A flexible modular power plant design with up to three (3) blocks of Combined Cycle Gas Turbines (CCGT), each block with a capacity of circa 200 MW for a total installed capacity of up to 600 MW. The multishaft arrangement of the power plant provides fast acting response with very low minimum stable generation and is ideally suited to support increased intermittent renewable generation. Each block shall comprise of two (2) gas turbine generators, two (2) heat recovery steam generator and one (1) steam turbine generator and an air-cooled condenser.
- A 120 MW for 1 hour (120 MWhr) Battery Energy Storage System (BESS). Due to its very fast response, the BESS supports intermittent renewable generation.
- High voltage 220 kV Substation;
- Auxiliary Boiler, powered by natural gas;
- Raw water treatment building;
- Firewater storage tanks and fire water pumps;
- Fuel storage consisting of five diesel tanks, two holding tanks and 3 day tanks, with a total capacity of 16000 m^3; and,
- Ancillary buildings.

1.4.2 AGI

The AGI will comprise of:

- Pig-trap (Bi-directional);
- Filtration;
- Fuel gas heaters/ heat exchangers and associated fuel gas skid;
- Metering equipment located in a Metering Building;
- Gas pressure regulation system located in a Regulator Building;

1 An application to connect to the national electrical transmission network via this 220 kV connection was submitted to EirGrid in September 2020. A Connection Agreement for a 600 MW Maximum Export Connection (MEC) was executed with EirGrid in 14th April 2023.

- Gas chromatographs/ Chromatograph Building;
- Generator Kiosk; and
- Control and Instrumentation building.

1.5 Hazardous Substances

Hazardous substances present in the power plant were identified during the MATTE preparation. Materials subject to control under COMAH regulations identified are presented in Table 1.

Table 1 Substances subject to control under COMAH regulations in the power plant

Substance
Natural gas
Diesel
Transformer oil
Cleaning materials, laboratory chemicals and paints

The QRA focuses only on accidents involving hazardous substances in quantities that are expected to lead to offsite impacts, which, in the power plant, are natural gas and diesel. Consequently, the scope of the study is limited to areas where these substances are present. The following sections presents the properties and the hazards related to natural gas and diesel.

1.5.1 Properties of Natural Gas

Natural gas is a mixture of low molecular weight (typically ≤ C4) hydrocarbons (predominantly methane), and in the present study it has been modelled as pure methane as only a very small fraction of the product stream will be heavier hydrocarbons. Physical properties for methane are provided in Table 2.

Table 2 Properties of methane [6]

Property	Value
Chemical Formula	CH_4
CAS Number	74-82-8
Appearance at 20°C	Colourless Gas
Atmospheric Boiling Point (°C)	-161.5
Melting Point (°C)	-182.5
Liquid Specific Gravity	0.422
Vapour Density (air = 1)	0.55
Lower Flammable Limit (vol %)	5
Upper Flammable Limit (vol %)	15
Flash Point (°C)	-188
Auto Ignition Temperature (°C)	595
Long Term Exposure Limit	N/A

Property	Value
LD_{50}	N/A
Eco-toxicity	Unlikely to cause adverse effects
Degradability	Disperses rapidly

1.5.2 Hazards of Natural Gas

The principal hazards of natural gas result from its:

- Flammability; and,
- vapour dispersion characteristics.

Natural gas is flammable when mixed in air at concentrations from 5 to 15% (volume basis).

The possible outcomes after a release of natural gas are a jet fire if an immediate ignition occurs and a flash fire or explosion if a delayed ignition occurs. These outcomes are shown in Figure 3.

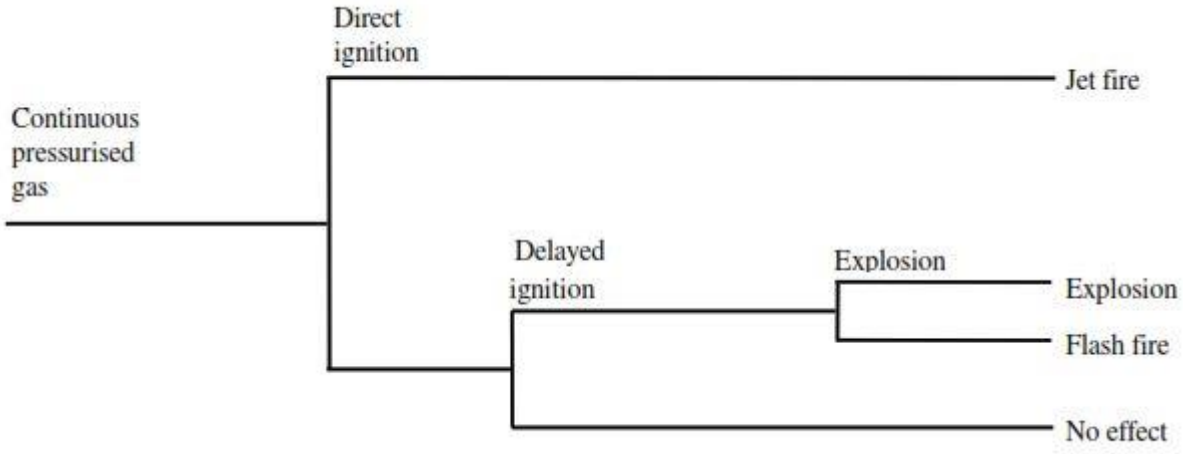


Figure 3 Event tree for a continuous release of a flammable gas (source: BEVI [3])

The description of the possible outcomes is presented below.

Jet fire

If natural gas is released from storage tanks, piping or pressurized equipment, it will form a gas jet that entrains and mixes with the ambient air. If the material encounters an ignition source while it is within the flammable range, it may result in a jet fire. Such fires have the potential to cause severe damage, but associated consequences are highly dependent on the direction of release (i.e. not omni-directional).

Flash Fire

When natural gas is released to the atmosphere, a vapour cloud forms and disperses (mixing with air as it does so). If the resultant vapour cloud is ignited before the cloud is diluted below its LFL, a flash fire may occur. The combustion normally occurs within only portions of the vapour cloud (where mixed with air in flammable concentrations), rather than the entire cloud. A flash fire may burn back to the release point, resulting in a jet fire but is unlikely to generate damaging overpressures (explode) when unconfined.

Explosions

If some confinement is present when a natural gas vapour cloud ignites, it can produce damaging overpressures. Areas congested with equipment and structures can facilitate damaging overpressures if a vapour cloud is ignited within such an area. For example, if a vapour cloud infiltrates a process plant area with various vessels, structures, and piping and the cloud ignites, the portion of the cloud within that congested area may generate damaging overpressures.

If no ignition point is present, the flammable cloud will ultimately disperse with no effects.

1.5.3 Properties of Diesel

Diesel is used as an alternative fuel for the power plant. While it won't be used regularly, two separate tests will be conducted annually. Diesel fuel is defined as any liquid fuel suitable for use in diesel engines. It is derived from crude oil and primarily composed of heavy hydrocarbons (C8+).

Table 3 presents diesel properties according to the SDS provided by the supplier.

Table 3 Properties of diesel

Property	Value
CAS Number	64742-79-6
Appearance at 20°C	Bright yellow liquid
Atmospheric Boiling Point (°C)	172 to 379ºC
Melting Point (°C)	-40 to 6ºC
Liquid Density	0.8 to 0.9 g/cm^3
Vapour Density (air = 1)	N/A
Lower Flammable Limit (vol %)	N/A
Upper Flammable Limit (vol %)	N/A
Flash Point (°C)	>56ºC
Auto Ignition Temperature (°C)	224ºC
LD_{50} oral rat	>5000 mg/kg
Eco-toxicity	Toxic to aquatic life with long lasting effects

1.5.4 Hazards of Diesel

The Globally Harmonised System for the Classification and Labelling of Chemicals (GHS) classifies all diesel liquids as "Flammable Liquid Category 3". According to the SDS provided, the diesel used in the power plant has a flash point greater than 56ºC.

Referring to the decision tree from the guide [2], (Figure 8.- Assignment of Ignition Category), diesel it categorized as an Ignition Category 3 substance, corresponding to an ignition probability of 0. However, for conservative considerations, a probability of ignition of 0.01 is assumed, a value aligned with Category 2 liquids.

The consequence following a loss of containment (LOC) of diesel will be a pool fire, confined or unconfined depending on the location of the release.

The guide provides a maximum surface emissive power (SEP) of heat radiated outwards per unit surface area of the flame from a pool fire of 130 kW/m^2.

2 Facility Description

The QRA has considered hazards from natural gas and diesel associated with operation of:

- The AGI;
- The power generation Combined Cycle gas Turbine (CCGT) Plant; and,
- The diesel storage unit.

2.1 Above Ground Installation (AGI)

The AGI will accommodate the valves and control equipment to facilitate the connection to the already consented 26 km Shannon pipeline. It will facilitate the transportation of gas from GNI and will include fiscal metering and pressure control of the gas flow. The AGI is located in a separate compound within the Proposed Development site covering an area of approximately 11,282 m^2.

The details provided on the AGI are based on information provided by Gas Networks Ireland (GNI) and will be typical of existing GNI AGIs on the national gas transmission network.

The AGI compound will be remotely operated and will normally be unmanned.

The proposed AGI general arrangement is shown in Appendix B.

2.2 Power Plant

The power plant will primarily operate using natural gas and will export generated power via the 220 kV connection to the national electricity grid. The usual fuel supply to the power plant will come from the gas grid through the Above Ground Installation (AGI). However, twice a year, the plant will conduct a diesel test utilizing the diesel stored in the tanks.

The proposed Power Plant general arrangement is shown in Appendix C.

2.3 Diesel Storage Unit

The Diesel will be used as an alternative fuel for the power plant. It will be stored in 6 tanks: two 5,000 m^3 fuel oil storage tanks (A and B) and three 2,000 m^3 fuel oil storage day tanks (A, B and C).

The layout of these tanks is shown in Appendix D.

3 Overview of the QRA Methodology

3.1 Introduction

The COMAH Regulation 24 refers to the siting and development of new establishments. In this context, new establishments are expected to provide sufficient information to enable the Central Competent Authority (CCA) to apply the method outlined in the guidance [2]. Specifically, the individual location-based risk contours depicted in Figure 4 must be plotted on a map.

Figure 4 Individual risk zones to be plotted on a map according to the guide [2]

Four development types are defined, and each one is permitted or forbidden based on the zone where it is located and the risk contours outlined. The acceptance criteria are shown in Figure 5:

Figure 5 Development types allowed in each risk zone according to the guide [2]

The definition of development types is presented in Appendix A.

Additionally, depending on the results, a societal risk evaluation may also be necessary.

3.2 Sectors

The guide [2] defines 13 different sectors, each of which with characteristic dangerous substances and types of major accidents. For each sector, a method of generating generic TLUP risk zones is elaborated. For complex sites, sector-specific approaches from the guide can be combined.

As the power plant is not specifically mentioned in the guide, a combination of scenarios from other sectors has been used (see Section 3.3).

3.3 Scenarios and Frequencies Definition

To define the scenarios to be calculated, all installations and equipment present in the power plant have been compared to those outlined in the guide. Subsequently, a selection based on their similarities has been made. All scenarios are defined to occur either in the power plant or in the storage unit.

3.3.1 Scenarios in the AGI

In the power plant, the only dangerous substance present is the natural gas.

Natural gas is fed to the power plant via a pipeline. Scenarios for natural gas aboveground pipelines are defined in table 40 of the guide [2] and are shown below in Table 4.

Table 4 Scenarios for aboveground natural pipelines with D > 150 mm (Table 40 of the guide [2])

LOC scenario	Frequency (m^{-1} yr^{-1})	Event #, [2]
Pipeline rupture	1E-07	087
Pipeline leak of 0.1D (max 50 mm)	5E-07	088

3.3.2 Scenarios in the Power Plant

In the power plant, the only dangerous substance present is the natural gas.

Natural gas is fed to the turbine via a pipeline. Scenarios for natural gas aboveground pipelines are defined in table 40 of the guide [2] and are shown in Table 4.

An additional scenario, specific to steam turbines, has been included, shown in Table 5.

Table 5 Additional scenario, specific for steam drums in the HRSG

Initiating event	Consequence
Failure of the containment of the high-pressure steam vessel	BLEVE

The BLEVE occurring in a steam drum results in a significant overpressure primarily concentrated close to the centre of the explosion and rapidly diminishing with distance. In addition, given the substance involved is water, there are no thermal effects (fireball). Considering these factors, coupled with the vessels' locations, it is anticipated that the lethality curves associated with this scenario will not extend beyond the site boundaries. As the focus of this QRA is on external risk only, this scenario has been excluded from consideration.

There is the potential for a major accident scenario which involves the application of firewater and subsequent release to the environment due to the presence of the BESS. Although there are secondary and tertiary containment systems which will be installed at the proposed development, these may be insufficient to cope with the potentially large volume of water which may be needed to actively contain a thermal runaway event associated with the BESS. Additional fire suppression systems such as gas purging systems linked to temperature / carbon monoxide sensors may minimise the extent of a thermal runaway event and reduce the requirement for fire water. Water used in managing a thermal runaway event may contain other heavy metal ions and toxic substances such as hydrogen fluoride, which have potential to cause harm to human health and the environment. This scenario has environmental consequences that can reach offsite, but the thermal radiation due to the fire will affect only the BESS building, not reaching offsite. Therefore, the scenario has not been calculated in the QRA.

3.3.3 Scenarios in the Storage Unit

For the liquid fuel storage, scenarios are extracted from the "Flammable liquid storage installations" on chapter 3.6 of the guide [2]. As mentioned previously, diesel is categorized as a category 3 substance, for which no scenarios need to be described. However, as a conservative approach, the QRA will treat Diesel as a Category 2 substance. The scenarios and their frequencies to be considered are shown in Table 6.

Table 6 Scenarios for diesel tanks (Table 48 of the guide [2])

LOC scenario	Leak Frequency (yr^{-1})	Ignition Probability	Consequence	Consequence Frequency (yr^{-1})	Event #, [2]
Instantaneous failure	5E-06	0.01	Pool Fire	5E-08	123
Failure over 10 minutes	5E-06	0.01	Pool Fire	5E-08	125
10 mm pipe leak over 30 minutes	1E-04	0.01	Pool Fire	1E-06	127
Overtop pool fire	-	-	Pool Fire	5E-08	--

The guide does not consider scenarios related to flammable liquid pipelines. Vysus recommends using the values from the BEVI [3]. The corresponding scenarios are shown below in Table 7:

Table 7 Scenarios for aboveground pipelines (according to BEVI [3])

LOC scenario	Frequency (m^{-1} yr^{-1})		
	D < 75 mm	75 mm ≤ D ≤ 150 mm	D > 150 mm
Pipeline rupture	1E-06	3E-07	1E-07
Pipeline leak of 0.1D (max 50 mm)	5E-06	2E-06	5E-07

The transport of diesel to the power plant via pipeline is expected to be carried out twice a year when the power plant is run on diesel as a test, lasting just a few hours. A total pipeline operation time of 24 h per year has been initially considered. However, there may be an incipient problem that is not revealed whilst the pipeline is not in operation, leading to a leak when the pipe is in use; and therefore, the enabling factor of use is not considered.

Table 8 Scenarios for aboveground pipelines (according to BEVI [3])

LOC scenario	Frequency (m^{-1} yr^{-1})	Ignition P	Length (m)	Pool fire freq. (yr^{-1})
Pipeline rupture	3E-07	0.01	350	1.05E-06
Pipeline leak of 0.1D (max 50 mm)	2E-06	0.01	350	7.00E-06

Diesel unloading operations are expected to be conducted very infrequently as the diesel is only maintained as a backup fuel and no consumption is foreseen. Considering the presence of trucks as once per year, with a total duration of the unloading operation of 12 h, frequencies for transport scenarios are presented in Table 9:

Table 9 Scenarios for aboveground pipelines (according to BEVI [3])

LOC scenario	Frequency (yr^{-1})	Trucks per year	Unloading duration (h)	Ignition P	Pool fire freq. (yr^{-1})
Instantaneous failure	1E-05	1	12	0.01	1.37E-10
Leak largest connection	5E-07	1	12	0.01	6.85E-12

Unloading operations from truck have not been considered in the QRA due to the fact that the risk is negligible compared to the minimum risk level to be considered from the guide [2] of 1E-07/y.

3.4 Consequence Analysis

The purpose of consequence analysis is to determine the potential outcome (or outcomes) of the various scenarios comprising the QRA. Consequence analysis may be broken down into the following steps:

- Source term modelling;
- Physical effects modelling; and,
- Impact modelling.

SAFETI performs these steps in a single model that automatically proceeds from one step to the next.

3.4.1 Source Term Modelling

Source term modelling determines the behaviour of the material upon leakage, in terms of:

- Release rate and / or quantity;
- The velocity of the material;
- The phase of the material (liquid, gas / vapour or two-phase); and,
- The conditions within the material upon release (temperature, density, etc.).

Where the material forms a pool of liquid, it will also be necessary to model the pool spreading and rate of vaporisation of material from the pool. Where a bund (i.e. secondary containment) is provided, the potential size of the pool is limited to the size of the bund.

3.4.2 Physical Effects Modelling

Modelling of physical effects predicts the behaviour of the material once it has been released, using the source term modelling results as inputs. The types of physical effects considered may include:

- Gas or vapour dispersion;
- Fire dimensions and heat output (for ignited releases of flammable material); and,
- Size and strength of explosions (for ignited flammable clouds in congested / confined regions).

Since some of the calculations performed can be quite complex, and the number of calculations required in a QRA study can be large, software packages are usually employed to perform the modelling.

3.4.3 Impact Modelling

Impact modelling evaluates the effect of different physical phenomena on receptors of interest (i.e. people, environmental features or assets, depending on the objectives of the study). In the present study, the parameters used for impact modelling are derived from the guide [2]. Specifically, the parameters related to flammable substances, given the absence of toxic substances in the STEP.

To estimate the fatal consequences of major accidents, established probit relationships for fatality are used; these are conservatively derived and help to ensure consistency in approach, resulting in a risk-based analysis that is robust and transparent. A range of consequences can be expected in a population exposed to an acute hazard (dose) which can be represented mathematically by a dose-response curve, with the number of people suffering fatal effects being the response.

Below are described the probit equations used in the QRA for estimating the consequences of specific types of major accident as detailed in the HSA guide [2].

3.4.3.1 Consequences for thermal radiation

Thermal radiation exposure arises from fire-type events, with accidents that give rise to a thermal (heat) effect having a different impact on indoor and outdoor populations.

The thermal effect on people outdoors (i.e. directly exposed to the thermal radiation) is determined by the following probit equation from the HSA guide [2]:

$$Probit = -14.9 + 2.56 \cdot \ln\left(I^{1.33} \cdot t\right) \qquad (1)$$

Where I is the incident heat flux in kW/m^2 and t is the exposure duration in seconds. The recommended value for t is 60 seconds. Using this value, equation ***(1)*** gives the following fatality percentages at the heat flux levels shown in Figure 6.

Figure 6 Heat flux and fatality levels, outdoor, for a 60s exposure

For flash fires, the HSA guide [2] stipulates that a fatality rate of 100% is assumed inside the lower flammability limit (LFL) envelope, with 0% fatalities outside that envelope.

People inside buildings will have some protection from the effects of incident thermal radiation. The guide [2] stipulates the following values in Figure 7 for relevant thermal radiation thresholds.

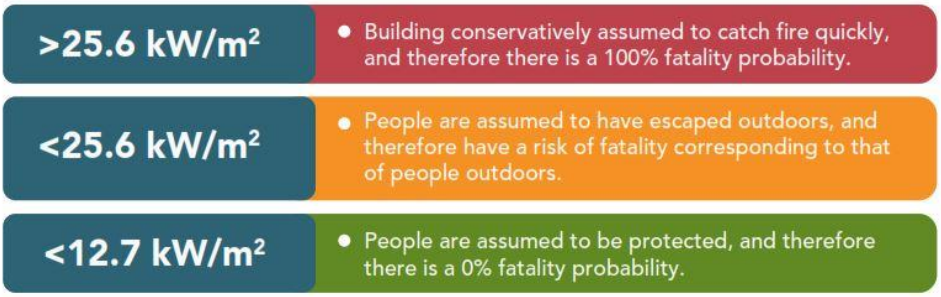


Figure 7 Heat flux levels relevant for people within buildings

For flash fire, within the flash fire envelope, indoor fatality levels are conservatively assumed to be 10% in the HSA guide [2].

3.4.3.2 Consequences for explosion overpressure

The probit equation used for determining consequences from blast overpressure for personnel outside presented in the guide [2] is:

$$Probit = 1.47 + 1.35 \cdot \ln(P) \qquad (2)$$

With P in psi.

This relationship applies only to people exposed to blast overpressure outdoors and gives the following in Figure 8 relationship between overpressure and fatality.

Figure 8 Overpressure fatality thresholds for people outdoors

As the plant constitutes an open and uncongested area, overpressure dissipates quickly and negligible effect at offsite buildings is expected, specially considering there are no buildings close to the site. Hence, overpressure over people indoors is not calculated.

3.5 Frequency Analysis

In general terms, frequency analysis is used to calculate:

- The likelihood of a given release of dangerous material occurring – this is usually expressed as a frequency (e.g. 1E-03 per year, or once in a thousand years);
- Given that a release has occurred, the probability that a given type of physical effect follows – for example, for releases of flammable material, the type of effect may depend on whether the material is ignited soon after the release begins, or at some time later; and,
- Given that a certain type of physical effects results, the probability of an undesired outcome – this may depend on the wind direction, the probability that a person is present within the hazard range, and the probability of successful emergency action.

Frequency analysis approaches fall into three categories:

- Use of relevant historical data;
- Use of analytical or simulation techniques (such as fault tree analysis or event tree analysis); and,
- Use of expert judgment.

In the present QRA, frequency values from the HSA guide [2] have been used in all scenarios for natural gas and diesel. Regarding the specific scenario, explosion in the steam vessel, has been considered equivalent to a rupture of a process vessel. A frequency of 5E-06/year has been obtained from the BEVI guideline [3].

3.6 Risk Analysis

In simple terms, risk is the chance of an undesired outcome with the chance usually expressed as a frequency; the undesired outcome may be fatality, environmental damage or financial loss. In terms of risks to people, there are different types of risk outputs that may be calculated using QRA:

- Risk indices (such as Fatal Accident Rate);
- Individual risk usually expressed as the risk of harming a hypothetical person with a defined set of characteristics. Individual risk results may be expressed as a point value (the individual risk to a hypothetical person at a given geographical location), as a graph of individual risk versus distance (a risk transect) or as risk isocontours overlaid on a map;
- Societal risk, which expresses the frequency with which different numbers of people could be affected by an accident. It is usually presented as an ‘FN curve’, where F is the frequency with which N or more people are affected.

3.7 Risk Assessment

Once the risk analysis results have been obtained, it is necessary to assess their significance. This usually involves comparison of the results with risk acceptance criteria. The risk acceptance criteria used in this study corresponds to the criteria shown in Figure 4 (see Section 3.1).

4 Identification of Scenarios

Scenarios for inclusion in the QRA have then been obtained from the guide.

The scenarios have been coded as follows: XX-YY-nn A/B… with:

- XX: the substance considered in the scenario, being NG for Natural Gas and DI for Diesel;
- YY: the location of the scenario, being AG the Aboveground Installation and PP the Power Plant (including the storage area);
- nn consecutive number to identify the scenario; and,
- A/B… to indicate that the scenario is repeated in identical equipment.

A complete list of the considered scenarios and their conditions is shown in Table 10.

Table 10 Scenario conditions

Scn. ID	Description	Substance	Pipe diameter (mm)	Pipe length (m)	Vessel / Tank diameter (m)	Height / Length (m)	Temperature (°C)	Pressure (barg)
NG-AG-01	Rupture of the natural gas pipeline	Natural gas	750	250 (1)	--	--	Ambient	
NG-AG-02	Leak in the natural gas pipeline	Natural gas	750	250 (1)	--	--	Ambient	
NG-AG-03	Rupture of the natural gas pipeline	Natural gas	250	100 (1)	--	--	Ambient	
NG-AG-04	Leak in the natural gas pipeline	Natural gas	250	100 (1)	--	--	Ambient	
NG-PP-01	Rupture of the natural gas pipeline	Natural gas	250	872	--	--	Ambient	45
NG-PP-02	Leak in the natural gas pipeline	Natural gas	250	872	--	--	Ambient	45
DI-PP-01A/B/C	Instantaneous release of the content of tanks A/B	Diesel	--	--	18	21	Ambient	Atmospheric
DI-PP-02A/B/C	Failure over 10 minutes of tanks A/B	Diesel	--	--	18	21	Ambient	Atmospheric
DI-PP-03A/B/C	10 mm pipe leak over 30 minutes from tanks A/B	Diesel	--	--	18	21	Ambient	Atmospheric
DI-PP-04A/B/C	Overtop fire on tanks A/B	Diesel	--	--	18	21	Ambient	Atmospheric
DI-PP-05A/B	Instantaneous release of the content of day tanks A/B/C	Diesel	--	--	13	15.5	Ambient	Atmospheric
DI-PP-06A/B	Failure over 10 minutes of day tanks A/B/C	Diesel	--	--	13	15.5	Ambient	Atmospheric
DI-PP-07A/B	10 mm pipe leak over 30 minutes from day tanks A/B/C	Diesel	--	--	13	15.5	Ambient	Atmospheric
DI-PP-08A/B	Overtop fire on day tanks A/B/C	Diesel	--	--	13	15.5	Ambient	Atmospheric
DI-PP-09	Pipeline rupture	Diesel	50	365	--	350	Ambient	10
DI-PP-10	Pipeline leak of 0.1D (max 50 mm)	Diesel	50	365	--	350	Ambient	10

(1) To account for possible pipe features such as bends or changes in direction, and to be more conservative (since the frequency is per meter) this estimated length has been multiplied by a factor of 2 in the final calculations.

5 Frequency Analysis

5.1 Piping and Equipment Release Frequencies

The frequency of releases from equipment used are those from the guide [2].

Table 11 shows the summary of piping and equipment scenarios and their frequencies and sources.

Table 11 Release frequencies used for piping and equipment

Substance	Scenario	Frequency	Source
Natural gas	Pipeline rupture	1E-07 ($m^{-1} \cdot yr^{-1}$)	Table 40 of the guide [2]
	Pipeline leak of 0.1D (max 50 mm)	5E-07 ($m^{-1} \cdot yr^{-1}$)	Table 40 of the guide [2]
Diesel	Instantaneous failure of the tank	5E-06 (yr^{-1})	Table 48 of the guide [2]
	Release of the content in 10 minutes	5E-06 (yr^{-1})	Table 48 of the guide [2]
	10mm pipe leak over 30 minutes	1E-04 (yr^{-1})	Table 48 of the guide [2]
	Pipeline rupture	1E-06 ($m^{-1} \cdot yr^{-1}$)	Table 40 of the guide [2]
	Pipeline leak of 0.1D (max 50 mm)	5E-06 ($m^{-1} \cdot yr^{-1}$)	Table 40 of the guide [2]

5.2 Specific Scenario

The specific scenario's frequency has been estimated using the BEVI [3] values for failures of process vessels. The explosion has been assimilated to the instantaneous release of the entire contents of the vessel.

Table 12 Frequencies for explosion in the steam drum

Substance	Scenario	Frequency	Source
Water	Explosion in the steam vessel due to a failure of the containment system	5E-06 (yr^{-1})	Table 31 of the BEVI [3]

5.3 Release Outcome Frequency

A given release of flammable material may ultimately result in a variety of outcomes, depending on a number of factors, including whether automatic isolation is successful, whether ignition of the release occurs immediately or whether it is delayed.

For diesel releases, the only possible consequence is the formation of a pool (i.e. if ignition takes place, it results in a pool fire).

For releases of natural gas, the possible outcomes are jet fire, flash fire or explosion, as presented in Section 1.5 and in Figure 3.

The probability of successful leak detection and automatic isolation of the pipe has been taken as 0.99, with a detection time of 30s.

6 Ignition

Ignition probabilities to be used, according to the guide [2] are shown in Table 13.

Table 13 Ignition Probability

Substance	Immediate Ignition Probability	Delayed Ignition Probability	Source
Natural gas	0.09	0.91	Table 20 of the guide [2]
Diesel	0.01	0	

7 Consequence Modelling

7.1 Modelling Software

The Shannon Power Plant QRA has used the suite of models incorporated into the DNV SAFETI software (version 8.9). SAFETI is a comprehensive hazard and risk analysis software tool for all stages of design and operation.

SAFETI evaluates the progress of a potential incident from the initial release to far-field dispersion including modelling of pool spreading and evaporation, and flammable and toxic effects.

SAFETI contains models tailored for hazard analysis of offshore and onshore industrial installations. These include:

- Discharge and dispersion models, including a Unified Dispersion Model (UDM).
- Flammable models, including resulting radiation effects, for jet fires, pool fires and boiling liquid expanding vapour explosions (BLEVEs).
- Explosion models, to calculate overpressure and impulse effects.

7.2 Fluid Composition

As discussed in Section 1.5.1, releases from the natural gas pipeline are modelled as methane releases. Diesel releases are modelled as dodecane releases.

7.3 Operating Conditions

Operating conditions for each release scenario are provided in Section 4.

7.4 Effect of Bunding

Releases of diesel are assumed to be confined within the dimensions of the bunded area containing the tanks, estimated at 3,900 m^2.

For the scenario of overtop fire, the pool is confined on the top of the tank, so the pool area is the area of each tank: 254 m^2 for the two 5,000 m^3 fuel oil storage tanks (A and B) and 133 m^2 for the three 2,000 m^3 fuel oil storage day tanks (A, B and C).

7.5 Effect of Topography

At the proposed location, when moving south from the riverbank, the terrain elevates to an approximate height of 30 metres before gradually descending. The Shannon facility will be constructed on ‘plateaux’ carved into the hillside descending toward the river.

It has been assumed that topography has minimal effect on dispersion of natural gas.

7.6 Releases onto Land and Water

The only liquid release evaluated in this QRA is a release of diesel from the diesel tanks. The diesel tanks are in a triple containment system, with 2 bunded areas. This contains the diesel within the bunds and prevents the diesel from spreading onto the water.

7.7 Dispersion Modelling

Dispersion of methane is dependent on several parameters, including: surface roughness, averaging time, material properties, wind speed and weather conditions. The weather data used in the study are discussed in Section 7.10.

Diesel releases will be contained within the bund around the tanks, with minmal gas flashing off.

7.8 Surface Roughness Parameter

Surface (terrain) roughness affects how quickly and how far a release may spread. The guide [2] gives the roughness lengths in Figure 9 for typical types of terrain. As recommended in [2] for general terrain without defining features, a surface roughness parameter of 0.1 has been used in this study for dispersion as recommended in the guide [2].

#	Short description of the terrain	Roughness length (m)
1	Open water (at least 5 km)	0.0002
2	Mud flats, snow; no vegetation, no obstacles	0.005
3	Open, flat terrain; grass, a few isolated objects	0.03
4	Low vegetation; large obstacles here and there, x/h > 20	0.10
5	High vegetation; distributed large obstacles, 15 < x/h < 20	0.25
6	Park, bushes; many obstacles, x/h < 15	0.5
7	Strewn with large obstacles (suburb, wood)	1.0
8	Town centre with high-rise and low-rise buildings	3.0

Figure 9 Roughness lengths for given types of terrain

7.9 Averaging Time

When using gas dispersion models the ‘averaging time’ is a description of the time over which a gas concentration is averaged. At a particular point in space the concentration of a plume at equilibrium will vary for two reasons. Firstly, as the wind direction is not perfectly constant the plume will meander about a mean value. Secondly there are ‘in-cloud’ fluctuations due to the turbulence inherent in the atmosphere. As dispersion models aim to show a ‘time averaged’ concentration at a particular point, this average will depend on the length of time over which the concentration was ‘sampled’. The situation is made more complicated because the different types of dispersion model assume different definitions of ‘averaging time’.

The use of a short averaging time will maximise the recorded concentration at a given point, whereas a longer averaging time will give a lower value. This is because the use of a short averaging time captures the concentration ‘peaks’ at a location.

In this study an averaging time of 18.75 s has been used (this is the SAFETI default value for flammable gases).

7.10 Weather Data

Within a risk assessment, weather conditions are usually described as a combination of a letter with a number, such as ‘F2’. The letter denotes the Pasquill stability class and the number gives the wind speed in metres per second.

The Pasquill stability classes describe the amount of turbulence present in the atmosphere and range from A to F. Stability class A corresponds to ‘unstable’ weather, with a high degree of atmospheric turbulence, as would be found on a bright sunny day. Stability class D describes ‘neutral’ conditions, corresponding to an overcast sky with moderate wind. A clear night with little wind would be considered to represent ‘stable’ conditions, denoted by stability class F.

Wind speeds range from light (1-2 m/s) through moderate (around 5 m/s) to strong (10 m/s or more). The probability of the wind blowing from a particular direction is commonly displayed graphically as a ‘wind rose’.

According to the guide [2], dispersion should be modelled in D5 and F2 conditions, with a temperature of 15ºC used in D5 conditions and 10ºC for F2 conditions.

However, the wind directionality distribution is not given in the guide [2]. Therefore, nearest weather data is used to derive the directionality distribution probabilities. Shannon Airport is the nearest weather station, located 35 km away from the site, near Ballylongford, and is therefore the most representative data source to be used in the QRA.

A detailed analysis of the weather data during day and night has been performed for this study.

The fraction of time considered to be ‘day’ was calculated by assigning day and night hours to different months of the year, then calculating the number of daytime hours. Note that ‘day’ and ‘night’ were defined according to hypothetical resident behaviour (i.e. on when people may typically get up and go to bed, and not sunrise and sunset). Within the weather calculation, this has been defined as a 14 hour period during summer (defined as the period from April to the end of October, when daylight saving time operates) from 07:00 GMT (06:00 DST) until 21:00 GMT (20:00 DST); and a 12 hour period during winter (all months not defined as summer) from 06:00 GMT to 18:00 GMT.

The data were then processed to obtain wind direction probabilities (i.e. ‘wind rose’ data) and the proportion of time for which D5 and F2 weather conditions occurred. As part of this analysis combinations of stability and wind speed that are not F2 or D5 are grouped together and included in the F2 and D5 distribution. i.e. Stability Classes A, B, C and D are grouped together as D5, Stability classes E, F and G are grouped together as F2.

The guide [2] established that D5 conditions are assumed to occur 80% of the time and F2 conditions occurring for the remaining 20%. In the QRA this relation is maintained.

The results are shown in Table 14 and Table 15.

Table 14 Wind Rose for Day

Stability Class	Wind Sector															
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	WSW	WNW	NW	NNW
D5	0.037859	0.03706	0.02175	0.04749	0.11664	0.11708	0.06808	0.09121	0.19493	0.11961	0.06769	0.05836	0.03786	0.03706	0.02175	0.04749
F2	0.000843	0.00142	0.00062	0.00053	0.00155	0.00160	0.00089	0.00102	0.00355	0.00453	0.00311	0.00257	0.00084	0.00142	0.00062	0.00053

Table 15 Wind Rose for Night

Stability Class	Wind Sector															
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	WSW	WNW	NW	NNW
D5	0.01189	0.02006	0.01574	0.03758	0.08888	0.10377	0.05797	0.06342	0.11833	0.06567	0.02781	0.02335	0.01189	0.02006	0.01574	0.03758
F2	0.02598	0.02509	0.01682	0.01978	0.03782	0.02659	0.02034	0.02335	0.04148	0.04186	0.04214	0.04434	0.02598	0.02509	0.01682	0.01978

8 Populations

Onsite personnel and off site population numbers used in the assessment are described below.

8.1 Offsite Populations

In the event of a major accident, the likelihood of harm to a person indoors differs from that for a person outdoors (see section 3.4). Therefore, it is common practice for QRA studies to consider the proportion of time individuals may spend indoors and outdoors.

To account for time spent indoors and outdoors, the previous QRA study [7] employed the concept of a 'hypothetical house resident' originally developed by the UK HSE [8]. The hypothetical house resident is present all of the time at their dwelling, spending 90% of their time indoors during the day and 99% of their time indoors at night.

In accordance with the guide [2], it is assumed that people are indoors 90% of the time. While this value is considered very conservative, it has been utilized as indicated in the guide. However, an exception is the population in the Money Point Power Station, as this is an industrial site and therefore a higher proportion of time spent outdoors (i.e. more exposed to risk) is assumed. In this case, the estimation from the previous QRA is applied.

The offsite populations used are sourced from various references. Data in **bold** is acquired from reports from The Central statistics Office [10] and correspond with data from the 2022 census. Data for individual residences and the Money Point Power Station are taken from the QRA for the site undertaken in 2013 [9].

Table 16 Offsite Populations

Area / Location	No. People	Fraction indoor Day	Fraction Indoor Night
Individual residences within 2 km	4 per residence	0.9	0.9
Ballylongford	**415**	0.9	0.9
Tarbert	**546**	0.9	0.9
Kilrush	**2649**	0.9	0.9
Money Point Power Station	313	0.5	0.7

8.2 Onsite Personnel

The objective of the methodology described in the guidelines [2] relates to TLUP advice, wich is external to the establishment and is future oriented: the assessment methods presented are not sufficiently detailed to address risk to on-site populations and should not be used for that purpose.

9 Risk Criteria

9.1 Individual Risk

The current HSA criteria [2] are stated in terms of risk of fatality. Use of probit equations is prescribed for calculation of the probability of fatality given exposure to a dose of a harmful agent (such as thermal radiation, overpressure or toxic gas).

The land use planning zone boundaries in the HSA guidance [2] are presented in Figure 4 (see Section 3.1) and defined as:

- Zone 1 (inner): within the 1E-05/y individual risk of fatality contour;
- Zone 2 (middle): between the 1E-05/y and 1E-06/y individual risk of fatality contours; and,
- Zone 3 (outer): between the 1E-06/y and 1E-07/y individual risk of fatality contours.

The criteria for new establishments found in the HSA guidance [2] are:

- The maximum trolerable risk to a member of the public should not exceed 1E-06/y; and,
- The maximum tolerable risk to a person at an off-site work location should not exceed 5E-06/y.

Land uses are assigned to one of four 'Sensitivity Levels' as summarised in Appendix A.

9.2 Expectation Value (EV)

The EV is the calculated number of fatalities per year, multiplying the number of expected fatalities by the frequency in chance in a million years (cpm). For example, a major accident that could result in 120 fatalities with a frequency of occurrence of 1 cpm would have an EV of:

$$EV = 120 * 1 = 120 \qquad (3)$$

According to the HSA guidance, the total off-site EV should not exceed the criterion upper limit 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. Where the EV exceeds 10,000, the TLUP advice to the planning authority will always be 'Advice against'.

9.3 Societal Risk – FN Curve

When the risk of multiple fatalities from an accident should be taken into account more explicitly, the societal risk must be determined. Societal risk results are commonly presented as an 'FN' curve, which shows the cumulative frequency with which N or more fatalities are experienced.

HSE2001 [11] provides an upper limit value for an intolerable societal risk criterion: for a predicted accident occurring no more frequently than once in 5,000 years, there should be no more than 50 fatalities. This has gained international acceptance as an anchor point for a line (of slope -1) to create an intolerable societal risk criterion for single accidents. The HSA document [5] recommended using points at (200 cpm / 50 fatalities) and (1,000 cpm/10 fatalities) to create that line. An acceptable societal risk single risk criterion line can then be drawn at frequencies that are two orders of magnitude below the intolerable line (so a frequency of 1E-04 on the intolerable line becomes 1E-06 on the acceptable line). The risk criterion lines are shown in Figure 10.

Between the two lines, operators and potential operators will be required to demonstrate that, in relation to proposed changes, all reasonable efforts have been made to reduce the risk to a level that is as low as reasonably practicable.

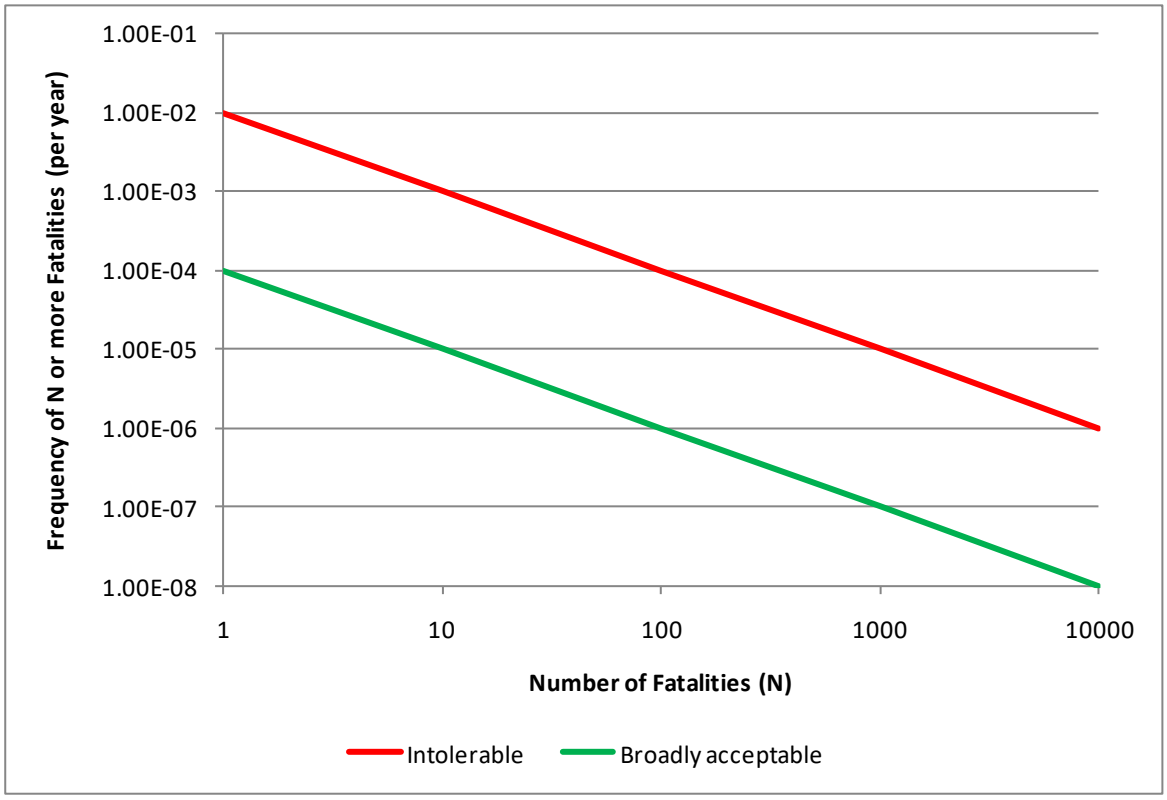


Figure 10 HSA Upper and lower societal risk criterion (log scale)

10 Risk Calculation Results

Individual risk of fatality and societal risk have been calculated using the DNV Safeti software (version 8.9).

10.1 Individual Risk

The individual risk contours for people outdoors in the area are presented in Figure 11 and Figure 12, contours for people indoors are presented in Figure 13 and Figure 14.

Figure 11 Outdoors Individual Risk Contours

Figure 12 Outdoors Individual Risk Contours with plot plant

Figure 13 Indoors Individual Risk Contours

Figure 14 Indoors Individual Risk Contours with plot plant

In both cases, indoors and outdoors, the risk curve corresponding to 1E-07/y slightly extends beyond the site limits, not affecting any installation or vulnerable element.

10.2 Expectation Value and Societal Risk

To determine the expectation value (EV) and societal risk, the population potentially affected by the risk from the plant has to be evaluated. For this purpose, the risk curve corresponding to 1E-09/y has been selected which serves as a conservative measure to define the affected population. It's worth noting that the guide [2]

does not impose any limitations beyond 1E-07/y. Figure 15 shows the 1E-09/y curve overlaid over a map with residential properties identified in purple.

Figure 15 Affected population

From Figure 15 it can be seen that there is no population that is within the 10-9/y per year risk level. Therefore the EV is 0, and hence an FN curve is not required.

11 Conclusions

A comprehensive quantitative risk assessment (QRA) of the proposed STEP has been performed. The analysis has been conducted in accordance with the current HSA guidance [2] and it does not constitute a full QRA of the risks to onsite personnel. It is intended for land use and permitting purposes only.

The following results have been obtained:

- Individual risk of fatality contours;
- The individual risk at the nearest residential property;
- Societal risk FN curves; and,
- Societal risk Expectation Values (EVs).

The results for the STEP project presented above have been compared with the HSA's risk criteria presented in Section 9.1.

The conclusions drawn from the results are as follows:

- Comparing the QRA results against land use planning criteria shows there are no incompatible land uses in any of the three LUP zones;
- The individual risk at the nearest residential property is negligible;
- The Expectation Value for members of the public is 0, as no lethality is expected in the populated areas near to the site. And hence no societal risk FN curve is required.

12 References

[1] 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, amending and subsequently repealing Council Directive 96/82/EC, Official Journal of the European Union, 24 July 2012.

[2] Guidance on technical land-use planning advice. For planning authorities and COMAH establishment operators. HSA, version 2, February 2023.

[3] RIVM (2009). Reference Manual BEVI Risk Assessments. Version 3.2.

[4] Chemicals Act (Control of Major Accident Hazards Involving Dangerous Substances) Regulations 2015. SI No. 209 of 2015.

[5] HSA (2010). Policy and Approach of the Health and Safety Authority to COMAH Risk-based Land-use Planning.

[6] Hazardous Chemicals Data Book, Second Edition1986. G. Weiss

[7] ERM (2007). Land Use Planning QRA Studies of the Proposed Shannon LNG Terminal. Report 0059890-R02 Issue 1.

[8] HSE (1989). Risk criteria for land use planning in the vicinity of major industrial hazards. HMSO Books C30.

[9] Land -Use Planning QRA of Alterations to Shannon LNG Terminal and addition of a CHP Plant. Scandpower Risk Management. Lloyd's Register. Report No 50102216 R01 Rev 03. 6/3/2013.

[10] An Phiromh Staidrimh; Census - CSO - Central Statistics Office

[11] Reducing risks, protecting people: HSE's decision-making process, HSE Books, 2001.

Appendix A. Description of Development Types According to the Guide [2]

In the guidance [2], four levels of development are defined as presented in Figure 16:

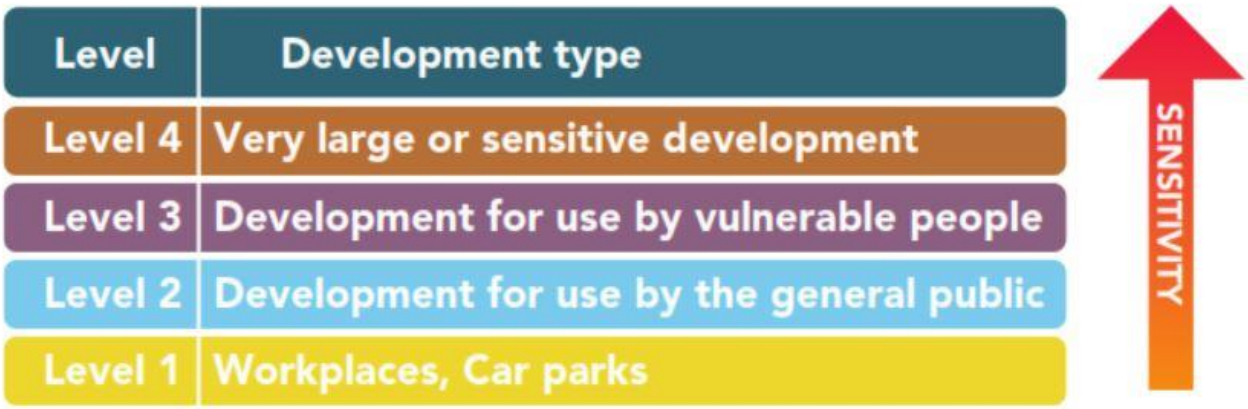


Figure 16 Levels of development according to the guide [2]

The more detailed description of these development levels is presented in the Appendix 2 of the guide [2] and shown next.

SENSITIVITY LEVEL 1: People at work, Car Parks

Level 1

DT1.1 – Workplaces

DT1.2 – Parking areas

DEVELOPMENT TYPE	EXAMPLES	DEVELOPMENT DETAIL AND SIZE	JUSTIFICATION
WORKPLACES (DT 1.1)	Offices, factories, warehouses, haulage depots, farm buildings, non-retail markets, builder's yards.	Workplaces (predominantly non-retail), providing for fewer than 100 occupants in each building **and** fewer than three occupied storeys – **Level 1**	Places where the occupants will be fit and healthy, and could be organised easily for emergency action. Members of the public will not be present or will be present in very small numbers and for a short time.
	EXCLUSIONS		
		Workplaces (predominantly non-retail) providing for 100 or more occupants in any building **or** 3 or more occupied storeys in height **(DT 1.1.1)** **Level 2** (except where the development is at the major hazard site itself, where it remains Level 1).	Substantial increase in numbers at risk with no direct benefit from exposure to the risk.
	Rehabilitation and training services for people with disabilities.	Workplaces (predominantly non-retail) specifically for people with disabilities – **(DT 1.1.2)** **Level 3**	Those at risk may be especially vulnerable to injury from hazardous events and/or they may not be able to be organised easily for emergency action.
PARKING AREAS	Car parks, truck parks, lock-up garages.	Parking areas with no other associated facilities (other than toilets) – **Level 1**	
	EXCLUSIONS		
	Car parks with picnic areas, or at a retail or leisure development, or serving a park and ride facility.	Where parking areas are associated with other facilities and developments the sensitivity level and the decision will be based on the facility or development. **(DT 1.2.1)**	

Appendix 2

Development sensitivity levels

SENSITIVITY LEVEL 2: Developments for use by the general public

Level 2

DT2.1 – Housing

DT2.2 – Hotel/Hostel/Holiday accommodation

DT2.3 – Transport links

DT2.4 – Indoor use by public

DT2.5 – Outdoor use by public

DEVELOPMENT TYPE	EXAMPLES	DEVELOPMENT DETAIL AND SIZE	JUSTIFICATION
HOUSING (DT 2.1)	Houses, apartments, retirement flats/ bungalows, residential caravans, mobile homes.	Developments up to and including 30 dwelling units **and** at a density of no more than 40 per hectare – **Level 2.**	Development where people live or are temporarily resident. It may be difficult to organise people in the event of an emergency.
	EXCLUSIONS		
	Infill, backland development (development of land at rear of existing property).	Developments of one or two dwelling units **(DT 2.1.1)** – **Level 1**	Minimal increase in numbers at risk.
	Larger housing developments	Larger developments for more than 30 dwelling units **(DT 2.1.2)** – **Level 3**	Substantial increase in numbers at risk
	Developments at high density.	Any developments (for more than two dwelling units) at a density of more than 40 dwelling units per hectare – **(DT 2.1.3)** **Level 3**	High-density developments.
HOTEL/HOSTEL/ HOLIDAY ACCOMMODATION (DT 2.2)	Hotels, motels, guesthouses, hostels, youth hostels, holiday camps, holiday homes, student accommodation, accommodation centres, holiday caravan sites, camping sites.	Accommodation of up to 100 beds or 33 caravan/tent pitches – **Level 2.**	Development where people are temporarily resident. It may be difficult to organise people in the event of an emergency.

SENSITIVITY LEVEL 2: Developments for use by the general public *Continued*

Level 2

DEVELOPMENT TYPE	EXAMPLES	DEVELOPMENT DETAIL AND SIZE	JUSTIFICATION
		EXCLUSIONS	
HOTEL/HOSTEL/ HOLIDAY ACCOMMODATION **(DT 2.2)**	Smaller guesthouses, hostels, youth hostels, holiday homes, student accommodation, holiday caravan sites, camping sites.	Accommodation of fewer than 10 beds or three caravan/tent pitches – **Level 1**	Minimal increase in numbers at risk.
	Larger hotels, motels, hostels, youth hostels, holiday camps, holiday homes, halls of residence, dormitories, holiday caravan sites, camping sites.	Accommodation of more than 100 beds or 33 caravan/tent pitches – **(DT 2.2.2)** **Level 3**	Substantial increase in numbers at risk.
TRANSPORT LINKS **(DT 2.3)**	Motorway, dual carriageway.	Major transport links in their own right, i.e. not as an integral part of other developments – **Level 2.**	Prime purpose is as a transport link. Potentially large numbers exposed to risk, but exposure of an individual is only for a short period.
		EXCLUSIONS	
	Estate roads, access roads.	Single-carriageway roads – **(DT 2.3.1)** **Level 1**	Minimal numbers present and exposed to risk for a short time period (predominantly). Associated with other development.
	Any rail or tram track.	Railways – **(DT 2.3 × 2)** **Level 1**	Transient population, exposed to risk for short time periods. Times with no population present.

Appendix 2

Development sensitivity levels

SENSITIVITY LEVEL 2: Developments for use by the general public *Continued*

Level 2

DEVELOPMENT TYPE	EXAMPLES	DEVELOPMENT DETAIL AND SIZE	JUSTIFICATION
INDOOR USE BY PUBLIC **(DT 2.4)**	**Food and drink:** Restaurants, cafés, drive-through fast food, pubs. **Retail:** Shops; petrol filling stations (total floor space based on shop area, not forecourt); vehicle dealers (total floor space based on showroom/sales building not outside display areas); retail warehouses; super-stores; small shopping centres; markets; financial and professional services to the public. **Community and adult education:** Libraries, art galleries, museums, exhibition halls, day surgeries, health centres, religious buildings, community centres. Adult education, second-level education colleges, colleges of further education. **Assembly and leisure:** Coach/bus/railway stations, ferry terminals, airports. Cinemas, concert/bingo/dance halls. Conference centres. Sports/ leisure centres, sports halls. Facilities associated with golf courses, flying clubs (e.g. changing rooms, club house), indoor go-kart tracks.	Developments for use by the general public where total floor space is from 250m² up to 5000m² - **Level 2.**	Developments where members of the public will be present (but not resident). Emergency action may be difficult to coordinate.
	EXCLUSIONS		
		Development with less than 250 m² total floor space – **(DT 2.4.1)** **Level 1**	Minimal increase in numbers at risk.

SENSITIVITY LEVEL 2: Developments for use by the general public *Continued*

Level 2

DEVELOPMENT TYPE	EXAMPLES	DEVELOPMENT DETAIL AND SIZE	JUSTIFICATION
INDOOR USE BY PUBLIC **(DT 2.4)**		Development with more than 5000 m² total floor space – (DT 2.4.2) **Level 3**	Substantial increase in numbers at risk.
OUTDOOR USE BY PUBLIC **(DT 2.5)**	**Food and drink:** Food festivals, picnic area. **Retail:** Outdoor markets, car boot sales, funfairs. **Community and adult education:** Open-air theatres and exhibitions. **Assembly and leisure:** Coach/bus/railway stations, park and ride facilities, ferry terminals. Sports stadia, sports fields/pitches, funfairs, theme parks, viewing stands. Marinas, playing fields, children's play areas, BMX/go-kart tracks. Country parks, nature reserves, picnic sites, marquees.	Principally an outdoor development for use by the general public, i.e. developments where people will predominantly be outdoors and not more than 100 people will gather at the facility at any one time – **Level 2.**	Developments where members of the public will be present (but not resident) either indoors or outdoors. Emergency action may be difficult to coordinate.
	EXCLUSIONS		
	Outdoor markets, car boot sales, funfairs. Picnic area, park and ride facilities, viewing stands, marquees.	Predominantly open-air developments likely to attract the general public in numbers greater than 100 people, but up to 1,000 people at any one time – **(DT 2.5.1)** **Level 3**	Substantial increase in numbers at risk and more vulnerable due to being outside.
	Theme parks, funfairs, large sports stadia and events, open-air markets, outdoor concerts, pop festivals.	Predominantly open-air developments likely to attract the general public in numbers greater than 1,000 people at any one time – **(DT 2.5.2)** **Level 4**	Very substantial increase in numbers at risk, more vulnerable due to being outside and emergency action may be difficult to coordinate.

Appendix 2

Development sensitivity levels

SENSITIVITY LEVEL 3: Developments for use by vulnerable people

Level 3

DT3.1 – Institutional accommodation and education

DT3.2 – Prisons

DEVELOPMENT TYPE	EXAMPLES	DEVELOPMENT DETAIL AND SIZE	JUSTIFICATION
INSTITUTIONAL ACCOMMODATION AND EDUCATION **(DT3.1)**	Hospitals, convalescent homes, nursing homes. Housing for elderly with warden on-site or 'on call', sheltered housing. Nurseries, crèches. Schools and academies for children up to school-leaving age.	Institutional, educational and special accommodation for vulnerable people, or that provides a protective environment – **Level 3.**	Places providing an element of care or protection. Due to age, infirmity or state of health, the occupants may be especially vulnerable to injury from hazardous events. Emergency action and evacuation may be very difficult.
	EXCLUSIONS		
	Hospitals, convalescent homes, nursing homes, sheltered housing.	24-hour care where the site on the planning application being developed is greater than 0.25 hectare **(DT3.1.1)** **Level 4**	Substantial increase in numbers of vulnerable people at risk.
	Schools, nurseries, crèches.	Day care where the site on the planning application being developed is greater than 1.4 hectares **(DT3.1.2)** – **Level 4**	Substantial increase in numbers of vulnerable people at risk.
Places of detention **(DT3.2)**	Prisons, detention facilities, remand centres.	Secure accommodation for those sentenced by court, or awaiting trial, etc. – **Level 3.**	Places providing detention. Emergency action and evacuation may be very difficult.

SENSITIVITY LEVEL 4: Very large and sensitive developments

Level 4

DT4.1 - Institutional accommodation

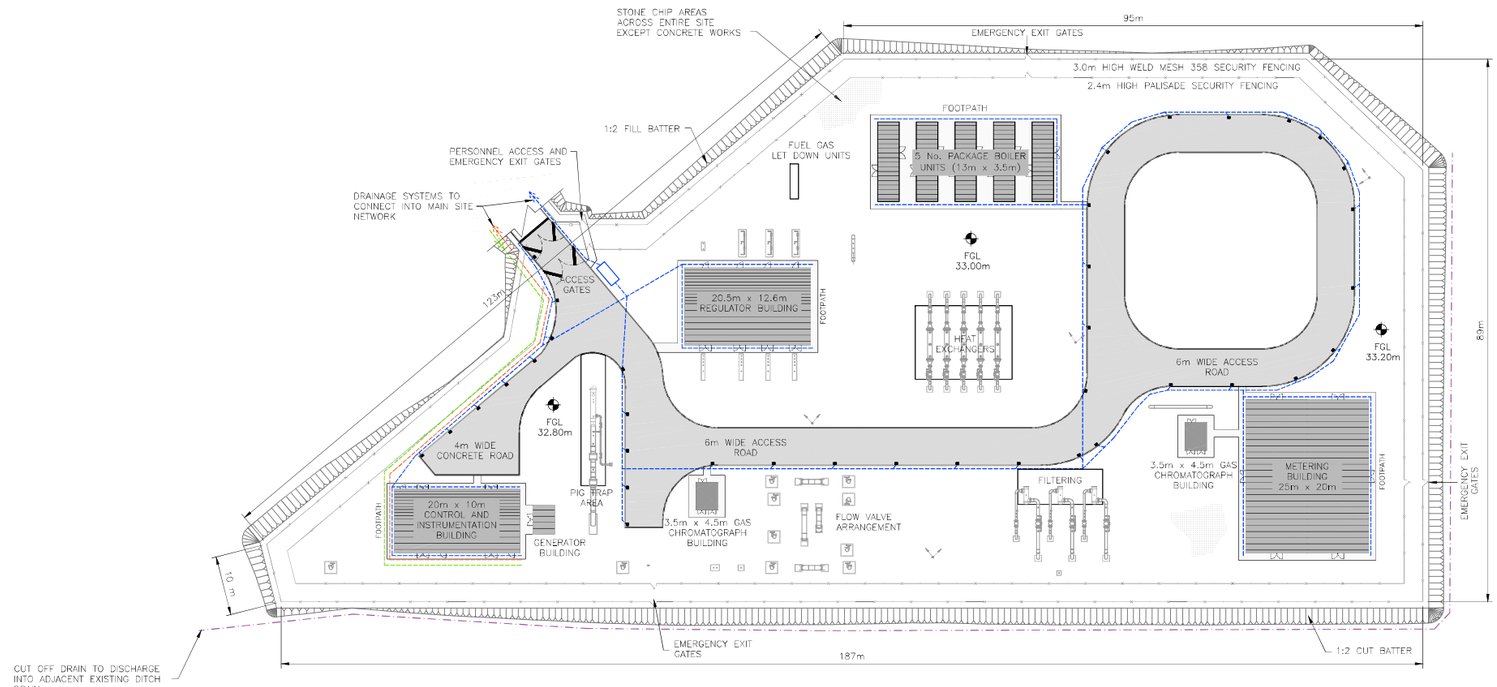
DT4.2 - very large outdoor use by public

DEVELOPMENT TYPE	EXAMPLES	DEVELOPMENT DETAIL AND SIZE	JUSTIFICATION
		EXCLUSIONS	
INSTITUTIONAL ACCOMMODATION (DT4.1)	Hospitals, convalescent homes, nursing homes, sheltered housing.	Large developments of institutional and special accommodation for vulnerable people (or that provide a protective environment) where 24-hour care is provided. And where the site on the planning application being developed is greater than 0.25 hectare: **Level 4.**	Places providing an element of care or protection. Due to age or state of health, the occupants may be especially vulnerable to injury from hazardous events. Emergency action and evacuation may be very difficult. The risk to an individual may be small, but there is a larger societal concern.
	Nurseries, crèches. Schools for children up to school-leaving age.	Large developments of institutional and special accommodation for vulnerable people (or that provide a protective environment) where day care (not 24-hour care) is provided. And where the site on the planning application being developed is greater than 1.4 hectares: **Level 4.**	Places providing an element of care or protection. Due to their age, the occupants may be especially vulnerable to injury from hazardous events. Emergency action and evacuation may be very difficult. The risk to an individual may be small, but there is a larger societal concern.
VERY LARGE OUTDOOR USE BY PUBLIC (DT4.2)	Theme parks, large sports stadia and events, open-air markets, outdoor concerts, and pop festivals.	Predominantly open-air developments where there could be more than 1,000 people present **Level 4.**	People in the open air may be more exposed to toxic fumes and thermal radiation than if they were in buildings. Large numbers make emergency action and evacuation difficult. The risk to an individual may be small, but there is a larger societal concern.

Notes

1. Where a development straddles zones, the development will be considered to belong to the zone that gives rise to the greatest expectation value (EV) – a societal risk assessment may be necessary if there is significant expectation contribution from the other zone(s). For developments consisting of multiple development types, a societal risk evaluation will likely be necessary.

Appendix B. Above Ground Installation General Arrangement



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SITE LAYOUT
SCALE 1:500

NOTES

LEGEND

DENOTES U/G SURFACE WATER DRAIN

DENOTES OPEN CUT-OFF DRAIN

DENOTES U/G FOUL WATER DRAIN

DENOTES U/G POTABLE WATER MAIN

DENOTES U/G KLARGESTER SEPERATOR OR SIMILAR

DENOTES ROAD GULLY

TWO 200W LED LIGHTS ON A 8.5 METER ROUND GALVANIZED STEEL POLE WITH TOP TENON

ISSUE FOR PLANNING

Applicant

Shannon LNG Limited

REV.	DATE	REVISION	BY	CHKD.	APPR.
2	29/05/23	ISSUE FOR PLANNING	JD	VOH	BF
1	24/03/21	ISSUE FOR PLANNING	MAH	MC	BF
0	02/10/20	CONCEPTUAL ISSUE	MAH	MC	BF

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Consultant

Fingleton White

Bridge Street Centre
Portlaoise
Co. Laois
R32 W0CC
Ireland
T:(00353)(0)57 866 5400
www.fingleton.ie

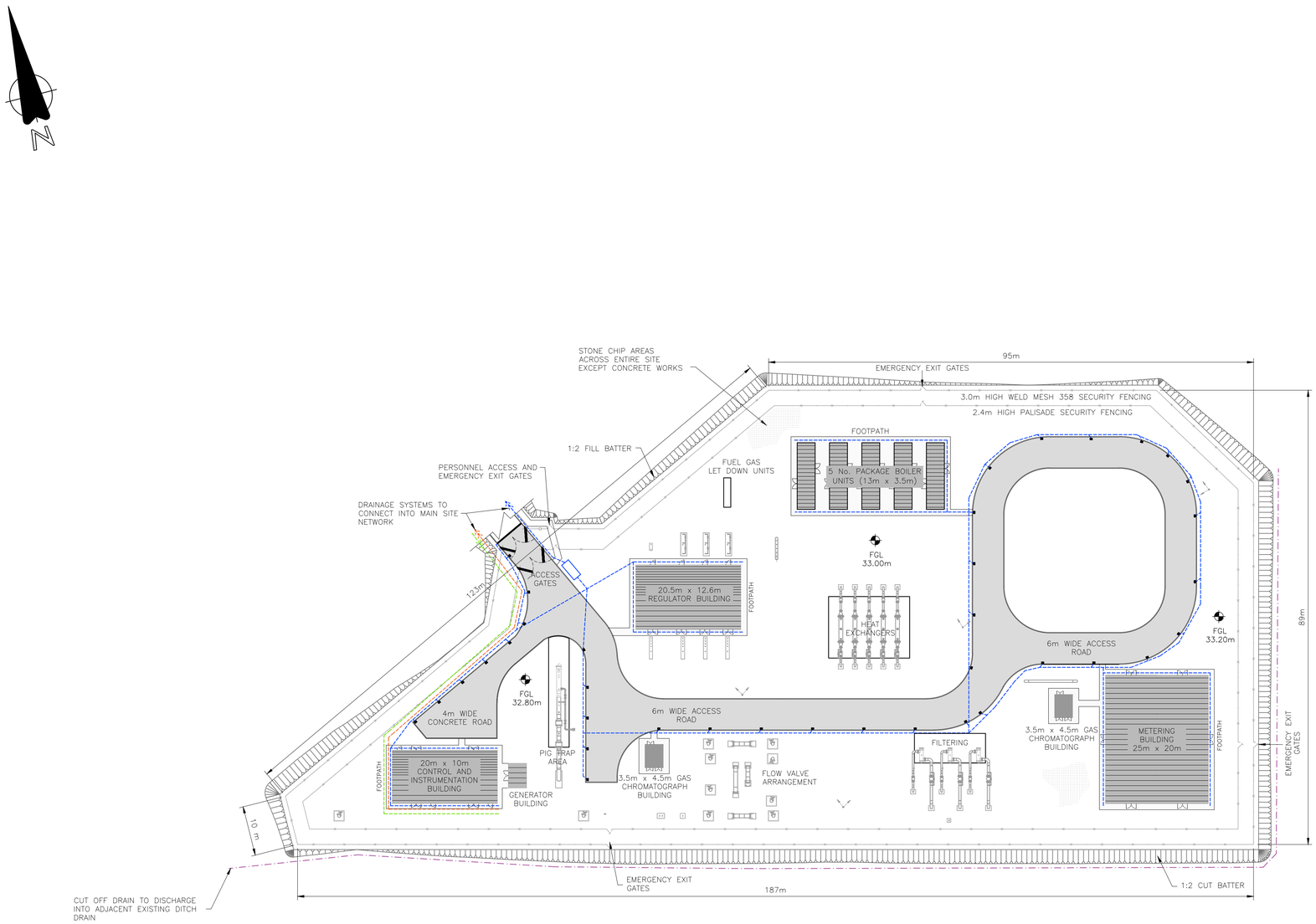
Project

SHANNON TECHNOLOGY AND ENERGY PARK (STEP)

Title

RALAPPANE AGI - SITE LAYOUT

Drawn	Scale	Drawing Number	Rev.
J.DELANEY	1:500/A1	1227-02-DG-0001	2
Chkd. V.O'HARA	Date 19/06/2023		
Apprd. B.FINGLETON	Status ISSUED		



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SITE LAYOUT
SCALE 1:500

NOTES

LEGEND

- DENOTES U/G SURFACE WATER DRAIN
- DENOTES OPEN CUT-OFF DRAIN
- DENOTES U/G FOUL WATER DRAIN
- DENOTES U/G POTABLE WATER MAIN
- DENOTES U/G KLARGESTER SEPERATOR OR SIMILAR
- DENOTES ROAD GULLY
- TWO 200W LED LIGHTS ON A 8.5 METER ROUND GALVANIZED STEEL POLE WITH TOP TENON

ISSUE FOR PLANNING

Applicant

Shannon LNG Limited

REV.	DATE	REVISION	BY	CHK'D.	APPR.
2	29/05/23	ISSUE FOR PLANNING	JD	VOH	BF
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Project

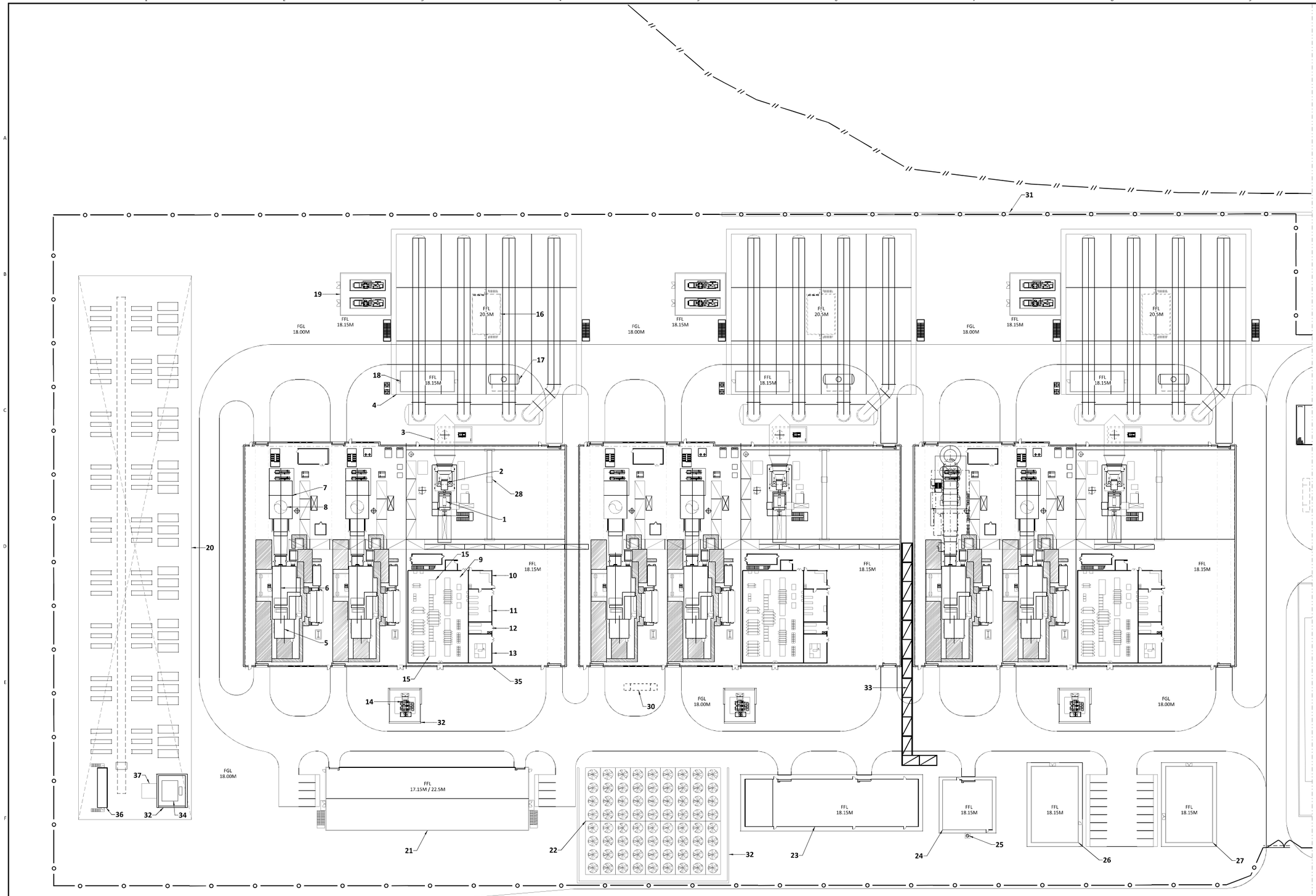
SHANNON TECHNOLOGY AND ENERGY PARK (STEP)

Title

RALAPPANE AGI - SITE LAYOUT

Drawn.	Scale	Drawing Number	Rev.
J.DELANEY	1:500/A1	1227-02-DG-0001	2
Chkd. V.O'HARA	Date 19/06/2023		
Apprd. B.FINGLETON	Status ISSUED		

Appendix C. Power Plant General Arrangement



ITEM NO.	EQUIPMENT IDENTICATION
1	STEAM TURBINE GENERATOR
2	STEAM TURBINE
3	STEAM TURBINE EXHAUST DUCT
4	AIR COOLED CONDENSER
5	COMBUSTION TURBINE GENERATOR
6	COMBUSTION TURBINE
7	HEAT RECOVERY STEAM GENERATOR
8	HRSG EXHAUST STACK
9	ELECTRICAL EQUIPMENT ROOM
10	AUXILIARY CONTROL ROOM
11	DCS ROOM
12	BATTERIES ROOM
13	STANDBY DIESEL GENERATOR ROOM
14	GENERATOR STEP-UP TRANSFORMER
15	AUXILIARY TRANSFORMER
16	ACC ELECTRICAL EQUIPMENT POWER DISTRIBUTION CENTER
17	CONDENSATE COLLECTION TANK
18	CONDENSATE POLISHING EQUIPMENT ENCLOSURE
19	ACC AIR EXTRACTION EQUIPMENT ENCLOSURE
20	BATTERY ENERGY STORAGE SYSTEM (BESS) EQUIPMENT AREA
21	ELECTRICAL (GIS) SUBSTATION BUILDING
22	AIR COOLED HEAT EXCHANGERS
23	WORKSHOP/STORES/CANTEEN
24	AUXILIARY BOILER BUILDING
25	AUXILIARY BOILER EXHAUST STACK
26	CENTRAL CONTROL/OPERATIONS BUILDING
27	ADMINISTRATION BUILDING
28	OVERHEAD CRANE
29	INDICATIVE ELECTRICAL GRID INTERFACE BUILDING
30	OIL/WATER SEPARATOR
31	RETAINING WALL
32	SOUND RETENTION WALL
33	UTILITY RACK
34	BESS STEP-UP TRANSFORMER
35	TURBINE HALL (TYP OF 3)
36	BESS POWER DISTRIBUTION CENTER
37	BESS AUXILIARY POWER TRANSFORMER

NOTES.

1. THE FINISHED SURFACE LEVEL (FSL) OR PLATFORM FOR THE POWER PLANT, IS +18M ABOVE ORDINANCE DATUM (AOD).
2. THE PROPOSED FINISHED GRADE LEVEL (FGL) ARE IDENTIFIED THRU OUT THE PERIMETER OF THE POWER BLOCK AREA.
3. THE PROPOSED FINISHED FLOOR LEVEL (FFL) ARE IDENTIFIED WITHIN THE BUILDING STRUCTURES.
4. SEE DRAWING 198291-1GSU-G1003 FOR SITE ARRANREMENT.

NOT TO BE USED FOR CONSTRUCTION

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1	18/JUN/2021	ISSUED FOR PLANNING	TMC	DJL		DAC	
0	30/APR/2021	ISSUED FOR PLANNING	TMC	DJL		DAC	

BLACK & VEATCH CORP HEADQUARTERS:
11401 LAMAR AVENUE, OVERLAND PARK,
KANSAS, USA

BLACK & VEATCH

DESIGNER	DRAWN DJL
CHECKED	DATE

SHANNON LNG LIMITED
SHANNON TECHNOLOGY AND ENERGY PARK (STEP)

GENERAL ARRANGEMENT
COMBINED CYCLE POWER PLANT
MAIN POWER BLOCK AREA

PROJECT	DRAWING NUMBER	REV
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AREA		

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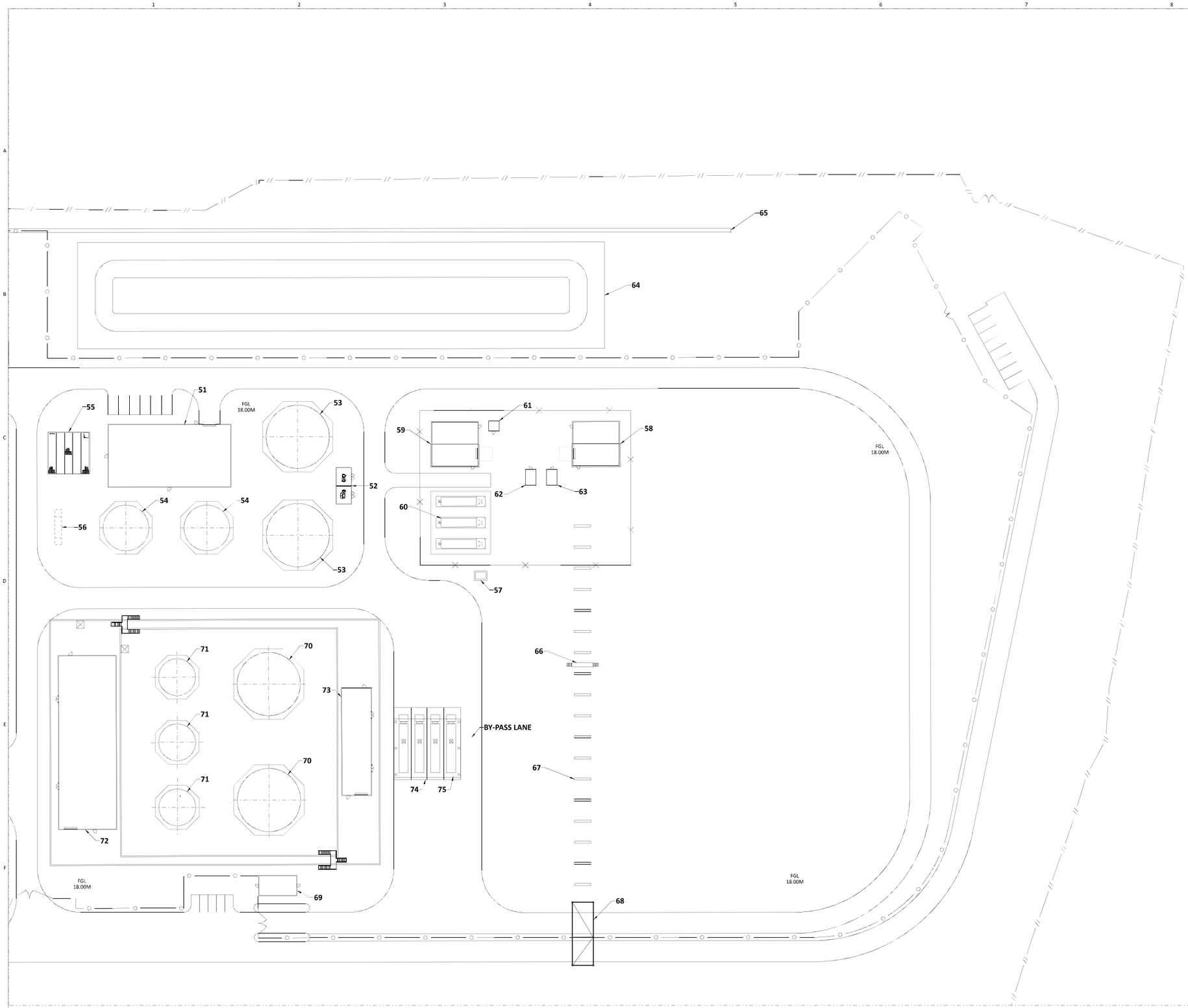

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51	WATER TREATMENT BUILDING
52	FIRE WATER PUMPS ENCLOSURE
53	RAW/SERVICE/FIRE WATER STORAGE TANK
54	DEMINERALIZED WATER STORAGE TANK (TYP OF 2)
55	EFFLUENT SUMP
56	OIL/WATER SEPARATOR
57	WASTEWATER TREATMENT EQUIPMENT PACKAGE
58	FUEL GAS METERING ENCLOSURE
59	FUEL GAS REGULATING ENCLOSURE
60	FUEL GAS HEATER - WATER BATH TYPE (TYP OF 3)
61	KIOSK ENCLOSURE - METERING AND REGULATING AREA
62	ANALYZER ENCLOSURE - METERING AND REGULATING AREA
63	INSTRUMENT ENCLOSURE - METERING AND REGULATING AREA
64	FIRE WATER RETENTION POND
65	RETAINING WALL
66	CROSSOVER PLATFORM
67	UTILITY SLEEPER
68	UTILITY RACK
69	SECURITY BUILDING
70	FUEL OIL STORAGE TANK (TYP OF 2)
71	FUEL OIL STORAGE DAY TANK (TYP OF 3)
72	FORWARDING PUMP BUILDING
73	CENTRIFUGE AND FUEL OIL UNLOADING PUMP BUILDING
74	FUEL OIL TRUCK UNLOADING AREA
75	FUEL OIL TRUCK UNLOADING SHELTER

NOTES.
1.THE FINISHED SURFACE LEVEL (FSL) OR PLATFORM FOR THE POWER PLANT, IS +18M ABOVE ORDINANCE DATUM (AOD).

NOT TO BE USED FOR CONSTRUCTION

PLANT TRUE 31.6°

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0	30/APR/2021	ISSUED FOR PLANNING	TMC	DJL		DAC	

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11401 LAMAR AVENUE, OVERLAND PARK,
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SHANNON LNG LIMITED
SHANNON TECHNOLOGY AND ENERGY PARK (STEP)

GENERAL ARRANGEMENT
COMBINED CYCLE POWER PLANT
BALANCE OF PLANT AREA

DESIGNER	DRAWN	DJL
CHECKED	DATE	

PROJECT 198291-1GSU-G2002
DRAWING NUMBER
REV 3
CODE
AREA

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Rev. 1.4
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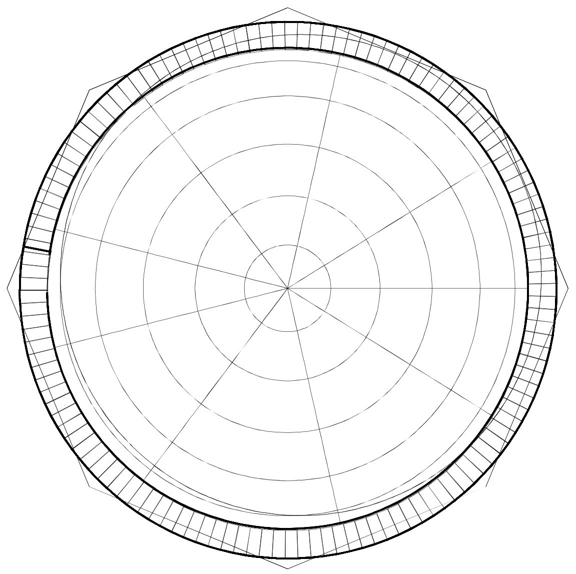
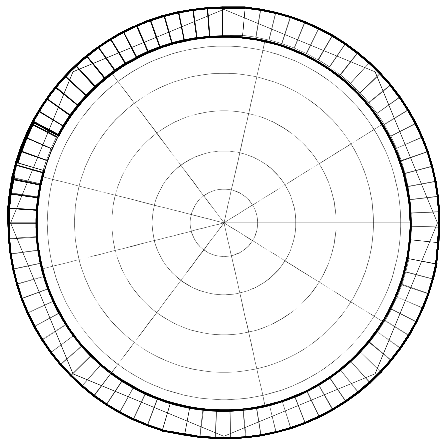
Appendix D. Tanks Layout

NOTES:

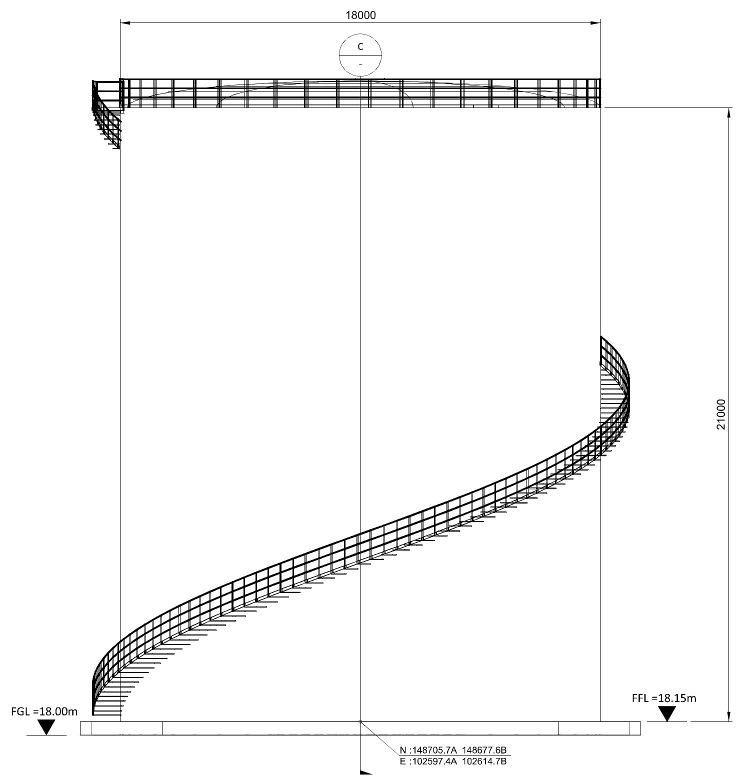
1. THE TANK IS FOR PLANNING PURPOSES ONLY AND NOT FOR CONSTRUCTION. EQUIPMENT LOCATIONS ARE INDICATIVE ONLY AND ARE SUBJECT TO CHANGE WITHIN BUILDING.
2. TANKS TO BE CONSTRUCTED FROM PAINTED CARBON STEEL. COLOUR GREY-OLIVE, RAL 6006.



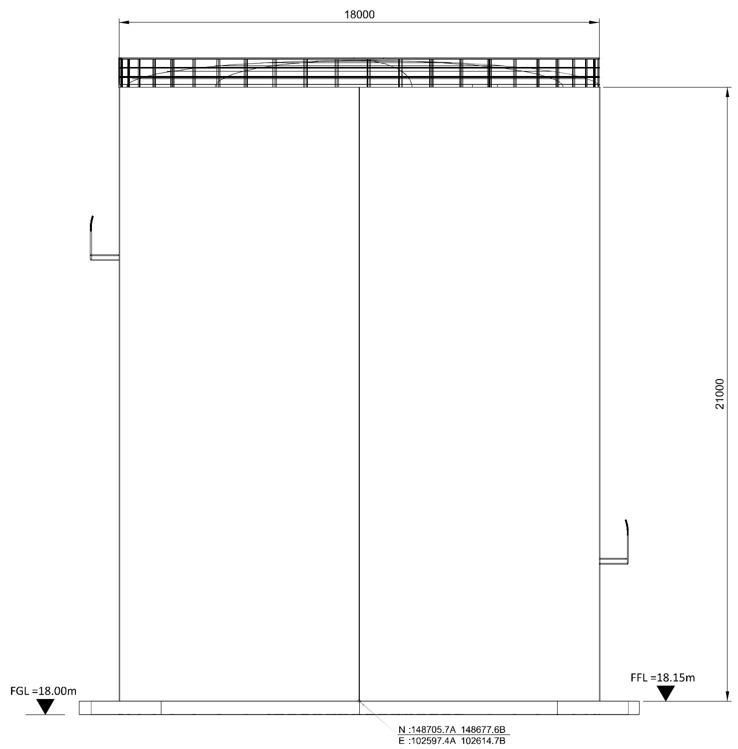
PLAN VIEW
FUEL OIL STORAGE
TANK A, B



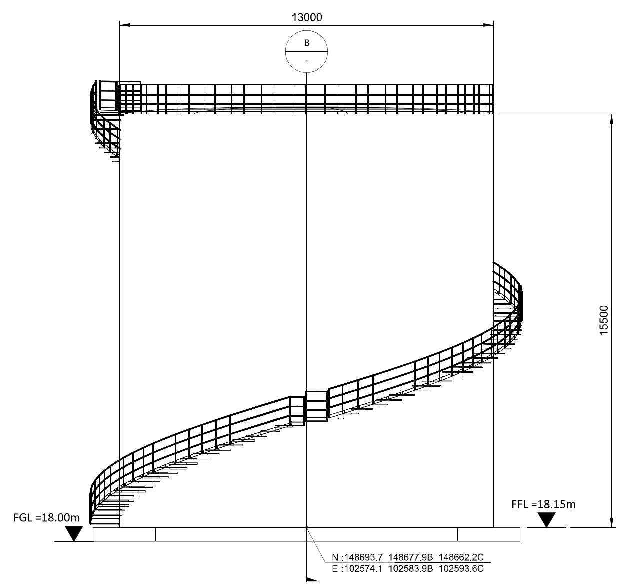
PLAN VIEW
FUEL OIL STORAGE
DAY TANK A, B & C



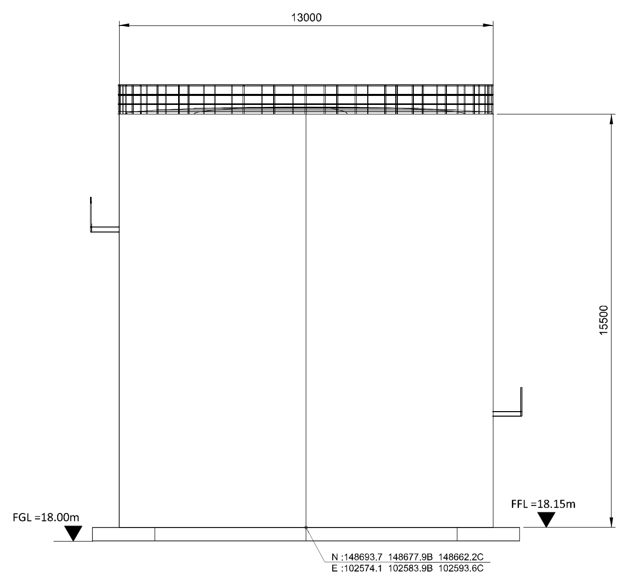
ELEVATION
FUEL OIL STORAGE
TANK A, B



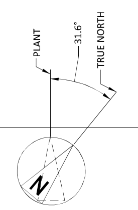
SECTION C
FUEL OIL STORAGE
TANK A, B



ELEVATION
FUEL OIL STORAGE
DAY TANK A, B & C



SECTION B
FUEL OIL STORAGE
DAY TANK A, B & C



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0	28/APR/2023	ISSUED FOR PLANNING	SRB	HK		DAC	

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BLACK & VEATCH

DRAWN: DJ TMC
CHECKED
DATE

SHANNON LNG LIMITED
SHANNON TECHNOLOGY AND ENERGY PARK (STEP)

CCGT FUEL OIL STORAGE TANKS
PLAN AND ELEVATIONS

PROJECT / DRAWING NUMBER: 198291-SS-A4112
REV: 1
CODE
AREA

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Report for:	Shannon LNG Limited
Report reference:	RMC0500653.1.4
Date:	10 April 2024
Revision:	02

Vysus Group

MATTE assessment for Shannon Technology Energy Park Power Plant

Report prepared for Shannon LNG Limited

Report Information

MATTE assessment for Shannon Technology Energy Park Power Plant		
Report reference: RMC0500653.1.4	**Date:** 10 April 2024	**Revision:** 02
Prepared by: Ian Thomas Senior Principal Consultant	**Reviewed by:** Chris Swift Lead Risk Specialist Lloyd's Register	**Approved by:** Adam Baxter Department Manager, UK & Spain
		
Client contact: Kieran O'Connor Permit, Regulatory and Environmental Lead T/M: +353 87 1464 794 koconnor@newfortressenergy.com	**Client entity and address:** Shannon LNG Limited 27 Market Street, Listowel Co. Kerry, V31 Y436 Ireland	
Vysus Group contact: Mireia Amigó Senior Consultant T: + 34 936097131 M: + 34 676639206 mireia.amigo@vysusgroup.com	**Vysus Group entity and address:** Vysus UK Limited Regus Manchester Business Park 3000 Aviator Road Manchester, M22 5TG United Kingdom	

Document control (Vysus Group internal use):

Revision	Prepared by	Reviewed by	Approved by	Date	Comments
00	DIT	CJS	AB	20 Mar 2024	Issued to client
01	DIT	CJS	AB	09 Apr 2024	Revised accounting for client comments
02	DIT	CJS	AB	10 Apr 2024	Revised accounting for client comments

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ABP	An Bord Pleanala (Planning Authority)
AGI	Above Ground Installation (Operated by Gas Networks Ireland)
AONB	Areas of outstanding natural beauty
ALARP	As Low As Reasonably Practicable
CA	Competent Authority
CCGT	Combined Cycle Gas Turbine
CDOIF	Chemical and Downstream Oil Industries Forum
COMAH	Control of Major Accident Hazards
CRU	Commission for Regulation of Utilities
DAU	Development Applications Unit
DEFRA	Department for Environment, Food and Rural Affairs
EPA	Environmental Protection Agency
ESA	Environmentally Sensitive Area
HSA	Health and Safety Authority
kV	Kilo Volt
LNR	Local Nature Reserves
LUP	Land use planning
MAPP	Major Accident Prevention Policy
MATTE	Major Accident to the Environment
MW	Mega Watt
NHA	Natural Heritage Area
NSA	Nitrate Sensitive Areas
QRA	Quantitative risk assessment
SAC	Special Area of Conservation
SPA	Special Protection Area
SPR	Source, Pathway, Receptor
SSSI	Site of Special Scientific Interest
STEP	Shannon Technology Enterprise Park

Executive Summary

This report has been prepared for Shannon LNG Limited by Vysus Group. The report documents the findings of a MATTE (Major Accidents to the Environment) study for the proposed Shannon Technology Enterprise Park (STEP) power plant.

Purpose

The purpose of the MATTE study is to identify potential scenarios associated with Major Accidents for the proposed STEP power plant involving dangerous substances which can pose a credible threat of damage to the environment, as defined and governed by COMAH Regulations.

Scope

The scope for this MATTE study is the Power Plant Only development (ABP-311233-21*).*

The report does not address Major accident scenarios which can give rise to serious injury to people; routine environmental emissions associated with the operation of the installation, and connection to gas supply via pipeline.

Methodology

The MATTE study was conducted as a desk study using the HSA Guidance on technical land-use planning advice for planning authorities and COMAH establishment operators, also taking into account HSA Guidance to Inspectors on the Assessment of Safety Reports under the COMAH Regulations 2015, DEFRA Guidelines for Environmental Risk Management, the COMAH regulations and the Chemical and Downstream Oil Industries Forum (CDOIF).

As per the HSA Guidance, the basic approach was to apply the Source, Pathway, Receptor methodology to identify hazards and assess any residual environmental risk (MATTE) associated with a major accident.

Findings

The findings of the MATTE assessment are summarised in the table below.

Material	Potential MATTE?	Evaluation	MATTE Risk
Diesel	Yes	The proposed 11,500 m^3 diesel stored on site falls within the Qualifying quantity (>2,500 tonnes) of dangerous substances as referred to in the COMAH Regulations, but the low likelihood of a release occurring combined with the triple containment system means that it is very unlikely for a release to occur resulting in the material entering the estuary (pathway).	Low
Transformer oil	Yes	Transformer oil may be hazardous to the environment depending on its chemical composition and a significant release to the estuary could result in a MATTE. Measures on site would prevent the material entering the estuary (pathway)	Very low
Firefighting Water	Yes	Firefighting the water may be contaminated with materials that are toxic to the environment and, as such, a release of a large quantity of firefighting water into the Shannon estuary may lead to a MATTE. Measures on site would prevent the material entering the estuary (pathway)	Very low

Material	Potential MATTE?	Evaluation	MATTE Risk
Natural Gas	No	There is no MATTE associated with the natural gas used on the facility as it does not have any liquid constituents.	N/A Not a MATTE
Ammonia Hydroxide	No	Small quantities of material that is not significantly ecotoxic with low possibility of entering the marine environment.	N/A Not a MATTE
Tri-Sodium Phosphate	No	Small quantities of material that is not significantly ecotoxic with low possibility of entering the marine environment.	N/A Not a MATTE
Sodium Bisulphite	No	Small quantities of material that is not significantly ecotoxic with low possibility of entering the marine environment.	N/A Not a MATTE
Sulphuric acid	No	Small quantities of material that is not significantly ecotoxic with low possibility of entering the marine environment.	N/A Not a MATTE
Cleaning materials, laboratory chemicals and paints	No	Materials may be harmful to the environment but only present in small quantities with low possibility of entering the marine environment.	N/A Not a MATTE

All of the identified MATTE events are described as low or very low risk, as the likelihood of a release occurring is low and measures for prevention of discharge to the estuary are present within the plant design and operating philosophy.

It is noted that the risks associated with the facility are in accordance with HSA criteria.

1 Introduction

This report has been prepared for Shannon LNG Limited by Vysus Group. The report documents the findings of a MATTE (Major Accidents to the Environment) study for the proposed Shannon Technology Enterprise Park (STEP) power plant.

This study has been performed in accordance with HSA Guidance on technical land-use planning advice for planning authorities and COMAH establishment operators [1] and HSA Guidance to Inspectors on the Assessment of Safety Reports under the COMAH Regulations 2015 [2].

1.1 Location of proposed development

The Proposed Development site is located approximately 4.5 km and 3.5 km from Tarbert and Ballylongford in Co. Kerry, respectively.

The Proposed Development site is located within the boundary of two townlands: Kilcolgan Lower and Ralappane, Co. Kerry.

- 450 acres of land zoned for marine and industrial development by local and regional development plans (600 total acres)
- Proximity to high-capacity gas and electricity networks
- 220 kV electrical connection at substation 5 km to East
- Successful in recent ECP 2.1 electrical grid connection process

Figure 1. Site location

Within the wider area, energy infrastructure is a significant feature of the landscape. Moneypoint power station lies approx. 2.5 km north of the site in Co. Clare, while Tarbert power station lies approx. 4 km east of the site. Kilpaddoge 220 kV substation lies approx. 3 km to the east of the site, to which a number of high voltage overhead lines are connected. Wind energy projects within both Co. Clare and Co. Kerry form part of the background to views in this area. There are a number of designated conservation sites located in the vicinity including:

- Lower Shannon candidate Special Area of Conservation (SAC), 002165.
- Shannon-Fergus Estuary Special Protection Area (SPA), 00407
- Ballylongford Bay proposed Natural Heritage Area (pNHA), 1332.

1.2 Key features of the proposed development

The key features of the Power Plant only development comprise:

- Three (3) blocks of CCGT facilitating a flexible multi-shaft power plant. Each block up to 200 MW for a total capacity of up to 600 MW.
- Each block comprises of two (2) gas turbine generators, two (2) heat recovery steam generator and a steam turbine generator.

- Cooled by means of air-cooled steam condensers.
- A 120 MW for 1-hour (120 MWh) battery storage facility
- High voltage 220 kV Substation
- Raw water treatment building
- Firewater storage tanks and fire water pumps
- Under the CRU's Decision Paper CER/09/001 5 days continuous Secondary Fuel storage will be stored on site, equating to approximately 11,000 cubic metres.
- The 220 kV cable(s) will run 5 km east under the L-1010 road to the Eirgrid Killpaddogue 220 kV substation.

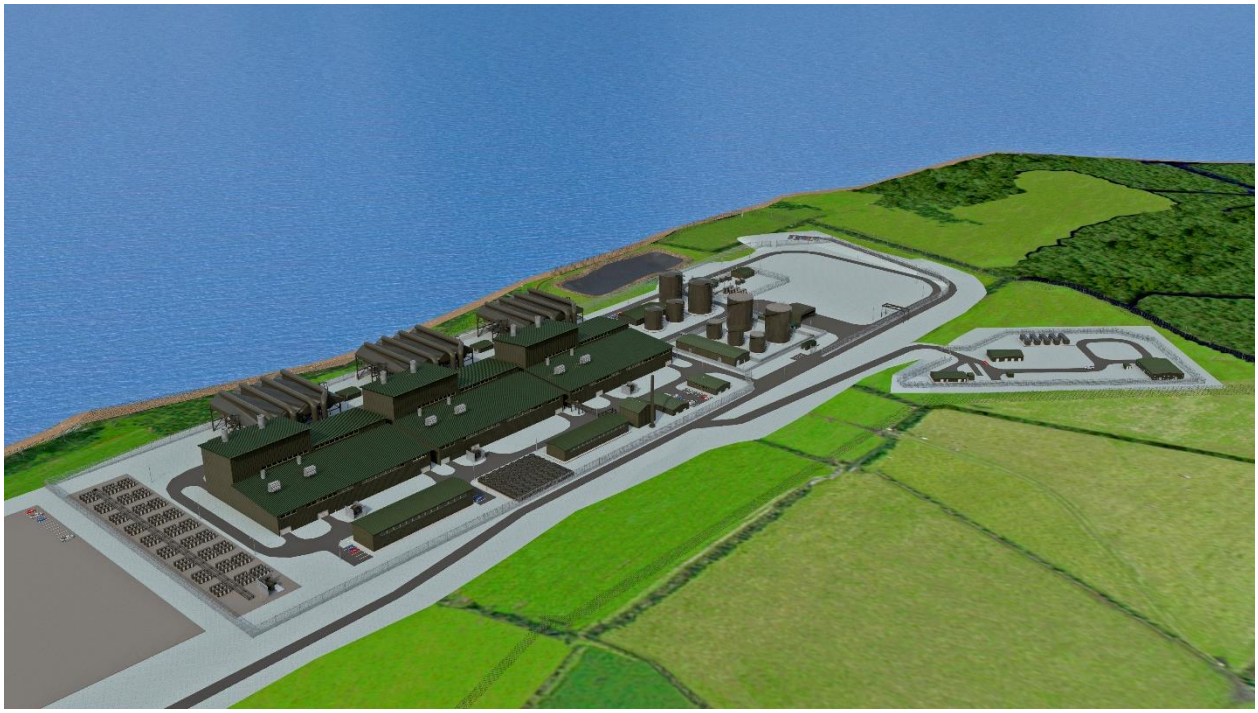

Figure 2. Impression of proposed Power Plant only development and 120MW – 1 hr Battery Storage System.

2 Purpose

The purpose of the MATTE study is to identify potential scenarios associated with Major Accidents for the proposed STEP power plant involving dangerous substances which can pose a credible threat of damage to the environment, as defined and governed by COMAH Regulations.

3 Scope

This MATTE study is concerned with credible MATTE Scenarios associated with a Major Accident, as defined by COMAH regulations [3] and industry guidance [1], [2], [4], [5], for the Power Plant Only development (ABP-311233-21*).*

The scope of the proposed Power Plant considered in this MATTE study includes:

- Site access point and main administration building
- Process building, Electrical substations, security building, Maintenance / warehouse and equipment building
- Power plant
- Secondary diesel fuel storage for the power plant (11,500 m^3, equivalent to approximately 10,000 tonnes)
- AGI
- Construction laydown
- Battery storage facility
- Drainage outfall pipe
- Fire water retention pond

3.1 Exclusions to the scope

Major accidents scenarios which can give rise to serious injury to people are addressed separately in a dedicated QRA report.

Routine environmental emissions associated with the operation of an establishment are a matter for the local authority or the Environmental Protection Agency (EPA), as relevant, and are subject to separate permitting/licensing requirements. Routine emissions are not considered within the scope of this report.

4 Governing regulations and definitions

HSA Guidance on technical land-use planning advice for planning authorities and COMAH establishment operators [1] considers that in addition to assessment of risk to human health, there is also a requirement to assess risks to the environment by applying the source-pathway-receptor model.

[1] interprets Health and Safety Authority (HSA) policy on technical land-use planning (TLUP) advice under the Seveso-III Directive (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, amending and subsequently repealing Council Directive 96/82/EC), as implemented by the COMAH Regulations 2015 (Chemicals Act (Control of Major Accident Hazards involving Dangerous Substances) Regulations 2015, S.I. No. 209 of 2015, the "COMAH Regulations" [3]).

The COMAH Regulations implement the Seveso III Directive (2012/18/EU) [6].

4.1 MATTE definitions and thresholds

As neither the regulations nor the Directive define the term MATTE. The Competent Body refer to the HSA Guidance on technical land-use planning advice for planning authorities and COMAH establishment operators and the Guidance to Inspectors on the Assessment of Safety Reports under the COMAH Regulations 2015 Rev 4 Jan 2017, which specify the CDOIF guidance [4] which defines the term.

The term MATTE is used by industry and the Competent Authorities (CAs) to indicate when a major accident has caused serious harm to the environment (or when it has potential to do so):

- a Major Accident which could cause serious harm to the environment (i.e. lead to serious danger) is a potential MATTE (i.e. a Major Accident with MATTE potential);
- a Major Accident which has caused serious harm to the environment is a MATTE.

In accordance with the definitions for of a MATTE and a Major Accident, a MATTE would be taken to require harm or damage to the environment above defined thresholds when considering key environmental receptors in relation to a designated area.

MATTE thresholds defined in the CDOIF guidance concern [4]:

- Extent and Severity; and
- Duration of harm

Designated areas and potential receptors considered within the CDOIF definitions concern [4]:

- Nationally important: SSSI and National Nature Reserves
- Internationally important: SACs, SPAs & Ramsar sites
- Other designated land (ESA's, AONB's LNRs, NSA's etc.)
- Scarce habitat
- Widespread habitat (land/water)
- Groundwater
- Soil or sediment (land/water)
- Built environment (land, man-made)
- Particular species (land, water, air)
- Marine (water)
- Freshwater and estuarine habitats (water)

4.2 MATTE Scenarios

MATTEs are most frequently due to liquid releases (including firewater) impacting on land and water. The prevention measures of most relevance to environmental protection are those which reduce the risk of accidental liquid releases or enable their retention on site [1].

MATTE incidents caused by aerial dispersion are less frequent, but aerial pathways should not be overlooked. Where the potential for such a MATTE has been identified, efforts should be focused on measures for prevention and mitigation [1].

4.3 Compliance requirements

4.3.1 COMAH

COMAH requires all Upper Tier and Lower Tier establishment operators to submit a safety report to the Competent Authority (CA) that demonstrates the environmental risk for the whole COMAH establishment has been reduced to a tolerable level.

4.3.2 Land use planning

In the context of land use planning (LUP), the prevention of MATTEs will be the primary objective and it is expected that accident pathways will be prevented. Where this is not practicable, or in the context of significant modifications at existing COMAH establishments, the assessment of major accidents to the environment focuses on the specific risks to sensitive receptors within the local environment, the extent of consequences to such receptors and the ability of such receptors to recover: environmental damage may be relatively long-lasting but is not necessarily irreversible. Recovery of habitats within a reasonable period of time is possible, depending on the dangerous substance involved.

Emphasis is initially placed on the prevention phase, the control of potential pollution routes and available response measures, rather than on the development of a quantitative risk assessment approach and use of risk based criteria [1].

4.3.3 Assessment expectations

Assessment is based on a Source-Pathway-Receptor model. For new establishments, the CA will focus on the removal of accident pathways to receptors (through the use of additional technical measures: appropriate containment, within the confines of current good practice and ALARP, for example).

Irrespective of whether the approach is qualitative or quantitative, the HSA expect the following items to be considered when assessing a MATTE:

- environmentally sensitive areas in the vicinity,
- presence of endangered species,
- protected water resources/biospheres,
- types of accident that can cause environmental damage (firewater run-off, for example),
- contamination routes (watercourses, for example),
- measures in place to protect the environment and their reliability,
- hard/reliable measures in place to contain run-off in the context of internal and external emergency plans,
- recovery periods with and without intervention,
- clean-up and remediation plans and resources, and
- if necessary, tolerability of assessed risk.

Under COMAH, operators are required to use best practicable means, specifically:

- to prevent a major emission of dangerous substances resulting from uncontrolled developments in an establishment into the environment, and
- for rendering harmless and inoffensive the substances emitted.

5 MATTE assessment methodology overview

The general approach to environmental risk assessment followed by Vysus, applies industry guidelines such as the DEFRA Guidelines for Environmental Risk Management [5] whilst considering COMAH Regulations and CDOIF guidance. The basic outline for the DEFRA approach to environmental risk assessment is summarized in the model below.

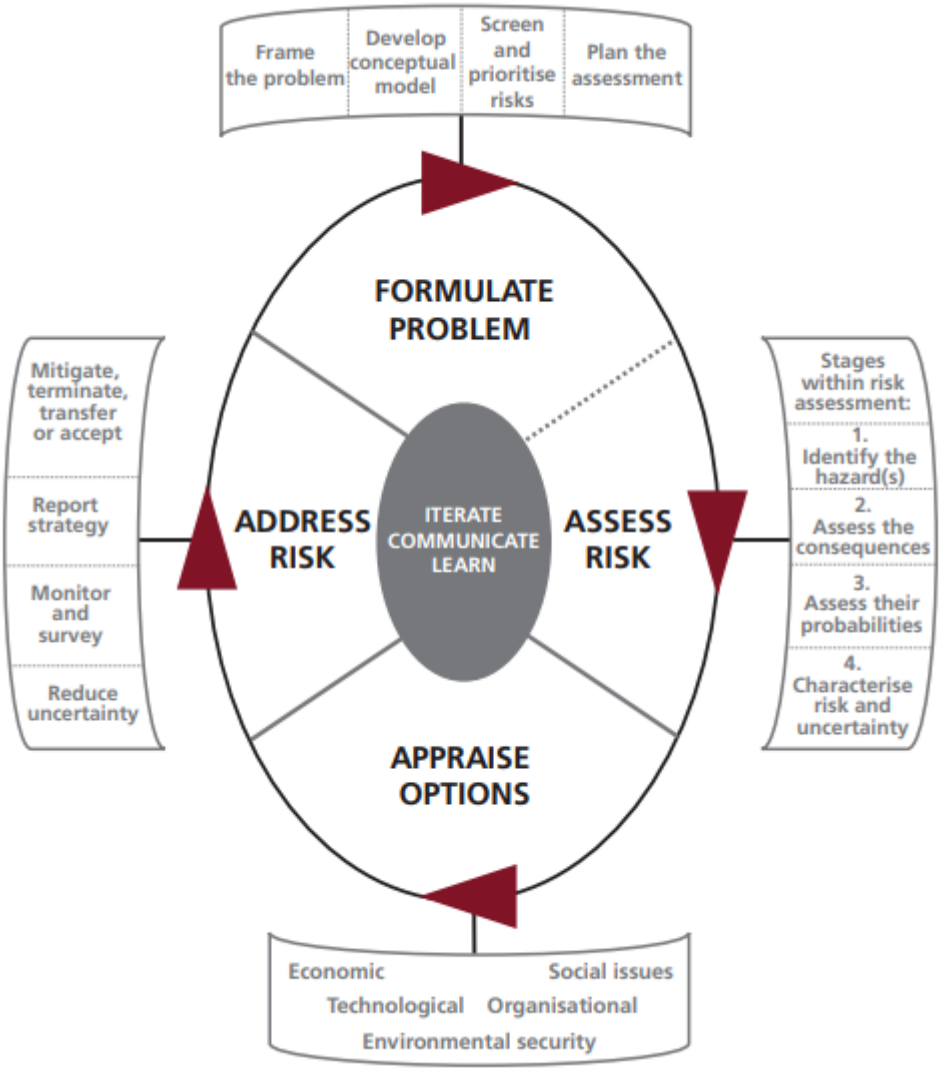

Figure 3. A framework for environmental risk assessment and management.

The DEFRA risk assessment model allows the re-appraisal of the proposed design in a systematic manner, whereby:

- the conceptual model and problem formulation is informed by the revised design features.
- the approach to hazard identification and risk assessment is progressed by applying the source, pathway, receptor concept.
- residual risk identified by confirmation of the Source, Pathway, Receptor linkage can be assessed, eliminated, mitigate and / or managed to ALARP. Environmental risk assessment follows the source-pathway-receptor method, which requires that a linkage (pathway) must exist between the source and receptor in order for an accident to occur. Therefore any assessment of potential MATTE events will require the presence of a material that could harm the environment, a scenario for the release of the material, some pathway through which the material could pass to the environment, and some feature of the environment that could be significantly harmed.

The source, pathway concept methodology considers the features of a conceptual model to identify:

- sources of environmental impact from a major accident e.g. fire water or diesel spill
- pathway for pollutant to reach a receptor e.g. surface drain
- receptor e.g. groundwater aquifer, habitat.

An example of identifying and representing the S-P-R linkages regarding leakage from an underground gasoline storage tank that contains benzene.

Table 1. Example, source, pathway, receptor linkage concept [5]

Hazard	Source	Pathway	Receptor	S-P-R Linkage
Benzene	Underground fuel storage tank	Leaching Groundwater supply	Groundwater supply	Yes
			Public water supply	Yes

5.1 Sources

Sources are inventories of materials within the facility that are major environmental hazards (i.e. that have the potential to result in significant impact on the environment if released and reach an environmental receptor). The evaluation of sources includes quantity, location and properties of environmentally hazardous materials present on the site.

5.2 Pathways

Pathways may have a number of features; including the initial release of material, secondary failures and local factors.

Possible sources of release of materials that may be hazardous to the environment are primarily due to failure of containment. A range of possible causes of loss of containment exist and are typically due to:

- Impact by vehicle, machinery or dropped object;
- Dropped or punctured container;
- Corrosion, erosion or chemical attack;
- Overpressurisation or vacuum;
- Overfilling of equipment;
- Internal explosion (where flammable materials are present);
- Runaway chemical reaction or mixing of incompatible chemicals;
- Overheating or overcooling of equipment;
- On site events such as fires or explosions; or,
- Offsite events that may affect the area, such as earthquakes, landslip, flooding or extreme weather;

Secondary factors are those where some barrier or safeguard fails. For releases of liquids a secondary failure may be a damaged drain or bund, or the failure to treat a material if discharged into an effluent treatment system.

Pathways will also depend upon the type of surface onto which a material is released and drainage systems.

Local factors that influence pathways are often related to environmental conditions. For example, where releases could enter rivers, the hydraulic state of the river may be a factor. For releases to air, the

atmospheric conditions (wind speed, stability and direction) and rainfall could influence the consequences of a release. Releases to air may also include vapours generated by pools of spilt liquid.

5.3 Receptors

The assessment of major accidents to the environment focuses on the specific risks to sensitive receptors within the local environment, the extent of consequences to such receptors and the ability of such receptors to recover, noting that environmental damage may be long-lasting but not necessarily permanent.

Consideration of local environmental receptors and their sensitivity is required in order to allow an assessment of the consequences of a release from an establishment and whether it would be classified as a MATTE.

6 Environmental setting, sensitivities and impact assessment

The information presented in this section has been sourced from the original AECOM EIA report to enable the Vysus team to apply a Source, Pathway, Receptor approach to the review of the potential for a MATTE associated with the Power Plant only ABP Application.

Note: The potential impact of operations, abnormal events and accidents on the local environment not covered by COMAH regulations are outside the scope of this review and are not addressed here.

6.1 Site setting and operation

The area to be developed within the Proposed Development site is characterised by predominantly improved grassland in an agricultural setting. Field boundaries predominantly comprise hedgerows with small drainage ditches. A small section of the Ralappane Stream is located in the southernmost part of the Proposed Development site.

The Shannon Estuary comprises 500 square kilometres (km^2) of navigable water extending from Loop Head, in Co. Clare, and Kerry Head, in Co. Kerry, eastwards to the city of Limerick, a distance of approximately 100 km. The naturally occurring deep and sheltered waters of the estuary are connected to the Atlantic Ocean and are accessible to large ocean-going vessels of varying types and sizes [7].

The location of the Proposed Development is within the protected area of the Shannon Estuary (the Lower River Shannon SAC, the River Shannon and River Fergus Estuaries SPA and the Ballylongford Bay pNHA). Therefore, the highest standards of environmental protection will be incorporated into the design of the Proposed Development [7].

6.2 Major accidents and disasters

The risk of a major accident occurring, is considered to be very low, however a detailed pollution response plan, emergency equipment and procedures will be in place prior to construction and throughout the lifetime of the Proposed Development.

The Proposed Development site location has been carefully chosen and there is a very low risk of natural disasters occurring such as flooding and earthquakes.

There is a very low risk of a major accident or disaster occurring at the Proposed Development. The facility will be regulated as a Lower Tier COMAH Installation and the highest levels of safety and environmental protection will be in place for the lifecycle of the facility, from prior to construction and throughout the operational lifetime. Detailed risk analyses for the Proposed Development such as Quantitative Risk Assessment (QRA) and Environmental Risk Assessment (ERA) will be carried to analyse the potential for further risk reduction.

The facilities associated with the Proposed Development will be designed, constructed and operated by specialist, experienced organisations who will adhere to all applicable national regulations and internationally recognised best practice in the design and operation of the facility, controlling the risks and delivering essential gas supplies to the national network [7].

6.3 Major accident scenarios

The Power Plant will contain process equipment such as natural gas compressors, turbine generators and electrical transformers, containing flammable and combustible substances. Consequently, a fire has been identified in this assessment as the most significant potential major accident in this area of the Proposed Development.

A number of fire prevention and protection measures are included in the design of the Proposed Development, which are as follows:

Layout of the Proposed Development to minimise the potential for an incident in one area affecting other areas;

Passive fire protection systems will be installed in appropriate areas, which allows certain systems to withstand a fire for a defined period of time to enable the emergency response plan to be initiated [7]:

- A network of fire and gas detectors, audible and visual fire alarms will be installed throughout the Proposed Development to alert operations personnel who will initiate the emergency response; and
- Active fire protection systems will be installed onsite, supplied by large firewater storage tanks and activated on demand from the fire and gas system or manually initiated from the central control room.

7 MATTE assessment

The MATTE study for the proposed power plant only development has been conducted as a desk study using the DEFRA Guidelines for Environmental Risk Management whilst taking account of the COMAH regulations and CDOIF.

The basic approach to the study was to apply the Source, Pathway, Receptor methodology to identify hazards and assess any residual environmental risk (MATTE) associated with a major accident.

7.1 Sources

Materials that have been identified as present at the STEP are shown in the table below.

Table 2. Materials and Inventory

Material	CAS Number	Inventory	Annual Use	Form	Containment	Use
Natural Gas	74-82-8	Natural Gas: <50 tonnes	Unknown	Gas	Piping and equipment containing gas	Process material (gas supply)
Ammonia hydroxide (19%)	1336-21-6	1,500 litres	13,140 litres	Liquid	Tote 1,500 litres	pH control
Tri-Sodium Phosphate	7601-54-9	1,500 litres	13,140 litres	Liquid	Tote 1,500 litres	pH buffer and harness/scale treatment
Sodium Bisulphite (30% - 50%)	7631-90-5	1,500 litres	3,500 litres	Liquid	Tote 1,500 litres	Dechlorination agent
Sulphuric Acid (77-100%)	7664-93-9	3,000 litres	Unknown	Liquid	Storage tank and Batteries	pH Control
Diesel	68476-34-6	11,500 m^3	Unknown	Liquid	Diesel Tanks	Fuel
Transformer oil (Mineral oil, petroleum distillates)	Varies depending on supplier	110 m^3	Unknown	Liquid	Within transformers	Electrical system cooling

Additional materials including antiscalants, biocides, corrosion inhibitors, antifreeze, cleaning chemicals, paints, hydraulic oil, grease and lubricating oils are expected to be present on site in small quantities. These materials, whilst present at the site, are not anticipated to be present in sufficient quantities to materially affect the outcome of this assessment.

A review of the Material Safety Data Sheets (MSDS) [9][10][11][12][13], the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) [8] and the COMAH Regulations [3] has provided details of the classification and ecotoxicity of the materials listed in the table above. The findings from this review are summarised in the table below. Where the material classification is not directly available from GHS relevant data then date from the Material Safety Data Sheets (MSDS) has been used.

Any materials that are identified as ‘Dangerous Substances’ under the COMAH Regulations or have Hazard Classifications indicating the potential for significant environmental damage on release have been identified.

Table 3. Material Classification and Ecotoxicity

Chemical [CAS No.]	GHC Classification	Hazard Statement	Environmental Effects			COMAH Classification
			Toxicity	Biodegradability	Bioaccumulation	
Natural Gas	Flam. Gas 1 Press. Gas	H220	No environmental toxicity identified.	No data available	No data available	**Flammable gases**
Ammonia Hydroxide	Harmful if swallowed. Causes severe skin burns and eye damage. May cause respiratory irritation. Very toxic to aquatic life.	H302 H314 H335 **H400**	LD50 Oral – Rat – 350 mg/kg (Ammonium hydroxide) LC50 – Fish – 0.44 mg/l – 96 h (Ammonium hydroxide) LC50 – Daphnia magna (Water flea) – 25.4 mg/l – 48 h (Ammonium hydroxide)	No data available	Does not bioaccumulate	**Hazardous to the Aquatic Environment**
Tri-Sodium Phosphate	Causes skin irritation Causes serious eye irritation May cause respiratory irritation	H315 H319 H335	LD50 Oral – Rat – female - > 2,000 mg/kg LC50 Inhalation – Rat – male and female – 4 h - > 0.83 mg/l LD50 Dermal – Rat – male and female - > 2,000 mg/kg LC50 – Oncorhynchus mykiss (rainbow trout) - > 100 mg/l – 96 h EC50 – Daphnia magna (Water flea) - > 100 mg/l – 48 h ErC50 – Desmodesmus subspicatus (green algae) - > 100 mg/l – 72 h Toxicity to bacteria static test EC50 – activated sludge - > 1,000 mg/l – 3 h	Not applicable to inorganic materials	No data available	None
Sodium Bisulphite	Exempt from Regulation (EC) No 1272/2008.	-	No data available	No data available	Not bioaccumulitive	None

Chemical [CAS No.]	GHC Classification	Hazard Statement	Environmental Effects			COMAH Classification
			Toxicity	Biodegradability	Bioaccumulation	
Diesel	Flam. Liquid Skin Corrosion/Irritation Aspiration Hazard STOT SE Carcinogenicity Aquatic Chronic Eye Damage/ Irritation	H226 H315 H304 H336 H350 **H411** H319	Inhalation LC50 Rat >6 mg/l/4h Acute Toxicity LD50 Dermal Rabbit >5000 mg/kg Acute Toxicity LD50 Oral Rabbit >5000 mg/kg Toxic to aquatic organisms based on an acute basis LC50/EC50 >1 but < 10 mg/L in the most sensitive species. Material is a long-term aquatic hazard based on a chronic basis (C50/EC50 >1 but < 10 mg/L in the most sensitive species.	No data available	No data available	**Named: Petroleum products (gas oils)**
Transformer Oil (1)	May be fatal if swallowed and enters airways. Harmful to aquatic life with long lasting effects.	H304 **H412**	LD50 (Rat): > 2,860 mg/kg LC50 (Rat): > 5.2 mg/l, 4 h	No Data available.	No data available.	**Hazardous to the Aquatic Environment**

Notes:

(1) Transformer oil classification based on review of a range of oil MSDS, the H412 categorisation may not be applicable to some transformer oils.

Of the materials listed in Table 2 those classified with the following categories are the most hazardous to the environment. Specifically:

- H400 – Very toxic to aquatic life (Ammonia hydroxide);
- H411 – Long-term (chronic) aquatic hazard (Category 2) (Diesel); and,
- H412 – Harmful to aquatic life with long lasting effects (Transformer Oil).

7.2 Pathways

A review of the processes undertaken and measures provided on the site has identified the following possible onsite pathways (refer to the following subsections), which have been considered, where appropriate, for the assessment of MATTE scenarios.

7.2.1 Drainage systems on site

The Environmental Impact Assessment Report (EIAR) [7] describes the details of the drainage systems on the site, which is summarised in this subsection.

A surface water drainage network consisting of piped drainage and swales/ catch basins will be constructed to collect, convey, and attenuate the surface water runoff generated.

The access road levels will be profiled to drain road runoff to an engineered swale adjacent to the road, the majority of which will drain to the engineered storm drainage system at the Power Plant site and discharge to the shared constructed outfall to the Shannon Estuary.

There will also be a stormwater discharge point at the Ralappane D1 stream crossing located 50m from the site entrance (Drawing Ref: 198291-1STF-S3001), and a second stormwater discharge point will be located at the D2 stream crossing located 20m from the construction laydown area (Drawing Ref: 198291-1STF-S3002). Both will be fitted with Class 1 hydrocarbon interceptors.

Stormwater collected from roof drains and permeable areas will discharge directly to the estuary via the final discharge monitoring station. All bunded areas within the Proposed Development site will have valved discharge points as part of their connection to the drainage network (see Figure Appendix A).

Groundwater seepages from springs or at the toe of cut slopes will be collected via a groundwater drainage network which will then discharge directly to the Shannon Estuary via the same discharge outfall pipe as the surface water.

Silt traps will be incorporated in all groundwater drainage points prior to discharge.

During the operational phase, all drainage from the Proposed Development site will be controlled and monitored in compliance with the terms of the IE licence.

A firewater retention pond is included in the Proposed Development and sized according to EPA Guidance on Retention Requirements for Firewater Runoff, as the most effective and suitable measure for retaining firewater. The retention pond will be rendered impermeable by use of an appropriate liner, and integrity-tested in line with the requirements of the site's licence. All process area site drainage will pass through the retention pond. An automatic shut-off valve linked to the site's fire detection system will be installed on the drainage outlet point.

7.2.2 Releases into Bunded Areas

Bunds are designed to contain liquid releases from bulk storage tanks. Where bunds are correctly designed, operated and maintained, the only release to the environment will be due to evaporation from liquid that is contained in the bund. All bunds will be sized to contain the full storage tank inventory plus

an additional allowance for safety where appropriate. These bunds will have valved discharge points as part of their connection to the drainage network. Prior to draining of rainwater from bunded areas, checks will be carried out to ensure that the material discharged is not contaminated.

Possible failure of bunds may be due to poor design, substandard construction, damage, overtopping, overfilling and the failure of systems for rainwater removal. Depending upon the failure type and location, possible outcomes of bund failure could be a release to unmade ground below the bund, release onto plant areas that are covered in broken stone, or release into the surface water drains. Bund failures that are coincident with a release of dangerous substance from the primary containment, while discussed in this assessment, are considered to be very low probability events.

7.2.3 Releases in the Power Plant Area

All stormwater collected from paved and impermeable areas within the Power Plant will pass through a class 1 hydrocarbon interceptor prior to discharge to the Shannon Estuary.

At the end of the system there is a valve which is normally open to allow rainwater to discharge to the estuary but can be closed in an emergency to prevent discharge.

Stormwater collected from roof drains and permeable areas within the power plant will discharge directly to the estuary via the final discharge monitoring station.

7.2.4 Releases to the Storm Water Drain System

The access road levels will be profiled to drain road runoff to an engineered swale adjacent to the road, the majority of which will drain to the engineered storm drainage system at the Power Plant site and discharge to the shared constructed outfall to the Shannon Estuary.

There will also be a stormwater discharge point at the Ralappane D1 stream crossing located 50m from the site entrance (Drawing Ref: 198291-1STF-S3001), and a second stormwater discharge point will be located at the D2 stream crossing located 20m from the construction laydown area (Drawing Ref: 198291-1STF-S3002). Both will be fitted with Class 1 hydrocarbon interceptors.

Releases to the Shannon Estuary are only possible of there is a failure to control discharge from the sumps or through the drains.

7.2.5 Releases to Ground/Ground Water from permeable areas

Ground water from permeable areas will be collected by means of a ground water drainage network that will collect the ground water and discharge where possible into either the existing stream/drainage ditches within the site or directly to the estuary via same discharge outfall pipe as the storm water. Silt traps will be incorporated onto all groundwater drainage points prior to discharge.

As the site groundwater drains are only located along the outside perimeter of the developed site, away from process equipment, roadways and buildings it is thought that a release into these drains is not possible.

7.2.6 Releases into Storage Buildings/Warehouses

Building areas used for chemical or hydrocarbon storage on the site, Power Station and AGI will have impermeable floors with no drains. Therefore, any spillage in these building areas should be contained.

7.2.7 Releases at the AGI Area

Water collected on the paved and impermeable areas of the AGI will be collected and discharged to the storm water drain system after passing through an inceptor located at the AGI. The drainage route from the AGI Interceptor through the storm water drains pass through a second interceptor located near the

instrument air package prior to discharge into the fire water retention pond. The fire water retention pond discharges to the estuary.

7.2.8 Fires

Any fires on site will release combustion products, and in some cases may release unburned material to atmosphere. Systems will be installed on site for preventing and mitigating fires (e.g. inerting systems, minimisation of ignition sources and water or firefighting systems).

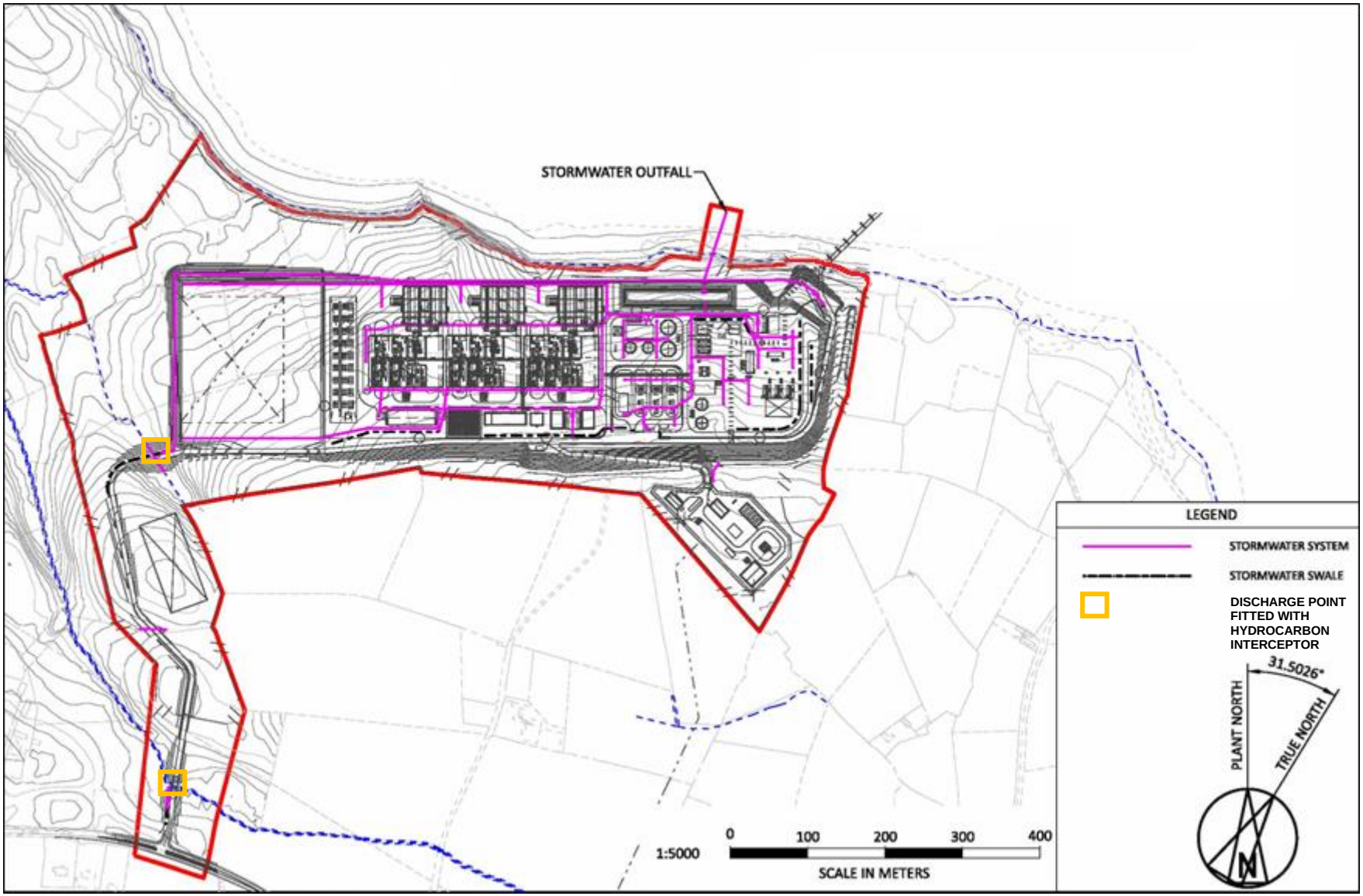

Figure 4. Proposed Site Drainage

7.3 Receptors

The Proposed Development site is in pasture, comprising primarily improved grassland with some wet grassland adjacent to the Shannon Estuary, as shown on the aerial photograph below.

Figure 5. Proposed Development Site

The Lower Shannon Special Area of Conservation (SAC) is partly within and adjacent to the site along the northern/ north-western boundary and also along part of the eastern boundary of the Proposed Development site (see below). The Ballylongford Bay Natural Heritage Area (NHA) is adjacent to a part of the north-western boundary of the Proposed Development site (see below). The Shannon-Fergus Estuary Special Protection Area (SPA) is to the west of the Proposed Development site (at a distance of approximately 750 m from the western extremity of the terrestrial elements of the Proposed Development site).

For the purpose of this assessment only the possible impacts to the most sensitive receptors will be considered (NHA, SPA and SAC). It is recognised that there are criteria for harm to other receptors but the criteria for extent and duration of harm for these receptors is less stringent than those for SACs, SPAs and NHAs.

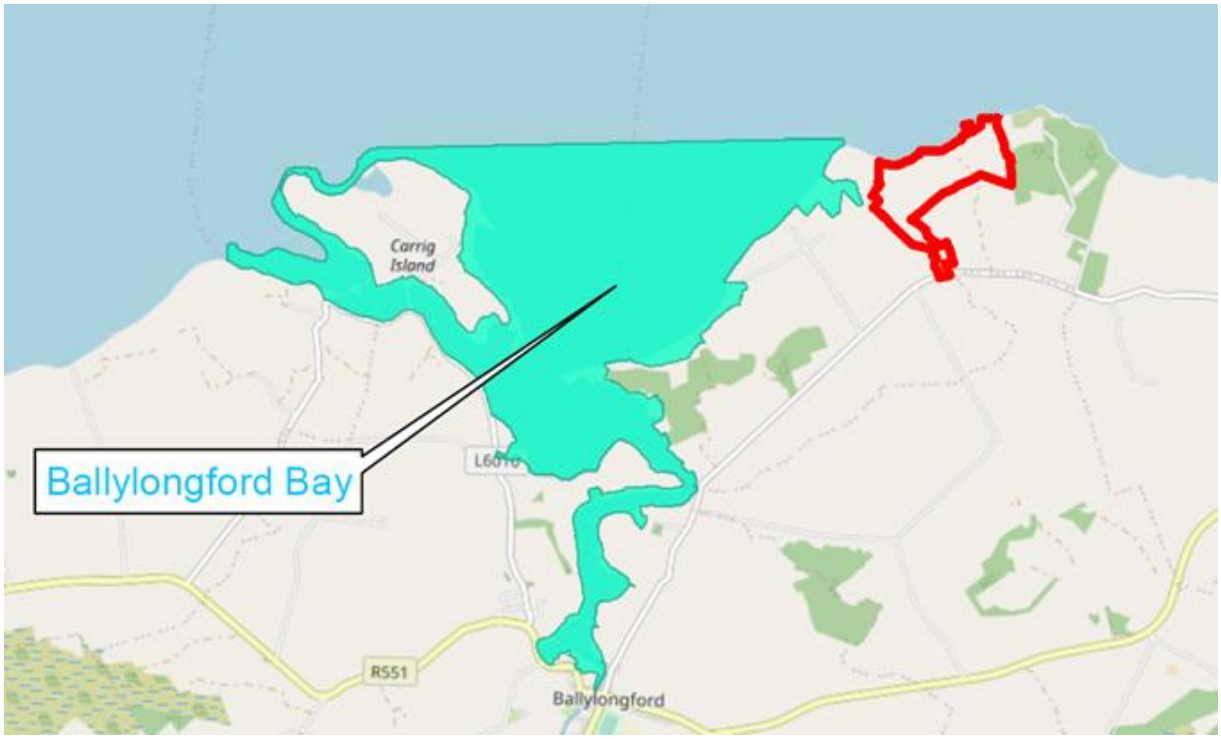

Figure 6. Proposed National Heritage Areas (NHA)

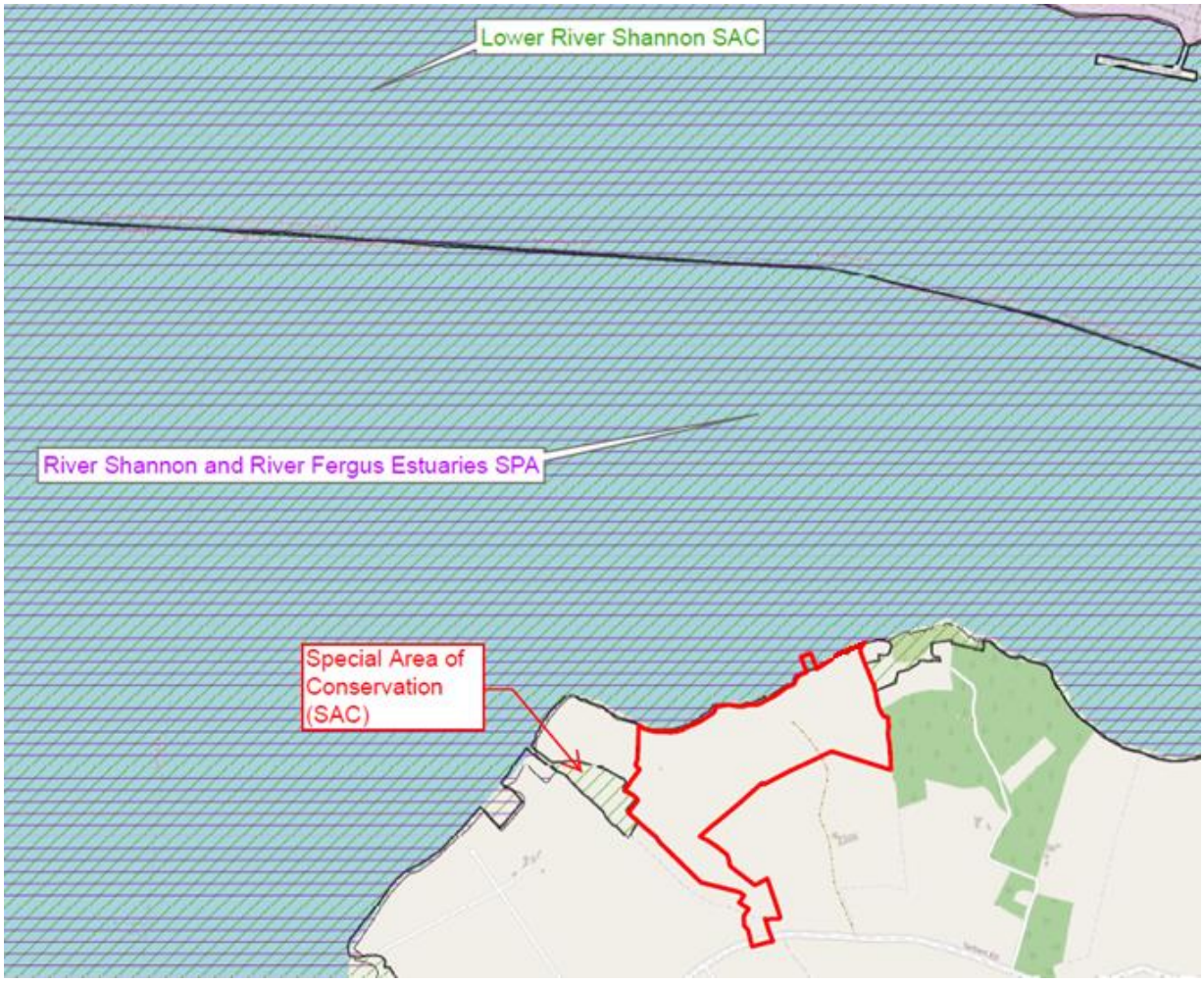

Figure 7. SPA and SAC

7.4 COMAH materials

Materials that are covered by the COMAH Regulations as either Named Substances or by their hazardous characteristics, such as flammability or toxicity require specific assessment as their release may lead to a MATTE, as detailed in the 'COMAH Classification' column of Table 3.

Materials that fall into this category are:

- Natural gas;
- Ammonia hydroxide;
- Diesel; and,
- Transformer oil.

7.4.1 Natural gas

Natural gas is not toxic to the environment, hazards are associated with exposure to fires if a release of natural gas is ignited. Environmental receptors at risk are flora and fauna in the NHA and SAC to the west of the site.

There is no MATTE associated with the natural gas used on the facility as it does not have any liquid constituents.

7.4.2 Ammonia Hydroxide

Up to 4 tonnes of ammonia hydroxide solution will be stored at the Power Plant in 1,500 litre totes. It will be used for Power Plant feedwater treatment.

Ammonia hydroxide solution is considered to be toxic to the environment under the COMAH Regulations as it classified as H400 "Very toxic to aquatic life".

A possible worst case release for ammonia solution is the loss of the contents of a tote. This could occur during offloading or during storage. Any releases within the storage building would be contained by the building's impermeable flooring or bund and could be cleaned up (e.g. using absorbent material) and disposed of safely. Releases outside the building onto roadways could possibly enter the roadway storm water drains and flow through the drainage system to the estuary. However action can be taken to contain spillages and prevent flow to the estuary by closing the storm water drainage system valve.

The loss of the contents of a Tote of ammonia solution to the estuary is likely to have short term environmental effects at the point of discharge. However, it is thought that the release would not be of sufficient size to result in a MATTE.

Spillages onto ground covered in broken stone have not been considered as possible events, as ammonia solution is not used or transported over areas with this surfacing.

Spillage of ammonia solution will lead to a pungent odour close to the spillage. For a release of a tote of ammonia hydroxide solution the odour will not lead to off-site concentrations of concern as the solution is an aqueous solution and only small quantities of ammonia will be released from it to atmosphere.

7.4.3 Diesel

Diesel is present onshore within the STEP in a number of locations, provisionally identified as:

- Power Plant CCGT Standby Diesel Generator; 3,200 litres (three off);
- Power Plant CCGT Diesel Fire Pump; 1,400 litres; and,
- Power Plant CCGT secondary diesel fuel storage for the power plant, 11,500m^3.

Diesel is considered to be toxic to the environment under the COMAH Regulations as it classified as H411 "Long-term (chronic) aquatic hazard".

The use of localised small inventory storage tanks for the items of equipment listed above means that the largest credible spillage of diesel (from the secondary diesel fuel storage) would be 11,500 m^3. This is above the Lower Tier threshold of 2,500 tonnes for petroleum products, but below the Upper Tier threshold of 25,000 tonnes [3]. The volume of diesel is less than the Lower Tier threshold for a "Long-term (chronic) aquatic hazard" of 100 tonnes.

Regulations for the storage of diesel such as the "Control of Pollution (Oil Storage) Regulations (Northern Ireland) 2010" and "HSG 176 Storage of flammable liquids in tanks", detail specific requirements for diesel storage that, if followed, mean that a release of diesel is an unlikely event.

The diesel tanks are in a triple containment system, with 2 bunded areas. This contains the diesel within the bunds and prevents the diesel from spreading to the water.

The low release frequency combined with the triple containment system mean that the likelihood of release of diesel occurring and reaching the water is considered extremely low.

7.4.4 Transformer Oil

There is transformer oil present in four transformers, each of 25,000 litres capacity.

For the purpose of this assessment Transformer oil is considered to be toxic to the environment under the COMAH Regulations as it classified as H412 "Harmful to aquatic life with long lasting effects". It should be noted that assumption of this classification is conservative as transformer oils that do not pose a significant effect to the environment are available.

If a release of transformer oil was to enter into the storm water drainage system it would be contained by the Class 1 petrol interceptor. If the interceptor was unable to contain the release and the shut off valve on the storm water drainage system was not closed, there could be a discharge of transformer oil to the estuary. Possibly resulting in a surface layer of hydrocarbons on the estuary. In unfavourable conditions it is conceivable that this could affect the SAC/SPA. A MATTE is therefore considered to be possible, but only if the release of transformer oil was very large. However, the volume of transformer oil is less than the Lower Tier threshold for an H412 category fluid of 200 tonnes.

7.5 Non-COMAH Materials

Materials that are not rated as hazardous to the environment under the COMAH Regulations require MATTE assessment where it is credible that they could be released, as the result of an incident involving a material that is covered by the COMAH Regulations [3].

The conservative assumption that incidents involving natural gas could lead to the release of any of the non-COMAH materials listed in Table 2 has been made. It should be noted that, due to the separation distances between the natural gas systems and areas where these materials are present, the likelihood of secondary releases of this type are very low.

Materials considered are:

- Tri-Sodium Phosphate;
- Sodium Bisulphite (30% - 50%); and,
- Sulphuric Acid (77-100%).

In addition, releases of cleaning chemicals, laboratory chemicals, paints and fires have been considered at a high level.

7.5.1 Tri-sodium Phosphate

Tri-sodium phosphate will be used for feedwater treatment. It is a solid material that will be stored in 1,500 kg Totes at the Power Plant water treatment store. It is not classed as hazardous to the environment under the COMAH Regulations. The material has been identified as being toxic to fish.

A possible worst-case release for tri-sodium phosphate solution is the loss of the contents of a tote. This could occur during offloading or during storage. Any releases within the storage building would be contained by the building's impermeable flooring or bund and could be cleaned up (e.g. using absorbent material) and disposed of safely. Releases outside the building onto roadways could possibly enter the roadway storm water drains and flow through the drainage system to the estuary. However action can be taken to contain spillages and prevent flow to the estuary by closing the storm water drainage system shut off valve.

The loss of the contents of a Tote of tri-sodium phosphate ammonia solution to the estuary is likely to have short term environmental effects at the point of discharge. However, it is considered that the release would not be of sufficient size to result in a MATTE.

7.5.2 Sodium Bisulphite

Sodium bisulphite solution will be used for feedwater treatment. It is a is a liquid material that will be stored in 1,500 kg Totes at the Power Plant water treatment store. It is not classed as hazardous to the environment under the COMAH Regulations. The material has been identified as being toxic to fish.

A possible worst-case release for sodium bisulphite solution is the loss of the contents of a tote. This could occur during offloading or during storage. Any releases within the storage building would be contained by the building's impermeable flooring or bund and could be cleaned up (e.g. using absorbent material) and disposed of safely. Releases outside the building onto roadways could possibly enter the roadway storm water drains and flow through the drainage system to the estuary. However, action can be taken to contain spillages and prevent flow to the estuary by closing the storm water drainage system shut off valve.

The loss of the contents of a Tote of sodium bisulphite solution to the estuary is likely to have short term environmental effects at the point of discharge. However, it is considered that the release would not be of sufficient size to result in a MATTE as a release would be limited to a single tote.

Even if a pathway between the material and an environmental receptor could be identified, release of the material would not result in a MATTE.

7.5.3 Sulphuric Acid

Approximately 3 m^3 of sulphuric acid will be present on the Power station, and also used within uninterruptable power supply (UPS) batteries.

Sulphuric acid is a mineral acid that is corrosive and toxic to the aquatic environment at low levels. As sulphuric acid is not classified as being dangerous to the environment under the COMAH Regulations, as events requiring consideration are those that are due to an incident involving a COMAH material. In the Power Plant area this could be due to an incident involving natural gas that damaged the sulphuric acid containment systems or batteries.

A possible event taken for MATTE assessment is the release of sulphuric acid on the Power Plant. A worst case scenario would be the release of the entire tank contents due to failure of both the tank and leakage from or overtopping of the bund. In this scenario up to 3 m^3 of acid could be released. As the tank is located at some distance from the buried natural gas supply line to the Power Plant, the likelihood of a release of this size is considered to be very unlikely. However, in such an event, a release of sulphuric acid into the storm water drains may be possible.

At the end of the storm water system there is a shut off valve which is normally open to allow the rainwater to discharge to the estuary. This valve can be closed in the event of spillage, as required. A spillage of sulphuric

acid could potentially be released to the estuary through this route if the shut off valve was not closed. As the quantities released would be small, and sulphuric acid is not highly toxic to the environment, it is judged that a MATTE from a leak of sulphuric acid is not credible.

7.5.4 Cleaning Chemicals, Laboratory Chemicals and Paints

Various types of laboratory chemicals, paints and cleaning materials will be stored in Maintenance & Warehouse Buildings and will be used throughout the STEP. Details of the properties of these materials are not available but it is likely that some of the materials will be hazardous to the environment or flammable.

These types of materials are commonly stored and transported on site in small containers and if accidentally spilled can be treated, absorbed into inert materials and disposed of safely. Any releases in storage areas will be contained by impermeable flooring. On this basis it is concluded that a MATTE from the release of laboratory chemicals, paints and cleaning materials is not credible.

7.5.5 Storage Building Fires

A variety of materials such as laboratory chemicals, paints, cleaning materials, oils and process chemicals will be present in storage buildings on the site. Storage building fires may occur as a consequence of a natural gas fire and a range of materials stored in the buildings could combust, be carried into the atmosphere in the smoke plume, be released to the building floor (liquids) or enter firewater.

In the event of a storage building fire the materials being released to atmosphere will be primarily carbon dioxide, carbon monoxide, water vapour, soot and unburned materials that may be carried in the smoke plume.

Local environmental factors such as wind speed and direction will influence which environmental receptors are likely to be affected and the potential for dry deposition of materials in the plume. Washout of material from the plume may occur if it is raining, leading to deposition of materials.

The primary combustion products (carbon monoxide, carbon dioxide and water vapour) in fire plumes will have short term environmental effects as they are not considered to be highly hazardous to the environment and will not produce long term contamination. Soot deposited from the plume may lead to short-term marking of vegetation but is also unlikely to lead to long term or acute environmental damage. Therefore, a MATTE from a storage building fire smoke plume is not thought to be a credible event.

Fire water run-off from a storage building fire will be expected to be contained on site and will only reach the Shannon estuary if a very large quantity of firewater is used. In this event, water contaminated with materials that may be hazardous to the environment could enter the estuary. If such a release was prolonged, and contained materials that are ecotoxic, it is possible that the local SAC/SPA could be affected, possibly leading to a MATTE. With the measures proposed for preventing building fires and controlled discharge of fire water to the estuary, the risk of a MATTE from fire water run-off is considered to be very low.

7.6 MATTE risk evaluation

The evaluation of risk associated with the identified MATTE events is provided below.

Table 4. MATTE Sources for the Power Plant only design.

Material	Risk of MATTE
Diesel	Low - the proposed 11,500 m^3 diesel stored on site falls within the Qualifying quantity (>2,500 tonnes) of dangerous substances as referred to in the COMAH Regulations, but the low likelihood of a release occurring combined with the triple containment system means that it is very unlikely for a release to occur resulting in the material entering the estuary (pathway).

Material	Risk of MATTE
Transformer oil	Very low - measures on site would prevent the material entering the estuary (pathway)
Firefighting Water	Very low – measures on site would prevent the material entering the estuary (pathway)

A review of the escalation potential, vulnerabilities, and potential environmental impacts is provided below:

Escalation

In respect of the risks of escalation, facilities will be designed to incorporate separation distances to prevent major accidents such as fires and explosions originating in one area from spreading to another area or escalating via domino effects, based on established engineering guidance for industrial site layout. Further the development will be partitioned into fire zones, where equipment is grouped by nature and / or homogeneous level of risk. The consequences of a fire, flammable gas leak or an explosion corresponding to the credible event likely to occur in one fire zone shall not impact other fire zones.

Vulnerability

In terms of the vulnerability of the project to potential disasters/accidents, including both natural and man-made disasters it is noted that the application is accompanied by a flood risk assessment, which concludes that with the exception of crossings of Ralapanne Stream by the access road, there is no development proposed within either Flood Zones A or B. The proposed watercourse crossings have been sized to have a minimal impact on the hydraulic regime in the area and provide an adequate freeboard for a 1% AEP fluvial event. The site is also remote from other major accident sites and would not be at risk from events at such sites.

Environmental impacts

Table 5. Review of Environmental Impacts

Phase	Impact	Effect	Comment
Land & Soils			Impacts that are predicted to arise in relation to Land and Soils would be avoided managed and mitigated by the measures which form part of the proposed scheme and the proposed mitigation measures. The proposed development would not have any unacceptable direct, indirect or cumulative impacts in terms of Lands and Soils.
Construction phase	Accidental spills and leakage of oils and fuels.	Minimal	
Operational	Spillages of fuel, oil, wastewater or other hazardous substances	Minimal	
Cumulative effects	N/A	N/A	

Phase	Impact	Effect	Comment
Water	Accidental spills and leaks from use and storage of liquid chemicals, oils and fuels.	Minimal	Impacts in relation to Water would be avoided, managed and mitigated by the measures which form part of the proposed scheme and by appropriate conditions. The proposed development would not have any unacceptable direct, indirect or cumulative impacts in terms of Water. See also the assessment of effects on Marine Ecology below.
Marine ecology	Accidental large-scale oil spill during operations -Habitats, Marine Mammals, Fish and crustacean species of the estuary and SAC, birds of the SPA	Not significant	Impacts that are predicted to arise in relation to Marine Ecology, would be avoided managed and mitigated by the measures which form part of the proposed scheme. The proposed development would not have any unacceptable direct, indirect or cumulative impacts in terms of Marine Ecology.
Terrestrial Ecology	N/A	N/A	N/A
Major Accidents and Disasters	Loss / spillage of other contaminants. Potential for release of contaminants in firewater.	Not significant	Impacts in relation to major accidents and disasters would be satisfactorily avoided, managed and mitigated by the measures which form part of the proposed scheme and by appropriate conditions. The proposed development would not have any unacceptable direct, indirect or cumulative impacts in terms of major accidents and disasters

7.7 MATTE assessment summary

The table below provides the results of the MATTE assessment for the Power Plant only design.

Table 6. MATTE potential for the Power Plant only design

Material	MATTE	MATTE Risk
Diesel	Yes	Low - The proposed 11,500 m^3 diesel stored on site falls within the Qualifying quantity (>2,500 tonnes) of dangerous substances as referred to in the COMAH Regulations, but the low likelihood of a release occurring combined with the triple containment system means that it is very unlikely for a release to occur resulting in the material entering the estuary (pathway).
Transformer oil	Yes	Very low - measures on site would prevent the material entering the estuary (pathway)
Firefighting Water	Yes	Very low – measures on site would prevent the material entering the estuary (pathway)
Natural Gas	No	N/A Not a MATTE
Ammonia Hydroxide	No	N/A Not a MATTE
Tri-Sodium Phosphate	No	N/A Not a MATTE
Sodium Bisulphite	No	N/A Not a MATTE
Sulphuric acid	No	N/A Not a MATTE
Cleaning materials, laboratory chemicals and paints	No	N/A Not a MATTE

8 Conclusions

The results from the MATTE assessment are summarised in the table below.

Qualitative assessment of possible scenarios for accidental releases associated with the STEP has indicated that releases or accidents of large quantities of some materials have the potential for causing a MATTE; specifically diesel and Transformer Oil. Release of firefighting water to the estuary could result in a MATTE if it is contaminated with ecotoxic materials.

Table 7. MATTE assessment summary

Material	Potential MATTE?	Evaluation	MATTE Risk
Diesel	Yes	The proposed 11,500 m^3 diesel stored on site falls within the Qualifying quantity (>2,500 tonnes) of dangerous substances as referred to in the COMAH Regulations, but the low likelihood of a release occurring combined with the triple containment system means that it is very unlikely for a release to occur resulting in the material entering the estuary (pathway).	Low
Transformer oil	Yes	Transformer oil may be hazardous to the environment depending on its chemical composition and a significant release to the estuary could result in a MATTE. Measures on site would prevent the material entering the estuary (pathway)	Very low
Firefighting Water	Yes	Firefighting the water may be contaminated with materials that are toxic to the environment and, as such, a release of a large quantity of firefighting water into the Shannon estuary may lead to a MATTE. Measures on site would prevent the material entering the estuary (pathway)	Very low
Natural Gas	No	There is no MATTE associated with the natural gas used on the facility as it does not have any liquid constituents.	N/A Not a MATTE
Ammonia Hydroxide	No	Small quantities of material that is not significantly ecotoxic with low possibility of entering the marine environment.	N/A Not a MATTE
Tri-Sodium Phosphate	No	Small quantities of material that is not significantly ecotoxic with low possibility of entering the marine environment.	N/A Not a MATTE
Sodium Bisulphite	No	Small quantities of material that is not significantly ecotoxic with low possibility of entering the marine environment.	N/A Not a MATTE
Sulphuric acid	No	Small quantities of material that is not significantly ecotoxic with low possibility of entering the marine environment.	N/A Not a MATTE
Cleaning materials, laboratory chemicals and paints	No	Materials may be harmful to the environment but only present in small quantities with low possibility of entering the marine environment.	N/A Not a MATTE

All of the identified MATTE events are described as low or very low risk, as the likelihood of a release occurring is low and measures for prevention of discharge to the estuary are present within the plant design and operating philosophy.

It is noted that the risks associated with the facility are in accordance with HSA criteria.

9 References

[1] Guidance on technical land-use planning advice. For planning authorities and COMAH establishment operators. HSA, version 2, February 2023.

[2] Health and safety authority Guidance to Inspectors on the Assessment of Safety Reports under the COMAH Regulations 2015, Rev. 4 Jan 2017

[3] Chemicals Act (Control of Major Accident Hazards Involving Dangerous Substances) Regulations 2015. SI No. 209 of 2015.

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

[5] DEFRA. (2011). Guidelines for Environmental Risk Assessment, Green Leaves III. DEFRA

[6] Official Journal of the European Union. (2012). 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, amending and subsequently repealing Council Directive 96/82/EC

[7] Shannon Technology and Energy Park Environmental Impact Assessment Report, AECOM.

[8] Globally Harmonized System of Classification and Labelling of Chemicals (GHS). About the GHS | UNECE

[9] Olin Chlor Alkai Products Material Safety Data Sheets. www.olinchloralkali.com

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[11] Sigma Aldrich Material Safety Data Sheets. www.sigmaaldrich.com

[12] Robinsons Brothers Material Safety Data Sheet for Odorant NB. 3/03/2013 Revision No. 7.

[13] Air Liquide Material Safety Data Sheets. www.uk.airliquide.com

[14] Policy & Approach of the Health and Safety Authority to COMAH Risk-based Land-use Planning, 19th March 2010.

Appendix A. Drainage

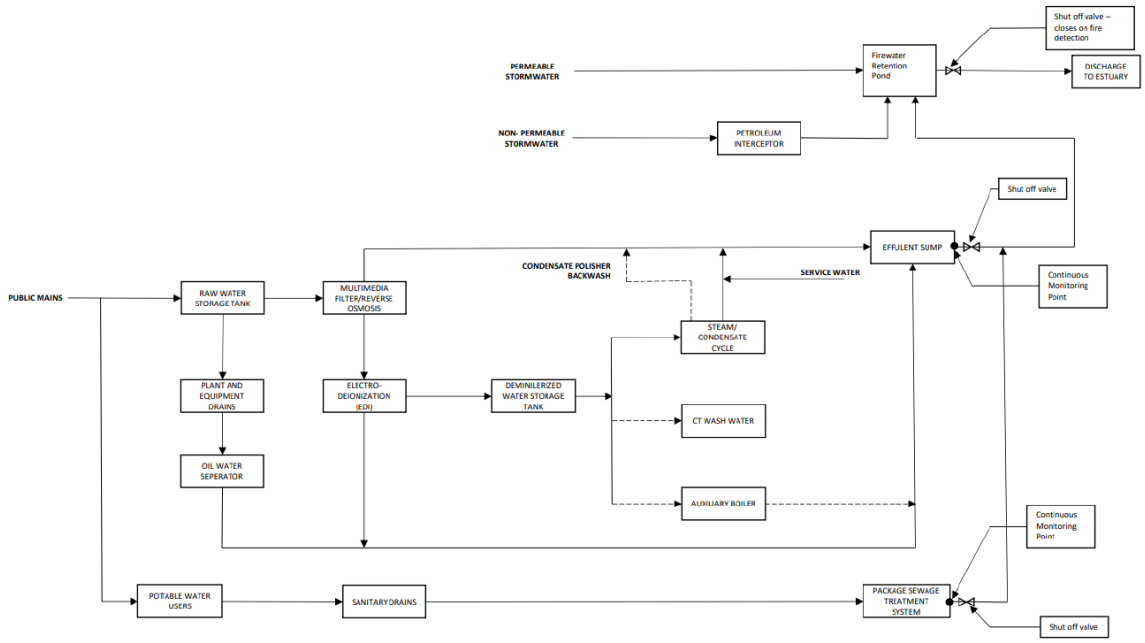

Figure 2-24 Proposed Development Water Flows