CDOIF

Chemical and Downstream Oil Industries Forum

Supplement to Guideline – 'Environmental Risk Tolerability for COMAH Establishments'

Storage Terminal Example

Whilst the CA cannot comment on the accuracy of any site specific data or assumptions, the worked example provided does demonstrate an appropriate interpretation and application of the CDOIF guidance, with a sufficient level of detail to allow the screening process to be complete

CDOIF **Chemical and Downstream Oil Industries Forum**	*CDOIF is a collaborative venture formed to agree strategic areas for joint industry / trade union / regulator action aimed at delivering health, safety and environmental improvements with cross-sector benefits.*

Contents

1	Introduction	1
1.1	Limitations	1
2	Part 1: MATTE Definition and Thresholds	2
2.1	Establishment Overview	2
2.2	Establishment Location	2
2.3	Credible Release Scenarios	3
2.4	Environmental Receptors	4
2.5	Identification of Migration Pathways	5
2.6	MATTE Severity Thresholds	6
2.7	MATTE Consequence Levels	7
3	Part 2: Establishment Risk Frequencies	9
3.1	Failure Frequencies	9
3.2	Aggregating Failure Frequencies per Receptor	10
3.3	Worked Example of Tolerability Matrices	15
3.4	Outcome of Phase I Screening	16
4	Phase 2 Assessment	17

1 Introduction

This case study is an example of how a Phase I screening assessment would be carried out in accordance with the Guideline on Environmental Risk Tolerability for COMAH Establishments, Version 1.0 (the 'CDOIF Guidance'), published by the Chemical and Downstream Oil Industries Forum (CDOIF).

1.1 Limitations

This case study presents a simplified example of a fictional establishment to illustrate the approach to undertaking a Phase I screening assessment. The case study is not intended to be a complete description of the steps that would be undertaken when carrying out an assessment. It should be noted that a full Phase I assessment of environmental risk tolerability would include a detailed description of the environmental baseline at, and surrounding the establishment, a conceptual site model describing plausible source-pathway-receptor relationships, evaluation of credible scenarios and major accidents to the environment (MATTE) and justification of failure frequencies used in the tolerability assessment. For the purpose of this case study these elements have been summarised at a high level.

The reader should familiarise themselves with the detailed requirements of the CDOIF Guidance and it is likely that environmental specialists will need to be involved in the identification of MATTE and assessment of severity and duration of harm.

The focus of this case study is Phase I screening, as set out in the CDOIF Guidance; Phase 2 assessment is not covered in this example.

2 Part 1: MATTE Definition and Thresholds

2.1 Establishment Overview

The establishment is a fuel storage depot located on the shore of an estuary. Activities at the establishment include:

- Diesel storage in two large semi-buried storage tanks, T1 and T2, both with a maximum capacity of 10,000m^3. The tanks are constructed of a welded steel liner surrounded by a concrete jacket. The tanks have been terraced into a steep hillside and are covered with soil.
- Diesel is delivered to the establishment by vessel. The vessel moors at a jetty which is within the establishment boundary. Diesel pipelines are present on a 75m long pipe bridge which lies directly above the estuary.
- Diesel is transferred from the vessel to the jetty pipelines by loading arms. The onshore pipelines which transfer the diesel to the tanks are above ground. The pipelines run across open ground and do not have cathodic protection or leak detection systems installed.
- Diesel is also exported from the establishment by commercial road tankers. The 35m^3 capacity road tankers fill up at the road tanker loading bay. Approximately 10 tankers are filled each week.
- Mixed waste oils and water are stored in four above ground tanks:
  - Tank T3 with a capacity of 750m^3;
  - Tank T4 with a capacity of 20m^3; and
  - Tanks T7 and T8 both with capacities of 500m^3.
- The waste oils and water are transferred by above ground pipelines and are loaded onto 35m^3 commercial road tankers at the road loading bay for off-site removal. This activity takes place once a year, which involves approximately 20 tankers.
- Diesel fuel additive is stored in two above ground tanks T5 and T6, both with 53m^3 capacity. The additive is delivered to the establishment by road tanker at the road loading bay. Additive is injected into the diesel during loading of the commercial road tankers.
- A redundant tank farm is located to the north east and east of the active diesel tanks. These redundant tanks have been cleaned and degassed; as such they do not require assessment at present. However, if these tanks were to be brought back into service the assessment would be updated.

2.2 Establishment Location

The establishment covers approximately 15 hectares and slopes steeply down towards the estuary. The majority of the site is unpaved, although the road loading bay and the foreshore area are surfaced in concrete. An industrial estate is located to the south and a small number of residential properties lie outside the establishment boundary.

A stream is located adjacent to the eastern boundary of the establishment; this accepts the outfall from the tank farm interceptor. The stream is then culverted under the adjacent industrial estate

and discharges into the estuary. The establishment has a second interceptor serving a separate drainage system. This interceptor is located on the foreshore and discharges directly into the estuary.

The geology comprises fractured rock and groundwater seepages can be seen in the exposed foreshore next to the estuary. A previous site investigation at the establishment has also identified a thin layer of permeable gravelly soil above the bedrock, which is likely to allow liquids at the surface to penetrate into the fractures within the bedrock.

2.3 Credible Release Scenarios

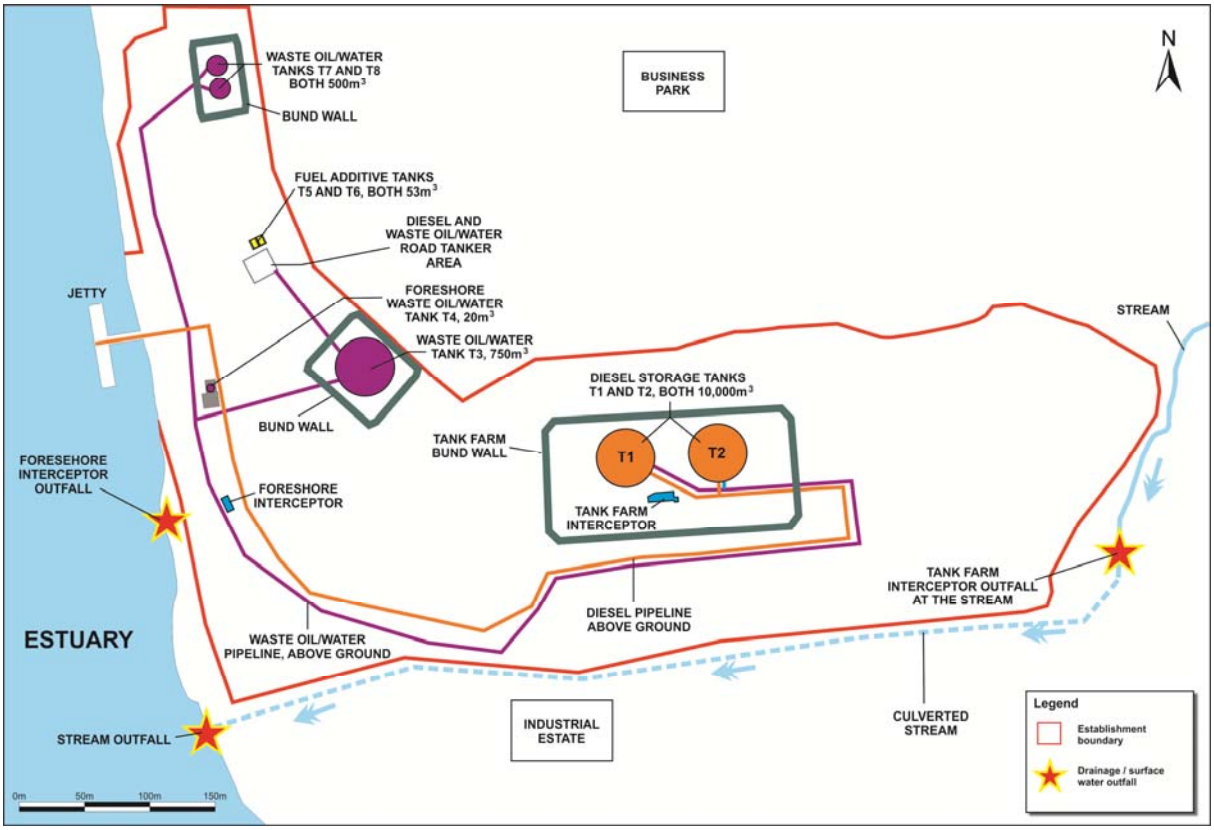
The existing Safety Report has identified a number of credible release scenarios, including releases of diesel, waste oils and water, mixed waste oils and water, and fire water. This case study has selected four of these credible scenarios as follows:

- release of diesel from tanks T1 and T2 (hazard reference ‘H01’). This includes acute releases (e.g. catastrophic tank failure) and chronic releases from the tank bases;
- acute release of diesel during vessel unloading at the jetty (H02);
- acute release of diesel fuel additive during road tanker delivery to above ground tanks T5 and T6 (H03); and
- acute release of fire-water containing fire-fighting foam and entrained hydrocarbons during operations to combat a major fire (H04).

The existing hazard and effects register has identified a number of factors which make up each credible scenario, including:

- source and maximum (worst case) release volume;
- causes of loss of containment;
- preventative controls; and
- mitigation controls.

It should be noted that a full Phase I assessment report would identify and describe each credible release scenario at the establishment in detail.



2.4 Environmental Receptors

Section 3.1 Environmental Receptors, Appendix 2 and Appendix 3 provide information on the types of environmental receptors which need to be considered in the assessment. In this case study, a number of these types of environmental receptors are present within 10km of the establishment. For the purpose of this case study, four receptors have been selected to demonstrate how the unmitigated source – pathway – receptor linkages are identified.

- the adjacent estuary is classified as Receptor Type 6 – 'widespread habitat – non designated water' and Receptor Type 15 – 'fresh and estuarine water habitats';
- a fish farm within the estuary is also classified under Receptor Type 6 – 'widespread habitat – non designated water';
- a protected bird species, the Godwit, resides in the estuary. The Godwit occurs at nationally significant numbers in the estuary (i.e. in excess of 1% of the UK population), at 5.6% of the UK population. The Godwit is classified under Receptor Type 13 – 'particular species'; and

- groundwater is present in the fractured bedrock underlying the establishment and is classified as a Receptor Type 8 – 'groundwater body non-drinking water source'.

Detailed descriptions of the environmental and ecological baseline would be included in a full Phase I assessment report.

2.5 Identification of Migration Pathways

A conceptual site model has been developed to identify the 'unmitigated' migration pathways between credible release scenarios and the environmental receptors. The conceptual site model has identified a number of plausible source-pathway-receptor linkages, but also confirmed that some linkages are not plausible due to the absence of migration pathways. For the purposes of this case study an example plausible linkage is:

Source	Migration Pathway	Receptor
10,000m^3 release of diesel from storage in T1 and T2 (H01)	Drainage infrastructure	• Estuary • Godwit living within the estuary • Fish farm in the estuary

In a full Phase I assessment report each plausible source-pathway-receptor linkage would be described.

2.6 MATTE Severity Thresholds

Now that the plausible pollutant linkages have been identified, the scale of the unmitigated impact for each of the receptors has been evaluated and 'sub-MATTE' level impacts have been excluded from further assessment. Section 3.2 MATTE Thresholds and Table 1 in Appendix 4 provides the thresholds used to determine whether an impact is 'sub-MATTE' or 'MATTE'.

An example of the MATTE severity comparison for release scenario H01 is presented below. A ✘ indicates the impact is unlikely to exceed the MATTE severity thresholds. A ✓ denotes the linkages which are likely to exceed the MATTE severity thresholds. These will be taken forward to assess the MATTE Consequence Level.

Receptor Type	MATTE Threshold (effects below this are considered sub-MATTE)	Credible release scenario and migration pathway		
		H01: 10,000m^3 release of diesel from storage in T1 and T2		
		Drainage infrastructure	Overland flow	In-ground migration
6 - Widespread habitat – non designated water	Contamination of aquatic habitat which prevents fishing or aquaculture or renders it inaccessible to the public.	✓	✓	✘
8 - Groundwater body (non-drinking water source)	1-100ha of groundwater body where the Water Framework Directive (WFD) status has been lowered	✘	N/A	✓
13 - Particular species (Godwit within the estuary)	Loss of 1-10% of animal or 5-50% of plant ground cover (based on national population levels)	✓	✓	✘
15 - Fresh and estuarine water habitats	WFD chemical or ecological status lowered by one class for 2-10km of watercourse or 2-20ha or 10-50% area of estuaries or ponds. Plus interruption of drinking water supplies.	✓	✓	✘

In a full Phase I assessment report justification for the decisions made in the evaluation of MATTE would be included.

2.7 MATTE Consequence Levels

As the final part of the MATTE definition, the Consequence Level (A to D) of each MATTE is assessed by determining the severity and duration of the harm using Table 1 (severity/harm criteria), Table 2 (duration/recovery criteria) and Table 3 (method and matrix for deriving receptor tolerability for MATTE) in Appendix 4 of the Guidance.

For the purpose of this case study an example of a consequence level assessment for two receptor types is presented below:

Receptor Type	Credible scenarios	Migration pathways	Severity of Harm Category	Duration of Harm Category	Consequence Level
6 - Widespread habitat – non designated water (estuary)	H01: Acute release from a semi-buried diesel tank (up to 10,000m^3) H02: Acute release during receipt of diesel from a vessel (up to 10,000m^3) H04: Release of firewater containing AFFF and entrained hydrocarbons (up to 15,000m^3)	Drainage infrastructure (H01 and H04) Overland flow (H01 and H04) Direct release to surface water (H02)	**Severe (2):** Contamination of aquatic habitat which prevents fishing or aquaculture or renders it inaccessible to the public.	**Medium term (2):** greater than 1 year but less than 10 years	Consequence Level **A**
13 - Particular species (Godwit within the estuary)	H01: Acute release from a semi-buried diesel tank (up to 10,000m^3) H02: Acute release during receipt of diesel from a vessel (up to 10,000m^3) H04: Release of firewater containing AFFF and entrained hydrocarbons (up to	Drainage infrastructure (H01 and H04) Overland flow (H01 and H04) Direct release to surface water (H02)	**Severe (2):** loss of 1 – 10% of animal or 5-50% of ground cover	**Very long term (4):** >20 years	Consequence Level **C**

Receptor Type	Credible scenarios	Migration pathways	Severity of Harm Category	Duration of Harm Category	Consequence Level
	15,000m^3)				

In a full Phase I assessment report, justification would be given for the severity and duration of harm for each MATTE.

3 Part 2: Establishment Risk Frequencies

Part 2 of the screening process involves aggregating the failure frequencies for each MATTE, per receptor, per year to define the 'total' risk tolerability for each environmental receptor, per year. This number will either lie in the 'Intolerable', 'TifALARP' or 'Broadly Acceptable' tolerability ranges.

The aggregated frequencies are plotted on the matrix below; initially for unmitigated scenarios and then for the mitigated scenarios, where credit is taken for existing preventative and mitigation controls. Unmitigated risk is denoted by '**UnMi**', mitigated risk is denoted by '**Mi**':

Tolerability Ranges							
	Frequency per establishment per receptor per year						
MATTE Consequence Level	**10^{-8} – 10^{-7}**	**10^{-7} – 10^{-6}**	**10^{-6} – 10^{-5}**	**10^{-5} – 10^{-4}**	**10^{-4} – 10^{-3}**	**10^{-3} – 10^{-2}**	**>10^{-2}**
D – MATTE	**Broadly Acceptable**			**TifALARP**	**Intolerable**		
C - MATTE							
B - MATTE					**Mi**		**UnMi**
A - MATTE							
Sub MATTE	Tolerability not considered under the CDOIF environmental risk tolerability methodology						

It should be noted that the frequencies should be aggregated per receptor. Some receptors have the potential to be impacted by more MATTE scenarios then others; therefore, for these receptors the overall 'risk' is likely to be higher.

This approach allows the most vulnerable receptors to be identified, along with the highest risk release scenarios and migration pathways.

Details of the control measures being considered, release frequencies and failure rates of individual protection layers would be provided within the full Phase I assessment report, or cross reference made to relevant sections of the Safety Report.

3.1 Failure Frequencies

3.1.1 Unmitigated Failure Frequencies

In many cases the existing Safety Report will have identified frequencies for the causes of a release for each credible release scenario. The unmitigated failure frequencies may be based on generic failure rate data, for example:

- Health & Safety Executive's (HSE's) Failure Rate and Event Data (FRED), see http://www.hse.gov.uk/landuseplanning/failure-rates.pdf; and
- The Environment Agency (EA), Scottish Environment Protection Agency (SEPA) and Natural Resources Wales (NRW) 'All Measures Necessary' Guidance.

3.1.2 Mitigated Failure Frequencies

For the purpose of this case study, examples of control measures which can be taken into account when deriving the mitigated frequencies include (but are not limited to):

- site operational procedures and controls which minimise the likelihood of a release occurring from primary containment e.g.:
  - the high level alarm on the tanks which reduces the likelihood of overfilling; and
  - routine site patrols along the pipeline routes;
- secondary containment which mitigates the impact on environmental receptors from a loss of primary containment e.g.:
  - the earth bund around the storage tank farm preventing overland flow;
- tertiary containment which mitigates the impact on environmental receptors from a loss of secondary containment e.g.:
  - the drainage infrastructure which includes pollution probes and automatic shut-off valves.

A probability of failure of demand (PFD) factor can be applied for each of the control measures. However, it should also be noted that for some release scenarios there may be more than one migration pathway to the same receptor; for example, via the establishment's drainage system and by overland flow. One migration pathway may be afforded a greater level of protection from the available control measures than the other(s). This needs to be taken into account when aggregating the overall mitigated release frequencies per receptor.

3.2 Aggregating Failure Frequencies per Receptor

The following table presents the total unmitigated and mitigated failure frequencies for each of the MATTE level credible release scenarios in the case study.

Unmitigated and Mitigated Failure Frequencies			
Credible release scenario	**Failure types covered**	**Total Unmitigated Failure Frequency per Scenario**	**Total Mitigated Failure Frequency per Scenario**
H01: Diesel storage in T1 and T2; 2 x 10,000m^3 semi-buried tanks – non pressure vessels. Maximum acute release volume: 10,000m^3 from a catastrophic failure	Failure rates for pipework 304.8mm diameter: 4mm diameter, 25mm diameter, 1/3 pipework diameter and guillotine release sizes.	**$2.76x10^{-01}$ years**	**$1.46x10^{-03}$years**

Unmitigated and Mitigated Failure Frequencies			
Credible release scenario	**Failure types covered**	**Total Unmitigated Failure Frequency per Scenario**	**Total Mitigated Failure Frequency per Scenario**
Chronic releases from the tank bases can go undetected for some time. 1,000m^3.	Overfill of storage tank during refuelling operations (based on two semi-buried tanks)		
	Major and minor release frequencies rate for AST > 450m^3 (includes chronic release and catastrophic failure).		
H02: Receipt of diesel by vessel. Receipts of fuel from vessels are pumped to T1 and T2 via on-board vessel pumps and a foreshore pump house. Maximum release volume 10,000m^3.	Loading arm failure during transfer	**6.57x10^{-03} years**	**3.57x10^{-05} years**
	Jetty pipeline failure		
	Release from jetty equipment		
	Vessel impact with jetty structure		
H04: Release of fire-water containing aqueous film forming foam (AFFF) and entrained hydrocarbons during operations to combat a major fire. Maximum release volume 15,000m^3 based on current fire water requirement assessments. AFFF in 3% solution in water.	Ignition of releases following loss of containment	**1.48x10^{-03} years**	**7.40x10^{-04} years**

The following table then presents the total release frequencies for each credible scenario, aggregated for each receptor, per year, and also taking into account the different MATTE consequence levels.

Aggregate Unmitigated and Mitigated Failure Frequencies per Receptor				
Receptor Type		**H01: Diesel storage in T1 and T2; 2 x 10,000m^3 semi-buried tanks – non pressure vessels.** **Maximum acute release volume: 10,000m^3 from a catastrophic failure** **Chronic releases from the tank bases can go undetected for some time. 1,000m^3**	**H02: Receipt of diesel by vessel. Receipts of fuel from vessels are pumped to T1 and T2 via on-board vessel pumps and a foreshore pump house.** **Maximum release volume 10,000m^3.**	**H04: Release of fire-water containing aqueous film forming foam (AFFF) and entrained hydrocarbons during operations to combat a major fire.** **Maximum release volume 15,000m^3, based on current fire water requirement**
Unmitigated total failure frequency per scenario		2.76x10^{-1} years	6.57x10^{-03} years	1.48x10^{-03} years
Mitigated total failure frequency per scenario		1.46x10^{-03} years	3.57x10^{-05} years	7.40x10^{-04} years
6 – widespread habitat – non designated water (adjacent estuary) Scenarios **H01, H02 and H04** result in a Consequence Level A	**Aggregate unmitigated failure frequency for the establishment**	**2.84x10^{-01} years**		
	Aggregate mitigated failure frequency for the establishment	**2.24x10^{-03} years**		
8 – groundwater body (non-drinking water source) (groundwater within the fractured bedrock) Scenarios (**H01, H02 and H04**) result in a Consequence Level A	**Aggregate unmitigated failure frequency for the establishment**	**2.77x10^{-01} years**		
	Aggregate mitigated failure	**2.20x10^{-03} years**		

Aggregate Unmitigated and Mitigated Failure Frequencies per Receptor				
Receptor Type		**H01: Diesel storage in T1 and T2; 2 x 10,000m^3 semi-buried tanks – non pressure vessels.** **Maximum acute release volume: 10,000m^3 from a catastrophic failure** **Chronic releases from the tank bases can go undetected for some time. 1,000m^3**	**H02: Receipt of diesel by vessel. Receipts of fuel from vessels are pumped to T1 and T2 via on-board vessel pumps and a foreshore pump house.** **Maximum release volume 10,000m^3.**	**H04: Release of fire-water containing aqueous film forming foam (AFFF) and entrained hydrocarbons during operations to combat a major fire.** **Maximum release volume 15,000m^3, based on current fire water requirement**
Unmitigated total failure frequency per scenario		2.76x10^{-1} years	6.57x10^{-03} years	1.48x10^{-03} years
Mitigated total failure frequency per scenario		1.46x10^{-03} years	3.57x10^{-05} years	7.40x10^{-04} years
	frequency for the establishment			
13 – particular species (Godwit within the estuary) Scenarios **H01, H02 and H04** are Consequence Level C	**Aggregate unmitigated failure frequency for the establishment**	**2.84x10^{-01} years**		
	Aggregate mitigated failure frequency for the establishment	**2.24x10^{-03} years**		
15 – fresh and estuarine water habitats (adjacent estuary)	**Aggregate unmitigated failure frequency for the**	**2.84x10^{-01} years**		

Aggregate Unmitigated and Mitigated Failure Frequencies per Receptor				
Receptor Type		**H01: Diesel storage in T1 and T2; 2 x 10,000m^3 semi-buried tanks – non pressure vessels.** **Maximum acute release volume: 10,000m^3 from a catastrophic failure** **Chronic releases from the tank bases can go undetected for some time. 1,000m^3**	**H02: Receipt of diesel by vessel. Receipts of fuel from vessels are pumped to T1 and T2 via on-board vessel pumps and a foreshore pump house.** **Maximum release volume 10,000m^3.**	**H04: Release of fire-water containing aqueous film forming foam (AFFF) and entrained hydrocarbons during operations to combat a major fire.** **Maximum release volume 15,000m^3, based on current fire water requirement**
Unmitigated total failure frequency per scenario		2.76x10^{-1} years	6.57x10^{-03} years	1.48x10^{-03} years
Mitigated total failure frequency per scenario		1.46x10^{-03} years	3.57x10^{-05} years	7.40x10^{-04} years
Scenarios **H01, H02 and H04** result in a Consequence Level A	**establishment**			
	Aggregate mitigated failure frequency for the establishment	**2.24x10^{-03} years**		
15 – fresh and estuarine water habitats (adjacent estuary) Impact from the jetty and fire water releases (**H02 and H04**) can also impact at Consequence Level B	**Aggregate unmitigated failure frequency for the establishment**	**8.05x10^{-03} years**		
	Aggregate mitigated failure frequency for the establishment	**7.76x10^{-04} years**		

3.3 Worked Example of Tolerability Matrices

Examples of the resulting unmitigated and mitigated risk tolerability matrices for selected receptor types are presented below. Unmitigated risk is denoted by '**UnMi**', mitigated risk is denoted by '**Mi**':

Receptor Type 6 – widespread habitat – non designated water (adjacent estuary)

	Frequency per establishment per receptor per year						
MATTE Consequence Level	**10^{-8} – 10^{-7}**	**10^{-7} – 10^{-6}**	**10^{-6} – 10^{-5}**	**10^{-5} – 10^{-4}**	**10^{-4} – 10^{-3}**	**10^{-3} – 10^{-2}**	**>10^{-2}**
D – MATTE	**Broadly Acceptable**			**TifALARP**		**Intolerable**	
C - MATTE							
B - MATTE							
A - MATTE					**Mi**		**UnMi**
Sub MATTE	Tolerability not considered under the CDOIF environmental risk tolerability methodology						

Receptor Type 8 – groundwater body non drinking water source (groundwater within the fractured bedrock)

	Frequency per establishment per receptor per year						
MATTE Consequence Level	**10^{-8} – 10^{-7}**	**10^{-7} – 10^{-6}**	**10^{-6} – 10^{-5}**	**10^{-5} – 10^{-4}**	**10^{-4} – 10^{-3}**	**10^{-3} – 10^{-2}**	**>10^{-2}**
D – MATTE	**Broadly Acceptable**			**TifALARP**		**Intolerable**	
C - MATTE							
B - MATTE							
A - MATTE					**Mi**		**UnMi**
Sub MATTE	Tolerability not considered under the CDOIF environmental risk tolerability methodology						

Receptor Type 13 - particular species (Godwit within the estuary)

	Frequency per establishment per receptor per year						
MATTE Consequence Level	**10^{-8} – 10^{-7}**	**10^{-7} – 10^{-6}**	**10^{-6} – 10^{-5}**	**10^{-5} – 10^{-4}**	**10^{-4} – 10^{-3}**	**10^{-3} – 10^{-2}**	**>10^{-2}**
D – MATTE	**Broadly Acceptable**			**TifALARP**		**Intolerable**	
C - MATTE						**Mi**	**UnMi**
B - MATTE							
A - MATTE							
Sub MATTE	Tolerability not considered under the CDOIF environmental risk tolerability methodology						

Receptor Type 15 – fresh and estuarine water habitats (adjacent estuary)							
	Frequency per establishment per receptor per year						
MATTE Consequence Level	**10^{-8} – 10^{-7}**	**10^{-7} – 10^{-6}**	**10^{-6} – 10^{-5}**	**10^{-5} – 10^{-4}**	**10^{-4} – 10^{-3}**	**10^{-3} – 10^{-2}**	**>10^{-2}**
D – MATTE	**Broadly Acceptable**			**TifALARP**	**Mi**	**Intolerable**	
C - MATTE							
B - MATTE						**UnMi**	
A - MATTE					**Mi**		**UnMi**
Sub MATTE	Tolerability not considered under the CDOIF environmental risk tolerability methodology						

In a full Phase I assessment the unmitigated and mitigated risk tolerability would be defined for each relevant environmental receptor.

3.4 Outcome of Phase I Screening

From these matrices, it can be seen that all of the unmitigated risks to all receptors are in the 'intolerable' range. When the protection provided by the preventative and mitigation controls are accounted for, the mitigated risk to most receptors is reduced to within the TifALARP range. However, one environmental receptor, the Godwit living in the estuary (receptor type 13 – particular species), remains in the 'intolerable' range. This is primarily driven by the higher consequence level (C) of a MATTE harming this receptor.

The outcome of this screening level assessment is that the Godwit residing in the estuary are one of the most vulnerable receptors in the event of an acute release, primarily from scenarios H01 (release from a semi-buried tank), H02 (acute release of diesel during vessel unloading at the jetty) and H04 (release of fire water containing foam and entrained hydrocarbons). The pathways by which the Godwit population could be impacted are migration within the drainage network and overland flow (scenarios H01 and H04) and by direct release into surface water (scenario H04).

4 Phase 2 Assessment

The outcome of this case study is that the risk to the Godwit population in the estuary, taking into account mitigation, is in the 'intolerable' range. At this establishment two options would be considered:

- Option 1: Provide additional mitigation to reduce the risk to an acceptable level; or
- Option 2: Undertake more detailed assessment of the risk to this receptor.

In this instance the more detailed assessments could include obtaining additional data on the population and residency of the species in the vicinity of the establishment, natural variability in the population baseline, the ecotoxicity and fate of the substances released to the habitat and/or further assessment of the natural recovery of the species following a MATTE.

The outcome of the Phase 2 assessments may also support cost benefit analysis in the demonstration of ALARP.