



**ENVIRONMENTAL LIABILITY
RISK ASSESSMENT
(ELRA)**

BY

DONEGAL COUNTY COUNCIL

TO

ENVIRONMENTAL PROTECTION AGENCY



DONEGAL COUNTY COUNCIL
BALLYNACARRICK LANDFILL SITE
ELRA
OCTOBER 2010

DOCUMENT CONTROL SHEET

Client	Donegal County Council					
Project Title	Ballynacarrick Landfill Site					
Document Title	Environmental Liability Risk Assessment ELRA					
Document No.	IBR0132/Reports					
This Document Comprises	DCS	TOC	Text	List of Tables	List of Figures	No. of Appendices
	1	1	28	1	1	3

Rev.	Status	Author(s)	Reviewed By	Approved By	Office of Origin	Issue Date
	Draft	AMG	EB	DD	Letterkenny	14/07/10
	Final	AMG	EB	DD	Letterkenny	10/10/10

TABLE OF CONTENTS

1.0	INTRODUCTION.....	1
1.1	FACILITY AND LICENCE DETAILS	1
1.2	FACILITY DESCRIPTION AND HISTORY.....	2
2.0	STUDY METHODOLOGY.....	4
3.0	SYSTEM DEFINITION AND OBJECTIVES.....	6
4.0	RISK IDENTIFICATION	7
4.1	METHODOLOGY	7
4.2	IDENTIFICATION OF ENVIRONMENTAL RECEPTORS.....	7
4.3	IDENTIFICATION OF PROCESSES	7
4.4	IDENTIFICATION OF RISKS USING FAILURE MODE EFFECT ANALYSIS FORMS	8
5.0	ASSESSMENT OF RISKS.....	10
5.1	METHODOLOGY	10
5.2	RISK CLASSIFICATION TABLE.....	10
5.3	RISK RANKING	11
5.4	RISK MATRIX.....	13
5.5	DISCUSSION OF RISK LEVELS.....	14
6.0	IDENTIFICATION AND ASSESSMENT OF MITIGATION ACTIONS	15
6.1	IDENTIFICATION OF MITIGATION ACTIONS.....	15
6.2	EFFECTIVENESS OF MITIGATION MEASURES IN RISK REDUCTION.....	15
7.0	RISK MANAGEMENT PROGRAM.....	21
7.1	GENERAL	21
7.2	RISK MANAGEMENT PROGRAMME	21
7.3	RISK MANAGEMENT REVIEW	23
8.0	ASSESSMENT OF POTENTIAL ENVIRONMENTAL LIABILITIES.....	24
8.1	TYPES OF ENVIRONMENTAL LIABILITIES	24
8.2	‘KNOWN’ ENVIRONMENTAL LIABILITIES.....	24
8.3	‘UNKNOWN’ ENVIRONMENTAL LIABILITIES – CURRENT STATUS	25
8.4	‘UNKNOWN’ ENVIRONMENTAL LIABILITIES – POST RISK MITIGATION.....	26
8.5	TOTAL CURRENT ENVIRONMENTAL LIABILITIES.....	27
9.0	CONCLUSIONS AND RECOMMENDATIONS	28

LIST OF TABLES

Table 2.1	Waste Categories and Quantities	3
Table 4.1	Project Risk Register	9
Table 5.1	Risk Classification Table.....	10
Table 5.2	Project Risk Register – Ranked by Risk Score	12
Table 5.3	Risk Matrix – Current Status.....	13
Table 6.1	Proposed Risk Mitigation Measures	17
Table 6.2	Revised Risk Matrix – Post Recommended Mitigation Measures.....	20
Table 7.1	Proposed Risk Owners with Mitigation Measures and Timescales.....	22
Table 8.1	Known Liabilities and Associated Cost.....	25
Table 8.2	Summary of Potential “Unknown” Environmental Liabilities.....	26

APPENDICES

- Appendix A** **Failure Mode Effect Analysis Form**
Appendix B **Expected Cost Model for “Unknown” Environmental Liabilities**

1.0 INTRODUCTION

This report provides the results of a risk assessment and identification of environmental liabilities at Ballynacarrick Landfill Site Co Donegal.

This study has been prepared in order for Donegal County Council to comply with Condition 12.2.2 of Waste Licence, W0024-04.

“12.2.2 The licensee shall arrange for the completion, by an independent and appropriately qualified consultant, of a comprehensive and fully costed Environmental Liabilities Risk Assessment (ELRA), which addresses the liabilities from past and present activities. The assessment shall include those liabilities and costs identified in Condition 10 for execution of the CRAMP. A report on this assessment shall be submitted to the Agency for agreement within twenty-four months of date of grant of this licence. The ELRA shall be reviewed as necessary to reflect any significant change on site, and in any case every three years following initial agreement; review results are to be notified as part of the AER”.

This ELRA also takes due regard of the EPA Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision Document (2006).

This Guidance Document presents a systematic approach to the assessment and management of Environmental Liabilities in order to comply with IPPC and Waste Licence conditions for Environmental Liability Risk Assessment (ELRA), Residual Management Planning (RMP) and Financial Provision (FP).

There are several environmental benefits of proper ELRA, CRAMP and FP planning which include;

- The reduction in the potential for environmental damage as the result of accidents
- The minimisation of residual / long term impacts from manufacturing and waste management facilities upon closure
- Forward Financial planning for environmental liabilities
- Reduction in the financial provision required

1.1 FACILITY AND LICENCE DETAILS

Ballynacarrick Landfill Site has been in operation since 1980. In 2000 Donegal County Council submitted an application to the Environmental Protection Agency for the continued operation of the landfill site, as required by the Waste Management (Licensing) Regulations 1997.

On the 7th December 2000 the Environmental Protection Agency (EPA) granted the Council a Waste Licence (registration number W0024-01) for the facility, in accordance with the Third and Fourth Schedule of the Waste Management Act, 1996.

In November 2003 the Council submitted a waste licence application to the EPA and a planning application to An Bord Pleanála for an extension of 3.5 hectares to the landfill site. A waste licence W0024-02 was granted to Donegal County Council on the 10th December 2004 and planning permission was granted by An Bord Pleanála on the 15th July 2004.

A waste licence review was undertaken in November 2007 to increase the annual tonnage accepted at the facility from 24,000 tonnes to 35,000 tonnes per year and to raise the final contours of the site to increase the capacity of the site. This waste licence (W0024-03) was approved in November 2008.

The Agency commenced a review of the waste licence in 2009 in accordance with Section 46(2)(b) of the Waste Management Acts, 1996 to 2008. The review was in relation to the following;

- Need to give effect to articles 5 and 6 of Council Directive 1999/31/EC on the landfill of waste (Landfill Directive) regarding the treatment of waste prior to landfill and diversion of biodegradable municipal waste from landfill.
- Need to give effect to article 49(5) of the Waste Management (Licensing) Regulations 2004 which states that waste that has not been subject to treatment shall not be accepted or disposed of in a landfill facility. Article 52(5) of the Waste Management (Licensing) Regulations 2004, as amended, requires the EPA to review a waste licence in order that a landfill will operate in compliance with the relevant requirements of the Landfill Directive.
- Need to further the general Best Available Techniques (BAT) obligation to reduce the overall environmental impact of landfill.
- The EPA will also (a) determine whether new conditions on odour prevention and control should be proposed, (b) amend, replace or delete a number of other conditions where this is appropriate and (c) propose new conditions where these are deemed necessary.

Licence W0024-04 was issued in March 2010.

1.2 FACILITY DESCRIPTION AND HISTORY

The site is located at Ballynacarrick, Ballintra, Co Donegal and occupies an area of approximately 9 hectares; this consists of 5.5 hectares of historic landfill and 3.5 hectares extension. The facility is located in a rural setting and surrounding land use is of a purely

agricultural nature. The site is located in a low lying position in an area of marginal hill land and is bounded on all boundaries by a chain link fence. The site lies 3km southeast of Ballintra and 7 km south of Laghy.

In accordance with the waste licence only those wastes types and quantities listed in Schedule A shall be recovered or disposed of at the facility unless prior agreement from the Agency has been obtained. The maximum annual tonnage of individual waste categories for acceptance to the site is listed in Schedule A of the Waste Licence as shown in Table 2.1

Table 2.1 Waste Categories and Quantities

WASTE TYPE ¹	MAXIMUM QUANTITY (Tonnes per Annum) ^{2,3}
Residual Non Hazardous Household Commercial and Industrial Waste. ⁴	34,950
Residual Non Hazardous Construction and Demolition waste.	
Composting of Biodegradable waste (<1000m ³ capacity).	
Household Hazardous Waste deposited at the Civic Waste Facility for off-site recovery or disposal ⁵	<50 t per annum
TOTAL	35,000

¹ Any proposals to accept other compatible waste streams must be agreed in advance by the Agency and the total amount of waste must be within that specified

² Construction & demolition or Inert or compost waste imported to the site for use in the construction/closure are not included in these limitations. A detailed statement (with mass balance) of waste used in construction should be included as part of the AER.

³ Quantities of waste types may be altered, subject to the agreement of the Agency, provided the total quantity for disposal does not exceed 35,000 tonnes per annum.

⁴ Includes non-hazardous WEEE deposited at the Civic Waste Facility for off-site disposal/recovery.

⁵ Includes hazardous WEEE deposited at the Civic Waste Facility for off-site disposal/recovery.

2.0 STUDY METHODOLOGY

The methodology adopted for this initial risk assessment was designed to allow the identification of the major risks in the closure, remediation and aftercare of the landfill. A risk has been defined as a measure of the likelihood and severity of an occurrence that is in some way harmful to a receptor.

Each risk was assessed in terms of its current controls and the availability of additional risk controls to reduce the level of risk. Risk management measures were allocated to each risk using the following approaches: risk acceptance, risk prevention / avoidance, risk reduction, risk transfer, or risk sharing.

The cost of the potential environmental liabilities was estimated based on the environmental liabilities identified during the risk assessment, plus the “known” liabilities at the site.

The following major tasks were undertaken during the study:

Task 1: Risk Management Workshop – Risk Data Collection:

A Risk Management Workshop was held by the project team to identify and quantify the risks inherent in the operation, closure, restoration and aftercare of the landfill facility, and to identify potential risk mitigation measures. The workshop was held in RPS Letterkenny on the 23rd February 2010 and was facilitated by Ms. Eleanor Boland of RPS. The workshop was also attended by the following persons:

- | | | |
|------------------------|------------------------|------------------------------------|
| ▪ Mrs Julie McMahon | Donegal County Council | Executive Environmental Officer |
| ▪ Mr. Don Smith | Donegal County Council | Executive Environmental Technician |
| ▪ Mr. Nigel Ruxton | RPS | Design Engineer |
| ▪ Miss Angela McGinley | RPS | Senior Scientist |

The following tasks were undertaken during the workshop;

- Identification of environmental receptors;
- Identification of processes carried out on site now and in the future;
- Identification of the environmental hazards that may arise as a direct result of the processes carried out on site using Failure Mode Effect Analysis (FMEA) forms;
- Assessment of the level of risk posed by each hazard based on it's potential severity and likelihood of occurrence, and the allocation of a Risk Score;
- Identification of risk mitigation measures;
- Identification of responsibilities for the management of each risk; and

-
- Re-evaluation of the level of risk following the implementation of mitigation measures.

Task 2: Interpretation and Analysis of Risk Data:

The risk data collected from the Risk Management Workshop in FMEA forms was interpreted and analysed through the following tasks:

- Completion of Failure Mode Effect Analysis forms;
- Creation of Risk Register and Risk Classification Table;
- Ranking of Current Risks;
- Identification of mitigation measure(s); and
- Ranking of risks following the implementation of mitigation measure(s)

Task 3: Assessment of Environmental Liabilities:

The environmental liabilities were identified and quantified through the following tasks:

- Identification and quantification of known environmental liabilities;
- Identification of potential liabilities associated with the environmental risks;
- Quantification of potential liabilities associated with the environmental risks; and
- Determination of the total environmental liabilities for the site.

3.0 SYSTEM DEFINITION AND OBJECTIVES

The Objectives and System Definition was agreed at the commencement of the study to define the limits of the risk assessment.

The Risk Assessment is being undertaken in accordance with the EPA's requirements as stated in Waste Licence W0024-04. The objectives of the study are to;

- Identify post closure risks at the landfill and risk mitigation measures where risk levels are unacceptable.
- Identify environmental liabilities at the site to allow for the making of a financial provision in accordance with the Waste Management Act 1996.

The risk assessment covers current remediation works and management including the closure, restoration and aftercare phases. The risk assessment allowed for the participation of the main landfill stakeholders through the facilitated workshop during which risks were identified and quantified.

4.0 RISK IDENTIFICATION

4.1 METHODOLOGY

Risk identification was initially undertaken during the Risk Management Workshop with the main landfill stakeholders. The risk identification process involved;

- The identification of potential environmental receptors at the site.
- The identification of landfill processes that posed potential hazards to the environmental receptors.
- The identification and quantification of the risks using Failure Mode Effect Analysis (FMEA) forms.

4.2 IDENTIFICATION OF ENVIRONMENTAL RECEPTORS

The term 'environmental receptors' describes those parts of the surroundings likely to be affected by the processes that are ongoing at Ballynacarrick Landfill Site. The significant environmental receptors identified at the workshop are listed below. These receptors are used as a starting point to ensure that all significant risks are identified and all major aspects of the environment are taken into account.

Environmental Receptors;

- Groundwater
- Surface water
- Adjacent land
- Human Beings
- Air Quality

4.3 IDENTIFICATION OF PROCESSES

A number of processes associated with the operation of a public bring banks area, and other processes associated with the operation and restoration and aftercare period of the Landfill site were identified during the course of the workshop and afterwards and are listed below;

Processes:

- Construction – capping of the landfill and other associated works.
- General Facility Operations – including nuisance control, traffic management, routine maintenance, monitoring and other site operations.
- Bring Banks area – including the temporary storage and transfer of waste for recovery and waste for disposal at working face.
- Landfill Gas – including landfill gas generation, migration, and control.

- Leachate – including leachate generation, collection, storage and transfer off site.

These current processes have been identified to cover all activities on site that may result in a risk to the environmental receptors. Each environmental receptor was assessed against the list of processes in order to identify potential hazards. The potential hazards identified were entered onto the FMEA forms.

4.4 IDENTIFICATION OF RISKS USING FAILURE MODE EFFECT ANALYSIS FORMS

Failure Mode Effect Analysis (FMEA) forms were used during the workshop to facilitate risk identification and quantification. The purpose of these forms is to assist in the identification and quantification of the risks posed to the environmental receptors by the processes carried out at the landfill. The final FMEA form for the project is provided in Appendix A and a description of each aspect of the form is also provided there.

A brainstorming activity was undertaken during the Risk Management Workshop to identify the major risks at the site. The process aimed to identify the major risks through linking the processes and their potential hazards to each of the environmental receptors. The Risk Identification Tool was used to assist in the brainstorming exercise.

The major risks identified were transferred to the FMEA (refer to Appendix A). A total of 27 major risks were identified in the FMEA and these risks are listed in the Project Risk Register provided in Table 4.1.

Table 4.1 Project Risk Register

Risk	Potential Failure Mode / Risk
1	landfill gas - die back of vegetation from landfill gas migration within the site.
2	landfill gas - die back of vegetation from landfill gas migration outside the site.
3	landfill gas - escape of landfill gas to the atmosphere
4	landfill gas - landfill gas migration and accumulation in structures on/off site.
5	landfill gas - intrusion / vandalism at flare compound
6	leachate management - leachate escaping from unlined cells. contamination of groundwater from leachate.
7	leachate management - leachate escaping from unlined cells. damage to bog lands and surrounding area due to shallow groundwater
8	leachate management - leachate tanks rupturing and entering surface water and groundwater.
9	leachate management - overflow of leachate from existing cells
10	leachate management - silt clogging pumps. overflowing of sumps causing lack of containment
11	leachate management - leachate break out due to breach in liner
12	leachate management - traffic accidents within the site during the tankering of leachate.
13	leachate management - traffic accidents during off site disposal of leachate.
14	leachate management - pipeline flanges integrity checking
15	leachate management - leachate being unsuitable for treatment at local wwtp
16	capping - degradation of capping
17	capping - breach of capping system
18	landfill operations - odour
19	landfill operations - dust causing a nuisance, blown off site.
20	landfill operations - vermin carrying disease out of the landfill
21	landfill operations - wind blown litter, off site migration of litter causing nuisance
22	landfill operations - fire
23	landfill operations - fire hydrant, connection status.
24	landfill monitoring - H&S accident during environmental monitoring
25	landfill monitoring - landscape
26	bring banks - vehicles and/or person accidents in the bring bank area.
27	bring banks - improper handling of waste by staff and members of the public

5.0 ASSESSMENT OF RISKS

5.1 METHODOLOGY

A significant number of risks were identified during the workshop. These risks were assessed against the risk classification table (RCT) as provided in Table 5.1. The risk classification table was designed to reflect the critical levels of risk appropriate to the landfill.

Risk ratings were applied to each risk in the FMEA table for severity and occurrence as taken from the RCT. The severity rating adopted for each risk reflected the highest severity rating of the severity parameters (cost, safety and environment). This was generally found to be the rating for the financial cost, since the financial cost severity was deemed to include the costs associated with any corresponding environmental or safety impact. Where a parameter other than cost was the dominant severity parameter, this was noted on the FMEA.

A risk score was calculated for each risk using the selected severity and occurrence ratings. The risks were then ranked and compared based on the risk scores. The risks were placed in a risk matrix to illustrate the ranking and level of each risk, and allow the risks to be visually prioritised. The risk matrix is a particularly useful tool for tracking changes in risk levels over time. The level of management required for each risk is identified from the risk matrix.

Risk management measures were identified for each risk during the workshop and included in the FMEA. These measures are presented in Section 6.0.

5.2 RISK CLASSIFICATION TABLE

The Risk Classification Table (RCT) has been designed to reflect the critical levels of risk appropriate to the landfill. The table is provided in Table 5.1 below;

Table 5.1 Risk Classification Table

Rating	Description	Likelihood of Occurrence (%)	Severity		
			Financial Cost	Safety	Environment
1	Low	<10%	€ 1,000 – < € 5,000	Near Miss	Minor impact, temporary
2	Medium	10-25%	€ 5,000 – € 25,000	First aid injury	Local impact, recoverable losses
3	High	>25%	> €25,000	Notifiable incident	Major impact, severe damage

The RCT provides appropriate levels of probability and severity for the ranking of risks. The levels for each parameter reflect suitable levels for assessing and ranking the risks identified at the landfill and allocating appropriate management measures. The RCT was agreed with the main landfill stakeholders at the Risk Management Workshop.

5.3 RISK RANKING

Risk ratings were applied to each risk in the FMEA table for severity and occurrence as taken from the RCT. A risk score was then calculated for each risk using the ratings. The risk score is based on the product of the severity rating and the occurrence rating. This system allowed the risks to be ranked and compared.

The project risk register listing all the major risks identified at the landfill was provided in Table 4.1. This register has been expanded and rearranged in Table 5.2 to include the risk scores and rank the risks in order of risk score.

Table 5.2 Project Risk Register – Ranked by Risk Score

Risk	Potential Failure Mode	Risk Score
9	leachate management - overflow of leachate from existing cells	6
23	landfill operations - fire hydrant, connection status	6
10	leachate management - silt clogging pumps. overflowing of sumps causing lack of containment	4
11	leachate management - leachate break out due to breach in liner	3
4	landfill gas - landfill gas migration and accumulation in structures on/off site.	3
5	landfill gas - intrusion / vandalism at flare compound	3
6	leachate management - leachate escaping from unlined cells. contamination of groundwater from leachate.	3
7	leachate management - leachate escaping from unlined cells. damage to bog lands and surrounding area due to shallow groundwater	3
8	leachate management - leachate tanks rupturing and entering surface water and groundwater.	3
14	leachate management - pipeline flanges integrity checking	3
15	leachate management - leachate being unsuitable for treatment at local wwtp	3
16	capping - degradation of capping	3
21	landfill operations - wind blown litter, off site migration of litter causing nuisance	3
22	landfill operations - fire	3
24	landfill monitoring - H&S accident during environmental monitoring	3
25	landfill monitoring - landscape	3
26	bring banks - vehicles and/or person accidents in the bring bank area.	3
27	bring banks - improper handling of waste by staff and members of the public	3
12	leachate management - traffic accidents within the site during the tankering of leachate.	3
2	landfill gas - die back of vegetation from landfill gas migration outside the site.	2
3	landfill gas - escape of landfill gas to the atmosphere	2
13	leachate management - traffic accidents during off site disposal of leachate.	2
17	capping - breach of capping system	2
18	landfill operations - odour	1
19	landfill operations - dust causing a nuisance, blown off site.	1
20	landfill operations - vermin carrying disease out of the landfill	1
1	landfill gas - die back of vegetation from landfill gas migration within the site.	1

5.4 RISK MATRIX

The Risk Matrix has been developed to allow the risks to be easily displayed and prioritised. The severity and occurrence ratings are used in the matrix; with the level of severity forming the x-axis and the likelihood of occurrence forming the y-axis. This matrix will provide a visual tool for regular risk reviews since the success of mitigation can be easily identified. The risk matrix is displayed here in Table 5.3. The risks have been colour coded in the matrix to provide a broad indication of the critical nature of each risk. The colour code is as follows;

- Red – These are considered to be high-level risks requiring priority attention. These risks have the potential to be catastrophic and as such should be addressed quickly.
- Yellow – These are medium-level risks requiring action, but are not as critical as a red coded risk.
- Green (light and dark green) – These are lowest-level risks and indicate a need for continuing awareness and monitoring on a regular basis. Whilst they are currently low or minor risks, some have the potential to increase to medium or even high-level risks and must therefore be regularly monitored and if cost effective mitigation can be carried out to reduce the risk even further this should be pursued.

Table 5.3 Risk Matrix – Current Status

Occurance	High	3			
	Medium	2	3,6,7,20,21	10	9,23
	Low	1	1,18,19	2,10,13,17	4,5,8,11,12,14,15,16, 22, 24, 25, 26, 27
			1	2	3
			Low	Medium	High
		Severity			

5.5 DISCUSSION OF RISK LEVELS

The following risks lie in the red zone and require priority attention;

- Risk 9 - leachate management - overflow of leachate from existing cells.
- Risk 23 - landfill operations - fire hydrant., connection status.

The following risks lie in the yellow zone and require attention as soon as possible;

- Risk 4 – landfill gas - landfill gas migration and accumulation in structures on/off site.
- Risk 5 – landfill gas - intrusion / vandalism at flare compound.
- Risk 8 – leachate management - leachate tanks rupturing and entering surface water and groundwater.
- Risk 10 – leachate management - silt clogging pumps. Overflowing of sumps causing lack of containment.
- Risk 11 – leachate management - leachate break out due to breach in liner.
- Risk 12 – leachate management - traffic accidents within the site during the tankering of leachate.
- Risk 14 – leachate management - pipeline flanges integrity checking.
- Risk 15 – leachate management - leachate being unsuitable for treatment at local WWTP.
- Risk 16 – capping - degradation of capping.
- Risk 22 – landfill operations – fire.
- Risk 24 – landfill monitoring - H&S accident during environmental monitoring.
- Risk 25 – landfill monitoring - landscape.
- Risk 26 – bring banks - vehicles and/or person accidents in the bring bank area.
- Risk 27 – bring banks - improper handling of waste by staff and members of the public.

All remaining risks lie in the green zone. These risks require continuing awareness and monitoring on a regular basis. As these risks may have the potential to increase to yellow or red zone risks, additional risk management measures should be put in place to manage them at their current levels, or preferably to reduce them further, if required.

6.0 IDENTIFICATION AND ASSESSMENT OF MITIGATION ACTIONS

6.1 IDENTIFICATION OF MITIGATION ACTIONS

Risks requiring additional mitigation actions were identified in Section 5. These are comprised of two risks located in the red zone and sixteen risks located in the amber / yellow zone. All remaining risks were found to be in the green zone.

Additional risk mitigation measures were identified during the risk management workshop for the two risks in the red zone, reducing the risk for these to yellow.

Additional risk mitigation measures were also identified during the risk management workshop for one of the risks in the yellow zone, reducing the risk for this to green. The remaining risks in the yellow zone have a certain level of risk by their nature, and the risk cannot be readily reduced as mitigation measures are already in place. These measures will reduce these risks to more acceptable levels. Again, a review should be carried out regularly identifying any further opportunities to reduce these risks and to ensure that the risk level does not increase.

Additional cost-effective risk mitigation measures were also identified for 2 of the 7 green zone risks during the workshop. Since green zone risks may have the potential to increase to yellow or red zone risks, these risk mitigation measures should be implemented since they are considered cost-effective.

For the remaining 5 of the 7 green zone risks the current risk management measures were considered acceptable and additional cost-effective risk mitigation measures have not been identified.

The recommended risk mitigation measures identified during the workshop and included in the FMEA are provided in Table 6.1. This table provides the risks in descending order of risk score with the proposed mitigation measure. The current controls are also provided.

6.2 EFFECTIVENESS OF MITIGATION MEASURES IN RISK REDUCTION

The risk scores have been re-calculated on the basis that the additional mitigation measures are fully implemented. Table 6.1 provides the revised risk scores after the implementation of the risk mitigation measures, and compares them to the current risk score. Table 6.2 provides a revised risk matrix following the implementation of the risk mitigation measures.

Table 6.1 indicates that the risk scores for 3 of the risks are reduced by the implementation of the measures, whilst there would be no significant change to 24 of the risks. However,

recommended mitigation measures have been proposed and assessed for 7 of the 24 risks which do not exhibit improved risk scores and these measures should increase the robustness of the risk controls already in place.

In addition, the risk matrix indicates that the two red code risks have been reduced to a yellow code risk. One yellow code risk has been reduced to a green zone risk.

The recommended mitigation measures therefore show a real reduction in risk at the landfill and since they are considered cost-effective, should be implemented. Section 7.0 provides a management plan for the implementation of the recommended mitigation measures.

Table 6.1 Proposed Risk Mitigation Measures

Risk	Potential Failure Mode / Risk	Current Controls	Recommended Mitigation Measures	Current Risk Score	Revised Risk Score
9	leachate management - overflow of leachate from existing cells	Scada System, Site inspections	Capping of site to commence in 2010	6	3
23	landfill operations - fire hydrant	Emergency response procedure,	Check status with fire hydrant connection and ensure it is working properly.	6	3
10	leachate management - silt clogging pumps. overflowing of sumps causing lack of containment	Scada System, Flow meters installed, Site inspections	Capping of site to commence in 2010. A revised hydrogeological Assessment is being undertaken. Rationalisation of the leachate pumping system.	4	2
11	leachate management - leachate break out due to breach in liner	SW / GW monitoring, visual monitoring	Ensure adequate instruction and supervision of the installation of the wells.	3	3
4	landfill gas - landfill gas migration and accumulation in structures on/off site.	Landfill Gas Extraction System Field Balancing. Monitoring of piezometers undertaken weekly including caravan. Continuous landfill gas monitoring in site office. Landfill Gas Cut Off Trench. Offer relocation of local resident.	Continuing with management as existing	3	3
5	landfill gas - intrusion / vandalism at flare compound	Scada System, security fence, CCTV	Continuing with management as existing	3	3
6	leachate management - leachate escaping from unlined cells. contamination of groundwater from leachate.	Capping of unlined areas of the site. Management of the site. Continuous improvement of leachate management scheme	A revised hydrogeological Assessment is being undertaken from which further actions will be determined	3	3
7	leachate management - leachate escaping from unlined cells. damage to bog lands and surrounding area due to shallow groundwater	Capping of unlined areas of the site. Management of the site. Continuous improvement of leachate management scheme	Continuing with management as existing. Continuous monitoring, improve pumping regime.	3	3
8	leachate management - leachate tanks rupturing and entering surface water and	Integrity Testing Inspection of all flanges pipe work	Continuing with management as existing	3	3

Risk	Potential Failure Mode / Risk	Current Controls	Recommended Mitigation Measures	Current Risk Score	Revised Risk Score
	groundwater.				
14	leachate management - pipeline flanges integrity checking	SW / GW monitoring, visual monitoring. Site inspections	Continuing with management as existing. Continuous monitoring	3	3
15	leachate management - leachate being unsuitable for treatment at local WWTP	Leachate monitoring	Continuing with management as existing	3	3
16	capping - degradation of capping	On going research by manufactures to ascertain life span of HDPE. Monitoring	Continuing with management as existing	3	3
21	landfill operations - wind blown litter, off site migration of litter causing nuisance	Litter Netting and litter picker.	Continuing with management as existing	3	3
22	landfill operations - fire	Emergency response procedure, waste inspection procedure. CCTV	Continuing with management as existing	3	3
24	landfill monitoring - H&S accident during environmental monitoring	Use experienced personnel	Current measures are considered adequate	3	3
25	landfill monitoring - landscape	Restoration and aftercare plan. Planting undertaken. Berm installed around site	Confirm with ecologist regarding root sizes of trees within capped areas. Are these a problem	3	3
26	bring banks - vehicles and/or person accidents in the bring bank area.	Staff wear PPE, supervision of public on site, speed limits in place	Continuing with management as existing	3	3
27	bring banks - improper handling of waste by staff and members of the public	Staff wear PPE, supervision of public on site	Current measures are considered adequate	3	3
12	leachate management - traffic accidents within the site during the tankering of leachate.	Only use licenced drivers, traffic designated routes, speed limits, maintenance of vehicles.	Check maintenance schedule of contractor in order. DCC Drivers trained to drive tankers. Contractors to be checked.	3	3
2	landfill gas - die back of vegetation from landfill gas migration outside the site.	Landfill Gas Extraction System, Field Balancing, Monitoring, Site Inspections	Continuing with management as existing	2	2
3	landfill gas - escape of landfill gas to the atmosphere	Survey of the capped areas have been undertaken and repairs made. Gas extraction system in place. Field Balancing	Continuing with management as existing	2	2

Risk	Potential Failure Mode / Risk	Current Controls	Recommended Mitigation Measures	Current Risk Score	Revised Risk Score
		undertaken every two weeks. Regular servicing of the flare			
13	leachate management - traffic accidents during off site disposal of leachate.	Only use licenced drivers, traffic designated routes, speed limits, maintenance of vehicles, vehicles labelled non hazardous and leachate, vehicles weighed leaving the site.	Check maintenance schedule of contractor in order. DCC Drivers trained to drive tankers. Contractors to be checked.	2	2
17	capping - breach of capping system	Survey of the capped areas have been undertaken and areas identified.	Continuing with management as existing. Confirm with ecologist regarding roots of any trees identified on site.	2	2
18	landfill operations - odour	Landfill capped, gas extraction and flaring system installed. Site Inspections	Current measures are considered adequate. Odour Management Procedure to be developed in accordance with waste licence W0024-04.	1	1
19	landfill operations - dust causing a nuisance, blown off site.	Nuisance control procedures	Continuing with management as existing	1	1
20	landfill operations - vermin carrying disease out of the landfill	Nuisance control procedures	Continuing with management as existing	1	1
1	landfill gas - die back of vegetation from landfill gas migration within the site.	Landfill Gas Extraction System Field Balancing	Continuing with management as existing	1	1

Table 6.2 Revised Risk Matrix – Post Recommended Mitigation Measures

Occurance	High	3			
	Medium	2	3,6,7,20,21		
	Low	1	1,18,19	2,10,13,17	4,5,8,9,11,12,14,15,16,22,23,25,26,27
			1	2	3
			Low	Medium	High

Severity

7.0 RISK MANAGEMENT PROGRAM

7.1 GENERAL

Every risk requires a certain amount of management in order to reduce the risk or manage the risk at an acceptable level. Risk owners have therefore been allocated to each risk to undertake this role. For the majority of the risks identified, the management of the risk will involve the implementation of the recommended mitigation measures and the maintenance of current controls.

Where additional risk mitigation measures have not been identified, the risk owner is required to ensure that the current levels of controls are maintained and that the level of risk does not increase.

A time scale has been applied to all proposed risk mitigation measures in order to ensure that the mitigation measures are implemented in a timely fashion.

7.2 RISK MANAGEMENT PROGRAMME

The risk owner must be competent enough to understand the risk and the recommended mitigation measures and have the authority to implement the mitigation measure. The risk owner must also be able to be held responsible for the risk. The risk owners considered suitable for the risk management programme were:

- Licencee (Donegal County Council)
- Landfill Manager

The proposed timescales for the implementation of the mitigation measures must be realistic and appropriate to the level of risk. The timescales have been prepared in consultation with the risk owners where available.

Table 7.1 allocates risk owners to each individual risk, and provides timeframes for the completion of each risk mitigation measure. However, it should be noted that ultimately the licencee is responsible for all risks, and the allocation of risk owners is undertaken to assist the Licencee manage the risks.

Table 7.1 Proposed Risk Owners with Mitigation Measures and Timescales

Owner	Mitigation measure	Relevant Risk ID	Mitigation Measure Completion Date
Landfill Manager/Licensee	Current measures are considered adequate	1,2,3,4,5,8,14,15, 16,19,20,21,22,24, 26,27	-
	A revised hydrogeological Assessment is being undertaken from which further actions will be determined.	6	October 2010
	Continuing with management as existing. Continuous monitoring, improve pumping regime.	7	December 2010
	Capping of site to commence in 2010	9	2011
	Capping of site to commence in 2010. A revised hydrogeological Assessment is being undertaken. Rationalisation of the leachate pumping system.	10	2011
	Ensure adequate instruction and supervision of the installation of the wells.	11	2013
	Check maintenance schedule of contractor in order. DCC Drivers trained to drive tankers. Contractors to be checked.	12	December 2010
	Check maintenance schedule of contractor in order. DCC Drivers trained to drive tankers. Contractors to be checked.	13	December 2010
	Continuing with management as existing. Confirm with ecologist regarding roots of any trees identified on site.	17	December 2010
	Current measures are considered adequate. Odour Management Procedure to be developed in accordance with waste licence W0024-04.	18	June 2010
	Check status with fire hydrant connection and ensure it is working properly.	23	October 2010
	Confirm with ecologist regarding root sizes of trees within capped areas. Are these a problem	25	December 2010

7.3 RISK MANAGEMENT REVIEW

Risk management at the landfill is a dynamic process. This assessment and report provides a baseline assessment of the major risks at the landfill and provides recommendations for risk mitigation and management measures. However, landfill processes and conditions will change and this assessment should be reviewed periodically to ensure that all risks are being identified and managed.

This document should be considered to be a live document. It is recommended that the Licensee reviews the risk management at the site on a six-monthly basis and updates the risk register and risk management programme as appropriate. It is also recommended that a formal risk assessment be undertaken every three years at the landfill to assist in this process and to comply with Condition 12.2.2.

8.0 ASSESSMENT OF POTENTIAL ENVIRONMENTAL LIABILITIES

8.1 TYPES OF ENVIRONMENTAL LIABILITIES

The assessment of potential environmental liabilities may be broken down into two separate sections, the “known” environmental liabilities and the potential or “unknown” environmental liabilities.

The “known” environmental liabilities are understood, definable and current. These liabilities relate to costs that are currently known to be required for the protection of environmental receptors based on past and present operations at the landfill and civic amenity. These include ongoing maintenance of the capping, leachate and gas management systems and ongoing maintenance of the civic amenity area.

The “unknown” environmental liabilities are those liabilities that may or may not arise due to the occurrence of the environmental risks identified in the risk assessment.

8.2 ‘KNOWN’ ENVIRONMENTAL LIABILITIES

The ‘known’ environmental liabilities can be broken into those arising during the aftercare phase of the landfill. The aftercare phase of the landfill includes costs associated with the management of the leachate infrastructure, landfill gas infrastructure and environmental monitoring.

The aftercare phase liabilities are those costs that will arise during a 30 year period following the closure of the entire site. The assessment of the environmental liabilities has been limited to a 30 year period in accordance with Article 10 of the Council Directive 1999/31/EC of 26 April 1999 on the Landfill of Waste. However, it is expected that the environmental liabilities will extend beyond the 30 years period. The aftercare phase environmental liabilities include costs for ongoing monitoring and maintenance.

Table 8.1 provides the “known” liabilities and an estimate of their approximate cost. The cost estimates have been based on 2009 rates and prices.

Table 8.1 Known Liabilities and Associated Cost

Environmental Liability	Description	Cost Estimate ⁶
Operational		
Capping system, leachate surface water and gas management system.	Restoration of the site in two contracts - 2010 and 2013.	€1,409,000
Aftercare		
General Management and maintenance of site during aftercare phase (30 yrs). Leachate and Landfill Gas Management.		€ 7,500,000
Overall Total		€8,909,000

8.3 'UNKNOWN' ENVIRONMENTAL LIABILITIES – CURRENT STATUS

The 'unknown' environmental liabilities are associated with the environmental risks identified in Sections 4 and 5, and may or may not occur. The best case scenario is that none of the environmental risks occur, and hence at the end of the assessment period, the additional costs incurred by the landfill owner due to the environmental risks are zero. Alternatively, should a significant number of the risks materialise, significant additional costs could be incurred.

In order to identify an indicative level of environmental liability associated with the environmental risks for the purposes of Condition 12.2.2 of the Waste Licence, a cost model has been used to generate the expected cumulative cost of the risks. The modelling has been undertaken using specialist risk management and decision making software utilising the Monte Carlo sampling method to estimate the probability distribution for the expected costs.

The process assumes triangular distributions for the probability and cost ranges for each risk. Samples of expected costs are estimated based on random values of probability and cost for each risk. The sample expected costs are calculated using 1000 iterations of cost and probability values generated from the triangular distributions. A probability distribution for the expected cost is then generated.

The probability distribution can be converted to a cumulative probability distribution. This cumulative distribution provides the expected costs at each percentile. Therefore, the 50% percentile expected cost represents the cost at which 50% (or 500) of the samples/iterations

⁶ All cost estimates based on previous tenders received.

exceeded this cost and 50% did not exceed this cost. Similarly, the 90% percentile expected cost represents the expected cost at which 10% (or 100) of the samples / iterations exceeded this cost and 90% did not exceed this cost.

The most likely expected cost is usually taken as the 50% percentile expected cost. This amount is €215,560. However, in order to allow a contingency on the expected costs due to the environmental risks, the 90% percentile has been adopted, which is €264,657.

This figure represents an indicative cost of liabilities due to environmental risks based on the estimated cost and probability ranges for each risk. The method cannot give an accurate prediction of the final cost due to the subjective and uncertain nature of the risk data. However, it should be accurate enough to assist making judgements on the appropriate level of financial provision required for environmental liabilities at the landfill.

Table 8.2 summarises the highest cost scenario, the lowest cost scenario, the most likely (50% percentile cost scenario), and the most likely scenario with contingency (90% percentile). It is recommended that the later value be adopted as an indicative cost for the “unknown” environmental liabilities.

Table 8.2 Summary of Potential “Unknown” Environmental Liabilities

Description	Estimate of “Unknown” Environmental Liabilities	Assumptions
Highest Cost Scenario	€ 722,750	Assumes all risks occur at their maximum cost
Lowest Cost Scenario	€750	Assumes none of the risks occur
Expected Cost - Most Likely Scenario with Contingency	€ 215,560	Based on the 50% percentile of the statistical analysis of the risk costs.
Expected Cost - Most Likely Scenario with Contingency – 90% Percentile	€ 264,657	Based on the 90% percentile of the statistical analysis of the risk costs.

8.4 ‘UNKNOWN’ ENVIRONMENTAL LIABILITIES – POST RISK MITIGATION

The ‘unknown’ environmental liabilities can be re-evaluated after the proposed mitigations for the risks have been implemented and a reduced liability should be evident. This should be undertaken during the future risk assessments and following the implementation of the mitigation measures.

8.5 TOTAL CURRENT ENVIRONMENTAL LIABILITIES

The total current environmental liabilities at Ballynacarrick, assuming that the landfill shall remain closed, is estimated to be the sum of the 'known' environmental liabilities and the 'unknown' environmental liabilities.

The 'known' environmental liabilities currently outstanding are;

€8,909,000

The 'unknown' environmental liabilities which may arise due to unexpected risk events is;

€215,560 (most likely scenario with contingency)

The total current environmental liabilities is therefore estimated to be;

€9,124,560 (most likely scenario with contingency)

It is proposed that the financial provision to cover environmental liabilities be based on this figure.

9.0 CONCLUSIONS AND RECOMMENDATIONS

This study has been undertaken at the request of Donegal County Council in order to comply with Condition 12.2.2 of Waste Licence W0024-04. This condition requires the completion of an Environmental Liabilities Risk Assessment at Ballynacarrick Landfill.

The landfill operations risk assessment identified 27 major risks at the landfill. These risks were quantified and potential risk mitigation measures identified. A risk management programme was prepared to manage the risks, and in particular the implementation of the risk mitigation measures. Risk owners were allocated to manage each risk and timeframes agreed for the implementation of the mitigation measures.

Through the implementation of the risk management programme, the major risks identified at the landfill will be reduced. This has been illustrated in the comparison of pre-risk levels and post-risk levels presented in Section 5.

It is noted that the risk assessment process is a dynamic and continuous process. The associated FMEA's, risk registers, and the risk mitigation programme should be regarded as live documents and subjected to regular reviews. It is therefore recommended that the landfill operators review the risk management at the site on a monthly basis and update the risk register and risk management programme as appropriate. It is also recommended that a formal risk assessment be undertaken annually at the landfill to assist in this process.

Potential environmental liabilities at the landfill have also been quantified. These were comprised of "known" environmental liabilities and "unknown" environmental liabilities. The "known" liabilities are known, well defined, and current liabilities. The "unknown" environmental liabilities are potential liabilities that may arise due to the environmental risks associated with the operation, closure and aftercare of the landfill. The "unknown" liabilities have been quantified using an expected cost model, based on the expected financial cost of each potential risk, and the expected probability of occurrence of each risk.

The current estimate of environmental liabilities at the landfill is **€9,124,560**. It is proposed that the financial provision to cover environmental liabilities be based on this figure.

APPENDIX A

FAILURE MODE EFFECT ANALYSIS FORM

Table 3: Current Risk Assessment - provides details on the risks and how they are rated, also what are the actions to manage the risks and who on the team owns the risk

Risk ID (from 'Risk Register' sheet)	Description (from 'Risk Register' sheet)	Risk start date	Optimal Risk end date	Potential Failure Mode - What happens to make this risk eventuate?	Potential Failure Effects - What impact does it have on the project?	Basis for Severity Rating - describe what could happen	SEVERITY	Basis for Occurrence Rating - for what reason is this rating chosen.	OCURRENCE	Current Controls - what is in place at the moment to stop this event occurring	Risk rating (occurrence x severity)	Actions Recommended - What are the actions proposed for reducing the occurrence of the cause?	Who is the appointed Risk Owner?	When are these actions to be completed by?
1	LANDFILL GAS - Die Back of vegetation from landfill gas migration within the site.	23/02/2010	ASAP	Inside Site. Failure of active landfill gas extraction system. Build up and migration of gas from leaks in capped areas.	Other: damage to flora and visual impact Air: Release of noxious fumes. HH: human exposure, Odour.	Minor Impact Temporary	L	Effective measures are in place preventing occurrence	L	Landfill Gas Extraction System Field Balancing	1	Continuing with management as existing	DCC	Ongoing
2	LANDFILL GAS - Die Back of vegetation from landfill gas migration outside the site.	23/02/2010	ASAP	Outside Site. Failure of active landfill gas extraction system. Field balancing required. Build up and lateral migration of gas from unlined areas.	Other: damage to flora and visual impact Air: Release of noxious fumes. HH: human exposure, Odour.	Medium Local impact, recoverable losses	M	Effective measures are in place preventing occurrence	L	Landfill Gas Extraction System, Field Balancing, Monitoring, Site Inspections	2	Continuing with management as existing	DCC	Ongoing
3	LANDFILL GAS - Escape of landfill gas to the atmosphere	23/02/2010	ASAP	Passive venting of gas through small point sources over the site	Air: Release of noxious fumes, Greenhouse effect, Air Quality, Odour	Minor Impact Temporary	L	Survey of the capped areas have been undertaken using a VOC analyser (FID and PID) and areas identified.	M	Survey of the capped areas have been undertaken and repairs made. Gas extraction system in place. Field Balancing undertaken every two weeks. Regular servicing of the flare	2	Continuing with management as existing	DCC	Ongoing
4	LANDFILL GAS - Landfill gas migration and accumulation in structures on/off site.	23/02/2010	ASAP	Failure of active landfill gas extraction system. Build up and migration of gas.	Air: Release of noxious fumes. HH: human exposure, Odour, Explosions, Asphyxiation illness, fatalities in site office, off site caravan	High Major impact, severe damage	H	Weekly landfill monitoring undertaken.	L	Landfill Gas Extraction System Field Balancing. Monitoring of piezometers undertaken weekly including caravan. Continuous landfill gas monitoring in site office. Landfill Gas Cut Off Trench. Offer relocation of local resident.	3	Continuing with management as existing	DCC	Ongoing
5	LANDFILL GAS - Intrusion / Vandalism at flare compound	23/02/2010	ASAP	Accident, vandalism	HH: illness due to gas/leachate exposure, burns, Air Quality Odour Climate Explosion	High Major impact, severe damage	H	There has been no previous break-ins to site.	L	Scada System, security fence, CCTV	3	Continuing with management as existing	DCC	Ongoing
6	LEACHATE MANAGEMENT - Leachate escaping from unlined cells. Contamination of groundwater from leachate.	23/02/2010	ASAP	Groundwater is contaminated due to historic landfill.	SW/GW: contamination. Leachate entering groundwater and surface water	Minor Localised	L	Measures have been put in place to reduce contamination from unlined area, capping, leachate extraction, surface water management.	M	Capping of unlined areas of the site. Management of the site. Continuous improvement of leachate management scheme	3	A revised hydrogeological Assessment is being undertaken from which further actions will be determined	DCC	Ongoing
7	LEACHATE MANAGEMENT - Leachate escaping from unlined cells. Damage to bog lands and surrounding area due to shallow groundwater	23/02/2010	ASAP	Land is contaminated from groundwater from site due to historic landfill.	Other: Contaminated groundwater from the unlined landfill flows down gradient of the site.	Minor Localised	L	Measures have been put in place to reduce contamination from unlined area, capping, leachate extraction, surface water management.	M	Capping of unlined areas of the site. Management of the site. Continuous improvement of leachate management scheme	3	Continuing with management as existing. Continuous monitoring, improve pumping regime.	DCC	Ongoing
8	LEACHATE MANAGEMENT - Leachate Tanks Rupturing and entering surface water and groundwater.	23/02/2010	ASAP	Tank leak, accident or vandalism causing leachate escape	HH: human exposure. SW/GW: contamination.	High. Rectification costs potentially very high. Breach should be identified.	H	SW / GW monitoring, visual monitoring	L	Integrity Testing Inspection of all flanges pipe work	3	Continuing with management as existing	DCC	Ongoing
9	LEACHATE MANAGEMENT - Overflow of leachate from existing cells	23/02/2010	ASAP	Due to perched leachate, temporary capping system - cell overflow causing leachate to escape	SW/GW: contamination. Leachate entering groundwater and surface water	High. Rectification costs potentially very high. Breach should be identified.	H	Audit have been undertaken and areas identified. SW / GW monitoring, visual monitoring	M	Scada System, Site inspections	6	Capping of site to commence in 2010	DCC	Ongoing
10	LEACHATE MANAGEMENT - Silt clogging pumps. Overflowing of sumps causing lack of containment	23/02/2010	ASAP	Lack of containment causing leachate to escape	SW/GW: contamination. Leachate entering groundwater and surface water.	Medium Local impact, recoverable losses	M	SW / GW monitoring, visual monitoring	M	Scada System, Flow meters installed, Site inspections	4	Capping of site to commence in 2010. A revised hydrogeological Assessment is being undertaken. Rationalisation of the leachate pumping system.	DCC	Ongoing
11	LEACHATE MANAGEMENT - Leachate break out due to breach in liner	23/02/2010	ASAP	Installation of landfill gas wells.	SW/GW: contamination.	High. Based on expected repair costs and environmental damage.	H	Measures in place. Levels and depth of wells calculation checked, factor of safety taken into consideration and supervision of installation of wells, the likelihood of the occurrence of such an incidence would be low.	L	SW / GW monitoring, visual monitoring	3	Ensure adequate instruction and supervision of the installation of the wells.	DCC	Ongoing
12	LEACHATE MANAGEMENT - Traffic accidents within the site during the tankering of leachate.	23/02/2010	ASAP	Carelessness, poor road conditions, negligence.	HH: human exposure. SW/GW: contamination.	High. Rectification costs for spill to surface water potentially high	H	No incidents have occurred to date. Only use licenced drivers and traffic management procedures in place(traffic designated routes).	L	Only use licenced drivers, traffic designated routes, speed limits, maintenance of vehicles, vehicles weighed leaving the site.	3	Check maintenance schedule of contractor in order. DCC Drivers trained to drive tankers. Contractors to be checked.	DCC	Ongoing
13	LEACHATE MANAGEMENT - Traffic accidents during off site disposal of leachate.	23/02/2010	ASAP	Carelessness, poor road conditions, negligence.	HH: human exposure. SW/GW: contamination.	Medium. Rectification costs for spill to surface water potentially high	M	No incidents have occurred to date. Only use licenced drivers and traffic management procedures in place(traffic designated routes).	L	Only use licenced drivers, traffic designated routes, speed limits, maintenance of vehicles, vehicles labelled non hazardous and leachate, vehicles weighed leaving the site.	2	Check maintenance schedule of contractor in order. DCC Drivers trained to drive tankers. Contractors to be checked.	DCC	Ongoing
14	LEACHATE MANAGEMENT - Pipeline flanges integrity checking	23/02/2010	ASAP	Accident, vandalism, degradation over time	HH: human exposure. SW/GW: contamination.	High. Rectification costs for leak to surface water and groundwater potentially high if undetected.	H	No incidents have occurred to date. SW / GW monitoring, visual monitoring	L	SW / GW monitoring, visual monitoring, Site inspections	3	Continuing with management as existing. Continuous monitoring	DCC	Ongoing
15	LEACHATE MANAGEMENT - Leachate being unsuitable for treatment at local WWTP	23/02/2010	ASAP	Leachate concentrations change due to mix of waste	Other: Increased treatment costs.	Potential very high costs to take to a suitable treatment facility	H	Based on previous experience	L	Leachate monitoring	3	Continuing with management as existing	DCC	Ongoing

Risk ID (from 'Risk Register' sheet)	Description (from 'Risk Register' sheet)	Risk start date	Optimal Risk end date	Potential Failure Mode - What happens to make this risk eventuate?	Potential Failure Effects - What impact does it have on the project?	Basis for Severity Rating - describe what could happen	SEVERITY	Basis for Occurrence Rating - for what reason is this rating chosen.	OCCURRENCE	Current Controls - what is in place at the moment to stop this event occurring	Risk rating (occurrence x severity)	Actions Recommended - What are the actions proposed for reducing the occurrence of the cause?	Who is the appointed Risk Owner?	When are these actions to be completed by?
16	CAPPING - Degradation of capping	23/02/2010	ASAP	Settlement, degradation over time	SW: contamination by leachate. Air: impacted by release of landfill gas.	Potentially high costs to rectify before significant environmental impact. May not be identified quickly.	H	Considered unlikely to cause significant impact prior to identification and rectification.	L	On going research by manufactures to ascertain life span of HDPE. Monitoring	3	Continuing with management as existing	DCC	Ongoing
17	CAPPING - Breach of capping system	23/02/2010	ASAP	Sapling tree roots leading to passive venting of gas through small point sources over the site. Increased leachate production. Increased tankering from lined cells. Increased leachate production in unlined areas.	Air: Greenhouse effect	Medium environmental impact. Very low financial cost	M	Considered unlikely to cause significant impact prior to identification and rectification.	L	Survey of the capped areas have been undertaken and areas identified.	2	Continuing with management as existing. Confirm with ecologist regarding roots of any trees identified on site.	DCC	Ongoing
18	LANDFILL OPERATIONS - Odour	23/02/2010	ASAP	Odours from landfill. Poor wind conditions. Flare not operating	Air: Odours causing a nuisance. HH: human exposure. Complaints from local residents	Limited number of local residents close to potential source.	L	No complaints have been received recently.	L	Landfill capped, gas extraction and flaring system installed. Site Inspections	1	Current measures are considered adequate. Odour Management Procedure to be developed in accordance with waste licence W0024-04.	DCC	Ongoing
19	LANDFILL OPERATIONS - Dust causing a nuisance, blown off site.	23/02/2010	ASAP	Dry weather, uncapped areas, traffic, unsealed roads.	Air: Reduced quality. HH: human exposure. Other: local resident complaints	Low. Limited number of local residents close to potential source	L	No complaints have been received recently.	L	Nuisance control procedures	1	Continuing with management as existing	DCC	Ongoing
20	LANDFILL OPERATIONS - Vermin carrying disease out of the landfill	23/02/2010	ASAP	Birds, flies and rats allowed to come onto the site	HH: Illness to employees or public	Low. Medically treated injury. Low financial cost.	L	Measures taken but possibility of occurring.	M	Nuisance control procedures	1	Continuing with management as existing	DCC	Ongoing
21	LANDFILL OPERATIONS - Wind blown litter, Off site migration of litter causing nuisance	23/02/2010	ASAP	Ineffective litter controls - nets, covering, compaction, Working in high winds	AM: Litter spreading off site	Low. Cost of rectifying considered low.	L	Due to past experience, litter is escaping off site	M	Litter Netting and litter picker.	3	Continuing with management as existing	DCC	Ongoing
22	LANDFILL OPERATIONS - Fire	23/02/2010	ASAP	Accident, carelessness, vandalism	Air: Release of noxious fumes. HH: human exposure. Other: damage possibly liner/capping.	High. Rectification cost to extinguish fire very high.	H	Unlikely to occur due to current procedures	L	Emergency response procedure, waste inspection procedure. CCTV	3	Continuing with management as existing	DCC	Ongoing
23	LANDFILL OPERATIONS - Fire Hydrant	23/02/2010	ASAP	Located at front of the site. Not connected. No access to water	Air: Release of noxious fumes. HH: human exposure. Other: damage possibly liner/capping.	High. Rectification cost to extinguish fire very high.	H	Fires occur at landfills, with current procedures the likelihood of occurrence would be medium.	M	Emergency response procedure,	6	Check status with fire hydrant connection and ensure it is working properly.	DCC	Ongoing
24	LANDFILL MONITORING - H&S Accident during environmental monitoring	23/02/2010	ASAP	Accident, carelessness	HH: Illness due to gas/leachate exposure	High. Potential fatality. Very high financial cost	H	Low possibility of occurrence due to experience of personnel	L	Use experienced personnel	3	Current measures are considered adequate	DCC	Ongoing
25	LANDFILL MONITORING - Landscape	23/02/2010	ASAP	Ineffective maintenance program undertaken to control.	AM - Amenity Visual Impact Other - Damage to liner	High. Very high financial cost	H	Measures taken but possibility of occurring.	L	Restoration and aftercare plan. Planting undertaken. Berm installed around site	3	Confirm with ecologist regarding root sizes of trees within capped areas. Are these a problem	DCC	Ongoing
26	BRING BANKS - Vehicles and/or person accidents in the Bring Bank area.	23/02/2010	ASAP	Poor traffic management, not wearing PPE, poor visibility, poor road conditions	HH: Injury/death to people, Other: vehicle damage	High. Based on costs resulting from lost time injury / damage to vehicle.	H	Unlikely due to current procedures, low traffic volumes.	L	Staff wear PPE, supervision of public on site, speed limits in place	3	Continuing with management as existing	DCC	Ongoing
27	BRING BANKS - Improper handling of waste by staff and members of the public	23/02/2010	ASAP	Improper handling of the waste(recovery and disposal) causing injury	HH: Risk of accident to public and staff	Low. First aid injury. Very low financial cost.	L	Could occur given the processes.	M	Staff wear PPE, supervision of public on site	3	Current measures are considered adequate	DCC	Ongoing

APPENDIX B

EXPECTED COST MODEL FOR “UNKNOWN” ENVIRONMENTAL LIABILITIES

Crystal Ball Report - Full

Simulation started on 9/23/2010 at 14:52:04

Simulation stopped on 9/23/2010 at 14:59:32

Run preferences:

Number of trials run	1,000
Monte Carlo	
Random seed	
Precision control on	
Confidence level	95.00%

Run statistics:

Total running time (sec)	3.12
Trials/second (average)	320
Random numbers per sec	9,288

Crystal Ball data:

Assumptions	29
Correlations	0
Correlated groups	0
Decision variables	0
Forecasts	3

Forecasts

Worksheet: [IBR0132 ELRA draft_AppCD02.xls]Stats

Forecast: Expected Cost

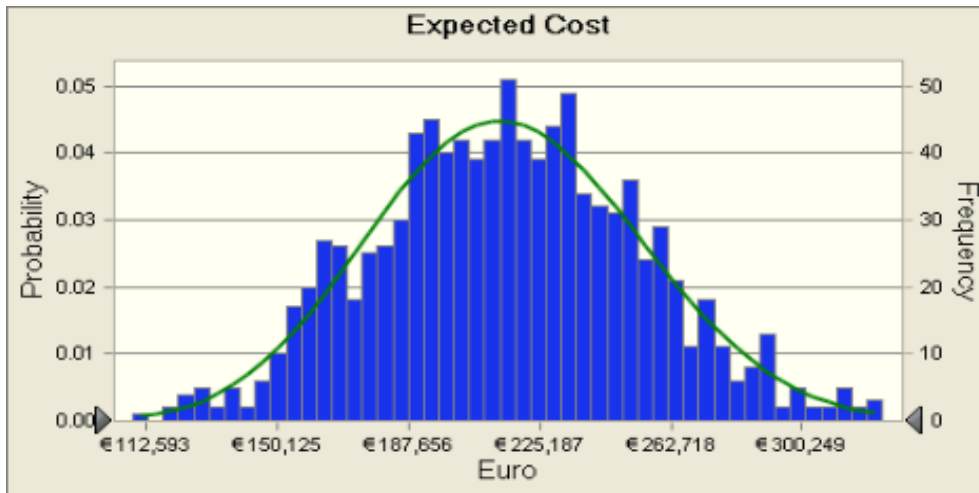
Cell: J32

Summary:

Entire range is from € 100,322 to € 333,928

Base case is € 51,700

After 1,000 trials, the std. error of the mean is € 1,211



Statistics:	Forecast values
Trials	1,000
Mean	€ 215,875
Median	€ 215,587
Mode	---
Standard Deviation	€ 38,297
Variance	€ 1,466,668,142
Skewness	0.1073
Kurtosis	2.88
Coeff. of Variability	0.1774
Minimum	€ 100,322
Maximum	€ 333,928
Range Width	€ 233,606
Mean Std. Error	€ 1,211

Forecast: Expected Cost (cont'd)**Cell: J32**

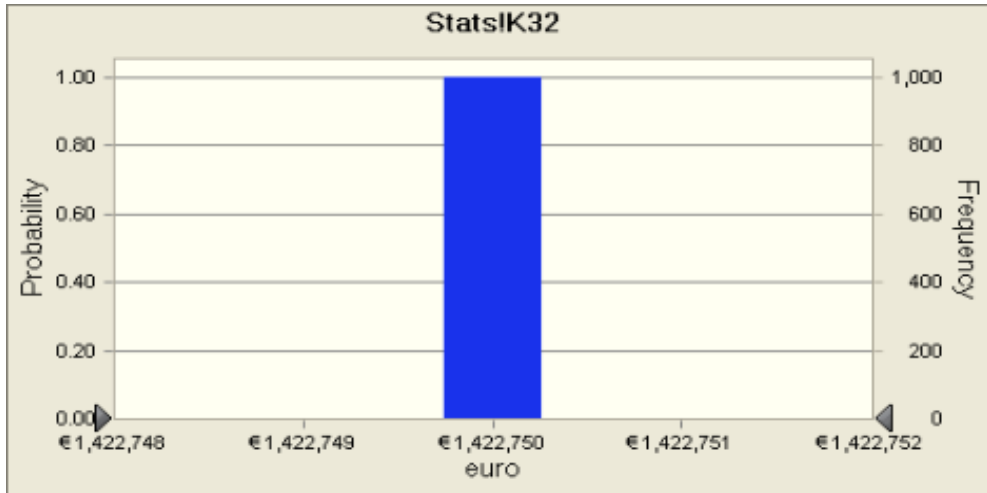
Percentiles:	Forecast values
0%	€ 100,322
10%	€ 165,045
20%	€ 183,313
30%	€ 194,565
40%	€ 205,017
50%	€ 215,560
60%	€ 225,787
70%	€ 235,299
80%	€ 248,620
90%	€ 264,657
100%	€ 333,928

Forecast: K32

Cell: K32

Summary:

Entire range is from € 1,422,750 to € 1,422,750
 Base case is € 1,422,750
 After 1,000 trials, the std. error of the mean is € 0



Statistics:

Trials
 Mean
 Median
 Mode
 Standard Deviation
 Variance
 Skewness
 Kurtosis
 Coeff. of Variability
 Minimum
 Maximum
 Range Width
 Mean Std. Error

Forecast values

1,000
 € 1,422,750
 € 1,422,750
 € 1,422,750
 € 0
 € 0

 0.00
 € 1,422,750
 € 1,422,750
 € 0
 € 0

Forecast: K32 (cont'd)

Cell: K32

Percentiles:	Forecast values
0%	€ 1,422,750
10%	€ 1,422,750
20%	€ 1,422,750
30%	€ 1,422,750
40%	€ 1,422,750
50%	€ 1,422,750
60%	€ 1,422,750
70%	€ 1,422,750
80%	€ 1,422,750
90%	€ 1,422,750
100%	€ 1,422,750

Forecast: L32

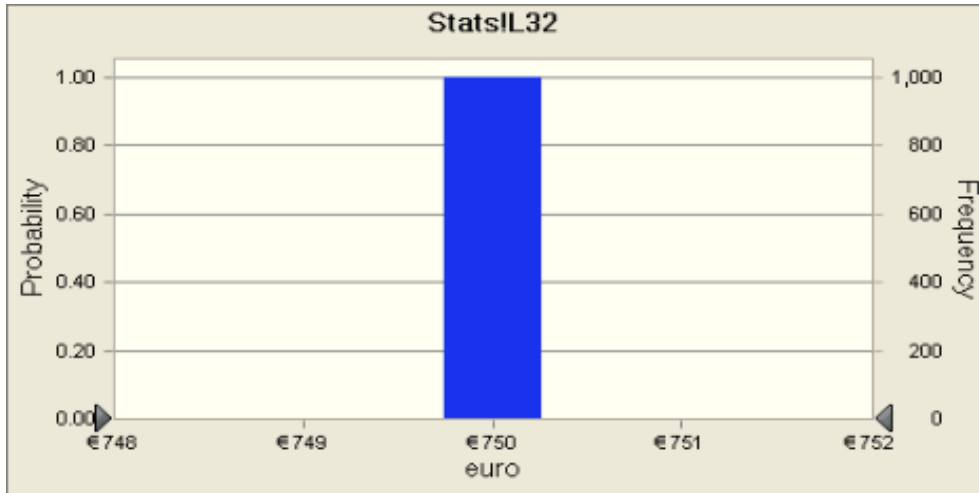
Cell: L32

Summary:

Entire range is from €750 to €750

Base case is €750

After 1,000 trials, the std. error of the mean is €0



Statistics:

Forecast values

Trials	1,000
Mean	€750
Median	€750
Mode	€750
Standard Deviation	€0
Variance	€0
Skewness	---
Kurtosis	---
Coeff. of Variability	0.00
Minimum	€750
Maximum	€750
Range Width	€0
Mean Std. Error	€0

Forecast: L32 (cont'd)

Cell: L32

Percentiles:	Forecast values
0%	€ 750
10%	€ 750
20%	€ 750
30%	€ 750
40%	€ 750
50%	€ 750
60%	€ 750
70%	€ 750
80%	€ 750
90%	€ 750
100%	€ 750

End of Forecasts

Assumptions

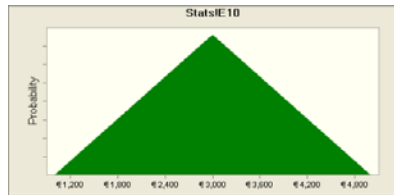
Worksheet: [IBR0132 ELRA draft_AppCD02.xls]Stats

Assumption: E10

Cell: E10

Triangular distribution with parameters:

Minimum	€ 1,000	(=D10)
Likeliest	€ 3,000	
Maximum	€ 5,000	(=F10)

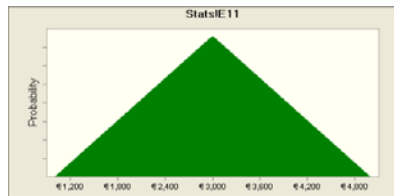


Assumption: E11

Cell: E11

Triangular distribution with parameters:

Minimum	€ 1,000	(=D11)
Likeliest	€ 3,000	
Maximum	€ 5,000	(=F11)



Assumption: E12

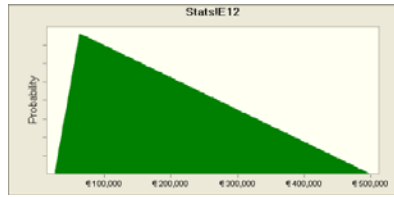
Cell: E12

Triangular distribution with parameters:

Minimum	€ 25,000	(=D12)
Likeliest	€ 62,500	(=E12)
Maximum	€ 500,000	(=F12)

Assumption: E12 (cont'd)

Cell: E12

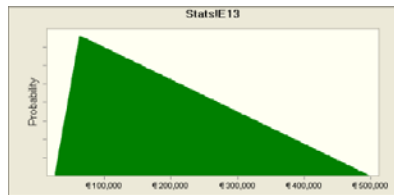


Assumption: E13

Cell: E13

Triangular distribution with parameters:

Minimum	€ 25,000	(=D13)
Likeliest	€ 62,500	(=E13)
Maximum	€ 500,000	(=F13)

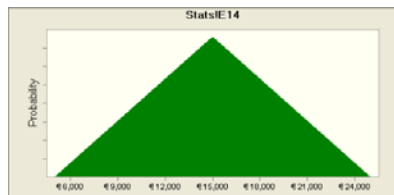


Assumption: E14

Cell: E14

Triangular distribution with parameters:

Minimum	€ 5,000	(=D14)
Likeliest	€ 15,000	(=E14)
Maximum	€ 25,000	(=F14)



Assumption: E15

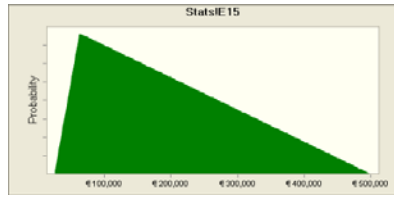
Cell: E15

Triangular distribution with parameters:

Minimum	€ 25,000	(=D15)
Likeliest	€ 62,500	(=E15)
Maximum	€ 500,000	(=F15)

Assumption: E15 (cont'd)

Cell: E15

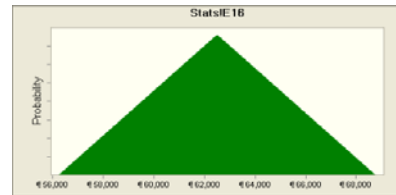


Assumption: E16

Cell: E16

Triangular distribution with parameters:

Minimum	€ 56,250
Likeliest	€ 62,500
Maximum	€ 68,750

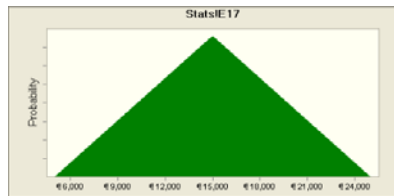


Assumption: E17

Cell: E17

Triangular distribution with parameters:

Minimum	€ 5,000	(=D17)
Likeliest	€ 15,000	
Maximum	€ 25,000	(=F17)



Assumption: E18

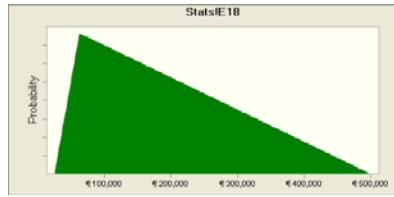
Cell: E18

Triangular distribution with parameters:

Minimum	€ 25,000	(=D18)
Likeliest	€ 62,500	
Maximum	€ 500,000	(=F18)

Assumption: E18 (cont'd)

Cell: E18

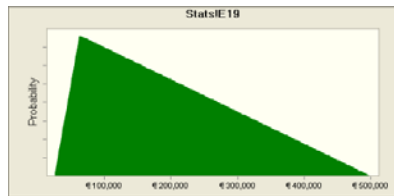


Assumption: E19

Cell: E19

Triangular distribution with parameters:

Minimum	€ 25,000	(=D19)
Likeliest	€ 62,500	
Maximum	€ 500,000	(=F19)

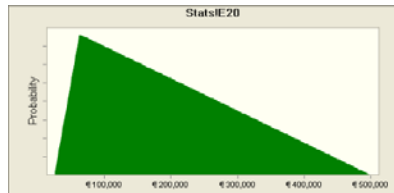


Assumption: E20

Cell: E20

Triangular distribution with parameters:

Minimum	€ 25,000	(=D20)
Likeliest	€ 62,500	
Maximum	€ 500,000	(=F20)



Assumption: E21

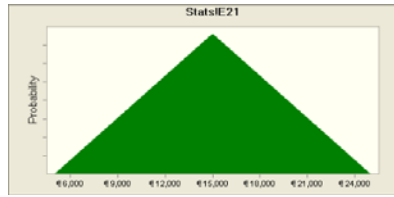
Cell: E21

Triangular distribution with parameters:

Minimum	€ 5,000	(=D21)
Likeliest	€ 15,000	
Maximum	€ 25,000	(=F21)

Assumption: E21 (cont'd)

Cell: E21

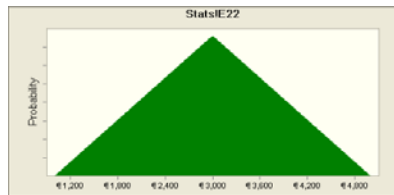


Assumption: E22

Cell: E22

Triangular distribution with parameters:

Minimum	€ 1,000	(=D22)
Likeliest	€ 3,000	
Maximum	€ 5,000	(=F22)

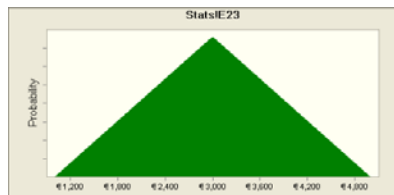


Assumption: E23

Cell: E23

Triangular distribution with parameters:

Minimum	€ 1,000	(=D23)
Likeliest	€ 3,000	
Maximum	€ 5,000	(=F23)



Assumption: E24

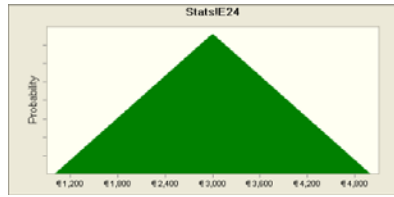
Cell: E24

Triangular distribution with parameters:

Minimum	€ 1,000	(=D24)
Likeliest	€ 3,000	
Maximum	€ 5,000	(=F24)

Assumption: E24 (cont'd)

Cell: E24

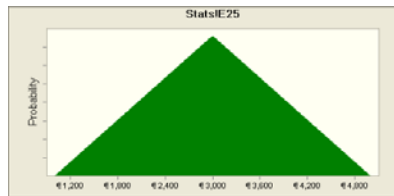


Assumption: E25

Cell: E25

Triangular distribution with parameters:

- Minimum € 1,000 (=D25)
- Likeliest € 3,000
- Maximum € 5,000 (=F25)

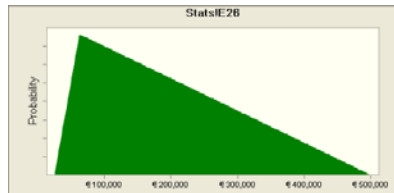


Assumption: E26

Cell: E26

Triangular distribution with parameters:

- Minimum € 25,000 (=D26)
- Likeliest € 62,500
- Maximum € 500,000 (=F26)



Assumption: E27

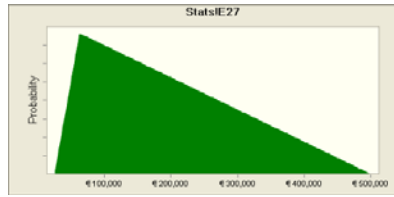
Cell: E27

Triangular distribution with parameters:

- Minimum € 25,000 (=D27)
- Likeliest € 62,500
- Maximum € 500,000 (=F27)

Assumption: E27 (cont'd)

Cell: E27

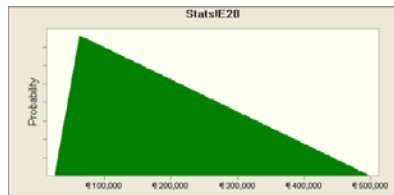


Assumption: E28

Cell: E28

Triangular distribution with parameters:

Minimum	€ 25,000	(=D28)
Likeliest	€ 62,500	
Maximum	€ 500,000	(=F28)

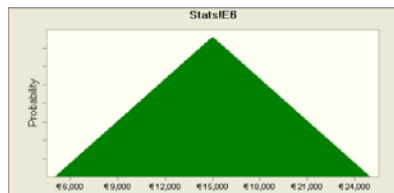


Assumption: E6

Cell: E6

Triangular distribution with parameters:

Minimum	€ 5,000	(=D6)
Likeliest	€ 15,000	(=E6)
Maximum	€ 25,000	(=F6)



Assumption: E7

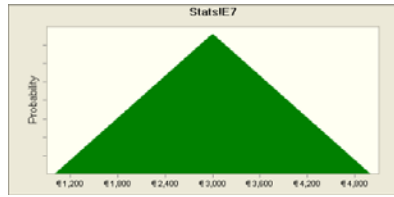
Cell: E7

Triangular distribution with parameters:

Minimum	€ 1,000	(=D7)
Likeliest	€ 3,000	(=E7)
Maximum	€ 5,000	(=F7)

Assumption: E7 (cont'd)

Cell: E7

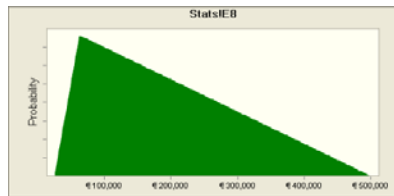


Assumption: E8

Cell: E8

Triangular distribution with parameters:

Minimum	€ 25,000	(=D8)
Likeliest	€ 62,500	(=E8)
Maximum	€ 500,000	(=F8)

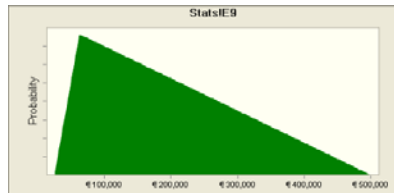


Assumption: E9

Cell: E9

Triangular distribution with parameters:

Minimum	€ 25,000	(=D9)
Likeliest	€ 62,500	(=E9)
Maximum	€ 500,000	(=F9)



Assumption: H27

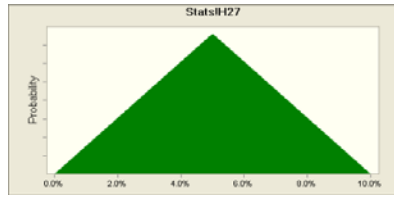
Cell: H27

Triangular distribution with parameters:

Minimum	0.0%	(=G27)
Likeliest	5.0%	
Maximum	10.0%	(=I27)

Assumption: H27 (cont'd)

Cell: H27

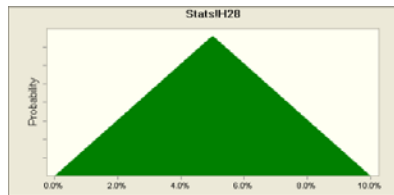


Assumption: H28

Cell: H28

Triangular distribution with parameters:

Minimum	0.0%	(=G28)
Likeliest	5.0%	
Maximum	10.0%	(=I28)

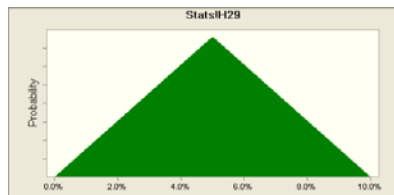


Assumption: H29

Cell: H29

Triangular distribution with parameters:

Minimum	0.0%	(=G29)
Likeliest	5.0%	
Maximum	10.0%	(=I29)



Assumption: H30

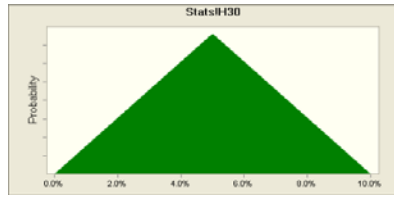
Cell: H30

Triangular distribution with parameters:

Minimum	0.0%	(=G30)
Likeliest	5.0%	
Maximum	10.0%	(=I30)

Assumption: H30 (cont'd)

Cell: H30

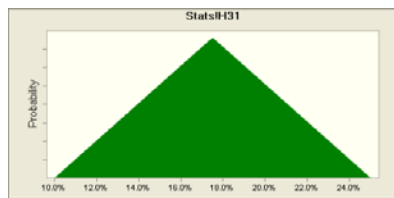


Assumption: H31

Cell: H31

Triangular distribution with parameters:

Minimum	10.0%	(=G31)
Likeliest	17.5%	
Maximum	25.0%	(=I31)

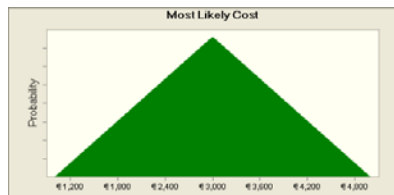


Assumption: Most Likely Cost

Cell: E5

Triangular distribution with parameters:

Minimum	€ 1,000	(=D5)
Likeliest	€ 3,000	(=E5)
Maximum	€ 5,000	(=F5)



End of Assumptions