Appendix B

Human Health

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Health Report

on the

Extension of Gortadroma Landfill

Gortadroma, Co. Limerick, Ireland

by

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A. Introduction

Limerick County Council has identified the necessity for extra landfill capacity to deal with the future waste production within the sub-regions of Limerick City and County. The Strategic Development Plan for Gortadroma Landfill (May 2001) examined the requirements of any future extension and concluded that the remaining life of the landfill will vary according to how well the Limerick/Clare/Kerry Waste Management Plan is implemented.

The proposed extension of Gortadroma landfill is aimed at providing necessary void space for the Limerick/Clare/Kerry region for the next 20 years.The landfill extension is located 12 km north pf Newcastle west, 9 km south of Foynes, and 54 km from Limerick City. The existing site covers an area of approximately 35 hectares and lies in a rural area.

B. Existing landfill - monitoring

Monitoring of leachate, surface water and groundwater quality in the vicinity of the landfill, and air quality measurements are part of the assessment of the (potential) impact of a landfill on human health. In order to obtain more insight in the possible effects on human health of the extension, these parameters are discussed here in detail based on data obtained from the current landfill.

1. Leachate

Results from the extended aeration lagoon are taken from reports by EURO environmental services, Southbank House, Southbank Ind Est, Drogheda, Co. Louth and are shown in Table 1.

Table 1 shows a variety of marked fluctuations in some parameters primarily ammonia. According to the reports, these were due to changing conditions such as the addition of sewage sludge in order to improve the biological activity.

Further analysis of leachate revealed levels of metals < 0.01 mg/l for Cd, < 0.01 mg/l for Cu, < 0.001 mg/l for Hg, and between 0.04 and 0.09 mg/l for Pb. It is

assumed that the upper levels mentioned indicate the limits of detection of the methods used.

Table 1. Median values of water parameters; samples taken from the aeration lagoon

Month	CBOD (mg/l)	COD (mg/l)	Ammonia N (mg/l)	Conductivity (µS/cm)	Susp. solids (mg/l)	SVI (index)	FM ratio (index)
10/2000	32	921	<0.2-0.74	4275	2916	16	0.0008
11/2000	35	825	<0.2	3196	2612	17	0.0013
01/2001	42	866	0.23	2920	2568	14	0.0031
02/2001	55	958	2.2	3260	3026	22	0.0535
03/2001**	912	3080	6.1	3230	4637	13	0.0328
04/2001	375	2875	2.2	2820	6019	19	0.0229
05/2001	425	3370	3.1	2930	8368	14	0.0152
06/2001*	238	2400	1	3	5660	19	0
07/2001**	90	794	52.8	3640	1086	28	0.0613
08/2001	66	820	0.35	3590	1598	24	0.0258
09/2001	77	1011	0.17	4020	1771	43	0.0190
10/2001	86	987	107	4190	1602	29	0.0197
11/2001	58	959	<0.1	4180	1619	60	0.0097
12/2001	52	961	0.12	4230	1606	75	0.0034
01/2002	43	1002	<0.1	4550	1623	49	0.0022
02/2002	76	968	14	4070	1598	43	0.0042
03/2002	62	637	1	3875	1673	39	0.0019
04/2002	48	984	0	3935	1604	37	0.0017
05/2002	39	698	0.21	3900	1009	45	0.0008
06/2002	51	626	27.8	4395	886	37	0.0020
07/2002	42	806	6.5	6150	1023	29	0.0009
08/2002	16	870	4.1	6900	1052	35	0.0010
09/2002	47	1045	19.5	7865	997	23	0.0010
10/2002*	48	1193	56.3	8290	1345	17.6	0.0020
11/2002*	80	793	282	5800	1144	8.7	0.0044
12/2002	66	1,027	118	5430	855	6.7	0.0028
02/2003	16	535	54.8	5940	383	15.3	0.0024

*damage of the aeration basin liner, reduced biological activity in the aeration basin, plant partially out of commission
** after treatment with sewage sludge

The parameters measured allow the categorization of the leachate as a typical wastewater originating from mixed organic/inorganic waste. This type of water cannot be used as drinking water and usually shows a fairly high degree of microbial contamination. For this reason and for being loaded with contaminants which can affect surface water quality, this type of wastewater is treated in a wastewater treatment plant.

The fact that the toxic metals Cu (copper), Hg (mercury) and Cd (cadmium) could not be detected (within the limits of detection), suggests that the raw leachate *per se* is not harmful to humans except for a probable microbial contamination. The levels found for Pb (lead) are slightly higher than the EU drinking water limit of 10 µg/l (0.01 mg/l). They are, however, in a range typical for wastewater. There is no indication of a health risk from this type of leachate if treated in a wastewater treatment plant.

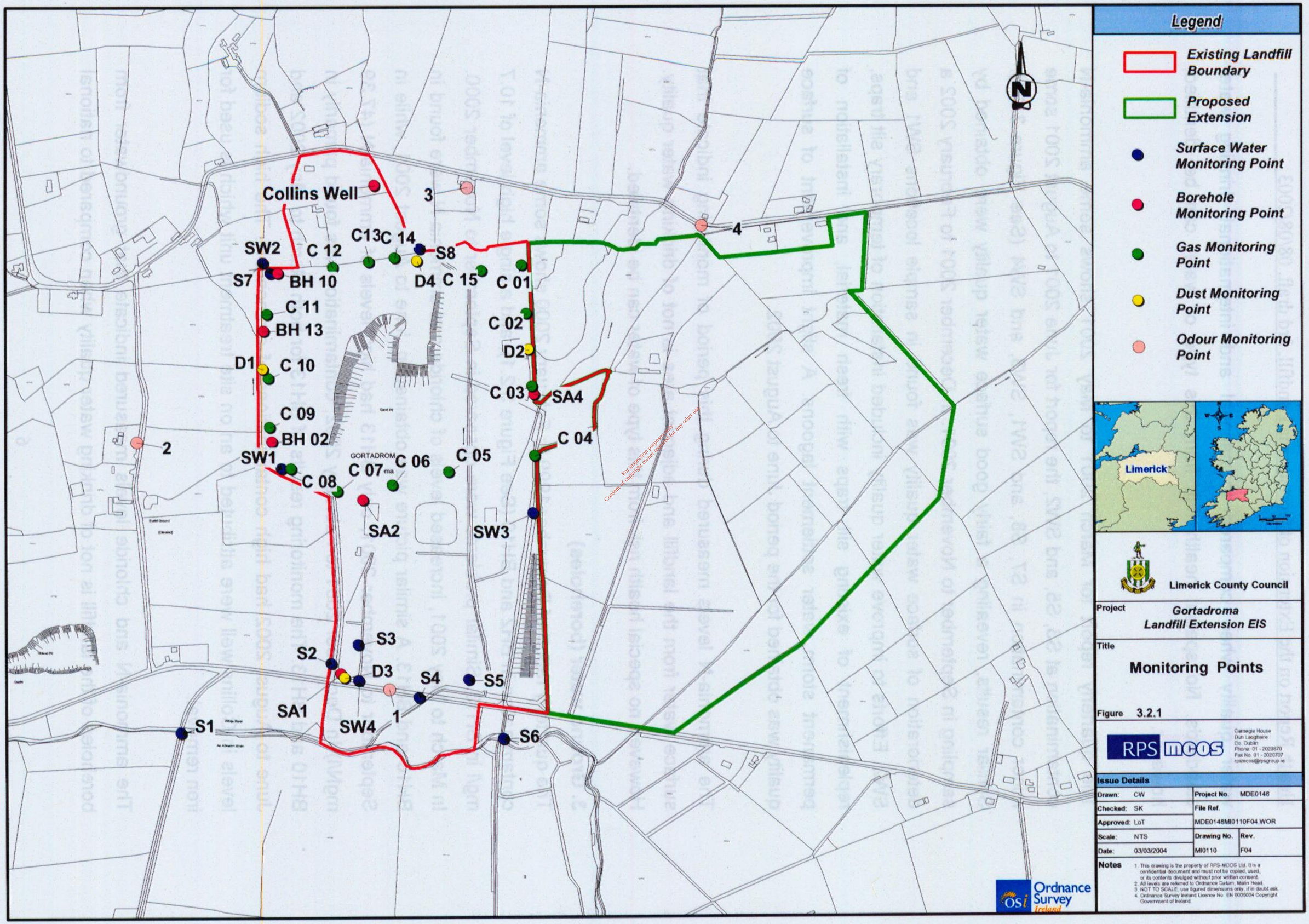
2. Surface water

landfill and adjacent area

Results of the visual inspections for the quarterly report for December 1999 to February 2000 indicates problems of silt in some samples especially at sample locations S4 and S5 (See Figure 3.2.1). Elevated COD levels were detected in samples taken at sample locations S3, S4, S5, and S7. Sample S4 had an ammonia-N level of 0.6 mg/l and S5 of 1.54 mg/l. All other locations had low values. A comparison of indicators between S6 (White River upstream) and S1 (White River downstream) show little or no change in the parameters BOD, COD, suspended solids and ammonia nitrogen indicating that the landfill has no measurable impact on White river water quality.

Some of the values measured indicate that surface water from the landfill and adjacent area is not suitable for drinking when compared to national and international drinking water standards. However, this does not mean that this water will necessarily have an adverse effect on health, in fact the data provided, does not indicate any special health risk possible originating from this type of water.

The quarterly report for March 2000 to June 2000 included the new surface water sampling points SW1 to SW4. By visual inspection a major reduction in silt levels was found probably due to the completion of excavation works for cell 8/10 and to the construction of silt traps. Increased levels of contamination were found in SW1 and SW2. Some of the values measured for the quarter, March 2000 to June 2000 indicate that surface water from the landfill and adjacent area is not of drinking



water quality when compared to national and international drinking water standards. No special health risk from this type of water can be identified, however.

The quarterly report for March 2001 to May 2001 shows some ammonia-N contamination at S3, S5, and SW2, the report for June 2001 to August 2001 some minor contamination in S7, S8, and SW1, SW3, and SW4 (See Figure 3.2.1). Similar results, revealing a fairly good surface water quality were obtained by sampling in September to November 2001. In December 2001 to February 2002 a deterioration of surface water quality was found in sample locations SW1 and SW2. Efforts to improve water quality included installation of temporary silt traps, replenishment of existing silt traps with fresh material, and installation of permanent storm water settlement lagoons. A slight improvement of surface quality was obtained for the period June to August 2002.

The ammonia-N levels measured during this period of monitoring indicate that surface water from the landfill and adjacent area is not of drinking water quality. However, no special health risk from this type of water can be identified.

3. Ground water (boreholes)

The quarterly report of December 1999 to February 2000 shows some ammonia-N contamination in BH2 and BH10 (See Figure 3.2.1), and a single high level of 10.7 mg/l in BH13. Similar problems were observed in September to November 2000. In March to May 2001, increased levels of chloride and ammonia-N were found in BH10 and BH13. A similar picture was obtained in June to August 2001, while in September to November 2001, only BH13 had high levels of ammonia-N (47.39 mgN/l) In December 2001 to February 2002, contamination was found primarily in BH10 and BH13. The monitoring results of BH13 for both March to May 2002 and June to August 2002 had high contaminations of ammonia-N. The high sodium levels in Collins well were attributed to an on site treatment unit which is used for iron removal.

The ammonia-N and chloride levels measured indicate that groundwater from boreholes of the landfill is not of drinking water quality when compared to national

and international drinking water standards. However, no special health risk from this type of water can be identified.

4. Landfill gas

Landfill gas monitoring at boreholes C1-14 (See 3.2.1) revealed oxygen levels between 8.0 and 21.1 vol. %, carbon dioxide levels between zero and 10.7 vol. % and methane levels between zero and 14.2 vol. %.

At the sample stations the levels ranged between 0.3 and 20.9 vol. % for oxygen, zero and 52.0 vol. % for carbon dioxide, and zero and 64.5 vol. % for methane. The data suggests an inverse relationship between methane and oxygen, which may be due to changing aerobic/anaerobic conditions in the cells. Under anaerobic conditions (lack of oxygen) methane forming bacteria grow and generate methane.

Both carbon dioxide and methane show a very low toxicity to humans and to the environment except for their activity as so-called 'green-house' gases. Carbon dioxide is a natural constituent of the atmosphere (0.03 % vol.), whereas only traces of methane occur in 'natural' air (0.0002 % vol.). Methane is assumed to have a higher specific impact on global heating than carbon monoxide, however the overall effect of carbon monoxide is higher than that of methane due to the much lower abundance of the latter.

5. Air quality

The Gortadroma Waste Licence Reg 17-1 requires that Dust and PM_{10} monitoring is carried out annually. In 2001, PM_{10} sample collection was carried out in July, and dustfall was collected in August/September. The levels were in the range of 13 – 25 $\mu g/m^3$, i.e., below the trigger level of 50 $\mu g/m^3$. The figures for dustfall were in the range of 6.3 – 42.2 mg/m^2 x d, i.e., clearly below the limit of 350 mg/m^2 x d.

PM_{10} exposure has been discussed as a possible cause of asthma and other chronic diseases of the respiratory tract. In industrialized zones in Central Europe, PM_{10} levels average at 60 – 90 $\mu g/m^3$ at achieve maximum values in the range of 400 – 500 mg/m^3 (Georisk, 1997). The levels measured in the Gortadroma area

indicate high air quality usually found in rural areas. In summary these levels do not indicate relevant emissions of PM_{10} or dust from the landfill.

B. Existing Environment

1. Human health status in the Mid Western Health Board Region

According to the Irish Health Statistics 2002 (Section B, Life Expectancy and Vital Statistics), life expectancy at birth is slightly lower in Ireland (79.2 years for females, 73.5 years for males) than EU average. The standardised mortality rate for Ireland was at 743.3 per 100 000 population in 2001. The value for the Mid-Western Health Board/Region was in the same range.

Overall, men and women had similar risks of developing cancer, although men were more likely to die from it. Older people were much more likely to develop cancer, with the risk doubling in every successive decade of life. Between 1994 and 1998 there was no significant change in the risk of developing or dying from cancer. Although some cancers showed trends of increase or decrease with time, the overall pattern was of an unchanged risk.

A comparison of age-standardised mortality rates for overall causes of death and a number of major causes nationwide and in the Mid Western Health Board is given in Table 3.

Table 3. Age-standardised mortality rates for Ireland in comparison to the Mid-Western Health Board/Regional Authority

Parameter	Ireland	Mid-Western
Total mortality	**734.3**	**761.6**
All circulatory system diseases	286.8	312.3
Ischaemic heart disease	150.2	174.6
Stroke	60.9	50.2
All malignant neoplasms	198.0	193.5
Trachea, bronchus and lung	39.4	37.1
Female breast	35.2	37.2

Whereas the mortality from ischaemic heart disease was higher than the Irish average, no increased mortality for all cancers, neoplasms of the trachea, bronchus and lung, and neoplasms of the female breast were observed.

The infant mortality rate, neo-natal mortality rate, and perinatal mortality rate in Ireland were above the EU average.

A detailed analysis of the incidence of individual types of cancer (National Cancer registry, 2001) shows that the incidence of colorectal cancer in females was significantly statistically lower in the Mid Western Health Board compared to the national average. For female breast cancer no significant difference was observed. The incidence of lung cancer was significantly lower for both sexes. The incidence of prostate cancer was 13 % below the national range, for bladder cancer there was no significant difference. The incidence of stomach cancer in males was significantly below the national average. For Non-Hodgkin's lymphoma and melanoma of the skin no significant differences were observed.

In summary, the statistics show that the overall incidence and mortality from all cancers and from a number of specific types of cancer is lower in the Mid Western Health Board than in the rest of Ireland.

An analysis of disability in childhood revealed a shift from physical health problems to psycho-social and lifestyle-related problems in young people as observed in most developed countries.

As part of the Askeaton Human Health Investigation published in 2001 by the Environmental Protection Agency (EPA, 2001), an area forming a rough concentric ring around the Askeaton area was investigated. This area, called 'Area 2' in the report comprised a number of DEDs including the DEDs Dunmoylan West and Dunmoylan East where Gortadroma landfill is located.

There was a lower rate for birth defects (congenital abnormalities) compared to other European registries but within the norm accepted internationally (1-2 % births). The rate did not differ significantly from that found in a control area. A health status survey did not reveal any differences in health status between Area 2 and other rural areas in the Mid-Western Health Board. A lower cancer incidence was observed when compared to the control area. With respect to overall cancer mortality Area 2 showed a more favourable experience than other areas in the Mid-Western Health Board. Respiratory mortality did not differ significantly between all areas investigated.

2. Air quality

The Annual Report 2001 on air quality in Ireland (EPA, 2001) revealed that limit levels for smoke and sulphur dioxide were not exceeded at any location tested. The level for ambient particulate matter mass concentration (PM_{10}) exceeded the 50 $\mu g/m^3$ limit at one site in Dublin. The same was true for nitrogen oxides (NO_x) and nitrogen dioxide (NO_2). Both types of air pollutants were strongly related to the very heavy traffic at the respective sites in Dublin City. Ozone levels exceeded the eight-hour health protection threshold of 110 $\mu g/m^3$ on a total of only fifteen days over the six stations in Ireland, while the one-hour population information threshold of 180 $\mu g/m^3$ was exceeded on the two days at Valencia, Co. Kerry. Benzene levels above the limits anticipated for 2010 were detected at two locations in Dublin.

In summary, no indication of any air quality problems in rural

areas has been found with the possible exception of ozone which represents a general problem in remote areas at periods of intense sunlight. Therefore the landfill extension at Gortadroma will have no relevant impact on air quality.

C. Impact and mitigation measures

1. General

The landfill is planed to provide void space for the Limerick City and County sub-region for the next 15 to 20 years. The progressive development of the site will be based on a phased system with each phase typically providing 3 – 4 years of filling time. Completed cells will be progressively capped and restored. During the capping phases the gas collection system and the leachate recirculation system will be linked to the existing leachate treatment systems and gas utilisation/flaring systems on site.

The landfill will be situated and designed so as to meet the necessary conditions for the prevention of the pollution of the soil, groundwater and surface water and to ensure efficient collection of leachate in accordance with the EU Directive on Landfill and Waste (99/31/EC), the EPA manuals on 'Landfill Site Design' and BAT principle (Best Available Technique).

2. Impacts and mitigation during the construction phase and during operation

Leachate

Leachate from municipal waste landfill is usually contaminated with non-pathogenic micro-organisms, inorganic salts such as sodium chloride, and products of the biological degradation of organic material. A loss of leachate into the groundwater reservoir should be avoided because of general hygiene standards for drinking water. The occurrence in the leachate of toxic compounds such as heavy metals, organic solvents or biological toxins in trace amounts cannot be excluded completely. The complete collection of leachate, however, does exclude even trace amounts of such chemicals from entering the groundwater.

The treatment of leachate will be carried out in order to reach the criteria as defined by the license. If these criteria are not met, no leachate will be discharged. Leachate storage, treatment, and discharge will have no impact on health quality of the population living in the vicinity of the landfill or on the environment.

Landfill gas

Landfill gas contains the gases carbon dioxide and methane as major constituents. Both gases show extremely low toxicity and are natural constituents of the lower atmosphere. Both gases are major contributors to the so-called green house effect which is related to global heating. The major source of carbon dioxide is the burning of fossil fuels such as coal, oil, petrol and natural gas used for heating, power generation, and in automobiles.

Landfill gas also contains trace amounts of other gaseous compounds generated during the microbial degradation of organic waste. Some of these compounds, though not occurring in toxic concentrations, can be sensed by humans because of the low smelling threshold for such compounds, e.g., for hydrogen sulphide.

Odour, in most instances, does not represent any direct harm to human health but can be very disturbing. Therefore, landfill gas should be collected as completely as

possible. Currently, all gas is collected and 'flared'. Flaring destroys most if not all smelling organic constituents converting them to carbon dioxide and water.
It is planed in the medium term to insert a gas utilisation plant, which will generate electric power. Both the current technology, and a possible use of landfill gas for the generation of power will have no impact on human health or on the environment.

Groundwater protection

Groundwater in many areas is a major source of drinking water. The quality of groundwater, therefore, has to be protected rigorously. In addition, many plants and other organisms as well as part of the surface water depend on groundwater reservoirs. The lining of the waste cells will prevent any leachate from reaching groundwater thus making sure that groundwater quality, human health, and the environment will not be affected.

Control of rodents

Rodents can be harmful since they may transfer pathogenic viruses, micro-organisms, parasites etc. and may, therefore, represent an important factor for the spreading of various disease. Control of rodents is a mandatory prerequisite for any landfill.
A commercial pest control company will be contracted to avoid the occurrence of any rodents which may affect human health or the environment.

Dust and odour

Dust originating from landfills usually contains organic and inorganic particles such as cellulose, salts, oxides etc. In addition, micro-organisms and spores may be found in landfill dust. No specific diseases originating from exposure to dust have been reported from the vicinity of well-maintained landfills.
Nevertheless, any avoidable exposure to dust should be prevented by appropriate measures since, in general, particulate matter is discussed as a contributing factor in the development of diseases of the inhalation tract such as asthma, chronic bronchitis and allergic reactions. To avoid this, waste will be covered at the end of each day to prevent any litter or waste dispersing by wind.

For 'odour' see 'landfill gas'.

Contamination of roads and neighbourhood

All HGVs leaving the landfill go through a wheelwash station to prevent any transfer of contaminated material to roads and neighbourhood. Contamination of roads and the neighbourhood will be kept to a minimum. Therefore, no impact on human health is to be expected.

Traffic

The maximum tonnage per year of 130,000 tons will be delivered over approximately 255 working days resulting in an average tonnage of 510 tons per day at maximum. A traffic assessment predicted movements of 26 articulated HGVs , 16 subsoil trucks and 12 compactor's HGVs, and 13 other HGVs per day as well as approximately 19 smaller motor vehicles. The hours of waste acceptance are from 8:00am to 4:30 pm on weekdays and on Saturdays preceding bank holidays for delivery of waste.

On average this would result in 67 HGVs per (approx.) 8 hrs. If evenly distributed over the working hours, approximately 8.38 HGVs per hour can be expected at maximum. This figure is below the frequency of HGVs in urban areas or on major roads and therefore will not have a significant impact on human health. An estimate of the daily distribution of HGVs movements is needed, however, for a more precise assessment.

Monitoring

All parameters listed in the EPA license will be monitored as part of an ongoing monitoring programme.

D. Residual Impacts

Data from the existing landfill demonstrates that no effects on air and surface water quality could be found. It is anticipated that the mitigation measurements will maintain this situation for the extension.

The burning of landfill gas has priority over the unmodified release of the gas since raw gas from landfills has a much higher 'green house impact' than carbon dioxide and may contain compounds with adverse odour. Furthermore, burning contributed to the removal/conversion of odorous compounds such as hydrogen sulphide. The future use of landfill gas as an energy source is strongly recommended.

E. Non-technical Summary

The extension of Gortadroma landfill will not lead to an increase in the annual tonnage of waste delivered to the landfill. From this fact it can be concluded that the frequency of heavy vehicle movements per day will not change significantly after the extension. The predicted frequency of HGV movements per day will be below that in many urban neighbourhoods and/or on major roads.

The impact of the current landfill on the quality of groundwater, air and surface water seems to be low. Borehole sampling revealed contamination of groundwater with ammonia-N and chloride at certain locations. An extension of the landfill with appropriate lining to prevent any transfer of leachate into the groundwater will lead to an improvement of this situation. The leachate will be transferred to a wastewater treatment plant, a common procedure which has been applied successfully at many modern landfills.

The use of landfill gas as a source of electric power is strongly recommended. This measure would also help to prevent the release of methane which is currently achieved by 'flaring', i.e., conversion of methane to carbon dioxide and water.

A major mitigation of transfer of waste or dust to the vicinity, and to the occurrence of odour or rodents is the daily coverage of the waste with soil at the end of the working hours. Further mitigation measures include a strict inspection of waste delivery at the gate, and a wheelwash station at the exit.

In summary, the extension of Gortadroma landfill under the conditions and measures listed above will not represent any additional health risk to the residents living in the vicinity of the site and/or to the public.

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