1 REMEDIAL OPTIONS

The remedial options are complex are require careful consideration. While the landfill has been inactive over 20 years the landfill is still producing a dilute leachate and landfill gas albeit at greater reduced concentrations and flows. Below is two main options considered.

1.1 SOURCE REMOVAL

This volume of the source of pollution could be 200,000 tonnes of solid material and potentially a large volume of Leachate. A detailed method statement and environmental management plan would be required for this operation to include the designated accepting facilities, the restoration measures proposed and the monitoring and validation process. In consultation with the relevant regulatory authorities the appropriate permissions, licences and permits must be obtained prior to any remedial activity taking place. The clear advantage of this method is that it entails the complete removal of the source of contamination; the disadvantages are the associated costs, considerable environmental nuisance during the excavation process and high number of vehicle movements to remove the material offsite.

This remediation option for the Landfill site at Churchtown, involves:

- Prior removal of Leachate from boreholes in domestic commercial and industrial waste at the Landfill site and treatment at an approved wastewater treatment facility.
- Construction of sumps in advance of the excavation works to facilitate collection and extraction of any residual Leachate;
- Excavation and removal of all domestic commercial and industrial waste from the Landfill. This will include excavation and removal of up to 15m thickness of soil.
- Segregation, temporary storage and classification testing of potentially hazardous waste (identified by visual inspection, in-situ monitoring and testing of the excavated domestic commercial and industrial waste) at a designated waste inspection and quarantine facility.
- Transfer of any hazardous material which is not acceptable at the engineered remediation landfill off-site to licensed hazardous waste recycling / disposal facilities.
- Removal of any material from the back gardens of adjacent houses to the east of the landfill area. Works would also need to consider the structural impact of material removal;
- Restoration of landfill area using appropriate soils;
- Extensive Environmental monitoring of surface water, groundwater and landfill gas would also be required as part of the process.

The estimated cost of this option is **€15 M excl. VAT** with the vast majority of cost arising from the disposal of waste at an appropriate Licenced facility.

1.2 INSTALLATION OF GAS VENTING, LANDFILL CAPPING AND GROUNDWATER TREATMENT

The capping of the landfill area to prevent infiltration of rainfall would pose additional problems with the lateral migration of landfill gas towards adjacent housing.

The main options for managing landfill gas at landfill facilities are:

- barriers;
- venting; and
- Active control and flaring.[1]

As the landfill is a historic landfill with limited landfill gas generation, the option of venting is most appropriate in this case.

On this basis it is proposed to do the following:

- Install capping layer
- Install Passive Gas Vent

The main options for managing landfill leachate at Churchtown landfill are:

- Enhance groundwater collection on site and discharge to sewer
- Pump and treat with discharge to sewer; and
- Groundwater flow barrier with groundwater collection.[2]

The cost estimates are estimates only, based on similar works, where possible, and are based on the information available at the time of preparation. The cost estimates are for implementation of the corrective actions only and do not include for any investigations, designs, land costs, permitting, or any other costs associated with the works.

1.2.1 Capping Layer

Capping Layer – 0.4m

The capping process involves the creation of a 0.4 metre deep "cap" over the site. The "cap" comprises of a liner, drainage layer, subsoil and topsoil. The drainage layer, subsoil and topsoil are placed over an impermeable liner which does not allow water to permeate down to the landfill (thus reducing the potential for groundwater pollution) and allows the collection of landfill gas. The area of landfill to be capped is 16,700 m^2 (approx.1.67 hectares). The areas capped will be planted with grass once capping is complete. Costs may vary depending on the availability of suitable capping material.

Capping Layer – 1m

The capping process involves the creation of a 1 metre deep "cap" over the site. The "cap" comprises of a liner, drainage layer, subsoil and topsoil. The drainage layer, subsoil and topsoil are placed over an impermeable liner which does not allow water to permeate down to the landfill (thus reducing the potential for groundwater pollution) and allows the collection of landfill gas. The area of landfill to be capped is 16,700 m^2 (approx.1.67 hectares). The areas capped will be planted with

[1] EPA Landfill Site Design, 2000

grass once capping is complete. Costs may vary depending on the availability of suitable capping material.

1.2.2 Passive Venting

Passive vent systems rely on natural pressure and convection mechanisms to vent the landfill gas to the atmosphere. Shallow gas venting trenches, or gas venting pipes, installed within the landfill and vented to the atmosphere, have been used to allow gas from interior regions of the landfill to escape.

The main advantages of venting trenches are their low constructional, operational, and maintenance costs. Their main disadvantage is that the technique is, on its own, most applicable to shallow landfill sites.

Venting systems should be designed in a manner as to prevent ingress of water. Vent stacks may be designed similar to gas wells that are used for gas extraction. Vent stacks installed during landfilling should be constructed as to be suitable for connection to the active extraction and utilisation system. The vent stacks should extend upwards through the capping system to provide permanent monitoring and both passive and active extraction locations.

It is proposed to install passive trenches approximately 500m long along the entirety of the landfill to the east and south east. The trenches will also connect to existing gas wells to enhance the gas collection potential. While the radius of influence of a passive vent is relatively small the transport of landfill gas is multi-dimensional and will take the path of least resistance. This may be problematic if relatively high concentrations of VOCs in the Landfill Gas are located in perimeter sections of the landfill near potential receptors. Testing would indicate that VOC concentrations are low within the landfill however this will be further assessed prior to undertaking the works.

The estimated costs of a Passive Vent are €50,000 with additional costs for landfill capping.

1.2.3 Groundwater treatment

While the contamination concentrations at the site appear to be with limits for all parameters with the exception of ammonium. In order to reduce the ammonium concentrations in the Dooally tributary/drainage ditch it is proposed to install a leachate collection system to collect and treat groundwater. It is proposed to install a groundwater collection trench along the southern boundary, gravity drain to a sump and pumped towards the nearby sewerage treatment plant.

An effective leachate collection and removal system is a prerequisite for all landfill sites. The purpose of the leachate collection layer is to allow the removal of leachate from the landfill. While the level of contaminants in the leachate is low, the removal of leachate will reduce the ammonical nitrogen load on the nearby stream/drainage ditch.

The estimated costs of a Groundwater treatment in situ pump and treat is approximately €100,000 plus €120,000 - €200,000 operation and maintenance costs per annum.

Direct discharge to sewer is estimated to cost in the region of €100,000 per annum.

1.2.4 Bentonite cut off wall

It is envisaged that a barrier would entail the construction of a vertical cutoff wall from the surface level down to the bedrock, along the boundaries. This would reduce the migration of any leachate from within the landfill boundary. However the base of the landfill is unlined and some waste is below the watertable therefore some migration would continue. The installation of a cut off wall would also impact on adjacent properties. The estimated costs of a groundwater cut off wall approximately €600,000. The cost of a cutoff wall is dependent on the depth, length, and width of wall site geological and hydrological characteristics; available workroom and other ancillary costs. It is considered that is not feasible at the current site and would achieve limited success or environmental benefit. The installation of a barrier wall may reduce the potential for off site migration. The installation of barriers in natural soils is less complicated that within the landfill material or where permeable bedrock is encountered. The alignment of the vertical barrier should be outside the contaminated zone. However due to site constraints this may not be achievable at the site.

Comparison of feasible corrective actions

Table 1

	Corrective Action	Description	Constraints	Residual Issues	Additional Corrective Actions	Rates	Cost Estimate
Remove Risk Source	Removal of contaminated material	Pump contaminated surface/groundwater to river.	Disturbance of Neighbouring properties	Issues with site boundaries, ownership etc.	Break leachate migration pathway	200,000 m3 @ 75 €/m^3 for excavation, disposal, transport, disruption, reinstatement, boundary issues etc.	€ 15 million
	On site treatment	Install GW trench Pump to Local Authority sewer for treatment at municipal WwTP Plus onsite air stripping plant.	Capacity of treatment plant	Source of leachate still present so ongoing contamination likely.	Break leachate migration pathway	Pump and Treat range – 2.4-4 €/m^3 treatment + costs for set up 35 €/m^2 500m	€100,000 set up costs €120,000 - €200,000 (based on 50,000m^3)

						of Drainage	
Break Pathway between Source and Receptor	Offsite treatment		Capacity in local sewers Capacity in treatment plant	Source of leachate still present so ongoing contamination likely.	Break leachate migration pathway	€2/m^3 35 €/m^2 500m of Drainage	€100,000 per annum €17,500
	Passive Venting	Installation of Passive Venting trench	Variable permeability of subsoils	Source of gas still present so ongoing gas generation likely.		35 €/m^2 plus associated costs €10,000	€23,500
	Passive Venting + extension into gardens	Installation of Passive Venting trench plus extension into gardens	Variable permeability of subsoils and issues with adjacent gardens	Source of gas still present so ongoing gas generation likely.		35 €/m^2 plus associated costs €20,000	€37,500
	Active Venting	Installation of Passive Venting trench + Active Venting	Variable permeability of subsoils – limited gas volumes and lack of a pressure deferential	Source of gas still present so ongoing gas generation likely.		40 €/m^2 plus associated costs €100,000	117,500 plus O&M costs
	Capping Layer **1m**	Cover system including barrier system such as geomembrane, compacted soil or geosynthetic clay liner (GCL) and drainage	Considerable earthworks may be required, as existing site gradients may not be conducive to natural drainage	Does not deal with exiting contamination .		€30/m^2 To include capping, drainage, anchor trench etc. (based on previous projects)	€500,000

		layer.	of site.				
	Capping Layer **0.4m**	Cover system including barrier system such as geomembrane, compacted soil and drainage layer.	Considerable earthworks may be required, as existing site gradients may not be conducive to natural drainage of site.	Does not deal with exiting contamination .		€16/m^2 To include capping, drainage, anchor trench etc. (based on previous projects)	€267,000
	Vertical barrier cut off wall	Typical vertical barrier is a bentonite slurry wall.	Depth of bedrock	Does not deal with exiting contamination	Address existing contamination	580m @ €950/m assuming 10m depth. Based on previous projects	€550,000 estimated 580 m^2 perimeter plus €50,000 reinstatement of gardens on completion