

ARTHURSTOWN LANDFILL – GAS MANAGEMENT AND DATA MANAGEMENT CASE STUDY

Location: Kill, Co. Kildare, Ireland

Client: Roadbridge Limited
and South Dublin Co Co

Status: Ongoing project

Overall Project Works Value: est
€50m

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Background

Arthurstown Landfill is located in Kill, Co. Kildare and is Ireland's largest municipal solid waste disposal facility with a total area of 72 hectares (180 acres). It catered for the municipal waste disposal needs of the greater Dublin region and is licensed by the Environmental Protection Agency (EPA) to accept 600,000 tpa of municipal non-hazardous baled waste. The landfill was developed adjacent to an old small dump. This was remediated prior to development of the new landfill.

The development of the landfill was carried out as Ireland's first waste management design and build (DB) contract. Roadbridge Ltd was the contractor with Fehily Timoney and Company (FTC) acting as the designer. The site is a fully engineered landfill that is designed, built and operated in accordance with the EU Landfill Directive on the Landfill of Waste.

Development of the landfill has been in a number of stages mainly:

1. Remediation of dump 1996
2. Stage 1 cell development 1997
3. Stage 2 cell development 1999
4. Stages 3 & 4 cell development 2002
5. Stage 5 Capping phases 1 to 3 during 2002, 2003 and 2004
6. Stage 6 Leachate treatment plant upgrade 2005, 2006
7. Stage 7 Capping Phase 4 2007-2008
8. Stage 8 Capping Phase 5 2009/2010 design ongoing
9. **Landfill Gas Management Model** 2008
10. **MP5 Database Management** of all data outputs (gas management, weighbridge, SCADA leachate management and treatment, utilisation and flaring)
11. **Reporting Tool** for quarterly and annual licence compliance
12. Stage 9 Penultimate capping Phase 6 2011

This project profile presents an overview of the bespoke software developed for the facility in relation to landfill gas management, data management and reporting.

Landfill Gas Management

FTC developed a landfill gas management model for South Dublin County Council (SDCC) at Arthurstown landfill to facilitate balancing of gas extraction from the Arthurstown landfill gas collection system. The landfill has a large landfill gas utilisation plant comprising eleven engines and two 2,500 m³/hr enclosed flares.

The utilisation plant peaked at 13.2 MW and in of 2010 generated 10 MW of electricity which was exported to the National Grid. The gas management model is designed to facilitate balancing and to highlight operational conflicts by:

- Defining operating criteria in relation to gas flow rates, quality and allowable variance
- Entering data from audits into the model either manually or via data loggers
- Producing automated reports of audit findings
- Exporting data to the MP5 database which facilitates:
 - Graphical and tabular presentation of data to address queries
 - Standardised reporting templates using Crystal Reports or similar
 - GIS graphical interface allowing interrogation and mapping of data
 - SURFER interface allowing contouring and sections of gas audit parameters
- Predicting infrastructural extraction requirements over the lifetime of the landfill
- Inputting gas model predictions from "LandGem", "GasSim" or other models over the lifetime of the landfill
- Monitoring gas extraction flow rates in relation to model predictions and allowing adjustments following automated calibration of LandGem prediction curves using audit records
- Reviewing system performance of flares, manifolds and engines
- Reviewing well characteristics in relation to CH₄, CO₂, O₂, CO, N₂, flow and pressure
- Reviewing data from other landfill related monitoring as required
- Producing headloss checks on strategic gas pipelines using audit flows
- Providing economic analysis of internal rate of return, payback and economic life of utilisation related investments based on calibrated prediction curves
- Facilitating sizing and scheduling of flare and engine requirements using calibrated landfill gas prediction models

Awards

FTC has been awarded in respect of works carried out in association with and at Arthurstown Landfill:

- 2008 Association of Consulting Engineers 2008 Highly Commended Award for Innovation in Design of Landfill Gas Management Philosophy
- 2000 Presidents Award for Excellence – Association of Consulting Engineers Arthurstown Landfill, Co. Kildare
- 2000 Construction Industry Excellence Awards Commendation Construction Industry Federation (Civil Engineering Category) – Arthurstown landfill.

Relevant Papers

The gas collection design philosophy and associated gas balancing work at Arthurstown led to a balancing philosophy which required wells to be balanced in relation to flow. This philosophy is described in the following publication:

A Management And Auditing Model For Balancing Landfill Gas Extraction

C. J. Cronin*, P. Kelly*, E. Hanley*, T. Ruddy*, J. Smith^o.

Proceedings Waste 2008: Waste and Resource Management – a Shared Responsibility 1 Stratford-upon-Avon, Warwickshire, England, 16-17 September 2008 © 2008 Golder Associates (UK) Ltd, managing organisation for Waste 2008

Key Economic Impacts of Using the Gas Model

Gas prediction modelling was historically carried out using GasSim and LandGem by the energy provider and the locally authority respectively.

Use of the FTC model facilitated balancing in relation to flow from respective wells and following several audits at the facility it quickly became apparent that all previous prediction models were underestimating the gas production from the waste body. This resulted in utilisation and flaring infrastructure being under sized with a consequent loss in revenue from the power utilisation plant in excess of €500,000 annually.

As a consequence of this and because the economic impacts were so significant two additional modules were developed for the FTC model:

- a calibration algorithm for the LandGem model to select appropriate gas prediction curves based on available audit records; and
- an economic tool to assess the internal rate of return, payback period and economic life of possible future investments in utilisation using calibrated gas prediction curves.

One other benefit of using the flow balancing philosophy is the ability to monitor flow rates from respective wells for respective suction pressures. This highlights where over extraction occurs allowing the operator to reduce extraction flow rates and so extend the longevity of respective wells.

Key Operational Observations from Arthurstown when Using the Gas Model

The landfill gas model is both a database and a design tool. The key operational strengths at Arthurstown are reported as follows:

- Implementation of a prescriptive procedure which helps define problem areas and monitor the impacts of corrective balancing and other actions over time.
- Simple data logger capture and data transfer to the model such that following an audit it is possible to generate an audit report within 10 minutes of downloading the data.
- Presentation of audit results with a predefined weighting to respective problems to assist the operator in prioritising remedial actions.
- As landfill filling develops operations often deviate from the original design criteria in relation gas collection infrastructure flows and headloss. The model uses audit flow rate observations on critical gas main collector pipework to determine whether the actual flows are within the design limits and clearly shows conflicts.
- Ability to define at source poor quality gas from good quality gas. At Arthurstown pipe gas collection infrastructure allows gas of all qualities to be extracted at a rate equal to waste generation rates regardless of quality, to prevent off site migration. Once extracted the twin pipeline allows landfill gas of differing qualities to be sent to either engines tuned for 50% v/v CH₄ or to engines tuned to 35% v/v CH₄ methane or to flares as maybe required in the future. The net economic effect of this is to maximise recovery of gas that can be utilised in engines.

Landfill Data Management

Under the sites waste licence (WL004-4) there is a requirement to gather, review and interpret landfill related data in quarterly and annual submissions to the Agency. This requirement may extend for 30 years or more years even though waste acceptance into the facility ceased in December 2010.

Data management requires extensive laboratory analysis and reporting (as of 2007 laboratory data records alone exceeded 50,000 and this excludes gas balancing, SCADA outputs from the leachate treatment plant, weighbridge records etc).

Landfill staff were required to manage the operational requirements of the facility and satisfy onerous licence reporting requirements to manage data which often caused resource conflicts. Management therefore commissioned FTC to streamline data management and reporting.

The design philosophy for the Arthurstown software required:

- Proprietary data import and export systems (CSV, spreadsheet and SCADA) to enter data into database
- Automatic generation in Word/Excel/pdf formats of appendices to support an AER or similar submissions
- Advanced templates to present and interrogate data such that User can bypass the onerous setting up of specific data queries associated typical database packages
- Standardised AER report in word format referencing generated appendices (tables and graphs)
- GIS interface on aerial photographs to allow access to data
- 3D modelling (contouring and sectioning) capabilities using SURFER software
- Integration with the FTC gas model

MP5 was ultimately selected as the central database. It is very proficient at accepting and interrogating data streams be they from a laboratory, a weather station, the weighbridges, the gas management audits, or SCADA outputs from the leachate treatment and flare/power generation plants.

MP5 also has useful GIS and SURFER contouring and section capabilities to access and interrogate all data. MP5 is also very user friendly when interfacing with spreadsheets. It was therefore ideally suited to receive outputs from the FTC gas model.

The Arthurstown bespoke software has a menu driven front end which fully integrates MP5, the gas model and FTC developed proprietary reporting systems.
The web based system also allows remote access for third parties.

Reporting Tool

The database reporting tool developed by FTC is designed such that predefined database selections are structured as appendices to support standardised annual environmental and quarterly reports.

The database selections are structured in tabular and graphical formats, show compliance limits and non compliance events are automatically formatted to highlight same. The table selections are dynamic and structured to allow the user to select alternate records to support discussion and explanations as may be presented in the standardised reports.

Use of this approach has reduced by 90% manhour inputs required to prepare compliance reports.

Summary

The primary benefit of this bespoke software application at Arthurstown is user friendly access to all waste management related data which in turn facilitates:

- Structured data capture systems many of which are automated to reduce time consuming manual data entry exercises
- Controlled access to data
- Cost effective reporting
- Access to a relational database which can support and facilitate day to day management decisions and operations

The gas management tool has facilitated economic decisions to maximise utilisation of landfill gas and has provided the Client with easy access to database records that facilitated informed management decisions in relation to infrastructure planning and day to day operations.

The information provided also facilitated the ability to balance gas extraction in relation to flow which was unique in Ireland initially but is now steadily gaining acceptance at other sites as the benefits are being realised.