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DEERDYKES COMPOSTING FACILITY: A CASE STUDY OF THE CONVERSION OF A CONVENTIONAL ACTIVATED SLUDGE SEWAGE WORKS TO IN-VESSEL COMPOSTING, WITH SLUDGE CO-COMPOSTING FACILITY

Last SD*,
MacBrayne D**
MacArthur AJ***
(Technical Manager – Enviros Consulting)*
*(** Waste Services Manager, Scottish Water Waste Services)*
*(***Consulting Group Manager – Enviros Consulting)*

ABSTRACT

A case study in which the authors describe the innovative re-use of the infrastructure of a 30 year old redundant Sewage "Purification" Treatment Works (STW), in Cumbernauld, Scotland, United Kingdom, originally designed along "traditional" lines as an activated sludge treatment works, with pre-settlement tanks, stormwater storage tanks, aeration tanks, and Clarifier Units, all of which have been maintained in place and after modifications have been converted, with ramp accesses added, to become part of the "Aerated Static Pile In-vessel Tunnel Compost Plant", "Compost Reception and Screening Areas", "Site Run-off Storm Balancing", and "Sludge Press Ancillary Tanks".

The original STW structures and drains were found to be in excellent structural condition, and of a suitable height and width for incorporation into the in-vessel tunnels, and reception and storage areas. The original interconnecting pipework and ducts were also re-used. The sustainable nature of the project turned a liability into an asset for the owner Scottish Water Waste Services and attracted a grant of approximately £600,000 from WRAP's (the Waste and Resources Action Programme) Organics Capital Support Programme through funding provided by the Scottish Executive. The project is described in this paper to encourage others to seek out similar synergistic projects in keeping with the ethos of composting.

The paper discusses the design adopted, and implementation of the concept of waste minimization and recycling; from the site infrastructure of the plant, to the high quality compost end-product it will produce.

KEYWORDS

Deerdykes; compost; composting; in-vessel; aerated static pile; windrow; recycling of infrastructure.

1 INTRODUCTION

The development of composting capacity to achieve the EU Landfill Directive Targets for the diversion of organic waste away from landfill, is an important part of United Kingdom and Scottish strategic waste management planning.

Following the completion of an initial feasibility study, SWWS approached Enviros to design and project manage the conversion of the redundant Deerdykes Sewage Treatment Works (STW), located in Cumbernauld, Scotland, United Kingdom, into a composting facility.

The idea at first appeared somewhat surprising. The Deerdykes Sewage Works was originally designed and constructed in 1972 along "traditional" lines as a conventional activated sludge treatment works, with pre-settlement tanks, stormwater storage tanks, activated sludge aeration tanks, Clarifier Units and ancillary works, including sludge thickening equipment. Several hundreds of plants of this successful treatment technology have been built, and continue to be constructed throughout Europe. The process is well known and is not discussed further, other than, to provide a schematic diagram, (Figure 1), which shows the original, and proposed (in brackets) composting plant functions.

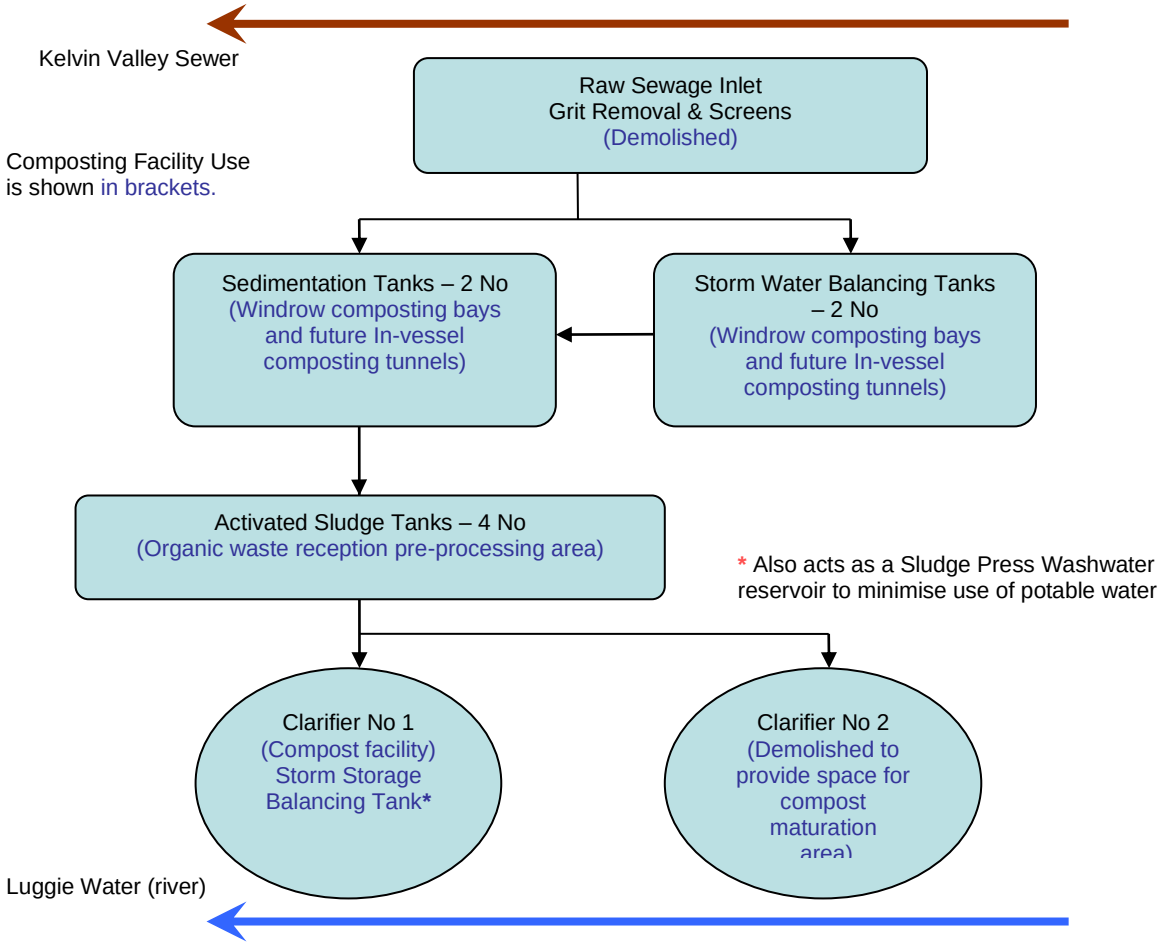

Figure 1. Schematic diagram of the Deerdykes Activated Sludge Sewage Works, with uses after conversion.

Since 2001, when a larger modern sewage treatment works was commissioned at Clydebank near Glasgow, the Deerdykes STW had been standing idle, and the owners Scottish Water (SW) had been looking for an alternative use.

Alternative uses for the site were considered that highlighted a number of potential development challenges. The site was not suited to housing development being within an industrial zone. However, finding an industrial tenant was not easy as other industrial sites of a similar size were standing vacant nearby. Furthermore, these properties could be utilised without the need or cost of demolition as required for the substantial existing STW structures.

Discussions with the planning authority were simplified for development as a waste management centre, based upon the previous established use as a waste site. Residential neighbours were limited to one property only and this would be upwind of the site's prevailing conditions.

The suitability of the site was also recognised as ideally situated geographically between the main population centres of Scotland, these being the city of Glasgow to the west (14 Km), and Edinburgh (50 Km) to the east, with the site also being directly accessible to a junction of the A80 dual carriageway, and thus readily accessible to the three neighbouring unitary authorities comprising Glasgow City, East Dunbartonshire and North Lanarkshire Councils.

Structural inspections also showed the original structures to be very well preserved with overall expectations of a further structural life for the original structures of in excess of 20 years.

Plate 1 – The disused west Sedimentation Tank, looking south during 2003, before commencement of the project.

So when business managers at SWWS began to look for possible sites for the construction of a new composting facility both as a profitable commercial venture, and to assist the Scottish Executive (SE), and the Waste Resources Action Programme (WRAP) tasked with promoting the development of new waste facilities in Scotland, the Deerdykes site rapidly became the prime choice

A feasibility study by Enviros in early summer of 2004, showed that there would be strong initial demand from local authorities for facilities to accept large quantities of green waste, which could be economically processed on the site by windrow composting on open slabs.

The need for this facility was also urgent, with kerb side collections of green (garden) waste due to start in January 2005, so there was very little time to design and construct the facility to offer to the local authorities on a term contract basis. Enviros was engaged to obtain competitive quotations and commence demolition works in early Autumn of that year, whilst fast-tracking the design process on a 30,000tpa green waste plant so that construction works could commence as soon as the demolition contractor departed.

SWWS has also a growing number of clients in industries such as food processing that requires additional sludge processing capacity, for both dewatering and treating liquid sludges as well as treatment of industrial sludge arriving on site in cake form. Co-disposal of sludge cake solids by co-composting has been shown to be successful elsewhere if in-vessel composting technology is utilised to ensure a high degree of control of composting conditions as well as odours and bio-aerosols (Ref 1). Therefore, Sludge Press facilities have been included within the initial design stages and subsequent construction contracts.

It has been recognised from the start that the composting market, will develop in Scotland, and capacity will need to be expanded further by the SE and WRAP. Furthermore there will be a growing demand for the more sophisticated composting techniques required for:-

- Sludge co-composting with other (mostly green/garden) wastes;
- In vessel composting, both to reduce emissions and especially to avoid odours and provide a more controllable environment for the sanitisation stage;
- To accept waste which would be subject to the Animal By-products Regulations, both from industry and from the planned segregation and collection of additional organic waste streams, such as the introduction of household kitchen waste collections which are being planned by the unitary authorities.

2 THE EXISTING SITE STRUCTURES AND THEIR RE-USE

While writing the feasibility study it was soon realised that the geometry and depth of the Pre-Settlement (Sedimentation) Tanks were well suited to conversion to In-vessel Composting Tunnels. When the Works had been constructed ground levels in the vicinity of these tanks had also been raised, so the re-introduction of ramps for access comprised no more than a reversion to original ground levels.

Plate 2 – The sedimentation tanks under construction. View looking north, April 1972.

The Activated Sludge Aeration Tanks when demolished would provide an area for Waste Reception and Processing for the initial compost sanitisation stage, and were suitably close to the future tunnels. One of the large circular Clarifier Units would provide surface water balancing storage whilst the other Clarifier was demolished to provide additional composting slab area.

Disposal of excess surface water (classed as contaminated from its contact with actively composting material), and liquid effluents from tanker deliveries is also well served by the presence of the large diversion (trunk) sewer at the top of the site, into which all liquid discharges would be consented.

A final bonus offered by the site was the presence of the original Sludge House, which with modifications has been returned to its original function, but this time for processing liquid wastes from tankers delivering to the site, for sludge concentration from tanker deliveries, and in future will provide sludge cake for co-composting of sludge solids with compost.

Plate 3 - *The sedimentation tanks under construction in 1972. View looking north, July 1972.*

3 PHASES OF CONSTRUCTION

The construction stages completed and planned are as follows:-

Stage 1 Open Windrow Composting, Sludge Dewatering and Liquid Waste Transfer

A. Removal of **Mechanical & Electrical Plant and Equipment, Demolition** (mostly removal of end walls and side walls to tanks, plus the infilling of one of the two Clarifiers; (Contractor: Dalton Demolitions) – November 2005 through December 2005;
B. Construction of **Drainage Modifications, Sludge House conversion, and Windrow Composting Slab Area construction, Drainage System Cleaning & Inspection, Drainage Modifications, Services Renewal and new Power Supply;** (Principal Contractor: Mackenzie Construction Ltd, MEICA Sub Contractor PSI Limited) – January 2005 to June 2005, with handover of part of the site for the acceptance of the first green (garden) from waste Refuse Collection Vehicles (RCVs) in late February 2005.
   The stage 1 works are now complete and the plant is now de-watering sludge on site. This will be composted on site once the stage 2 works, in-vessel composting, are complete.

The main source of material being treated on site by SWWS is green waste from the Local Authorities. Since February more than 13,000 tonnes of green waste has been delivered for processing. This material arises from new kerbside collections routes and the material would previously have been sent to landfill for disposal.

The green waste is currently being processed in static aerated piles turned by a side turner, SWWS are producing a PAS 100 (ref: 2) compliant product and the material is being sold in bulk for landscaping and land restoration projects.

One of the site using the product for restoration is the site of a former steel rolling mill that closed in the 1980s. The site is only 3 miles from the composting plant.

Stage 2 In-Vessel Composting

In vessel **4 or 8 tunnel in-vessel (full utilisation of existing STW tanks) scheme**; tenders returned late September 2005, with planned construction commencing in the same year. Acceptance of ABPR wastes, and co-composting will commence with the availability of the in-vessel co-composting tunnels in the early part of 2006.

Plate 4 – View looking north, showing composting plant slab construction in progress in the original Activated Sludge Tanks during February 2005. The Sedimentation tank walls, with ends removed, are visible in the background.

4 WASTE MINIMISATION AND CONSTRUCTION SUSTAINABILITY

The two causes of waste minimisation and sustainability of construction were served in this project by:

- Maximising the re-use of the existing structures;

- Reuse of demolition material by on-site crushing and use on site as stone material for sub-base formation for the additional areas of slabbing and raised slabs to some tank bases.
- Diversion of waste from landfill (13,000 tonnes in the first 6 months of operation).
- Use of compost in the regeneration of a brown field site.
- A local solution has been delivered for customers resulting in reduction of emissions from transport.

Existing site surface water, and sewage treatment process gravity drains and pressure mains were cleaned out, inspected, found to be mostly constructed in Ductile Iron Pipe and sound for re-use. The exception to the general re-use was some shallow vitreous clay pipe which had been used for ducts, which was found damaged from presumed wheel loads, either during construction or previously, and which required replacement.

Plate 5 – View looking south showing the ramp under construction, and Sedimentation Tanks in the foreground, February 2005.

5 DESCRIPTION OF THE PROPOSED IN–VESSEL COMPOSTING TECHNIQUE

The in-vessel aerated static pile composting facility comprises the second stage of construction, and has been designed by Enviros Consulting Limited. Construction is due to commence late 2005. It has been designed to accept industrial sludges, animal by-products, green waste and sludge cake. Initially, the site will only accept industrial sludges, green waste and liquid wastes. The liquid wastes will be stored on site and discharged to sewer. The sludges will be pressed and the cake will be co-composted with green waste in composting tunnels on site. Some green waste will also be composted separately in open windrows.

Enviros has designed the bespoke in-vessel system in which the compost tunnels will utilise the existing site infrastructure. The tunnels, and process control system has been designed for the plant to accept Animal By-product Waste in the near future once construction has been completed.

Similar to the successful Beddington Composting Plant (See Plate 6), the composting process has been designed as a forced-air, in-vessel composting process, which provides an initial sanitisation and stabilisation process over a two week composting period. Oxygen is supplied using blowers through a network of pipes cast into the concrete base slab. Control over the air-flow rate is by frequency inverters linked to the tunnel blower/fan, with the primary movement being re-circulation of air through the composting mass.

Supplementary (fresh) air is introduced via a valve/damper to control both oxygen concentration and temperature. Waste composting air is transferred to a biofilter via a dedicated blower from where it is released to atmosphere. The relative air flow rates are controlled using pressure sensors.

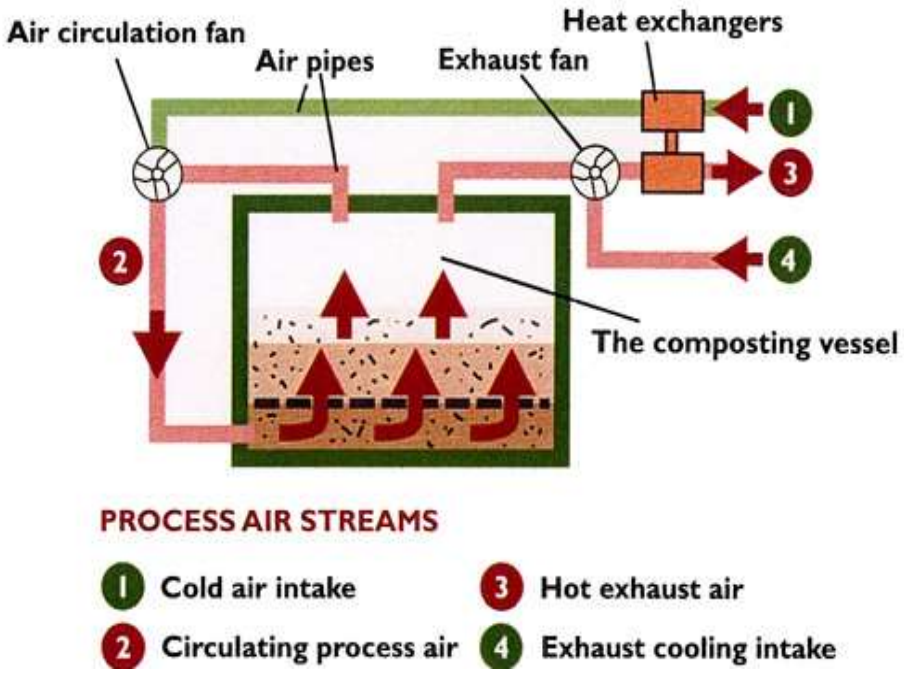

Figure 2. Schematic diagram of in-vessel process control system.

Plate 6 - A similar in-vessel system to the proposed tunnels at Deerdykes, designed by Enviros Consulting and constructed during 2004, at Beddington, Carshalton, Surrey, UK, for Viridor Waste Management Plc.

The in-vessel system is fully automated, being controlled by a bespoke software package developed specifically for this kind of process and to suit the SWWS's requirements. The composting mass inside the tunnel is aerated using a high air volume/pressure centrifugal fan, as shown in Figure 2. Air is re-circulated through the floor of the tunnel, through the composting mass, and via an outlet in the tunnel roof leading into duct work back into the fan.

Fresh air is drawn into the fan to ensure an operator settable minimum oxygen content in the re-circulating stream. A series of probes set within the composting mass are used to monitor the temperature. The aeration process is automatically controlled to maintain minimum oxygen, whilst controlling on a target temperature, again set by the operator.

Air exhausted from the composting tunnel is passed through a scrubber and a biofilter.

6 CONCLUSIONS

The project has turned a liability into an asset for the owner Scottish Water Waste Services and attracted a grant of approximately £600,000 from WRAP's Organics Capital Support Programme through funding provided by the Scottish Executive.

It has been shown that sustainable and innovative re-uses can be found for redundant civil engineering structures.

The project was a first of its kind in Scotland, and has provided much needed composting capacity in the region which will encourage others to set up similar ventures. As the market requirements become more sophisticated SWWS will progress from the present open windrow systems into premium areas of the compost market:-

- Through **Feedstocks:** in accepting more difficult to process organic wastes, including those arriving as liquids or sludges;
- In **Products:** in producing yet higher quality compost product.

The success of this project is described to encourage others to seek out similar synergistic projects in keeping with the ethos of composting, recycling and innovation.

ACKNOWLEDGEMENTS

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REFERENCES

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[2] British Standards Institution's Publicly Available Specification for Composted Materials (BSI PAS 100), published by the British Standards Institution.