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Solid Waste Management Case Study

150 tpd Compost Plant, Mansoura, Governorate of Dakahleya

Introduction

A 150 ton per day municipal solid waste composting plant has been constructed at Mansoura to treat waste from the City and surrounding environs. The SEAM Project and the Governorate of Dakahleya jointly financed the plant, designed by SEAM. Total cost for plant, equipment and construction was LE2.4 million, significantly cheaper than similar size plants built elsewhere in Egypt. Construction time was 7 months. The quality of the compost is good and is presently sold as a conditioner for land reclamation schemes. Dry recyclables are also recovered and sold. The plant is now operated by a private contractor, under a management contract with the Dakahleya Governorate.

150 tpd Compost Plant Constructed for Mansoura City

Why Compost?

Waste generation in the urban areas of Mansoura and adjoining Talkha is estimated to be 305 tons per day. A further 105 tons is generated in the rural districts of both areas. Typically, the organic content of urban waste is 60-70% and for rural waste, 50%. Recyclable material (paper, cardboard, plastic, glass, metal, rags) is 3-7% of urban waste and less than 2% of rural waste. All wastes had been previously disposed at the municipal dumpsite.

As much of Dakhaleya is prime agricultural land, the availability of sites suitable for landfilling is severely limited. This problem can be partially addressed through composting, which will reduce the amount of material to be landfilled by 40%. In addition the demand for compost in Egypt has been rising. Within Dakahleya around 55,000 feddans of arid land in the northern part of the Governorate are being reclaimed for which compost can be used as a soil conditioner. Other desert reclamation schemes in Egypt will place further demands on available compost.

Composting is not new in Egypt, the first plant having been established more than 15 years ago. Currently there are 15 plants operating and a further 40 plants have been proposed. The purpose of constructing this plant was not only to take advantage of the economic benefits but also to demonstrate:

- Low cost technology, the capital cost being at least 40% cheaper than most other plants that had been commissioned.
- The applicability of a shredder to reduce particle size instead of the more commonly used rotary homogenising drum.
- Commercial viability through the introduction of a Gate Fee of LE5 per ton, which may in turn encourage the private sector to enter the market.

What is the Capacity of the Mansoura Plant?

The plant was designed with a daily capacity of 150 tons, equivalent to 45,000 tons per annum on the basis of 300 operating days per year. The recovered organic content of the waste was estimated to average 50% of the incoming waste stream and compost yield was estimated at 70% of the organic component. Recoverable recyclables (plastics, paper, metal, glass, rags and bones) were estimated to be 5% of the waste stream. A summary of the design capacity follows.

Design Capacity of the Mansoura Compost Plant

	%	Tons/Day	Tons/Year
Waste intake	100	150.0	45,000
Recovered dry recyclables	5	7.5	2,250
Organic matter	50	75.0	22,500
Rejects to landfill	45	67.5	20,250
Compost produced	35	52.5	15,750

Construction and Commissioning

Detailed design and bills of quantities were prepared for all plant and equipment as well as civil, mechanical and electrical engineering requirements. Tenders were called, the successful bidder being Dakahleya Construction Cooperative, a Mansoura based construction company. All metal fabrication was done locally with only the shredder mill being imported from Germany.

Construction took 7 months commencing April 1998. Commissioning took a further 3 months during which time engineering defects were identified and rectified, staff training was provided, an operations manual prepared and waste characterisation tests undertaken.

The contractor formally handed over the plant to the Governorate in February 1999. Management of the plant was tendered in January 1999 and awarded to a private contractor in March 1999. As at April 1999 the plant was operating at around 55-60% of design capacity and is expected to be close to full production by late 1999.

The plant operates on two 7 hour shifts, 300 days a year. There are 50 employees, including 20 staff on the picking belt, 10 drivers and 10 general labourers.

What is the Operating Process?

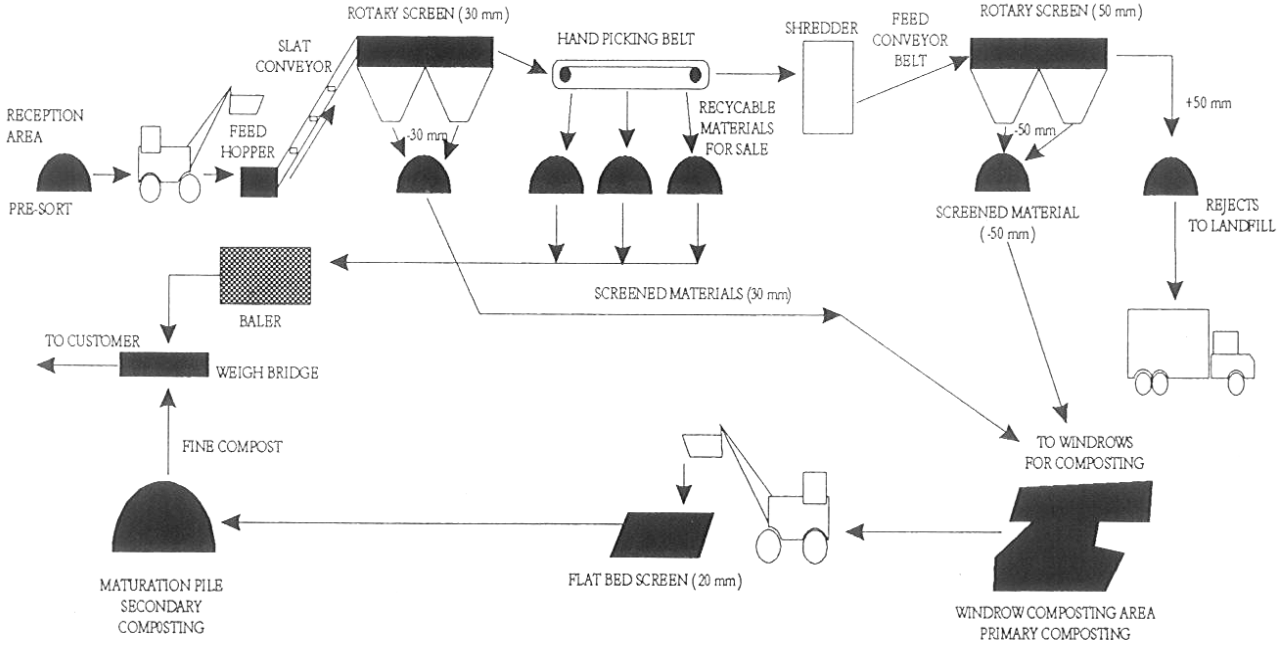
Figure 1 illustrates the process in graphical form

The process may be summarised as follows:

1. Rough Sorting

Material entering the site is first weighed at the weighbridge and then delivered to the reception area. Here large objects (e.g. lumps of concrete, tree stumps) are removed by hand and transferred to the dumpsite. Rejects in the first few months of operation averaged 7%.

Figure 1 - Process Stages



2. Pre-screening (30 mm rotary screen)

Waste material is loaded into a hopper at a rate of 10.7 tons per hour using a front-end loader. The hopper feeds a 30 mm rotary screen via a chain link slat conveyor. The screen incorporates fixed blades within the drum, which facilitates the break-up of waste material. The minus 30 mm component (fines) comprising mostly dust and smaller particles of organic material are collected and transported to the windrows. Fines averaged 33% of the treated waste in pre-testing.

Picking Belt and Sorters Recovering Dry Recyclables

3. Picking Belt for Removing Dry Recyclables

The picking belt is 24 m long and 1.3 m wide and travels at 15 m per minute at waist height. There are five picking stations on either side with chutes leading to collection bays below. Pickers are assigned to recover paper, cardboard, plastics, metals, rags, glass and bones. The separated materials are dropped down the chutes and subsequently pressed into bales, except the glass and bones. The percentage of recyclables in the first few months of operation averaged less than 2%.

4. Shredder Mill

The material from the picking line passes through a magnetic separator to collect any remaining ferrous metals and then into a shredder mill. The shredded material falls by gravity onto a conveyor belt. The shredder mill breaks down the organic material to the optimal size for composting. Any plastic bags passing through the mill tend not to be shredded and are removed by subsequent sieving.

5. Rotary Screen (50 mm)

The shredded material is fed into a high level rotary screen by means of a belt conveyor. The material passing through the screen is collected and transported to the windrows. This has been averaging around 30%. The plus 50 mm fraction, approximately 35% of throughput, is sent to the landfill.

Rotary Screen Used for Sieving Material and Fabricated Locally

6. Aerobic Composting

The minus 50 mm and minus 30 mm fractions are laid out together in windrows, which are approximately 3 m at the base, 2 m high and 50 m long. Water is added to the screened material to raise the moisture content to approximately 50-55%. Windrows need to be turned approximately once a week to avoid material drying and to facilitate aerobic breakdown.

Material is held in windrows for 4-6 weeks during which time degradation of the composting process results in a loss in mass of around 30-45%. During this process the temperature will range from 50° C to 70° C.

7. Final Screening and Maturation

When primary composting is complete (4-6 weeks), the material is fed onto a 20 mm flat bed screen using a front end loader. The oversize material is recycled into new windrows. The minus 20 mm material is moved to a maturation pile where it remains for a further 6-8 weeks during which secondary composting takes place. At the end of this period the compost is suitable for sale and the moisture content is in the range 15-30%.

What Equipment and Infrastructure is Required?

The total area for the compost plant is about 20,000 m^2 of which about 8,500 m^2 are for windrows, and 1,000 m^2 for waste reception.

Main items of equipment and infrastructure are summarised below.

1. Plant and equipment Main Items

- Hopper and swan neck feeder and slat conveyor 1.5m x 17.7 m 5 kW motor.
- Rotary screen (30 mm) 1.8 m diameter x 5.5 m long 10 kW motor.
- Hand picking conveyor - 1.3 m x 24 m 6.9 kW motor.
- Magnetic separator - producing 600 gauss.
- Heavy duty shredding mill with vibrating feeder 75 kW motor.
- Inclined belt conveyor 1.3 m x 15 m 5.5 kW motor.
- Rotary screen (50 mm) 1.8 m diameter x 5.5 m long 10 kW motor.
- Baling press for paper, cardboard, plastics and textiles.
- Baling press for metals.

2. Infrastructure Main Items

- Incoming power supplies 120 KVA.
- Incoming water supplies 100 mm UPVC pipe.
- Reinforced concrete area for waste reception, buildings and fixed plant.
- Concrete area for windrow composting and maturation pile.
- Administration and maintenance buildings.
- Drainage.
- Perimeter fence.

The total costs for plant, equipment and infrastructure construction costs was LE2.4 million.

Waste Characterisation

Six samples varying in size from 11.3 tons to 26.8 tons (average 20.9 tons) were tested during commissioning to determine size fractions and amount of dry recyclables that could be recovered. The averaged results show:

Fines (minus 30 mm)	:	33%
Dry recyclables	:	1.6%
Coarse fragment (minus 50 mm)	:	30%
Rejects (plus 50 mm)	:	35.4%

What is the Compost Quality?

The quality of the compost produced is considered good. Analysis of compost taken from the final maturation pile gave the following results:

Type of Analysis	Sample 1	Sample 2	Sample 3	Average
Weight per cubic meter, kg/m^3	610	460	525	532
Humidity, %	35.9	23.4	40.0	33.1
Acidity, pH	8.6	8.5	7.4	8.2
Conductivity, milliohms/cm	5.4	4.6	5.5	5.2
Total Nitrogen, %	1.12	1.03	1.20	1.1
Ammonium Nitrogen, mg/kg	2188	735	2359	1761
Nitrogen nitrate, mg/kg	35	21	259	105.0
Organic matter, %	31.8	36.8	32.1	33.6
Organic carbon, %	18.4	21.3	18.6	19.4
Ash, %	68.2	63.2	68.0	66.5
Carbon : Nitrogen ratio	16.3	20.7	15.4	17.5
Total intestinal bacteria cell/gm x10^3	5.0	3.0	15.4	7.8

Recovery of Recyclables and Compost

Recovery of materials for recycling and the production of compost have been assessed over a three month operational period, from February to April 1999. Recoverable fractions are expressed as a percentage of total waste throughput and are compared to those used in the design stage.

Recovered Materials as a % of Waste Throughput

	ESTIMATED Design Stage		ACTUAL Feb. - April 99	
	%	Selling Price Per Ton	%	Selling Price Per Ton
Compost Produced	35	LE18-21	38	LE25
Dry Recyclables	5.0		1.6	
Cardboard and paper	1.6	60	0.4	70
Plastics	0.7	400	0.2	415
Glass	0.7	40	0.4	50
Rags	1.0	30	0.3	15
Metals	0.7	150	0.3	60
Bones	0.3	100	negligible	300
TOTAL	**40.0**		**39.6**	

The lower than expected recovery of dry recyclables would seem to indicate that these materials are being scavenged before the waste is delivered to the site.

Are Capital Costs High?

Capital costs for plant, equipment and construction were at least 40% less than other similar size composting plants that had been commissioned. A summary of costs is:

Component	Costs in LE
Mechanical works	1,585,000
Electrical works	222,000
Civil works	145,000
Sanitation	39,000
Roads	409,000
TOTAL	**2,400,000**

Receiving Hopper and Slat Conveyer Leading to 30mm Rotary Screen and Picking Belt

In addition to the above items the Dakahleya Governorate provided the land as well as vehicles for windrow turning, waste and compost handling.

What are the Revenue and Operating Costs?

As part of the feasibility study it was estimated that the plant would hit full capacity in its third year. Capacity in Year 1 is reduced due to commissioning and inevitable problems associated with plant start up. As a result it was estimated that revenue from the sale of compost and dry recyclables would rise from LE177,000 in Year 1 to LE578,250 in Year 3 onwards. A breakdown of revenues follows.

Estimated Annual Revenue from the Composting Plant

Item	Year 1	Year 2	Year 3 on
Waste Treated (tpa)	15,000[1]	37,500	45,000
Compost Yield (tpa)	5,250	13,125	15,750
Dry Recyclables (tpa)	750	1,875	2,250
Selling Price Per ton			
Compost	18[2]	18/21	21
Dry Recyclables (weighted)	110[3]	110[3]	110[3]
Revenue (LE per year)			
Compost	94,500	260,000	330,750
Dry Recyclables	82,500	206,250	247,500
Total	177,000	466,250	578,250

Notes:

(1) Reduced capacity due to commissioning and plant start-up
(2) Reduced price during first year to help establish market
(3) Average price for recovered recyclables

To achieve full cost recovery a gate fee of LE5 per ton (roughly equivalent to LE0.50 per household per month) is to be imposed on waste treated at the plant. This would generate additional revenue of LE75,075 in Year 1 rising to LE224,950 in Year 3 onwards. The total projected revenue and operating costs for the plant are summarised below.

Projected Revenue and Operating Costs of the Composting Plant (LE)

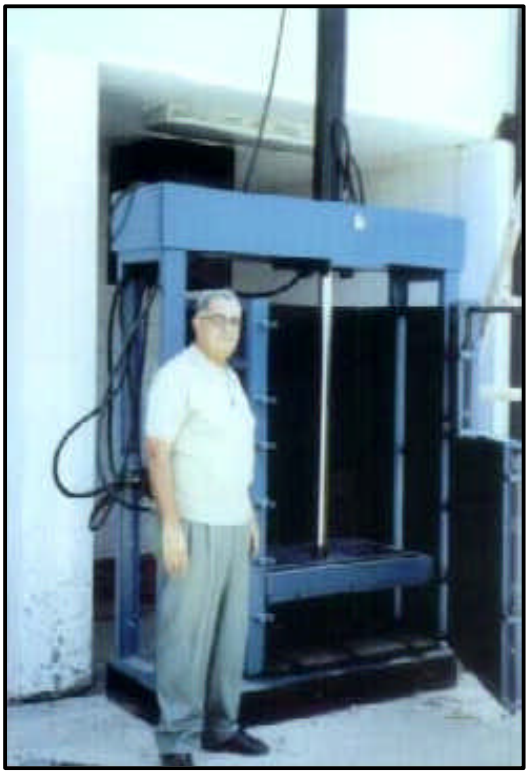
Revenue	Year 1	Year 2	Year 3 on
Sales of Compost	94,600	259,875	330,825
Sales of Recovered Recyclables	82,500	206,250	247,500
Gate Fee	75,075	187,550	224,950
Total Revenue	**252,175**	**653,675**	**803,275**

Operating Costs & Expenses	Year 1	Year 2	Year 3 on
Labour	85,387	170,775	170,775
Repairs and Maintenance	66,687	100,045	133,375
Utilities and Fuel	121,687	141,906	162,250
Contingency	27,376	41,272	46,640
Total Costs	**301,137**	**453,998**	**513,040**

Income (Without Capital Depreciation)	**(48,962)**	**199,677**	**290,235**

All operating costs are born by the Governorate and plant operator.

High Level 50mm Rotary Screen and Plus 50mm Rejects area



Baling Press for Paper, Cardboard and Plastics

Is the Compost Plant Sustainable?

The compost plant has been designed to be sustainable through the following actions:

- Capital costs were shared between the SEAM Project and the Governorate of Dakahleya thus increasing local ownership.
- All operating costs have been paid by the Dakahleya Governorate and the plant management company.
- Demonstrable economic benefits in reducing costly land requirements for final waste disposal.
- Good demand for the type of compost produced both within and outside the Governorate.
- Recovery and sale of dry recyclables.
- Imposition of a gate fee of LE5 per ton which enhances financial viability.
- Technology deployed is straightforward and can be easily maintained.
- The local manufacture of all equipment, with the exception of the shredder, will facilitate ongoing maintenance and support.
- Local recruitment and training of the workforce.

CONTACTS

More information on this project and the SEAM Project, are available from:

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The SEAM Project

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Solid Waste Management

Improving solid waste management had been identified as a high priority in the Governorates of Dakahleya and Sohag. The SEAM project developed a strategic approach to tackle the problem and funded projects that showed tangible benefits of improved waste practices.

Solid Waste Strategies

To address the issue of solid waste management, an assessment of the current waste practices has been undertaken in the Governorates of Dakahleya and Sohag. Information was collected on the type and quantity of waste generated, the present collection, separation, treatment and disposal practices as well as the institutional and social dynamics.

A strategic approach to deal with the solid waste problems was developed and priority issues identified.

Solid Waste Demonstration Projects

Solid waste demonstration projects were undertaken in both Governorates to address priority issues that had been identified in the waste strategies. Four demonstration projects were implemented covering areas of waste collection, transfer and disposal, maintenance, dumpsite remediation, recycling and composting. In all cases solutions were sought that:

- Are practical and affordable.
- Improved the efficiency of previous practices.
- Adapted the most cost effective technology to suit the purpose.
- Strengthened local capacity.
- Developed local manufacturing capability.
- Addressed sustainability issues.
- Involved the community.

As a result of the demonstration projects:

- 23,000 tons of municipal waste are collected each year.
- 45,000 tons of waste each year are recycled and converted to compost rather than being disposed to dumpsites.
- 115,000 people living in four low income urban and rural communities in Sohag and Dakahleya Governorate now benefit from improved waste collection and disposal services.
- Fires extinguished, odour and litter minimised at 2 municipal solid waste dumpsites.