Proposal for Integrated Waste Management Plants:
Recycling, composting and Pyrolysis – Clean Energy From Waste,
in a phased approach to waste management in Hampshire.

Hampshire County

Volume 1

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1 Introduction

This report constitutes the first in a series of pre-feasibility studies produced for the County of Hampshire in England. The report is based upon waste data supplied by the County of Hampshire and the International Mercantile Group Ltd. (IMGroup).

The IMGroup consortium are able to provide in some cases "Total Funding" or up to 90% funding to Hampshire County Council and possibly Hopkins Ltd. and technically proven processes to recover materials and produce products from municipal solid waste (MSW). Hampshire could adopt an Integrated phased approach to waste management, producing recycled products, composting. and lowest emissions - energy from waste if required. This conceptual report is produced in respect of the County needs for an environmentally sound waste disposal strategy & possible an Integrated Recycling plant. The Hampshire area produces a total of million tonnes of MSW and million tonnes per annum of industrial wastes from a County population of million and million in the immediate regions. The site for the first phase of waste management could be the Solhtievo landfill, which was visited by Scott Wilson in June 2001. This site at deals with tonnes per annum (tpa) of Municipal Solid Waste (MSW), of which it would be possible to provide, in phase one, a recycling plant for example of 250,000 tpa. The proposals are made which have very little environmental impact thereby minimising landfill requirements, depletion of any natural resources to the benefit of the environment and maximising recycling capacity in the County.

The Integrated Waste Management Recycling scenario is flexible in it's approach and is based upon a phased approach to recycling the domestic (MSW) waste of Hampshire and it treats refuse waste as a resource, resulting in the reclamation of approximately 82% up to 95% of the waste collected. The system can be designed in a phased manner to handle specific tonnages of waste for each County or County. Hampshire has a requirement for a recycle plant to process, for example in this study for a 250,000 tonnes of waste per year, which is the best financial option. In view of the flexibility of the modular based plant higher and lower quantities of waste can be handled in the recycling plant dependent upon the exact County requirements. Reduction to landfill, recovery, reuse and recycling is at the heart of the consortiums waste management proposals. Designs can be developed on an individual County requirement and are based upon the preliminary and approximate analysis of MSW obtained from the British Embassy, which will, at a later date be checked. The plant however, allows for a considerable amount of flexibility in both changes to the waste constituents and variations in the volumes to be handled. For more significant changes – such as an increase in districts or towns from which waste is collected – in phase two, the plant will have to be enlarged and the proposals in volume (III) of this series indicates the effect on size and area of doubling the current MSW capacity and indicates what can be achieved by recycling the County or Counties construction, demolition and all types of wastes. The feasibility has been based upon world-wide experience and includes the best technology and equipment available to the Consortium to achieve maximum recycle rates, up to 82% - 95% and lowest emissions energy from waste, if required.

2 Viability of the Project

This Conceptual review has been produced by the Consortium for Hampshire, which relates to the first phase of the development, which will be designed to receive, for example 250,000 tonnes of MSW and fully funded. The amount of waste processed will be restricted to site availability and size. The principal benefit of constructing a separation and recycling plant is in the opportunity to re-use material, which might otherwise be incinerated or deposited in Landfill. It is intended that granulated plastics, baled ferrous and non-ferrous metals, baled textiles, compost and refuse derived fuel (RDF) is produced by the plant, but it is essential that local markets are quickly identified and established for the sale of these products.

The proximity of associated secondary industries, which could process the recycled products, could partly satisfy these requirements. They could, for example, take the form of generating heat or power by using the RDF, recycle Paper & Card or by manufacturing finished plastic goods on an adjacent site.

This report, however, has concentrated on the core processes of waste separation and not on sequential processes. A more detailed marketing survey will be a priority of a further stage in the development of this project to identify ways in which the recycled products can be marketed and sold.

Due to fluctuations in the value of recycled product goods and the uncertainty of the market potential, it is essential, for the viability of the plant, that a commercially realistic fee (gate fee) currently set at £2.50 per tonne for taking-in MSW is agreed with the Municipal Authorities. The fee should reflect the rapidly increasing costs of landfill in England. These increases are resulting from more stringent controls and the imposition of landfill taxes as well as the higher costs of alternative forms of waste disposal.


Moscow's Solhtievo landfill

3 Plant Operation, Implementation and Site Requirements

The new Integrated plants for waste separation and the plastics plant will operate on 3 shifts. Before commissioning, the Consortium will, together with its suppliers, appoint sufficient, qualified personnel in the technology to train local staff. A management team will be in place before commissioning to operate and manage the whole plant and Industries planned for in order to manufacture products from the various processes. Plant and equipment are generously sized and are robustly designed to ensure, as far as possible, trouble-free operation for many years.

The principal separation processes are as follows;

(i) Manual picking facilities for the removal of textiles and plastics (plastic sorting can be augmented by mechanical means)
(ii) Recovery of ferrous and non-ferrous metals
(iii) Removal of glass and minerals
(iv) Separation of organic and combustible materials suitable for composting or RDF.
(v) Screening and Crushing Construction & Demolition Waste.

The plant will produce, as a viable operation, saleable products from waste with minimum pollution or environmental impacts on the environment. Each process has been reviewed on its own merit, and the processes proposed will be considered to be the best available.

Implementation

The existing members of the IMGroup Consortium, ONYX and Hopkins Ltd. And HCC intend that a Joint Venture Partnership is established to obtain the land and the necessary licences, to design, fund, obtain tenders, project manage the construction and operate the completed plant.

The plant will be constructed to take 250,000 tonnes of MSW per annum or could be designed to take a DISTRICTS waste up to tonnes, more or less based upon requirements in a phased approach. A contract for the assured supply of waste at an appropriate tipping (gate) fee will have to be agreed with the Local Government.

An experienced project team will expertly manage the design, supply and erection of the plant. Its function will be to ensure quality control and conformity with agreed programmes. The project will require 18 months to complete from the start of the construction to the end of the commissioning period.

The Site Requirements

The buildings for a 250,000 tonne plant ideally will occupy an area of approximately 20,000 square metres, which will double for subsequent upgrading. The overall area required for the plant, storage areas and roads would not be less than 10 Hectares.

The building layout will be sufficiently flexible to accommodate reasonable site constraints and modifications to the plant technology. An engineering feasibility study and geo-technical survey will have to be undertaken to assess the work needed on the site prior to any construction. Access to the site will be via security gates. Refuse delivery vehicles will discharge their loads in the waste reception building passing over computer controlled weigh-bridges on entry and exit. Approximately 150 vehicles per day will pass through the site to serve the 250,000 tonne per annum plant. Provision for the increase of traffic in the area and the Municipal Authorities should allow the upgrading of roads. The Consortium has only given consideration to roads and services within the site.

The whole recycle plant will be made secure and control systems will control and monitor all the activities within the plant and its compound. It will be designed to meet stringent environmental standards.

4 The Consortium

International Mercantile Group Ltd has prepared this study for the consortium of companies with a common interest and experience in environmental issues and waste management. The Consortium is made up of the following groups;

The Client: Hampshire County Council

Hopkins Ltd

John Laing International Ltd: A Civil Engineering and Construction Company eminently established for many years. Major civil engineering construction experience roads, bridges, refineries, Airports together with developments in the Environmental Sustainable Development waste programme for County under Agenda21 guidelines in the UK and Global market place. Strong project management experience also will be utilised in the Hampshire County plant.

Scott Wilson Kirkpatrick Co. Ltd: The International waste management consulting engineering company responsible for all project management, waste management and environmental assessment functions of the project for Hampshire.

HLC Henley Burrowes Ltd: A well-established environmental engineering company with experience in waste recycling plants for many years. Providers of the recycling technology machinery. Their technology will be used to meet the increased European and Global requirements for recycling of waste and the generation of recycled products. HLC have an impressive list of both private and Government clients in the UK.

O.Kay Engineering Services Ltd: This is a UK based recycling company with a solid record in supplying Recycling machinery to both Government and commercial clients.

VKW – Vogel & Muller GmbH: an Austrian company with many years experience in composting and environmental engineering projects. Large scale composting abilities for MSW. The company Crestwood Environmental will act as technical liaison between John Laing International and VKW – Vogel & Muller GmbH.

Graveson Energy Management Ltd: A United Kingdom company specialising in the lowest EU emissions Energy from Waste plants. This company will design and build the Gasification plant, which has the lowest emissions energy recovery process for the client with minimal environmental impact.

International Mercantile Group Ltd: An Investment Company with several years experience in providing Capital and Project finance in the Civil Engineering, Power Industry, environmental and infrastructure field. Associated consultants with Sustainable Development (Agenda21) Environmental / Energy Policy & Strategy experience.

5 Design Criteria

Waste Separation Plant

In Hampshire, on the basis of the following criteria, the plant will be designed to handle 250,000 tonnes per annum of domestic and other suitable solid wastes (MSW).

Plant Operational Period: - 24 hrs/day, 7 days/week, 347 days/year.

Waste Input - 721.02 tonnes/day i.e. 5,047 tonnes/week average

Plant Design Capacity - Requirement (average over 168 hours/operating week) 30.05 tonnes per hour TPH.
Maximum period of operation, allowing 0.95 availability.

Separation plants, similar to this, have an availability factor better than 0.90. Hence there is sufficient time to maintain the plant without affecting the production capacity.

The waste reception area is of sufficient size to store a three-day's supply of MSW to allow time for maintenance of equipment without the need to divert waste directly to the landfill.

The principal separation processes are as follows:

(i) Picking facility for the separation of textiles, paper, card and plastic (bottles & film)
(ii) Recovery of ferrous and non-ferrous metals
(iii) Removal of glass and minerals
(iv) Organic materials are treated and made suitable for RDF and compost, or the Paper & Card can be directly recycled for retail.

As with process plant where it is not possible to clearly define the input material, it is extremely important that maximum flexibility is in-built into the selected flow line to allow for considerable swings in the input at any one time. It is therefore, possible to cater quite large seasonable fluctuations. All prime items of equipment, such as screens, pulverisers, etc., in the main core line are generously sized to cater for relatively large fluctuations in throughput, analysis and rate. Flexibility also assists in the commissioning of the plant where sections of the process can be systematically tested.

Pre-screening is an essential part of waste processing particularly when resources recovery is required. This screen allows a degree of size selection that improves the efficiency and reduces the size of the pulverisation stage by screening –50mm size material from the process stream to the pulverisers. It also allows the retrieval of several products.

The following factors are taken into consideration in the design of the facility:

A. The majority of vegetable matter and organic food waste is in the –50mm size range together with in excess of 90% of the glass, grit, stone etc, which is broken down during its progress along the pre-screen barrel. This can be further processed to separate the lighter organic from the dense glass fraction.

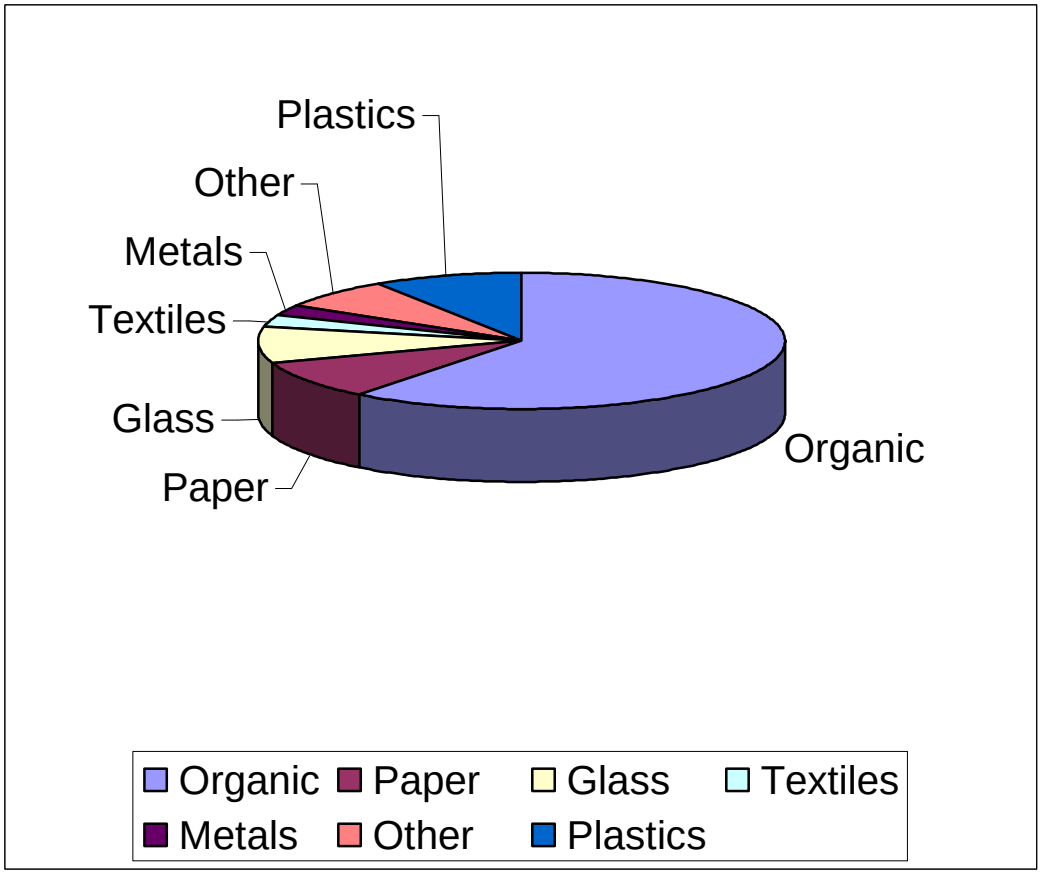
B. Drink and food cans, together with most of the heavy or dense plastic (PET) containers, are found in the + 50mm to 300mm size range. Ferrous and non-magnetics can be removed from this fraction using magnetic and non-magnetic separators whilst the plastic containers can be removed manually from a thin bed-stream then identified and sorted into their respective plastic types for further processing.

C. Most textiles, paper, card and lightweight film plastics appear in the +300mm or screen oversize.

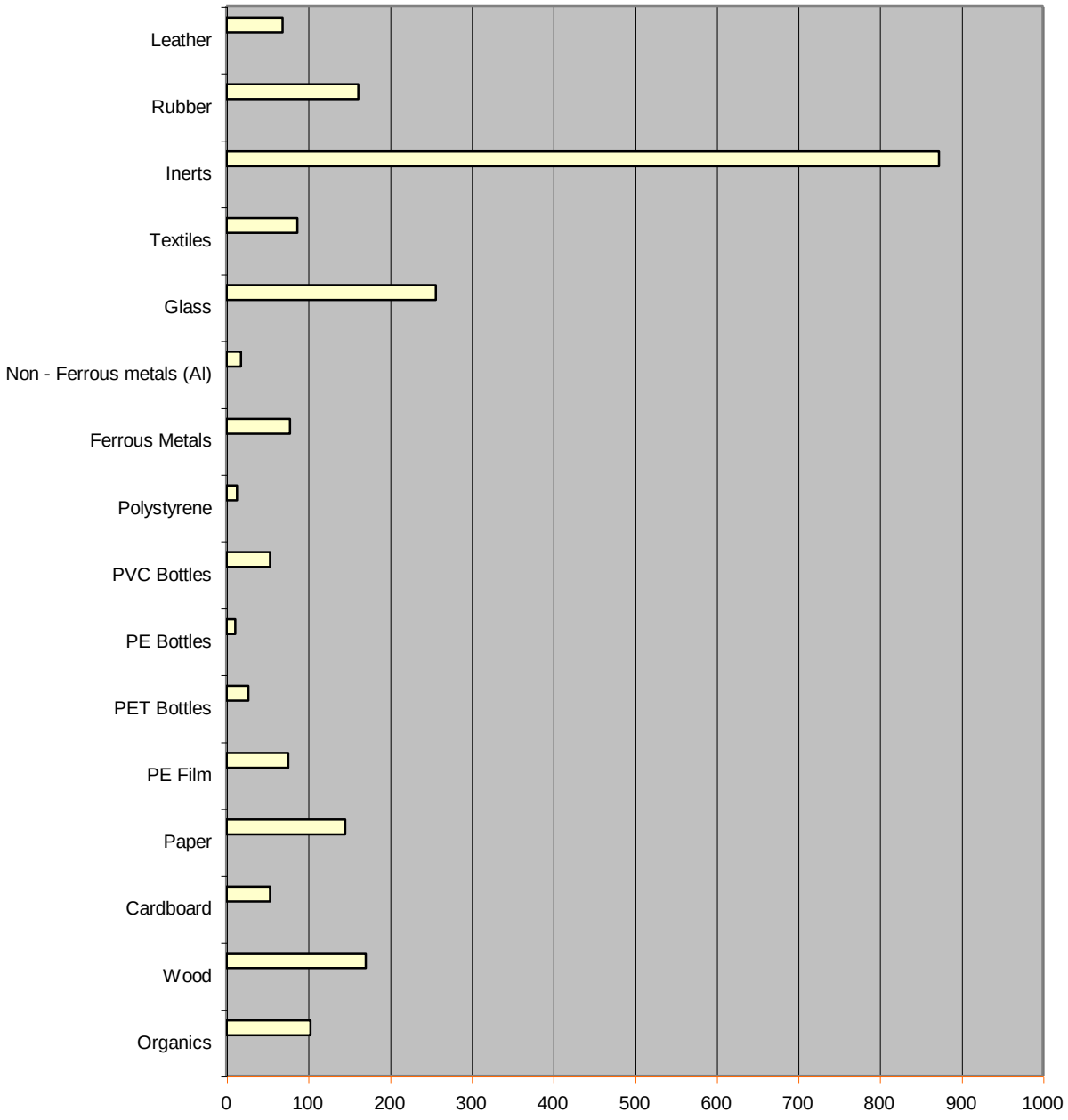
All items intended for further reclaiming or recycling in the plastic processing plant, will be stored either in bins for plastic bottles or bales for plastic film. Storage is required should any one process line be temporarily out of action.

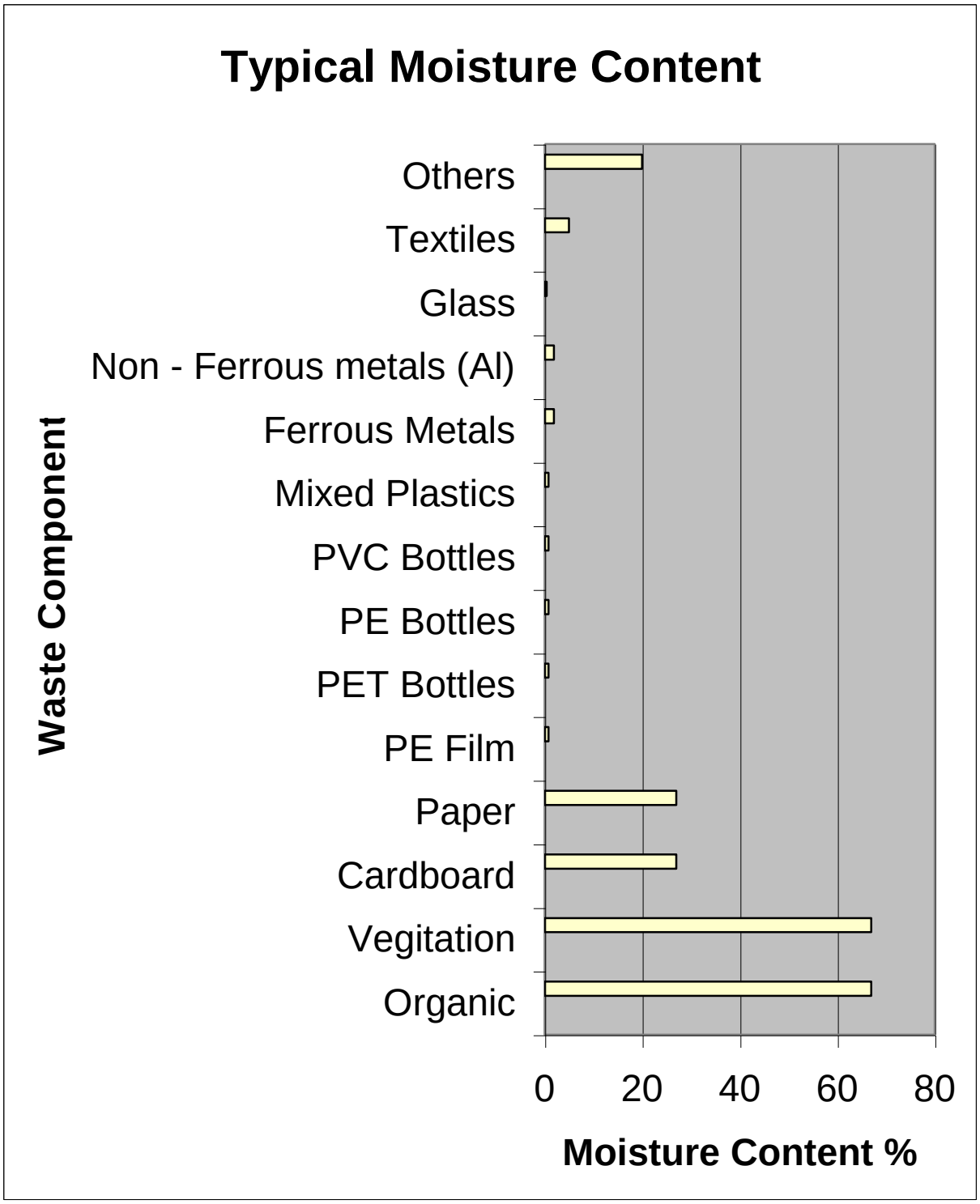
Waste Analysis supplied by the British Embassy November 2001..

Domestic Waste Analysis (MSW)	Fraction percentage (%)
Plastics	9.23
Organic	60.55
Paper	9.29
Glass	8.61
Textile	2.58
Metal	2.46
Other	7.28
Total	100.00%



Typical Mean Density of Waste components




Typical Moisture Content
Waste Component
Others
Textiles
Glass
Non - Ferrous metals (Al)
Ferrous Metals
Mixed Plastics
PVC Bottles
PE Bottles
PET Bottles
PE Film
Paper
Cardboard
Vegitation
Organic
0
20
40
60
80
Moisture Content %

Estimated waste component size distribution.
Based upon waste analysis from Gdansk in Poland – February 2001.

Component	Input % as received	-50mm	+50mm - 300mm	+300mm
Organics	**60.55**	**45**	**15.55**	**0**
Paper	**9.29**	**0**	**9.29**	**0**
PE Film	**3.23**	**0**	**0**	**3.23**
PE Bottles	**2.00**	**0**	**2**	**0**
PET Bottles	**2.00**	**0**	**2**	**0**
PVC Bottles	**2.00**	**0**	**2**	**0**
Metals	**2.46**	**1.23**	**0**	**1.23**
Glass	**8.61**	**2**	**6.61**	**0**
Textiles	**2.58**	**0**	**0.58**	**2**
Other	**7.28**	**2**	**2.28**	**3.0**
Total	**100%**	**50.23%**	**40.31%**	**9.46%**

The above table was included for Hampshire to understand more fully the expected size distribution of the waste fractions.

6. Hampshire gate fee and market prices for recycled products.

Market analysis prices supplied by Scott Wilson Ltd Hampshire.

Recycled product, Service & employment	**Hampshire market price per tonne. ($)**	**Hampshire company buying products.**
Manual staff	200 $per month	
Professional staff	334 $per month	
Waste (MSW) gate fee.	3.5 $per tone	
ElectriCounty costs per KWH	0.0174 $ per Kwh	
Paper	183.94 $ per tonne	Mos Obl Vtor Resursy
Plastcis:		
PE boxes	267.55 $ per tonne	VtorBytStekloService
PE sheets	200.66 $ per tonne	Trigla
PE rejects	150.50 $ per tonne	LegionEcoInvest
PVC sheets	66.88 $ per tonne	VtorBytStekloService
PVC for Windows (granules)	300.00 $ per tonne	VtorBytStekloService
PET granules or shredded rejects	600.00 $ per tonne	-
PET un shredded rejects	400.00 $ per tonne	-
Compost	0.267 $ per tonne	-
Metals:		
Category A1	750.00 $ per tonne	Technocomp
Category A2	1,100.00 $ per tonne	Technocomp
Aluminium	1,140.00 $ per tonne	LegionEcoInvest
Textiles	41.80 $ per tonne	VtorSyrjoPererabotka
Coal	10.00 $ per tonne	-
Exchange rate	29.9 Rub per USD $	

Plastics Recovery Plant

721.02 TPD Input to plant.

Type	Composition % of total Waste without contamination	Plastic Recovered (TPD)
PE Film	3.23	24.03
PE Bottles	2.0	14.88
PET Bottles	2.0	14.88
PVC Bottles	2.0	14.88
Total	9.23	68.67

Two plastic plants can be provided with one washing, grinding and pelletising the PE film. The other will be washing, grinding and pelletising the PE bottles or washing, grinding and milling the PVC bottles or hot washing, grinding and flaking PET bottles. The PE film plant will operate at up to 95%, 24 hours per day, 7 days a week and 347 days per annum. The plant is sized to process 3.23 tonnes per hour of PE film. The plastic bottles plant will also operate for 24 hours per day, 7 days per week, 347 days per annum. The plant is sized to process on a batch basis:

0.62 TPH of PE bottles
0.62 TPH of PET bottles
0.62 TPH of PVC bottles

The average throughput of the plant is 1.86 tonnes per hour of plastic bottles.

Refuse Derived Fuel (RDF)

The RDF plant, which handles combustible items such as paper, cardboard, wood and plastics, identifies the items by shredding them to –50mm.
Also, organic material, which has been dried and stabilised in the composting plant, is also fed to the RDF plant for mixing and storage with the other combustible materials. The plant will operate 24 hours per day, 7 days per week and 347 days per annum. It is anticipated that all the RDF, having a calorific value of about 13.9 MJ/Kg, will be used in the plant gasification process for heat and electricity production.

Compost

All the organic material will go to the composting plant for drying and stabilisation. It is anticipated that a maximum of 10,000 tonnes per annum of compost will be sold locally in Hampshire and hence the majority of the dried organic material will be fed to the compost plant. This design can be altered to suit local requirements.

Typical plant input & outputs table

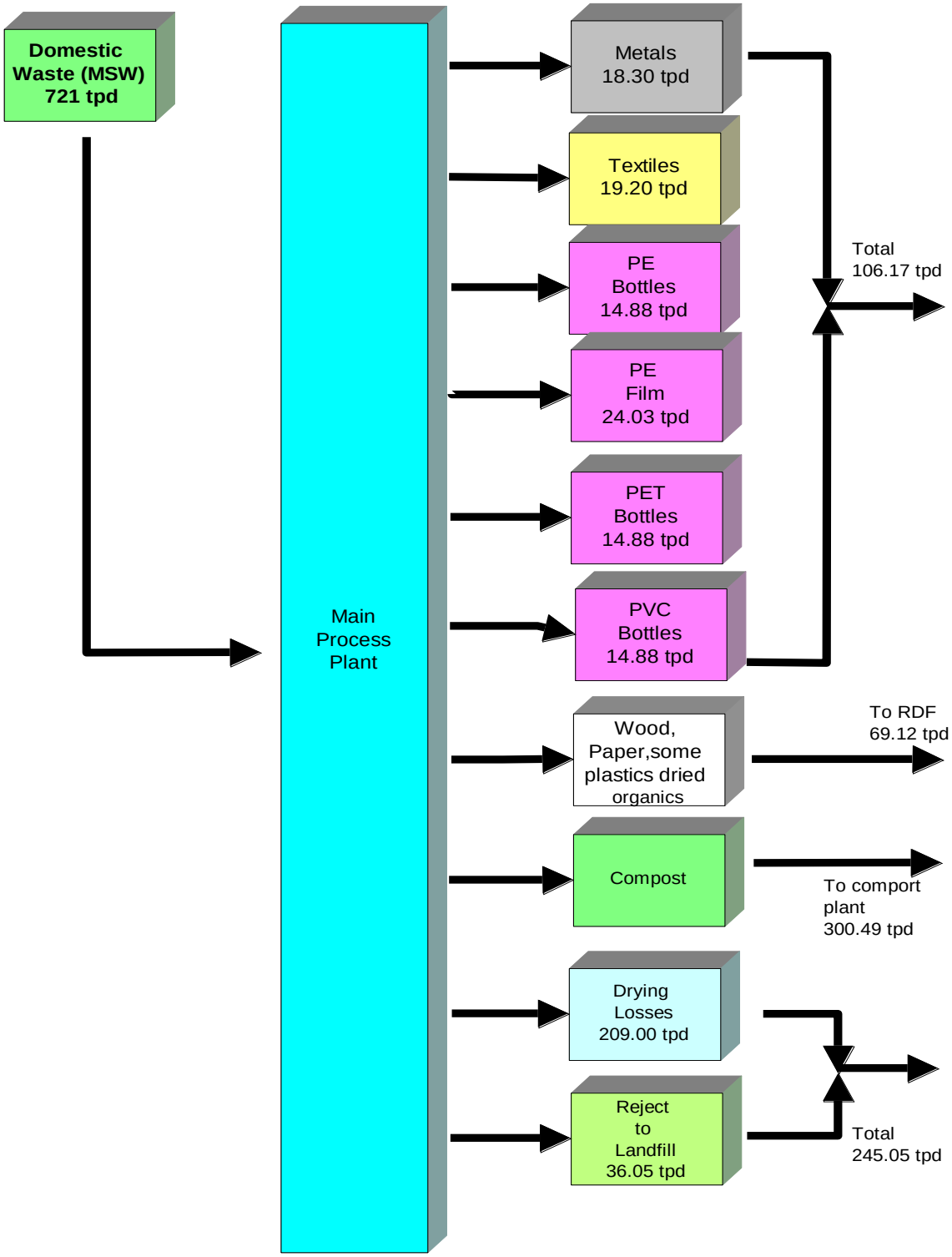
Inputs

Domestic Waste – 721.02 TPD

Outputs

Products	**Throughput TPD**
Metals	18.30
PE Film	24.03
PE Bottles	14.88
PET Bottles	14.88
PVC Bottles	14.88
Textiles	19.20
Feed to RDF plant	69.12
Compost	300.49
Losses in drying organics	209.00
Rejected to Landfill	36.05
Total	721.02 tpd.

Integrated Waste Management Plant – Inputs & Outputs.



7 Hampshire – England: Staffing

General Staff & Administration Support				
Title	**Shift**			**Total**
	1	**2**	**3**	
Administration				
Plant Manager	1			1
Secretary/Receptionist	1			1
Site Cleaner	4			4
Accountant	1			1
Purchaser	1			1
Security Guard	3	3	3	9
Quality Control				
Quality Controller	1	1		2
Production Controller	1	1		2
Sales/Marketing				
Manager	1			1
Sales Engineer	4			4
Research &				
Development				
Plastics Engineer	**1**			**1**

Total **27**

14 professional staff / and 13 manual workers.

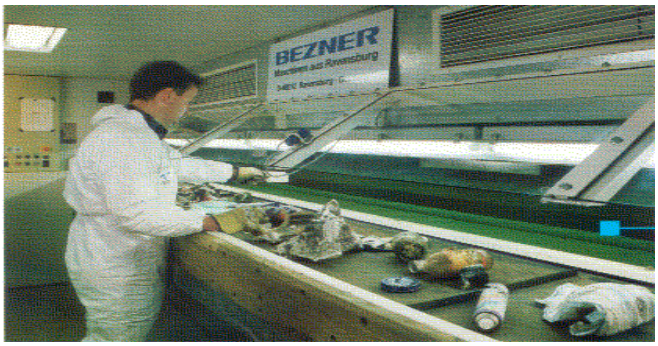
Hampshire - Operational Staff				
Division & Occupation	**Staff / Shift**			**Total**
	1	**2**	**3**	
Chief Production Supervisor	1	1	1	3
Separation Plant				
Production Supervisor	1	1	1	3
Plant Attendant	2	2	2	6
Plant Attendant/Driver	2	2	2	6
Relief Driver/Cleaner	2	2	2	6
Waste Sorter/Inspector	20	20	20	60
Plastic Film Plant				
Production Supervisor	1	1	1	3
Plant Attendant	2	1	1	4
Relief Driver/Cleaner	1	1	1	3
Waste Sorter/Inspector	4	4	4	12
Plastic Bottles Plant				
Production Supervisor	1	1	1	3
Plant Attendant	2	1	1	4
Relief Driver/Cleaner	1	1	1	3
Waste Sorter/Inspector	4	4	4	12
Compost				
Production Supervisor	1	1	1	3
Plant Attendant	2	2	2	6
Driver/Cleaner	1	1	1	3
Weighbridge				
Operator	1	1	1	3
Total				**143**

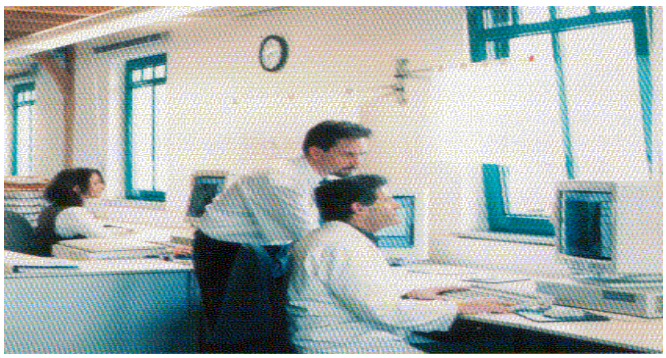
Manual workers – 137 and professional staff – 6

Hampshire – professional staff.						
	Maintenance			**Stores**		**Total**
Title	**Shift**			**Shift**		
	1	**2**	**3**	**1**	**2**	
Engineer Mechanical	1	-	-	-	-	1
Engineer Electrical/Control	1	-	-	-	-	1
Electrical Technician	1	1	1	-	-	3
Mechanical Electrician	1	1	1	-	-	3
Planner	1	-	-	-	-	1
Material Controller	-	-	-	1	-	1
Store-man	-	-	-	1	1	2
Chief Engineer 1		1				
Total						**13**

Manual workers – 2 and professional staff – 11.

The above tables indicate what employment opportunities could be a available with up to a total of 183 jobs available in each recycling plant processing 250,000 tpa.





8 Waste Separation

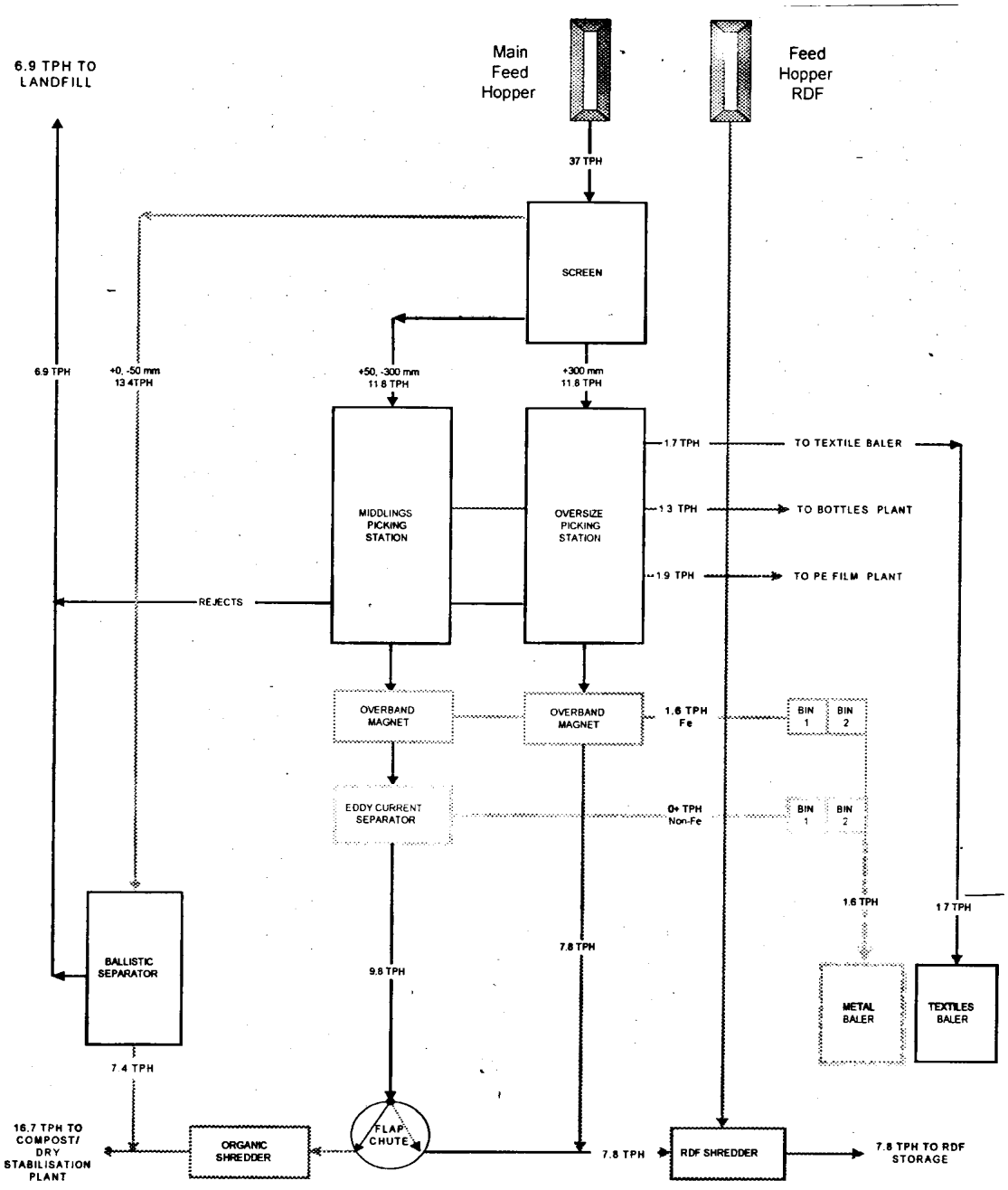
Incoming Hampshire refuse vehicles deposit their loads onto the reception/storage floor where mobile bucket loaders are used to stack and transfer the waste into the feed conveyors into the process plant. This also offers the opportunity to remove any unwanted bulky items prior to treatment in the plant whilst stacking the refuse to maximise the storage area. Waste is loaded into the reception hopper of the plate feeder by the bucket loader. The pre-picking station is provided alongside the plate feeder to remove any objects unsuitable for the process and any items greater than 1000 x1000x500mm. The bucket operator should set aside items unsuitable for the process such as mattresses and carpets. The pre-picking station will take those that are missed off. Situated at the head of this conveyor is a bag liberator that opens the sacks of waste contained in the waste feed to enable down-stream screening equipment to perform effectively.

The rotating screen is a critical item in the performance of the separation plant. The screen has internal spirals at the feed end to propel the waste to the mesh sections where angled lifters elevate the tumbled materials providing an efficient screening action. The screen is slightly angled to assist flow and this factor, together with peripheral speed gives the required throughput characteristics, Different fractions are separated by the screen, firstly the –50mm, in the second +50mm to 300mm, and thirdly the oversize (+300mm) discharges from the end of the screen.

Undersize (-50mm) which contains the majority of organic elements, removed in the first section of the screen, gravitates via a hopper where it is conveyed away by a belt conveyor from which ferrous metals are removed by an overhead magnetic separator and non-ferrous metals are removed by an eddy current separator. The remaining materials pass through a de-stoner to remove glass, stones, batteries and other dense items before being belt conveyed to the area of the plant producing compost or RDF. The middle fraction size range (+50mmto –300mm) of the waste, which is rich in metals and plastic bottles, is collected from the screen and after passing the picking station is conveyed under a magnetic separator to remove ferrous metals and then to a vibrating feeder which ensures the feed material is evenly distributed prior to discharging onto an eddy current separator that removes non-ferrous metals (predominantly aluminium). The non-ferrous metals are collected on a belt conveyor, which deposits the metals in the non-ferrous store. The un-picked items remaining on the picking belt are conveyed to the pulveriser and then to the compost / RDF plant. The manual picking stations are designed to be as flexible as possible so that it is possible to pick materials in a different order. Oversize segment (+300mm), which contains the larger particles of card, paper and plastic film, together with textiles, also passes over a picking conveyor. The residue of this portion of the waste is then conveyed under a magnetic separator to remove any remaining ferrous metals and then to the pulveriser plant where it is reduced to –50mm. It is then delivered to conveyor to the compost / RDF plant. It is possible to separate up to 95% of waste material that can be recovered; the remaining material is usually deposited in landfill.

Waste separation flow chart

Chart based upon an upper limit of 250,000 tpa .MSW and is an example from the Gdansk plant proposal in Poland.



9 Recycling Processes

Plastics

Plastic constitutes a significant part of both domestic and commercial waste coming in the form of packaging, containers and consumer goods. The volume of plastic tends to increase with "quality of life".

Plastic film can be separated, washed and reprocessed into pellets, which can be used in the manufacture of a wide range of commercial and industrial products. These pellets have a purity of approximately 99% of the virgin material.

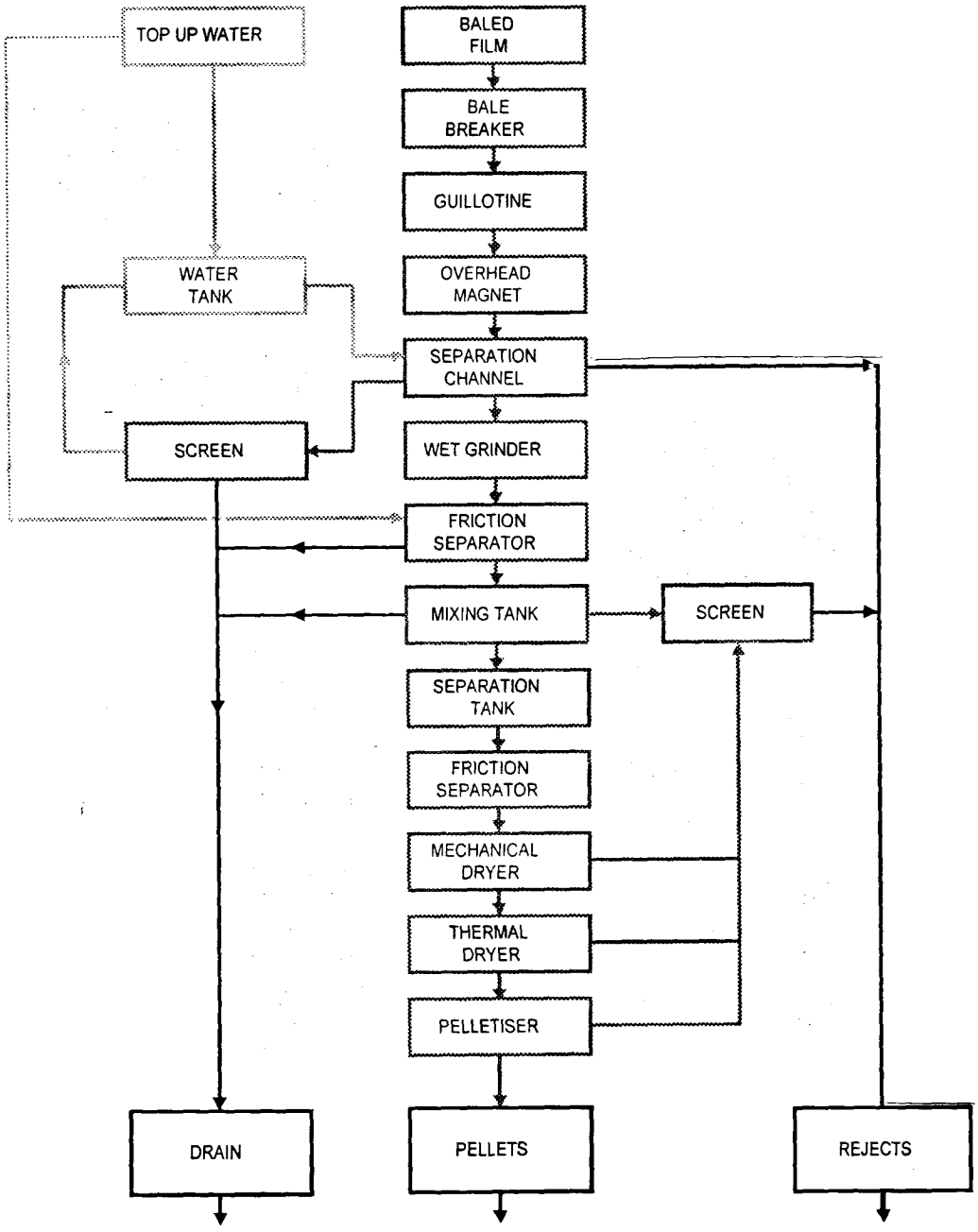
By separating, granulating and washing bottles and containers it is possible to recover the original polymers. Polymers such as PE, PVC and PET can be individually separated and reclaimed in this way. As with recycled film, the purity of the flakes is approximately 99% of the virgin material.

Plastics generally fall into two main categories called Thermoplastics and Thermosets. The accompanying chart showing Thermoplastics summarises the main plastic types with their application and typical uses after recycling.

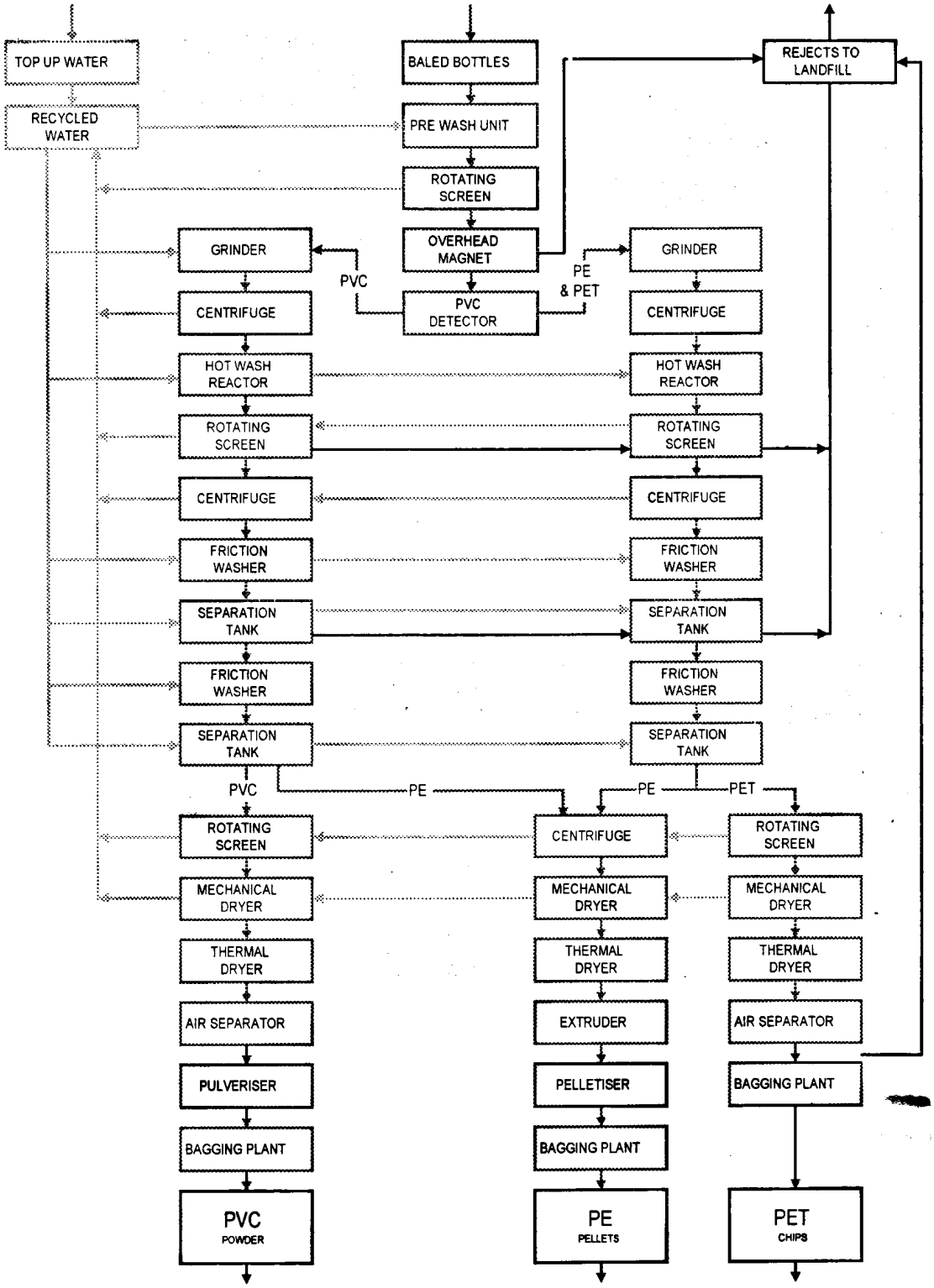
Thermoplastics change state and go softer when heated, and then able to be extended or moulded, after which they become solid as they cool. This process can be repeated many times before significant deterioration occurs in the material. These characteristics make Thermoplastics ideally suited for recycling.

Thermosets become hard when processed at the required higher temperatures, and cannot be re-melted. Recycling of these materials generally requires chemical treatment or fine grinding for use as a filler.

Typical PE Film Flow Chart



Typical PE, PET & PVC Bottle Flow Chart



Thermoplastics – primary applications and typical use after recycling.

HDPE

High Density Polyethylene

Containers, toys, house wares, industrial wipes, film, gas & waste pipes.

↓

Bags, bottles, pipes & Wood substitutes.

LDPE

Low Density Polyethylene

Cling film, bags, toys, coatings, containers, and pipes.

↓

Bags, bottles, pipes, waterproof membranes, wood substitutes.

PET

Polyethylene Terapthalate

Bottles, films, food packaging, fibre & tape.

↓

Textiles, rope string, carpets, fibre & tape.

PP
Polypropylene

Film, battery cases, microwave – proof containers, crates, automotive parts & electrical components.

↓

Crates, wood substitutes, automotive components, car battery cases, chairs * textiles.

PS
Polystyrene

Blister bricks, electrical appliances, thermal insulation, tape cassettes, cups & plates.

↓

Thermal insulation, office accessories.

PVC
Polyvinyl Chloride

Window frames, pipes, flooring, wallpaper, bottles, cling film, toys, guttering, cable insulation, credit cards, medical products & bottles.

↓

Pipes, conduits, floor tiles, fencing, containers, footwear & garden furniture.

Epoxy Resins

Adhesives, automotive components, electrical / electronic parts, sports equipment & boats.

↓

Most recycling of this thermoset is at laboratory or pilot plant stage.

Phenolics

Adhesives, appliances, automotive parts, electrical components

↓

Most recycling of this Thermoset is at laboratory or pilot plant stage.

PU

Polyurethane coatings, finishes, cushions, mattresses, vehicle seats**.**

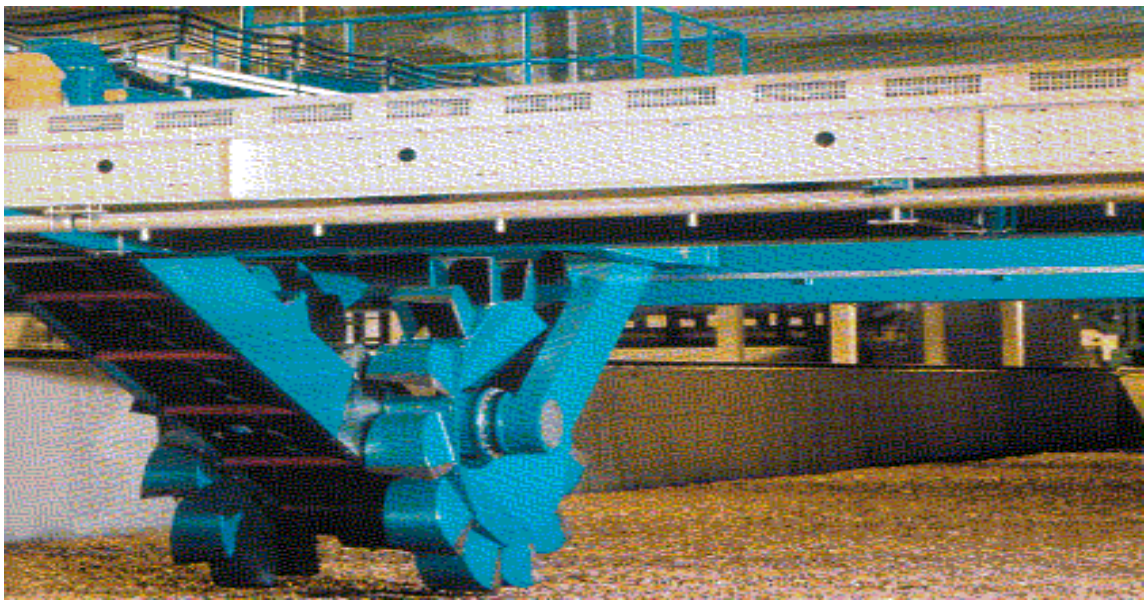
↓

Carpet underlay
&
Shoe soles.

Compost / Dry Stabilisation of Organic materials

The predominantly organic element segregated by the Waste Separation Plant is transformed into compost by VKW – Vogel Muller GmbH KUM process, an automatic stack composting system, or the company HLC can also produce it. The rail-based system allows the use of rotting plates in lightweight construction, which makes it easier to aerate the rotting organic material. With each transposition cycle also precise irrigation is possible. The design of the composting system KUM is done on an individual client requirements. The KUM system can be designed for a waste compost tonnage of 300,000 tonnes per annum output, or smaller amounts of waste, as required. The composting of the organic fraction takes place in a six-week intensive rotting process followed by six weeks of final post rotting in closed halls.

The composting process is completed in closed halls. The exhaust air is detected and cleaned by biological filters, the problem of environmental smells was solved and the process of composting has reached a state of easy control. KUM is a sophisticated automatic rotting system for partly closed or completely self-contained composting plants for the organic fraction of the MSW. It is based upon the automatic transposition of the stack combined with simultaneous homogenising, loosening, aerating and post-irrigation while transporting the stack within the rooting halls. The systems have an additional advantage of being low in cost, energy use and personnel. The final product is always a high quality compost for sale locally for agricultural use of domestic use in the home gardens. The compost can also be used in forestry, horticulture, landscaping, construction and sports grounds.



Refuse Derived Fuel (RDF)

Paper & Card could be recycled for retail or RDF. The biological reaction that takes place during the composting process is exothermic and the reaction as well as the heat generated removes moisture from the organic material so that it can be used as a fuel having a calorific value of approximately 10 MJ/Kg – 13MJ/Kg. During the winter months, hot air can be supplied to the organic material to assist in promoting the biological reaction. This dry stabilised organic material can then be mixed with the RDF material separated from the rest of the waste in the separation process. Ideally all the organic material should be composted and sold. It is estimated that up to 10,000 tonnes per annum of compost may be sold locally leaving the bulk of the organic material to be dried and sold as RDF fuel to a power station or in the lowest emission Gasification plant.

RDF

Glass / Minerals

Glass, if easily seen, is picked at the pre-picking platform in the waste reception area. This material can be re-used if a local market exists otherwise it will be rejected and landfilled. The glass which is not picked will be broken up in the separation drum and the majority will leave the screen on the –50mm conveyor with the mainly organic material. This material passes over a ballistic separator, which removes, as reject material, hard dense particles such as batteries, glass and minerals. Glass and minerals that are not less than 50mm will be hand picked at the picking station and deposited onto the rejects collection conveyor for removal to the landfill. A small amount of the glass and minerals will end up in the compost plant and in the material for RDF. The compost material undergoes further refining to remove any remaining glass as described in the section on compost. The small amounts of minerals in the RDF will remain as these are not harmful to the Gasification plant and will be removed after burning along with the ash, which can be vitrified to produce building blocks.

Textiles

Textiles in Hampshire can either be hand picked at the picking station and baled for sale or they can be shredded along with the other combustible material such as paper and wood to be sold as RDF. After separation, cotton and man-made fibres are normally utilised in the manufacture of under felts, carpet backing, upholstery and similar applications. Woollen garments and products are un-picked and often reused in the manufacture of blankets, felts and floor coverings. Higher-grade materials can be separated and re-used as clothing. In many developed countries, reusable cloths form as much as 27% of the textile waste stream. The remaining material is used to manufacture a range of industrial wipers. Zips, buttons, hooks etc. are mechanically removed and the fabric is shredded and rewoven into industrial wipes. These can be as many as 20 grades, some of which sell at high prices. For example, simple cotton wipers are used to clean bodywork of machines and cars. Lint-free cotton wipes are used to clear oil and grease soiled machines and surfaces, synthetic crimplene produces lightly abrasive wipers whilst net from old curtains are used as wipers by French Polishers. These net curtains wipers can sell at high prices. Old carpets can be "down cycled" into carpet backing or carpet underlay. Alternatively old carpet can be thoroughly cleansed, shredded, dyed and used to remake carpets.

Ferrous and Non -Ferrous Metals

Overband magnetic separators of the electromagnetic type are positioned at various strategic points throughout the plant for the recovery of ferrous metal objects.

The units are of various sizes and duties commensurate with their location in the process. The separators are generally of the cross belt type suspended above the belt on adjusters that are variable to obtain the most efficient removal characteristics. After ferrous metal removal, the remaining material is discharged from the picking conveyor onto a vibrating feeder that evens out the feed before passing onto the non-ferrous metal separator.

The separator consists of a rare earth permanent magnet rotating at high speed inside a slowly rotating shell, generating strong eddy currents, around which a belt rotates. Both the angle and speed of the belt can be varied to suit the final installation. The non-ferrous items fed into the eddy current separator, together with other materials, are thrown off at a higher trajectory due to the eddy current forces, thus by the use of splitter plates in the two way chute, non-ferrous items are segregated out of the input materials. Both the separated ferrous and non-ferrous metals are conveyed into their respective storage bins.
As soon as there is sufficient metal of either type for a complete bale it is conveyed to the common baler for baling and sale to metal industries that are usually very ready to meltdown the separated scrap metals for re-fabrication.

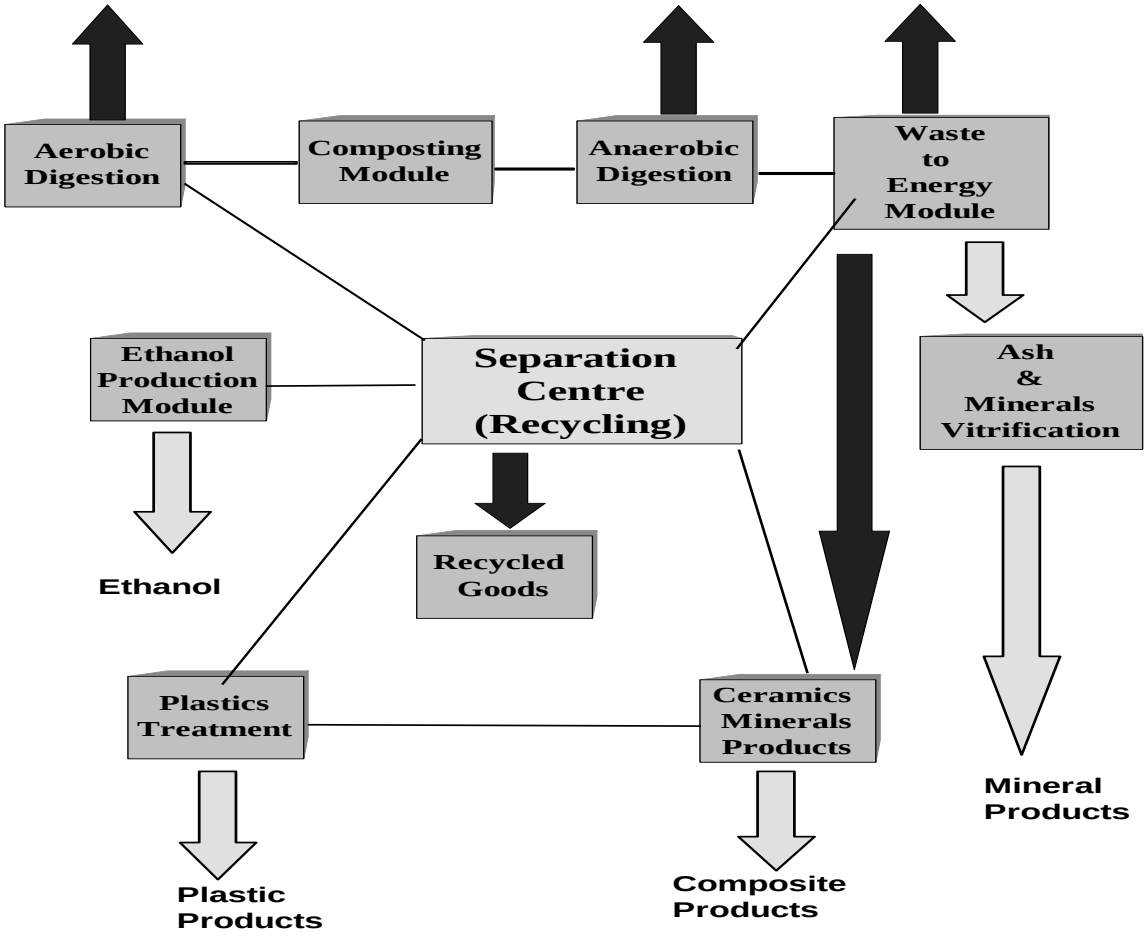
10 Market Potential for Recycled Products

Information supplied by the IMGroup consultants obtained from the British Embassy in Hampshire England relating to component parts of the 250,000 tonnes per annum municipal Solid waste (MSW).

1.	Paper / card & cellulose	9.29%	69.12 tpd	23,225 tpa
2.	Plastics	9.23%	68.67 "	23,075 tpa
3.	Organic Material	60.55%	450.49 "	151,375 tpa
4.	Glass	8.61%	64.06 "	21,525 tpa
5.	Textiles	2.58%	19.20 "	6,450 tpa
6.	Metals	2.46%	18.30 "	6,150 tpa
7.	Other	7.28%	54.16 "	18,200 tpa

tpd = tonnes per day / tpa = tonnes per annum.

Modular Recycling



a) Paper / Card & Cellulose

Recycled as RDF Fuel with a potential value of $10 per tonne.

When equated to the resale market for recycled waste paper, the best potential for the paper stream from the plant is in the production of Refuse Derived Fuel (RDF). Paper recycle manufacturers offer a potential market dependent upon price and market availability.

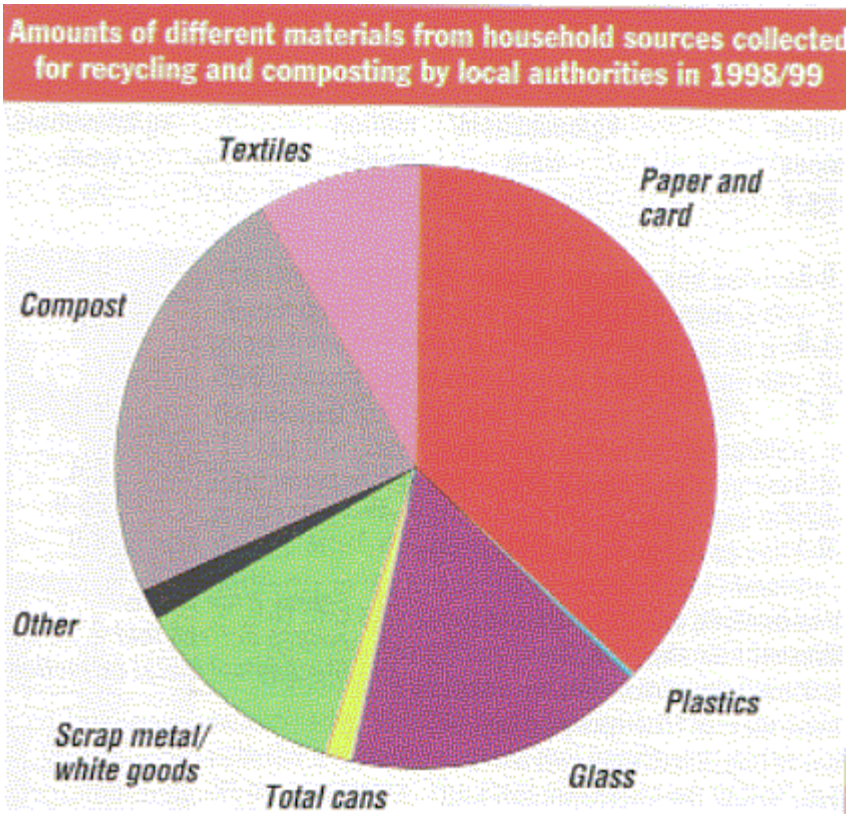
b) Organic Material

Recycled as RDF with a potential of $0.267 tonne and as Compost with a potential of $40 per tonne in the UK. Due to its low nutrient value, compost can only be sold locally. The market has not been established and for the purposes of the feasibility study it has been assumed that the maximum of 10,000 tonnes per year can be sold locally. Some of the organic material can be bagged and the rest sold in bulk. Until a full market research is carried out it can be assumed that a price of $10 per tonne for RDF & for paper $183.94 is realistic. The principal application of this product is likely to be in agriculture and horticulture. It can be used as a soil improver, growing media, and land reclamation and landfill coverage. The success in the market place will depend upon price, quality, continuity of supply and acceptance as a safe and clean product. Any remaining organic material can be used in the RDF plant.

c) Glass

Recycled glass (Cullet) with a potential value in of $70 per tonne.
Having looked at the European market for this product, it would appear that the best price for colour sorted and unclean glass in basic colours of green, amber and clear is $40 per tonne. At this price level it would be difficult to justify the work involved to prepare the glass for marketing in the England or the UK. However, the market for glass is potentially very large with over 50 possible uses identified in a recent American report. This report suggests the use of glass cullet in the manufacture of building blocks, bricks, foam bricks, cement, ceramic tiles, clay pipes, decorative products, and road surfacing, as filler for road foundations. The price of glass cullet as an additive for these building materials has not been established although this information will be available in the future.

Example for Hampshire of recycling in the UK



<u>During the period 1998 to 1999 the following amounts were recycled:</u>

Paper / card	**-**	**840,000**	**tonnes**
Glass	**-**	**370,000**	**tonnes**
Compost	**-**	**530,000**	**tonnes**
Metal cans	**-**	**32,000**	**tonnes**
Mixed waste (Including oils, Aluminium, foil, Batteries, & wood**)**	**-**	**200,000**	**tonnes**

d) Textiles

Recycled textiles have a potential value of £90 per tonne in the UK and in Hampshire $41.8.

A healthy return can be expected from recycled textiles. The market in the UK at this time is obtaining prices between £80 and £100 per tonne for clean, sorted textiles in Eastern Europe this figure is expected to be $158. Discussions have started with companies producing industrial wipes with the possibility of establishing a small manufacturing plant on site as a joint venture project with the Consortium.

The value of recycled textiles depends upon the quality of the feedstock, in terms of colour fibre type and fabric purity. Preference is given to white, natural, unmixed fibres as opposed to the coloured synthetic or mixed fibres, which are more difficult and costly to process. One of the largest potential markets for textile use is for the manufacture of cleaning cloths. Uses, apart from the manufacture of industrial wipes, are flocked filling material for upholstery or sound proofing, yarn for the manufacture of new textiles and carpet underlay or for sale of salvaged garments.

e) Plastics

Recycled plastics have a potential average value of $66.88 and $600 in Hampshire and £80 - £250 per tonne in the UK.

The potential markets for this recycled material are very good, taking into account the different manufacturing processes that can be adopted. The selling price for the various recycled plastics varies between £80 and £250 per tonne in the UK and is clearly determined by the degree of processing that is required to produce a high quality marketable product. There is opportunity to set up manufacturing plants on site and for joint venture partnerships to be formed with manufacturers to increase the value of the recycled materials as products for sale.

Following discussions with England and UK companies who purchase recycled plastic, it is clear that there is quite a divergence in the price that can be achieved. There was also a reluctance to disclose the true value of recycled plastic. Indications are that mixed plastic will sell for between $40 and $79per tonne. Prices for sorted High Density Polyethylene (HDPE) natural range from between $300 and $400 per tonne. Sorted HDPE jazz (multi coloured) prices range from $160 to $300 per tonne. These figures clearly indicate that the increased value and revenue that will be generated by processing the sorted material will contribute substantially to the profitability of the plant.

In Western Europe the total plastics recycled in 1994 was calculated at 3,664,000 tonnes.

After sorting and cleaning the single polymer material is blended with proprietary additives and re-compounded into pellets for extrusion into new products. The pellets can be remoulded into new commodities or sold onto another plastics manufacturer as secondary raw material, which is mixed with virgin material for the production of laminates or other production processes. The thermoplastics are reground and used as fillers.

With the increased European Legislation the market for recycled plastic will be over subscribed in the near future and outlets in other districts should be quickly identified. A small manufacturing plant is recommended to be built on site for the production of plastic commodities such as pipes, pots, storage containers and building materials. Plastics do have a high calorific value and are often used in RDF, however, if the plastics are cleaned, flaked and pelletised, high prices can be achieved and it is more cost effective for the plastic to be recycled.

Municipal waste management in the UK in 1997/98 and 1998/99.

Method of Waste management	1997 to 1998	1997 to 1998	1998 to 1999	1998 to 1999
	Million tonnes	KG/household/week	Million tonnes	KG/household/week
Landfill	23.1	20.7	23.1	20.3
Incineration without EFW	0.1	0.1	0.0	0.0
Incineration with EFW RDF	1.6	1.4	2.1	1.9
Manufacture recycled	0.2	0.1	0.1	0.1
Composted	2.1	1.9	2.7	2.4
Total	27.2	24.3	28.0	25.0

Source: Municipal Solid Waste Management survey – 1998 – 1999, published by UK Government DETR.

f) Metals

Recycled ferrous metals have a potential value of $800 per tonne in Eastern Europe – Hampshire and non-ferrous metals (Aluminium) an average potential of $1,140 per tonne.

It is estimated that 1% of the waste will be ferrous with about 1.46% as non-ferrous, this will vary slightly according to the individual clients waste stream.

Although the volumes of non-ferrous metals will be limited, these materials will be high value metals such as aluminium, copper, brass, etc. Market prices are in a continuous state of flux but will always achieve substantially higher values than ferrous metals. Baled aluminium cans, as an example will have a resale value of about £800 per tonne - UK.

G) Wood

Recycled as RDF with a potential value of $10 per tonne.

Wood that will be segregated in the separation process will have no resale value but will provide good feedstock material for conversion to RDF. Local information in Hampshire should confirm that the value of the RDF in the local market could be $40 per tonne if possible.

11 Power Generation & Distribution

General

The recycle plant will require electrical power, which will primarily be available from the national grid system. A small standby emergency power generator or uninterrupted power supply (UPS) will be provided to maintain power to critical items in the plant. If required a Combined Heat and Power systems can be installed to provide all the heat and power for the plant and resale back to the national grid the surplus electricity. This can be achieved via the GEM Gasification energy from waste plant with the lowest emissions in the UK and Europe. Electricity costs for Industrial use in Hampshire is 0.52 (Rub) or $0.0179 per KWH.

Facilities & Utilities

Maintenance

All vehicles needed to operate the site will be provided and with the exception of major work, will be maintained on site. Maintenance on waste processing equipment will also be handled from workshops on site.

Staff Accommodation

Management areas will be designed to allow a degree of privacy but will also be located to allow ease of supervision for the rest of the plant. Provision will be made for visitors in the form of a waiting and exhibition areas and the use of the main conference room. Good public relations will be important and visitors will be welcomed and informed on the objectives and operation of the plant. Education and training of all site personnel will be a priority and areas will be allocated for this purpose.

Control Systems

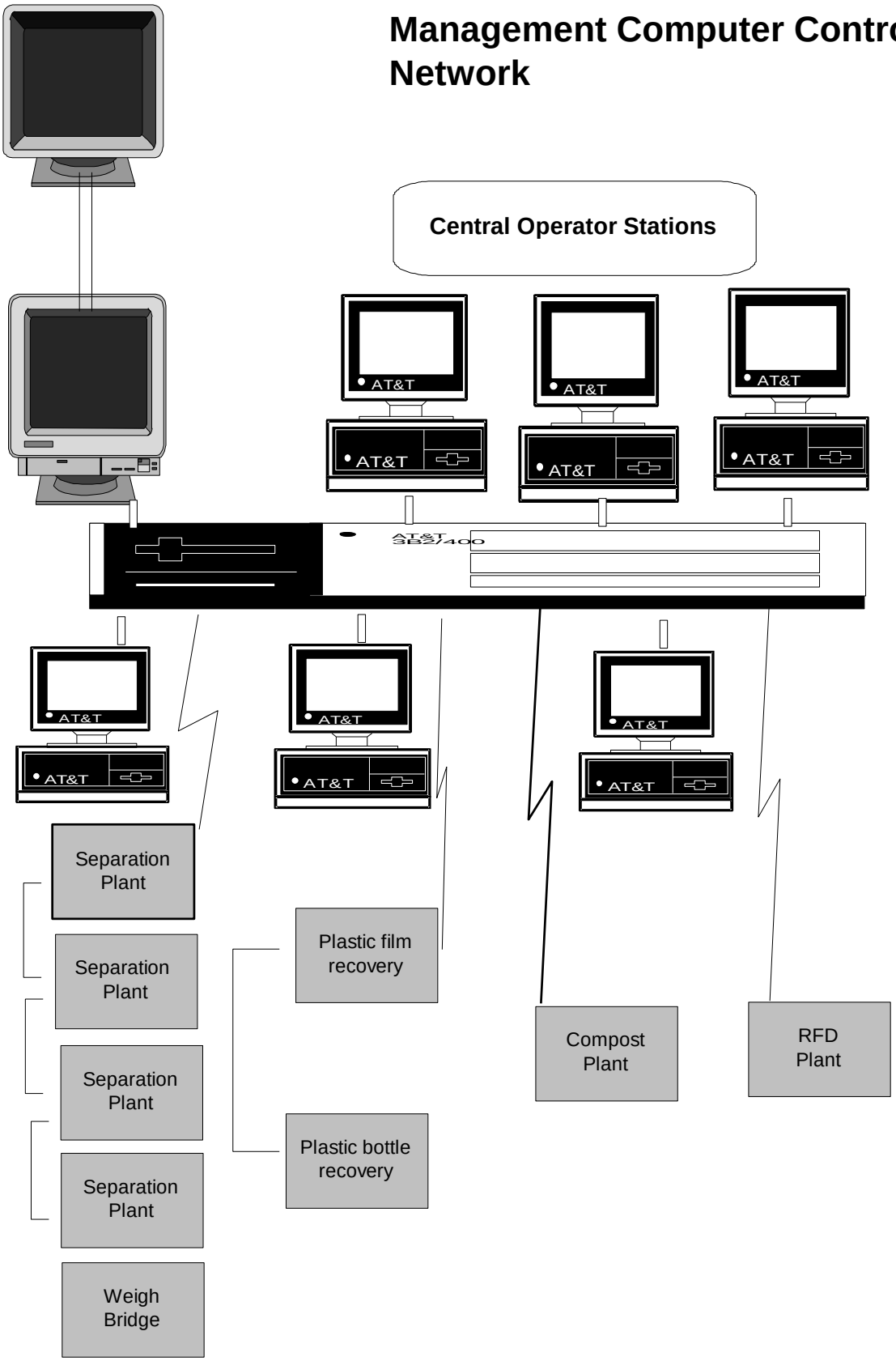
Plant Control

The entire plant is to be controlled by a distribution control centre (DCS). Where individual process plants have their own control systems, provided by the package supplier as integral to their system, these control systems will interface to the DCS.

DCS

Modem DCS systems are highly versatile monitoring and control systems, utilising the latest hardware technology. The operator stations will use industrial PC-based workstation.

Management Computer Control Network



12 Building Proposals

Intent

One of the major intentions of the project is to present a development which will be an asset to the environment and demonstrate Sustainable Development criteria in line with the Agenda 21 programme.

Site Services & Access

There will be a regular flow of vehicles to and from the recycle plant and it will be important to ensure that the approach roads are of sufficient standard to take a significant number of vehicles per day arriving and leaving the site. The site will be landscaped to enhance the appearance of the development. Water drained from any of the industrial washing processes will be treated and re-circulated.

Building Design

The form and organisation of the buildings is dictated by the sequence of the different processes. Apart from the functional requirements, the Architects aim in planning the buildings on the site is to define the process stages with building enclosures clearly related to internal functions, from intake of the raw material to discharge of separated recycled products.

Two basic criteria are followed in the development of the design. It is recognised that the buildings should be cost effective and that they must also be visually appropriate. The process determines the size and design of the external envelopes of the buildings that they contain. Buildings containing only process equipment are provided with basic enclosures to give sufficient weather protection, whereas spaces housing workers will be constructed to meet the more exacting requirements for suitable internal working environments. Consideration will be given to cheap cladding systems, such as fabric for building enclosing compost, RDF and maturation areas.

Sub-Structure

A detailed geo-technical survey of the proposed site in Hampshire will be carried out to ascertain the optimum foundation requirements. The roads and the floor slabs within the buildings will be designed to carry the maximum anticipated loading for standard commercial road vehicles. Floor slabs will be designed for the equipment loads that they carry. Individual foundations will be provided as required for large heavy items of plant. Roads constructed on normal ground will be formed using tarmacadam on a crushed aggregate base.

Superstructure

The buildings will generally be steel framed and prefabricated for erection on prepared foundations. Portal frames will be used where possible. Main steel work will include all bracing, support rails and purlins for roof and cladding panels. Small independent buildings may be located around the site to provide staff facilities or accommodation for services and maintenance.

Standards

Buildings will be designed, constructed, maintained and operated to comply with applicable standards and meet the requirements of the Local Authorities. A good level of aesthetic design will apply.

13 Project Management

Management Structure

The Consortium recommends that the Project Management Company Scott Wilson Ltd be appointed as the prime point of contact between the designers and the client organisation. The project manager manages, organises and directs the multi-discipline design team, ensuring the adherence of agreed baseline costs, times and quality standards. He has the responsibility for delivering the entire project, from design through to hand over, in accordance with the contract.

Following the placement of an order, the scope of work is finalised with the representatives of the shareholders and the Local Authority. Goals and objectives for the project are jointly established, and all available background data is acquired.

Project management and design teams are established and standard procedures for communication between the client organisation and the design team are implemented. Formal reporting and approval procedures are agreed. Relevant administrative standards are adopted and all standards and procedures are included in the Project Manual.

Project Control

Firm project control will be implemented on the project. Planning, monitoring and forecasting systems are maintained throughout the duration of the work.

The Project Manager establishes control mechanisms, which are also implemented individually on each of the main stages.

- Scheme Design
- Tender and Evaluation
- Detailed Design and Fabrication
- Construction
- Commissioning and Hand-Over

The Project Manager prepares a project estimate. This forms the baseline budget against which all costs are monitored. Both computerised and manual cost control techniques are used. A continuous analysis of progress is maintained, schedule controls, forecasting, planning and monitoring systems are used to ensure that the project is completed on cost, time and to agreed quality standards. Regular progress reports are prepared and distributed to respective parties. Individual design disciplines are co-ordinated in the design team and the Project Manager ensures that the detailed work programmes are adhered to. Close co-ordination of all design elements is achieved by active liaison between the lead designers in each discipline.

Project Design

Project design is divided into four main areas. The senior designer within each discipline is responsible for his team's design.

The main design discipline areas are:

- Process and Equipment Design
- Building Architecture
- Structural and Civil Design
- Building Services and Utilities

14 Environmental Impacts & Site Conditions

Environmental Principles

The following points are relevant to the development and wherever possible will be taken into account in the design of the plant:

- The effect of the traffic related impact that the development would generate.
- The need to safeguard living conditions in the locality
- The likely effects of the proposed development on air and water quality, including the possible amenity and wider environmental implications of any emissions, changes in quality and quantity of
- any emissions, changes in quality and quantity of watercourses and ground water, drainage and flooding impacts.
- The effect on the landscape and visual impact of the proposed development and the need for additional on site and off site landscaping, including planting and screening, planting in advance of the development and the need to safeguard the existing local landscape character.
- The need to safeguard the character and amenities of individual settlements. The opportunity should be taken to secure a general environmental improvement and other benefits both on site and in the surrounding area for environmental enhancement.

15. International Mercantile Group Ltd. Financial Proposals

Following recent discussions in Hampshire – England with executive members Hampshire County Council and associated Enterprise units regarding the development of the enclosed project to install a new Integrated Waste Management Plant in the County or close by to the County boundary. We are pleased to present the following offer from International Mercantile Group Ltd in which we are, in principle, prepared to fund the construction of the waste management plant for Hampshire. This will be subject to approval of our underwriters and the payment of any fees and charges. It is possible to offer 90% funding and in some cases up to 100% funding, dependant upon a case by case basis and exact client requirements.

Amount.	USD 30 Million as per the final contract price.
Down Payment.	USD 3.0 Million, being 10% of the capital sum to be rebated on receipt of the final debt repayment. Up to 100% can be provided, in some cases, such as for Hampshire, dependant upon exact requirements.
Currency.	USD - $
Borrower	Hampshire County Council. England
Lender	Global Project Portfolio No. 1 Ltd.
Portfolio Lawyers	Simons & Simons 21 Wilson Street London EC2M 2TQ
Portfolio Auditors	Deloitte + Touche
Purpose	Construction of a 250,000 tonne per annum Integrated Waste Management Plant
Lead Contractor	John Laing International Ltd. or HLC.
Sub-contractors	HLC Henley Burrowes Ltd, Scott Wilson Ltd, O.Kay Engineering Services, VKW – Vogel & Muller GmbH, Graveson Energy Management Ltd. EcoSecurities Ltd.