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Agricultural Waste Management Plan for the Maltese Islands – Final Report

1. Introduction

Agriculture, in particular animal husbandry, creates large volumes of solid or liquid residues and waste products. Unfortunately, some of these wastes are not dealt with properly and are causing considerable harm to the environment. A significant part of the residues originating from the agricultural sector is animal manure. It is extremely important that this waste is managed properly, especially since Malta and Gozo have been designated Nitrate Vulnerable Zones in terms of the EC Nitrate Directive. This designation presents a severe limitation on the quantity and manner by which untreated biological residues and manure may be disposed of on agricultural land, hence entailing the need to improve the handling of manure on farms and its subsequent application/disposal on agricultural land.

As the administrative body responsible for the implementation of the Environment Protection Act and for the Solid Waste Management Strategy for the Maltese Islands, the ex-Ministry for Rural Affairs and the Environment (MRAE) issued a call for tenders for the preparation an Agricultural Waste Management Plan for the Maltese Islands (the Plan) in December 2003.

The tender was awarded in October 2004 to a consultancy team (the Team) led by Sustech Consulting. The Team included local and international experts.

The Team produced a Draft Final Report that was submitted to the Ministry in May 2005. The Team made a presentation to the relevant Minister and to officials from MRAE and MEPA the following month. The Draft Final Report was subsequently circulated by the Ministry to a number of public agencies and stakeholders including the Malta Environment and Planning Authority (MEPA), the Malta Resources Authority (MRA) and the Water Services Corporation (WSC) for feedback.

MRAE received comments in writing from the WSC in November 2005. It is not known whether MEPA and MRA submitted any comments on the Draft Agricultural Waste Management Plan.

In May 2008, Sustech Consulting was asked to produce a Final version of the Agricultural Waste Management Plan that takes into account new developments that affect the Plan, such as:

- WSC’s prohibition of the discharge of pig slurry and farmyard wastewaters into the sewerage system once the new sewage treatment plants come on line,
- the construction of a number of on-farm waste management facilities during the last three years (particularly on cattle farms),
- changes in animal populations,
- the construction of solid and liquid waste treatment facilities by Wasteserv and WSC respectively,
- Malta’s recent commitment to generate 10% of its electricity from renewable sources by 2020,
- the spiraling cost of fossil fuels, thus making waste-to-energy processes more competitive.

This report has been prepared by Sustech Consulting on the basis of information provided by the Ministry for Resources and Rural Affairs (MRRA) and though consultations held with MRRA, Wasteserv and WSC during May-June 2008. This report was compiled in good faith and based on documentation made available to the consultants at the time of presenting this report. Every effort was made to ensure that the information collected was factual and accurate.
2. The Draft Agricultural Waste Management Plan (2005) – Key Results and Conclusions

This Final Report builds on the findings and the recommendations of the 2005 Draft Agricultural Waste Management Plan. It is therefore useful to summarise the work carried out in the formulation of the Draft Plan (2005) and to explain the results and recommendations arising thereof.

The work in the preparation of the Draft Plan consisted of three phases - The Preliminary Phase, Phase I and Phase II.

The Preliminary Phase was conducted in November 2004 and set the framework for the work that was to be carried out in the following months. An important milestone in the Preliminary Phase was the identification of key stakeholders and the compilation of a list of information that had to be made available in order to attain the project’s aims. An evaluation of EU Directives and regulations as well as national plans on waste, wastewater and agricultural development programs and policies, in particular the Maltese Code of Agricultural Practice (CoGAP), was carried out in order to draft a plan that not only reflects Malta’s status as an EU Member State but also seeks to be coherent with other ancillary developments in Malta. During the Preliminary Phase it was apparent that there was little or no reliable data relating to the composition and the quantity of animal waste in Malta – a critical factor in the formulation of the Agricultural Waste Management Plan.

Given the absence of this important data, Phase I of the study focused on obtaining factual information on the quality and quantity of manure in Malta. This task involved the collection and analysis of slurry and manure samples from various farms covering a wide spectrum of farm sizes and main livestock types. In parallel with this task, the Team compiled and analysed information relating to farm sizes and location, traditional practices of manure handling on Maltese farms, and supplementary information such as waste treatment processes in Malta, national water and wastewater plans, energy policies, etc.

Phase II involved a thorough review of the Best Available Technologies (BAT) for the treatment of agricultural wastes. However, solutions that have been found to work successfully in other (much larger) countries may not necessarily work for Malta, because of Malta’s unique circumstances. Therefore, the treatment processes were rigorously evaluated for their application in the Maltese context. The treatment solutions that were investigated included both on-farm treatment processes and off-farm (centralized) solutions.

The preferred treatment option for Malta was then rigorously assessed for economic and financial viability. The Draft Plan described the preferred option in detail and put forward an implementation plan.
2.1 Stakeholders Analysis

During the Preliminary Phase it was immediately apparent that agricultural waste management was of concern to various public agencies and corporations largely because the mismanagement of agricultural waste impacts on a wide range of sectors – from potable water production to livestock welfare, tourism, air quality and even renewable energy generation. It was therefore necessary to understand the main concerns of the regulators and operators in the various related sectors, while keeping account of the veritable limitations of animal husbandry farming in Malta. For this reason consultations were carried out with the following agencies and organizations:

- Permanent Secretary’s office, Ministry for Rural Affairs and the Environment (MRAE)
- Animal Husbandry Section, MRAE
- Rural Development Section, MRAE
- Food and Veterinary Regulation Division, MRAE
- Environment Protection Directorate, MEPA
- Malta Resources Authority (MRA) within the then Ministry of Resources and Infrastructure
- Water Services Corporation (WSC) within the then Ministry for Investment, Industry and Information Technology
- Waste-to-Energy Commission set up by MRAE in 2005
- Farming Co-operatives including KPH and KIM

The minutes of meetings held with the various stakeholders can be found in Appendix II of the Draft Plan (2005). Appendix III of the Draft Plan provides a stakeholders’ analysis.

2.2 Review of Policy, Standards, Guidelines and Codes of Agricultural Practice

2.2.1 Agricultural Development Programmes

Agricultural activity in Malta is limited by the small size of its holdings, soil type, water scarcity and ecological constraints. This makes it harder for Malta to compete within the EU in the agricultural sector, unless some necessary actions are taken in this respect.

New sets of regulations for the Maltese agricultural sector had to be introduced in order to upgrade this sector on the islands and make enable it to compete within the European market. The formulation of the Agricultural Waste Management Plan and the recommendations arising hereof is a continuation of this upgrading process.

Important objectives for Malta’s agricultural policy include the elevation of farmers’ income level and the promotion of the multi-functionality role of agriculture. Specific measures were devised by the Government of Malta to achieve these objectives, these being:

- The subvention of the farmers’ income (SMPPMA: Special Market Policy Programme for Maltese Agriculture) in such a way as to allow the price of local goods to go down after levies were removed
- The restructuring of support for the processing industry
- The negotiation of a five-year safeguard
- The introduction a Rural Development Plan to provide support other than SMPPMA
- The establishment’s of Malta’s status as a Less-Favoured Area for the purposes of EU’s Common Agricultural Policy (CAP)
- Negotiated measures on specific sectors
- The introduction of compensation mechanisms in case of import of agricultural products (supply measures)

With Malta’s accession to the EU, it was necessary to adopt the Common Agricultural Policy (CAP) which not only has the objective of protecting farm incomes but also that of stabilising prices within the EU. Consequently, the degree of economic protection that it provides is much less than Maltese farmers have been used to.

Malta lacks comparative advantage in most livestock production and processing activities compared to the other Member States. James, A. (2000)\(^1\) provides some information on the impact of accession to the EU on livestock production and the limitations of livestock production in Malta. It should be noted that this economic study did not take the incremental cost of proper waste management on Maltese farms into account – which may result in a further loss of competitiveness of Maltese farms when compared to their European counterparts because of economies of scale and lack of agricultural land for the application of manure.

Other EU policies to ensure the free movement of goods between Member States by requiring common standards of product quality, labelling, traceability, food safety and animal disease control, impose additional costs on producers and processors of livestock products.

There exist also considerable differences between the producer prices of most livestock products in Malta compared to EU member states (James, 2000), making Maltese producers vulnerable to imported products on the dismantling of tariffs on foreign products on Malta’s accession to the EU. In fact, this has resulted in a decline in some of the local produce since accession, particularly poultry. According to the National Statistics Office (March 2005), the number of heads slaughtered in the poultry sector declined by 17.2% in 2004 when compared to data from 2003. Data on animal population numbers for more recent years is presented in Section 3.3 of this report.

A Rural Development Programme (RDP) 2004-2006 was adopted as part of Malta’s agricultural strategy. This programme provided a mechanism to build a new agricultural sector (for the medium- to long-term) to be integrated with the rest of the economy. The Rural Development Plan was partially financed by the EU. The plan aims to modernize holdings, promote environmentally friendly products and introduce the multi-functionality of agricultural enterprises.

The main elements of the RDP 2004-2006 were:

1) Producer Groups: Main objectives for this group were: to eliminate the structural deficiencies affecting marketing and supply of agricultural products, to protect and increase market share of such products and to supply farmers with market data and new marketing activities.

2) Agro-Environment: This is the core compulsory measure for the plan’s implementation and it has been divided into three sub-measures: (1) reduction of the incidence of soil erosion, (2) enlarging the scale of bio-diversity and enhancing local indigenous species and (3) introducing organic farming as a new alternative type of cropping.

3) Less-favoured areas: The entire Maltese islands were declared a “less-favoured area” (LFA) – which status qualifies the islands for additional support from the EU.

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\(^1\) Assessment of the Impact of the European Union on the Activities of the Malta Veterinary Services – A. James et al, December 2000
4) Ad-hoc or full-time farmers measure: The “Ad-Hoc” is a specific-case-for-Malta proposed measure. According to this measure, full-time farmers were able to address the gaps in farm income and cash flow during the period of restructuring the business in terms of technology, management and husbandry systems.

5) Complements to State-aid: Malta was requested to adopt a “Special Market Policy Programme for Maltese Agriculture” (SMPPMA), in order to enable farmers and food industries to gradually implement CAP measures. It ensures the removal of levies, which in their turn will be replaced with direct income support for farmers and restructuring assistance for the processing industry.

6) Meeting Standards: This measure provided support and knowledge to the farmers to adapt to the EU standards in the fields of the environment, public health, animal welfare and occupational safety. However, in Malta’s particular case this was solely limited to observation of the Nitrates Directive and to help farmers adapt their storage capacity and slurry to the requirements of the CoGAP.

7) Technical Assistance: This measure reinforced the institution building and administrative capacity of the national, regional and local level bodies, which are responsible for formulating and implementing the plan.

Of all the above, the Meetings Standards Measure is the most relevant to the formulation of the Agricultural Waste Management Plan. The focus of the Meeting Standards measure is to ensure that all animal farm units have the necessary on-farm infrastructure to contain manure in such a manner that limits the release to the environment of pollutants in liquid, solid or gaseous forms – until such a time in the year when it becomes acceptable to apply or dispose of the stored manure to the fields.

These requirements mean that animal units are to be modified or upgraded, such that animal waste is collected close to the source of release as possible and that dilution with rainwater does not take place. The need to modify existing units to meet these requirements is greatest for dairy units, where the present yard system encourages the production of large volumes of liquid waste containing soluble nitrogen that is easily lost to groundwater and the atmosphere.

The concerns with the waste from the pig and poultry sectors relate mainly to the disposal and not collection of manures and slurry.

A detailed description of the Meeting Standards measure is provided in Appendix XII of the Draft Agricultural Waste Management Plan, 2005.

The Rural Development Programme for Malta 2007–2013, which supersedes the RDP 2004-2006 has been prepared.

2.2.2 The Nitrate Directive and the Code of Good Agricultural Practice

Guidance for the handling, storage and fertilization with manure is provided by the Code of Agricultural Practice (CoGAP), which was developed within the Twinning Light Project MT2001/IB/AGRI/01/TL in 2003. The driving force for the development of the CoGAP is Article 4 of the Nitrate Directive 91/676/EEC that stipulates the requirement for the Member States to establish a Code of Good Agricultural Practice which can be adopted by farmers on a voluntary basis. The Directive was transposed into national legislation as LN 233/04.

According to the Directive, EU Member States have to identify the water resources affected by nitrate and then designate the polluted regions as Nitrate Vulnerable Zones (NVZs). Due to the intensive nature of agricultural production and the porous geology, all of Malta’s groundwater is
highly vulnerable to nitrate pollution. Indeed, by virtue of LN 233/04, the whole of Malta and Gozo has been declared a Nitrate Vulnerable Zone. Under these conditions Malta will have to implement all the requirements of the Directive regarding the protection of the groundwater from pollution by nitrate.

Consequently, measures have to be put in place to regulate the quantity and period of application of manure that is to be applied on agricultural land. These measures are provided by the CoGAP. Indeed, establishing a Code is a required action according to the Directive.

Among other measures, the CoGAP details the type and capacity of manure storage structures to be constructed on animal farms for the proper collection and containment of manure. Together with, the ‘Policy and Design Guidance on Agriculture, Farm Diversification and Stables, Approved Document, MEPA - December 2007’ it provides the basis for the construction of manure retaining structures for farms in Malta and Gozo.

According to the CoGAP, manure must be stored in leak-proof covered storage clamps connected to a cesspit, and the cesspits must be leak-proof and covered. Cesspits must have sufficient capacity to collect all urine and washings for at least 15 days and solid manure must be stored in covered clamps from the 15 October to the 15 March (hereafter referred to as the ‘closed’ period). This period is equivalent to the rainy season in which all types of livestock manure are prohibited from being applied to the land.

This requirement has resulted in the construction of a number of on-farm manure and slurry containment systems (manure clamps and cesspits) on Maltese farms over the last 3-4 years. While this measure has resulted in an improvement in off-farm waste management systems on the situation prior to EU accession, the Team are of the opinion that off-site treatment of manure is a better proposition than on-farm containment. Section 7.4 of the Draft Plan – Treatment Measures proposed by the CoGAP, the Rural Development Plan (RDP) and the Nitrate Action Programme – put forward various arguments why the manure clamp/cesspit proposal advocated in the CoGAP and the RDP is considered problematic and not practical in Malta’s particular circumstances.

Notwithstanding the draft Plan’s recommendation that the CoGAP be amended to exempt animal farmers from the need to construct manure clamps having a 5-month storage capacity, current policy remains in favour of manure clamps and cesspits. In fact, a significant number of cattle (and some poultry) farms have invested in manure clamps in the last 3-4 years, some with solid-liquid separators. These recently constructed on-farm waste management structures now form part of the national agricultural waste management infrastructure and have to be taken into consideration in the formulation of this updated agricultural waste management plan. Section 3.2 of this report addresses the impact of these structures on the recommendations contained in the Draft Plan.

The CoGAP also obliges the producer (and contractor, if one is employed) to keep records of slurry and manure transports/disposal, including dates, quantities and final destination. Solid manure can only be stored on the fields between the 16 March and the 14 October if the dry matter content is at least 30%. Needless to say, it is almost impossible to implement and control this measure in practice.

Another difficult measure to implement and control is the obligation to limit the amount of livestock manure that can be applied to the land by the nitrogen content\(^2\), i.e. 210 kg N/ha for the first four years of the action programme (2004–2008) and 170 kg N/ha thereafter. These measures are all obligatory measures primarily relating to the Nitrate Directive.

\(^2\) The amount of “total nitrogen” applied from livestock manure includes solid manure, liquid manure, slurry and urine, including excreta by the animals themselves
The CoGAP also regulates the following matters:

- Procedures for application of fertiliser, whether mineral or organic, to minimise losses (including rate and uniformity of spreading)
- Record keeping of all types of mineral, organic fertilisers and livestock manures

The CoGAP also recognizes that, if managed properly, animal waste can become an important nutrient resource with economic value and recommends that the use of straight inorganic fertilizers be kept to a minimum. It is uneconomical to use (imported) inorganic fertilizers in large quantities when there is a surplus of animal manure on the Maltese Islands. It also identifies the benefits arising from the use of organic fertilizers (including farmyard manure) to the soil – especially when it is known that Maltese soils are suffering from low organic matter (MALSIS, 2004).

Farmers shall have to comply with the CoGAP in order to receive Rural Development benefits under the Less Favoured Area and Agro-Environment Measures (MRAE, 2003a).

**Guidelines on Agricultural Buildings, Farm Diversification and Stables – MEPA, December 2007**

In February 2005, MEPA issued the “Revised Supplementary Planning Guidance on Agricultural Buildings, Farm Diversification and Stables (July 2004)” for public consultation. The “Policy and Design Guidance on Agriculture, Farm Diversification and Stables” had been approved in December 2007.

The Policy and Design Guidance document gives policy guidance on various forms of agricultural development (including farms) whilst taking into account EU requirements and emerging Government policy on agriculture, including the RDP. To this effect, specific policies are set out for agricultural buildings and structures including those for livestock farming.

In particular, the guidelines state that development of a new farm structure (or redevelopment, or extension of an existing farm) shall be considered only if the development proposals for management, storage, treatment and disposal of effluent are acceptable and the development will not cause pollution of adjoining land, watercourse or water aquifers.

Moreover, there are other considerations to be taken into account such as the need for the development, the distance from residential and/or tourist facilities, and vehicular accessibility, amongst others.

**Sewerage Master Plan**

The amount of the untreated sewage discharged into the Mediterranean Sea from the Maltese Islands is approximately 18 million cubic meters. Only about 4.5 million cubic meters are treated at the only municipal sewage treatment plant in operation: the Sant Antnin Sewage Treatment Plant. The sludge resulting from that treatment is still discharged into the sea (MEPA, 1998). The capacity of the Sant Antnin Sewage Treatment Plant currently stands at 15-20% of the total volume of raw sewage generated on the islands. The quantity of (untreated) wastewater originating from the agricultural and food industry sector (i.e. farms, dairy industry, food processing plants, bakeries and confectioneries) is believed to be significant – though it has never been quantified.

The Water Services Corporation is in the process of implementing the Sewerage Master Plan for Malta and Gozo, which, apart from the rehabilitation of the main sewer lines and systems, shall provide for the construction of another three sewage treatment plants. During negotiations, Malta obtained a transition period until March 2007 to implement EU law and set up the necessary infrastructure for wastewater treatment.
Two of the three treatment plants have been designed and their construction awarded by public tender in 2004. Plans for the larger (Malta South) plant are still underway.

**Municipal Solid Waste Plan**

One of the major tasks proposed in the 2001 Solid Management Waste Strategy is the reduction of the biodegradable wastes to be disposed of in landfill to 75% of 1995 levels by 2010, in accordance with the EU Directive 1999/31/EC.

At the time of writing of the Draft Plan (May 2005), the waste management infrastructure on the Islands consisted of an engineered landfill (Ta’ Zewra), a composting plant for Municipal Solid Waste (the Sant Antnin Solid Waste Treatment Plant) and a number of small incinerator plants functioning as facilities for managing and disposing of wastes.

During 2001, biodegradable waste generated in Malta was measured at 162,171 tonnes; of which about 22,680 tonnes was going to the Sant Antnin composting plant and the remainder (together with rejects from the composting plant) going to landfill; about 2,700 tonnes of sewage sludge being discharged to sea and approximately 14,000 tonnes of biodegradable waste going to the Gozo Landfill. Since 1st May 2004, all the waste generated in Gozo is being transferred to Malta for treatment and/or disposal.

Although the Sant Antnin composting plant was originally designed to process around 80,000 tonnes of Municipal Solid Waste (MSW) per year, for technical reasons just around 30,000 tonnes per year were being processed by the plant. Approximately 2,400 tonnes of compost were produced by the plant in 2000, going down to 1,717 tonnes in 2003 (Data from Wasteserv, November 2004). Since the start of operations, the Sant Antnin composting plant has been dogged with many technical and environmental problems. For this reason the Maltese Government prepared a plan to upgrade the Sant Antnin plant. This is to be done in order to meet the following goals:

- To receive and process a larger amount of organic wastes originating in Malta and Gozo;
- To receive, sort and process a larger amount of dry recyclable materials originating in Malta and Gozo;

The proposed development will include:

- A materials recovery facility (MRF) capable of sorting 36,000 tonnes of separately collected recyclables per annum;
- A digestion plant that will treat 35,000 tonnes of biodegradable waste. This plant will recover energy from waste through anaerobic digestion; and
- A modular composting plant that will compost the product from the digestion plant

Section 3.4 of this report provides an update on the upgrading of the municipal waste management infrastructure in Malta and Gozo since the preparation of the Draft Plan in May 2005.

**Review of the veterinary and health sector / situation**

In addition to the conventional provisions for animal health and welfare and food safety, the Department of Veterinary Services (FVRD) is responsible for the operation of the main public abattoir, the maintenance of population and movement records for the main livestock species and providing assistance in the development of an appropriate legal and institutional framework for meeting the requirements of the *Acquis Communautaire* for accession to the EU.
It is estimated that the Maltese livestock industries produce between 35 and 40 tonnes of animal product waste per week (1,820 – 2,080 tonnes a year). This includes inedible products from abattoirs and meat processing plants, and carcasses of animals dying on farms or condemned to slaughter. Animal wastes from poultry and other animal slaughtering centres are estimated to be 2,500 tonnes (Solid Waste Management Strategy, MoE, 2001). In 2005, most of this waste was being disposed of in landfill sites, except for infected animal carcasses which were incinerated at the public abattoir(s).

It is/was the intention of the Maltese authorities to dispose of all animal waste, including waste coming from poultry plants, by incineration thus precluding any possible entry of waste material to the food/feed chain. To this effect, an incinerator (waste thermal facility) having a capacity of 12,500 tonnes a year was contracted out in 2004 to dispose of the waste from the public abattoir and dead carcasses. The thermal facility started operations in 2008.

**Review on national energy and water plans**

**Energy**

Malta has no fossil fuel resources of its own and to date imports heavy fuel oil and gas oil to generate electrical power. Moreover, Malta is not connected to any existing electricity grid in Europe or Africa. The national organization responsible for power generation is the Enemalta Corporation. In 2005, the total generating capacity stood at 576 MW, produced by two oil-fired power stations, based at Marsa and Delimara, generating 272 MW and 304 MW respectively (*Twinning Light Project*, Project Number 2002/000-268, 2002). The Corporation’s fifteen year energy plan for the Maltese Islands (1994-2010) includes plans for further extension of generating capacity and the reinforcement of the transmission and distribution network. Increased energy efficiency and the development of alternative, renewable sources of energy are dual national priorities. This plan has since been superseded by Enemalta’s Generation Plan 2006 – 2012, comment on which is provided in Section 3.5 of this report.

Malta’s energy regulator is the Malta Resources Authority (MRA). Various studies were conducted by this agency to assess the potential of renewable energy in Malta that may be achieved by 2010, with the focus being on wind, solar and biogas.

With regards to the potential of electricity from the treatment of municipal solid waste, MRA estimate that around 25 GWh/annum can be obtained from Mechanical Biological Treatment (MBT) plants, and another 36 GWh/annum may be derived from a Refuse Derived Fuel (RDF) plant (Energy Efficiency and Renewable Energy – Malta National Study, Plan Bleu. March 2007).

The Draft Agricultural Waste Management Plan had estimated that 24 GWh of electricity every year can be generated by 3-4 centralised anaerobic digestion (CAD) plants operating on manure. However, the MRA reports state that no decision on the construction of these plants had been taken (by 2007) and therefore the plants are not expected to be implemented before 2010.

**Greenhouse Gas Emissions**

Malta has signed (17 April 1998) and ratified (11 November 2001) the Kyoto Protocol on climate change and has the status of a non-Annex 1 country to the UNFCCC (i.e. it has no obligations to reduce greenhouse gas emissions).

Agriculture contributed 3% of Malta’s total greenhouse gas (GHG) emissions in 2005.
As a non-Annex 1 country, Malta can participate in the Clean Development Mechanism (CDM), which allows industrialised countries to achieve part of their emission reduction commitments by conducting emission-reducing projects abroad and counting the reductions achieved toward their own commitments. In 2007, the national administrative structures were put in place to allow (public or private) projects from Malta to qualify for CDM registration. An agricultural waste treatment plant that reduces GHG emissions can therefore be registered as a CDM project.

As a member of the EU, Malta is also obliged to establish a scheme for greenhouse gas emission allowance trading within the EU Community as per Directive 2003/87/EC. Malta submitted its national allocation plan to the EU Commission, which plans were approved by the EU Commission on 4 December 2004. The scheme commenced on 1 January 2005. The first phase runs from 2005 to 2007. In September 2006, Malta forwarded the National Allocation Plan (NAP) 2008 – 2012 to the EU Commission. It should be noted that only Malta’s two power plants fall within the remit of the EU Emissions Trading Scheme.

**Water**

All of the urban population has access to safe drinking water, sanitation and health services. Water production capacity in Malta and Gozo is approximately 145,000 m$^3$ per day. 60% of the potable water supply is produced by seawater desalination using reverse osmosis and 40% from groundwater sources. The groundwater for the public water supply is drawn from 95 boreholes in Malta and 43 boreholes in Gozo and a smaller number of pumping stations. Some water is recovered from the Sant Antnin sewage treatment plant and is used for irrigation. There are plans to significantly increase this supply when new sewage treatment plants are brought into operation. The sewage treatment plants will have the capacity to remove nitrogen from the effluent, thus facilitating its re-use for irrigation of agricultural areas overlying the groundwater protection zone.

At the time of writing, the water regulator, MRA is in the process of completing a Water Policy for the Maltese Islands, which among other things will address the issues of rampant groundwater extraction by various sectors (including farming), the protection of groundwater resources, as well as the use of alternative sources of water (such as treated sewage effluent).

The need for a Water Policy is also derived from Malta’s obligation to meet the requirements of the Water Framework Directive (2000/60/EC). The aim of this directive is to achieve good status of both groundwater and surface water by the year 2015. The directive aims at reducing pollution from groundwater, including pollution from agricultural sources.
2.3 The Livestock Sector in the Maltese Islands

2.3.1 Size and Distribution of Animal Farms

An assessment of farm size and distribution in 2005 provided the following results:

- By far, the majority of animal farms in the Maltese Islands are very small. Although this was to be expected, the results also show that the greater proportion of farms have very small herds. For example, 72% of cattle farms have less than 100 livestock units (LU) or less and 75% of pig farms have 500 heads or less. The situation is the same for the other livestock sectors.

- With the exception of the pig sector, most of the animal farms are concentrated in 3 regions, these being Gozo, Zejtun and Maghtab. There are also a number of livestock farms in and around Rabat in Malta. Maps showing the geographical distribution of cattle, pig and poultry farms in Malta and Gozo are presented in Appendix I of this report.

- From laboratory analysis of manure samples, it was established that the volume of manure is high. As much as 850,000 m$^3$ of manures and slurries are generated in Maltese farms every year; the pig sector alone makes up 550,000 m$^3$ of this amount. This is not attributable solely to the high livestock density in Malta but largely to poor farm management practices (particularly water and manure management). The excessive use (and wastage) of water in pig farm results in a 250% increase in volume of slurry to be managed (and treated). The practice of storing cattle and poultry manure in open fields results in the loss of nutrients, polluting groundwater and contaminating watercourses in the process and must be addressed.

It is useful to note that in EU Member States farmyard slurries and manure are rarely treated. Manure management is normally achieved through the long-term storage and spreading on agricultural land.

However, the voluminous nature of the manure, the small size of the farms and the high livestock density (i.e. the amount of manure in proportion to the agricultural land available), as well as the high (human) population density of the Maltese Islands eliminate the possibility of using ‘standard’ means of storing and disposing of manure in Malta. Treatment is therefore considered a must. This conclusion was also arrived at by Dr. Peter Jackson, consultant to the then Ministry for Agriculture and Fisheries, in his report entitled ‘Animal Waste in Maltese Agriculture’ dated September 2001.

A detailed investigation was carried out by the Team on the possibility of on-farm waste treatment in Malta but this was found to be impractical and very uneconomical. In most cases, adequate space is not available but the biggest constraints generally relate to economies of scale.

2.3.2 Overview of Farms’ Manure Management Practices

Cattle

Animal waste from the cattle sector is a mixture of the urine and faeces of the cattle, mixed with bedding. It is common practice in Malta to remove the solid waste from the yard with a scraper before adding fresh bedding; the waste is generally removed on a daily basis. The liquid fraction
runs off into the ground (in the case of an un-surfaced yard) or into a cesspit. The solid waste is transported to an open storage place, where it remains for several months until it dries up naturally and is then used as a fertilizer by crop farmers in summer. In general, the manure storage area is not impermeable with the result that there is considerable loss of nutrients to the groundwater and surface runoff.

The composition of the manure depends on the type and quantity of feed and bedding used, which varies from farm to farm. With regards to bedding, substitutes like shredded paper are often used because straw is not readily available in Malta, and in some instances rubber mats are used instead. Feed is a combination of fodder (such as straw, clover and alfalfa) and either home-mixed feed or concentrates from the local feed mill (KPH).

**Pigs**

In contrast to all other livestock production systems in Malta there is no solid waste generated on pig farms. Faeces and urine from the pigs, and unconsumed water from drinking nipples, falls through the slats in the pen floor and is flushed with additional washing water to cesspits. In some cases, the farm is directly linked to the sewer system, but in general the liquid slurry is transported to a sewage manhole by means of a bowser. Depending on the storage capacity and the pig population on the farm, the bowser may be brought to operation once or twice a week. When this is done, the cesspit is usually emptied to the lowest possible level. Some farmers own their own bowser, while others make use of a contractor. In general, the larger farms own their own bowser; the smaller ones use a subcontractor. Some farms make use of a bowser service provided by the Water Services Corporation.

**Poultry – Layer**

In general, layer chickens are kept in stacked battery cages without bedding. The manure drops through the cages’ floors onto the manure belts below each row of cages. The conveyor belts are either manually-operated or automatically-operated, and the manure is generally collected from the belts every few days. Automatically-operated conveyors are normally found on the larger farms.

**Poultry – Broiler**

Broiler production is carried out as a batch system with a production cycle of 6 weeks. At the onset of the cycle, the young chicks are kept in a limited space of the broiler house floor which is covered with bedding. Bedding used is usually either (imported) rice husks or sawdust. The floor space available for the chicks is increased according to the growth of the animals until the whole area of the shed is taken up. At the end of the production cycle, the animals are removed for slaughter and the shed is cleaned out. The cleaning includes the removal of the bedding and is often done by a contractor.

2.4 **Manure Generation Estimates**

Over the period Dec 2004 – Feb 2005, the Team carried out a thorough determination of the composition and quantity (i.e. volumes) of manures and agricultural slurries generated in Malta. The accurate determination of this basic information was considered a key task in attaining the study's main objective i.e. that of determining the most appropriate manure treatment process(es) for Malta.

This, coupled with up-to-date (February 2005) records of animal population numbers allowed the Team to draw up an estimate, on a national basis, for wet slurry, dry matter and nitrogen
generated by the various livestock sectors as shown in Figures 4 to 6 in Appendix 1, and Table 4.

The situation of manure generation in the Maltese Islands can thus be summarized as follows:

**Manure Generation by (wet) weight**

<table>
<thead>
<tr>
<th></th>
<th>Quantity (in tonnes)</th>
<th>Percentage of Total (%)</th>
<th>Average (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>224,400</td>
<td>26.6 – 42.7</td>
<td>34.7</td>
</tr>
<tr>
<td>Pig</td>
<td>256,000 – 558,000</td>
<td>48.8 – 66.2</td>
<td>57.5</td>
</tr>
<tr>
<td>Broiler</td>
<td>11,400 – 26,300</td>
<td>2.1 – 3.1</td>
<td>2.6</td>
</tr>
<tr>
<td>Layer</td>
<td>30,500</td>
<td>3.6 – 5.8</td>
<td>4.7</td>
</tr>
<tr>
<td>Rabbit</td>
<td>3200</td>
<td>0.4 – 0.6</td>
<td>0.5</td>
</tr>
</tbody>
</table>

**Manure Generation by Dry Matter**

<table>
<thead>
<tr>
<th></th>
<th>Quantity (in tonnes)</th>
<th>Percentage of Total (%)</th>
<th>Average (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>22,800</td>
<td>42.7 – 54.6</td>
<td>48.7</td>
</tr>
<tr>
<td>Pig</td>
<td>4,000 – 8,600</td>
<td>9.5 – 16.2</td>
<td>12.9</td>
</tr>
<tr>
<td>Broiler</td>
<td>5,300 – 12,100</td>
<td>12.5 – 22.7</td>
<td>17.6</td>
</tr>
<tr>
<td>Layer</td>
<td>9,000</td>
<td>16.8 – 21.4</td>
<td>19.1</td>
</tr>
<tr>
<td>Rabbit</td>
<td>830</td>
<td>1.5 – 2.0</td>
<td>1.7</td>
</tr>
</tbody>
</table>

**Nitrogen Generation by Sector**

<table>
<thead>
<tr>
<th></th>
<th>Quantity (in tonnes)</th>
<th>Percentage of Total (%)</th>
<th>Average (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle Solid</td>
<td>770</td>
<td>21.2 – 27.8</td>
<td>24.5</td>
</tr>
<tr>
<td>Cattle Liquid</td>
<td>800</td>
<td>22.0 – 28.9</td>
<td>25.5</td>
</tr>
<tr>
<td>Pig</td>
<td>465-1,012</td>
<td>16.8 – 27.8</td>
<td>22.3</td>
</tr>
<tr>
<td>Broiler</td>
<td>244 – 564</td>
<td>8.8 – 15.5</td>
<td>12.2</td>
</tr>
<tr>
<td>Layer</td>
<td>462</td>
<td>12.7 – 16.7</td>
<td>14.7</td>
</tr>
<tr>
<td>Rabbit</td>
<td>26</td>
<td>0.7 – 0.9</td>
<td>0.8</td>
</tr>
</tbody>
</table>

It can be seen from the above tables that whereas pig manure represents more than half the manure generated by (wet) volume, it only represents 12.9% of the total in terms of dry matter. It also accounts for 22.3% of the total nitrogen found in fresh manure in the Maltese Islands.

The cattle sector contributes half of the dry matter in manure, and also half of the nitrogen, while making up for around a third of all the manure by wet volume. This calculation does not take into account the volumes of washing water generated on the cattle farms.

The dry matter originating from the poultry sector is substantial (36.7%), but only accounts for 7.3% of total quantities with respect to wet weight.

In other EU countries (apart from Denmark and Hungary), the cattle sector is the largest manure producer. In general, cattle produce 40-70% of all the manure. Pigs’ contribution is in the region of 20-40% (with the exception of Denmark and Hungary where pig manure accounts for over 50% of total manure). Although it would seem that the pig sector in Malta is the main contributor of manure, this has to be calibrated against the fact that there is a high dilution of the pig manure
with water which tends to inflate the manure generation figures. For this reason, it is believed that pig manure realistically represents 45-50% of all the manure generated in the Maltese Islands (i.e. after water saving measures are put into effect).

2.5 Other Agricultural Waste

Although manure from livestock units by far accounts for the greater part of waste arising from the agricultural sector, there are a number of waste streams which are also of agricultural origin and may therefore be considered as falling under the remit of this current study. These mainly concern animal by-products from slaughterhouses and meat processing plants.

These waste streams include:

- Waste from the public slaughterhouse(s)
- Waste from the private slaughterhouses (mainly poultry and rabbit)
- Animal tissue and sludges from washing and cleaning
- Waste from processing of meat (e.g. bacon and sausages), fish and other foods
- Wastes from the dairy products industry
- Residues from the vegetable market (*Pitkali*)
- Residues from the fish market (*pixkerija*)
- Residues from tomato processing
- Residues from canning processes
- Waste products from the tuna penning industry
- Spent bedding from mushroom production

Other bio-wastes which are however not of agricultural origin but which may be considered similar in composition to manure/slurries and other agricultural wastes include:

- Wastes from the bakery, brewing and wine industries
- Waste (sludges) from urban wastewater treatment plants
- Septic tank waste

Estimates for the quantities of these biowaste streams in Malta are provided in the Draft Plan.

The reason for mentioning these waste streams in this current study is that given the technical possibility of co-treating some of these wastes with agricultural wastes, it may be of mutual benefit to both the waste producer and the operator of an agricultural waste treatment plant for the latter to accept to treat this waste in the ‘agricultural waste treatment plant’, against a gate fee. That is, the treatment of some of these waste streams may result in a source of revenue for the operators of an agricultural waste treatment plant. However, one has to factor in the additional cost of sanitising these waste streams in the co-digestion process, as stipulated in EU Regulations 1774/2002.

It is interesting to note that the substrate of centralised anaerobic digestion (biogas) plants in Denmark consists of 11 – 39% of industrial waste and wastewaters including abattoir, fish processing, food processing, sugar industry and brewery wastes.
The possibility of co-digestion will be discussed in more detail at a later stage of the report.

### 2.6 Treatment Options

In general, treatment of manure and slurries is not commonplace in EU countries - other than storage, and often, mixing before application.

Slurry and manure is generally stored in the winter season, when application of manure to the frozen / water-logged land will result in pollution, and is therefore not allowed within the EU because of limitations imposed by the Nitrate Directive.

The average storage capacity for livestock slurry is 6 months in many EU countries; it is longer in Scandinavian countries and shorter in some Southern and Eastern European countries. The storage capacity for solid manure varies from 2 – 12 months, and is less or equal to that of slurry. The country with the shortest slurry storage time is Portugal with a requirement of 1 – 3 months storage. In Italy, pig slurry must be stored for 6 months.

By comparison, the storage capacity for solid manure in Malta is 5 months, but only 2 weeks for slurry.

Solid-liquid separation is carried out on a limited basis in some countries. Nitrification/denitrification processes for the removal of nitrogen are sometimes used in the Netherlands, as well as some aeration of pig slurry. Anaerobic digestion with biogas production is present in varying degrees in a number of countries, although it is not a major system anywhere, and is mostly used for pig slurry rather than cattle slurry.

Apart from some composting (in France and some Southern and European countries) no special treatment is applied to solid manure. Where composting is reported, it is unclear whether this entails an active treatment or merely the natural degradation process during storage.

Table 5 gives a summary of the treatment processes used in various countries.

<table>
<thead>
<tr>
<th>Type of Treatment</th>
<th>Countries using Manure / Slurry treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separation</td>
<td>Spain, Italy, Netherlands, UK</td>
</tr>
<tr>
<td>Aerobic Treatment</td>
<td>Netherlands, France, Norway and Germany, UK</td>
</tr>
<tr>
<td>Anaerobic Treatment</td>
<td>Germany, Denmark, Poland, Italy</td>
</tr>
<tr>
<td>Composting Systems</td>
<td>France, Italy, some southern and eastern countries</td>
</tr>
</tbody>
</table>

**Treatment Technologies used in the management of livestock slurries in selected EU countries**

<table>
<thead>
<tr>
<th>Country</th>
<th>Treatment Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>Biogas (central processing plants)</td>
</tr>
<tr>
<td>France</td>
<td>Aerobic treatment to remove Nitrogen</td>
</tr>
<tr>
<td>Germany</td>
<td>Aerobic treatment, Biogas (on-farm) plants</td>
</tr>
<tr>
<td>Greece</td>
<td>Anaerobic lagoons, Separation</td>
</tr>
<tr>
<td>Ireland</td>
<td>Acidification to remove ammonia emission</td>
</tr>
<tr>
<td>Italy</td>
<td>Aerobic &amp; Anaerobic treatments, Biogas recovery, Composting</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Redistribution of manures, Central processing</td>
</tr>
<tr>
<td>Portugal</td>
<td>Aerobic &amp; Anaerobic lagoons</td>
</tr>
<tr>
<td>Spain</td>
<td>Composting, Anaerobic lagoons, Separation, Biogas recovery</td>
</tr>
</tbody>
</table>

Table 5. Treatment Processes used in EU Countries
The Draft Agricultural Management Plan (2005) provides a detailed review of the various treatment processes available and discusses the applicability of each process to Malta’s particular situation. The treatment options were assessed against administrative, legislative, financial, environmental, economic, technical and social benchmarks. An exhaustive list of criteria against which the treatment options were assessed may be found in Section 7.3.2 of the Draft Plan.

When assessing treatment options, it was established that the measures proposed by the CoGAP and the Malta Action Programme for Nitrate Directive (NAP) for the on-farm management of slurries, manures and wastewaters are inadequate for a number of reasons. The same Rural Development Plan realistically anticipated that up to 5% of the farms in Malta would be in a position to comply to the EC Nitrate Directive as concerns manure and storage facilities before the 3-year investment period 2005 – 2008.

In the Draft Agricultural Waste Management Plan (2005), it was argued that the manure clamp/cesspit proposal is not considered a suitable treatment option since:

- the measures in the CoGAP and Nitrate Action Plan relate exclusively to containment and not treatment i.e. the composition of the manure/slurry is practically unchanged (except for a slight increase in dry matter content through drying and some loss of nitrogen through the release of ammonia);
- the liquid slurry cannot be discharged into the public sewer (after the 2 weeks storage), and requires additional (expensive) treatment;
- capital investment for the construction of manure clamps and new cesspits on all farms is high (circa €20,500,000 on a national level);
- this policy necessitates the take-up of a significant amount of space on the farms (128,000 m²); moreover, a considerable number of farms do not have the space to store the mandatory 5-months manure production;
- these measures will not generate any revenues except from the sale of manure from cattle and poultry farms (estimated at LM 150,000 per year) i.e. revenues will remain at the current levels;
- the current policy does not generate any renewable energy, and moreover does not result in any GHG emission reduction;
- implementation of the current policy is difficult as the measures have not been fully endorsed by the animal farmers. To be eligible for the grants, the RDP measures oblige farmers to obtain the necessary development permits from MEPA within a stipulated timeframe – which process is proving to be very tedious, time-consuming and frustrating for both the farmers and the regulator;
- aid for the restructuring of the farms is only available from the Rural Development funds; this proposal does not benefit from EU Structural and Cohesion Funds;
- the on-farm storage of untreated manure is undesirable in situations where the farms are close to residences; moreover, the storage of manure on the farm might affect the health of the animals if the manure clamp is too close to the sheds;
- this proposal will not solve Malta’s nitrogen surplus problem; control (enforcement, monitoring, reporting) of the regulations relating to the Nitrate Directive, particularly those related to the application of manure to fields is extremely difficult within the context of the existing measures.
2.7 Recommended Option (as presented in the Draft Agricultural Waste Management Plan)

After discarding the ‘on-farm storage’ option for reasons outlined earlier, the study focused on centralised treatment processes and options. An evaluation of the technical, economic and social benefits of various centralized treatment options resulted in the selection of a preferred treatment option which proposed:

1. The disposal of pig slurry into the public sewerage system for subsequent treatment at the to-be-constructed municipal sewage treatment plants. This option entails minor investment on the pig farms, but entails a treatment fee to be paid to WSC for this service. This option was recommended because it was considered that specialized treatment of pig slurry is beyond what the sector can afford and that the to-be-constructed municipal wastewater treatment plants in Malta would have the capacity to treat this material in a cost-effective manner. This recommendation was based on estimates for the treatment costs that were provided by WSC at the time.

2. The digestion of cattle, poultry and rabbit manure in 3-4 centralized anaerobic digestion (CAD) plants for stabilization of the manure and the production of electricity from biogas. These treatment plants would have provided 24,000 MWh of electricity every year, equivalent to 1.15% of Malta’s current electricity generation capacity in 2004. The residue from the digestion process would then be separated by mechanical means, with the solid fraction being composted to provide a high-quality compost. The liquid fraction could be used as a nutrient-rich fertilizer; surplus liquid would be disposed of into the sewerage system.

The implementation of this recommendation in Malta would have entailed the following:

- The construction of only short-term (2 week) manure storage facilities on the farms (instead of the 5 months storage stipulated by the CoGAP) - which recommendation should be welcomed by the farmers who, as things stand, have to construct much larger (and more expensive) waste containment structures at their own expense;
- The regular transportation of the manure by means of slurry tankers (bowsers) from the farms to the treatment plants;
- The construction of 3-4 strategically located treatment plants so as to minimize transportation distances and public nuisance. The suggested locations for the plants are: Gozo, Maghtab and Zejtun (a fourth plant, if necessary, should be located in the Rabat-Mriehel-Zebbug area). The plants will provide surplus electricity and heat, and produce a saleable compost and fertilizer. The compost is to be stored on the plants’ premises during the closed fertilization period.

A thorough economic and financial review was carried on this agricultural waste treatment solution. Three models have been considered:

- **A Full (Macro) model**: This is based on the total capital investment including on-farm improvements, operating expenditure (including cost of disposal of pig slurry into the sewer) and revenue streams. In this scenario, much depends on the price at which the electricity can be sold to Enemalta (as a renewable energy source). At the time of the preparation of the Draft Agricultural Waste Management Plan in the 1st Quarter of 2005, Enemalta’s cost of producing electricity from fossil fuel stood at LM 0.035/kWh (€ 0.082/kWh). At this (relatively low) cost of generation, the agricultural waste plants were not considered to be financially sustainable; the return on investment (of LM 9.68 million) would only have been recovered after 43 years. In order to achieve an IRR of 5% (the target rate of return for a public investment project), the price of electricity sold to
Enemalta must increase to LM 0.0541 per kWh (i.e. an increase of c. 55% over the cost to Enemalta in 2005). It should be noted that a similar project in Germany will be eligible for an average electricity sales price of € 0.139 per kWh (i.e. LM 0.0597 / kWh).

- **Economic and Environmental model**: This scenario corrects the Full (Macro) model for the environmental and macro costs/benefits arising from the project. This scenario appraises the project’s contribution to the wider economic welfare of the country, rather than to the owner of the infrastructure. Environmental benefits considered in this scenario include: the benefits accruing from a reduction in land take-up arising from the treatment proposal (when compared to the CoGAP³ measures); reduction in the import of fertilizers; reduction in CO₂ emissions; and the cost of generating renewable energy by other means (e.g. wind turbines). Based on the revenues generated from the above, the project returns an economic IRR of 24.6% and an overall economic NPV of approximately LM 13 million. These economic indicators support the case for the public good generated by the project.

- **Public Private Partnership (PPP) model**: This scenario excludes the collection and disposal costs associated with pig slurry and on-farm investments and sets out the revenue targets required in order to generate a 13% project IRR (the assumed target of a prospective private investor). To achieve an IRR of 13.0%, the price of electricity sold to Enemalta has to be c. LM 0.0482 per kWh. This represents a 38% increase on the Enemalta cost to produce electricity from fossil fuel over the generating cost in the 1st Quarter of 2005.

Non-monetary benefits from the centralized treatment plant option include:

**Better manure management control and administration**: Control of manure generation/use/disposal is much simpler and effective with the centralized treatment plants since the control function is limited to the few number of treatment sites instead of the > 1,000 livestock farms in Malta and Gozo. Moreover, this option allows for the controlled re-distribution of fertilizers to crop farmers. In this way, over-fertilization may be avoided, resulting in reduced costs and pollution of the groundwater, in accordance to the requirements of the Nitrate Directive.

**Reduction in Nitrogen in Manure**: The treatment process will reduce the nitrogen content in manure from c. 3,200 tonnes to around 2,000 tonnes, of which 500 tonnes will be present in the compost and approximately 1,500 tonnes in the form of a liquid fertilizer. This is not far off from achieving the limits imposed by the Nitrate Directive of 170 kg ha⁻¹ yr⁻¹ (representing approximately 1,700 tonnes per year). In other EU Member countries, failure to adhere to this limit has resulted in a reduction in livestock numbers (e.g. the Netherlands).

**Reduced greenhouse gas emissions**: Methane is a major contributor to the greenhouse effect when it escapes to the atmosphere. Current farmyard waste disposal practices cause methane to be released through natural processes. Methane is 21 times more harmful as a greenhouse gas than carbon dioxide. Anaerobic digestion exploits this process so that the gas can be harnessed and used as a fuel.

**Renewable Energy Production**: Anaerobic Digestion (AD) plants can provide an on-site energy source, displacing existing bought-in electricity. Due to EU policies promoting energy from renewable sources and the de-regulation of the electricity sector, the market for electricity from renewables sources such as AD, is likely to grow significantly, and opportunities for AD operators to sell their energy will, therefore, be increased. The amount of electricity produced from the agricultural waste treatment plants is estimated at 24,000 MWh per year. This equates

³ Code of Good Agricultural Practice
to approximately 1.15% of Malta’s electricity production; this amount of electricity from agricultural waste will assist Malta in meeting its 5% target of electricity from renewable energy production by 2010.

Cost effective and environmentally-sustainable waste recycling: When co-digesting and co-composting organic wastes with animal manures, it is possible to achieve environmentally attractive recycling of a number of other waste streams, apart from manures. The agricultural waste treatment plants can be designed to treat a number of problematic wastes such as abattoir waste, food processing waste, fish waste, animal by-products from meat processing plants, vegetable residue, etc. In doing so, the treatment plants will enhance the biowaste treatment capacity in Malta and can provide farms, industries and municipal authorities with a lasting and relatively cheap solution to their organic waste disposal problems. The list of waste/wastewaters that may be treated at the agricultural waste treatment plant is presented as Appendix I.

Reduction of odour nuisances: The storage and land-spreading of raw animal manures and slurries is associated with significant odour nuisance. With the recommended treatment option, odours will only be limited to 3-4 sites, and moreover, this can be mitigated through the use of appropriate odour abatement technologies and processes. Properly composted manure and digested slurries are relatively odourless.

Public and animal health benefits: Anaerobic digestion and composting results in significant die-off of the bacterial, viral and protozoan pathogens present in animal manures. The inclusion of a hygienisation step, as is commonly practiced in CAD plants, further reduces the pathogen load in the digestate. Composting at a temperature of > 55°C for 2 weeks ensures sanitisation (EU Working Document, Biological Treatment of Biowaste, 2 Draft, February 2001). This ensures that digested slurries and composted manure can be applied to fields without any risk to public health.

Tried and tested technology: The centralized agricultural waste treatment concept based on anaerobic digestion has an established track record in several European countries, such as Denmark, Germany, Austria and Sweden. Similarly, composting is a well established process.

Space saved on the farms: A considerable amount of on-farm space (approximately 70,000 m²) would be recuperated through the reclamation of the fields that are currently taken up for the storage of manure. This space can be better utilised to increase production or make the existing operations of the farm more efficient.

Potential problems in the implementation of the recommended option are:

Traffic movements: All waste management systems create traffic movements but, although overall quantities of vehicle movements may not be a major issue, the traffic may be concentrated in a small area, especially where such a centralized treatment plant is established. Apart from the vehicles delivering manure to the plant, one should also consider crop farmers’ trucks taking compost and liquid fertilizer from the treatment plants to their fields. The selected sites for the treatment plants should therefore be easily accessible and benefit from a good road network.

Space requirement: The 3-4 treatment plants will require a considerable amount of space. The greater part of the space is not taken up by the digestion plant, but by the composting plant. The use of compact in-vessel composting technology will reduce the land take-up.

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4 Indicative target in 2005 (This has now changed to 10% by 2020).
Implementation of the recommended option

When proposed in May 2005, the implementation of the recommended solution entailed the following administrative and legislative steps:

1. Approval in principle of the proposed Agricultural Waste Management Plan by MRAE and the Cabinet of Ministers which will then lead to the following legislative and administrative changes:
   i. Amendment to LN 139/02 (Sewer Discharge Control Regulations) so as to allow the controlled discharge of pig slurry into the sewerage system for end-of-pipe treatment at the municipal sewage treatment plants. It is understood that MRA are in the process of amending the same legal notice, for unrelated reasons.
   ii. Amendment of the Malta Action Programme for the Nitrate Directive and the Code of Good Agricultural Practice (CoGAP) to meet the requirements of the proposed solution. With the agricultural waste treatment plants in operation there is no need for the construction of manure clamps having a 5-month storage capacity on the farms. 2-week storage is sufficient.

2. Negotiation with the water regulator (MRA) and the operator of the sewerage treatment plants (WSC) for the establishment of a fair tariff for the collection and treatment of pig slurry at the municipal treatment plants.

3. Negotiation with the energy regulator (MRA) and the national energy operator (Enemalta) for the introduction of a favourable feed-in tariff for the production of electricity from biogas (a renewable source). This study has shown that the treatment plants will provide an adequate rate of return if the electricity sales price is increased to LM 0.0541 when the project is considered as a public investment project; the plants will attract potential investors at an electricity price of LM 0.048 in a PPP arrangement.

   The agricultural waste treatment plants are potential CDM (Clean Development Mechanism) projects and may attract investment from EU Member States and other countries seeking to purchase GHG emission credits in order to meet their obligations with regards to the Kyoto Climate Change Protocol. It is recommended that this avenue of potential FDI (Foreign Direct Investment) be actively pursued.

4. Establishment of a single official administrative body to oversee the implementation of the Agricultural Waste Management Plan, including the on-farm infrastructural requirements.

5. Dissemination of the benefits and costs of the recommended option to all stakeholders, including farmers’ cooperatives. In other EU Member States, similar treatment plants are operated by the farmers’ cooperatives. The treatment option has to be ‘sold’ in such a way to promote a sense of ‘ownership’ of the proposal. This should be followed by the undertaking of a survey/questionnaire amongst all animal husbandry farmers in order to establish the potential participation rate of the farmers in such a project. Participation in such a scheme can only be voluntary i.e. a farmer can choose to treat his farm’s manure in another way.

Technical issues to be undertaken include:

6. Determination of whether the planned sewage treatment plants will have sufficient treatment capacity to treat the pig slurry. Tests are being carried out by WSC to this effect. Additional treatment capacity can be made available at the Sant Antonin Sewage Treatment Plant if required – but this entails additional costs. Should it be confirmed that WSC actually do have the in-built treatment capacity within their designs for the new treatment plants to treat this additional wastewater, then the costs for slurry disposal will be lower to the benefit of the pig sector.
7. Selection of suitable sites for the construction of the 3-4 agricultural waste treatment plants. Suitable sites shall take into consideration the logistics involved in the transportation of manure from the animal farms to the treatment plants (and the compost and fertilizer to the fields), the distance from residences and tourist establishments (to mitigate for odour generation), visual impact, and the proximity to industrial estates, large farms etc. for the possible use of the surplus heat. The possibility of incorporating the agricultural treatment plants within existing/planned waste and wastewater treatment plants should be considered. There are also technical and economic benefits to be reaped in the co-firing of biogas and landfill gas at the Malta North plant.

8. Detailed design of the treatment plants, including corrections for the possible change in manure quantities and composition (arising from a reduction in herd numbers as a result of on-going restructuring and effects of competition, changes in water and feed management practices, etc.), and the co-digestion of other agricultural and non-agricultural wastes.
3. **Updating of the Draft Agricultural Waste Management Plan**

In May 2008, Sustech Consulting was asked to produce a Final version of the Agricultural Waste Management Plan that takes into account new developments that affect the Plan, such as:

- WSC’s prohibition of the discharge of pig slurry and farmyard wastewaters into the sewerage system once the new sewage treatment plants come on line,
- the construction of a number of on-farm waste management facilities during the last three years (particularly on cattle farms),
- changes in animal populations,
- the construction of solid and liquid waste treatment facilities by Wasteserv and WSC respectively,
- Malta’s recent commitment to generate 10% of its electricity from renewable sources by 2020,
- the spiralling cost of fossil fuels, thus making waste-to-energy processes more competitive.

### 3.1 Discharge of pig slurry into the sewerage system

In October 2006, the Water Services Corporation (WSC) notified the Ministry for Rural Affairs and the Environment that the WSC will no longer accept the direct or indirect discharge of agricultural waste into the sewers. WSC’s letter addressed to the Director of Environment Policy and Initiatives, MRAE of 4 October 2006 states that “the Water Services Corporation has gone a step further (from the COWI November 2005 report) and is calling for all untreated, direct and indirect agricultural waste discharges to the sewers to be discontinued”.

The Draft Agricultural Waste Management Plan (May 2005) had recommended that pig slurry and other wastewaters from agricultural sources continue to be discharged into the sewers (at discharge points indicated by WSC), because, given the price estimates provided at the time by WSC, this was believed to be the most cost-effective solution. However, revised estimates supplied by COWI (consultants to WSC) in November 2005 show that the acceptance of the pig slurry fraction into the sewer network will increase the Corporation’s annual capital amortization and running expenditure by € 4.0 million – which is unacceptable for WSC (and ultimately the animal farms that would have to fork out the additional costs as per the Polluter Pays Principle).

For this and other reasons, the current practice of discharging pig slurry in the sewerage network will not be accepted by WSC in future even though the COWI report (Nov 2005) stated that pig slurry does not constitute a problem for the Gozo sewage treatment plant and that the Malta North can handle the slurry from a maximum of 5,000 pigs (or 55% of pig slurry in the Malta North catchment area).

Nevertheless, WSC’s letter of Oct 4, 2006 supersedes this agreement; this effectively means that the possibility of direct discharge of all pig slurry in Gozo and partial-discharge of pig slurry in the Malta North catchment area is no longer available.

WSC’s prohibition order effectively means that the agricultural sector (including the pig farms) must build the necessary waste treatment infrastructure to treat its own waste and wastewaters.
This Final Draft Agricultural Management Plan takes this decision into account and attempts to provide a cost-effective alternative solution for the treatment and disposal of all agricultural waste, including pig slurry.

At the time of writing, the Gozo sewage treatment plant has been commissioned. The Malta North sewage treatment plant is expected to be operational during 2008, while the large Malta South treatment plant is at the tendering stage, and is planned to be fully operational by the end of 2009.

This implies that the need for an agricultural waste treatment is most urgent in Gozo (even though the Gozo sewage treatment plant has adequate treatment capacity to handle the wastewaters generated at the farms).

As an interim measure, part of farms in the north of Malta may be allowed to continue discharging into the sewerage system until an agricultural waste treatment solution is provided for the farms in the north of Malta.

The farms in the south of Malta must be provided with a solution before the end of 2009 if the operation of the Malta South municipal sewage treatment plant is not to be overloaded by agricultural discharges.

3.2 On-farm investments in waste management infrastructure

Compliance and observance of the Nitrates Directive in Malta became mandatory as from 1 May 2008. This implies that there should have been significant investments in on-farm manure and slurry storage facilities over the last 3-4 years to meet the requirements of the Directive and the Nitrate Action Plan. At the time of writing, it is reported that a number of cattle farms and some poultry farms are in fact in compliance, whilst a significant number of farms are still non-compliant. A review of the compliance status as of May 2008 has been carried out and the results are provided in this report.

The reasons for non-compliance may be various, but may be divided into three groups:

- farms that have the intention of becoming compliant and are in the process of doing so;
- farms that have the intention of becoming complaint but are unable to do so because of space limitations or other constraints;
- farms that have no intention of becoming compliant.

During its pre-accession negotiations with the EU, Malta had requested a three year investment period so as to give adequate time for the animal farms to construct manure and slurry storage facilities (manure clamps and cesspits).

In order that such works be effected it would have been necessary to first engage surveyors and architects to assess and quantify the necessary works; an application will then have to be submitted to MEPA in order to obtain the necessary development permits, a procedure which should take at least 6 months but may also take up to three times as long. Furthermore, banking procedures to obtain the necessary finance usually take at least a period of two months. Following these arrangements it would then be necessary for the applicant to engage contractors who would carry out the necessary works.

Most livestock enterprises in Malta are intensive and moreover they do not have further area available for expansion or modification of their activity. This may give rise to considerable delays
in the execution of restructuring works as these would very likely involve either curtailing of certain areas of production or temporary stalling of the livestock enterprise production process. As a consequence it was expected that this second procedure would have entailed 1 to 2 years for execution.

It should be pointed out that some farmers have received financial support under the Meeting Standards measure of the RDP for the construction/improvement of manure/slurry storage, starting from 2005.

Farmers were eligible to receive partial investment support in relation to the Nitrates Directive for a maximum of 3 years. The proposed ceiling for investments related to waste management and waste storage facilities in livestock farms could not exceed € 25,000 per farm per year for the first 3 years. This was calculated on actual capital investment required. Support was granted annually in the form of a flat rate aid and on a digressive basis owing to budget constraints. It is estimated that the financial support that was offered would have catered for approximately 20% of the total investment.

The capital investment for the construction of manure clamps and new cesspits on all farms in Malta and Gozo is estimated at approximately €20,500,000.

The support scheme has now come to a close - with some farmers having made the necessary investments, while others did not.

As part of the preparation of the Final Plan, it was considered necessary to carry out an assessment of the number of farms that are in compliance with the regulations. Data on the compliance status is not readily available; nevertheless, one can obtain a general idea of the situation through analysing MEPA development application data.

It should be pointed out that not all farms in possession of a MEPA permit would have constructed the manure containment facilities. Some may be in the process of obtaining finance; others in the process of engaging building contractors.

However, unless there is a change in policy that would encourage farmers not to invest in these structures, and provided that the farmers do not decide to close shop and/or downsize, it is to be assumed that those farms that have obtained a development permit would eventually make the necessary investments and come in line with the regulations.

The status of compliance by herd type was evaluated and presented hereunder.

**Dairy Farms**

The number of dairy farms that were in compliance with the Meeting Standards measure with respect to the construction of manure clamps and cesspits by May 2007 can be evaluated from data provided by the Animal Husbandry Unit at Ghammieri at the time, reproduced below.

**Malta (May 2007 data)**

<table>
<thead>
<tr>
<th>Herd Size (no. of heads)</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEPA Permit Granted</td>
<td>1998</td>
</tr>
<tr>
<td>With separator</td>
<td>930</td>
</tr>
<tr>
<td>Possibly with separator</td>
<td>556</td>
</tr>
<tr>
<td>No Separator</td>
<td>512</td>
</tr>
<tr>
<td>Permit Refused</td>
<td>120</td>
</tr>
<tr>
<td>No Application Submitted</td>
<td>2278</td>
</tr>
<tr>
<td>Application Pending</td>
<td>4118</td>
</tr>
<tr>
<td>---------------------</td>
<td>------</td>
</tr>
<tr>
<td>With separator</td>
<td>1529</td>
</tr>
<tr>
<td>Possibly with separator</td>
<td>187</td>
</tr>
<tr>
<td>No Separator</td>
<td>2402</td>
</tr>
<tr>
<td>Relocation being offered</td>
<td>1671</td>
</tr>
<tr>
<td>Should have applied</td>
<td>1326</td>
</tr>
<tr>
<td><strong>TOTAL MALTA</strong></td>
<td>11511</td>
</tr>
</tbody>
</table>

Gozo (May 2007 data)

<table>
<thead>
<tr>
<th>Herd Size (no. of heads)</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEPA Permit Granted</td>
<td>331</td>
</tr>
<tr>
<td>Permit Refused</td>
<td>0</td>
</tr>
<tr>
<td>No Application Submitted</td>
<td>1373</td>
</tr>
<tr>
<td>Application Pending</td>
<td>3727</td>
</tr>
<tr>
<td>Relocation being offered</td>
<td>0</td>
</tr>
<tr>
<td>Should have applied</td>
<td>1064</td>
</tr>
<tr>
<td><strong>TOTAL GOZO</strong></td>
<td>6495</td>
</tr>
</tbody>
</table>

Malta and Gozo (May 2007 data)

<table>
<thead>
<tr>
<th>Herd Size (no. of heads)</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEPA Permit Granted</td>
<td>2329</td>
</tr>
<tr>
<td>Permit Refused</td>
<td>120</td>
</tr>
<tr>
<td>No Application Submitted</td>
<td>3651</td>
</tr>
<tr>
<td>Application Pending</td>
<td>7845</td>
</tr>
<tr>
<td>Relocation being offered</td>
<td>1671</td>
</tr>
<tr>
<td>Should have applied</td>
<td>2390</td>
</tr>
<tr>
<td><strong>TOTAL MALTA AND GOZO</strong></td>
<td>18006</td>
</tr>
</tbody>
</table>

Therefore, after two years from the start of the implementation of the support scheme:

- 12.9% of the dairy farms in Malta and Gozo had been granted a development permit by May 2007 and would have been at different stages of construction of the necessary structures at the time. Therefore, one can assume that these farms are or will be compliant in the near future.
- 0.7% of the farms have had their application refused.
- A significant 20.3% of the farms did not submit an application. It is therefore unlikely that they will become compliant in the short or medium term.
- 43.6% were still at the application processing stage, which means that they were running the risk of not being compliant by the May 2008 deadline.
- 9.3% have been offered relocation. However, given that these farms have not been relocated to date, they may be considered to fall under the non-compliant category.
- A significant 13.3% should have applied for a development permit, but did not. There is no indication as to the reason why they did not apply.

Other observations relative to the data obtained in May 2007:
- The number of permits granted for dairy farms in Malta was significantly higher than those in Gozo.
- Of those farms granted permits in Malta, it seems that more than half the farms will have solid-liquid separators. The benefit of having a separator lies in the fact that the storage space requirement for the solids fraction is greatly reduced.
- There was a significantly larger number of permits still pending in Gozo (57.4%) than in Malta (35.8%).
- One in five farms in Malta (19.8%) and Gozo (21.1%) did not submit an application for the construction of manure containment facilities.

Updated information for the status of compliance as of 14 May 2008 (i.e. after the 1 May 2008 deadline had expired) presented the following situation:

**Malta and Gozo (May 2008 data)**

<table>
<thead>
<tr>
<th>Herd Size (no. of dairy cows)*</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEPA Permit Granted</td>
<td>4,530</td>
</tr>
<tr>
<td>No Application Submitted</td>
<td>1,657</td>
</tr>
<tr>
<td>Application Pending</td>
<td>708</td>
</tr>
<tr>
<td>Relocation being offered</td>
<td>860</td>
</tr>
<tr>
<td><strong>TOTAL MALTA</strong></td>
<td><strong>7,755</strong></td>
</tr>
</tbody>
</table>

* The number of heads on dairy farms can be obtained from the number of dairy cows multiplied by an empirical factor of 2.01

It is clear that over the last year there has been a considerable improvement in the processing of MEPA permits, with the result that 58.4% of the national dairy farms (by herd) are now in possession of a development permit that will enable them to come in compliance with the Meeting Standards measures in the short- to medium-term. This figure increased from a mere 12.9% a year ago.

The number of farms not intending to become compliant remains constant at around 20%.

Some other observations relating to the May 2008 data:
- It seems that the larger dairy farms either already have a development permit or did not apply at all.
- The dairy farms being relocated are relatively small farms (at approximately 36 heads per farm on average). These farms represent 17% of total dairy farms (11% by herd size).
- With the assumption that the ‘Application Pending’ farms will eventually get a development permit, the total farms obtaining a development permit will represent 61% of all farms (67% of herd size). If one had to add the farms to be relocated, the number of ‘regularised’ farms would represent 78% of all farms. The amount of farms not being in
compliance in the long-term would therefore be 22% of current. One can assume that the latter farms will be forced to cease operations in the future.

**Poultry Farms**

**Broiler**

Until April 2007, only a small amount of broiler farms were compliant with the Meeting Standards measure, as shown by the information below, extracted from farm-by-farm data provided by the Food and Veterinary Regulation Division (FVRD).

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Malta</strong></td>
<td></td>
</tr>
<tr>
<td>Already compliant (in April 2007)</td>
<td>4.0%</td>
</tr>
<tr>
<td>Probable compliance</td>
<td>13.1%</td>
</tr>
<tr>
<td>Uncertain outcome</td>
<td>29.4%</td>
</tr>
<tr>
<td>Will not be compliant</td>
<td>53.5%</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gozo</strong></td>
<td></td>
</tr>
<tr>
<td>Already compliant (in April 2007)</td>
<td>2.6%</td>
</tr>
<tr>
<td>Uncertain outcome</td>
<td>3.4%</td>
</tr>
<tr>
<td>Will not be compliant</td>
<td>94.0%</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Malta and Gozo</strong></td>
<td></td>
</tr>
<tr>
<td>Already compliant (in April 2007)</td>
<td>3.6%</td>
</tr>
<tr>
<td>Probable compliance</td>
<td>9.2%</td>
</tr>
<tr>
<td>Uncertain outcome</td>
<td>21.8%</td>
</tr>
<tr>
<td>Will not be compliant</td>
<td>65.4%</td>
</tr>
</tbody>
</table>

**Observations**

- It can be seen that only 3.6% of the broiler farms were compliant by April 2007 i.e. obtained the necessary development permits and have made the necessary investments
- 9.2% have/will probably get the development permits but have not yet made any investments
- 65.4% will not be compliant. If one had to assume that half of the ‘uncertain outcome’ category would not obtain the necessary permits then the total amount of farms that will not be compliant comes up to 76.3%. This means that if the regulations were to be strictly enforced, the broiler sector in the Maltese Islands will contract by around 75% of April 2007 levels.
- The situation in Gozo is significantly worse than that of Malta. Almost all of the broiler farms in Gozo will not be compliant (94%).
Layers

The situation with regards to layers is slightly better than that for broilers, with the percentage of layer farms being compliant to the Meeting Standards measure by April 2007 reaching the 9.4% mark, and the ‘probable compliance’ sector making up another 41.9%.

<table>
<thead>
<tr>
<th></th>
<th>Malta</th>
<th>Gozo</th>
<th>Malta and Gozo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Already compliant (in April 2007)</td>
<td>5.1%</td>
<td>42.2%</td>
<td>9.4%</td>
</tr>
<tr>
<td>Probable compliance</td>
<td>47.4%</td>
<td></td>
<td>41.9%</td>
</tr>
<tr>
<td>Uncertain outcome</td>
<td>23.6%</td>
<td></td>
<td>23.1%</td>
</tr>
<tr>
<td>Will not be compliant</td>
<td>23.9%</td>
<td></td>
<td>25.6%</td>
</tr>
</tbody>
</table>

Observations

- Only 9.4% of the layer farms were compliant as of April 2007. Incidentally, the level of compliance in Gozo is significantly higher than that of layer farms in Malta.
- 41.9% of the layer farms had obtained (or will probably obtain) the necessary permits for manure clamp/cesspit structures but had not yet made any investments.
- It is estimated that around 37% of the layer farms will not reach compliance status. Similarly, if the regulations are enforced, based on these figures, one may see a contraction of 35-40% of the poultry layer sector in the Maltese Islands in the medium- and long-term.

More recent data (May 2008) on the level of compliance of the poultry sector shows that out of the 193 poultry units in Malta and Gozo, 43 units (22.2%) have been granted a development permit, while 30 units (15.5%) are awaiting a permit. The remaining 120 units did not apply for a development permit for the construction of waste management facilities by May 2008.

As for the dairy sector, the number of permits approved by MEPA for the poultry sector in the last year is very high, with the fraction of farms having their application approved reaching 22.2% from around 6.5% last year. Nevertheless there remain more than 60% of the layer farms that will not be compliant in the medium- and long-term.
**Pig Farms**

There is no information relating to the level of compliance of pig farms with respect to the Meeting Standards measure. It is not clear as to which regulating agency is responsible for ensuring compliance on pig farms.

### 3.3 State of the animal husbandry industry in Malta and future predictions

It is not the purpose of this study to provide a detailed evaluation of the economic viability of the animal husbandry sector in Malta. However, it is important to attempt to assess the capability of the livestock sector to cope with economic pressures because this will affect the viability of the animal husbandry sector in Malta and hence the quantities of manure to be treated.

Economic pressures arise from:

- Competition from imported products. Previous studies (James. A, 2000 and Jackson. P, 2001) had expressed concern on the capability of Malta’s animal farming sector to withstand the pressures of a liberalized market, with some sectors (dairy and rabbit) believed to be more resilient than others (pig and poultry).

- Charges in water use. EU Water Framework Directive stipulates the need to protect groundwater resources. In Malta's case this reflects in a need to reduce groundwater extraction. Most of the animal farms in Malta (and Gozo) use free groundwater as the main (or only) source of water. The eventuality that groundwater users will be made to pay the economic cost of water will especially affect dairy and pig producers.

- The cost of animal feed and electricity/fuel.

Measures to improve the productivity and profitability of animal production in Malta, while reducing the amount of biowaste to be treated/disposed of are provided by Jackson. P (2001), Section 4.2.

In the preparation of this Final Report, it was considered necessary to undertake an assessment of National Statistics Office (NSO) data on animal populations in Malta and Gozo in order to establish whether there were any significant changes in the animal production sector since accession to the EU. The changes in animal population (if any) will provide an insight as to whether the animal husbandry sector in Malta has been successful in withstanding the pressures of EU accession.

### Cattle

<table>
<thead>
<tr>
<th>Year</th>
<th>Malta</th>
<th>Gozo</th>
<th>Malta and Gozo</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>13,393</td>
<td>6,015</td>
<td>19,408</td>
</tr>
<tr>
<td>2005</td>
<td>13,758</td>
<td>5,984</td>
<td>19,742</td>
</tr>
<tr>
<td>2006</td>
<td>13,123</td>
<td>6,110</td>
<td>19,233</td>
</tr>
<tr>
<td>2007</td>
<td>13,166</td>
<td>6,276</td>
<td>19,442</td>
</tr>
</tbody>
</table>

The cattle population increased by 1.7% in 2005 (over 2004 levels), then dropped by 2.6% in 2006 (with a significant drop of 4.6% in Malta being cushioned by an increase of 2.1% in Gozo). A slight increase of 1.1% of the national cattle population was registered in 2007.
Over the three years since accession, there was no net significant change in the national cattle population. The cattle herd in Gozo increased by 4.3%, while the population in Malta decreased by 1.7%.

### Pig

<table>
<thead>
<tr>
<th>Year</th>
<th>Malta</th>
<th>Gozo</th>
<th>Malta and Gozo</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>71,939</td>
<td>5,045</td>
<td>76,853</td>
</tr>
<tr>
<td>2005</td>
<td>68,722</td>
<td>4,914</td>
<td>73,635</td>
</tr>
<tr>
<td>2006</td>
<td>69,051</td>
<td>4,303</td>
<td>73,354</td>
</tr>
<tr>
<td>2007</td>
<td>71,831</td>
<td>4,632</td>
<td>76,463</td>
</tr>
</tbody>
</table>

Similarly to the cattle sector, the pig population in the Maltese Islands fell in 2005 (-5.0%), and then recovered slightly in 2006 (+0.9%) and increased again in 2007 (+4.4%).

The national pig population changed marginally (<0.1%) over the period 2004-2007, although significant swings from year to year have been observed.

It is interesting to note that although the pig population increased in 2006 and again in 2007, the amount of heads slaughtered at licensed slaughterhouses in Malta decreased by 4.3% in 2006, and by 9.0% in 2007. Clearly, something is amiss. It is not the scope of this study to investigate this phenomenon. However, it is understood that the amount of pigs slaughtered is more indicative of the resilience (or rather non-resilience) of the pig sector in Malta than pig population numbers. It is quite evident that the pig sector is suffering pressures from imported products, and this despite the fact that pig farmers have not had to invest in slurry treatment facilities or pay for groundwater supplies.

### Layers

Data for the poultry sector is only available for the period 2001-2005, in bi-annual intervals.

<table>
<thead>
<tr>
<th>Year</th>
<th>Malta</th>
<th>Gozo</th>
<th>Malta and Gozo</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>301,497</td>
<td>73,691</td>
<td>375,188</td>
</tr>
<tr>
<td>2003</td>
<td>429,320</td>
<td>76,241</td>
<td>505,561</td>
</tr>
<tr>
<td>2005</td>
<td>412,970</td>
<td>56,218</td>
<td>469,188</td>
</tr>
</tbody>
</table>

The layer population increased considerably during the period 2001-2003, with a registered population increase of 35%. The increase in Malta was 42% while Gozo only registered a slight increase of 3.5%.

However, Malta’s accession to the EU may have resulted in a contraction of the layer population, since a reduction in layer numbers to the tune of 7.4% was recorded in 2005, over 2003 figures. This reduction was more pronounced in Gozo, which experienced a drop of 26% in the number of laying hens.
Broilers

The NSO data for broilers is presented below.

<table>
<thead>
<tr>
<th></th>
<th>Malta</th>
<th>Gozo</th>
<th>Malta and Gozo</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>912,430</td>
<td>271,727</td>
<td>1,184,157</td>
</tr>
<tr>
<td>2003</td>
<td>623,821</td>
<td>228,864</td>
<td>852,685</td>
</tr>
<tr>
<td>2005</td>
<td>428,773</td>
<td>146,379</td>
<td>575,152</td>
</tr>
</tbody>
</table>

Contrary to the other livestock sectors, the broiler population is in a steady decline. A 28% decrease in broiler population was experienced over the period 2001-2003, followed by another significant decline of 33% in 2003-2005.

The decrease in broiler population has taken place both in Malta and Gozo, with Gozo experiencing a very significant drop in the period 2003-2005 (of 36%).

The broiler population in 2005 was approximately half (51.4%) of what it was in 2001.

A cross-check with poultry slaughtering figures confirms this negative trend.

<table>
<thead>
<tr>
<th></th>
<th>Poultry Slaughters (in tones)</th>
<th>% change from previous year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>6,661</td>
<td>-</td>
</tr>
<tr>
<td>2003</td>
<td>7,405</td>
<td>+ 11.2%</td>
</tr>
<tr>
<td>2004</td>
<td>6,294</td>
<td>- 15.0%</td>
</tr>
<tr>
<td>2005</td>
<td>4,518</td>
<td>-28.2%</td>
</tr>
</tbody>
</table>

The reduction in slaughtered numbers was particularly acute for Gozo in 2004-2005, which registered a drop of 65.5% during this period.

Conclusion

It is evident that the animal husbandry sector in Malta is still in a phase of transition, adaptation and consolidation since Malta’s accession to the EU. Although livestock population numbers have not shown a marked decrease since accession (except for the poultry sector, and broilers in particular), it is to be expected that these will decrease and then stabilize at a lower level in the medium and long term.

Following consultations carried out with officials from MRAE in June 2006, it was forecast that the animal livestock sector in Malta will stabilize as the following levels in the medium and long term:

<table>
<thead>
<tr>
<th></th>
<th>Change from 2005 levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle (dairy and beef)</td>
<td>- 20%</td>
</tr>
<tr>
<td>Pigs</td>
<td>- 30%</td>
</tr>
<tr>
<td>Broiler</td>
<td>- 25%</td>
</tr>
<tr>
<td>Layer</td>
<td>- 25%</td>
</tr>
<tr>
<td>Rabbit</td>
<td>0%</td>
</tr>
</tbody>
</table>
These projections should be taken into account when planning any centralized treatment plants for the livestock sectors. However, given that the livestock sector is still going through a period of uncertainty one should re-evaluate the situation at the more appropriate time.

3.4 Co-treatment with Municipal Solid Waste

The Draft Agricultural Waste Management Plan (2005) suggested the possibility of incorporating the agricultural waste management plants within existing/planned waste (and wastewater) treatment plants, as there are technical, logistic and economic benefits to be reaped in doing so.

In 2006, Wasteserv Malta Ltd. signed contracts for the construction of a Mechanical Biological Treatment (MBT) plant at Sant Antnin, Marsascala to treat 71,000 tonnes of municipal solid waste (MSW) of which 35,000 tonnes will be biodegradable waste. The biodegradable waste will be digested anaerobically for the production of biogas and generation of electricity. The digestion process will be of the ‘wet digestion’ type similar to that recommended for the treatment of agricultural waste in the Draft Agricultural Waste Management Plan. The Sant Antnin facility will help Malta to meet its 2010 target of reducing biodegradable waste sent to landfill to 75% of the 1995 level in accordance to the EU Landfill Directive.

Other waste treatment facilities need to be developed to meet Malta’s obligations with regards to the EC Landfill Directive beyond 2010. This would involve the construction of additional treatment facilities in Malta and Gozo.

These are likely to take the form of an MBT plant in Gozo and another in the North of Malta. Studies relating to the design and planning of the proposed MBT plants are being carried out by Carl Bro A/S of Denmark who have been engaged through the General Technical Assistance for Project Pipeline 2007-2013 to provide technical assistance to Wasteserv on these matters.

Preliminary studies were carried out by Carl Bro A/S in the last quarter of 2006 on treatment options for Gozo and the North of Malta. Carl Bro’s remit included the investigation of the co-treatment of municipal waste with agricultural waste.

Gozo

In October 2006, Carl Bro A/S produced a report that considers the co-treatment of MSW and agricultural waste generated in Gozo.

The consultants evaluated two options:

1) a Mechanical Treatment Facility (MTF) for the reception, sorting and transfer of the various waste fractions to Malta, including biodegradable waste

2) a Mechanical Biological Treatment (MBT) Facility for the reception and biological treatment of MSW, agricultural slurries and manure, and sludge from the municipal sewage treatment plant in Gozo, as well as the post-treatment of the solids and transfer to Malta of the Refuse Derived Fuel (RDF) generated in Gozo.

The amount of waste generated in Gozo is approximately 9,300 tonnes (in 2006) of which 4,600 tonnes is estimated to be biowaste. The main advantage of Option 2 over Option 1 lies in the fact that the amount of waste to be transferred to Malta for treatment is reduced from approximately 1 trip per day to 2 per week.

The process being proposed for the co-treatment of MSW and agricultural waste (Option 2) is illustrated in Figure 7.
In the pre-treatment section the waste is sorted into biodegradable waste and RDF; the biodegradable waste if further processed to prepare it for biological treatment.

The RDF will be compacted into containers for the transport to Malta for landfilling (until an RDF facility in Malta is set up).

From the pre-treatment the biodegradable waste is pumped to the biological treatment, which takes place in the digester tanks (anaerobic treatment). In the digesters, organic material is degraded resulting in the production of biogas. The biogas is cooled, dried and pumped into a pressurised gas storage containers for eventual re-use in the generation of electrical power (a renewable source).

From the digesters, the digestate is taken to a solid/liquid separation. The solids are post-treated in a closed composting plant (aerobic treatment) and end up as a stable fertilizer product to be returned to farmers. A small part of the end products will not have the quality required by the farmers, and this product will be used for landscaping, afforestation projects and for the rehabilitation of the disused rubbish dump in Gozo.

The liquids are evaporated by use of the surplus heat from the power generation.

**Waste Types and Amounts**

Table 6 shows the waste types and amounts to be received and treated by the two options.

<table>
<thead>
<tr>
<th>Type of waste</th>
<th>Amount of Waste (tonnes/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Option 1</td>
</tr>
<tr>
<td>MSW</td>
<td>7,400 8,000 9,600</td>
</tr>
<tr>
<td>Biodegradable waste</td>
<td>4,500 5,000 6,000</td>
</tr>
<tr>
<td>Sludge</td>
<td>No No No</td>
</tr>
<tr>
<td>Pig manure</td>
<td>No No No</td>
</tr>
<tr>
<td>Cattle manure</td>
<td>No No No</td>
</tr>
<tr>
<td>Other manure</td>
<td>No No No</td>
</tr>
<tr>
<td>Total for treatment</td>
<td>No No No</td>
</tr>
<tr>
<td>Waste to Malta</td>
<td>7,400 8,000 9,600</td>
</tr>
</tbody>
</table>

Table 6. Waste types and amounts for the two options considered for Gozo

The figures for manure used by Carl Bro A/S are taken from the Draft Agricultural Waste Management Plan (2005), with the following assumptions:

- 85% of the manure being generated in Gozo will arrive at the plant for treatment (i.e. there will be a ‘leakage’ of 15%)
- Cattle manure will arrive as a slurry having a dry matter content of 10-12% in the summer months, and a 7-8% dry matter content in the winter.
- Pig manure will arrive at the plant at a dry matter content of 5%
- Collection and mixing of the different types and amounts of manure at a central biological plant in Gozo will result in an average dry matter content of the mixture of approximately 13%
Figure 7. Proposed Treatment Process for the co-treatment of MSW and manure and slurries
While Option 1 will provide a sorting facility whereby MSW generated in Gozo can be sorted for further processing in Malta, Option 2 provides the following additional benefits:

- Considerable reduction in the amount of waste to be transported to Malta
- Reduces the requirement for treatment of biowaste in Malta
- Provides a cost-effective solution for the treatment of agricultural waste (particularly manure) in Gozo; this will in turn reduce the organic load on the municipal wastewater treatment plant operated by WSC and thereby achieve a considerable saving on the operation costs
- Generates a significant quantity of electricity from a renewable source, in accordance with the vision of making Gozo an eco-island
- Removal of around 50% of the nitrogen, which today is causing nitrate pollution of the groundwater
- Production of a fertilizer product, which is stable and easy to use, with little or no odours, and which may even reduce the importation of chemical fertilizers.

In November 2006, Carl Bro A/S presented a progress report wherein they evaluated the technical options of:

- installing an MBT plant for MSW only in Gozo (i.e. without manure)
- installing an MBT plant for MSW and a biogas (digestion) plant for manure

Initial estimates for the investments and the operating costs have been prepared for the two options for the Gozo MBT plant and are presented hereunder.

<table>
<thead>
<tr>
<th>Investment in MBT and Biogas plant for manure</th>
<th>MBT and Biogas Plant for manure Euro</th>
<th>MBT only (without manure) Euro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings</td>
<td>1,190,000</td>
<td>1,050,000</td>
</tr>
<tr>
<td>Tanks</td>
<td>1,320,000</td>
<td>400,000</td>
</tr>
<tr>
<td>Equipment and Installation</td>
<td>12,090,000</td>
<td>5,750,000</td>
</tr>
<tr>
<td>Trucks &amp; Transport Equipment</td>
<td>1,250,000</td>
<td>40,000</td>
</tr>
<tr>
<td></td>
<td>15,850,000</td>
<td>7,240,000</td>
</tr>
</tbody>
</table>

The investment costs for the combined plant are c. € 8.6 million higher than for the MBT for MSW plant only.

Treatment costs are considered to be an important factor in the decision process, especially regarding the treatment of manure. Therefore initial estimates of the treatment costs have been prepared by Carl Bro A/S for the options considered for Gozo and are presented in Table 7 below.

<table>
<thead>
<tr>
<th>Treatment costs for biodegradable waste at MBT and Biogas plant</th>
<th>Total Cost Euro/tonne</th>
<th>Capital Costs Euro/tonne</th>
<th>Operational Costs Euro/tonne</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBT with manure</td>
<td>30</td>
<td>23</td>
<td>7</td>
</tr>
<tr>
<td>MBT without manure</td>
<td>140</td>
<td>97</td>
<td>42</td>
</tr>
</tbody>
</table>

Table 7. Treatment Costs
It is immediately evident that there are clear economical benefits to be accrued if the MBT plant for MSW is combined with a biogas treatment plant for the treatment of manure.

Indeed Carl Bro A/S recommended that the Maltese Government opts for Option 2 (the co-treatment of MSW, agricultural waste and sewage sludge), “if it is the intention of the Government to implement a manure management system at Gozo in the near future like the system described in the draft Agricultural Waste Management Plan for the Maltese Islands (2005)”. 

**Malta**

In October 2006, Carl Bro A/S presented a report that evaluates a number of options for the treatment of biodegradable waste on Malta.

The treatment options for Malta take into consideration:

- The need to treat manures and slurries arising from the livestock farms;
- The refurbished Sant Antnin MBT plant that will take 71,000 tonnes mixed MSW per year. When source segregation is implemented it will take only the biodegradable part which is expected to constitute approximately 35,000 tonnes a year;
- The possibility of treating sewage sludge from the municipal wastewater plants to be constructed in Malta and Gozo

To this end, Carl Bro investigated three alternative options for the MBT plant(s) in Malta. All options will treat manure and biowaste (from MSW) in separated lines to ensure good quality of the end products and all three options are seen as additional facilities to the refurbished Sant Antnin MBT plant.

**Option 1:** Two Treatment Facilities to be established on Malta,

*One anaerobic treatment plant in the south of Malta* to receive and treat sludge from sewage treatment plants on Malta together with solid and liquid manure from the southern part of Malta

*One MBT plant in the north of Malta* to receive and treat mixed MSW which is not taken by the Sant Antnin plant, as well as solid and liquid manure from the central and northern parts of Malta.

**Option 2:** Two Treatment Facilities to be established on Malta, but not catering for the treatment of sewage sludge

This option is similar to Option 1; the only difference being that the anaerobic treatment plant in the south will **not receive sewage sludge**

**Option 3:** Only One Treatment Facility to be established in Malta

Only one new treatment facility to be established. This is a new MBT plant in the north of Malta to receive and treat all mixed MSW which is not going to Sant Antnin, and **all** the solid and liquid manure generated on Malta.
Options 1 and 2 consider that some 102,900 tonnes of manure (36% of total) will be treated at the Malta South biogas plant, and 185,400 tonnes of manure (64% of total) being treated at the Malta North plant.

Option 3 considers the treatment of 288,200 tonnes of manure (i.e. all the manure generated on Malta) to be treated at the Malta North MBT plant.

The following general assumptions were used for the calculation of the mass flow for the treatment plants:
- 85% of the manure being generated in Malta will arrive at the treatment plants for treatment (i.e. there will be a ‘leakage’ of 15%)
- Pig farmers will change the manure handling system/procedures at their farms to increase the dry matter content of the slurry to 5% total solids content.

Calculations for the area needs for the plants included in the three options are presented in Table 8 below.

<table>
<thead>
<tr>
<th>Area for Treatment Facilities</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>m²</td>
<td>South</td>
<td>North</td>
<td>South</td>
</tr>
<tr>
<td>16,600</td>
<td>32,650</td>
<td>15,050</td>
<td>32,650</td>
</tr>
<tr>
<td></td>
<td>49,250</td>
<td>47,700</td>
<td>40,200</td>
</tr>
</tbody>
</table>

Table 8. Area required for the waste treatment facilities

Therefore, there is some space to be saved through the consolidation of all treatment facilities at a single site in the North of Malta. However, this necessitates the acquisition of a relatively large single piece of land (40,000 m²).

The Biogas Plant and the MBT Plant will generate biogas which will be used as fuel for gas engines to produce electricity. Table 9 below shows the amount of electricity to be generated by each option.

<table>
<thead>
<tr>
<th>Energy Generation (in 2015)</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>MWh/year</td>
<td>South</td>
<td>North</td>
<td>South</td>
</tr>
<tr>
<td>5,600</td>
<td>24,600</td>
<td>4,500</td>
<td>24,600</td>
</tr>
<tr>
<td>30,200</td>
<td>29,100</td>
<td>29,200</td>
<td></td>
</tr>
</tbody>
</table>

Table 9. Estimates of generated electrical energy
Within the uncertainties of the estimations presented above, the production of electricity (and heat) is practically the same for all 3 options. The difference between Option 1 and the other two options is the contribution of sludge from the sewage treatment plant. If this sludge is to be treated elsewhere (at a sludge treatment facility within the premises of the Malta South Sewage Treatment Plant, for example), the amount of electricity produced by the three options will be the same.

<table>
<thead>
<tr>
<th>Investment Costs</th>
<th>Euro</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option 1</strong></td>
<td><strong>Option 2</strong></td>
</tr>
<tr>
<td>South</td>
<td>North</td>
</tr>
<tr>
<td>11,350,000</td>
<td>45,960,000</td>
</tr>
<tr>
<td>57,310</td>
<td>57,310</td>
</tr>
</tbody>
</table>

The investment costs include the construction of buildings, tanks, equipment, installation costs, and trucks and transport equipment.

Treatment costs are considered to be an important factor in the decision process especially regarding the treatment of manure. Therefore initial estimates of the operating costs have been prepared by Carl Bro and are reproduced hereunder.

<table>
<thead>
<tr>
<th>Treatment Costs</th>
<th>Euro / tonne</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option 1</strong></td>
<td><strong>Option 2</strong></td>
</tr>
<tr>
<td>South</td>
<td>North</td>
</tr>
<tr>
<td>17</td>
<td>25</td>
</tr>
</tbody>
</table>

The treatment costs have been estimated on the assumption that the investments are financed through loans with a real interest rate of 5% p.a. The capital cost (repayment of loan and interest) contributes the major part of the costs (as much as 80% for the MBT plants, going up to 90% in the case of the Malta South biogas plant).

If the investments are not going to be repaid i.e. because the plants may be financed by EU Cohesion Funds, the real costs are reduced to cover the operating costs, or roughly reduced to 20-25% of the treatment costs shown above.

An exercise was carried out to calculate the annual treatment costs pertaining to each option; the results are shown in Table 10. Given that the treatment processes result in the production of electricity (i.e. a saleable product of high value), the net treatment costs were arrived at by subtracting the revenue to be accrued from the sale of electricity (to the national electricity provider, Enemalta) from the gross treatment costs.
Annual Treatment Costs

<table>
<thead>
<tr>
<th></th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>South</td>
<td>North</td>
<td>South</td>
</tr>
<tr>
<td></td>
<td>112,900 t</td>
<td>322,500 t</td>
<td>102,900 t</td>
</tr>
<tr>
<td>Treatment Costs</td>
<td>€ 17 / t</td>
<td>€ 25 / t</td>
<td>€ 17 / t</td>
</tr>
<tr>
<td></td>
<td>€ 1,919,300</td>
<td>€ 8,062,500</td>
<td>€ 1,749,300</td>
</tr>
<tr>
<td>Net Treatment Costs</td>
<td>€ 9,981,800</td>
<td>€ 9,811,800</td>
<td>€ 8,931,300</td>
</tr>
</tbody>
</table>

| Less Revenue from Sale of Electricity* | € 3,517,300 | € 3,389,200 | € 3,400,900 |
| Net Treatment Costs | € 6,464,500 | € 6,422,600 | € 5,530,400 |

* Assuming a sales price of Euro 0.116/kWh (Lm 0.05/kWh)

Table 10. Treatment Costs

It can be seen from the above table that there is no significant difference between the treatment costs of Option 1 and Option 2; Option 3 is clearly the most cost effective option. This is to be expected since the establishment of one large facility instead of two will result in a slight reduction of investment costs.

However, given that the Malta South Biogas Plant (associated with Option 1 and Option 2) is also a large plant and therefore benefits from economies of scale, the effect of scale is in itself not a decisive factor.

Moreover, the lower investment costs pertaining to Option 3 may be offset against the higher transportation costs associated with this option - which entails the transportation of around 103,000 tonnes of manure (and a lesser amount of soil conditioner) generated in the south of Malta to be shuttled across the length of the island.

The revenue that may be accrued from all treatment options is substantial and will offset part of the investment costs in a not insignificant way. If the capital investments were not to be repaid (by the use of EU Cohesion Funds for example), the gross treatment costs were to be reduced to 20-25% of those shown above. At these relatively low treatment costs treatment plants will render a profit even if a gate fee were not charged – provided that Enemalta pays € 0.116 (Lm 0.05) per kWh of electricity exported to the grid.

Overall Conclusions

- It is evident that the co-treatment of MSW with manure offers a number of technical, economical and strategic advantages. In a densely populated country like Malta it is preferable to have few large waste management centres. Combined treatment facilities for
MSW, sludge and manure will gather all waste treatment activities into two or maximum three sites, taking the Sant Antnin plant into account.

- A combined treatment plant for MSW and manure in Gozo will make an MBT plant in Gozo economically viable.

- Option 3 (the treatment of all the manure in Malta at a single large treatment plant in the north of Malta) requires only one (large) site to be identified in the north of Malta, unlike Options 1 and 2 – which require another site in the south of Malta. The siting factor is a very important issue since it will be very difficult to find a site for a relatively large waste treatment plant in the south or central parts of Malta (or indeed anywhere in Malta). So having a single treatment plant offers some advantages in this respect. However, it is not considered practical to transport more than 150,000 tonnes/year of manure and slurries across the length of Malta every year. To this, one must add the transportation of the end-products from the treatment plant for application on the fields, a significant proportion of which lie in the south of Malta. The willingness of crop farmers to use the end products of the treatment as a compost/fertiliser/soil-conditioning product is considered critical for the success of the manure management process and long distances may deter the farmers. For this reason, Option 3 (a single manure treatment facility in the north of Malta) is being sidelined.

- During discussions held with WSC in May 2008, it was evident that WSC have realised the energetic value of sewage sludge and will be installing their own sludge treatment facility at the Malta South sewage treatment plant. Therefore, the possibility of co-treating sewage sludge with MSW and manure (Option 1) is to be dropped.

- This leaves Option 2 (a biogas plant in the south of Malta for solid and liquid manure, and an MBT plant in the north to treat MSW and manure) as being the preferred option for the treatment of manure and slurries in Malta.

3.5 Cost of electricity generation

It is evident that that the economic and financial feasibility of the waste treatment plants depends heavily on the feed-in tariff for the renewable energy that can be generated by the waste treatment plants. At the same time, the feed-in tariff is generally tagged to cost of conventional electricity. That is, operators of a waste treatment plant that produces electricity can only hope to get to get a good price for the electricity they export to the grid if the selling price is competitive to that of conventional electricity generation.

The draft Agricultural Waste Management Plan had established that a feed-in tariff of LM 0.0482 per kWh (€ 0.11/kWh) was required in order to make the project viable on a PPP (private-public-partnership) basis. However, at the time of writing of the draft report in May 2005, the cost of generation to the public energy utility, Enemalta was (only) LM 0.035 per kWh (€ 0.082/kWh), thus making a proposal to increase the feed-in tariff to € 0.11/kWh unattractive to Enemalta.

Enemalta generates electricity at two oil-fired power stations, one in Marsa and the other in Delimara. The cost of generation is highly dependent on the cost of the fuel, with the fuel cost making up for more than 80% of the total generation cost.

By September 2006, the cost of generating one unit of electricity in Malta had increased to LM 0.0461 (€ 0.1072/kWh) - a 32% increase in generating cost when compared to that registered in May 2005.

The generating cost dipped slightly to LM 0.0435 (€ 0.101) / kWh over the period Oct 06 – Mar 07.

Source: Data provided by Enemalta, May 2007
However, since the last quarter of 2007 the price of fuel oil has increased exponentially, reaching the $140 mark in June 2008. Although data for electricity generation costs for the last quarter of 2007 and for 2008 is not available, one can easily assume that the cost of electricity generation in Malta now exceeds the LM 0.0435 (€ 0.101/kWh) mark.

Future Options for Electricity Generation in Malta

Enemalta’s Electricity Generation Plan 2006-2013 provides an insight as to the type of plant that Enemalta will invest in to meet Malta’s electricity needs in the short- and medium-term. The report recommends the commissioning of a combined cycle gas turbine plant (CCGT) and an electrical cable interconnection for a projected electricity cost of LM 0.0556 (€ 0.130) per kWh, of which the fuel cost accounts for 63% of total cost.

This estimate is calculated on the basis of information available for the period January – March 2006 when crude oil prices were around $60 per barrel. At the time of writing of this report in May 2008, crude oil prices have reached the $127 mark. On calibrating the projected electricity cost for the CCGT & cable option to reflect current fuel prices, one arrives at a projected electricity cost of LM 0.0947/kWh (€ 0.22/kWh). Although these figures may be considered as being very rough estimates, it is evident that at the current oil prices, properly designed biogas plants can be considered to be competitive and cost-effective when compared to conventional oil-fired generating plant.

Moreover, the demand for electricity in Malta is high and is projected to increase at a steady rate. Electricity consumption is estimated to increase from 2.26 terrawatt hours (TWh) in 2005 to 3.29 TWh in 2020. This implies that there is no shortage of demand in Malta and any electricity produced by whatever means will be consumed.

Malta’s Renewable Energy and CO2 emissions targets

In March 2007, European Heads of States agreed on binding targets to increase the share of renewable energy. By 2020, renewable energy should account for 20% of the EU’s final energy consumption (8.5% in 2005). The national target for Malta is 10%.

Although achievable, this target is considered to be tough especially when one considers that renewables only account for 0.36% of total primary energy at present. The market for Renewable Energy Sources (RES) in Malta is still at an early stage and, at present, penetration is minimal. RES has not been adopted commercially and only solar and biofuels are used. In order to promote the uptake of RES, the Maltese Government is currently creating a framework for support measures. In the meantime, it has set national indicative targets for RES-E lower than the ones agreed to in its Accession Treaty (between 0.31% and 1.31%, instead of 5% by 2010).

The Draft Renewable Energy Policy for Malta (August 2006) acknowledges the important contribution of waste-to-energy processes in renewable energy generation and provides the following information:

- 7 – 10 GWh/ annum (equivalent to around 0.24 – 0.35% of electricity consumption of 2010) can be generated through anaerobic digestion at the Sant Antnin solid waste treatment plant
- 24 GWh / annum from a new MSW treatment plant in the Northern part of Malta and possibly another in Gozo (0.85% of estimated electricity consumption in 2010)
- 36 GWh / annum through a Refuse Derived Fuel (RDF) plant
- 6.72 GWh / annum through anaerobic digestion of sewage sludge
- 24 GWh / annum from anaerobic digestion plants operating on agricultural waste as per the recommendations of the draft Agricultural Waste Management Plan (2005). This represents
0.84% of the estimated electricity consumption in 2010. The draft Renewable Energy Policy states that “Government is currently reviewing the cost-effectiveness of such plants”.

It is clear that agricultural waste treatment plants have a very important role to play in helping Malta achieve its renewable energy obligations.

**GHG Emissions**

Within the context of the United Nations Framework Convention on Climate Change (UNFCCC), Malta does not qualify for quantified greenhouse gas (GHG) emission reduction targets since it was considered a developing country at the time.

Carbon dioxide is main GHG produced in Malta arising from the burning of fossil fuel through electricity generation and transport. GHG emissions reached 3.2 Mt CO$_2$ eq. in 2006, representing a 45% increase over baseline 1990 levels. However, Malta is required to fulfil its EU obligations to reduce CO$_2$ emissions by 20 per cent by 2020.

Agricultural activities contribute directly to emissions of GHGs through a variety of processes including enteric fermentation in domestic livestock, livestock manure management, soil management and field burning residues. Carbon dioxide, methane and nitrous oxide are the primary GHGs emitted through agricultural activities. The major emitters of methane are beef and dairy cattle. Methane is produced by the anaerobic decomposition of manure whilst the production of nitrous oxide takes place through nitrification and denitrification of organic nitrogen in livestock manure and urine. Manure management and fertilisation applications also contribute to nitrous oxide production. In 2003, methane emissions from the agricultural sector contributed 3% of the total national GHG emissions, while nitrous oxide emissions from the agricultural sector were insignificant.

The harnessing of methane emissions through the controlled production and combustion of biogas from manure in biogas treatment plants will go a long way in reducing GHG emissions from the agricultural sector.

Although not considered to be a greenhouse gas, ammonia is considered a problem to animal health and is also of a detriment to human health. During 2003, estimated ammonia emissions from animal husbandry operations amounted to 95% of the total national emissions. Here again, the proper management and treatment of manure will go a long way in reducing ammonia emissions.

The European Community undertook to cut its overall GHG emissions by 8% of 1990 levels over the first Kyoto Protocol commitment period (2008-2012). In 2002, a burden sharing agreement was agreed by the (then) EU-15 Member States which allocated specific reduction targets to individual Member States, thus ensuring that the overall reduction target was met. Although not being obliged to reduce GHG emissions with regards to the Kyoto Protocol, as an EU Member State, Malta is obliged to participate in the EU Emissions Trading Scheme (ETS).

In its National Allocation Plan (NAP) Malta requested an allocation of 2.9 million tonnes of CO$_2$ to be emitted from its two power stations, but its allocation was reduced to 2.1 million tonnes over the period 2008 –2012. Should this allocation be exceeded, Enemalta would have to purchase allocation emissions, which will inevitably lead to higher electricity generation costs. The generation of electricity through a renewable energy process in Malta will decrease the load on the power stations and will therefore result in a reduction of emissions. Therefore the construction and operation of agricultural waste treatment plants that produce electricity will assist Enemalta in reducing its CO$_2$ emissions and therefore facilitate its compliance with respect to the EU ETS.
4. Recommended Option

It is clear that the competitiveness of the animal husbandry industry in Malta may be eroded in the short, medium and long term because of competition from imported products, and increases in operational costs, particularly the cost of feed, electricity, fuel and water. It is therefore essential that any costs of collection, handling, treatment and end-use/disposal of animal waste be kept to a minimum so as to allow this industry to remain competitive.

The situation is such that:

1) The majority of animal farms in Malta are very small and do not have the facilities to treat their own waste in a cost-effective and sustainable manner;
2) Only around 5% of animal farmers in Malta have their own land on which to dispose of the waste;
3) All of Malta and Gozo have been designated as Nitrate Vulnerable Zones which limits the end-use/disposal of untreated/treated manure; the limitations on use and shortage of land area for the disposal of animal waste make Malta a special case.

Treatment and disposal costs must therefore be kept to an absolute minimum, while every attempt must be made to maximize revenues. Without any doubt, the production of energy (in the form of electricity) is a very important revenue stream that may provide for full cost recovery.

This essentially depends on:

- Constructing reliable, cost effective treatment plant(s)
- Optimising the performance of the plant(s) through the control of the feedstock
- Getting a favourable feed-in tariff for the electricity produced
- Finding use for the surplus heat, liquid fertilizer and soil conditioner produced by the plant(s)
- Charging a competitive gate fee for certain biowaste that will enhance the performance of the plant(s)

The Draft Agricultural Waste Management Plan (2005) had arrived to the conclusion that 3 or 4 strategically constructed treatment plants ought to be built to treat manure and other agricultural waste in Malta and Gozo to produce saleable electricity and heat, as well as compost and fertilizer. The arguments in favour of this recommendation remain unchanged. Rather there is now a stronger argument for the construction of these plants, because of the improved economics arising from the sharp increase in the cost of fossil fuels and the importance being given to climate change issues, particularly in the EU.

The only difference lies in the fact that the treatment plants must now also cater for the treatment of pig manure and wastewaters from the animal husbandry sector, such as parlour wastewaters and high-organic washwaters – which wastewaters cannot continue to be disposed in the sewerage network.
A recalculation of the manure to be treated at the centralized treatment plants gave the following results:

**Gozo:**

A treatment plant designed to treat approximately 59,000 m$^3$ manure per annum (57,000 tonnes/year) at a solids concentration of 7.8%.

Assumptions:

- Livestock population figures as per June 2007 but corrected for livestock reduction estimates presented in Section 3.3
- Pig slurry will be delivered at a solids concentration of 1.55% (i.e. assuming that no on-farm water management practices are put in place)
- A manure collection efficiency of:
  - 50% for cattle
  - 85% for pig
  - 65% for poultry

This manure treatment capacity figure also takes into consideration the amount of:

- parlour washwater from cattle farms (estimated at 3.7 litres per LU per day at a 2.1% total solids content)
- the liquid fraction from separators installed on dairy farms as per the situation as of May 2007. The quantity of liquid generated by the separators is estimated at 20 litres per LU at a total solids content of 4.59%.

A stand-alone anaerobic digestion plant would generate approx. 2.3 million m$^3$ of biogas, for an electricity output of around 4.9 MWh/year when processing such volume of waste. The installed electricity generating capacity will be 1.5 MW.

**Malta:**

A treatment plant(s) designed to treat approximately 175,000 m$^3$ manure per annum (165,000 tonnes/year) at a solids concentration of 10.5%.

Assumptions:

- Livestock population figures as per June 2007 but corrected for livestock reduction estimates as per those presented in Section 3.3
- Pig slurry will be delivered at a solids concentration of 5.0% (i.e. with effective on-farm water management practices in place)
- A manure collection efficiency of:
  - 50% for cattle
  - 85% for pig
  - 65% for poultry
This manure treatment capacity figure also takes into consideration the amount of:

- parlour washwater from cattle farms (estimated at 3.7 litres per LU per day at a 2.1% total solids content)
- the liquid fraction from separators installed on dairy farms as per the situation as of May 2007. The quantity of liquid generated by the separators is estimated at 20 litres per LU at a total solids content of 4.59%.

A stand-alone anaerobic digestion plant would generate approx. 10.0 million m$^3$ of biogas, for an electricity output of around 22 MWh/year when processing such volume of waste. The installed electricity generating capacity will be 6.9 MW.

If the pig slurry were to be delivered in a diluted form (i.e. at a solids concentration of 1.55%), the treatment plant(s) will have to cater for a volume of 360,000 m$^3$ manure per annum at a solids concentration of 5.3%.

This means that:

- the size (and installed cost) of the plant(s);
- the volumes of manure to be transported to the treatment plant(s);
- as well as the volumes of digestate to be dewatered and post-treated will double with no increase in saleable outputs (electricity, heat and compost).

It is therefore imperative that effective measures are put in place in order to ensure that the pig slurry received by the treatment plants comply with the established requirement for total solids concentration (at least 5% total solids).

This requirement is much more critical for Malta than for Gozo, as the proportion of pig slurry to the overall manure mix in Gozo is significantly lower than that for Malta.

The following discussion will present detailed options that have been considered for Gozo and Malta, taking into account the possibility of co-treatment with municipal solid waste and sewage sludge.

**Detailed Options for Gozo and Malta**

1. **Options for Gozo**

   **Option 1A: Combined treatment of Municipal Solid Waste (MSW) and Manure/Slurries at a new site in Gozo**

   Gozo has a large cattle population but a relatively small pig population. The net result of this situation is that:

   - the potential for biogas and renewable energy generation is relatively high (4-5% of Gozo's electricity needs can be met through an agricultural biogas plant in Gozo)
- the loading on the sewers (and the sewage treatment plant) is comparatively low and within the treatment capabilities of the sewage treatment plant being commissioned in Gozo
- there is adequate opportunity for the application of the composted digestate and part of the liquid fraction to fields as a fertilizer in Gozo

Wasteserv has plans to construct a Mechanical Biological Treatment (MBT) plant in Gozo, so as to minimise the transportation of MSW to Malta for processing (and the transport of composted biowaste back to Gozo for application on agricultural land and for the rehabilitation of the Qortin rubbish dump). An MBT plant for the treatment of MSW only (i.e. without manure) is marginally viable (at an estimated treatment cost of Euro 140/tonne). When combined with manure, the overall treatment cost drops to Euro 30/tonne.

**Option 1B: Stand-alone treatment of agricultural waste in Gozo (i.e. not combined with MSW)**

This option loses some of the technical, economic and financial benefits of Option 1A, but reduces the planning and financing risks for Wasteserv’s MBT plant (for MSW only). In any case, this option still requires the identification of a new site for a manure treatment facility. The site for a manure treatment facility only will only be marginally smaller than that required for a combined MBT and manure treatment plant.

So, unless there are issues necessitating the immediate construction of an MBT plant in Gozo where the combination with manure treatment will result in serious delays of the former (such as the loss of EU funds), there are no benefits to be accrued by treating the two treatment projects separately.

On the other hand, it must be emphasised that there are economic, financial and technical benefits to be gained if the treatment of MSW and manure were to be combined.

**Option 2: Manure Clamps/Cesspits for all farms; discharge of pig slurry and wastewaters into the sewerage network (as per the existing practice); payment of annual compensation to WSC for additional treatment costs incurred as per the Polluter Pays Principle**

This option requires that all farms install manure clamps/cesspits (as per the guidelines in the RDP and CoGAP), which will:

- cumulatively take up more land (than would otherwise be taken up by the treatment plant)
- result in further investments for on-farm containment infrastructure (to be paid for by farmers),
- possibly result in some farms having to close shop because of lack of space to construct the manure containment structures, problems related to proximity to residences, planning issues, and a reduction in competitiveness if the farmers require loans in order to finance these waste structures,
- reduces control on the application of manure and slurries to land and therefore increases the risk of contamination of the groundwaters
Although LN 238 of 2002 prohibits the discharge of pig slurry and untreated wastewaters from farms into the sewerage network, verification studies carried out by COWI in November 2005 have shown that the discharge of pig slurry and wastewaters in Gozo will not significantly affect the operation of the Gozo sewage treatment plant (“pig slurry does not constitute a problem in Gozo” - COWI, November 2005). However, should WSC accept the discharge of these agricultural slurries and wastewaters into the sewers, the sewage treatment costs are estimated to increase by around LM 100,000 (Euro 233,000) per year - which costs may be passed on to the agricultural sector as per the Polluter Pays Principle.

**Recommended Option - Option 1A**

If the agricultural sector wants to have a 'self-sufficient' solution (i.e. one that does not depend on WSC or whoever will operate the Gozo sewage treatment plant in the future) then Option 2 is to be discarded outright.

Option 1 relates to the construction of a centralized plant in Gozo, which will generate a significant amount of electricity from a renewable source. The decision to be taken is whether to combine the manure treatment plant with Wasteserv's MBT plant or not.

There are strong logistic, financial, technical and economic arguments for combining the two processes. Therefore, all things considered, the combined treatment plant option is preferred to the stand-alone treatment plants alternative. However, a site must be found to accommodate this combined treatment plant.

**2. Options for Malta**

The equivalent of Option 2 described above for Malta is a non-starter. The nitrogen load of pig slurry on the sewerage system in Malta will result in excessive operating costs to be incurred by the operator of the municipal wastewater treatment plants, to the tune of almost Euro 4 million a year.

This limits the treatment options to that of centralized treatment of manure and slurries using anaerobic digestion for biogas (and electricity) generation, followed by composting for the production of a stable soil conditioner that may safely be applied to fields during the ‘open’ months (i.e. the months where fertilization is permitted).

There is no doubt that the quantity of manure to be treated in Malta requires more than one treatment plant, strategically located to minimise transportation distances and costs. The Draft Agricultural Waste Management Plan (2005) had recommended the construction of 2 treatment plants in Malta, one in the North of the island (Maghtab was mentioned as a likely location) and another plant in the South (Zejtun being a likely candidate). A third plant, if necessary, should be located in the Rabat – Mriehel – Zebbug area and cater for the farms in the central and north-western parts of Malta.

Despite the incorporation of pig farms into the equation, we are still of the opinion that 2, maybe 3 plants are required on Malta, to cater for those farms in the north, central and southern parts of Malta.

An investigation of the location of the farms clearly shows a concentration of cattle farms in the areas of Maghtab and Zejtun. Pig farms are concentrated in Zebbug-Qormi area with a scatter of farms extending to Mqabba and Siggiewi.
For this reason, it is believed that treatment facilities should ideally be located in the Maghtab and Zejtun areas, with possibly a third plant in the central part of Malta to cater for the farms in the centre of the island.

In recognition of the fact that it will be very difficult to find a site anywhere in Malta for the construction of a regional manure treatment plant, a compromise has to be sought between having an adequate number of strategically-located treatment plants and the need to transport manure to these plants.

For this reason, the number of treatment plants is to be limited to 2, maximum 3 plants in Malta.

Moreover, due consideration has to be given to the fact that Malta is currently in the process of constructing/planning waste and wastewater treatment facilities for solid waste, wastewater and also manure.

- Wasteserv have started construction of an MBT plant for MSW at Sant Antnin, l/o Marsascala in the south-east of Malta. The construction of this treatment plant is staged, with the anaerobic treatment facility likely to be constructed in 2009.

- Wasteserv are planning the construction of an MBT plant (and RDF plant) in the north of Malta, with Maghtab being a likely location. There are no definite locations or plans for this treatment facility as yet.

- The Water Services Corporation are in the process of awarding tenders for the construction of a large municipal wastewater treatment plant at ta' Barkat, limits of Zabbar. The treatment plant will have anaerobic digesters for the treatment of sludge. It is likely that this plant will commence operations in late 2009/early 2010.

- The Ministry for Resources and Rural Affairs (MRRA) intend to re-locate cattle farms to a site in Siggiewi. This re-development will necessitate a manure treatment facility of some sort. An application has been submitted for planning permission.

It is therefore logical that one investigates the possibility of combining one or more of the manure treatment plants with the treatment facilities mentioned above – particularly in view of the difficulties arising from finding new sites for treatment facilities, and also because of the clear advantages of combined treatment.

**Malta North**

The most clear-cut option for the treatment of manure generated in the north of Malta is that of combining it with the MBT to be constructed by Wasteserv in Malta North. This treatment plant can be designed to receive all the mixed MSW that is not going to be taken by the plant at Sant Antnin, as well as solid and liquid manure from the livestock farmers in the northern and the central parts of Malta.

The livestock farms in the north of Malta - representing 20% of the cattle farms, 21% of the pig farms and 36% of the poultry farms in Malta (i.e. excluding Gozo) - can easily be served by this treatment plant. The amount of slurry and manure requiring treatment from these farms is estimated at 70,500 tonnes a year.
As per the situation in Gozo, there are economic, financial and technical benefits to be gained if the treatment of MSW and manure were to be combined in a single treatment plant, on the same site.

An MBT plant for the treatment of MSW only (i.e. without manure) carries a unit treatment cost of Euro 64/tonne. When combined with manure, the overall treatment cost drops to Euro 25/tonne.

Considerable preparatory work on this option has already been carried out by Carl Bro A/S, consultants to Wasteserv.

**Malta Central and Malta South**

29% of the cattle farms, 51% of the pig farms and 46% of the poultry farms lie in the central region of Malta, while 51% of the cattle farms, 28% of the pig farms and 17% of the poultry farms are to be found in the south and south-east of Malta.

It is not recommended that all the manure and slurries from these farms (approx. 250,000 tonnes) is to be transported across Malta to the Malta North treatment plant, so a second (or third) treatment plant in the central or and southern part of Malta is required.

There are essentially three alternatives:

1. **Treatment of Manure at Siggiewi (Stage I) and at the Antnin Solid Waste Treatment Plant (Stage II)**

This option considers the installation of a manure treatment plant at the upgraded Sant Antnin Solid Waste Treatment Facility that will process all the manure and slurries from the south-east and central parts of Malta, and thus benefit from the economic and technical advantages of co-treatment as per the Malta North plant.

The farming community would also be well served because as a substantial amount of the cattle and pig farms lie in close proximity of the plant.

A variant of this alternative would be the installation of a second smaller manure treatment facility at Siggiewi where cattle farms are to be re-located. The treatment plant will handle the manure generated by these cattle farms (which represent some 10% of the national dairy herd) as well as the farms in the Rabat - Dingli areas (mainly cattle and poultry farms) and the Zebbug - Siggiewi - Mqabba - Qrendi - Zurrieq areas (mainly pig, but also poultry and beef). This will ensure a stable mix between pig and cattle manure, necessary for optimum operation of the digestion and composting plant.

The capacity of the plant in Siggiewi will be limited by:

1) the space available;
2) the distance from the farms supplying manure to the treatment plant;
3) achieving a stable feedstock with a suitable C:N ratio (i.e. there may be a limit on the amount of pig slurry that may be treated at the plant).

With this option, some 30% of all manure and slurries in Malta would be treated at the Malta North treatment plant; 25-35% at the Siggiewi plant and 35-45% at the Sant Antnin plant.
In order to reduce the technological and planning risk, it is recommended that the Malta North and Siggiewi plants be constructed first. The Plan should be revised in 2 years time and animal population numbers re-assessed in order to establish whether any investment at the Sant Antnin plant would be required.

**Pros**
- flexibility in operation when co-treating MSW and manure
- economies of scale and reduced investments as part of the infrastructure is already in place (at the Sant Antnin Treatment Plant)
- the Sant Antnin site is already committed for waste treatment operations
- this option provides for the operation of 2 - 3 relatively large plants, thus benefiting from economies of scale
- a manure treatment facility was still required at the Siggiewi site, so this option makes full use of a site that is already available
- this option eliminates the need to find another site for a waste treatment facility in the south of Malta, which will be very problematic in a densely populated country as Malta
- relatively short transportation distances
- the sewage treatment plant at Sant Antnin may be used for the pre-treatment of any excess liquid prior to discharge into the sewerage system
- this option does not require the collaboration of WSC (except for the use of the sewage treatment plant at Sant Antnin, if required)

**Cons**
- site at Sant Antnin may not be large enough to accommodate the additional infrastructure associated with the manure treatment plant
- the installation of a manure treatment plant at Sant Antnin will be a politically sensitive issue

### 2. Stand-alone Manure Treatment Plant in the South of Malta

This option considers the installation of a stand-alone treatment plant in the south or central part of Malta that would accept manure and slurries from the central and south/south-eastern parts of Malta.

The design capacity of this plant would be around 250,000 tonnes of manure and slurries a year.

Geographically the ideal location would be somewhere in/around Luqa - which lies equidistant from the two centres of concentrated farming activity (Zejtun for cattle and Zebbug for pigs) in the central and southern regions of Malta.

However, given that:
- such a site in Luqa or the environs will not easily be found and made available for the construction of a manure treatment plant; and
- a manure treatment plant is still required at Siggiewi, and
- the Siggiewi site can accommodate a regional treatment plant of the size required in the south of Malta
it is suggested that one carefully evaluates the option of installing a regional treatment plant that will take all the manure/slurries from the south and central parts of Malta at the site in Siggiewi.

With this option, 30% of the manure and slurries generated in Malta will be treated at the Malta North plant, and the remainder will be treated at the agricultural waste treatment plant at Siggiewi. In order to reduce the technological and investment risk, it is recommended that the Siggiewi plant be built in 2 stages: initially with 50% capacity (Stage I) and subsequently upgraded to full capacity at a later stage (Stage II). The Plan should be revised in 2 years time and animal population numbers re-assessed in order to establish whether any investment in Stage II would be required.

**Pros**
- this option provides for the operation of two relatively large plants thus benefiting from economies of scale
- a manure treatment facility was still required at the Siggiewi site, so this option makes full use of a site that is already available
- this option eliminates the need to find another site for a waste treatment facility in the south of Malta, which will be very problematic in a densely populated country as Malta
- this option does not require the collaboration of WSC

**Cons**
- the plant will only handle manure and slurries; it will not be as flexible in operation as a plant treating MSW and manure. Some surplus liquid may be generated which would require treatment prior to disposal into the sewer. The C:N ratio may be low, because of the disproportionate quantities of pig slurry.
- this plant will not make use of any existing infrastructure
- transportation distances are longer than for Option 1

3. **Treatment of manure at the WSC Sludge Treatment Facility at the Malta South Sewage Treatment Plant**

This option considers the possibility of treating part of the manure and slurries generated in the south and central parts of Malta at Siggiewi, and also treating the balance of the manure with sewage sludge at the still-to-be-constructed Malta South Sewage Treatment Plant (STP).

The amount of sewage sludge expected to be generated by the STP is 3,250 tonnes/year. The amount of manures and slurries requiring treatment at the STP amounts to around 150,000 tonnes/year.

Clearly there is no comparison between the size of the treatment facilities required for sewage sludge and that required for manure – so the addition of manure to WSC’s plans for sewage sludge treatment represents a completely new project.

Moreover, WSC have already published tenders for the construction of the sewage treatment plant, complete with sludge treatment facilities, so it is not possible to include manure treatment within the project at this late stage.
However, one should not completely write off the possibility of adding digesters to the WSC sludge treatment facilities at a later stage i.e. once the sewage treatment plant is up and running. In fact, WSC did not reject this possibility when approached with this proposal.

However, it is too early to establish whether:

1. WSC would be willing to accept any manure for treatment at a later stage (i.e. they will not commit themselves at this stage);
2. WSC would be willing to invest in manure treatment facilities;
3. There will be enough space for the treatment of manure at the site of the municipal sewage treatment plant.

One should also point out that the post-treatment of manure involves composting - which may generate odours. Given that the site at Ta’ Barkat is not too distant from Smart City, composting (and maturation) may have to be carried out elsewhere, resulting in double-handling and the need to identify another site.

With this option, it is being suggested that 30% of the manure and slurries generated in Malta will be treated at the Malta North plant, 25-35% at the Siggiewi site and 35-45% at the STP.

However, this option contains a number of inherent uncertainties and therefore necessitates a staged approach.

In order to reduce the technological and planning risk, it is recommended that the Malta North and Siggiewi plants be constructed first – especially since a decision on whether WSC would be willing to treat any manure will only be taken after the STP has been fully commissioned and commences normal operation.

This option should be revisited in 2 years time, by which time one would have monitored the animal husbandry sector and re-assessed the need for additional manure treatment facilities.

**Pros**
- flexibility in operation when co-treating sewage sludge and manure
- this option provides for the operation of three relatively large plants (in Malta) thus benefiting from economies of scale
- a manure treatment facility was still required at the Siggiewi site, so this option makes full use of a site that is already available
- the Ta’ Barkat site is already earmarked for waste treatment facilities
- this option eliminates the need to find another site for a waste treatment facility in the south of Malta, which will be very problematic in a densely populated country as Malta
- excess liquid can be recycled back to the STP for treatment and eventual discharge via the submarine outfall
- transportation distances are relatively short

**Cons**
- this option is dependent on the participation and collaboration of WSC
Overall Recommendation

The Agricultural Waste Management Plan has sought to identify an all-encompassing solution that is tailored to Malta’s unique requirements and which entails least costs and minimal space requirements.

There are logistic, economic, financial and technical advantages to be reaped if the treatment of manure is combined with the treatment of MSW and sewage sludge. Particularly since all three waste streams use the same treatment process, that of anaerobic digestion for the generation of biogas.

Moreover, Malta’s high population density makes it very difficult to identify, acquire and obtain development permission for new sites for the installation of manure treatment facilities. It is therefore preferable to have few large waste/manure management centres, and ideally within sites in which waste treatment activities are already taking place (or are planned to take place).

The waste treatment facilities should also be strategically located to minimise transportation of manure (and compost) to (and from) the treatment plants.

For these reasons, the recommended option for the treatment of manures and agricultural slurries in the Maltese Islands involves:

- the construction of a centralized manure treatment plant in Gozo to treat all the manures generated in Gozo, to be combined with Wasteserv’s MBT plant for MSW. It is likely that a new site has to be identified.

- the construction of a regional manure treatment plant in the north of Malta to treat the manures generated in the north of Malta, to be combined with Wasteserv’s MBT plant for MSW in Malta North. A site for these treatment plants is to be identified by Wasteserv. This plant will treat approximately 30% of all the manure and slurry generated in Malta.

- the construction of a regional manure treatment plant in Siggiewi to treat the manures and slurries generated in the north-west, central and south of Malta. A site for this treatment plant has already been identified by MRRA but this site may present some constraints that make it harder to have it permitted in good time. This plant will treat approximately 25 - 35% of all the manure and slurry generated in Malta.

Should the Siggiewi site, for one reason or another, not be available for the treatment of manure, a new site will need to be identified. The treatment facility should ideally be located in an area with (or in close proximity to) concentrations of farms.

Moreover, it is recommended that the Plan be revised in 2 years time to re-assess the need to invest in additional manure treatment infrastructure in which case, one may consider the following options:

1) Constructing a manure treatment facility at the Sant Antnin Solid Waste Treatment Plant (Option 1)
2) Upgrading the Siggiewi manure treatment plant (Option 2) or
3) Constructing a manure treatment facility at the Malta South Sewage Treatment Plant
4) Upgrading the Malta North manure treatment facility to take all of the manure being generated on Malta (i.e. including that from the central and southern parts of Malta)

In all cases, the recommended solution gives the following advantages:

- provides a staged approach to mitigate against the inherent uncertainties associated with the animal husbandry sector
- seeks to combine treatment facilities for MSW, sludge and manure within 3-4 sites for enhanced operational flexibility and economies of scale
- provides a future solution for the treatment of all agricultural manures and slurries, including pig slurry, and thereby achieve a considerable reduction on the loading of the new sewage treatment plants
- removal of approximately 50% of the nitrogen in manure, which today is causing pollution of the groundwater
- produces a high-quality fertilizer product, which is stable and easy to use, and may even reduce the import of commercial inorganic fertilizer
- provides a means of controlling the distribution and application of fertilizer and the recording of fertilization rates
- produces a significant amount of electricity from a renewable source (approximately 33,000 MWh if one also takes the biogas production from the MBT plants into account)
- reduces the amount of greenhouse gas emissions currently being released from the manure heaps and the improper management of manure

These conclusions have been arrived at on the basis of the following assumptions:

- At least 70% of manure produced (as calculated in June 2007) is delivered to the treatment facilities;
- Manure handling systems/procedures at pig farms are improved with the aim of increasing the dry matter content of the slurry. The dry matter content of the pig slurry is to be increased to at least 5% TS on average;
- Crop farmers can and will use the end-products of the treatment as a compost/fertiliser/soil conditioner. The willingness to use this product can be controlled by making the use of organic fertilizer attractive compared to the use of chemical fertiliser.
- The manure production (animal population numbers) in the Maltese Islands will not decrease by more than 20% within the next few years and that thereafter it will remain stable

Next steps in the Implementation of the Agricultural Waste Management Plan:

- Approval of the Plan by MRRA

Although the Agricultural Waste Management Plan provides a solution for the treatment of all manures, slurries, farm waste and other organic wastewaters, it goes counter to the current
CoGAP/Nitrate Action Programme policy of encouraging the construction of on-farm manure clamps and cesspits for the storage of manure - in the sense that the agricultural waste treatment plants will render the investment in (large) manure clamps and separators useless. With the treatment plants in operation, only a 2-week on-farm storage capacity will be required (instead of the 5-month storage requirement required today).

A decision has to be taken at governmental level as to whether to continue to encourage the construction of these on-farm storage facilities or not - among those that have managed to get a MEPA permit or those that have not. It is our understanding that given the option of temporary storage for off-site treatment, livestock farmers will prefer not to invest in expensive and space-consuming storage facilities that do not provide any revenue (i.e. they are a compliance cost). This hypothesis needs to be verified through discussions with the livestock farmers.

Although the construction of manure clamps and cesspits is believed to be effective in reducing the contamination of ground and surface waters with nitrate, it is however contributing to an increase in organic discharges into the sewerage system from the farms.

Therefore a reconsideration of the current COGAP policy is required in this regard. Moreover the installation of on-farm separators will result in a reduction in the total solids content of the overall mix of feedstock received at the treatment plants, with a resultant drop in efficiencies and economic viability.

The COGAP also has to be amended to allow for transportation of manure and slurries to the treatment facilities to be constructed according to the recommendations of this Plan.

- **Decisions on the financing, ownership and operation of the treatment plants**

It is believed that the livestock farmers will not, out of their own initiative, invest in centralized agricultural waste treatment plants because of the technical and financial risks involved.

Given that there are significant technical, economic and financial advantages to be reaped if agricultural waste were to be treated with MSW, it is recommended that Wasteserv take a leading role in the development and construction of these treatment plants.

These projects are capital intensive, but have low operating costs and given the right conditions may actually render a profit in the medium and long term. It is recommended that EU Cohesion funds be availed of for the financing of these treatment plants so as to offset the high investment costs.

Should this not be possible, the projects may still be developed as a BOT (Build-Operate-Transfer) or BOO (Build-Operate-Own) basis. Additional revenue can be obtained if the project is registered as CDM projects (as this will provide revenue in the form of carbon credits). If a Public-Private-Partnership (PPP) type of project is considered, it is strongly recommended that the livestock co-operatives come on board as partners in the consortium.

- **Consultations with the farmers**

The co-operation of the livestock and crop farmers is critical for the successful implementation of this project. The farmers’ participation is required to:

- deliver the required quantity of manure, at the right quality, and at the right time. This may require a change in current on-farm practices, which among other things, are resulting in the generation of excessive quantities of agricultural wastes.
- ensure that the compost and liquid fertilizer being produced by the treatment plants is taken up and correctly applied to agricultural land

Discussions must be held with livestock farmers on the implementation of the Plan to gauge their acceptance/resistance of/to the solutions being put forward in the Plan and to establish the level of motivation/reluctance to participate in achieving the objectives of the Plan.

Discussions must also be held with crop farmers to establish their fertilization requirements and to raise awareness on the benefits of using organic fertilizers as opposed to imported inorganic fertilizers. Moreover, the solid and liquid fertilizers and soil conditioners produced by the treatment plants must be tailored to the needs of the crop farmers; collaboration (and research) is recommended between the crop farmers and the operators of the waste treatment plants for the formulation of the appropriate fertilization mix.

- Preparation of detailed designs, including verification of feedstock input (quantity and quality), including any clean biowaste that may be co-digested with the manure

Wasteserv, through their consultants Carl Bro A/S have already carried out substantial preparatory work on the co-treatment of manure and MSW in Gozo and Malta. This Agricultural Waste Management Plan builds upon the work already carried out by Carl Bro A/S, and provides updated figures on the quantities of waste to be treated.

Detailed designs and specifications can be produced by Carl Bro A/S, also with a view of accessing EU Cohesion Funds for the financing of the treatment plants.

It is also recommended that Wasteserv (in collaboration with WSC and the Federation of Commerce and Industry) undertake a survey of all organic wastes and wastewaters in Malta and Gozo so as to establish the potential of treating these wastes at the agricultural waste treatment plants. The co-digestion of clean organic industrial wastes may accrue revenue from the charging of a gate fee, whilst also improving the biogas/electricity generating performance of the treatment plants. A list of wastes/wastewaters that may be treated at the agricultural waste treatment plants is provided in the Appendix.
### APPENDIX I

<table>
<thead>
<tr>
<th>Region</th>
<th>Share of Dairy Herd</th>
<th>Key Localities (% of National Herd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gozo</td>
<td>31 %</td>
<td>Sannat (10%), Xewkija (7%), Victoria (5%), Kercem (4%)</td>
</tr>
<tr>
<td>Malta North</td>
<td>14 %</td>
<td>Maghtab (4%), Naxxar (3%), Salina (2%), San Gwann (2%)</td>
</tr>
<tr>
<td>Malta Central</td>
<td>20 %</td>
<td>Rabat (8%), Qormi (4%), Siggiewi (3%), Msida (2%)</td>
</tr>
<tr>
<td>Malta South</td>
<td>35 %</td>
<td>Zejtun (12%), Ghaxaq (4%), Marsaxlokk (4%), Zabbar (3%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Region</th>
<th>Share of Pig Herd</th>
<th>Major Localities (% of National Herd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gozo</td>
<td>6 %</td>
<td>Kercem (1%), Xewkija (1%), Nadur (1%)</td>
</tr>
<tr>
<td>Malta North</td>
<td>20 %</td>
<td>Naxxar &amp; Maghtab (9%), St. Paul’s Bay (5%), Mgarr (3%)</td>
</tr>
<tr>
<td>Malta Central</td>
<td>48 %</td>
<td>Zebbug (19%), Qormi (13%), Rabat (10%)</td>
</tr>
<tr>
<td>Malta South</td>
<td>26 %</td>
<td>Mqabba’ (6%), Zabbar (4%), Zurrieq (4%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Region</th>
<th>Share of Capacity</th>
<th>Major Localities (% of National Capacity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gozo</td>
<td>19 %</td>
<td>Xewkija (5%), Kercem (4%), Victoria (4%)</td>
</tr>
<tr>
<td>Malta North</td>
<td>29 %</td>
<td>Naxxar (8%), Maghtab (6%), Mellieha (3%)</td>
</tr>
<tr>
<td>Malta Central</td>
<td>37 %</td>
<td>Rabat (9%), Qormi (7%), Dingli (6%), Zebbug (6%), Siggiewi (6%)</td>
</tr>
<tr>
<td>Malta South</td>
<td>15 %</td>
<td>Zejtun (3%), Zabbar (2%), Luqa (2%)</td>
</tr>
</tbody>
</table>

---

6 Excluding Comino Pig Farm. It is reported by KIM that this farm will be closed down in the near future. In any case, the manure generated at this farm accounts for less than 1% of the total pig manure generation.
Figure 1: Geographical distribution of Dairy Farms in the Maltese Islands (Data Source: FVRD, 2005)
Figure 2. Geographical distribution of Pig Farms in the Maltese Islands (Data Source: FVRD, 2005)
Figure 3. Geographical distribution of Poultry Farms in the Maltese Islands (as licensed capacity) (Data Source: MRA, 2005)
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Figure 4. Wet Slurry generated in the Maltese Islands by livestock sector (in tonnes / year)

Figure 5. Manure generated in the Maltese Islands by livestock sector (in tonnes Dry Matter / year)

Figure 6. Nitrogen in manure generated in the Maltese Islands by livestock sector (tonnes / year)

Excluding N in cattle urine (estimated at 900 tonnes / year) and nitrogen in washwaters from cattle, poultry and rabbit farms
### Table 4. National Manure generation estimates by livestock sector

*unless stated otherwise

<table>
<thead>
<tr>
<th>Livestock Sector</th>
<th>Population</th>
<th>Wet Slurry</th>
<th>Dry Matter</th>
<th>Nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Units</td>
<td>Litres / animal */ day</td>
<td>Tonnes / year</td>
<td>As % of DM</td>
</tr>
<tr>
<td><strong>Dairy</strong></td>
<td>17,823(^8) Heads (11,582 LU)</td>
<td>50.2 / LU ((\rho = 1000\text{kg/m}^3))</td>
<td>212,217</td>
<td>@10.18% of total slurry (solid + urine)</td>
</tr>
<tr>
<td></td>
<td>1,604(^4) Heads (664 LU)</td>
<td>(29.2 / LU as solid manure, 21.0 / LU as urine)</td>
<td>12,165</td>
<td></td>
</tr>
<tr>
<td><strong>All Cattle</strong></td>
<td>19,427 Heads (12,246 LU)</td>
<td></td>
<td>224,383</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pigs</strong></td>
<td>69,510(^10) Heads</td>
<td>10.1 – 22.0 ((\rho = 1000\text{kg/m}^3))</td>
<td>256,249 – 558,165</td>
<td>@ 1.55%</td>
</tr>
<tr>
<td><strong>Broiler</strong></td>
<td>688,904 Places</td>
<td>0.09 – 0.208 ((\rho = 503\text{kg/m}^3))</td>
<td>11,383 – 26,308</td>
<td>@ 46.15%</td>
</tr>
<tr>
<td><strong>Layer</strong></td>
<td>529,159 Places</td>
<td>0.167 ((\rho = 944\text{kg/m}^3))</td>
<td>30,449</td>
<td>@29.44 %</td>
</tr>
<tr>
<td><strong>Rabbit</strong></td>
<td>6,100 Doe-places</td>
<td>1.97 / doe-place ((\rho = 717\text{kg/m}^3))</td>
<td>3,145</td>
<td>@26.28 %</td>
</tr>
</tbody>
</table>

\(^8\) Herd breakdown: 2,222 (Male < 1 yr), 1,334 (Male 1-2 yr), 392 (Male >= 2 yr), 2,888 (Female < 1 yr), 2,688 (Female 1-2 yr), 8,299 (Female >= 2yr)

\(^4\) Herd Breakdown: 661 (Male < 1 yr), 523 (Male 1-2 yr), 86 (Male >= 2 yr), 84 (Female < 1 yr), 78 (Female 1-2 yr), 172 (Female >= 2yr)

\(^10\) Based on quota of 9,896, excluding Comino Pig Farm
List of Wastes/Wastewaters that may be treated at the Agricultural Waste Treatment Plants

Waste from agriculture, horticulture, aquaculture, and forestry, hunting, fishing as well as food preservation and processing

Animal tissue and sludges from washing and cleaning provided they meet the Directive on the use of sludges in agriculture (86/278/EEC) and the Directive on Animal Waste (90/670/EEC)

Animal faeces, urine and manure effluent collected and treated off site, provided they meet the requirements of the Directive on Animal Waste (90/670/EEC)

Waste from the processing of meat, fish and other foods

Animal tissue only if deemed fit for human consumption and as left over food preparations

Wastes from fruits, vegetables, cereals, edible oils, etc. and the sludges from processing such materials, providing they meet the requirements of the Directive on the use of sludges in agriculture (86/278/EEC)

Wastes from the dairy products industry

Wastes from the bakery, brewing and wine industries

Wastes from sorting paper and cardboard for recycling

Waste from processing supplies of drinking water and the treatment of urban wastewater

Digesta from the anaerobic treatment of urban waste provided it meets the Directive on Animal Waste (90/670/EEC)

Biodegradable wastes from kitchens and restaurants (including fats and sludges from grease traps)

Septic tank waste