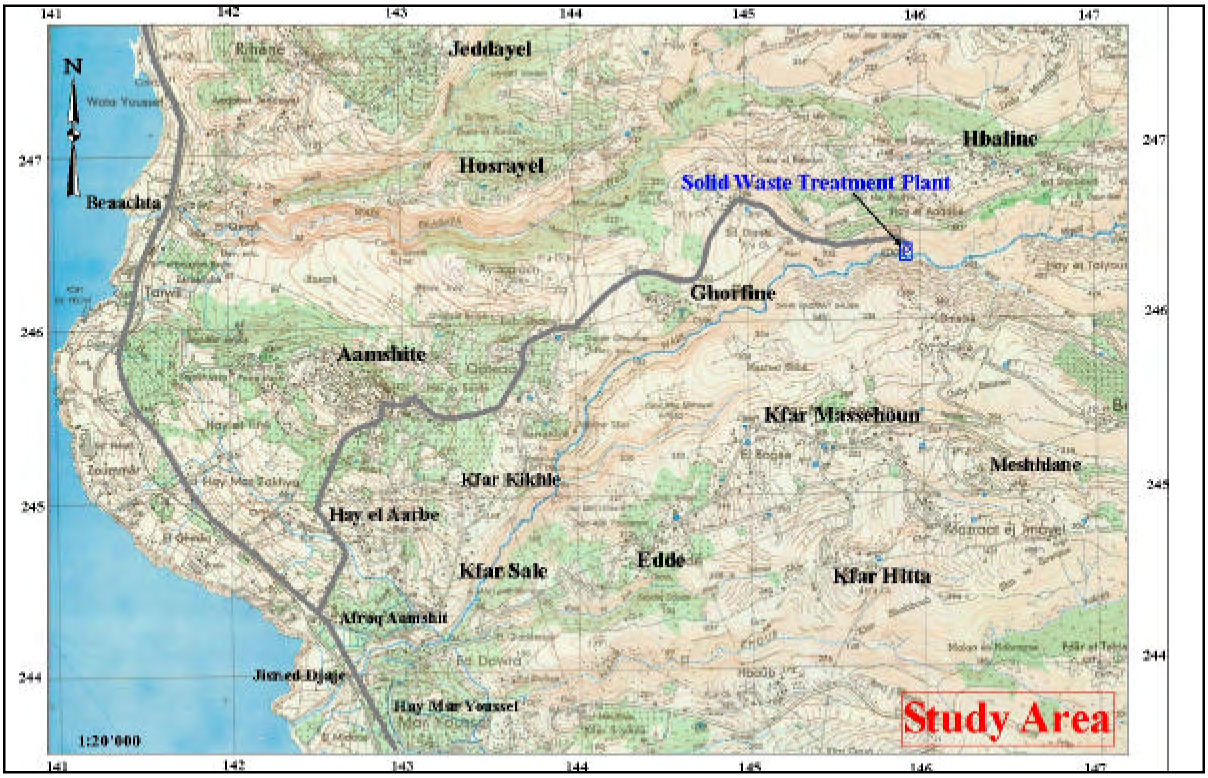
ENVIRONMENTAL IMPACT ASSESSMENT

SOLID WASTE TREATMENT CENTER
"JBEIL-HBALINE"
UNION OF MUNICIPALITIES OF JBEIL
CAZA OF JBEIL



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LIST OF ABBREVIATIONS

AUB	American University of Beirut
AEI	American Educational Institution
BIA	Beirut International Airport
CDR	Council for Development and Reconstruction
CNEWA/PM	Catholic Near East Welfare Association/ Pontifical Mission
DW	Dissemination Workshop
ELARD	Earth Link and Advanced Resources development
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GAS	General Awareness Seminars
GBA	Greater Beirut Area
GoL	Government of Lebanon
ISWM	Integrated Solid Waste Management
IW	Inception Workshop
LAU	Lebanese American University
METAP	Mediterranean Environmental Technical Assistance Program
MoA	Ministry of Agriculture
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MoIM	Ministry of Interior and Municipalities
MoH	Ministry of Health
MoPWT	Ministry of Public Works and Transport
MRF	Material Recovery Facility
MSL	Mean Sea Level
MSW	Municipal Solid Waste
NERP	National Emergency Recovery Program
NIMBY	Not In My Backyard
PFRP	Processes to Further Reduce Pathogens
PM	Pontifical Mission
PVO	Private Voluntary Organization
PSRP	Processes to Significantly Reduce Pathogens
SEG	Sukkar Engineering Group
SSP	Sorting at the Source Programs
STW	Specialized Training Workshop

SWM	Solid Waste Management
SWTP	Solid Waste Treatment Plant
UNDP	United Nations Development Program
UPP	Unit of Planning and Programming
UNDP	United Nations Development Program
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Association
USTDA	United States Trade and Development Agency
WG	Working Group

C4d	Upper Sannine Formation
C/N	Carbon to Nitrogen ratio
dm	Dry Matter
°C	degree Celsius
e.g.	Example
etc	Etcetera
Km	Kilometers
m	Meters
mg/Kg	Milligram per Kilogram
pH	Log $[H^+]/[OH^-]$
ppm	parts per million
SW	South West
T/d	Tons per day

NON-TECHNICAL SUMMARY

INTRODUCTION

Solid waste management has always been a chronic problem in Lebanon, causing serious environmental degradation. Uncontrolled dumping and burning are the common methods practiced for solid waste disposal resulting in serious land, water, and air pollution problems. Although such methods are legally banned and their adverse impacts widely recognized, until the present time, they are still practiced in rural areas and even in some urban areas, mainly due to the lack of law enforcement, financial means and awareness.

The proposed project sets an example to be followed by other municipalities or unions of municipalities in the country in order to prevent the numerous impacts associated with improper solid waste management. It is based on elementary principles of Integrated Solid Waste Management (ISWM), and should considerably reduce the negative impacts resulting from current practices while producing several positive impacts.

The main objective of this project is to provide the necessary means and tools for the adequate management of Municipal Solid Waste (MSW) in the Caza of Jbeil that consists of a total of 85 villages and towns, serving a total population of 105,000 persons. It also aims at increasing awareness of the local population on the importance of waste minimization, sorting at the source, and re-use as long-term strategies for the sustainable management of solid waste.

THE PROJECT

Funded by the United States Agency for International Development (USAID) and developed by Catholic Near East Welfare Association (CNEWA\PM), the project entails the implementation of an aerobic composting plant, which will serve the needs of 85 villages and towns that are represented by the union of municipalities of Jbeil. The same types of composting facilities were already developed by PM in Chacra (10 tons/day), Khirbit Silim (5 tons/day), Qabrikha (5 tons/day), and Qleia (10 tons/day). The proposed facility in Hbaline, with a maximum capacity of 80 tons per day, is designed to accept both sorted and unsorted wastes, to have a waste segregation unit to further sort the incoming waste, and to stabilize the organic fraction of the waste to produce compost of marketable quality. Inorganic waste or inert material that is not recycled (rejects) is to be landfilled next to the composting facility. The project is to be complemented by an awareness campaign that will focus on long-term waste management practices such as waste minimization, reuse, and source separation. One of the main outcomes of this campaign is expected to be a significant improvement in source separation of the waste, which in turn will facilitate the operation of the plant and enhance the quality of the compost.

THE ENVIRONMENTAL SETTING

The potential plant site is located Southwest (SW) of Hbaline village with land elevation ranging from 220 to 330 m above mean sea level. The site is located in a valley called “Ouadi-Edde” that extends towards the South West to reach the sea at the level of “Jisir Ad Djaje” at the southern edge of Aamchit. The winter channel that passes through the site becomes active only with heavy rainfall. The site is situated on a land owned by the union. Accessibilty to the site is through a paved road that connects the site to the nearby road that joins the village of Hbaline to the coastal town of Aamchit.

Precipitation patterns show large seasonal variations with more than 80 percent of the annual rainfall typically occurring between November and March. Precipitation in the area ranges between 850 and 1050 mm/year, as indicated in the pluviometric map of the area. The average annual temperature is 18.5 ^{0}C at Amioun village, (Service Meteorologique du Liban, 1977). This is the closest station to the study area that has records of temperature variation. Dominant wind direction all over Lebanon is however oriented in the NNE and NE. Local wind direction varies between orientations of ENE and E (Service Météorologique du Liban, 1969). According to local inhabitants, the general wind direction is from the proposed site location towards the East.

The vegetation community in the project area is grassland, containing a variety of annual plants and flowering species in addition to shrubs, oak and pine species. The project however does not affect any area of special concern, such as those designated as having national or international importance (e.g. world heritages, wetlands, biosphere reserve, wildlife refuge, or protected areas), or lead to the extinction of endangered and endemic species, or critical ecosystems and habitats.

In terms of infrastructure, the MSW collection in the Caza is conducted in three different manners: 1) by a collection fleet owned and operated by the municipalities; 2) by private haulers providing collection services; and 3) by some private haulers operating under contract with some individual households.

The total estimated collection cost paid by municipalities and individual household and industries is estimated to be around 500,000 USD/Year. Collected waste is disposed off in the wild dump of Hbaline, where monitoring and management of incoming wastes are currently controlled by the Union. A private contractor carries out the daily operation of the dump for a fee of 50,000 USD/Year.

On the socio-economic level, the towns and villages of Jbeil Caza have a population ranging from 81,000 residents to a peak population of 106,000. The annual demographic growth rate was estimated to be 0.7 percent. This growth rate indicates that in the year 2018 the resident population will reach 94,000 and a peak population of 122,000.

The economy in most of the municipalities is mainly driven by public and private sector employments. Trade and services are mostly prevalent in the coastal towns of the Caza. Tourism is mostly present in the old town of Byblos and its surroundings along with some beach resorts and hotels on the coast. Agricultural activities concentrate mainly on greenhouse production on the costal zone and fruit production on the mountainous area of the Caza.

IMPACT ASSESSMENT

The environmental impacts of the proposed facility were primarily assessed based on the similar existing facilities, previously implemented by PM. In fact, the implementation of a composting plant has many benefits. The project solves various environmental and social problems, reduces the waste volume to be landfilled, and results in the production of compost. Moreover, the application of compost to soils has direct and indirect advantages. Table A summarizes the potential positive impacts associated with MSW composting, and gives the significance of each impact with respect to its level of environmental conservation. Of particular importance is the positive socio-economic impact for the Caza of Jbeil as a whole. This project represents an income generating activity for the Union of municipalities, which should ensure the project's sustainability and improve the autonomy of the Union.

Table A. Potential Positive Impacts

Impact	Cause	Significance
Eliminating the negative effects of open dumping	The treatment plant will lead to the containment of the Hbaline open and uncontrolled dump since it receives and treats the waste generated in the villages	Long term
Compost use	Compost can be used as a soil conditioner and has significant positive impacts	Short term
Employment generation	Creating jobs for the locals	Short term
Creating income generating activity	Revenue to the union of municipalities of Jbeil from the waste management of the Caza, in addition to selling the compost and the recyclable material	Short term
Solid waste reduction and recycling	Separation of non-sorted waste at the compost plant, with gradual increase of at source separation following increased awareness of the local population	Long term
Protection of natural resource	If used In-vessel composting with no leachate generation	Long term
Decreased quantity of waste to be landfilled	The solid waste will be separated for recycling, and only a small portion of reject will result from the plant's operation. The facility by itself is not land-intensive	Short term

The project could also result in various potential and predictable negative impacts. The identified potential impacts could result from improper construction and/or operation activities of the facility. Table B provides a summary of the potential negative impacts.

Table B. Summary of Potential Negative Impacts

Impact	Cause	Significance
CONSTRUCTION PHASE		
Noise and dust	Resulting from construction activities and truck traffic	Short term
Construction waste	Resulting from construction activities, land reclamation	Short term
Health and safety	Accidents to workers and members of the local community due to lack of safety regulations and uncontrolled access to the construction site	Long term
Biodiversity	Land reclamation and construction activities leading to the destruction of the natural ecosystem at the facility site	Long term
OPERATION PHASE		
Litter	Light fraction of waste carried by winds	Short term
Odor production	Compost facilities that are not properly operated allow anaerobic conditions to develop thus generating foul odors. Waste trucks incoming and leaving the facility	Short term
Natural resources contamination	Application (on agricultural lands) of poor quality contaminated compost containing hazardous material, potential leachate generated, uncontrolled drainage, and improper storage and receiving areas and/or application of contaminated compost, uncontrolled dumping of composting residues such as un-compostable and un-recyclable material	Long term
Phytotoxicity	High compost application rates	Long term
Health and safety hazards	During waste separation and operation of the process, and with minimal precaution measures, uncontrolled access to the facility	Long term
Noise and dust	From circulation and unloading of trucks	Short term
Landscape aesthetic	Offensive sight in the natural landscape	Long term

However all impacts can be minimized and even eliminated if the plant is properly managed and mitigation measures are implemented as described in the Environmental Management Plan (EMP).

ENVIRONMENTAL MANAGEMENT PLAN

Mitigation Plan

The mitigation plan is designed to minimize or eliminate the negative impacts while improving positive impacts. Table C provides a summary of the recommended mitigation measures during design, construction, and operation of the project.

Table C. Recommended Mitigation Measures for Potential Negative Impacts

Impact	Recommended mitigation measure	Responsibility	Feasibility and cost
DESIGN PHASE			
Odor production	Include a buffer zone around the facility, provide closed containers for waste storage	PM/Contractor	Feasible/ no cost
Resources contamination	Paving of storage and operation areas, drainage control system, and small wastewater treatment unit	PM/Contractor	Include in design
Dust production	Paving of access roads	Municipality	From municipality budget (US $ 7/m^2)
Landscape esthetics	Include a landscape plan	PM/Contractor	US $ 4000 included in construction cost
Public hazards	Facility site fencing (3 m height)	PM/Contractor	Included in design requirements
Litter	Fencing and providing a closed depression pit for unloading waste	PM/Contractor	Included in design requirements
CONSTRUCTION PHASE			
Noise and dust	On-site operation activities, maintenance and repair of equipment, control of timing of noise emissions, informing local community	Contractor	No cost except for maintenance included in design
Construction waste	Waste transport and disposal in quarries for re-use or in sanitary landfills	Municipality/ Contractor	Included in construction
Health and safety	Provide protective clothing, follow general safety regulations, prevent un-authorized access to the construction site by fencing and night security guard	PM/Contractor/ Municipality	Included in construction, and provided by contractor
OPERATION PHASE			
Litter	Covered collection vehicles, unloading waste only in the designed depression pit	Municipality/ facility operators	Depending on number and type of trucks (US $ 20/ cloth traps)
Odor production	Proper process operation, maintaining aerobic conditions, and storing waste in designated areas for pre-determined durations	Facility operator	No extra cost
Natural resources contamination	Ensuring the production of good quality, safe compost according to the suggested standards, and appropriate disposal of contaminated compost, maintenance of the drainage system Keep on-site sorting at high efficiency levels Promote sorting at the source to complement on-site sorting.	Facility operator/ Compost contractor	No extra cost
Health and safety hazards	Always use protective clothing and equipment, implement safety regulations, prevent unauthorized access to the facility, keep the facility clean	Facility operator	No extra cost
Noise	Control waste collection and transport timing, do not exceed working hours	Municipality	No extra cost

Monitoring Plan

The contractor will be responsible for the environmental monitoring activities during the operation of the facility for the first year. After training the personnel throughout the year, the responsibility will pass on to the Union of municipalities. During the construction phase, Pontifical Mission would monitor the activities and convey the information to the Union of municipalities of Jbeil Caza. Environmental monitoring will be undertaken during both the construction and operation phases to ensure appropriate operation of the facility, the implementation, and effectiveness of the recommended mitigation measures, the production of good quality and safe compost, and the response to unanticipated environmental impacts. Furthermore, defined by the ordinance on the quality assurance set by the MoE, the main essential parameters to be monitored and provided regularly to the MoE for compost quality are:

- Heavy metals
- Bacteriological content
- Maturity test
- Moisture content and others parameters to be declared for the users.

Environmental parameters to be monitored with their frequency, duration, and responsible body are summarized in Table D.

Table D. Recommended Monitoring Activities

Parameter	Samples	Frequency	Location	Responsibility	Estimated cost
Construction phase					
Noise	Inspection	Monthly	Construction site and village	PM/contractor	No extra cost
Landscape	Visual inspection	Weekly	Construction site and surroundings	PM/contractor	No extra cost
Health and safety	Visual inspection	Continuous	Construction site	PM/contractor	No extra cost
Operation phase					
Noise	Inspection	Quarterly	Facility and village	Municipality & facility operatives	No extra cost
Odor	Inspection	Monthly	Facility and village	Municipality & facility operatives	No extra cost
Compost quality	Four samples	Monthly	Facility	Municipality & facility operatives	US $4800 +300 capital cost first year
Health and safety	Visual inspection	Continuous	Construction site	Municipality & facility operatives	No extra cost
Landscape	Visual inspection	Continuous	Construction site and surroundings	Municipality & facility operatives	No extra cost
				Total monitoring costs/year	4800 US $

Statement of Compliance

The Union of Municipalities, their consultants and contractors confirm they will adhere to the provisions of the EIA, will comply with the national regulations, will adopt the proposed mitigation measures and monitoring plans, and will send to the MoE all monitoring results generated at intervals not exceeding 3 months period, or as mutually agreed. Institutional Framework for the project is proposed in Figure I.

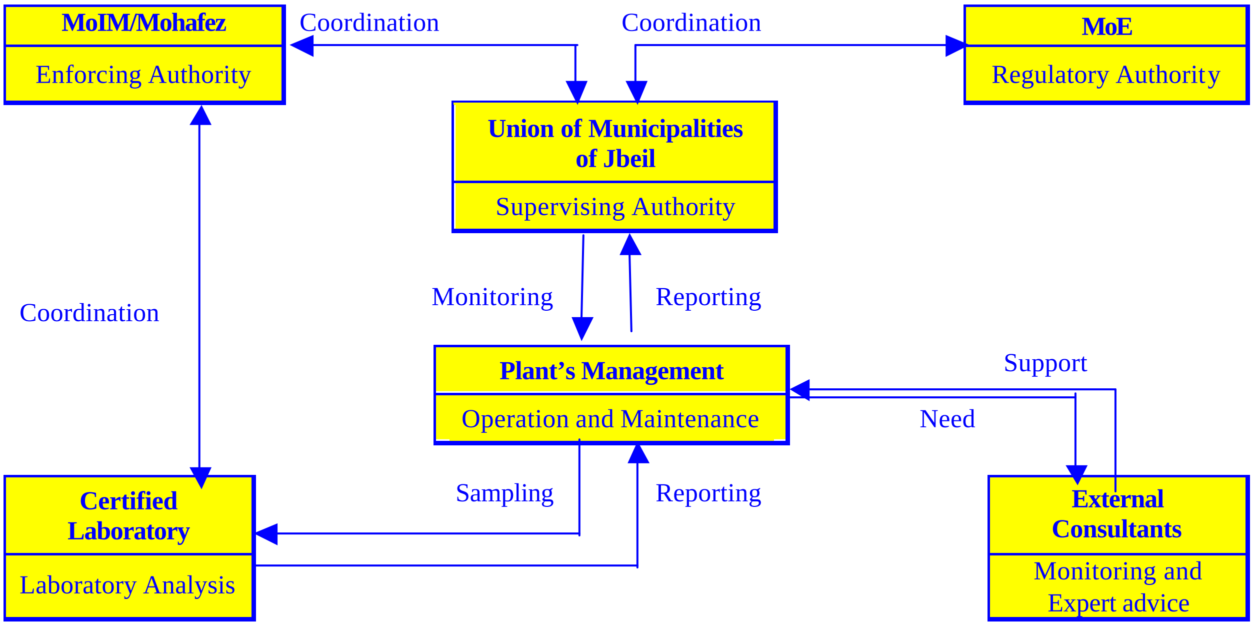


Figure I. Proposed Institutional Setting

Capacity Building and Awareness

Capacity building in the form of training and awareness campaigns will be conducted to ensure the sustainability of the project. Environmental awareness workshops will be conducted where all concerned parties will be informed of important issues related to the project such as integrated solid waste management and the importance of waste separation, recycling and reuse, environmental monitoring, health and safety measures, compost quality and usage, and pollution prevention and mitigation measures. Operators will also be trained on the proper operation of the facility.

PUBLIC PARTICIPATION

Public involvement is a vital component in any community development project especially when the project depends on community participation and cooperation in order to achieve the proposed objectives. Public participation is achieved in two complementary phases, the first started by PM with the initial phases of the project design to assess local needs and requirements and it was as well initiated through the feasibility study of solid waste management in the Caza of Byblos conducted by Ecodit and sponsored by the United States Trade and Development Agency (USTDA). The results of this study were incorporated in the EIA and used while setting the appropriate design of solid waste management in the Caza. The second phase was performed as part of the project to address local opinions and concerns about the proposed waste management facility and raise awareness among local community. This phase is composed of four main categories: 1) Inception Workshops, 2) Specialized Training Workshops, 3) Awareness Seminars, and 4) Sorting at the Source programs.

CONCLUSIONS AND RECOMMENDATIONS

Although the proposed project could result in some negative environmental impacts in case of improper operation, the implementation of the mitigation and monitoring plans would minimize or prevent the occurrence of the most significant negative impacts. That would render the operation of the facility very beneficial on the local, national environmental and socio-economical levels, especially that the implementation of the project would result in the closure of open uncontrolled dumping on site in Hbaline and would end the open burning activities still practiced in some small villages of the Union. The most important factor for the success of the facility is the product quality, hence, compost produced should be regularly monitored, and its quality improved by proper waste separation and operation activities. Moreover, the public participation process showed the willingness of the local community to separate waste in order to enhance the quality of the compost and prevent negative impacts.

Implementing a solid waste treatment facility to solve the waste problem at the level of Jbeil Caza could be a viable option since it complies with ISWM plans and with the latest recommendation of the ministerial committee for national solid waste management. This plan aims at reducing the waste volumes to be landfilled, by recovering and re-using recyclables, and changing the organic fraction of the waste into useful products. The project would be further beneficial when coupled with environmental awareness campaigns that would increase the community's willingness to home separate solid wastes, and involve locals in environmental protection. Furthermore, the success of the project will render the solution of solid waste management at the level of Cazas viable and this will render the Union's experience as pilot for the implementation of such solid waste management plans in the rest of the Lebanese Cazas.

1. INTRODUCTION

1.1. THE GENERAL CONTEXT

Lebanon has recently made significant progress towards sustainable development, and has placed more attention to environmental matters and the need to reduce the burden on the environment. The Ministry of Environment (MoE) has been able in the last 10 years to improve considerably its capabilities to fulfill its main role of protecting the environment from the various and varied sources of pollution. Financed by international organizations, several working units within the MoE are setting new environmental standards, building an informational database for the country, and providing the framework to prevent further pollution to widespread in Lebanon.

In particular, the Unit of Planning and Programming (UPP) has revised and further developed the Decree for Environmental Impact Assessment (EIA) that is being considered for ratification by the Government. The decree states that any planned project that could cause significant environmental impacts should be subject to the preparation of an EIA that would anticipate these impacts and allow provision of mitigation measures to minimize the significance of these impacts, or even eliminate their likelihood. The decree also states that projects that could have some impacts on the environment should undergo an initial impact assessment.

1.2. BACKGROUND AND RATIONALE

Recent government initiatives in the fields of solid waste and wastewater management in Lebanon have primarily covered major cities and urban areas in the country. The Integrated Solid Waste Management Plan (ISWMP) that serves the Greater Beirut Area (GBA) and the National Wastewater Management Plan (NWMP) illustrates this challenge. Limited achievements were experienced so far in rural areas except for community-based initiatives financed primarily by international donors.

The environmental pressure experienced in Lebanese rural areas can be illustrated by the fact that over 700,000 tons of municipal solid waste (MSW) and over 100 Mm^3 of raw municipal sewage are directly disposed off in the environment every year (MoE/Ecodit, 2002). A wide range of environmental, public health and socio-economic impacts result from the current situation, some of which are listed below:

- *Contamination of water resources*: Lebanon's groundwater resources are mainly of karstic nature (over 75 percent of the resources). That offers limited possibility for natural attenuation of pollutants before reaching water resources; recent surveys and studies have shown that over 90 percent of the water resources below 600 meters of altitude are contaminated (Jurdi, 2000); surface water streams are also affected by the direct discharge of untreated wastewater. As water becomes polluted, expensive treatment to make it, fit for use will inevitably lead to the increase in the price consumers will have to pay when privatization of water services occur and mechanisms such as full-cost accounting are adopted to set water prices.

- *Increased health problems among the population*: inadequate disposal of solid waste and wastewater lead to the release of numerous organic and non-organic contaminants into the environment. That can eventually reach human beings through diverse pathways including direct ingestion of contaminated water, ingestion of crops contaminated with polluted irrigation water and inhalation of polluted air (from open waste burning activities). For example, it is estimated that 260 children die every year in Lebanon from diarrhea diseases due to poor sanitary conditions leading to the consumption of polluted water (MoH, 1996; CBS/Unicef, 2001).

- *Negative impact on local economic activities*: uncontrolled spread of solid waste and wastewater in valleys, watercourses and along roads negatively affects economic activities such as those related to tourism development or eco-tourism by reducing the attractiveness of these areas. Similarly, irrigated areas can be at risk if the source of irrigation water is polluted due to poor waste management practices, thus potentially affecting the agriculture sector in some areas; additional economic impacts are attributed to poor health conditions that can affect human productivity in addition to increasing social costs. *It has been recently estimated that the cost of inadequate potable water quality, sanitation, and hygiene (largely due to inadequate waste management) could exceed 1 percent of national Gross Domestic Product (GDP), or as much as 170 million USD per year (World Bank/METAP, 2003).*

Overall development constraints and obstacles in Lebanon do not favor government assistance to rural areas. Political turmoil, regional instability, and huge public debt are affecting the smooth progress of planned projects in the country, most of which are stagnant with little achievement being made. This may lead for instance to the removal of the Solid Waste Environmental Management Plan (SWEMP) financed by the World Bank (WB), which has experienced limited progress since its inception in the late 1990s.

There are potential risks associated with poor waste management practices in rural areas, aggravated by the limited level of assistance from the central government. The result is that most of the rural areas in Lebanon are deprived of adequate sanitary infrastructure. A more consistent response with USAID strategic objectives would be to look for individual or cluster solutions.

A recent survey on waste management practices in 111 villages outside GBA (El-Fadel and Khoury, 2001) highlighted the following major challenges, in decreasing order of importance, budget deficit, lack of technical know-how, lack of equipment, lack of employees, negligence, mismanagement, lack of land and lack of public participation. These can be summarized in two major categories: 1) limited resources (financial and human) and 2) limited technical skills (technical expertise (Know-How), management, and environmental awareness).

Another important issue highlighted by the survey was the high level of co-disposal of hazardous and special waste stream (over 75 percent). This significantly increases the health risk associated with poor MSW disposal. Rural areas do not have the needed infrastructure to deal with special wastes such as those generated by olive press mills, hospitals, or slaughterhouses. An additional challenge posed by these types of wastes is the low volume-generated, which do not attract private sector investment for their treatment and/or valorization.

Financial support from international sources have assisted in supplying infrastructure and equipment to rural areas for solid waste and wastewater management, yet, additional challenges have been disclosed and lessons can be extracted from these experiences:

- Limited financial resources in municipalities can lead to poor operation of solid waste and wastewater technologies when funding is over;
- Insufficient training, know-how and/or commitment from municipalities can also lead to poor operation of technologies;

- Poor quality of compost, particularly due to the presence of inert materials, leads to significant problems in marketing the product to farmers; insufficient or no public participation in source separation activities contributed to this problem;

- Limited number of recycling factories in the country and the long distances usually existing between treatment facilities and these factories lead to very high and unaffordable transportation costs. Recyclable materials are poorly marketed to the consumers;

- Lack of public participation or consensus can delay or even stop the execution of such infrastructure projects.

Another important challenge is that rural cluster development programs may experience the need to obtain approval from the government. The government has demonstrated skepticism towards decentralized projects, fearing that these could be a short-term solution leading to long-term problems. Both the Ministry of Interior and Municipalities (MoIM) and the Ministry of Environment (MoE) have shown their reservations with respect to such initiatives, fearing that they could become out of their control due to difficulties in monitoring the performance of scattered projects across the country.

Implementing sustainable infrastructure projects in Lebanese rural areas requires a multi-disciplinary and clearly oriented approach with a long-sighted vision in order to overcome all the constraints presented above. The proposed approach calls for the involvement of several partners to ensure the sustainability and success of development initiatives. Figure 1.1 summarizes the overall situation of rural areas with respect to such infrastructure projects.

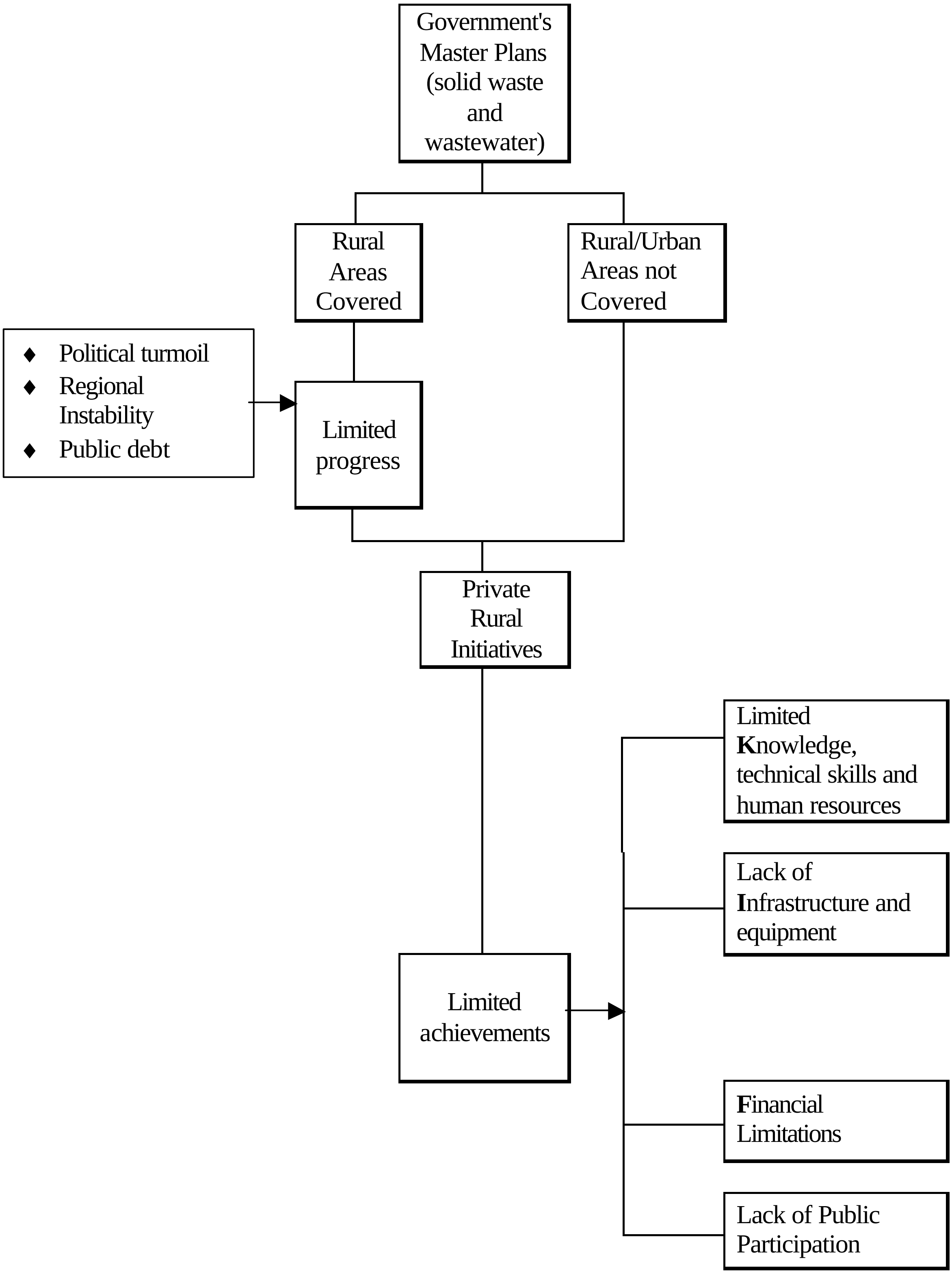


Figure 1.1. Constraints Hindering Infrastructure Development in Rural Communities in Lebanon

1.3. SOLID WASTE MANAGEMENT IN LEBANON

Solid waste management has always been a chronic problem in Lebanon, causing serious environmental degradation. Prior and during the war, uncontrolled dumping and burning were the common methods practiced for solid waste disposal resulting in serious land, water, and air pollution problems. Although such methods are legally banned and their adverse impacts widely recognized, until the present time, they are still practiced in rural areas and even urban areas, mainly due to the lack of law enforcement, financial means, and public awareness. Since 1997, the contracted Company (Sukleen) has reduced such a burden in major cities and towns of Greater Beirut Area (GBA) and its surroundings but for a very high price. However, the contract between the Government of Lebanon (GoL) and Sukleen/Sukomi will be terminated in the beginning of 2004, leaving the area and most of the country without a clear alternative for solid waste management. Hence, the termination of the contract would create again an absence of a national Integrated Solid Waste Management (ISWM) unless the government's recent efforts to hire new companies for implementation of SWM services throughout the country succeed.

This situation led the country's concerned ministries, officials, councils, and municipalities to look for urgent and sustainable solutions for the upcoming challenges. At present, many solutions and suggestions are being studied and assessed. For that purpose, a governmental committee was assigned to propose a new National ISWMP.

Consequently, the committee suggested that each Caza should be responsible in setting and implementing its own SWMP.

1.4. SOLID WASTE MANAGEMENT IN JBEIL CAZA:

The Jbeil Caza represented by the Union of municipalities of Jbeil had its own waste management for the last two decades. Due to the high prices incurred by private waste management companies, the union of municipalities did not sign any solid waste management contract with private companies. The Union's waste management plan consisted of collection from the 85 villages in the Caza and dumping of municipal wastes in a central uncontrolled landfill located in the village of Hbaline. This uncontrolled dumping lead to an accumulation of untreated solid waste estimated to a volume of 275,000 m^3.

In this respect, there is an urgent necessity to rehabilitate this landfill and to create a new sanitary landfill that will be used as a dumping site for the inert material generated at the intended sorting and composting plant located on site. Furthermore, the union of municipalities of Jbeil Caza will cover all the expenses subjected by the rehabilitation and initiation of this new sanitary landfill.

1.5. THE PROJECT

A solid waste management project was proposed to be implemented by Pontifical Mission (CNEWA/PM) financed by the United State Agency for International Development (USAID) to serve the 85 villages in this Caza of Jbeil. Such project was based on the urgent needs of the Union of municipalities of Jbeil for an ISWMP, as well as the coming ISWM contract termination at the national level, the recommendations of the governmental committee for each Caza to have its own ISWMP and to prevent any further environmental degradation.

The project entails the implementation of a sorting plant and an aerobic composting plant, which will serve the needs of the union towns and villages. The proposed facility, with a capacity of treating up to 56 tons per day of organic material, accepts both sorted and unsorted wastes, sorts the commingled waste on-site, separates the recyclables, and stabilizes the organic components to produce compost of marketable quality. The plant can accept up until 80 tons of solid waste per day considering that the organic portion of the total incoming wastes ranges between 60 and 70 percent by weight.

Inorganic waste that is not recycled (rejects or inert material) will be properly landfilled next to the composting facility after the rehabilitation of the old landfill is complete. The project will be complemented by numerous awareness campaigns that will focus on long-term waste management practices such as waste minimization, reuse, and sorting at the source programs. One of the main objectives of these campaigns is to enhance waste separation at the source, which will facilitate the operation of the plant and more importantly, improve the quality of the by-products, compost, and recyclables, hence their marketability and subsequently the sustainability of the project.

1.6. IMPORTANCE OF THE PROJECT

This project is expected to set an example to be followed by other Union of municipalities or even Cazas in the country in order to prevent the numerous impacts associated with lack of an adequate solid waste management. The concept is based on elementary principles of ISWM, and should considerably reduce the negative impacts resulting from practices such as open dumping and burning of municipal solid waste (MSW) and producing several positive impacts.

1.7. OBJECTIVES OF THE PROJECT

The main objective of this project is to provide the necessary means and tools for the proper management of MSW in the 85 towns and villages of the Union of Jbeil municipalities. It also aims at increasing the awareness of the local population on the importance of waste minimization, sorting and re-use as long-term strategies for the sustainable management of solid waste in the study area.

1.8. THE ENVIRONMENTAL IMPACT ASSESSMENT

The EIA identifies and evaluates any potential environmental impacts and, when appropriate, proposes measures to mitigate negative impacts. The need for safe, responsible, and sustainable management of wastes is vital in order to eliminate health hazards and adverse ecological effects. This EIA study was conducted according to the guidelines set in the proposed draft EIA decree. It describes the policy, legal, and administrative frameworks, the proposed project, and the existing environmental conditions, identifies potential environmental impacts, proposes alternatives, and recommends an environmental management plan with mitigation, monitoring, institutional and capacity building schemes. This EIA report is structured in ten (10) main sections including this introductory section. Section 2 provides the legislative and administrative frameworks. Section 3 describes the proposed plant including the associated treatment processes. Section 4 presents the environmental setting at the site. Section 5 assesses the impacts of the deployment of the plant. Section 6 presents the analysis of alternatives. Section 7 presents the mitigation plan. Section 8 presents the monitoring plan. Section 9 presents the Environmental Management Plan (EMP). Section 10 presents the results from the public participation session that was held with the members of the concerned municipality.

2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORKS

Lebanon has numerous laws related to solid waste management some dating back to 1931. However, the Lebanese civil war that lasted approximately 15 years had adverse effects on law enforcement in Lebanon, and consequently on solid waste collection and disposal. During the war, many open dumps were established without any environmental considerations and until the present time, open dumping and burning are used as waste disposal methods in some rural areas and others are paying large amounts of money to private companies.

2.1. ADMINISTRATIVE AND INSTITUTIONAL FRAMEWORKS

The main bodies involved in the solid waste management sector in Lebanon are the MoE, the Council for Development and Reconstruction (CDR), the Ministry of Interior and Municipalities (MoIM) and the municipalities.

2.1.1 The Ministry of Environment

The MoE, established in 1981 and reinstated in 1993, is responsible for planning and monitoring of environmental issues. It also plays a role in establishing a system of environmental management and introduces environmental planning into all aspects of national and sectorial decision-making. The general and specific duties assigned to the MoE as stipulated in Article 2 of law No. 216 include the following:

- Formulation of a general environmental policy and proposition of measures for its implementation in coordination with the various concerned governmental administrations.
- Protection of the natural and man made environments in the interest of the public health and welfare.
- Fighting pollution from whatever source by taking preventive and remedial actions.
- Developing a strategy for solid waste and wastewater disposal treatment, through participation in appropriate committees, conducting studies prepared for this purpose, and commissioning appropriate infrastructure works.

- Developing conditions and regulations for the use of public land, marine and riverine resources in such ways to protect the environment.
- Approving international agreements covering projects related to the environment.
- Encouraging the private collective initiatives, that improves environmental conditions.
- Classifying natural sites and landscapes and making decisions and decrees concerning their protection.

2.1.2 The Council for Development and Reconstruction

The CDR is the authority responsible for the implementation and operation of all activities related to development and reconstruction that are being instituted in Lebanon, including solid waste management. The CDR contracted a private company, Sukkar Engineering Group (SEG), for the collection of municipal refuse through Sukkleen, and the operation and management of the SW management plants of Amrousieh and Karantina by Sukomi. In addition, CDR designated LACECO as the consultant to provide technical assistance to the government through the supervision of SEG activities at Greater Beirut Area (GBA) sites. Its involvement outside the GBA is still limited. However, it is expected that this contract will be terminated early 2004, creating a necessity for a new National ISWP.

2.1.3 The MoIM and the Municipalities

The municipalities, under the tutelle of the Ministry of Interior and Municipalities (MoIM) are responsible for the financing of the SWM operations (law No. 118 of 1997). SWM is funded from the revenues of the municipalities, which consist of: (1) a municipal tax equivalent to 11 percent of the ascribed rental value of property, and the proceeds from land sales and construction permits, all of which are collected directly by the municipalities, (2) a share of certain revenues, such as a 10 percent surcharge on telephone, electricity and water bills, as well as duties on imports, liquor and fuel, collected by the Central Government and distributed to the municipalities based on population and size of the previous budget. Accordingly, Beirut benefits of 60 percent of the total under the existing formula. With the exception of GBA and few areas of Mount Lebanon, the waste collected at other Lebanese territories is monitored and contracted by local municipalities, with some areas being awarded to private companies.

2.1.4 Other Institutions with Responsibilities for SWM

The institutional responsibilities for SWM in Lebanon are overlapping thus hindering effective management and monitoring of SW. In addition to the stakeholders mentioned above, the Ministry of Public Health (MPH) is empowered to propose technical specifications and terms, which should be followed in solid waste collection and disposal projects. The Ministry of Public Works and Transport (MPWT), road building and sanitary engineering department and the directorate general of urban planning (DGUP) undertake the preparation of projects for collection and disposal of domestic garbage, draw up the documents for such projects and supervise their execution. DGUP has also an important role in the selection of sites for waste management facilities. Municipal unions deal with common interest projects benefiting all municipalities and in particular common garbage treatment projects.

2.2. LEGAL FRAMEWORK

Lebanon has many environmental laws and regulations dating back to 1930, however there is a lack of implementation and enforcement in most of the Lebanese territory. Laws for the protection and conservation of the environment in general, and management of solid waste in particular are presented in Table 2.1.

Table 2.1. Summary of Laws related to SWM

Law/Decree No.	*Year*	*Description*
2775	1928	Dumping of pollutants into public water is prohibited
7975	1931	Waste should not be dumped around houses, but be buried or removed by the municipality
1761	1933	Law summarizing the discarding and penalties involved while disposing of municipal and industrial waste
425/1	1971	Refuse should be stored in plastic bags
8735	1974	Municipalities are responsible for collection and disposal of domestic wastes. Household and construction wastes (rubble) may not be dumped in public places or private land adjacent to roads and residential districts. It is an offense to drop litter in streets, government buildings and public areas. Only tightly closed containers should be used for the storage of refuse. Municipalities may not pile waste on the roadside before it is collected. Wastes should not be transported in open vehicles, but in vehicles that are "tightly covered." Disposal sites must have the approval of the health council of the Mohafaza
64/88	1988	It is the duty of every person to preserve the safety of the environment from pollution. A list of hazardous material was published, and the importation or possession of radioactive or poisonous waste was prohibited. In extreme cases the death penalty could be applied
216	1993	Ministry of environment was created with a responsibility for environmental supervision

197	1993	Ministry of municipal and rural affairs was established, and is charged with municipal sector development in areas such as strategic planning, budgeting, and programming, as well as auditing the functions of the various municipalities in Lebanon
444	2002	Law for the protection of the environment stating that: it is the duty of every person to preserve the safety of the environment from pollution. Waste should be managed taking into consideration country specific economic conditions (including collection, transportation, storage, treatment, and final disposal). Disposal sites must be designed and managed within established guidelines and principles. Local authorities are responsible for collection, transport, storage, treatment and disposal of waste. Every person is responsible to inform the local authorities about any kind of waste that adversely affect the environment. Persons that dump wastes illegally are obliged to dig out all the waste, and minimize or compensate for adverse impacts on the environment

Another set of decisions and laws, No. 69, No. 1014, No. 68/6, and decree No. 15659, regulates the production, trade and usage of chemical and organic (such as compost) fertilizers. The Law for the protection of the environment (Law 444 of 2002) sets the legal framework necessary to implement the protection of the environment in order to prevent all forms of degradation, pollution and negative impacts, and ensure the sustainable use of natural resources, and allow a stable and environmentally safe livelihood.

2.3. Solid Waste Collection, Treatment and Disposal Policies and Plans

2.3.1 SWM in GBA

Prior and during the war, waste management included collection and disposal in uncontrolled open dumps followed by open burning. MSW collected from the vicinity of Beirut were dumped in Bourj Hammoud open dump, transferred to Karantina facility (140,000 tons/year) for composting or Amrousieh (200 tons/day) for incineration. However, both plants suffered from operational problems, and caused environmental disturbances, which lead to their closure. A number of national plans were developed but none was implemented before 1997. In 1992 a five-year public investment program (1993-1997) referred to as the National Emergency Recovery Program (NERP) was developed, followed by another ten-year (1995-2004) program with expenditure estimated at US$ 11.7 billion (1992 prices). In December 1995, the MoE and the CDR developed an integrated solid waste management master plan relying primarily on incineration and landfilling. The plan proposed the establishment of various incinerators and landfills distributed all over the districts to solve the solid waste problem, but failed to deal with the industrial, clinical and construction wastes. In 1997, the MoE issued an Emergency Waste Management plan, consisting of the development of an Integrated Municipal Solid Waste (IMSW) management system, to end the use of incineration (at the Karantina plant) and propose alternatives to the dumping of wastes. The plan aimed at:

- Closing Bourj Hammoud dump site
- Constructing waste sorting facility at Karantina with a capacity of 1200 tons/day
- Constructing a waste sorting facility at Amrousieh with a 600 tons/day capacity
- Establishing a composting plant at Karantina
- Incinerating combustibles at Karantina and Amrousieh
- Constructing sanitary landfills within old quarries
- Prohibiting uncontrolled dumping and waste transfer

2.3.2 SWM outside GBA

Currently, the facilities for solid waste collection, treatment, and disposal are highly inadequate, especially in the rural areas, and only 57 percent of the population is served by collection services (METAP, 1995). The municipalities are often incapable of ensuring proper collection and disposal method, especially in rural areas, mainly due to economical constraints. The most common disposal method in rural areas (52 percent of all towns and villages, according to a 1996 survey) is open dumping and burning of wastes. A recent study that covered 111 villages outside the GBA drew even a darker picture: over 90 percent of the surveyed villages practiced open dumping and/or burning (El Fadel and Khoury, 2001). Figure 2.1 illustrates these results. Furthermore, municipalities are generally restricted to villages with a population of more than 5,000, which leads to approximately one thousand villages without municipalities and therefore with no authority responsible for solid wastes (METAP, 1995).

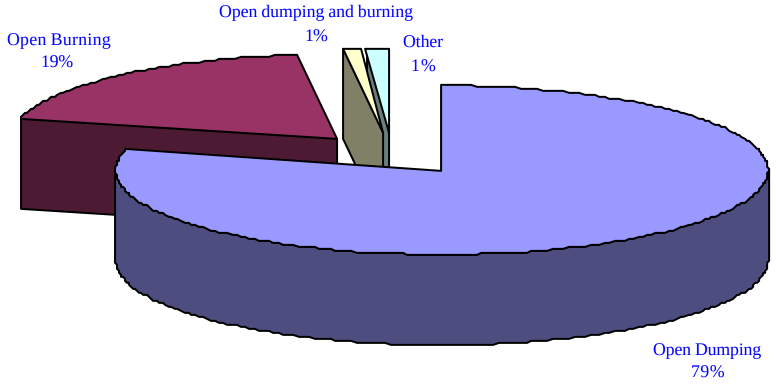


Figure 2.1. Current Solid Waste Management Practices outside Greater Beirut Area

3. PROJECT DESCRIPTION

3.1. PROJECT BACKGROUND

The project was initiated within the framework and supervision of the CNEWA/PM in the 85 villages that constitute the Jbeil Caza under the United State Agency for International Development (USAID) programme for the improvement of environmental practices in rural areas of Lebanon. Hbaline dump had been selected to host the project in order to reduce the amount of solid waste that is being currently disposed in the uncontrolled landfill present for more than 2 decades. The project consists of:

- Developing a local team to assist in conducting a solid waste management awareness campaign at the villages;
- Introducing and promoting the concept of solid waste sorting at the source;
- Installing a solid waste treatment plant to serve the 85 villages.

At the same time, the Union of Municipalities of Jbeil Caza intends to rehabilitate the existing old uncontrolled landfill site in order extend its life span.

3.2. THE PROPOSED PROJECT

The proposed project entails the treatment of municipal solid waste (MSW) generated in the 85 villages reaching a total of approximately 80 tons per day until 2022. Currently, the municipalities are collecting and dumping municipal solid wastes in the uncontrolled Hbaline dump. A contractor who sells most of the collected materials to recycling companies is performing some insignificant onsite sorting.

The Union of municipalities will be responsible for the management of the plant, as well as the collection and treatment of waste generated in the various villages. In order to encourage sorting at the source, an advantageous price rate will be charged over the village for the delivery of sorted waste as compared to unsorted waste.

A municipal solid waste treatment facility, with a peak capacity of 80 tons per day to serve approximately 123000 people, considering an average per capita generation of 0.65 kg/day, will be constructed to treat the organic fraction of waste expected to be around 56 tons/day, producing good quality compost. The municipal solid waste inflow nowadays is approximately 71 tons/day based on a 110'000 population number all over the Caza. The intended composting plant will not need any further upgrading before the year 2018. However, the plant can be easily upgraded to accommodate increases in population, include other villages if necessary.

The treatment method is aerobic, in-vessel composting, which is a biological process for the conversion of the organic portion of sorted municipal solid waste to a stable humus-like material, compost, used for soil amendment especially for agricultural purposes, landscaping or old quarries rehabilitation. Compost and recyclables would be sold to generate further income for the union of municipalities. On-site sorting will complement waste sorting at the source. As a result of the awareness campaign and due to the chain reaction that might take place over the various villages, the efficiency of source separation of the waste is expected to gradually increase with time.

Pilot facilities were implemented successfully earlier by P.M. in various villages over Lebanon such as in the village of Chacra (10 tons/day), Khirbit Silim (5 tons/day), Qabrikha (5 tons/day), and Qleia (10 tons/day). These were evaluated and used as example facilities to predict impacts and illustrate the proposed project components, as well as to identify the various operation and maintenance costs in order to ensure an acceptable level of sustainability over the project life span. A detailed description of the proposed project design components and characteristics is presented below and is illustrated using photographic documentation mainly from Qleia facility.

3.3. PROJECT LOCATION

The location of the facility is a critical parameter in solid waste management projects. The siting of the facility encounters many social and economic constraints, such as the NIMBY (not in my backyard) syndrome, the availability of land, and the distance from residential areas as well the pricing of the land by the owners. Moreover, the intended rehabilitation of the old and still operational landfill made it imperative that the composting plant would be sited on location in order to facilitate the process and to reduce the amount of landfilled wastes in the future. The main criteria taken into consideration while assessing the site suitability were:

- Land availability;

- Distance from residential areas (Table 3.1) ;
- Social acceptance from the local community;
- Land nature (land value, geology, hydrogeology);
- Availability of a road network;
- Availability of a nearby market for compost; and
- Presence/absence of sensitive habitats and richness of the ecosystem.

The Union of municipalities proposed the Hbaline site since it has been used as a wild dumpsite for the collected wastes from the Caza. As part of the suggested solutions for such a problem, the solid waste treatment plant will reduce dumping in the site to small portions of inert material hence facilitating the intended reclamation of the dump by the Union. The site is surrounded by two steep mountains newly expropriated by the union summing up to an area of 117,000 m^2. Further description of the site and its surroundings is provided in section 4.3.

Table 3.1. Distance of the dumpsite from the surrounding villages.

Village	*Distance (Km)*	*Direction*
Down-Town Jbeil	*5*	South-West
Hosrayel	2.5	North-West
Aammshit	3.2	South-West
Ghorfine	1.2	South-West
Kfar-Mashoun	1.2	South
Bentael	2	South-East
Hbaline	1	North-East

3.4. OPERATING CONCEPT

Aerobic composting is a biological treatment system based on aerobic fermentation of organic wastes using bacterial/enzymatic preparation. The objectives of aerobic composting operations are waste volume reduction (reaching up to 50%), and compost production (humus-like material) in a controlled and odor free environment. The system used, a drum called digester (bio-fermenter) (Photograph 3.1), accepts separated municipal solid wastes, and stabilizes the organic component to produce compost. The size and composition of the microbial population determines the rate and extent of the composting activity. The microbial population produces a large part of the heat released in the composting mass through exothermic biological reactions. Therefore, the high temperature attained in the compost pile results from internal processes and not external sources. However, introduction of hot dry air (produced by the generator's cooling unit) at the last stage of the process will provide additional heat to ensure pathogen destruction. The success of the composting operation depends on a careful control of pH and temperature, which is the most decisive factor in pathogen destruction. The humidity in the waste material usually ranges between 40 to 55%, thus moisture should be held well within the organic structure of the compost avoiding leachate production. This method eliminates the production of leachate, minimizes odors and process time, lowers labor costs, and requires a relatively small area.

Photograph 3.1. Typical Composting Drums in Qleia.

3.5. CONSTRUCTION AND INSTALLATION REQUIREMENTS

Construction requirements are limited. Most of the facility includes pre-fabricated equipment ready to be installed. Civil works include the construction of the hangar (steel) and that of the landfills for inert materials. A detailed site drawing is attached in Appendix A. No more than three (3) workers will be used to erect the facility. The facility will be operational within 12 months of contract signature between the municipality and the contractor. This includes time for procurement and shipment, construction, and start-up. The following equipment and materials will be provided:

- 15 material handling conveyors;
- 5 rotary trommel screen;
- 10 drums (digesters), 6 ton capacity/day each;
- 1 generator;
- Miscellaneous mechanical and electrical components;
- Fencing material to secure the site and prevent trespassing, illegal dumping, or litter;
- A shed over a concrete floor area for recyclable wastes separation and storage; recycled wastes are stored in separate closed rooms;
- A room with kitchen and toilet facilities for the site operatives;

- Landscaping and trees.

3.6. OPERATION REQUIREMENTS

Major operational requirements can be summarized as follows:

- Collection and transport of MSW to the center in acceptable hygienic conditions;
- Provision of not less than 12 trained workers every day;
- Mechanical (equipment) and biochemical (enzymatic preparation) maintenance;
- Municipality and contractors' commitment to manage the facility as to the standard operational procedures and to cover the facility's operational expenses.

3.7. OPERATION PROCESS

The operation process (Figure 3.1) involves three basic steps: 1) preprocessing and separation of wastes (at source and on-site), 2) aerobic decomposition of the organic fraction, and 3) final product preparation. MSW is collected from the villages and transferred to the material recovery facility (MRF) by various municipalities. The waste will be sorted at the household level; efficiency of this process depends on the commitment of the local community and the effectiveness of the awareness and sorting at the source campaigns. Waste is unloaded in the receiving area where bulky items and recyclables (plastics, glass, and metals) are separated and moved to a storage area. The remaining waste, together with the incoming sorted organic waste, is manually placed on sliding slopes that allow for further separation of the waste prior to transferring the waste to loading tanks, and subsequently to the digester drums (6-ton maximum capacity each).

Quantities shown in Figure 3.1 were estimated based on previous experience as well as common characteristics of local MSW. Main assumptions are that the organic fraction of the incoming waste amounts for 60-70% percent of the total mass, of which 50 percent are transformed into compost and the remaining 50 percent, is moisture. The remaining 30 percent inorganic material is composed mostly of recyclable materials.

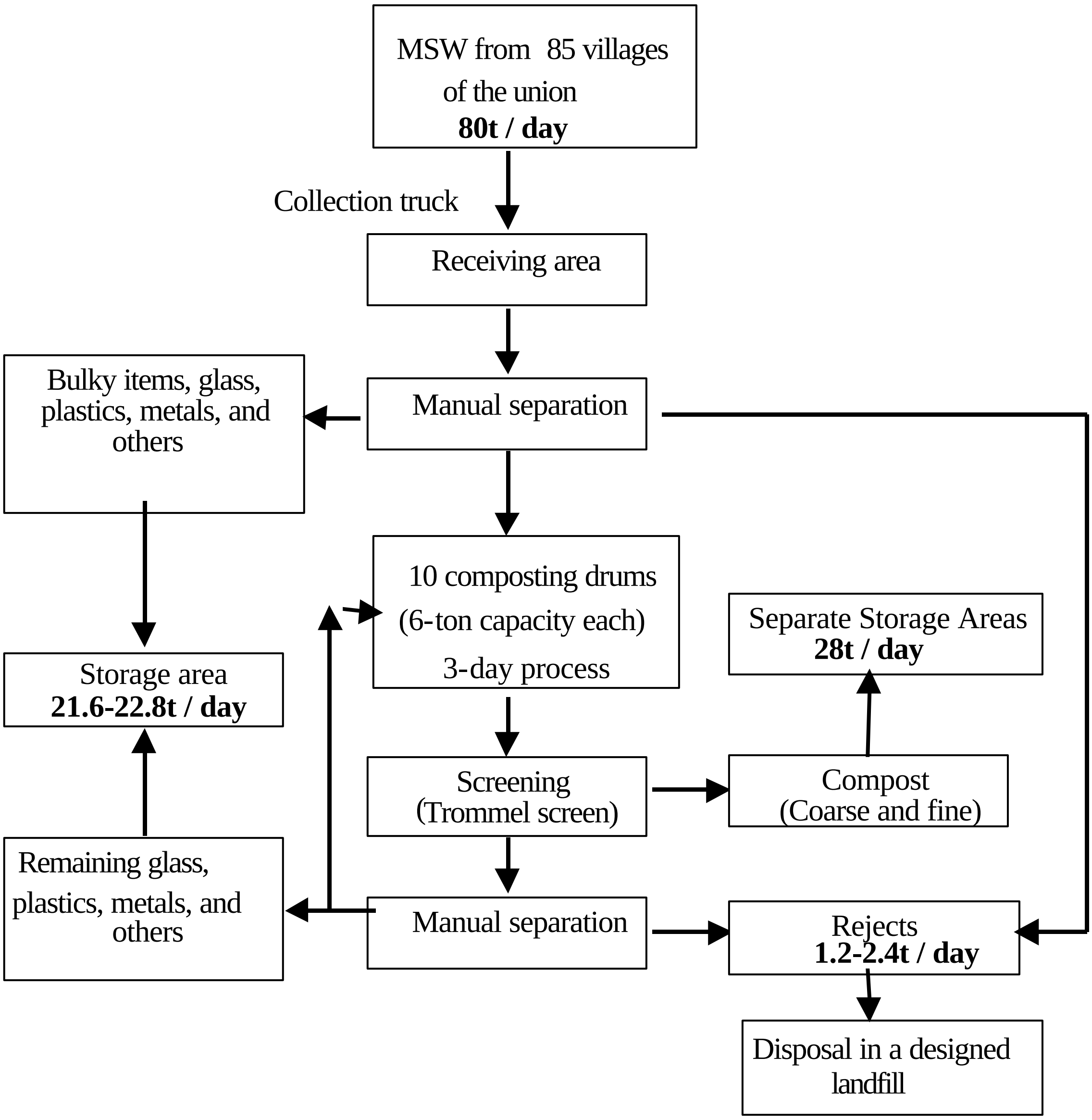


Figure 3.1. The Facility Operation Process

The waste is kept inside the drums for three days. The composted material mixed with remaining inorganic waste is unloaded out of the drums on a conveyer belt. Inorganic matter remaining in the waste stream after the manual separation is unaffected by the dynamic composting reaction. It includes mainly plastics, aluminum, metals, and rubber. The conveyer belt leads the material onto a trommel screen that screens out composted material (coarse and fine) and dumps residual materials (inorganics and rejects) in trolleys for further segregation. The material in the trolleys is taken to a storage area where the workers manually re-separate the recyclable material, transfer them to the recyclable material storage area, and divide them in separate rooms. The rest of waste material is also added to the waste re-entering the digester. All rejects, non-composted and non-recyclable wastes are stored prior to their final disposal.

Five main categories of by-products may be economically recyclable: PET, PE, nylon, metals, and glass. The remaining waste (rejects) includes clothes, shoes, rubber products and other inert materials that cannot be recycled. The project suggests disposal of such remaining waste in a landfill in allocated areas around the facility (Appendix A) assuming that the waste is inert and will not lead to significant negative impacts. The allocated land filling area is expected to serve for a period of at least 10 years given the amount of rejects generated and given that, the existing uncontrolled landfill is rehabilitated by the Union. After that period, rejects will be directed to regional sanitary landfills, if existent, or further land may be procured to expand landfill area. The compost may be sold but in the present time, the project will not depend on the revenues generated from compost sales. Table 3.2 presents the different expected outputs of the project and their potential destinations.

Table 3.2. Summary of Project Expected Products

Type	*Expected Amount*	*Suggested Destination*
Compost	28 tons/day	Agricultural fields, forests, rehabilitated ecosystems
Recyclables	21.6-22.8 tons/day	Recycling companies
Rejects	1.2-2.4 tons/day	On-site engineered landfill

3.8. PROJECT COSTS

The total costs of the project amount to USD 2,227,000. The costs of construction and complete initiation of the plant will be covered by the pontifical mission through the USAID grant (USD 1,136,500) along with a local contribution of USD 1,090,500. After the completion of the construction works, the operational costs will be covered by the contractor for the first operational year and then by the union of municipalities.

3.8.1 Initial Investment Cost

The pontifical mission will cover the initial investment costs along with a local contribution of the Union. The local contribution process aims towards creating incentives amongst the community and the officials in the Union. Table 3.3 presents a summary of investment costs with the responsible party.

Table 3.3. Summary of Approximate Distribution of Investment Costs

Item	Cost US $	Responsibility
Composting plant: Electro mechanical equipment (10 drums, trommel screens, conveyor belts, loading tanks, etc) Metal structure…	780,000	Pontifical mission
Sorting Plant	450,000	Pontifical mission/ Union of municipalities
Landfill	800,000	Union of municipalities
Reinforced concrete work	197,000	Pontifical mission/ Union of municipalities
Total	2,227,000	Pontifical mission/Union of municipalities

3.8.2 Annual Operational Costs

The contractor will cover the annual operational costs for the first operational year and subsequently by the Union of municipalities of Jbeil Caza. The identified annual costs include maintenance, operation (diesel for generator, oil, and filters), wages, and utilities (energy and water). Monitoring costs are detailed in section 0. Table 3.4 presents a summary of operational costs identified according to the suggested project design. The annual fixed cost excludes the potential sales revenue of compost and recyclable material and the depreciation cost of the equipment.

Table 3.4. Annual Estimate of Operational Costs

Item	Costs US $
Onsite Maintenance	7,200
Operation	8,800
Salaries/wages	52,800
Services (Diesel energy, water)	26,400
Total	95,200

3.9. LIFE SPAN OF THE FACILITY

When properly maintained, the MRF equipment, including the composting drum, should be viable up to 10 years. Care should be taken to maintain proper flow of electricity to all equipment. Operators should not load the drum with more than the nominated weight capacity of 5-6 tons per compartment. The designed landfill has an expected lifespan of 10 years considering that the existing uncontrolled landfill has been rehabilitated, with the possibility of the reclamation of additional land for waste disposal in the future.

3.10. OPERATIONAL RESPONSIBILITIES

The project will be implemented by the Pontifical Mission in collaboration with the contractor and the union of municipalities of Jbeil Caza. Since the site has been used as an uncontrolled landfill for a period of 2 decades a composting plant is then imperative in order to facilitate the intended rehabilitation of the landfill by reducing the amounts of wastes to be landfilled. Moreover, the union of municipalities bought an extension to the existing landfill to be used in the future.

After the implementation of the facility, the union of municipalities will be responsible for the collection of waste from the villages served, and will charge each municipality an amount of money paid for waste management according to the level of at the source waste separation. A reduced price will be offered for segregated waste to encourage separation at the source. For the first operational year, operation, management, and monitoring will be the responsibility of the contractor, who will take half the amount of compost and all recyclables produced. As for the subsequent years, operational responsibilities will be adopted from the following options:

Option 1: The contractor continues to operate the facility, ensures proper management and monitoring in return for a fixed amount of money per person served.

Option 2: The contractor trains municipality workers during the first operational year before transferring full responsibility to the municipality. The union of municipalities will therefore be responsible for the collection of waste from the villages served as well as the operation of the facility.

Furthermore, the contractor will be responsible for the maintenance of the facility for a period of 10 years (expected lifespan of the facility). Table 3.5 represents the design, construction and operation responsibilities.

Table 3.5. Project Responsibilities

Phase	Responsible bodies
Design	PM, contractor
Construction	PM, contractor, Union of Municipality
Operation	Contractor, Union of Municipalities
Monitoring	Contractor, Union of Municipalities

3.11. PROJECT SUSTAINABILITY

Project sustainability will be ensured if the by-products, particularly compost and recyclables are marketable. The domestic solid waste generated in Lebanon is characterized with a high percentage of putrefaction able materials, high moisture content, and relatively small percentages of plastics, paper/cardboard, and metals (Ayoub *et al.*, 1996). These characteristics render the waste suitable to be composted. High quality compost can therefore be produced and sold. The quality of the compost will depend mainly on the efficiency of waste sorting to avoid the presence of impurities in the final product; hence sorting at the source along with on site sorting will guarantee a better product quality. In general, farmers express interest in utilizing such compost as a source of soil amendment.

Recycling campaigns have been organized for several years in some schools and universities, and in some villages. Numerous scavengers remove considerable quantities of recyclables from the waste containers and dumps and sell them to scrap dealers. Sukkleen implemented a recycling plan, where containers for glass, plastic and metal were placed in several locations in Beirut. However, this recycling plan was not very successful since there were no serious awareness campaigns or incentives and regulations to increase the population involvement in recycling activities. This will be performed in this project.

Several companies in Lebanon use recyclable waste to manufacture new products. Table 3.6 presents a list of Lebanese recycling companies with their corresponding location and contact persons.

Table 3.6. Recycling Companies in Lebanon

Category	*Company*	*Contact*	*Location*	*Tel. Number*
Paper, cardboard	Solicar	Antoine Ghanem	Wadi Chahrour	01-940248/9
	Sipco	Mohammed Ghandour	Kfarchima	01-433500/553
	Sicomo	Jihad Azar	Kabb Elias	08-805039
	C.b.c	Laurent Chidiac	Jbeil	09-444023
	Ninex	George Abou Jaoude	Zouk Mosbeh	09-218400/1/2
Plastics	Hariri	Yehya Hariri	Saida	03-247790
	Rocky	Robert Khoury	-	03634400
	Lebanese recycling works	Elie Debs	Naher el Mot	01-888057 03-659065
Metals	Liban fonderies	Sami Nassar	Roumieh	03-703246
	Ugtal	Khaled Zouein	Taanayel-Bekaa	08-511747
	Tanak factory	-	Choueifat	08-432011
Glass	Solvier	Mazzen Labban Paul Tannous	Choueifat	05-803903 03-247748
	Arab glass factory	Ghassan Azzaz	Enfeh	03-742404
	Maliban	M. El Halawi	Chtoura	08-510156

4. DESCRIPTION OF THE ENVIRONMENT

4.1. GENERAL SETTING

Two parallel mountainous ranges, Mount Lebanon and Anti Lebanon, separated by the Bekaa plain are the dominating topographic features of Lebanon (Figure 4.1). These topographic features extend in a NNE-SSW direction. The study area is located on the Eastern slopes towards the Northern section of Mount Lebanon, where the lowest elevations coincide with the seasonal drainage channel Wadi Edde to reach the seashore at Jisir-el-Djaje area located at the Northern edge the town of Jbeil.

The towns and villages composing the Union of Municipalities are located on the Eastern side of the Mount Lebanon. Land elevations ranging from few meters from mean sea level to 1900 m above sea level

A generally good road network connects the towns and villages within the Caza of Jbeil, which extends over an area of 430 Km^2 about four percent of total Lebanon's area with 18 km of coastline. The Caza is delineated from the North by Naher El Madfoun and Naher Ibrahim from the South. Moreover, the road connection to Hbaline landfill site, the intended location for the solid waste treatment plant is in a good condition, but rehabilitation and renovation works would be required to be suitable for a heavy traffic of municipal waste collection trucks as well as the excavation and building machinery during plant construction phases. (Figure 4.5).

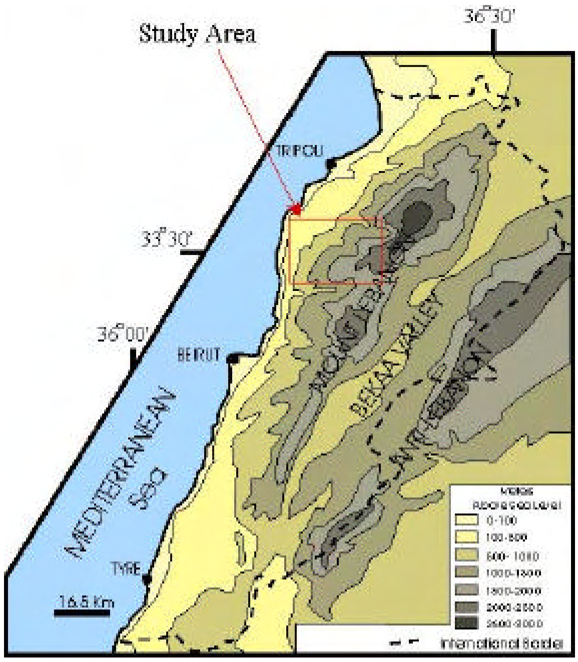


Figure 4.1. Topographic Map of Lebanon showing the area of study.

4.2. METEOROLOGICAL SETTING

The topographic features of Lebanon, in general, influence largely the climate of the country. The climate of the Lebanese coast is of Mediterranean subtropical type, where summers are hot and dry; and winters are mild and wet. On the other hand, snow covers the mountains of the two ranges at times for several months per year. The two mountain ranges tend to have a cool and wet climate in contrast to that of the coastal zone.

Meteorological information including primarily precipitation, ambient temperature, as well as wind direction and speed, are essential data for adequately assessing the environmental impacts. Unfortunately, meteorological records are seldom available, except for few locations in the country where stations are operating, in particular the Beirut International Airport (BIA) and the American University of Beirut (AUB) stations. Recently, new stations have been installed across different regions of the country, providing a better coverage of meteorological parameters. Examples include a station installed in Amioun at an elevation of 300 meters above mean sea level and another station located in Tripoli area at an elevation of 4 meters along with a pluviometric station in Batroun at 20 meters. Currently these stations record temperature, humidity, and precipitation, and are closest to the study area.

4.2.1 Precipitation

The two mountain ranges of Lebanon are perpendicular to the path of atmospheric circulation. They intercept humidity and receive high rainfall compared to areas with similar locations (Figure 4.2),(Figure 4.3) depicts monthly rainfall distribution from data collected at the AUB station (between 1996 - 1998 and between 1877 - 1970) at the Batroun station, which is located towards the Northwestern side of the site and Amioun located to the Northern side of Hbaline. Precipitation data was obtained from BIA records, Service Météorologique du Liban (1977) and from AUB records. The following observations can be made:

The total annual precipitation is 847, 1015, 660.3, and 887 mm at Amioun (1946-1970), Batroun (1940-1970), AUB (1996-1998), and AUB (1944-1977), respectively.

Precipitation patterns show large seasonal variations with more than 80 percent of the annual rainfall typically occurring between November and March.

A marked decrease in precipitation levels is noticed at the AUB station, with approximately 25 percent decrease between the two reported periods.

Based on the above observations, about 80 percent of precipitation that is 677.6 mm in Amioun and 812 mm in Batroun are probably distributed between November and March. On the other hand, if the same pattern of precipitation levels decrease has occurred in the mountains, similarly to the decrease noticed in the coastal area precipitation in Amioun and Batroun would be approximately 636 and 762 mm. This is however yet to be confirmed by future data.

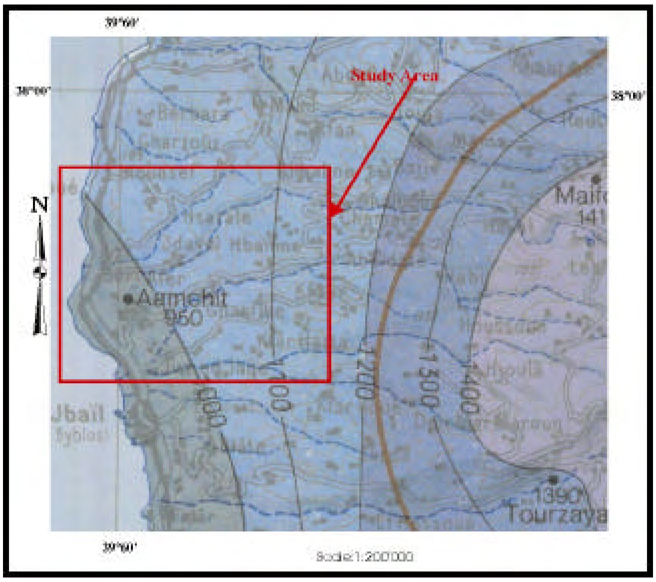


Figure 4.2. **Pluviometric Map of Jbeil Area and Surroundings (scale 1: 200 000) (Service Météorologique du Liban, 1971)**

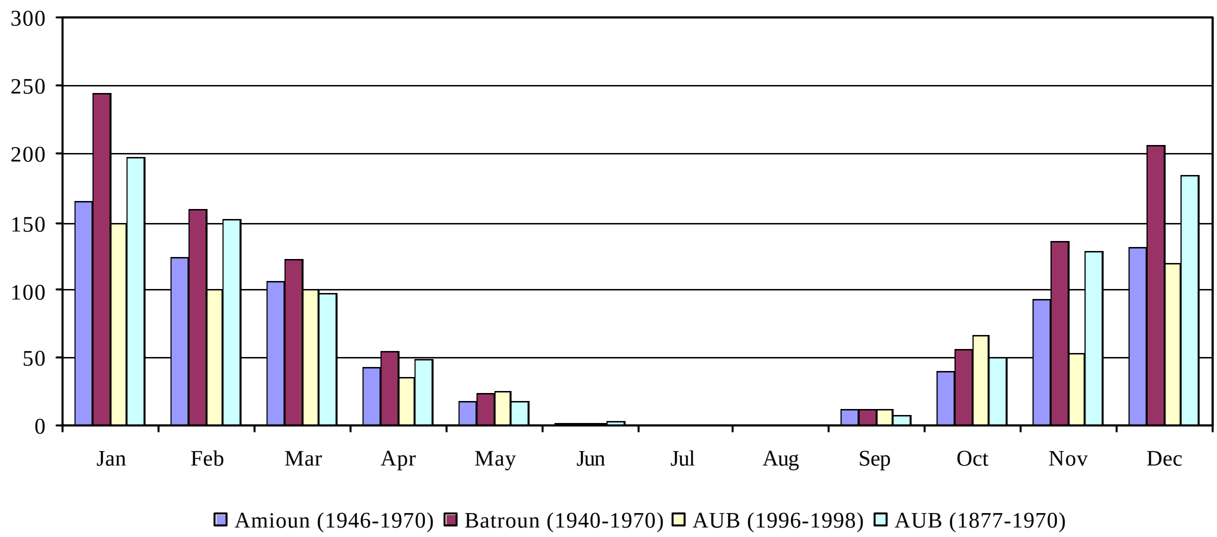


Figure 4.3. Precipitation Data from Amioun (300 m), Batroun (20 m), AUB (34 m). Stations (Elevations are from mean sea level).

4.2.2 Temperatures

The mean temperature along the coastal plains is 26.7° C in summer and 10° C in winter. The temperature gradient is around 0.57 °C per 100-m altitude (Blanchet, 1976). January is typically the coldest month with daily mean temperatures falling to -4 ºC in the mountains and 4 ºC in Jbeil, on the west coast. The warmest months are July and August, when mean daily temperatures can rise to 28 ºC in the mountains and 33 ºC on the coast. Figure 4.4 depicts monthly temperature distribution from data collected at the AUB station (between 1996 and 1998, and between 1931 and 1970); at Amioun station temperatures (between 1946 and 1970). The following observations can be made:

- Average monthly temperatures in Amioun vary between 15 ºC in January and 29 ºC in August.

- Temperature records did not change significantly at the AUB station between the two-recorded periods.

The average annual temperature is 18.5 at Amioun village. Temperature in the study area does not vary much (Figure 4.4); variation is probably in the order of 1 ºC. However, since temperature, records did not change much between the three-recorded periods in the AUB stations and Amioun the average yearly temperature in the study area would be approximately 18.5ºC.

4.2.3 Winds

Dominant wind directions are southwesterly; continental east and southeasterly winds are also frequent. The two mountain ranges have a major impact on wind direction, and contribute to reducing the incidence and strength of the southeasterly and northwesterly winds on the mountain-backed shoreline and in the Bekaa valley. Strongest winds are generally observed during the fall season. Wind data is available at AUB and BIA stations, in Tyr, Tripoli, Cedars, Dahr El Baidar, and Zahle. Dominant wind direction is oriented in the NNE and NE (Service Météorologique du Liban, 1969). Nevertheless, since the study area covers a wide range of settings from valleys to highs, locals were consulted regarding the general wind directions in the proposed locations.

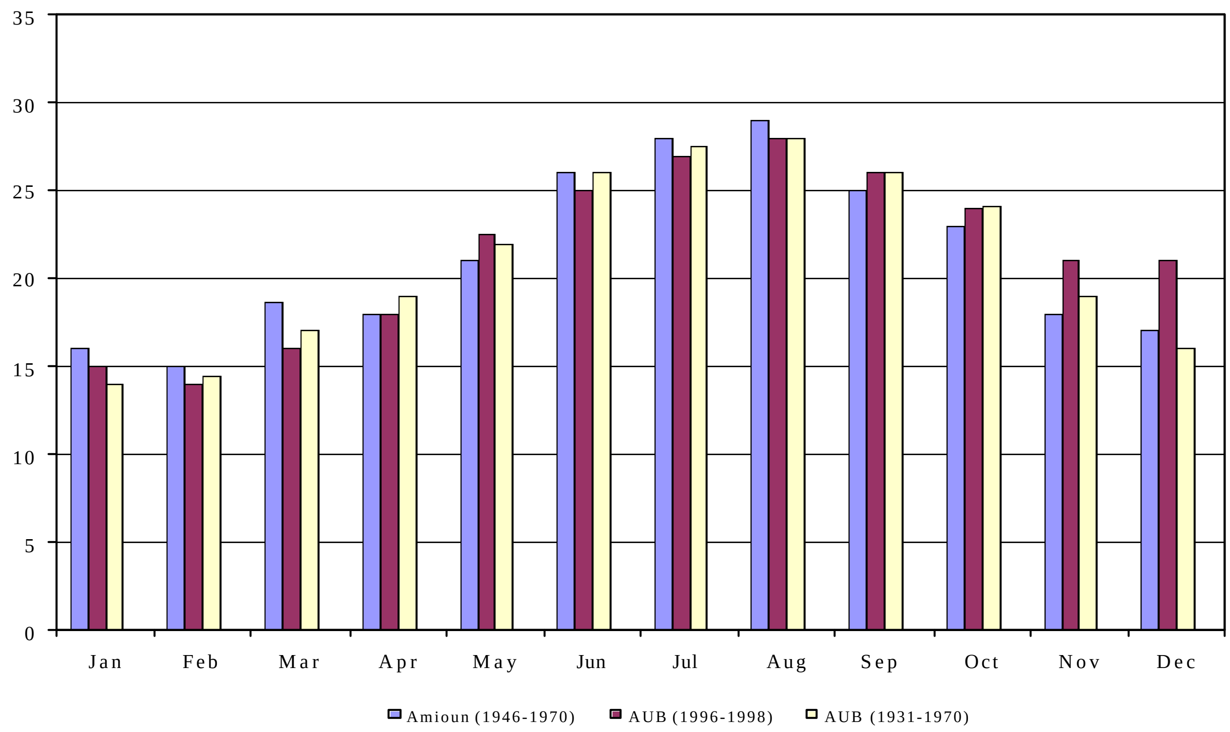


Figure 4.4. Monthly Temperature Data from Amioun (300m), AUB (34 m) Stations (Elevations are from mean sea level).

4.3. SITE SETTING

As mentioned above, with the agreement of Hbaline representatives and community the respective union of municipalities proposed the location of Hbaline landfill to construct the Solid Waste Treatment Plant (SWTP) in order to reduce the level of dumping to minor amounts of inert materials. The data presented in this section was either collected through field visits, research, and/or in consultation with municipalities and union officials or local citizens. Climate data were mainly obtained from records from Amioun and Batroun stations.

The Union of Municipalities of Jbeil expropriated a total area of 117,000 m^2 in and around the existing dumpsite to host the future facilities for the treatment plant along with the rehabilitation of the old existing dump.

Two distinct sites were selected as potential locations for solid waste treatment plants, these two options were presented to the various bidders (Appendix A) to build the plant on. These sites were designated at locations outside the existing landfill within the premises of the expropriated land in order to facilitate the intended rehabilitation of the dd landfill. The sorting and composting plant will cover an area of 3500-4000 m^2 (Photograph 4.1). Land elevation ranges from 220-320 m above mean sea level (Figure 4.5-Appendix A). The site borders a small seasonal drainage that becomes active only with heavy rainfalls; diverted by the uncontrolled dumping the seasonal drainage channel Wadi Edde reaches the sea shore at the level of Jisir Ad Djaje. Furthermore, the accumulation of wastes in the dump created a bottleneck constriction in the seasonal drainage watercourse at the eastern edge of the site (Photograph 4.2). This seasonal drainage is described as a temporary watercourse on the topographical map present in Figure 4.5.

The dumpsite location is down sloping towards the West direction along the direction of the winter channel present along the southern side of the dump. The proposed site is then located in a valley bound by two steep mountains on both the Southern and Northern side. However, very steep, a newly rehabilitated road extending on the northern flank of the valley is used as access road for municipal trucks to reach the actual dumpsite. (Photograph 4.3).

Figure 4.5. Topographic Map of the study area showing the proposed location of the treatment plant in Hbaline along with the road network leading to the site and the surrounding villages. (Scale 1:20'000)

Precipitation in the area ranges between 850 and 1050 mm/year (Service Meteorologique du Liban, 1977). Wind direction varies between orientations of ENE and

E (Service Meteorologique du Liban, 1969). According to local inhabitants, the general wind direction is from the proposed site location towards the village (ENE - E direction). Average annual temperature at Hbaline is approximately 18.5 °C (Service Meteorologique du Liban, 1977).

Photograph 4.1. The proposed sites for SWTP located at the Eastern edge of Hbaline landfill. Photograph looking towards East.

Photograph 4.2 Bottle neck constriction in the seasonal watercourse at the level of the dumpsite.

Photograph 4.3. Part of the landfill road on the Northern side of both selected locations. This road ends at the Western edge of the site.

4.4. TECTONIC SETTINGS AND SEISMICITY

Lebanon is located on the eastern coast of the Mediterranean Sea, along the Dead Sea Transform fault system. The Dead Sea Transform fault system in Lebanon has several surface expressions, represented in major faults (Yammouneh, Roum, Hasbaya, Rashaya and Serghaya faults), in uplifts as high mountainous terrain (Mount Lebanon and Anti Lebanon), and from the seismic activity record. Recent work has categorized the Lebanese section of the Dead Sea Transform fault as being a strong seismic activity zone (Khair *et al.*, 2000).

The studied area lies on the coastal highs of Lebanon (Figure 4.6). Harajli *et al.* (1994) proposed ground acceleration in this part of Lebanon, where the area of study is allocated, to be 0.15g.

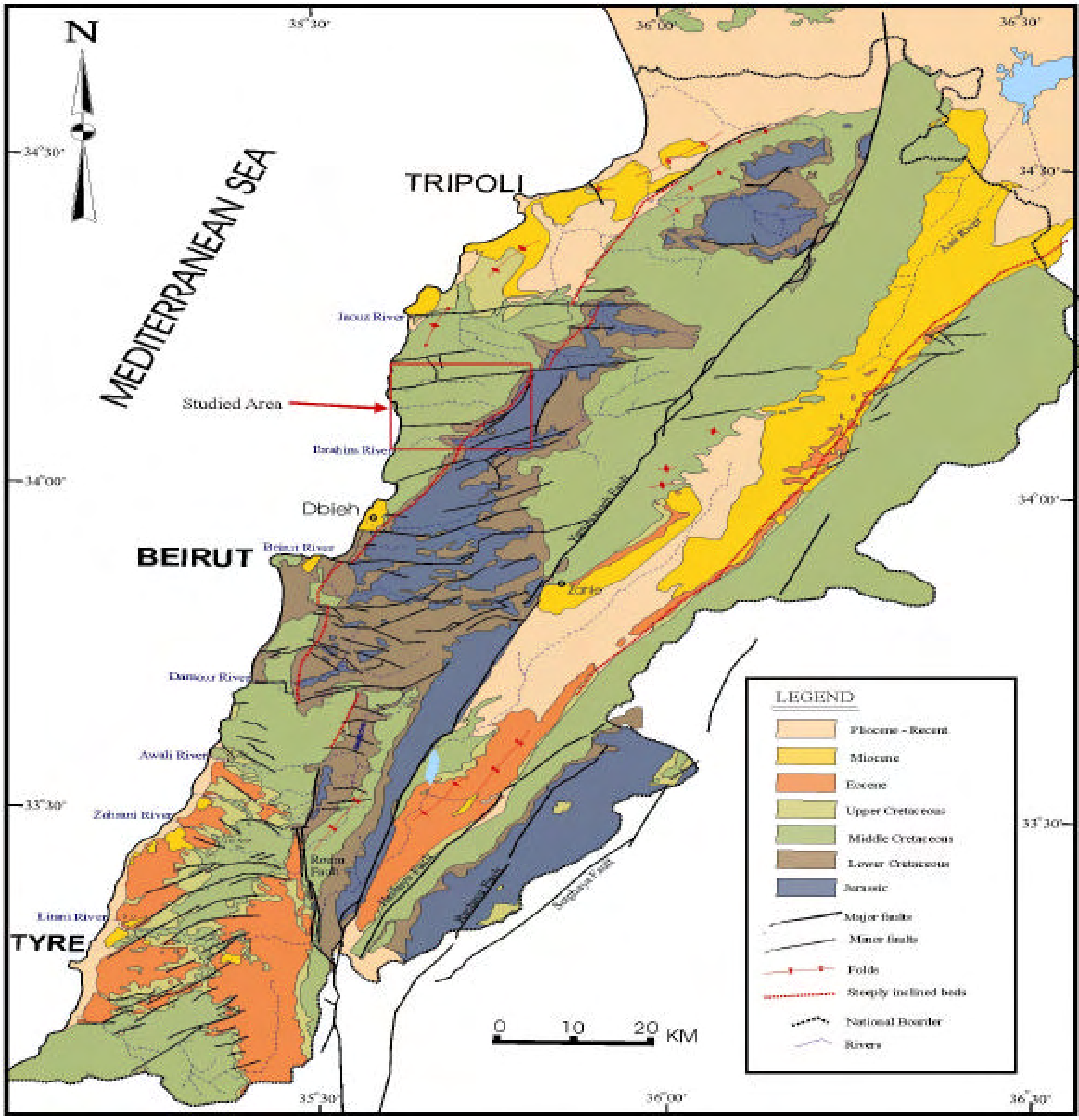


Figure 4.6. Tectonic Map of Lebanon modified by Dubértret (1955), showing the studied area.

4.5. GEOLOGICAL SETTING

The geology of the studied area, including subsurface Stratigraphy and structure, was developed based on: 1) review of available maps and literature, 2) analysis of aerial photographs, and 3) geological surveys and site visits conducted by ELARD geologists. The result was the generation of a geological map at a scale of 1:20,000 covering the area of study, reaching approximately 25 Km^2 and lying within grid coordinates 248 000 and 244 000 Northing, and 141 000 and 147 000 Easting. The geological map is included in Appendix A. One geological cross-section (A-B) that illustrates the subsurface Stratigraphy and structure, underneath the proposed site is presented on the map.

4.5.1 Stratigraphy

There are mainly four formations outcropping in the study area. Three formations belong to the Upper Cretaceous Period and one belongs to the Quaternary Period. The outcropping formations are described in the following section.

4.5.1.1 Quaternary Period

The Quaternary Period is represented in the study area by the Quaternary deposits. These deposits form an elongate stretch along the coast. They are composed mainly of beach deposits and fertile soil covering the Maameltein Formation underneath. They are few meters of sandy clay to conglomerate in nature.

4.5.1.2 Upper Cretaceous Period

4.5.1.2.1 The Maameltain Formation (C_5)

This formation mainly outcrops along the coastal beaches and on the hills facing the sea. It is mainly composed of hard crystalline and micritic limestone to dolomitic limestone. Fresh color is creamish white, while the weathered color is mainly gray. This Formation has a thickness of approximately 200m.

4.5.1.2.2 Sannine Formation

- Upper Cenomanian (C_{4a})

This formation outcrops in the central part of the area between the C_{4a} and C_5. The proposed area of Hbaline dump for Solid Waste Treatment Plant is located on this formation. It is composed mainly of marl and marly limestone. The bedding thickness ranges between 10 cm and 30 cm (Photograph 4.4). Chert bands and nodules are present. The thickness of this Formation is approximately 118 m.

- Cenomanian (C_4)

This formation outcrops in the eastern parts of the area mainly in Edde Valley. It is composed mainly of limestone and dolomitic limestone. Its fresh color is creamish white and its weathered color is gray. Quartz geode can be found along with chert nodules. This formation is sometimes highly fossileferous and it has a thickness of approximately 600 m in the studied area.

Photograph 4.4. Upper Cinomanian formation showing a bedding thickness ranging from 10 to 30 cm.

4.5.2 Structure

Formations in the study area are gently dipping towards the west with inclinations mainly less than 20°. Structural disturbances mainly through faults have a slight influence on the bedding attitude in the study area.

There exist three dominant trends for faulting in the study area: N-S, NE-SW and NW-SE. The gentle dip of the bedding and the slight variation of lithology of the formations did not allow a clear identification of the nature of the faults. NW-SE faults showed major strike slip component. However, their zone of disturbance varies between one meter and 10 meters.

4.5.3 Hydrogeological Setting

The hydrogeology of the surveyed area was developed based on: 1) the review of available maps and literature; 2) the hydrogeological surveys and site visits conducted by ELARD specialists. Geological maps, pluviometric and climatic data related to the studied area were as well used.

The Sannine Formation and the Maameltein Formations are the two main karstic aquifers in the study areas. These karstic aquifers are separated by the Upper Cenomanian semi-aquifer.

Over all the Sannine and Maameltein Formations constitutes the most important aquifer in the Cretaceous sequence. It is a karstic aquifer characterized by significant amount of groundwater flowing in channels, faults, and fractures. The Sannine – Maameltein aquifer represents one of the main aquifers in Lebanon and is the most productive aquifer in the Cretaceous sequence. It is characterized by its high secondary porosity causing ground water to flow mainly through fractures, joints and channels, which is a typical occurrence in karstic aquifers. The Sannine aquifer is considered the major aquifer in the study area, covering approximately 60% of it. Surface and underground features reveal the advanced karstic nature of this aquifer. These features include solution joint, solution pits, lapiaz, grooves, and sinkholes. Cavities in the rock are often filled with calcite and cave deposits. The thickness of the topsoil on this formation ranges from few centimeters up to few meters. According to the UNDP (1970) report, the amount of infiltration in this aquifer is approximately 40%.

The depth to groundwater in this aquifer is encountered few meters above Mean Sea Level. However, small channels and conduits of water might be encountered between the surface and the sea level. This is mainly the due to the karstic nature of the aquifer at hand.

4.5.3.1 Well Survey

A well survey revealed the presence of 15 wells in the study area. Six wells are public and seven are private (Photograph 4.5). All the wells have yields of 3-10 l/s, and are generally used for domestic and potable purposes. The wells are all tapping the Sannine and Maameltein Formations down to a depth around 350m. The 15 wells and their characteristics (owner, discharge, and usage) are listed in Table 4.1, whereas, the locations of identified wells are presented on the geological map in (Geological Map, Appendix A). Most of the water in the area is coming from Afqa spring and form groundwater mainly through wells.

Photograph 4.5. Private well located at the level of jsir el Djaje in Aamchit.

Table 4.1. Characteristics of surveyed wells

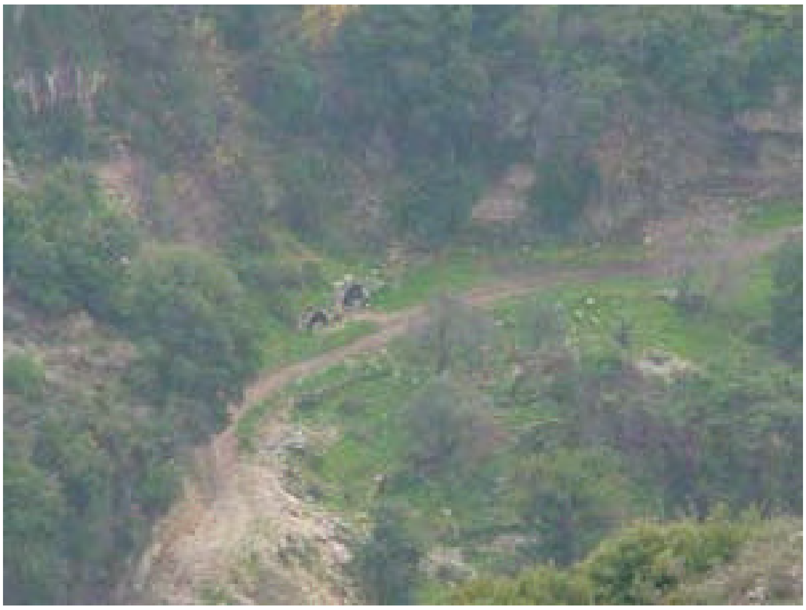
Well #	*Area*	*Owner*	*X coordinate*	*Y coordinate*	*Z(m) Elevation from sea level*	*Riser pipe*	*Depth to Water table (m)*	*Tapping aquifer*	*Usage*
1	Hbaline	Elias Hwaik	146 720	246 790	400	3”			
2	Hay el Aaqab	Public	146 020	246 510	372	-	150		Ab
3	Ghorfine	Public	144 810	246 390	275	-			Ab
4	Ghofine	Public	144 670	246 200	283	3”	276		Do. – Dr.
5	Ghrofine	El Rabieh Factory	144 660	246 290	260	2”			Dr.
6	Aamshite	Public	143 910	245 920	230	2”			
7	Aamshite	George Bakhous	143 750	245 860	210	3”			
8	Aamshite	Michel Abaid	143 720	245 760	200	-			
9	Aamshite	Private	143 730	245 650	210	-			
10	Aamshite	Private	143 040	245 780	149	2”			Dr.
11	Hosrayal	Public	144 440	247 460	300	-			
12	Edde	Public	144 500	244 760	215	-			
13	Jisr el Djaje	Private	142 730	243 890	10	3”	6		
14	Jisr el Djaje	Private	142 760	243 860	10	3”	6		
15	Jisr el Djaje	George	142 820	243 900	12	3”	6		

Do.: Domestic / Dr.: Drinking /NA: Not Available / Ab.: Abandoned

4.5.3.2 Spring Survey

For the purpose of the hydrogeological study of the area, a spring survey was conducted by ELARD team in the surrounding villages. One seasonal spring Ain el Kafer was discovered up gradient of the proposed site (See spring location on map in Appendix

A) (Photograph 4.6). This spring is a seasonal spring that generates from the karstic limestone of the Sannine Formation.



Photograph 4.6. Ain el Kafer spring located up gradient to the SWTP site in Hbaline.

4.5.4 Geological Site Setting:

The proposed area for the Solid Waste Treatment Plant of Hbaline is located in the Marly Limestone and marl of the Upper Sannine Formation (C4d). Chert bands and Nodules are present in this formation. The fresh color is creamish yellow sometimes the color changes into blue. The bedding thickness of this formation under the site ranges between 10 cm and 30 cm. The general inclination of the bedding is toward the west dipping approximately 15°. Two major sets of joints are present in the site; one set is 300°/90° and the other is 035°/80°. Joint spacing ranges between 5 cm and 20 cm. Clear joint features including feather marks are present on the joint surfaces. One major set and one minor set of fracturing are present on the proposed site. Approximately 31 fractures where measured on the outcrop of the proposed site hence, a rose diagram was constructed (Figure 4.7). The fractures showed a major set oriented WNW-ESE and a minor one oriented NNE-SSW. The fracture spacing ranges between 2.5 m and 7.5 m. The zone of disturbance on these fractures is approximately 2m.

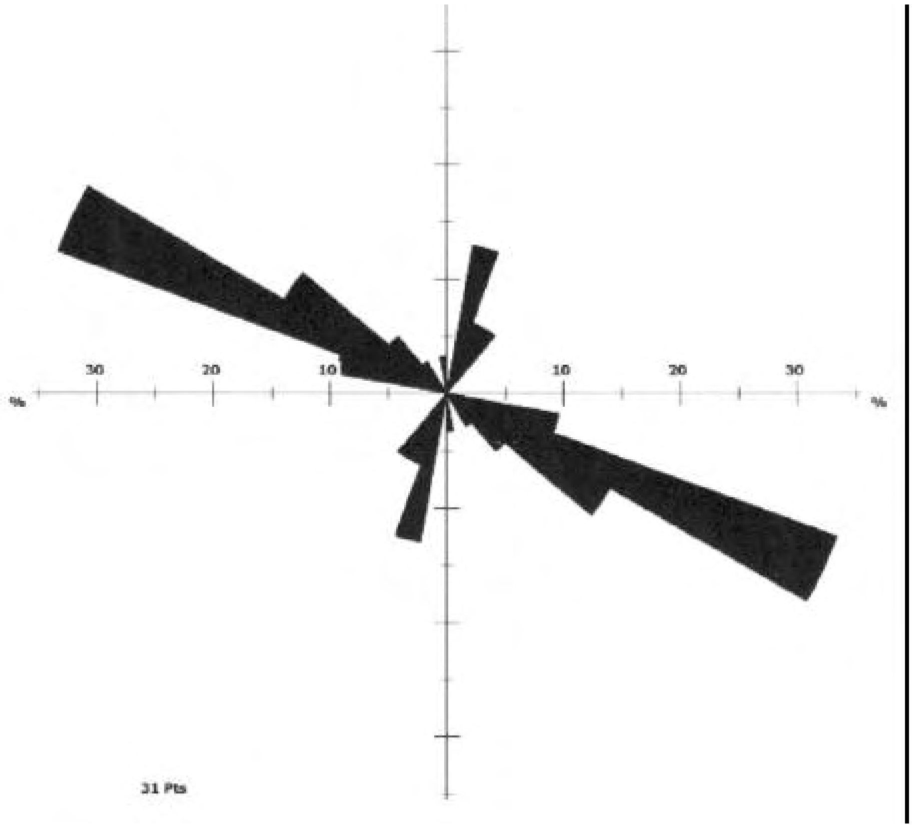
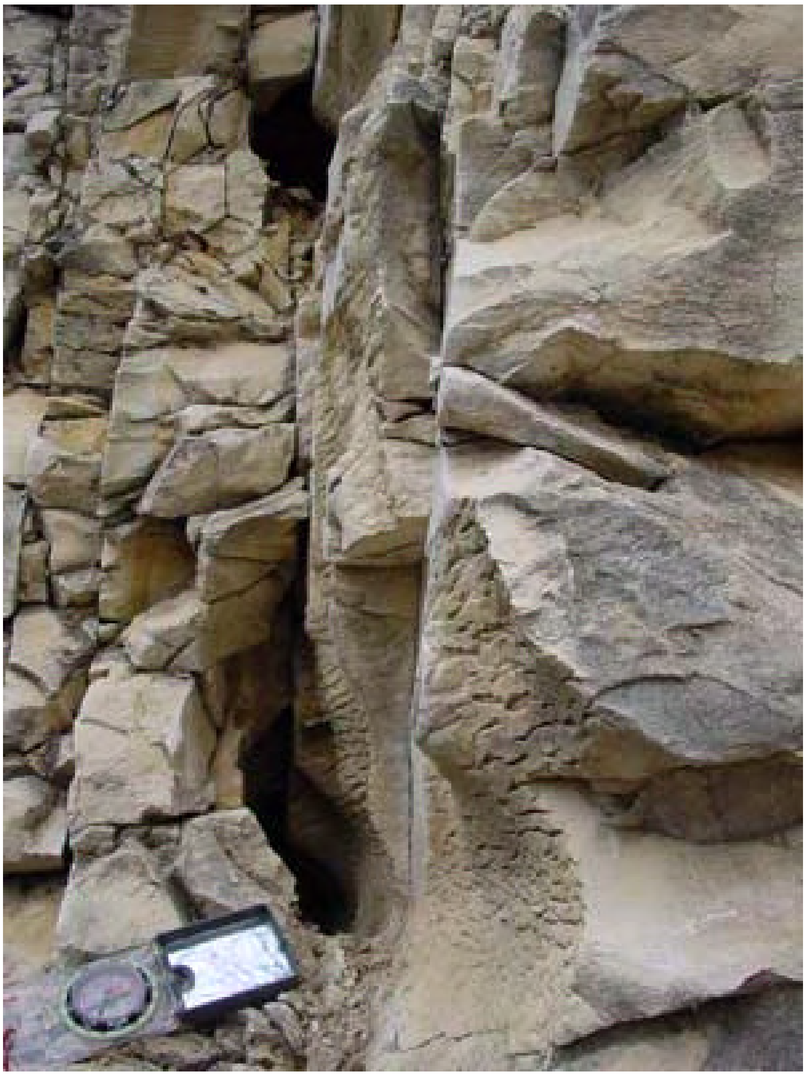


Figure 4.7. Rose Diagram constructed from fractures observed on outcrops of the proposed site

4.5.5 Hydrological Site Setting

The proposed area of Solid Waste Water Treatment Plant is located on the Upper Teronian Sannine Formation (C4d) which is a semi-aquifer. The marly limestone nature of this formation makes it a semi-karstic aquifer. The water if present in this formation flows through fractures, fissures, and conduits. However, the karstification is not as intensive as the Sannine and Maameltein Formations. Small cavities and conduits can be observed in this formation located along the road going down to the site and calcite precipitation from flowing groundwater can be identified in these cavities and fractures (Photograph 4.7).



Photograph 4.7. Calcite precipitation from ground water in cavities and fractures.

4.6. ECOLOGICAL CONTEXT IN HBALINE: (BIODIVERSITY)

Ecologically, the proposed area is not an area of special concern, such as areas designated as having national or international importance (e.g. world heritages, wetlands, biosphere reserve, wildlife refuge, or protected areas). The project will not lead to the extinction of endangered and endemic species, critical ecosystems, or habitats.

The proposed area or sites in Hbaline are situated in the Eu-mediterranean zone they extend over two types of ecosystems (Eastern and Western areas) with different vegetation communities and levels of disturbance. The Eastern area or site 2 contains at its edge developed mixed Pinus community with trees of various ages along with a small olive orchard (Photograph 4.8). Within the site, the vegetation community is degraded into a zone with shrubs and few growing trees. (Photograph 4.9)

Photograph 4.8. Pinus community along with an olive orchard located at the eastern side of site 2.

Photograph 4.9. Site 2 degraded zone with shrubs and few growing trees.

The Western area or Site 1 the ecosystem is a degraded garrigue containing *Spartium* and *Sarcopoterium* communities forming dispersed vegetation cover containing mixed shrubs and few dispersed growing trees such as *Quercus* species and *Pistacia* species trees (Photograph 4.10).

Photograph 4.10. Site 1 showing the degraded garrigue.

The dominating vegetation community present in both sites consists of mixed pine trees (*Pinus* spp.), some olive trees, wild fruit trees (Photograph 4.11), shrubs, and river side plants.

Found in both sites as well, communities of *Spartium* junceum and *Sarcopoterium* sp., that are good indicators of degradation (Photograph 4.12 and Photograph 4.13) with a dense to dispersed cover. Moreover, some locations around the dump show clear evidence of an occurrence of a fire in the previous years.

Photograph 4.11. *Pistacia* spp.

Photograph 4.12. *Spartium* junceum community.

Photograph 4.13. *Sarcopoterium* sp showing a degraded garrigue.

The proposed sites show advanced degrees of disturbances therefore they are suitable for any construction and operation works and this will not lead to significant impacts on biodiversity.

Site 2 is delineated by a rich and dense forest of pine spp communities therefore the construction of the facility might lead to some adverse disturbances such as the destruction of habitats, cutting down of trees, and loss of important species. Therefore, set mitigation measures should be applied in order to build the intended plant with least amount of damage to the biodiversity.

4.7. BIOLOGICAL ENVIRONMENT

The vegetation community in the project area is grassland on a hill slope, containing a variety of annual plants and flowering species in addition to few shrub and tree species community. Some of the trees, shrubs, climbers, bushes species and flowering plants identified in the project sites are included in Table 4.2. The project however does not affect any area of special concern, such as those designated as having national or international importance (e.g. world heritages, wetlands, biosphere reserve, wildlife refuge, or protected areas), or lead to the extinction of endangered and endemic species, or critical ecosystems and habitats.

Table 4.2. *Scientific name* and species of flora present in the sites.

Trees	Shrubs	Climbers	Bushes	Flowering plants
- *Quecus* caliprinos - *Laurus* nobilis - *Arbutus* andrachne - *Acer* syriacum - *Phillerea* media - *Pinus* brutia - *Ceratonia* siliqua - *Nerium* oleander - *Arbutus* unedo - *Pirus* syriaca - *Crataegus* monogyna - *Cercis* siliquastrum	- *Spartium* junceum - *Myrtus* communis - *Calcycotome* villosus	- *Simlax* aspera - *Ephedra* campylopoda - *Lonicera* estrusca - *Clematis* cirrohosa - *Rubia* brachypoda - *Rubia* tenufolia - *Clematis* flammula - *Tamus* orientalis - *Tamus* communis - *Aristolochia* altissima - *Bronia* multifida - *Bronia* syriaca	- *Cistus* salvifolius - *Lavadula* stoechas - *Erica* verticillia - *Salvia* triloba - *Thymbra* spicata - *Phlomis* longifolia - *Origanum* syriacum - *Euphorbia* thamnoides	- *Lotus* judaicus - *Asphodelus* microcarpus - *Eryngium* falcatum - *Bellis* sylvestris

4.8. STATUS OF PRESENT SOLID WASTE MANAGEMENT INFRASTRUCTURE

According to the feasibility study conducted by Ecodit, 2003, the MSW collection in the Caza is conducted in three different forms.

- Municipal collection fleets, owned and operated by the municipalities.
- Private haulers delivering collection services under contract with the municipalities

- Private haulers operating under contract with individual households mainly in rural areas and industries.

The total estimated collection cost paid by municipalities and individual households and industries reached about 500,000 USD in 2001. The frequency of collection ranges from once per week to once per day depending on community size, population density and season. The collected wastes are disposed of in the wild dump of Hbaline where such type of uncontrolled dumping started in 1982. The Union is currently monitoring and managing the income of wastes from the different parts of the Caza by controlling the entrance to the dumpsite. Currently, a contractor is running the daily operation of the dump for an annual fee of 50,000 USD/Year.

Along with the implementation of the SWTP in the Hbaline dump, funded by USAID and with the collaboration of CNEWA/PM, a sorting at the source program will be executed all over the Caza in order to achieve a high level of domestic presorting of wastes leading to a reduced sorting operation in the plant and an increased compost quality.

4.9. SOCIO-ECONOMIC STATUS

Socio-economic information about the Union was obtained during informal meetings with Mayors and union municipalities of Jbeil council members of the various municipalities of the 85 villages during the field visits as well as the information obtained from the feasibility study of solid waste management conducted by ECODIT throughout the year 2003.

According to a census on buildings and establishments conducted by the Central Administration for Statistics in 1996-1997, the resident and peak populations of the Caza of Jbeil were estimated at about 81,000 and 106,000 respectively. Based on the feasibility study annual demographic growth rate was estimated to be 0.7 percent. Therefore, the resident population would reach 94,000 by the year 2018 and the peak population would be 122,000. During this study, 63 industries were identified across 13 towns in the Caza of Jbeil, where 14 are located in Aamchit, 12 in Hosrayel and 11 in Halat. The main industries identified are metal products, chemical products, paper, and cardboard industries. Local habitants are mainly members of the active population (between 20 and 50 years old).

The economy in most municipalities is mainly driven by public and private sector employments. Trade and services are also prevalent in the agglomerations, such as Jbeil, Aamchit, Blat, and Halat where half of the population of the Caza is located. Tourism is mainly present in the old-Souk and town of Byblos in Jbeil and in the mountainous areas during summer and winter seasons. The population usually increases in summer time in the rural villages of the Caza, since a relatively large proportion of the village families in the work in coastal cities during winter and return to the village during summer vacation.

5. POTENTIAL ENVIRONMENTAL IMPACTS

The environmental impact analysis focused on identifying potential impacts based on the observation of plants executed earlier by P.M. such as Chacra (10tons/day), Khirbit Silim (5tons/day), Qabrikha (5tons/day) and Qleia (10tons/day) facility as well as the identification of other possible impacts associated with the construction and operation of the facility in the proposed site in Hbaline. Furthermore, necessary measures will be taken to improve the operation at the Hbaline facility (section 7).

5.1. POTENTIAL POSITIVE IMPACTS

The implementation of a composting plant has many benefits. The project solves various environmental and social problems, reduces the waste volume to be landfilled, and results in the production of compost. Moreover, the application of compost to soil amendment has direct and indirect advantages.

5.1.1 Benefits of the Project

The implementation of a compost facility could lead to various environmental benefits, with the most significant being environmental conservation since it stops the degradation caused by the presence of current open dumping in rural areas especially in the case of Hbaline dump. Table 5.1 summarizes the potential positive impacts associated with MSW composting, and gives the significance of each impact with respect to its level of environmental conservation.

Table 5.1. Potential Positive Impacts

Impact	Cause	Significance
Eliminating the negative effects of open dumping	• The composting plant will receive and treat the organic waste to Hbaline from Jbeil Caza. • The plant will provide the opportunity for the Union to treat and rehabilitate the old dump, leading to the closure of open dumping system in Hbaline. • Eliminate gas emissions and leachate generation from dumping of organic material.	Long term
Compost use	Compost can be used as a soil conditioner and has significant positive impacts	Short term
Employment generation	Creating jobs for the locals	Short term
Creating income generating activity	Revenue to the union of municipalities and specifically to Hbaline municipality from the waste management of the other villages and towns, in addition to selling the compost and the recyclable material	Short term
Solid waste reduction and recycling.	Separation of non-sorted waste at the compost plant, with gradual increase of source separation following increased awareness of the local population	Long term
Protection of natural resources	In-vessel composting with no/minor leachate generation	Long term
Decreased quantity of waste to be landfilled increasing the lifespan of the dumpsite.	The solid waste will be separated for recycling, and only a small portion of inert rejects will result from the composting activity. The facility by itself is not land-intensive.	Short term

5.1.2 Benefits of Compost

Compost helps divert organic materials from landfills. In addition, the use and application of finished compost result in a multitude of benefits, such as enhancing the physical, chemical, and biological properties of soils, which in turn results in various environmental and economic benefits. A summary of some of the major benefits of composting is provided below:

5.1.2.1 Direct Benefits to Soil

Compost has many benefits when applied as soil amendment:

-*Improvement of the physical properties of soils*: Compost enhances water holding capacity, soil aeration, structural stability, resistance to water and wind erosion, root penetration, and soil temperature stabilization.
-*Enhancement of the chemical properties of soils*: Compost increases macro- and micronutrient content, increases availability of mineral substances, ensures pH stability, and provides a long-term source of nutrient input by acting as a nutrient reservoir.
-*Improvement of the biological properties of soils*: Compost promotes the activity of beneficial microorganisms, reduces attacks by parasites, promotes faster root development, and promotes increase in yields of agricultural crops.

5.1.2.2 Indirect benefits

Land application of compost has further indirect environmental and economic benefits presented below:

Compost has the ability to improve soil water holding capacity and fix nitrogen into a form that can be used by plants, which mitigates (at least partially) non-point sources of pollution such as commercial fertilizers. By improving the soil water-holding capacity and reducing water loss as a result of percolation, evaporation, and runoff, compost application results in water conservation benefits.

Compost reduces reliance on pesticides, herbicides, and fungicides by providing an environment rich in organic matter and nutrients for healthy plant growth. Beneficial microorganisms thrive in this environment and can out compete and suppress detrimental pathogens found in soils where organic matter is low (if adequately composted).

Consistent application of compost reduces soil erosion resulting from wind and water by improving soil structural stability.

5.2. POTENTIAL NEGATIVE IMPACTS

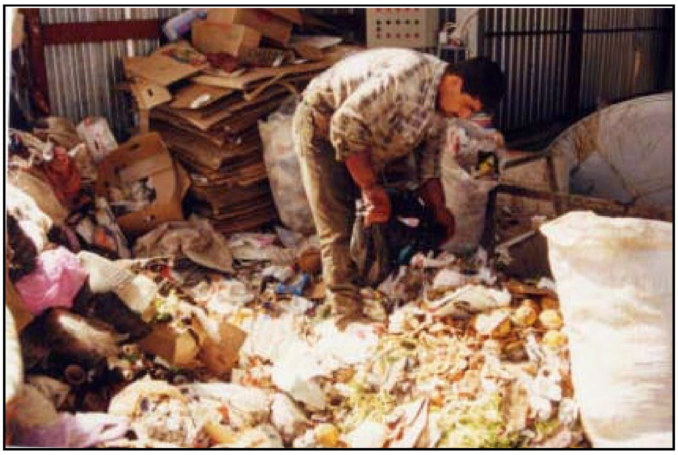
The project could result in various potential and predicted negative impacts. The identified potential impacts could result from improper construction and/or operation activities of the facility. Some negative impacts were identified in the waste management facilities implemented. For composting to be a viable option, the following issues should be controlled: production of odors, presence of pathogens, presence of heavy metals, compost quality, and blowing of papers and plastic materials.

5.2.1 Factors Identified Leading to Negative Impacts

The following factors were identified in some implemented facilities and were used to predict potential negative impacts of the proposed facility that could result from similar operational errors and process design (Photograph 5.1 to Photograph 5.3), unless the plant is properly managed:

Photograph 5.1. Exposed Improvised Waste Receiving Area

Photograph 5.2. Improper Waste Separation



Photograph 5.3. Manual Separation of Waste without Safety Precautions

- Improper and incomplete waste separation;
- Uncovered improvised trucks for waste collection and transportation;
- Improper storage of received and separated waste;
- Uncontrolled dumping of composting rejects;
- Improper fencing and waste handling leading to litter in the surrounding area of the plant;
- Manual handling of waste without appropriate safety precautions leading to occupational hazards.

5.2.2 Production of Odors

Without proper control of the waste transport and the composting process, the production of odors can become a problem. In the proposed facility, odors may be generated from:

- Improvised uncovered trucks transporting the waste to the facility;
- Piled wastes for long periods of time before their processing;
- Improper composting processes;
- Maturating compost piles;
- Separated wastes stored for recycling;

- Rejects dumped in improvised dumps;

Odors are generated when the compost is undergoing anaerobic decomposition and that, is usually promoted when the following conditions are prevailing: low carbon to nitrogen ratios, poor temperature and airflow control, excessive moisture and poor mixing.

5.2.3 Biologic and Soil Contamination

The final product must meet some specifications to be considered as compost (Table 7.4). Compost quality can be defined in terms of nutrient content, organic content, pH, texture, particle size distribution, moisture content, moisture holding capacity, presence of foreign matter, concentration of salts, residual odor, degree of stabilization or maturity, presence of pathogenic organisms, and concentration of heavy metals. The compost produced in some facilities can contain impurities (Photograph 5.4) such as plastics, glass and metals. Contaminated compost is a result of improper waste separation, which leaves metals and other contaminants in the waste stream or improper composting that, fails to eradicate pathogens. Metals in solid wastes may generate metal dust particles that become attached or held to the materials in the light fraction, and then in the compost produced. Contaminated compost could lead to soil contamination and potential consequent biological uptake of hazardous material subsequently leading to the food chain. Note that previous metal analysis of compost showed concentrations within standards since most of the organic material used to produce such compost is of domestic origin. Therefore, it is essential to restrict any introduction of hazardous wastes such as medical or industrial wastes in the composting process in order to prevent contamination of the produced compost.

Photograph 5.4. Production of Impure Compost

5.2.4 Contamination of Ground and/or Surface Water from Leachate

Although the proposed facility does not result in any leachate production during the composting operation, leachate can result from the waste received prior to its processing, waste stored for recycling, and maturating compost piles. Leachate production and subsequently water contamination is aggravated with the occurrence of rainstorm, in case the facility is not fully covered and does not possess adequate drainage control structures to divert rain water from the plant.

5.2.5 Health and Safety Impacts

Health and safety at the proposed facility are considered primarily in terms of potential exposure to pathogens and accident occurrence to workers and members of the local population during both the construction and operation phases.

5.2.5.1 Occupational Hazards

The composting plant is a potentially dangerous work environment unless proper precaution measures are implemented. The waste is manually transferred and sorted on the conveyor belts; which subjects the workers to multiple hazards. The project does not present any specification for worker's protection. Hazards to workers may result from equipment and conveyors, and from the manual separation of commingled MSW. Other issues to be considered are the worker's fatigue since the project does not provide moving belts with adjusted heights for the manual separation of waste.

5.2.5.2 Public Health and Safety Hazards

If the composting operation is not conducted properly, pathogenic organisms may survive the composting process and result in contaminated compost causing health hazards for the future users of the compost such as farmers. Bacteriological analysis two compost samples collected from Qleiya solid waste treatment plant showed no pathogen contamination, and both Salmonella levels and fecal coliform levels were found to be within MoE set standards (Appendix B). Furthermore, activities involved with the operations of the composting plant are potentially dangerous to the public. Uncontrolled access to the facility may result in various hazards.

5.2.6 Impact on Biodiversity

Potential negative impacts on the biodiversity of the area are presented in Table 5.2. Impacts could result from construction activities such as land reclamation, construction of buildings, and generation of construction waste and from the usage of contaminated compost. However, the analysis of the impacts resulting from this project on the biodiversity (based on the size, diversity, rarity, and naturalness of the affected vegetation) shows that the potential negative impacts are not very significant. This is because the project will only affect a small portion of the ecosystem, will not lead to the extinction of important species, and will not affect any sensitive or critical area. Furthermore, the project will reduce and limit the wild expansion of the existing landfill by reducing the amount of landfilled material.

Table 5.2. Potential Negative Impacts on Biodiversity

Impact	Cause
Habitat loss or destruction	Construction works
Altered abiotic/site factors	Soil compaction, erosion
Mortality of individuals	Destruction of vegetation
Loss of individuals through emigration	Following disturbance or loss of wild life habitats.
Habitat fragmentation	Habitat removal and/or introduction of barriers like roads
Disturbance	Due to construction noise, traffic, presence of people…
Altered species composition	Changes in abiotic conditions, habitats…
Vegetation loss	Soil/water contamination from poor quality compost

5.2.7 Other Potential Negative Impacts

- Production of dust from waste trucks while transporting and unloading the waste;
- Noise pollution due to truck traffic and/or to operation of the facility;
- Littering of the surrounding area by the light waste fraction, plastic bags and paper, transported by winds;
- Natural resource contamination and various other impacts from uncontrolled dumping of composting rejects;
- Phytotoxicity of plants due to high compost application rates; and
- Landscape and visual intrusion from the offensive sight of the facility buildings in the natural environment.

5.3. Negative Impacts Summary and Analysis

Impact analysis focused on characterizing negative impacts, according to their significance (long term vs. short term), extent (level of environmental degradation or conservation), and mitigation feasibility. The summary and analysis of potential negative impacts are presented in Table 5.3. Impacts classified as having long-term effects are the most significant compared to those with short-term effects, since they lead to long-term environmental degradation.

5.3.1 Construction Phase

The main negative impacts occurring during the construction phase result from construction works and land reclamation activities. Such activities will generate noise, dust, and wastes (all of which can be mitigated for and are short-term impacts). Health and safety hazards during the construction phase can be prevented by appropriate precaution measures. The destruction of vegetation caused as well by construction activities is not very significant since the project only affects a small portion of the ecosystem and will not destroy any sensitive or critical species or habitat.

5.3.2 Operation Phase

Impacts directly related to the operation of the facility include odor, dust, and noise generation, littering of surrounding areas, occupational and health hazards, and water and soil contamination from potential leachate. The most significant impacts having long-term environmental effects are those related to the usage of contaminated compost, which leads to soil, water and biological contamination. However, all impacts can be prevented by implementing the mitigation measures presented in section 7.

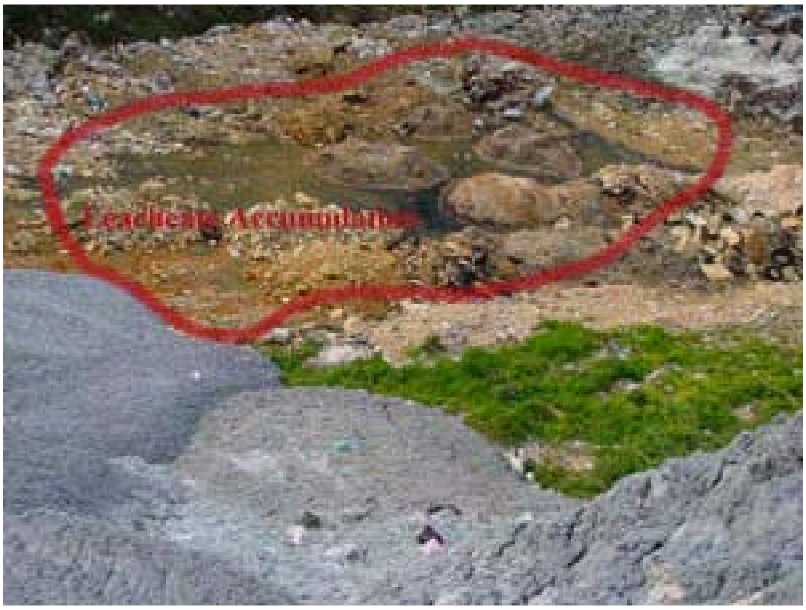
Table 5.3. Summary of Potential Negative Impacts

Impact	Cause	Significance
CONSTRUCTION PHASE		
Noise and dust	Resulting from construction activities and truck traffic	Short term
Construction waste	Resulting from construction activities, land reclamation	Short term
Health and safety	Accidents to workers and members of the local community due to lack of safety regulations and uncontrolled access to the construction site	Long term
Biodiversity	Land reclamation and construction activities leading to the destruction of the natural ecosystem at the facility site	Long term
OPERATION PHASE		
Litter	Light fraction of waste carried by winds	Short term
Odor production	Compost facilities that are not properly operated allow anaerobic conditions to develop thus generating foul odors Waste trucks incoming and leaving the facility	Short term
Natural resources contamination	Application (on agricultural lands) of poor quality contaminated compost containing hazardous material, potential leachate generated, uncontrolled drainage, and improper storage and receiving areas and/or application of contaminated compost, uncontrolled dumping of composting residues such as un-compostable and un-recyclable material	Long term
Phytotoxicity	High compost application rates	Long term
Health and safety hazards	During waste separation and operation of the process, and with minimal precaution measures, uncontrolled access to the facility	Long term
Noise and dust	From circulation and unloading of trucks	Short term
Landscape esthetic	Offensive sight in the natural landscape	Long term

6. ANALYSIS OF ALTERNATIVES

6.1. DO NOTHING ALTERNATIVE

This alternative implies that the current waste management used by the Union of municipalities will remain the same until a national plan is developed and implemented or until the income of the municipalities is increased. The current waste management adopted and practiced for the past two decades; open dumping and previously burning of wastes, has significant negative effects on the environment. Many negative impacts are associated with open dumps such as public nuisance, diminishing landscape aesthetics, and generation of unpleasant odors and irritating dusts. It also causes public health impacts by allowing the breeding of rats, flies, and other disease vectors, and the generation of toxic gases and irritating smokes. Other effects can be the contamination of the soil, the surface and ground waters by the leachate (Photograph 6.1) that may contain hazardous and toxic material. As such, this is not considered as a valid alternative.



Photograph 6.1. Accumulation of leachate in the landfill during winter.

Photograph 6.2. Leachate generated at the edge of a waste pile.

6.2. ALTERNATIVE SITES

Location of the facility is mainly controlled by the availability of land in the area. Based on previous studies, possible sites for waste management facilities are limited in the study area due to population density and growth, geological and hydrogeological characteristics, and topographic conditions.

Moreover, most municipalities refuse to implement waste facilities that receive wastes from other villages in the area. While the do-nothing option is not acceptable, placing the composting plant in the premises of the existing dump will allow a comprehensive solution for the problems incurred by the presence of the uncontrolled waste dump, in particular, by complementing its rehabilitation and conversion into an engineered landfill. This solution would represent a "least-damage" solution to waste management in the Caza by not promoting the development of new sites considered less suitable than the present site.

6.3. ALTERNATIVE BIOLOGICAL MSW CONVERSION TECHNOLOGIES

There are varieties of biological and chemical processes that can be used to transform the organic fraction of MSW into gaseous, liquid, and solid conversion products. Biologic processes other than aerobic composting include low-solids anaerobic digestion, high-solids anaerobic digestion, and high-solids anaerobic digestion /aerobic composting. Such processes can be used as alternative technologies since they allow the generation of energy and reduce the volume of wastes to be landfilled. Each process has certain design consideration and requirements, advantages and disadvantages.

6.3.1 Low-Solids Anaerobic Digestion

Organic wastes are fermented at solids concentrations equal to or less than 4 to 8 % to generate methane gas. This process requires the addition of considerable water to bring the solids content to the required range, which will result in a very dilute digested sludge that must be dewatered prior to disposal.

6.3.2 High-Solids Anaerobic Digestion

Fermentation of organic wastes occurs at total solids content of about 22 percent or higher. Advantages of this process are lower water requirements and higher gas production per unit volume of the reactor size.

6.3.3 Combined High-Solids Anaerobic Digestion and Aerobic Composting

This is a two-stage process where the first stage involves the dry digestion to convert the organic fraction of MSW to methane, and the second stage involves the aerobic composting of the anaerobically digested solids to produce compost (used as fuel or soil amendment). The major advantages of this process are the complete stabilization of the organic waste with a net energy recovery and without the need for major dewatering equipment. Other advantages include pathogen control and volume reduction.

6.4. ALTERNATIVE AEROBIC COMPOSTING TECHNIQUES

6.4.1 Windrow Composting

A windrow compost system can be constructed by forming the organic material into windrows 8 to 10 ft high by 20 to 25 feet wide at the base. This system could however take up to three to five years for complete degradation. A high rate windrow composting system (composting in three to four weeks) can be constructed by forming windrows 6 to 7 ft high by 14 to 16 ft wide, depending on the equipment and the waste volume. This system requires that the windrow is turned up to twice per week, and the temperature maintained above 55ºC. Turning of the windrows is often accompanied by the release of offensive odors. After complete composting (three to four weeks), the compost needs to be left to cure for an additional three to four weeks without turning.

6.4.2 Aerated Static Pile Composting

This system consists of a grid of aeration or exhaust piping over which the processed organic fraction of MSW is placed. Typical pile heights are about 2 to 2.5 m. a layer of screened compost is often placed on the top of newly formed piles for insulation and odor control. Each pile requires an individual blower controlled by a timer. The composting period is three to four weeks, followed by curing for an additional three to four weeks. Odor control is achieved by covering the system.

6.4.3 Aerated Pile with Agitation (with Turning).

This system, very similar to the previous one, consists of a grid of aeration or exhaust piping over which the processed organic fraction of MSW is placed. Typical pile heights are about 2.4 m high 3 m. wide and 69 m long. Over a period of 4 weeks the organic material under composting is moved from one end to the other using a specialized machine called compost turner. After four weeks, the compost can be removed from one end of the channel. The composting period extends then three to four weeks, followed by curing for an additional three to four weeks after acquiring lower respiratory needs throughout the completion of the composting period. Hence, the compost can be sold as stabilized Compost. Odor control is achieved by covering the system and the use of specialized biofilters.

6.4.4 In-Vessel Composting Systems

Composting is achieved inside an enclosed container or vessel. In-vessel systems are divided into two categories: plug flow, with no mixing of material, and dynamic composting, with mechanical mixing during the processing of material. This system minimizes odors and process time by controlling environmental conditions such as airflow, temperature, and oxygen concentration. The advantages of this system are process and odor control, faster throughput, lower labor costs, and smaller area requirements.

6.5. ANALYSIS OF THE DIFFERENT AEROBIC COMPOSTING SYSTEMS

The performance of properly operating windrow, aerated static pile, and in-vessel composting processes is essentially the same; therefore, the selection among alternative processes is based on capital and operation and maintenance costs, land requirement, sensitivity to cold or wet weather, odor control, operational complexity, and potential for nuisance problems. A successful composting operation is highly dependent on proper operation and maintenance as well as design along with a proper and thorough management. The selected method should have low operational and maintenance costs, have good odor control, operate in wet weather, and have low potential operating problems. Table 6.1 presents a comparison of the proposed methods according to the selected criteria.

Table 6.1. Comparison of Aerobic Composting Processes (Tchobanoglous et al. 1993)

Item	**Windrow**	**Aerated pile (Tunnel)**		**In-vessel, forced aeration**	
		Static	**With agitation**	**With agitation**	**No agitation (Plug flow)**
Capital costs	Generally low	Generally low in small systems, can become high in large systems	High ; considered for large capacity	Generally high	Generally high
Operating costs	Generally low	High (in sludge systems where bulking agents are used)	High; turner + aeration	Generally low	Generally low
Land requirement	High	High	Medium	Low, but can increase if windrow drying or curing required	Low but can increase if windrow drying or curing required
Sensitivity to cold or wet weather	Sensitive unless in housing	Demonstrated in cold and wet climates	Demonstrated in cold and wet climates (when covered)	Demonstrated in cold and wet climates	Demonstrated in cold and wet climates
Control of odors	Depends on feedstock, potential large-area source	May be large-area source but can be controlled	May be large-area source but can be controlled Increased cost using biofilters	No odors. Biofilters are not needed.	Potentially good
Potential operating problems \ Advantages	Susceptible to adverse weather	Control of airflow rate is critical, potential for channeling or short-circuiting of air supply	No channeling but rely on bulk Machine for turning operations	High operational flexibility, system may be mechanically complex	Potential for channeling or short circuiting of air supply, system may be mechanically complex

One of the factors to be considered in the evaluation is that the windrow and aerated static pile processes utilize standard components and have been designed and constructed successfully "in-house" by many communities in different countries, where as the in-vessel processes employ proprietary designs and custom made equipment. In-vessels processes require higher capital costs compared to ownership and operation of a simpler windrow or aerated static pile system. A scoring matrix can be used to analyze the different composting processes. The criteria for alternative analysis is tabulated with a raw score of 1 = poor, 2 = moderate and 3 = good. Each criterion is assigned a weighing factor between

1 and 10 in accordance to the relative importance of the criterion. The raw score is multiplied by the weighing factor and the weighted scores are added. Table 6.2 presents the results of the scoring process along with the selected criteria. Based on this scoring process, in-vessel dynamic composting is selected as it has the highest score. Moreover, the score for the aerated pile with agitation composting system holds a high expectancy since both systems rely on the same basic concept of dynamic aeration. However, the in-vessel dynamic composting a built in contingency plan can ensure a high level of sustainability of the process in case of operating problems since the process should not be discontinued at any case. Furthermore, the process of dynamic composting can treat different organic wastes stream apart therefore reducing the potential of contamination of the final product.

Table 6.2. Alternative Analysis Criteria Scoring Matrix

Alternative analysis criteria	**Weighing factor**	**Score**							
		Windrow		**Aerated static pile (Tunnel)**		**Aerated pile with agitation (Tunnel)**		**In-vessel dynamic composting**	
		Raw*	**Weighted**	***Raw***	**Weighted**	***Raw***	**Weighted**	***Raw***	**Weighted**
Operating cost	10	***3***	30	***3***	30	***3***	30	***2***	20
Land requirements	9	***1***	9	***1***	9	***2***	18	***2***	18
Build in Contingency Measures (Potential operating problems response).	8	***1***	8	***2***	16	***1***	8	***3***	24
Control of odors at all times	7	***1***	7	***1***	7	***3***	21	***3***	21
Operational control	6	***1***	6	***3***	18	***2***	12	***3***	18
Sensitivity to cold or wet weather	5	***1***	5	***3***	15	***3***	15	***3***	15
Capital costs	4	***3***	12	***3***	12	***2***	8	***1***	4
Control of air	2	***1***	2	***2***	4	***3***	6	***3***	6
Total score (maximum of 153)		***12***	***79***	***18***	***111***	***19***	***118***	***20***	**126**

*3= good; 2 = moderate; 1 = poor

6.6. ALTERNATIVE DISPOSAL SYSTEMS

The main disposal systems of MSW are sanitary landfills, composting, and incineration. Each system is characterized by certain advantages and disadvantages. The choice of the system depends on the existing conditions and constraints. One of the main constraints in Lebanon is the unwillingness of any Caza to accept the refuse of another

Caza. Thus, separate facilities have to be provided in each Caza within its constraints, which reduces choices and scope for economies of scale. Another constraint is the scarcity and value of land. SWM projects should be based on integrated strategies that incorporate waste reduction plans to decrease the volume of waste to be landfilled.

6.6.1 Sanitary Landfills

In Lebanon, sanitary landfills selection suffers from scarcity of appropriate sites; the mountainous terrain and high population density make it difficult to find low cost sites adjacent to urban areas and suitable for the construction of the landfill. Costs of establishing sanitary landfills will vary according to the price of land and the extent of preparation needed for the site. For example, in most of the landfills, a double layer of impermeabilization (impermeable geo-membrane and impermeable clay layer) is proposed. This is to ensure effective protection against possible contamination of water resources; on coastal landfill sites, a dyke would be built to ensure against spilling of refuse into the sea; land prices are significantly lower in the Bekaa Valley and in rural areas than on the coastal zone. The overall costs of collection and disposal would amount to US$ 40-50 per household per year, which is less than 1% of the average household income.

6.6.2 Composting

Composting has acquired a bad reputation amongst the farmer end users due to poor quality compost produced in the past. Better sorting and production control should eliminate this problem in the future. Furthermore, studies indicate that there is sufficient demand, and various potential uses for composting to be a viable option. Composting would be mostly applicable in agricultural and rural areas where there is potential demand from farmers and potential uses of the compost. Currently, there is no stable market or specific price for the compost. Compost price can be compared to manure, which is currently priced at about US$30 per ton. The combined costs of collection and disposal would be at about US$60 per household per year.

6.6.3 Incineration

Incineration could appear to be a possible option due to the availability of industrial sites for what is regarded as an industrial process, but it has high investment and operating costs and adverse environmental impacts, which make it unaffordable, unsustainable, and hazardous. Furthermore, the MSW in Lebanon is characterized by a high moisture content, which makes it difficult to burn. For incineration to work in these circumstances, it would need to be combined with other disposal systems, such as composting and/or sanitary landfills to dispose of the high moisture refuse. Incineration would in any event require complementary landfill facilities to dispose of residues, which can represent up to 30% of total waste incinerated.

6.6.4 Integrated Solid Waste Management Plan

An integrated solid waste management (ISWM) project can be defined as the selection and application of suitable techniques, technologies, and management programs to achieve specific waste management objectives and goals. The ISWM hierarchy adopted by the US EPA is composed of the following elements: *source reduction, recycling, waste transformation, and landfilling*. Elements of the ISWM plan are interrelated and selected to complement each other. An explanation of the different elements is presented below:

Source reduction would typically involve reducing the amount of waste that is generated, which will lead to a reduction of waste quantities, associated costs, and environmental impacts. On the household level, waste reduction occurs through selective buying patterns and re-use of products and materials.

Recycling involves separation and collection of waste materials, preparation, and re-use, re-processing, or re-manufacturing, which leads to a reduction of waste to be landfilled. Recycling could be achieved through home separation and separation in the facility.

Waste transformation involves physical, chemical and biological alteration of wastes performed to improve the efficiency of solid waste management operations and systems, recover reusable and recyclable materials, and recover conversion products (e.g. compost) or energy (e.g. heat, combustible biogas). This operation further leads to a reduction of wastes to be landfilled.

Landfilling involves the controlled disposal of wastes on or in earth's mantle, and is the most common method of ultimate disposal for waste residuals (stable inert solids that cannot be recycled, are of no further use, or are remaining after material recovery and conversion activities).

7. MITIGATION PLAN

In order to eliminate or reduce potential negative environmental impacts, mitigation measures are typically recommended to prevent the impacts associated with composting. Mitigation measures are highly dependent on the significance of the predicted impact, the nature of the impact (temporary vs. permanent), or the phase of the project (construction vs. operation).

7.1. MITIGATION MEASURES FOR THE PROJECT DESIGN

7.1.1 Litter and Odor

To prevent the contamination of the surrounding area by the light fraction of waste (paper and plastic bags) transported by winds, the unloading area should be designed as a depression pit, and all storage and receiving areas should be closed, which will also reduce the dispersion of odors. Furthermore, appropriate fencing (3 m and 25 mm net) around the facility area will catch any transported waste, and a buffer zone of one to two kilometers will prevent potential produced odors or transported waste from reaching residential areas.

7.1.2 Ground and/or Surface Water Contamination

All the facility, especially the storage, receiving, and compost maturating areas should be paved with an impermeable floor structure (10^{-7} cm/sec) and covered. Furthermore, an effective drainage system must be established for leachate and storm water collection and management. Storm water and runoff should be diverted to avoid any contact with the waste or the compost.

The diverted winter channel or intermittent river passing through the site should be confined using a retaining wall that should be built on its northern side for a distance of 470-500 meters. Although this measure might be costly, it is an essential measure in order to prevent any flash flooding, mainly in the winter, from reaching the plants and the landfill causing a major disaster. A wastewater treatment unit of small capacity is necessary for the evacuation and the treatment of wastewater and leachate incoming from the worker buildings, the receiving storage, and compost maturation areas. The treated wastewater and leachate from the plant can be discharged in the intermittent river that is located on the southern side of the site. The discharged treated effluent should be monitored regularly. The project design should be modified to include a drainage system and galleries that diverts rain and storm water away from the treatment plant and the landfill. Moreover, after its rehabilitation the landfill base should be lined with a proper Geo-membrane lining in order to prevent the infiltration of any generated leachate even though, only inert material is expected to be sent to the landfill.

7.1.3 Dust Production

To prevent dust along roadways, circulation and access roads used by the collection trucks should be paved. To prevent dust from unloading of wastes in the facility, a high quality paving capable of withstanding frequent truck traffic should be used to cover the receiving area.

7.1.4 Impacts Related to the Natural Landscape

The facility should not destroy any sensitive habitat or species. Furthermore, a landscape plan should be included to enhance the appearance of the facility. Although the portion of un-recyclable and non-compostable material is small and inert, it should not be disposed directly in land pits. Rejects resulting from composting operations will be contaminated and may lead to the production of contaminated leachate; therefore, they should be disposed in sanitary landfills. The rehabilitation of the old landfill will provide a proper area for landfilling of the generated inert material that is not expected to exceed 5% of the total treated wastes. Landfills should contain liners to prevent any contamination resulting from these rejects.

7.1.5 Public Hazards

Proper fencing at a minimal height of 3 meters around the whole site should be ensured in order to prevent unauthorized access to the facility.

The final compost material should be monitored constantly in order to prevent any potential contaminated compost material from reaching the market or end users.

7.2. MITIGATION MEASURES FOR THE CONSTRUCTION PHASE

During the construction phase, it is essential to adopt strategies to prevent or minimize dust emissions, noise generation, health and safety hazards, and negative impacts related to the generated construction wastes. The main control measures should be included within the construction contracts and be considered as requirements from contractors.

7.2.1 Noise and Dust Emissions

The major mitigation measures required to reduce noise and dust emissions are mainly during the construction phase. The recommended mitigation measures for dust emissions are on-site mixing and unloading operations, and ensuring adequate maintenance and repair of construction machinery. The recommended mitigation measures for noise impacts are usage of quiet properly maintained equipment, limiting site construction activities to the working hours (7:00 am to 4:00 pm) and noisy activities to morning hours (8:00 am to 12:00 am), and informing the local community when noisy activities are planned.

7.2.2 Construction Wastes

All waste resulting from construction works, land reclamation, or any other activity should be collected and disposed of appropriately such as in a sanitary landfill or an alternative government-permitted disposal site. In the case of Hbaline, the excavated soil and rocks could be disposed of in the process of rehabilitation of the old landfill. The contractor should be responsible for waste collection and transportation. Uncontrolled littering in the facility and surrounding areas should be prevented. Furthermore, some of the waste such as rocks or excavated soil can be used in the construction processes. For example the rocks can be used to prepare the base for the fence around the facility and soil can be used for landscape initiation as well as in the processes of cut and fill for the purpose of land level adjustments in the landfill area.

7.2.3 Health and Safety Hazards

7.2.3.1 Occupational Hazards

Health and safety regulations should be imposed on all the workers. Safety regulations include life and health insurance, first aid kits, protective clothing such as uniforms, gloves and helmets, in addition to regulations concerning the storage and use of hazardous material such as gas. Furthermore, the facility should be kept clean to prevent pest infestation and workers should not be allowed to exceed working hours.

7.2.3.2 Public Safety

To prevent accidents, members of the public should not be allowed to access the construction site at any time, especially after working hours. This is ensured by proper site closure, fencing, and securing the site using a night guard. In case, of local monitoring teams visits, the team should respect the safety codes set by the site management and should be accompanied by responsible personnel.

7.3. MITIGATION PLAN FOR THE OPERATION PHASE

7.3.1 Litter

To prevent littering along roadways, collection vehicles should be enclosed or covered with cloth traps. Littering of the surrounding area is prevented by ensuring appropriate unloading of wastes only in the designed depressions for that purpose and the landfilled material should be bailed and well protected to prevent any undesired dispersion all over the dumpsite.

7.3.2 Odor Production

To prevent odor production during the composting operation consider the following points:

Proper process design and operation are essential in minimizing potential odor production; special attention must be devoted to preprocessing, aeration requirements, temperature control, and mixing requirement. The facility should be able to mix completely and effectively any required additives, such as nutrients, inoculums or enzymes (if used), and moisture with the waste material to be composted. The aeration equipment must be sized to meet peak oxygen demand requirements. Temperature should be adequately controlled. The bio-filters if used should be regularly checked and maintained to prevent any noxious odors generation from the plant.

Ensure that the compost operation follows the specific design consideration to prevent anaerobic fermentation: sufficient velocity, moisture content 50 to 60 % and controlled airflow rate.

Furthermore, the received wastes should not be kept in the facility for more than 1 day before processing. Wastes separated for recycling should be kept in designated closed containers or rooms.

7.3.3 Soil, Water and Natural Resources Contamination

Mitigation of soil, water, and natural resources contamination is achieved by ensuring that the compost produced satisfies quality standards, is not contaminated by pathogens or metals. Specific measures are recommended to obtain good quality compost that does not lead to negative environmental impacts. Furthermore, compost quality should be constantly monitored. The compost produced should respect the levels of contaminants specified in the guidelines presented by the MoE. (Appendix C: Ordinance on the quality assurance and utilization of compost in agriculture, horticulture, and landscaping). Further mitigation measures to protect the environment are related to the level of compost contamination and the application rate; only standard application rates should be used depending on the grade of the compost obtained in the process.

7.3.3.1 Pathogen Contamination

Most pathogenic organisms found in MSW and other organic material to be composted will be destroyed at temperatures and exposure times used in controlled composting operations (typically 55ºC for 15 to 20 days). Only a few can survive at temperatures up to 67ºC for a short period. Elimination of all pathogenic microorganisms can be accomplished by allowing the composting waste to reach a temperature of 70ºC for 1 to 2 hours. It is also possible to kill all the pathogens, weeds, and seeds during the composting process by maintaining the temperature between 60 and 70ºC for 24 hours. The EPA suggests time-temperature standards, presented in Table 7.1, for pathogen control in composting systems.

Table 7.1. EPA Requirements for Pathogen Control in Compost Processes (Tchobanoglous et al. 1993)

Requirement	Remarks
Processes to Significantly Reduce Pathogens (PSRP)	Using the in-vessel, aerated static pile, or windrow-composting methods, the solid waste is maintained at minimum operating conditions of 40ºC for 5 days. For four hours during this period, the temperature exceeds 55ºC.
Processes to Further Reduce Pathogens (PFRP)	Using the in-vessel or aerated static pile composting methods, the solid waste is maintained at operating conditions of 55ºC greater for three days. Using the windrow composting method, the solid waste is maintained at operating conditions of 55ºC or greater for at least 15 days during the composting period. In addition, during the high-temperature period there will be a minimum of five turnings of the windrow.

Based on Criteria for Classification of Solid Waste Disposal Facilities and Practices," U.S. EPA, Federal Register 44:179 (1979).

However, the standards set by the Lebanese MoE require that the composted material should be exposed to temperature above 65ºC for at least a period of 7 days retention time

Shorter retention times could be allowed in case enzymes are used to accelerate the biological processes. The destruction of specific pathogen may require different temperature and time exposure. According to the identified pathogens, specific measures could be applied. Table 7.2 presents the WHO guidelines specifying temperatures required for the destruction of various pathogens.

Table 7.2. WHO Guidelines for Temperature and Time Exposure Required for the Destruction of some Common Pathogens and Parasites (Tchobanoglous et al. 1993)

Organism	**Observations**
Salmonella typhosa	No growth beyond 46ºC; death within 30 minutes at 55-60ºC and within 20 minutes at 60ºC; destroyed in a short time in compost environment.
Salmonella sp.	Death within 1 hour at 55ºC and within 15-20 minutes at 60ºC.
Shigella sp.	Death within 1 hour at 55ºC.
Escherichia coli	Most die within 1 hour at 55ºC and within 15-20 minutes at 60ºC.
Entamoeba histolytica cysts	Death within a few minutes at 45ºC and within a few seconds at 55ºC
Taenia saginata	Death within a few minutes at 55ºC.
Trichinella spiralis larvae	Quickly killed at 55ºC; instantly killed at 60ºC.
Brucella abortus or *Br. suis*	Death within 3 minutes at 62-63ºC and within 1 hour at 55ºC.
Micrococcus pyogenes var. *aureus*	Death within 10 minutes at 50ºC.
Streptococcus pyogenes	Death within 10 minutes at 54ºC.
Mycobacterium tuberculosis var. *hominis*	Death within 15-20 minutes at 66ºC or after momentary heating at 67ºC.
Corynebacterium diphtheriae	Death within 45 minutes at 55ºC.
Necator americanus	Death within 50 minutes at 45ºC.
Ascaris lumbricoides eggs	Death in less than 1 hour at temperatures over 50ºC.

7.3.3.2 Metal Contamination

Heavy metal contamination is prevented by magnetic separation of the wastes prior to their composting or by achieving source separation and that to prevent any chemical reaction of some unstable metal items during the composting process. Options for Contaminant Levels reduction in MSW Composts are:

Separate clean organic materials at the source for separate collection and composting: This option generally requires households to separate their waste into three streams: 1) recyclables, 2) compostable (yard trimmings, food scraps, and non-recyclable paper), and 3) materials destined for disposal. This option needs and rely mainly on the implementation of awareness campaigns. A variety of organic waste source separation programs have been developed and implemented successfully in different villages.

Separate contaminants at the source for separate collection and proper disposal or processing: Unlike the first option, which separates compostable materials from other waste, this approach attempts to remove those items identified as dangerous from the waste stream. Problems with this method are that not all targeted contaminants will be separated; some contaminated wastes cannot be manually separated (e.g., house dust and paint chips) and will remain in the stream destined for composting. Moreover, any industrial wastes such as by-products of paper and cardboard industries or even sawdust should be monitored for any contamination before their integration in the composting process or even a specialized vessel could be used to treat such kind of compostable industrial by-products.

Separate contaminants from MSW at facility before composting: a wide range of technologies has been developed to separate contaminants before composting. Manual picking lines, size separation, magnetic or eddy-current metal recovery, air classification, and other mechanical approaches can achieve waste separation. However, such approaches rarely target the specific sources of contaminants, many of which are not particularly amenable to these centralized separation approaches. Lead is a particularly difficult contaminant, since current mechanical technologies are not effective at separating lead acid batteries and consumer electronics, the major sources of lead in MSW. Special bins will be made available for the disposal of batteries. Usually car batteries lead is recycled but the process is hazardous and risky therefore, the ultimate disposal of such wastes would then be decided in close consultation with the MoE. Table 7.3 presents some of the technologies used for the separation of contaminants from the waste stream.

Table 7.3. Separation Technologies

Technology	Material targeted
Screening	Large: film plastics, large paper, and cardboard… Mid-sized: recyclables, organics… Fine: organics, metal fragments …
Hand picking	Recyclables, inert material, and chemical contaminants.
Magnetic separation	Ferrous metals
Eddy current separation	Non-ferrous metals
Air classification	Lights: paper, plastic Heavies: metals, glass, organics
Wet separation	Floats: organics Sinks: metals, glass, gravel …
Ballistic separation	Light (plastic, paper), Medium (compost), Heavy (metals, glass, gravel)

Separate contaminants from MSW compost after composting: This approach may be used as an additional step in the separation process; however, it is rarely used alone since delaying separation until after composting normally results in the highest levels of metal contamination.

The earlier sorting occurs during the collection and composting process, the lower the metal contamination in the finished compost. Once contaminants are mixed with compostables, they become increasingly difficult to recover. Leaching, abrasion, and mixing disperse contaminants in a mixed waste stream, and separation becomes less effective with time or intensive processing. Some contaminants, such as motor oil and oil in filters are liquid and, therefore, subject to spill. Abrasion during waste handling can break off bits of lead from oil or weights. Fine dust or paint chips can attach to otherwise clean organic wastes. Even seemingly, sturdy materials, such as consumer electronics, can contaminate neighboring organic materials through leaching and direct contact before, and during collection. The current waste separation method is insufficient and results in a highly impure and thus hazardous product. *Proper separation should be ensured to prevent the occurrence of adverse negative impacts associated with the usage of contaminated compost.*

7.3.3.3 Compost Quality

Composting process requires some design and operational considerations to achieve optimum results and good quality compost. The main parameters to be considered for a compost of a grade A are presented below in Table 7.4, while other grades characteristics along with their main fields of utilization are presented in Appendix C.

Temperature: for best results, temperature should be maintained between 50 and 55°C for the first few days and between 55 and 60°C for the remainder of the active composting period. If temperature goes beyond 66°C, biological activity is reduced significantly. Furthermore, the hygiene characteristics require that the compost should be subjected to a temperature above 65°C during the sanitization phase / thermophilic decomposition phase.

Particle size: most material in MSW tends to be irregular in shape. This irregularity can be reduced substantially by shredding the organic material (if necessary) before they are composted. Particle size influences the bulk density, internal friction and flow characteristics, and drag forces of the materials. A reduced particle size increases contact surface area subsequently increasing biological reaction rate during aerobic composting process. The most desirable particle size for composting is less than 5 cm, but larger particles can be composted. The required particle size depends on the compost requirement and on economic considerations. For optimum results, the size of solid wastes should be between 25 and 75 mm (1 and 3 in).

Carbon-to-nitrogen (C/N) ratio: initial carbon to nitrogen ratios (by mass) between 20:1and 30:1 are optimum for aerobic composting. At lower ratios, ammonia is given off. Biological activity is also impeded at lower ratios. At higher ratios, nitrogen may be a limiting nutrient causing nitrogen starvation in crops if used as an organic fertilizer.

Moisture content: moisture content should be in the range between 50 and 60 percent-during the composting process. The optimum value appears to be about 55 percent.

pH control: to achieve an optimum aerobic decomposition, pH should range from 7 to 7.5. To minimize the loss of nitrogen in the form of ammonia gas, pH should not rise above about 8.5.

Maturation Grade: the maturity of compost is determined and carried out by the DEWAR self-heating test, (Appendix C). The five categories on the interpretation scale are often grouped by practitioners and European agencies into three major classes, where the lowest grade (I) is called “fresh-compost,” the middle two (II-III) is referred to as “active compost,” and the upper two (IV-V) are termed “finished compost.” Compost marketers expect compost to be grade IV or V. The five categories identification are presented in

Table 7.5 and Table 7.6 presents the relationship between the maturation degree (DEWAR) and the best use of the compost produced. This method can as well be useful for assessing pathogen reduction.

Table 7.4. Quality standards for compost, Grade A

<table>
<tr><th>Quality characteristics</th><th colspan="4">Quality requirements</th></tr>
<tr><td>Origin of raw material</td><td colspan="4">Source-separated organic material from households or agriculture;
Mechanical sorting of impurities prior to composting process</td></tr>
<tr><td>Hygiene</td><td colspan="4">Exposure of entire material to temperatures > 65°C for at least 7 days during thermophilic decomposition phase (sanitizing phase).
Extensive exclusion of germinable seeds and sprouting plant parts (less than 1 germinable weed-seed in 2 liters of compost).
Exclusion of Salmonellae
Faecal coliforms must be < 1,000 MPN[1]/g of total solids calculated on a dry weight basis</td></tr>
<tr><td>Man-made impurities[2]</td><td colspan="4">Maximum of 0.5 weight-% in dm; plastic less than 0.1 weight-% in dm (selection of impurities in compost fraction > 2 mm)</td></tr>
<tr><td>Stones</td><td colspan="4">Maximum of 5.0 weight-% in dm (selection of stones in compost fraction > 5 mm)</td></tr>
<tr><td>Plant compatibility</td><td colspan="4">50% compost with 50 % standard soil media;
germination rate of barley seeds must pass > 90 % after 5 days</td></tr>
<tr><td>Decomposition degree</td><td colspan="4">Maturation degree V</td></tr>
<tr><td>Water content</td><td colspan="4">Loose material: maximum 45% weight
Bagged material: maximum 35 % weight
Higher contents of water are admissible for composts with more than 40% organic matter</td></tr>
<tr><td>Organic matter</td><td colspan="4">at least 15 % weight-% in dm, measured as volatile solids</td></tr>
<tr><td>Plant nutrients and salt content</td><td colspan="4">Salt content max. 2.5 g/l
Minimum nitrogen (sum NO3/NH4-N) <300 mg/l
Soluble phosphate P2O5 <1.200 mg/l
Soluble potassium K2O <2.000 mg/l
Soluble chloride <500 mg/l
Soluble sodium <250 mg/l</td></tr>
<tr><td rowspan="5">Contents of heavy metals</td><td colspan="4">Guide values[3] (mg/kg dm)</td></tr>
<tr><td>Lead</td><td>< 150</td><td>Cadmium</td><td>< 1.5</td></tr>
<tr><td>Chromium</td><td>< 100</td><td>Copper</td><td>< 100</td></tr>
<tr><td>Nickel</td><td>< 50</td><td>Mercury</td><td>< 1.0</td></tr>
<tr><td>Zinc</td><td>< 400</td><td></td><td></td></tr>
<tr><td>Parameter for declaration to user</td><td colspan="4">Mature compost from source – separated organic waste
Producer
Grain size and bulk density (volume weight)
C/N-ratio
pH value
Salt content
Plant nutrients total (N, P2O5, K2O, MgO, CaO)
Plant nutrients soluble (N, P2O5, K2O)
Organic matter
Net weight or volume
Information for a suitable application (method and application rate)</td></tr>
</table>

[1]MPN: Most probable number
[2] Glass, metal, plastics
[3]Guide values: The heavy meal limit values are adhered to if the mean value of the last four analyses lies under the limit value and no analysis surpasses the limit value by >25%. This guide exc ludes the cadmium test.
dm = dry matter; fm= fresh matter; om = organic matter;

Table 7.5. DEWAR Self-Heating Increments, Rating and Description of Stability Classification Based on the European System. (Brinton et.al, Woods End Research Laboratory, 1994).

Temperature rise above ambient temperature in °C	Official class of stability	Description of class or group	Major Group
0-10°C	V	Very stable; Well- aged compost	Finished Compost
10-20°C	IV	Moderately stable; Curing compost	
20-30°C	III	Material still decomposing; Active compost	Active Compost
30-40°C	II	Immature, young or very active compost	
40-50°C (or more)	I	Fresh, raw compost, just mixed ingredients	Fresh Compost

Table 7.6. Proposed relationship of DEWAR class to best use of compost produced. (Brinton et.al, Woods End Research Laboratory, 1994).

Maturation degree	Best use of compost
V	Potting mixes, seedling starter beds
IV	General purpose gardening, greenhouse cultivation
III	Grapes, fruits, apples
II	Field cultivation, e.g.: corn, tomatoes, broccoli, green houses hot beds
I	Compost raw feedstock, Mushroom compost

7.3.3.4 Expected Compost Quality at Hbaline Plant:

Recent analysis of decomposed organic waste samples collected from the Hbaline dump showed convincing results that can be used as an indicator to forecast the grade of compost that might be produced in the plant.

The results of the analysis show that only lead and copper content are slightly higher than the standard values of Grade A compost set by the MoE, therefore, such results could be expected in the final compost product from the future composting plant The results are presented in (Appendix B).

Furthermore, in order to reduce heavy metal contamination, organic waste streams separation during the sorting and composting process is recommended in order to prevent cross contamination of the final compost product.

7.3.4 Phytotoxicity

In order to prevent phytotoxicity and soil contamination, compost should be applied in proper quantities relevant to the crop and soil type. Each crop can tolerate certain chemicals and nutrients concentrations before it develops signs of phytotoxicity or even nutrient deficiencies due to competition among various available nutrients Depending on the concentration of these chemicals in the compost, the total concentration of chemicals and the amount of compost, to be applied to the crop before phytotoxic levels are reached, can be determined. Appendix C provides the variety of utilizations of the compost of grade A and grade B depending on the type of and area of use.

7.3.5 Health and Safety Hazards

7.3.5.1 Occupational Hazards

Health and safety regulations should be imposed on all the workers. Furthermore, workers should not be allowed to exceed working hours. Workers should have protective clothing (uniforms), air-filtering headgear, safety shoes, eye and noise protection gears, and puncture proof impermeable gloves for their protection while manually separating the MSW. Furthermore, each worker should not exceed the allowable working hours. The facility should be cleaned frequently to prevent the occurrence of diseases. Safety regulations include life and health insurance, first aid kits, in addition to regulations concerning the storage and use of hazardous material such as gas.

7.3.5.2 Public Hazards

The public should be excluded from access except under careful control as during conducted tours. Proper fencing at a minimal height of 3 meters around the whole site should be ensured. Furthermore, the facility should have a night guard. In case, of local monitoring teams visits, the team should respect the safety codes set by the site management and should be accompanied by responsible personnel.

7.3.6 Noise Pollution

To reduce objectionable noises, collection and transport of wastes to the facility should be performed at times not to create traffic, nor to disturb the public during hours of sleep. Noise from the plant should not reach objectionable levels, and working hours (7:00 am to 6 pm) should not be exceeded. The various incoming trucks to the location should be equipped with proper mufflers to reduce noise. Use of specialized electrical generators along with muffler silencers and electro-mechanical components of the plant should be maintained regularly to prevent malfunctions and subsequently unpleasant noise generation. Moreover, the location of the plant in the valley will significantly reduce the spread of generated noise to the surrounding. Even though, noise control is a requirement in order to provide a safe working environment for plant operators.

7.3.7 Impacts Related to the Natural Landscape

The facility should not destroy any sensitive habitat or species. However, if detected, sensitive species or habitats should be conserved. Furthermore, the facility and surrounding area should be kept clean, and the landscape plan properly implemented. The compost process rejects should be collected and disposed of in the sanitary landfill with proper liners and then proper closure is implemented by isolating the landfilled cells and restoration of the original landscape by using native plant and trees species already present in the area.

7.4. SUMMARY OF IMPACT MITIGATION

The identification and analysis of potential negative impacts indicated that significant impacts would occur during construction and operation phases, thus implying the necessity of implementing mitigation measures recommended for the project design, construction, and operation (Table 7.7). With respect to the project design, the following considerations should be included: a drainage system for leachate and runoff management, appropriate paving of the facility site and storage places, and fencing around the facility or site. With respect to the construction phase, dust and noise generation, waste production, and health and safety hazards are the most significant impacts and they are minimized by ensuring safety regulations, working during daytime and proper site paving and closure. However, impacts related to the operation phase are the most significant since they have long-term effects, especially impacts related to the application of contaminated compost. Mitigation measures to prevent the production of contaminated compost include appropriate operation of the facility according to the specified standards and considerations.

Table 7.7. Recommended Mitigation Measures for Potential Negative Impacts

Impact	Recommended mitigation measure	Responsibility	Feasibility and cost
DESIGN PHASE			
Odor production	Include a buffer zone around the facility, provide closed containers for waste storage	PM/Contractor	Feasible/ no cost
Resources contamination	Paving of storage and operation areas, drainage control system, covering areas where wastes are stored (incoming wastes and maturating compost), and wastewater treatment unit	PM/Contractor	Included in design
Dust production	Paving of access roads	Union of Municipalities	From municipality budget (US $ 7/m^2)
Landscape esthetics and visual amenity	Include a landscape plan	PM/Contractor	US $ 4000 included in construction cost
Public hazards	Facility site fencing (3 m height)	PM/Contractor	Included in design
Litter	Fencing and providing a closed depression pit for unloading waste	PM/Contractor	Included in design
CONSTRUCTION PHASE			
Noise and dust	On-site operation activities, maintenance and repair of equipment, control of timing of noise emissions, informing local community	Contractor	No cost except for maintenance included in design
Construction waste	Waste transport and disposal in quarries for re-use or in sanitary landfills	Union of Municipalities/ Contractor	Included in construction
Health and safety	Provide protective clothing, follow general safety regulations, prevent un-authorized access to the construction site by fencing and night security guard	PM/Contractor/ Union of Municipalities	Included in construction, and provided by contractor
OPERATION PHASE			
Litter	Covered collection vehicles, unloading waste only in the designed depression pit	Union of Municipalities/ facility operators	Depending on number and type of trucks (US $ 20/ cloth traps)
Odor production	Proper process operation, maintaining aerobic conditions, and storing waste in designated areas	Facility operator	No extra cost (Included in capital cost)
Natural resources contamination	Ensuring the production of good quality, safe compost according to the suggested standards, and appropriate disposal of contaminated compost (soil amendment in silviculture; woodland exploitation, in reforestation or landscape agriculture only), maintenance of the drainage system (section 7.1.2)	Facility operator/ Compost contractor	No extra cost (Required in the initial plant process design)
Phytotoxicity	Ensure standard application rates	Compost contractor	No extra cost

Health and safety hazards	Always use protective clothing and equipment, implement safety regulations, prevent unauthorized access to the facility, keep the facility clean	Facility Management and Operators	No extra cost
Noise	Control waste collection and transport timing, do not exceed working hours	Union of Municipalities	No extra cost
Landscape esthetic	Keep the facility clean, do not litter, implement and maintain the landscape plan	Facility Management and Operators	Included in maintenance cost

8. MONITORING PLAN

The Union of Municipalities of Jbeil with the technical support of the contractor will be responsible for the environmental monitoring activities during the operation of the facility (for an expected period of 10 years), whereas, during the construction phase, Pontifical Mission would undertake monitoring with the collaboration of the Union of Municipalities.

Environmental monitoring will be carried out during both the construction and operation phases to ensure appropriate operation of the facility, the implementation, and effectiveness of the recommended mitigation measures, the production of good quality and safe compost, and the response to unanticipated environmental impacts.

8.1. STANDARDS FOR COMPOST QUALITY

The US Environmental Protection Agency Standards for compost application on land as outlined in the Code of Federal Regulations for the Environment under EPA503 was previously selected as local standard for Lebanon.

Currently Lebanese standards set by the MoE in the ordinance on the quality assurance and utilization of compost in agriculture, horticulture and landscaping, are used for environmental safety of waste treatment techniques. Presented in Appendix C the ordinance introduces as well the different grades or types of compost and their recommended application rates in different agricultural uses.

To determine the safety of compost applied to land the MoE concerns itself mainly with two vectors, which might cause pollution, mainly pathogens and heavy metals. In general, compost should be rich in organic matter, be low in soluble salts, meet all regulatory standards for its end-use, contain negligible amount of germinable weed seeds , have no undesirable odor, have a consistent pH (usually near neutral), and have a moisture content of at least less than 50 percent. The suggested MoE standards are presented below:

Pathogens: *Salmonella sp*. should be absent completely. This is achieved by maintaining the operation temperature at 65ºC or greater for at least 7 days during the Sanitization phase.

Heavy Metals: (Table 8.1)

Table 8.1. Regulatory Maximums for Grade A Compost Parts Per Million (ppm) (Kg/mg), Dry Weight

	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc
MoE	<1.5	<100	<100	<150	<1.0	<50	<400

8.2. MONITORING OF COMPOST QUALITY

The compost should be tested for metal contamination, the presence of pathogens, and material composition (Table 7.4). Lab tests on the final compost produced should be performed on a monthly basis to determine the safety of the material produced for land disposal. If the compost does not meet suggested standards (presented in the impact mitigation section), it should be discarded to a landfill or used as daily cover. The parameters to be monitored are:

- The absence of pathogens
- The level of heavy metals and in particular the limits of mercury, cadmium, and lead to be within the allowable limits set by local standards for mainly Grade A and Grade B Compost.

While the other Grades, such as Grade C should be used only for landscaping, rehabilitation of quarries and green space along traffic roads. Grade D can be used in landfills as rehabilitation material.

- Material identification analysis, to identify the product obtained as compost based on the organic matter and carbon content (C/N ratio)
- Determination of maturity grade / decomposition degree (DEWAR self-heating test). The DEWAR self-heating test may be utilized by producers under field conditions where a temperature of 20-25°C can be maintained around the testing vessel.

Compost samples should be collected from different compost bags (at least four bags) in order to constitute a representative sample, and analysis could be performed in any certified laboratory or from the compost, pile according to sampling procedure described in Appendix C. Cost of compost monitoring is USD 400 per analysis, or USD 4800 per year.

This would include a full characterization of the compost that will be a key component in the marketing process of the produce showing the parameters for declaration to the user (Appendix C). Partial analysis that includes only environmental parameters required by the MoE (absence of pathogens and level of heavy metals) would cost around USD 250 per analysis. Hence, the estimated prices of testing are:

- Seven Heavy metal elements: 150 USD/test
- Bacteriological: 50 USD/test
- Others (Moisture Content, Salt Content): 50 USD/test
- Parameters for declaration to user (Compost marketing) : 150 USD/test
- Maturity test equipment (Field test-kit; Capital cost): 300 USD

8.3. ODOR MONITORING

The ideal goal for a compost facility would be to have an undetectable odor level at the property line as measured by the odor panel or alternatively a buffer zone specifying minimum distances to the nearest occupied residences.

Modern odor measurement involves: the collection of odorous air in tedar or tevlar plastic bags, metering precise diluted amounts of the collected odorous air through an olfactometer to human noses belonging to a group of people with normal sensitivities to odors (referred to as an odor panel), and determining the odor level after dilution of samples at which 50 percent of the panel can correctly detect the odorous sample so as to obtain an objective quantitative measure (referred to as a dilution factor). However, this method requires a high degree of quality control. For example, less than 4 hours storage of odorous samples, availability of 5-7 qualified odor panelists on the day of odor testing, high purity non-odorous bottled air, odor free room, precise dilution metering, trained personnel, etc. This method does not take into account varying meteorological conditions, and is not directly related to the degree of annoyance an odor will have in a community due to wide and different individual tolerance levels.

The odor monitoring approach adopted for World Bank financed compost plants in Lebanon consists of establishing if there is a recognizable odor problem in the community, as complaints from a limited number of people, or numerous complaints from the same people may not represent the feelings of the community as a whole. The goal is how to establish that there is genuine odor problem in the community, and to prove that spontaneous complainers are not just troublemakers. A practical approach to monitor odors comprises the following:

All odor complaints reported to the compost plant management, union of municipalities or government officials must be immediately forwarded to the municipal engineers for assessment.

The union's municipal engineer or trained investigator should immediately contact the complainant/s to ascertain the current situation. The situation is assessed by finding the level of the odor, which includes the nature, intensity and duration (for intensity description see Table 8.2), the suspected source, and any physical effects incurred by the complainant.

Table 8.2. Odor Intensity Scale

Scale/description	Odor intensity description
0 – no odor	Odor not detectable
1 – Very Light	Odorant present in the air which activates the sense of smell but the characteristics may not be distinguishable
2 - Light	Odorant present in the air, which activates the sense of smell and is distinguishable and definite but not necessarily objectionable in short durations. (Recognition Threshold)
3 - Moderate	Odorant present in the air, which easily activates the sense of smell, is very distinct and clearly distinguishable and/or irritating.
4 - Strong	Odorant present in the air, which would be objectionable and cause a person to attempt to avoid it completely, could indicate a tendency to produce physiological effects during prolonged exposure.
5 – Very Strong	Odorant present that is so strong it is overpowering and intolerable for any length of time and could tend to produce some physiological effects.

Adapted from "New Jersey's Approach to Odor Problems" in Recent Developments and Current Practices in Odor Regulations, Controls and Technology, A & WMA Transaction Series, ISSN 1040-8177; No. 18, Pittsburgh, PA. 1991. p. 25-35.

If a complainant identifies a suspected source, the investigators should quickly visit the source and record an arrival time.

The investigators should proceed to conduct a 360-degree odor survey of the suspected source (such as the receiving pit, to the fermentation area or the maturation or curing area). When an odor is detected, the investigator should record the characteristics of the odor, the weather conditions including wind speed and direction, and the intensity of the odor (Table 8.2).

Depending on the severity of the problem, the manager of the compost plant is requested by the union's municipal engineer to undertake corrective action to resolve the source of the odor.

In addition, the union's municipal engineer should form an odor committee composed of approximately five citizens from within the Caza and in the area close to the compost plant, which would be active and assist in the odor investigation when there are repeated complaints from the same people.

Odors should stay of an acceptable or unobjectionable level that does not cause intolerable annoyance to the general population. As many odors are difficult to detect using modern analytical chemical techniques, the human nose remains the most sensitive practical measuring instrument for odors. Hence, the best way to monitor odors is by monthly inspections performed by municipalities' members or facility operators, in addition to the suggested method following citizen's complaints.

8.4. OTHER MONITORING ACTIVITIES

Litter, health and safety monitoring is achieved continuously or weekly through visual inspections, and recording of accidents.

Noise monitoring is achieved by measuring noise levels in the facility and surrounding area only after complaints, since the facility is fairly distant from residential areas located in a valley that will prevent the dispersion of noise to the surroundings.

8.5. MONITORING RESPONSIBILITIES

The contractor (which will be the operation manager for at least the first year of operation depending on the contract) in collaboration with the union of municipalities should be responsible for the monitoring of various impacts to ensure the proper functioning and implementation of mitigation measures along with environmental management plan presented in the next section. Weekly inspections should be performed to ensure that the mitigation measures are implemented and that the facility is not adversely affecting the environment (EMP).

8.6. SUMMARY OF MONITORING PLAN

8.6.1 Construction Phase

During the construction phase, the contractor and the pontifical mission will be responsible for monitoring of dust and noise emissions in addition to health and safety hazards along with the proper implementation of the construction operation. The following parameters will be continuously monitored at the construction site:

- Noise levels
- Landscape visual inspection
- Health and safety

8.6.2 Operation Phase

During the operation phase, quarterly monitoring of some critical parameters is necessary, and will be the responsibility of the facility operation manager in collaboration with the union of municipalities of Jbeil. The parameters that will be monitored at the facility site include *water quality of surface runoff (Intermittent River), noise level, odor generation, compost quality, health and safety, and landscape esthetics*. Environmental parameters to be monitored with their frequency, duration, and responsible body are summarized in Table 8.3.

Table 8.3. Recommended Monitoring Activities

Parameter	Samples	Frequency	Location	Responsibility	Estimated cost
Construction phase					
Noise	Inspection	Monthly	Construction site and village	PM/contractor	No extra cost
Landscape	Visual inspection	Weekly	Construction site and surroundings	PM/contractor	No extra cost
Health and safety	Visual inspection	Continuous	Construction site	PM/contractor	No extra cost
Operation phase					
Noise	Inspection	Quarterly	Facility and village	Union of Municipalities & facility operatives	No extra cost
Odor	Inspection	Monthly	Facility and village	Union of Municipalities & facility operatives	No extra cost
Compost quality*	Four samples	Monthly	Facility	Union of Municipalities & facility operatives	US $ 4800
Health and safety	Visual inspection	Continuous	Construction site	Union of Municipalities & facility operatives	No extra cost
Landscape	Visual inspection	Continuous	Construction site and surroundings	Union of Municipalities & facility operatives	No extra cost
Total monitoring costs per year					US $ 4800

*refer to Monitoring Procedures and Test Methods in Appendix C.

8.7. EMERGENCY RESPONSE PLAN

Along with the monitoring plan of the SWTP, a contingency plan should be available in case of emergency. This plan focuses mainly on setting various emergency scenarios along with a specific response plan for each situation. The main concern in a SWTP is during the operation phase of the plant where any unexpected discontinuation in the plant operation could rapidly lead to an accumulation of untreated wastes in the premises of the plant and eventually to health and environmental problems.

However, the type of technology used can facilitate the tasks of remediation. Such is the case of in vessel composting, specifically the drums where more than one operating unit is installed hence each drum is independent, and therefore the likelihood of having all the drums malfunctioning is very low.

Additionally, the plant should be able to have its own autonomy with respect to energy supply in order to account for any shortage in electricity or fuel.

In case monitoring results show high pathogenic contamination of the final compost product, thorough investigation should be conducted in order to detect the contaminated waste source or the faulty composting process. Furthermore, in case vessel drum composting is used it is recommended to select drums for specific organic waste streams in order to prevent contamination. Moreover, the waste streams can be diverted into specific drums

Ultimately, the plant should be equipped according to international and local safety codes of industrial plants such as fire extinguishers, emergency doors, first aid kits, alarms and others.

8.8. STATEMENT OF COMPLIANCE

The Union of Municipalities, their consultants and contractors confirm they will adhere to the provisions of the EIA, will comply with the national regulations, will adopt the proposed mitigation measures and monitoring plans, and will send to the MoE all monitoring results generated at intervals not exceeding 3 months period, or as mutually agreed (Appendix D). Institutional Framework for the project is proposed in Figure 8.1.

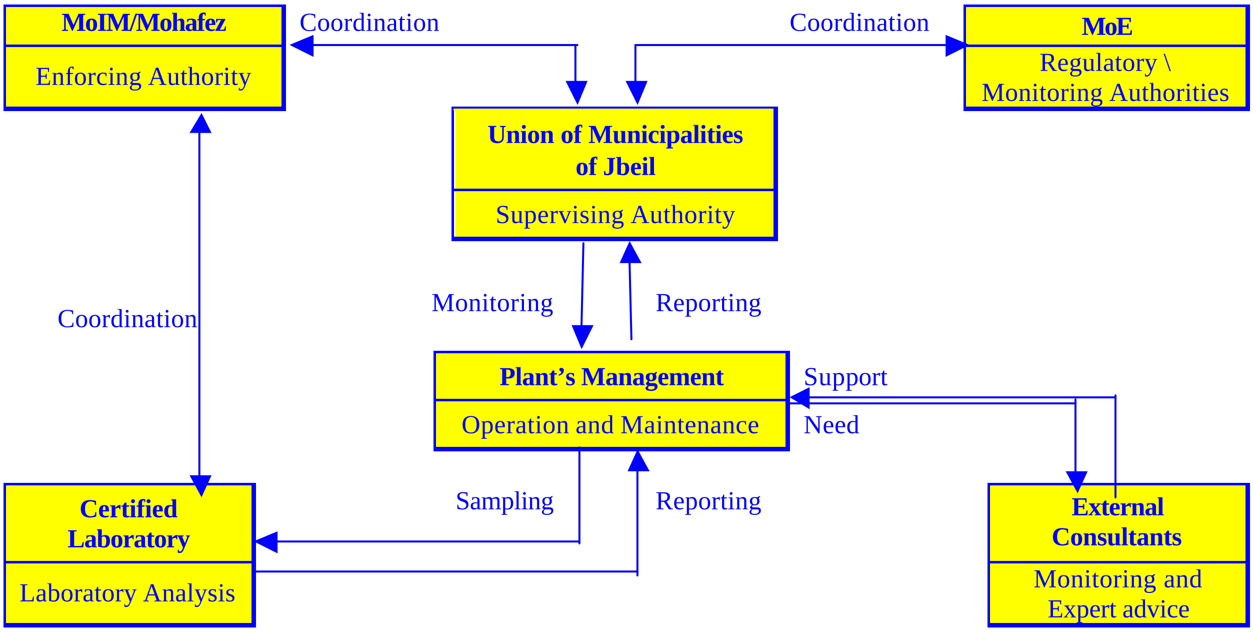


Figure 8.1. Proposed Institutional Setting

9. ENVIRONMENTAL MANAGEMENT PLAN

The development and implementation of an effective environmental management plan in Lebanon is hindered by weak institutional capacity for effective environmental management and protection, low environmental regulatory enforcement, and shortage of financial resources and qualified personnel in the environmental field. The relatively recent establishment of the MoE strengthened the institutional framework, however, further strengthening and enhancement of cross-sectorial coordination, planning, and control mechanisms is needed in order to effectively protect and enhance environmental conditions.

As part of the proposed project, the P.M./Union of municipalities will be responsible for implementing an environmental management plan, which aims at:

- Developing a local team to help in the awareness campaign;
- Implementing an awareness campaign regarding the sorting of waste;
- Training housewives and young on alternative solid waste management systems.

9.1. ENVIRONMENTAL MANAGEMENT PLAN FOR THE PROPOSED PROJECT

The implementation of an environmental management plan on the level of the proposed project could enhance environmental conditions. The objectives of this plan are to reduce the waste volume, recover recyclable material, achieve better quality compost, and develop the recycling and compost markets. Three main tasks are suggested to achieve the specified objectives: training, conducting local awareness campaigns, and ensuring markets for compost and recyclables. The training workshops having some common objectives with the awareness campaign will be also opened for the locals.

9.1.1 Training Requirements

Two types of training workshops are required. The first workshop is to increase environmental awareness of all individuals concerned with the project (construction, operation, mitigation, monitoring), whereas the second is to train the workers who will be involved in the facility operation.

9.1.1.1 Environmental Awareness Workshop

Municipality members, contractors, and personnel who will be involved in the construction and operation of the facility, and the mitigation and monitoring plans will be required to attend an environmental training workshop prior to the initiation of the project activities. The objective of this workshop is to ensure appropriate environmental awareness, knowledge, and skills for the implementation of environmental mitigation and monitoring measures. In an effort to increase local environmental awareness, the workshop will also be opened for individuals from the local community. The workshop will be conducted in one or two days during the construction, and twice a year during the operation phase. The workshop will increase environmental awareness of the participants by covering at least the following topics:

- Environmental laws, regulations, and standards
- Pollution health impacts
- Pollution prevention and mitigation measures
- Sampling techniques and environmental monitoring guidelines
- Integrated solid waste management (source reduction, separation, processing, etc.)
- Compost quality and usage (land application, standards and application rates)
- Health and safety measures

9.1.1.2 Facility Operation Training Workshop

Facility operators should receive appropriate training to assume the duties of managing the facility, implementing the suggested mitigation measures, and monitoring potential impacts. The training workshop should cover the following issues:

Waste separation: workers should be informed about appropriate waste separation required to prevent the production of contaminated compost. Furthermore, they should be able to identify all hazardous material, which could contaminate the compost such as batteries, and glass, and that should not enter the composting drums.

Negative impacts: to prevent the occurrence of negative impacts, workers should be aware of all potential impact, their causes, and mitigation measures

Environmental awareness: workers should have a sense of environmental awareness in order to understand the importance of environmental protection

Health and safety regulations

The contractor will be responsible for ensuring adequate training of all facility operators. This could be achieved by workshops that will be conducted, in the facility, before the operation phase for a period of one week, and during the operation phase for one day on a quarterly basis. The objective of the week workshop is to ensure appropriate operation of the facility and implementation of mitigation measures. It will cover all project components with respect to operational activities, composting process, mitigation measures, and maintenance activities. The objective of the one-day workshops is to monitor operation activities and further ensure appropriate operational skills, as well as solve any operational problems that might occur.

9.1.2 Environmental Awareness Campaigns

Environmental awareness campaigns will be conducted targeting all 85 villages and towns of the Union. The campaigns will focus on:

- Pollution health impacts
- ISWM (reduction, separation, composting, landfilling)
- Waste reduction: minimizing consumption, re-using, and home waste separation
- Recycling
- Compost usage

The objective of the campaign is to increase environmental awareness, induce home waste separation, which will lead to waste volume reduction, material recovery, and better quality compost, and inform the locals about the uses of compost. Community acceptance of the project and participation in waste separation is a vital component of a successful composting operation as well as waste reduction. The negative perception associated with the re-use of waste material should be overcome by explaining to the local community the role of composting as a component of an integrated solid management plan, and the utilities associated with compost application (separation options were presented in the impact mitigation section).

9.1.3 Market Stability

The operation of the proposed project results in material recovery and compost production, both resources should be allocated uses or diverted to appropriate markets. For compost, a local market can be ensured by implementing public awareness campaigns especially that the area contains agricultural fields and green houses. Alternative markets can be established by contacting other areas where compost is accepted. Further contracts could be made with governmental institutions to use compost on public lands or as landfill cover or even in landscaping projects and furthermore, in forests exploitation and reforestation projects. As for the recyclables market, several companies currently are accepting recovered material. A list of companies with contact persons and telephone numbers was presented in Table 3.6. The facility manager should contact recycling companies to ensure marketing of the recovered material.

9.2. Environmental Management Plan on the National SWM Level

The national ISWM plan aims at reducing the volume of MSW to be landfilled by re-using and transforming the waste stream. Therefore, proper management of MSW should be based on an integrated approach considering waste generation, collection, treatment, and disposal. Moreover, the determination of approaches to be adopted by different communities should be based on an assessment of current, short, and long-term requirements. This necessitates waste characterization studies that are essential for communities to collect information concerning their waste profile, including types of waste generated and quantities, in order to plan and finance efficient and economical programs, and further, contribute to the enhancement of national legislation and plans. The facility manager should continuously collect data, and keep records concerning the waste quantity per day and per village, waste composition (percentage material recovered by type), and compost quantities produced.

10. PUBLIC PARTICIPATION

Public involvement is a vital component in any community development project especially when the project depends on community participation and cooperation in order to achieve the proposed objectives. Public participation is achieved in two complementary phases, the first started by PM with the initial phases of the project design to assess local needs and requirements and it was as well initiated through the feasibility study of solid waste management in the Caza of Byblos conducted by Ecodit. The second performed as part of the EIA to address local opinions and concerns about the proposed waste management facility and raise awareness among local community. This phase is composed of four main categories: 1) Inception Workshops, 2) Specialized Training Workshops, 3) Awareness Seminars, and 4) Sorting at the Source programs.

10.1. FIRST PHASE OF PUBLIC PARTICIPATION

The feasibility study conducted by Ecodit throughout the year 2003, initiated the public participation campaign for solid waste management in the Caza of Byblos. The public participation workshops were conducted in three phases; and in order to complement this study, the highlights of key exchanges and public concerns recorded in these workshops along with the final recommendations were closely assessed by PM in order to guarantee social and public acceptance of the suggested solid waste management strategy.

Hence, in coordination with the Union, PM proposed a complete and clear solid waste management plan for the Caza, based on the findings of Ecodit who conducted population surveys, questionnaires, and meetings with community representatives in order to assess further local needs and demands with respect to municipal solid waste management.

This complete solid waste management plan was used as a basis to present tender documents and requirements for the intended bidding for the project.

Also in conformity with EIA guidelines, a notice was posted at the Union of municipalities informing the public about the EIA study that is being conducted and the proposed treatment plants, and soliciting comments. A copy of the notice is also included in Appendix D.

As part of this EIA, public participation involved meetings with project, municipalities and union members from the initial phases of the project design in order to propose and describe the waste treatment facility, the location, organize operational responsibilities, assess local concerns, and modify the project design as needed.

10.2. SECOND PHASE OF PUBLIC PARTICIPATION

10.2.1 Training, Awareness and Public Participation Program:

This activity is a key component of the overall project implementation and is necessary to secure sustainability of the proposed project.

The training, awareness, and public participation program is composed of four (4) main categories of activities: 1) Inception Workshops, 2) Specialized Training Workshops, 3) Awareness Seminars, and 4) Sorting at the Source Programs. These are further described in the following paragraphs and summarized in Table 10.1.

10.2.2 Inception Workshops (IW) and Dissemination Workshops (DW):

Inception workshops are organized at the early stage of project execution in the area. These workshops present to the participants the overall description of the project, and offer the possibility of joining the different stakeholders together to discuss the project and perhaps propose recommendations for further improvement. Stakeholders to participate in such workshops include:

- Union members, various municipalities' members, representatives of local community, farmers, local NGO's, local environmental organizations.
- Government representatives: (MoIM) Ministry of Interior and Municipalities, (MoE) Ministry of Environment, (MoPWT) Ministry of Public Works and Transport, (MoEW) Ministry of Energy and Water, (MoA) Ministry of Agriculture, (MoH) Ministry of Health, Council for Development and Reconstruction (CDR).
- Project Partners: PVO's, AEIs, private sector (recycling factories, consulting firms, waste management contractors).
- United States Agency for International Development. (USAID).

One major inception workshop will be held providing detailed information and description of the project, all along with an elaboration on the various issues studied in the EIA. The Inception workshop would bring several benefits to the program, as follows:

- Promotion of public participation and involvement from the early stages of the project;
- Promotion of coordination with the government;
- Promotion of coordination with project partners from the early stages of the project;
- Incorporation of stakeholders comments in the overall project implementation strategy.

Similarly, dissemination workshops would present the results of the program, focusing on success stories, lessons-learned, and prospects for replication. A major deliverable of this program will be a comprehensive report including a summary of lessons-learned, success stories and main achievements of the program, which will be a major reference to be kept by the beneficiaries and USAID.

10.2.3 Specialized Training Workshops (STW):

While inception workshops aim primarily to promote public participation and coordination with the government and different partners, STWs aim at improving the capacity of specific groups in the target areas in the different technical aspects of project implementation and operation. Plant operators, farmers, quarry owners, and other important parties who are affected or could benefit from the training sessions, will attend STWs.

STWs would be designed as 2-day workshops. Day 1 would have a theoretical session (morning session), and a more focused technical session in the afternoon. Morning session topics, depending on the project, could include topics like integrated solid waste management principles, wastewater treatment principles, and environmental impacts from inadequate waste disposal. Afternoon sessions that could be run in parallel sessions according to specific groups needs would include topics such as irrigation using treated wastewater effluent, use of fine compost as a soil conditioner, use of coarse compost in quarry rehabilitation, and sludge disposal issues. Day 2 would consist of demonstration trips to existing plants for discussion about typical operational problems, operation and maintenance requirements, and practical issues. Parallel visits would be conducted depending on participants needs.

In this way, STWs consist of a combination of theoretical lectures, focused training sessions, and field demonstrations that are believed to maximize workshop impacts. A highly technical training manual will be distributed to the participants to serve as a basis for future reference and application of proper environmental guidelines.

10.2.4 General Awareness Seminars (GAS):

General awareness seminars are targeted to the local community in general. Issues addressed in a GAS are less technical than those in STWs, and aim at raising awareness and improve environmental practices of the local population. It would be however rather difficult and expensive to provide these seminars to a very large portion of the local communities during the duration of the project. It is believed to be a more sustainable approach to TRAIN THE TRAINERS who will subsequently train and raise awareness in the community. These trainers include primarily school professors and NGO's that could take over this educational role. Topics to be included in these seminars could be environmental impacts from poor disposal practices, role of the local community in improving the environment and other general topics aimed to increase environmental awareness.

Awareness manuals and ready-made presentations will be prepared and provided to these trainers as tools to be used in raising awareness. Trainers would attend awareness seminars provided in schools and other public locations in order to be acquainted with the principle. Several GASs would be conducted (at least 3 per cluster) in order to initiate the environmental awareness in the rural communities. Gender considerations are taken into account here, whereby women would play an important role in this activity.

10.2.5 Sorting at the Source Programs (SSP):

Efficient sorting at the source is very important to support solid waste management programs especially to ensure that good quality compost and dean recyclable materials are generated in the process. If the by-products are to be marketed and valorized, their quality ought to be satisfactory; otherwise, they will not find sufficient outlets. The following action plan will be adopted and adapted for each target rural cluster in view of achieving acceptable rates of community participation:

Establishment of a local women committee and members of local NGOs and organizations (such as scouts) with designation of a project leader; gender considerations are strongly accounted for, and the role of women is crucial to the overall success of the program;

Development of a brochure explaining purpose of sorting at the source, benefits to the community, fate of sorted wastes, and how to sort the wastes;

Distribution of brochures in the largest possible number of households; the newly formed committee will visit the households and explain the process to the person in charge.

The awareness campaign would be conducted also in areas where solid waste treatment plants were already constructed and in villages geographically linked to the proposed project. In this way, a multiplier effect is also secured. The proposed sorting program would be a 2-stream sorting program. It would be too ambitious to start with a larger number of waste streams sorted. Food waste is placed in black bags, while other wastes (paper, cardboard, glass, metals, plastics, textiles) are placed in colored bags. No specific color is required, as long as it is not black. The bags can also be disposed off in the same collection bin in the streets.

The different bags are transported to the treatment facility. A second level of sorting is then performed. Black bags are opened, contents emptied, and further sorted to remove unwanted materials, if present. Colored bags are also opened and contents emptied and further sorted according to different waste streams. Sorted materials are processed according to requirements from recycling factories. Food waste enters the composting plant and recyclable materials are stored for future transportation to end-users.

Workshops will be held, as much as possible, within the premises of the municipalities. In this way, municipalities will have an increased feeling of ownership towards the project, and will automatically increase their commitment levels. Furthermore, all local activities will utilize local resources (logistics, food, etc.). In this way, local businesses are encouraged and favored to a certain extent.

Table 10.1. Summary of Training, Awareness, and Public Participation Activities

Type of Activity	*Duration/Structure*	*Targeted Audience*	*Relevance*
Inception Workshop and dissemination workshops	1/2 day presentation of the project to stakeholders	Local municipalities, NGOs, representatives of local communities, farmers, industrialists, representative from recycling factories, government representatives (MoIM, MoE, MoEW, MoPWT, MoA, MoH, CDR)	Promotes public participation from the early stages of the project Allows incorporation of stakeholders comments in the overall design and approach of the project Promotes coordination with government Promotes coordination with private sector (recycling factories)
Specialized Training Workshops	2-day Day 1: theoretical background related to solid and wastewater management + technical lectures on specific topics (application of compost in quarries rehabilitation or as soil fertilizer, use of treated wastewater in irrigation, sludge disposal) Day 2: Field visits to operational sites	Local municipalities, operators, farmers, quarries owners	Provides technical knowledge to those directly responsible for the operation of the facilities Tackles critical issues related to the disposal of by-products and presents environmental guidelines accepted by MoE and international environmental agencies (like USEPA) Promotes partnerships with AEIs by inviting professors (mainly from AUB and LAU) to contribute to the technical lectures Preparation of training manuals to be used as reference
General awareness seminars	1-day	School professors, local NGO's, local universities	By training the trainers, the activity provides opportunity for continuing environmental education in the area, and a long-lasting impact Preparation of awareness manuals and presentations to be used as reference by future trainers
Sorting at the source programme	1-day (several per cluster)	Local women committees School students	Promotes a key-component of solid waste projects, sorting at the source, which will significantly improve quality of by-products and their marketability Preparation of training and dissemination brochures

11. CONCLUSION AND RECOMMENDATIONS

Observations from the implemented waste management facilities helped to learn from previous experiences and in identifying most of the negative impacts, which are mainly related to operational inadequacies, resulting from the lack of environmental awareness, lack of waste separation, poor technical qualifications of workers, and poor facility management. The proposed project was evaluated and modified to account for local concerns and mitigate potential negative impacts and prevent negative impacts observed in previous projects. Furthermore, suggestions concerning proper operation of the proposed facility were provided. The proposed facility will be first managed by the contracting company, which has the necessary qualifications needed for proper operation. This would significantly reduce the probability of negative impacts. The operational responsibilities will be then transferred to the municipality after ensuring adequate training of local workers.

The proposed project could result in some negative environmental impacts. However, the implementation of the mitigation and monitoring plans would minimize or prevent the occurrence of the most significant negative impacts. That would render the operation of the facility very beneficial on the local, national environmental and socio-economical levels, especially that the implementation of the project would result in the closure of open uncontrolled dumping on site in Hbaline and would end the open burning activities still practiced in some small villages of the Union. The most important factor in the success of the facility is the product quality. The compost produced should be regularly monitored and its quality improved by proper waste separation and operation activities. Applying contaminated compost to agricultural or natural lands should be prevented since it leads to tremendous long-term negative effects. Moreover, the public participation process showed the willingness of the local community to separate waste in order to enhance the quality of the compost and prevent negative impacts.

Implementing a solid waste treatment facility to solve the waste problem at the level of Jbeil Caza could be a viable option since it complies with ISWM plans and with the latest recommendation of the ministerial committee for national solid waste management. This plan aims at reducing the waste volumes to be landfilled, by recovering and re-using recyclables, and changing the organic fraction of the waste into useful products. The project would be further beneficial when coupled with environmental awareness campaigns that would increase the community's willingness to home separate solid wastes, and involve locals in environmental protection. Furthermore, the success of the project will render the solution of solid waste management at the level of Cazas viable and this will render the Jbeil union experience as pilot for the implementation of such solid waste management plans in the rest of the Lebanese Cazas.

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APPENDIX A
TECTONIC MAP OF LEBANON; GEOLOGIC AND TOPOGRAPHIC MAP OF STUDY AREA; GEOLOGIC CROSS SECTION; SITES PLANS OF THE FACILITY

APPENDIX B

COMPOST ANALYSIS REPORTS ; ANALYSIS OF HBALINE DUMP SAMPLES

APPENDIX C
GUIDELINES FOR COMPOST QUALITY SET BY THE MOE.

Ordinance on the quality assurance and utilization of compost in agriculture, horticulture, and landscaping

OBJECTIVES

The main objective of this ordinance is to create a legal framework for the production and utilization of compost and to improve at long term the recycling quota of organic material from waste. Therefore the Compost Ordinance regulates the application of treated and untreated bio-wastes and mixtures on land which is used in agriculture, horticulture, viticulture or forestry and it treats as well the use of compost, having a low quality, in landscaping and in landfill operation. It also covers suitable raw materials, quality and hygiene requirements, and treatment and investigations of such bio-wastes and mixtures. The Compost Ordinance regulates – from a precautionary perspective – the waste side (e.g. heavy metals) of the application.

AREAS OF APPLICATION

All treated and untreated biodegradable wastes from animals or plants, and all mixtures under the collective name of 'biowastes' applied to soils through agriculture, forestry or horticulture, landscaping and landfill operations are subject to the requirements of the compost ordinance.

DEFINITIONS

Additives: Materials to improve structure and to form clay-humus-complexes of compost (e.g. basalt meal, calcium bentonite, clay granulate, bone meal, horn meal, lime etc.), are added to raw compost materials for their nutrient or bulk qualities.
Biowaste: Term used to describe the composting of separately collected organic domestic waste. It is collected separately from households in so-called 'bio bins', which are sometimes also known as compost bins or 'green' bins. Biowaste normally contains a certain amount of garden or green waste (up to 40%).
Bulk density: Density of loosely heaped material per volume unit in t/m^3.
C/N-ratio: Ratio of carbon to nitrogen (total content); used to describe nutrient or decomposing ability of organic waste.
Compost: Product of decomposition process resulting from the aerobic treatment of organic material.
Compost windrows: Stacking of organic matter intended for composting in regular piles of triangular or trapezoid cross-section.
Contaminants / pollutants: Organic and inorganic materials in concentrations harmful to health and environment.
Degree of maturation: Identification of the current status of the decomposition process to characterise the progress of maturation. Scale ranges from I(compost raw material) to V (mature compost).
DEWAR Self-Heating Test: used to determine maturation stage of compost by investigating temperature rise of compost under standardized conditions;

Dry substance: Amount of substance after removal of water; measurement after drying at 105°C until constant weight is reached.
Impurities: Unwanted substances which are disturbance factor either technically or optically and which lower the quality of compost (e.g. stones, glass, metal, plastics).
Fertilizers: Substances intended to be added directly or indirectly to plants to promote growth, increase harvests or increase quality of crops.
Food waste: Waste from restaurants and large kitchens (larger than a normal household) which is normally collected in addition to the regular bio-bin system, in special containers. (Those wastes have to undergo extra treatment (70 °C for one hour) to guarantee sanitation which has to be done before they are treated in composting or digestion plants.)
Green waste: Pure organic residues from gardens and parks.
Heavy metals: Lead, Chromium, Nickel, Zinc, Cadmium, Copper and Mercury.
Horticulture: Capital and/or labour intensive form of agricultural cultivation often carried out in relatively small areas; often close to houses.
Household waste: Waste from households and similar waste from small businesses which are regularly collected, transported, treated and disposed.
Humus: The end product of aerobic biological decomposition processes such as composting.
Immature Compost: Compost in an early stage of decomposition which is characterized by maturation stages I and II
Mature Compost: Compost in an advanced stage of decomposition which is characterized by maturation stages IV and V (i.e. temperature rise smaller than 10°C at DEWAR-self-heating test.)
Native organic waste: Organic waste consisting of materials in their natural state.
Pathogen: Causing diseases.
Quality criteria: Description of certain quality characteristics and contents for compost.
Sanitizing: Process stage with the aim to disinfect material.
Organic fraction of household waste: Fraction of household waste containing predominantly organic matter as result of previous sieving and sorting process.
Semi-mature Compost: Compost in an incomplete stage of decomposition which is characterized by maturation stages III (i.e. temperature rise between 10°C and 20°C at DEWAR-self-heating test.)

SUITABLE RAW COMPOST MATERIAL

Suitable raw material is listed in the enclosed Annex of this Ordinance and includes the following groups of organic waste materials:

- Source separated organic municipal waste
- Organic fraction of household waste
- Green waste
- Residues from the food and animal feed industry
- Mineral composting additives.

A detailed list of waste types suitable for composting either as organic matter or as additive is given in the enclosed annex. If the operator of the composting plant intends the composting of wastes not listed in annex than he requires a specific authorization by the Ministry of Environment.

TYPES AND QUALITY STANDARDS FOR COMPOST

4 different types of compost are defined by quality criteria presented in table 1 (overview) to table 5 are valid. The range goes from Grade A compost, being a high quality compost and most appropriate for any agricultural utilization, to Grade D compost which must only be used on controlled landfills as intermediate cover or as landscaping material. The product of a composting process which does not correspond to the specifications of Grade D compost cannot be considered as an organic recycling-product and must be categorized as waste.

Table 1: Definition of compost types (overview)

Type of compost	Characteristics	Main Fields of Utilisation
Grade A	Main characteristics are: • Native organic raw material, generated by source-separation; • Mature compost (maturation degree V); hygienised, biologically stable; • Corresponds to European Eco-label for composts	Food production in • Agriculture • Horticulture • Viticulture
Grade B	Main characteristics are: • Organic raw material, generated by mechanical treatment of household waste; • Mature compost (maturation grade IV or V); • hygienised, biologically stable; • Corresponds to European Eco-label for composts;	Food production in • Agriculture • Horticulture • Viticulture
Grade C	Main characteristics are: • Organic raw material, generated by mechanical treatment of household waste or appropriate waste from industrial sources (e.g. residues from the food and animal feed industry • Semi-mature compost (maturation grade III); hygienised material, • Limits given for heavy metals correspond to doubled values of European Eco-label for composts;	Utilized only if any risks to humans and any contamination of food or agricultural soil can be excluded; e.g. in • Landscaping • Recultivation of abandoned quarries • Soil for green space along traffic roads
Grade D	Main characteristics are: • Organic raw material, generated by mechanical treatment of household waste or appropriate waste from industrial sources (e.g. residues from the food and animal feed industry) after appropriate treatment • Immature compost (maturation grade II); hygienised material, • Limits given for heavy metals correspond to fivefold values of European Eco-label for composts;	Only to be used as recultivation material on controlled landfills and as intermediate layer of deposited waste. No to be utilized as top layer of recultivated landfill sites in order to prevent contamination of humans, fauna and flora as well as spreading of pollutants.

Table 2: Quality standard for compost, Grade A

Quality characteristics	Quality requirements
Origin of raw material	Source-separated organic material from households or agriculture; Mechanical sorting of impurities prior to composting process
Hygiene	Exposure of entire material to temperatures > 65°C for at least 7 days during thermophilic decomposition phase (sanitizing phase). Extensive exclusion of germinable seeds and sprouting plant parts (less than 1 germinable weed-seed in 2 liters of compost). Exclusion of *Salmonellae* Faecal coliforms must be < 1,000 MPN/g of total solids calculated on a dry weight basis
Man-made impurities[2]	Maximum of 0.5 weight-% in dm; plastic less than 0.1 weight-% in dm (selection of impurities in compost fraction > 2 mm)
Stones	Maximum of 5.0 weight-% in dm (selection of stones in compost fraction > 5 mm)
Plant compatibility	50% compost with 50 % standard soil media; germination rate of barley seeds must pass > 90 % after 5 days
Decomposition degree	Maturation degree V
Water content	Loose material: maximum 45% weight Bagged material: maximum 35 % weight Higher contents of water are admissible for composts with more than 40% organic matter
Organic matter	at least 15 % weight-% in dm, measured as volatile solids
Plant nutrients and salt content	Salt content max. 2.5 g/l Minimum nitrogen (sum NO3/NH4-N) <300 mg/l Soluble phosphate P2O5 <1.200 mg/l Soluble potassium K2O <2.000 mg/l Soluble chloride <500 mg/l Soluble sodium <250 mg/l
Contents of heavy metals	Guide values[3] (mg/kg dm) Lead < 150 Cadmium < 1.5 Chromium < 100 Copper < 100 Nickel < 50 Mercury < 1.0 Zinc < 400
Parameter for declaration to utilizer	Mature compost from source – separated organic waste Producer Grain size and bulk density (volume weight) C/N-ratio pH value Salt content Plant nutrients total (N, P_2O_5, K_2O, MgO, CaO) Plant nutrients soluble (N, P_2O_5, K_2O) Organic matter Net weight or volume Information for a suitable application (method and application rate)

[1]MPN: Most probable number
[2] Glass, metal, plastics
[3]Guide values: The heavy meal limit values are adhered to if the mean value of the last four analyses lies under the limit value and no analysis surpasses the limit value by >25%. This guide excludes the cadmium test.
dm = dry matter; fm= fresh matter; om = organic matter;

Table 3: Quality standard for compost, Grade B

Quality characteristics	Quality requirements
Origin of raw material	Organic raw material, generated by mechanical treatment of mixed household waste; minimum standard of treatment: sieving, hand-sorting, magnetic separation of impurities by drum-magnets or equivalent equipment
Hygiene	Exposure of entire material to temperatures > 65°C for at least 7 days during thermophilic decomposition phase (sanitizing phase). Extensive exclusion of germinable seeds and sprouting plant parts (less than 1 germinable weed-seeds in 2 liters of compost). Exclusion of *Salmonellae* Faecal coliforms must be < 1,000 MPN/g of total solids calculated on a dry weight basis
Man-made impurities[2]	Maximum of 0.5 weight-% in dm; plastic less than 0.1 weight-% in dm (selection of impurities in compost fraction > 2 mm)
Stones	Maximum of 5.0 weight-% in dm (selection of stones in compost fraction > 5 mm)
Plant compatibility	25% compost with 75 % standard soil media; germination rate of barley seeds must pass > 90 % after 5 days
Decomposition degree	Maturation degree IV or V
Water content	Loose material: maximum 45% weight Bagged material: maximum 35 % weight Higher contents of water are admissible for composts with more than 30% organic matter
Organic matter	at least 15 % weight-% in dm, measured as volatile solids
Plant nutrients and salt content (only required if compost is used as substrate for production of potting soil)	Salt content max. 2.5 g/l Minimum nitrogen (sum NO3/NH4-N) <300 mg/l Soluble phosphate P2O5 <1.200 mg/l Soluble potassium K2O <2.000 mg/l Soluble chloride <500 mg/l Soluble sodium <250 mg/l
Contents of heavy metals	Guide values[3] (mg/kg dm) Lead < 150 Cadmium < 1.5 Chromium < 100 Copper < 100 Nickel < 50 Mercury < 1.0 Zinc < 400
Parameter for declaration to utilizer	Mature compost from mixed waste Producer Grain size and bulk density (volume weight) C/N-ratio pH value Salt content Plant nutrients total (N, P_2O_5, K_2O, MgO, CaO) Plant nutrients soluble (N, P_2O_5, K_2O) Organic matter Net weight or volume Information for a suitable application (method and application rate)

[1]MPN: Most probable number
[2] Glass, metal, plastics
[3]Guide values: The heavy meal limit values are adhered to if the mean value of the last four analyses lies under the limit value and no analysis surpasses the limit value by >25%. This guide excludes the cadmium test.
dm = dry matter; fm= fresh matter; om = organic matter;

Table 4: Quality standard for compost, Grade C

Quality characteristics	Quality requirements
Origin of raw material	Organic raw material, generated by mechanical treatment of household waste; minimum standard of mechanical treatment: sieving, hand-sorting, magnetic separation of impurities by drum-magnets or equivalent equipment; Appropriate organic waste from industrial sources (e.g. residues from the food and animal feed industry) after proper treatment
Hygiene	Exposure of entire material to temperatures > 60°C for at least 7 days during thermophilic decomposition phase (sanitizing phase). Exclusion of germinable seeds and sprouting plant parts to a large extend (less than 5 germinable weed-seeds in 2 liters of compost). Exclusion of *Salmonellae* Faecal coliforms must be < 2,000 MPN/g of total solids calculated on a dry weight basis
Man-made impurities[2]	Maximum of 1.0 weight-% in dm; plastic less than 0.5 weight-% in dm (selection of impurities in compost fraction > 2 mm)
Stones	Maximum of 10.0 weight-% in dm (selection of stones in compost fraction > 5 mm)
Plant compatibility	25% compost with 75 % standard soil media; germination rate of barley seeds must pass > 75 % after 5 days
Decomposition degree	Minimum maturation degree III
Water content	Loose material: maximum 40% weight Bagged material: maximum 30% weight Higher contents of water are admissible for loose composts with more than 30% organic matter
Organic matter	at least 20% weight-% in dm, measured as volatile solids
Contents of heavy metals	Guide values[3] (mg/kg dm) Lead < 300; Cadmium < 3 Chromium < 200; Copper < 200 Nickel < 100; Mercury < 2.0 Zinc < 1000
Parameter for declaration to user	Semi-mature compost; only to be used for landscaping, rehabilitation of abandoned quarries and green space along traffic roads Producer Grain size and bulk density (volume weight) C/N-ratio pH value Salt content Plant nutrients total (N, P_2O_5, K_2O, MgO, CaO) Organic matter Net weight or volume Information for a suitable application (method and application rate)

[1]MPN: Most probable number
[2] Glass, metal, plastics
[3]Guide values: The heavy meal limit values are adhered to if the mean value of the last four analyses lies under the limit value and no analysis surpasses the limit value by >25%. This guide excludes the cadmium test.
dm = dry matter; fm= fresh matter; om = organic matter;

Table 5: Quality standard for compost, Grade D

Quality characteristics	**Quality requirements**
Origin of raw material	Organic raw material, generated by mechanical treatment of household waste; minimum standard of mechanical treatment: sieving, hand-sorting, magnetic separation of impurities by drum-magnets Appropriate organic waste from industrial sources (e.g. residues from the food and animal feed industry) Food waste after sanitation at 70°C for 1 hour or more
Hygiene	Exclusion of *Salmonellae* Faecal coliforms must be < 2,000 MPN/g of total solids calculated on a dry weight basis
Man-made impurities[2]	No specific requirements
Stones	No specific requirements
Plant compatibility	No specific requirements
Decomposition degree	Minimum maturation degree II
Water content	Loose material: maximum 40% weight Not to be bagged
Organic matter	No specific requirements
Contents of heavy metals	Guide values[3] (mg/kg dm) Lead < 750; Cadmium < 7.5 Chromium < 500; Copper < 500 Nickel < 250; Mercury < 5.0 Zinc < 2000
Parameter for declaration to utilizer (here: landfill)	Immature compost; only to be used on landfills as intermediate cover and as rehabilitation material; not to be used as top layer Producer Grain size and bulk density (volume weight) Net weight or volume Information for a suitable application (method and application rate)

[1]MPN: Most probable number
[2] Glass, metal, plastics
[3]Guide values: The heavy meal limit values are adhered to if the mean value of the last four analyses lies under the limit value and no analysis surpasses the limit value by >25%. This guide excludes the cadmium test.
dm = dry matter; fm= fresh matter; om = organic matter;

UTILIZATION OF COMPOST GRADE A AND GRADE B

Nutrients

Application rates, given for one year, shall specify that the amount of compost spreaded per year should not exceed the following limits:

- $17g/m^2$ total nitrogen
- $6g/m^2$ phosphate
- $12g/m^2$ potassium oxide

In addition to those limits the following figures and comments presented in table 5 and 6 should be used as an orientation for the specific use of compost from organic waste. Table 5 refers to subtropical climat as it can be found along the coastline of Lebanon, while the values presented in table 6 are to be applied for agricultural land in irrigated arid zones with a high rate of mineralization.

Table 6: Recommended use for compost from organic waste (coastal zones)

Area of use	Vegetation	Purpose	Amount[1] kg FS / m²	Frequency	Method
Horti-culture	Vegetable beds	Supply of humus	3 – 5	Annual	Work in superficially
	Vegetables with high nutrient needs	Fertilizing, soil improvement, supply of humus	4 – 6	Annual	Work in superficially
	Vegetables with medium nutrient needs	Fertilizing, soil improvement, supply of humus	2 – 4	Annual	Work in superficially
	Vegetables with low nutrient needs	Fertilizing, soil improvement, supply of humus	1 – 2	Annual	Work in superficially
	Trees/bushes	New planting	2 – 8	Once	Mix 3 parts soil and 1 part compost and add to hole for plant
	Sandy, heavy, shallow and contaminated sites	Soil improvement	10 – 15	Every 2 years	Work into loose topsoil
Fruit growing	Stone and soft fruit	Supply of humus, fertilizing	3 – 5	Annual	Spread on surface
Viticulture	Fertilizing of existing vineyard	Supply of humus	3 – 6	Every 2 years	Spread superficially
	New planting	Supply of humus	5 – 10	Once	Work into loose topsoil
Tree nursery	Nutrient poor soil	Soil improvement	8 – 10	Once	Work into loose topsoil
	Open land cultivation	Supply of humus, fertilizing	3 – 4	Every 2 years	Spread or work in superficially
	Container cultivation	Container substrate	25 – 50 vol. %	Once	As component for mixing with soil

Area of use	Vegetation	Purpose	Amount[1] kg FS / m²	Frequency	Method
Agriculture	Crop growing, generally	Soil improvement	Up to 15	Once	Work into loose topsoil
	Crop growing, generally	Supply of humus	4 – 8	Every 3 years	Work into loose topsoil
	Root crops, field vegetables	Supply of humus	3 – 5	Every 2 years	Work in superficially
	Root crops, field vegetables	Fertilizing, supply of humus, soil improvement	3 – 6	Annually	Work in superficially
	Cereals	Fertilizing, supply of humus, soil improvement	2 – 4	Every 2 years	Work in superficially
	Pasture	Fertilizing, supply of humus, soil improvement	3 – 6	Every 2 years	Work in superficially

[1]: The amounts refer to fresh compost, with a dry substance content of 60 %. The formula for t/ha is achieved by multiplying by the factor 10 (e.g.: 4 kg/m² = 40 t/ha). The formula for with a volume weight of e.g. 700 kg/m³ is achieved with the reciprocal value (e.g. 1/0.7= around 1.42). Example: 4 kg/m² = 5.7 l/m² = 57 m³/ha.
[2]:FS = fresh substance

Table 7: Recommended use for compost from organic waste (interior parts of Lebanon)

Plant culure	Amount[1] (kg FS / m²)
Root and tuberous vegetables	6 – 25
Cereals	10
Fodder plant	20
Pasture	3 – 5
Viticulture	8 – 30
Fruit growing	20 – 100
Vegetable growing	20 – 50
Tree nursery	Up to 30

[1]: (see table 5)

MONITORING PROCEDURE

Bill of Delivery

In order to document a properly executed process, the compost plant has to give a bill of delivery to the person responsible for application to the soil and to send every 3 months a report on the utilization of compost to the following authorities:

- Ministry of Environment,
- Ministry of Agriculture,
- Ministry of Health,
- CDR.

The report should outline the absolute amounts of utilized compost, the specific type of agricultural or other utilization and the specific amount of utilized compost per costumer.

Frequency of investigations
The frequency of the investigations during the first year of a composting plant and the subsequent on-going monitoring procedure depends on the plant input capacity (see Table 7). At least four inspections should be carried out during the first year of operation – one for every season – to assess the essential quality characteristics over the course of the year. At least one sample should be taken every three months.

Table 7: Frequency of investigations within the monitoring procedure (per year)

Plant input (tons/year)	Number of analysis during first year	Number of analysis after first year
Up to 2,000	4	4 analyses/year
2,001 to 5,000	5	4 analyses/year
5,001 to 10,000	10	8 analyses/year
More than 10,001	12	12 analyses/year

External monitoring
Within the framework of the quality monitoring procedure, sample-taking and analyses must be carried out by external monitoring laboratories that should be licensed by the Ministry of Environment. Licensing of the independent outside monitors is subject to verifying certain preconditions of the recognized laboratories (for example taking part in an interlaboratory ring test).

In-house analysis
The compost producer also does its own analyses. He is obliged to verify the safe hygiene status of the decomposition or the digestion process by documenting accurately the temperatures achieved during the first intense decomposition phase. Within the framework of the monitoring procedures carried out by external laboratories the correct measuring and documentation of those temperature protocols is examined in irregular intervals but at least once a month. The laboratory should produce a quarterly report on the results of their examinations. This report should be presented to the Ministry of Environment at the latest in the third week of the following month.
Further in-house analyses can be carried out on a voluntary basis. The determination of characteristics important for the application of compost and digestion residues which can be ascertained using simple techniques, such as water content, weight by volume, salt content, pH value, plant compatibility and extraneous matter in the end product, is recommended.

TEST METHODS

In the following the procedures to be applied can only be outlined in a few sentences.

Sampling procedure
In order to produce a representative sample 12 single samples (5 – 10l per sample) should be taken at 12 different spots of the compost heap to be examined. After thorough mixing of those samples the material is then reduced by dividing it repeatedly into quarters until the remaining representative sample has a volume of around 4 l. This sample, it is then

again divided into 4 separate samples. One sample is used for the determination of the water content. The other samples are dried in an oven at a temperature of 105°C until no further loss of water is detectable. They are then filled into airtight plastic bottles and conserved at a temperature level of a few degrees Celsius.

Determination of water content

The water content is determined according to the international standard ISO 11465 by drying 2 samples each having a quantity of around 100 g under an infrared-light and measuring permanently the weight. As soon as there is no further loss in weight the drying-process is stopped. The weight determined before and after the drying procedure is then used for the determination of the water content.

Determination of man-made impurities

The content of man-made impurities is determined by sieving a dried sample of around 200 g at a screen size of 2 mm. Then man-made impurities such as glass, metal an plastic are separately sorted by using tweezers. The plastic fraction is then weighed apart from the other fractions.

Determination of stones

The content of stones is determined by sieving the dried sample of around 200 g at screen size of 5 mm. Stones are then sorted by using tweezers.

Determination of maturity grade

The maturity of compost is determined by carrying out the DEWAR self-heating test. This test uses a standardized steel container that holds approximately 1 litre of compost. As with any test, the compost sample moisture content may need to be adjusted prior to incubation. A maximum-minimum thermometer is then inserted to about 5 cm of the bottom of the container which is left to stand at room temperature (20 °C) for a period of at least 5 days and no more than 10. The highest temperature of the compost sample is recorded daily. The results are calculated as maximum temperature rise during the test period. The maturity is then expressed as number ranging between I (fresh compost) and V (mature compost).

Determination of plant compatibility

In order to determine the plant compatibility of compost the germination of barley seeds in a mixture of compost and standard soil must be greater than the germination rate of barley in a control sample (standardized soil) and the growth rate of plants grown in a mixture of compost and soil must not differ more than 50 percent in comparison with the control sample.

Determination of organic matter

In order to determine the content in organic matter three samples of dried compost with 10 g /each are filled into temperature resistant ceramic vessels. The vessels are then set into a laboratory oven and exposed to a temperature of 750°C. After 3 hours all the organic material is burnt up and the amount of organic matter can be then calculated by weighing the totally mineralized residue in the vessels.

Determination of heavy metals

The determination of the heavy metal content is determined according to the international standard ISO 11047.

Determination of nutrients, pH and salt content

The determination of nutrient content is carried out according to test methods 86/ 278/EEC.

Suitable organic waste and mineral additives

Name of waste type	Key according to EWC[1]	Examples
I Waste with a high percentage of organic material		
Waste from plant tissue	02 01 03	• Wheat dust • Fodder waste
Animal feces, urine and dung (including spoilt straw)	02 01 06	• Chicken droppings • Liquid manure from cows • Dung • Used straw
Forestry waste	02 01 07	• Bark • Wood, wood chippings
Waste unsuitable for consumption or processing (Food processing)	02 03 04	• Spoilt foodstuff • Residues from preserving factories • Residue from oil seeds
Undefined waste	02 03 99	• Sludge from consumable oil production • Residues from spices • Residue from potatoe, corn or other starch production
Materials unsuitable for consumption	02 05 01	• Spoilt foodstuff
Undefined waste	02 05 99	• Whey
Materials unsuitable for consumption or processing	02 06 01	• Spoilt foodstuff • Dough remains
Waste from washing, cleaning of mechanical grinding of raw material	02 07 01	• Used filters and adsorption masses, active and siliceous earth
Waste from distilling spirits	02 07 02	• Fruit, wheat and potato pulp • Sludge from distillery
Undefined waste	02 07 99	• Malt • Hops • Liquid residue and sludge from breweries • Sludge from wine making • Wine remains • Yeast and similar residues
Bark and cork waste	03 01 01 03 03 01	• Bark
Sawdust	03 01 02	• Sawdust and wood shavings
Shaving, chippings, ends of planks, pressed wood and veneer	03 01 03	• Sawdust and wood shavings

[1] EWC: European Waste Catalogue

Name of waste type	**Key according to EWC[1]**	**Examples**
Waste from untreated textile fibers and other natural fibers, primarily from plant origin	04 02 01	• Cellulose fiber waste • Plant fiber waste
Waste from untreated textile fibers, primarily of animal origin	04 02 02	• Wool waste
Undefined waste	07 05 99	• Marc from medicinal plants • Myceliums • Remains from fungus remains
Solid waste from first filtration and sieving	19 09 01	• Fishing, mowing and raking remains • Protein waste
Paper and cardboard	20 01 01	• Used paper
Organic, compostable kitchen waste, fractions collected separately	20 01 08	• Kitchen and canteen waste
Compostable waste	20 02 01	• Garden and park waste • waste from landscaping and forest clearances • plant remains
Mixed settlement waste	20 03 01	• household waste
Market waste	20 03 01	• source separated biodegradable fraction suitable for utilization
II Mineral additives		
Calcium carbonate sludge which does not conform to specifications	02 04 02	• Carbonisation sludge
Sludge from decarbonisation	19 09 03	• Sludge from water softening
(no waste)	---	• Lime • Bentonite • Rock dust • Sand • Clay

APPENDIX D
EMP COMPLIANCE LETTER ; NOTICE POSTED AT THE UNION.