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August 1985
English

Syria.

ASSISTANCE TO THE MUNICIPALITY OF DAMASCUS IN THE CONSTRUCTION OF A COMPOST PLANT.

SI/SYR/79/802

SYRIA

Technical Report *.

8 September to 8 October 1984

Prepared for the Government of Syria
by the United Nations Industrial Development Organization,
acting as executing agency for United Nations Development Programme

Based on the work of John Marriott
Consultant in Compost Production

United Nations Industrial Development Organization
Vienna

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3932

1. INTRODUCTION AND TERMS OF REFERENCE

1.1. In August 1984 I was appointed by UNIDO under a Special Service Agreement to visit Damascus as quickly as possible to undertake a a technical evaluation of the tenders received for a large capacity Composting Plant to be constructed for the Governate of Damascus.

1.2. My duties to be strictly in conformity with the policy of UNIDO which is:

> To carry out a technical appraisal of the offers in respect to the requirements of the Specification and to the terms of reference contained in the tender invitation documents; and with respect to such other evaluation criteria as may be mutually agreed between the Consultant and the government authorities.
>
> The work is to be basically advisory in character with no committment of UNIDO to any position regarding the choice of the successful bidder, since this decisions rests with the government.

1,3 In advance of my visit to Syria I was authorised by UNIDO to prepare analysis schedules in order to ensure:

a - Comprehensive examination of each offer;

b - Uniformity of assessment of all the offers submitted.

1.4. I arrived in Damascus on 8th September in accordance with the request from UNIDO. I found how-ever that the tenders would not be opened until the evening of the 11th September.

1.5. The tenders each consist of THREE parts and are contained in seperate sealed envelopes as follows:

Envelope 1 - Administrative File and Bid Bond
Envelope 2 - Technical File
Envelope 3 - Economic and financial Offer.

Each Part in accordance with local custom has to be opened examined and checked before proceeding to the examination of the next part.

1.6. Eleven Tenders were received. After the envolopes for Part 1 had been opened it was discovered that there was a document missing from one of the tenders. This document was found later, but as the submission was not strictly in accordance with the specified procedure, there was a delay of several days until a decision was made to accept that tender for examination along with the other ten.

1.7 It was not until 18th September (ten days after my arrival) that authorisation was given to open Part 2 envelopes containing the technical submissions, and thus enable me to commence my tecnical evaluation of the various schemes submitted.

1.8. A number of offers were submitted containing multiple schemes each of which was submitted as full schemes and the technical assessment necessitated the detailed examination of FOURTEEN proposals. In view of the delays at the start of my mission, very long hours had to be worked to complete the examination by the last day agreed with UNIDO in my Special Service Agreement.

1.9. I have no knowledge of the contents of the Part 3 envelopes containing the actual financial tenders and also the details of operational costs of the various schemes submitted. My technical judgement of the various schemes therefore has not been influenced by knowledge of the relative cost of each scheme I have examined.

1.10 In view of the delay during the early part of this mission and after discussion and approval by Mr N. Haj Oghle of Damascus Municipality I have carried out two additional but related tasks:

1. - The detailed examination of the design and technical documents relating to the Damascus Sewerage, Sewage Treatment and River Re-Charge Project particularily in relation to its integration with the Composting Project, and

2. - An examination and assessment of the selected site for the Composting Plant (which adjoins the proposed site of the sewage treatment plant) and the submission of any relevant observations which relate to its development and use.

1.11 The result of my studies into each of these matters have an important contribution to make to the technical evaluation of the tender offers, and therefore before reporting on my technical examination of the tender offers it is desirable to report my findings in respect of the potential influence of the Sewage Treatment proposals, and the development factors of the site for the composting plant.

2. DESIRABLE INTEGRATION OF SEWAGE TREATMENT AND COMPOSTING PROJECTS

2.1 There would appear to be FOUR practical matters of common interest to both projects, namely:

1. Vehicular access to a public highway
2. Use by the Composting Plant of liquid sewage as processing water.
3. Incorporation of the whole production of semi-dried sewage sludge in the composting process
4. Joint utilization of specially skilled personnel.

2.2 Vehicular Access

This matter is fully reported in Chapter 3 of this report.

2.3. Composting Use of Liquid Sewage

2.3.1. The design requirements of the Composting Plant demand a substantial and regular supply of liquid for processing purposes which could be as high as $600M^3$ per day based on the refuse intake alone. Even if the entire production of semi-dried sewage sludge is added there will still be a need for a further supply of $230M^3$ of processing water or liquid each day.

2.3.2. The design of the sewage treatment works provides a pressure main carrying liquid sewage which encircles the sewage treatment plant and it is desirable that arrangements should be made to connect the composting plant to that supply.

2.3.3. IF this is agreed then the FINAL DESIGN of both the Sewage Treatment Plant and of the Composting Plant must take this supply to the Composting Plant into account.

2.4. Incorporation of Sewage Sludge in Composting

2.4.1. Considerable information regarding the yield, quality, character, density, de-watering treatment and final disposal of sewage sludge is contained in Vol III of the document entitled "Preliminary Engineering Design for the Sewage Treatment Plant". In particular Paras19.8.1.; 19.9.4; 19.10.2; and 19.10.3 are important.

2.4.2. The sewage sludge is to be substantially de-watered by passing it through a filter belt press, in order to reduce the moisture from 97% w/w to 70% w/w OR LESS. It should be noted that the Specification proposals for the Composting Plant envisage a sewage sludge with a moisture content of 66.6% w/w. After the sludge is de-watered it is proposed to store it at the sewage treatment plant for 90 days for which purpose a storage area of 28,200 M^2 is to be provided. During this storage period IN BULK there will be some further small scale drying of the sludge by evaporation and there will be some SLOW an-aerobic decomposition of the sludge. The moisture level is too high and the storage in bulk is such that aerobic composting can not occur.

2.4.3. The final disposal of the sludge will be by costly transport either to landfill or other places some considerable distance from the sewage treatment plant.

2.4.5. The yield of sludge from the filter press will be 524M^3 per day and 365 days each year. This equates to 611M^3 per working day of the Composting Plant. The density at emergence from the filter press is 1300kg/M^3.
There will however be some subsequent bulking during storage and handling.
The annual yield will be 200,000M^3 of semi-dried sludge (rising in later phases of development of the sewage treatment plant to 300,000M^3).

2.4.6. The semi-dried sludge will be transported from the filter press to the storage areas by the use of FIVE tipping lorries of 12M^3 capacity each. The distance of travel is 700metres. THIS SAME EQUIPMENT COULD CONVENIENTLY DELIVER THE SLUDGE DIRECTLY AFTER PRODUCTION TO THE INLET OF THE COMPOSTING PLANT. To enable this to be done a proper vehicular access between the two plants will be needed.

2.4.7. For the final disposal of the sludge from the storage area to

off-site landfill or other disposal points, it is proposed to provide FIFTEEN tipping lorries of 12M^3 capacity each, with the addition of a number of loading shovels for loading the vehicles with sludge from the stock-piles.
EACH tipping lorry will make FIVE trips in TWELVE HOURS each day and travel a total of at least 47,000 kilometres per annum.

2.4.8. Semi-dried Sewage Sludge is an excellent feedstock for composting especially when incorporated with municipal refuse. It has a Carbon/Nitrogen Ratio (C/N) which may be taken as 8. The original feedstock specified for the Composting Plant has a c/N Ratio of above 30. The incorporation of the whole yield of sludge with the municipal refuse will reduce the C/N Ratio to about 20 at the commencement of composting. This will be highly beneficial to the process, will acclerate fermentation, produce a better quality compost with a higher nitrogen content, and substantially increase the quantity of compost produced. It is calculated the increase in quantity could be about 22%. (from 470 tonnes day to 600 tonnes day). The yield from the municipal refuse alone without <u>any</u> sewage sludge will be about 350 tonnes day.

2.4.9. De-watered sludge is usually added to the refuse at the inlet of a composting plant where in the process of shredding and pulverisation it becomes thoughly incorporated and mixed with the refuse - the shredded refuse thus acts as an aeration media for the sludge. Surplus moisture (over 55%) is absorbed by refuse.

2.4.10. Sludge (primary) as produced at a sewage treatment plant is in liquid form containing only about 3% w/w solid matter. If the solid content is increased it remains pumpable until about a moisture content of 90% w/w. Further dewatering converts it slowly through a thickening stage to mud, thena highly plastic stage, and at about 70% w/w moisture content it becomes a firmish solid material which because of its density and nature is easily processed through a pulveriser mill.
The degree of dewatering is very important. At stages between a pumpable quality and a reasonable solid material it is difficult to transport and to incorporate in the composting process. One tender offer suggests to eliminate the need for processing water the sludge should only be de-watered to level to give an overall correct fermentation moisture content in the total composting feedstock. This would how-ever would create serious operational problems and I cannot recommend this practice.

2.4.11 The Specification for the Composting Plant provides for the incorporation in feedstock of sludge of the nature proposed by the Sewage Treatment proposals to the extent of 100 tonnes of dry solids per day. The yield from the sewage treatment works will be 246 tonnes per working day of the composting plant. Design is deficient in specified capacity by 146 tonnes sludge dry solids per day. This could be accommodated by either adjusting the design with the successful tenderer at final design stage of the composting project OR increase the working hours.

At the final contract design stage it is desirable that to make sure the throughput capacity is fully adequate the capacity of each stage of the plant and particularily the fermentation capacity is checked.

2.4.12 To accommodate ALL the sludge produced by the sewage treatment plant in an EIGHT WORKING SHIFT at the Composting Plant the following are the revised inputs:

		Tonnes	Cubic Metr
Refuse		700	2400
Sludge	66.6% w/w moisture	794	611
		1494	3011

2.4.13 The sludge will contain surplus moisture above the optimum level for ITS OWN fermentation (66.6% w/w instead of 55% w/w) It will contain 238 tonnes dry solids and 556 tonnes moisture.
The moisture requirement for the sludge fermentation is 290 tonnes so there is a surplus of 266 tonnes of liquid.

700 tonnes of refuse with a moisture content of 30% w/w contains 490 tonnes dry solids and 210 tonnes moisture. For optimum fermentation it needs 599 tonnes liquid. Its own inherent moisture content and the surplus from all the sludge is 476 tonnes, so that the additional moisture requirements are 123 tonnes. By incorporating ALL the sludge there is a daily saving of 266 M^3 of processing liquid.

2.4.14 I have carefully studied the various technical reports of the Consultants for the Sewage Treatment Project and it would appear from investigations already made the sludge

will not contain concentrations of heavy metals, trace elements, or salinity which can prove to be deletrious to the soil or to growing crops when incorporated into compost.

Careful laboratory control will be constantly necessary in this connection when the sewage works and the composting plant are both fully operational, in order to make sure that these concentrations remain at acceptable levels.

2.4.15 The Specification for the Composting Plant in-corporates about HALF of the potential yield of semi-dried sludge from the proposed sewage works.

I STRONGLY RECOMMEND that at the FINAL DESIGN STAGE for the composting project its capacity be adjusted to enable it to process the whole yield of sludge.

This policy would produce the following benefits:

a - The Feedstock Quality would be higher and the sludge content facilitate the composting process.

b - The final compost will be of an improved quality

c - The yield of compost will be increased by over twenty per cent.

d - A substantial saving will be made in the quantity of processing water.

e - The costly transportation of sludge for final off-site disposal will be eliminated.

f - The Sludge Storage Area at the sewage works can be substantially reduced in area.

2.5. Skilled Personnel

2.5.1. The Sewage Treatment Project and the Composting Project when they are operational will both require certain high level skills such as electricians, mechanical engineers, chemists and laboratory technicians.

The Sewage Treatment Proposals make a generous provision of these skills. It would appear (especially at a supervisory level) these skills could be jointly employed with considerable operational and financial benefit.

3. THE SITE FOR THE COMPOSTING PLANT

3.1. I attach three drawings to different scales which show:

a - The location of the site in relation to the built up area of Damascus where the refuse to be processed will be generated.

b - The Ghouta Area where the compost wil likely be utilised.

c - The relationship of the site to the proposed sewage treatment plant.

d - A similar drawing to the one supplied to the tenderer.

3.2 The site is situated about 6 km east of Central Damascus near to the village of Ayn Terme. It adjoins the eastern boundary of the proposed sewage works site, and its southern boundary is near the River Barada.

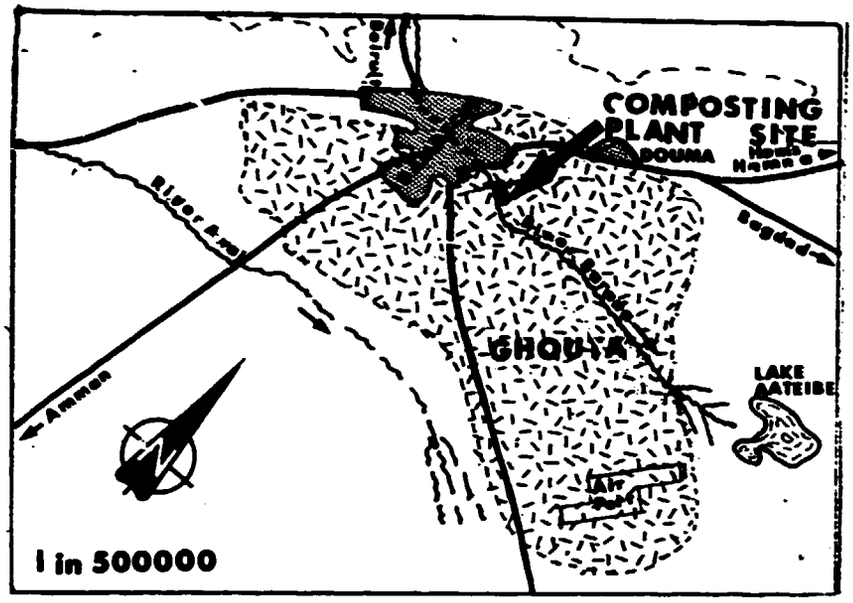
3.3. The site has a total area of about 11 hectares. It is generally flat cultivated land with a gentle slope of about 1 in100 to the river.
It contains some irrigation channels and numerous mature and developing trees especially near to its boundaries.

3.4. The geo-technical survey of the sewage works site suggests that similar conditions will extend to the Composting Plant Site. These are that the sub-surface strata consists of silty clay with sandy gravel lenses, and some gravel deposits especially near to the river.
The ground bearing capacity is generally 1.5kg/cm^2, but there may be localised "soft-spots" or pockets with a bearing capacity in the region of 0.5kg/cm^2.
The ground water level is generally high and it fluctuates in accordance with the top water level of the River Barada which is highest in January/February. Its average level is - 2 metres.

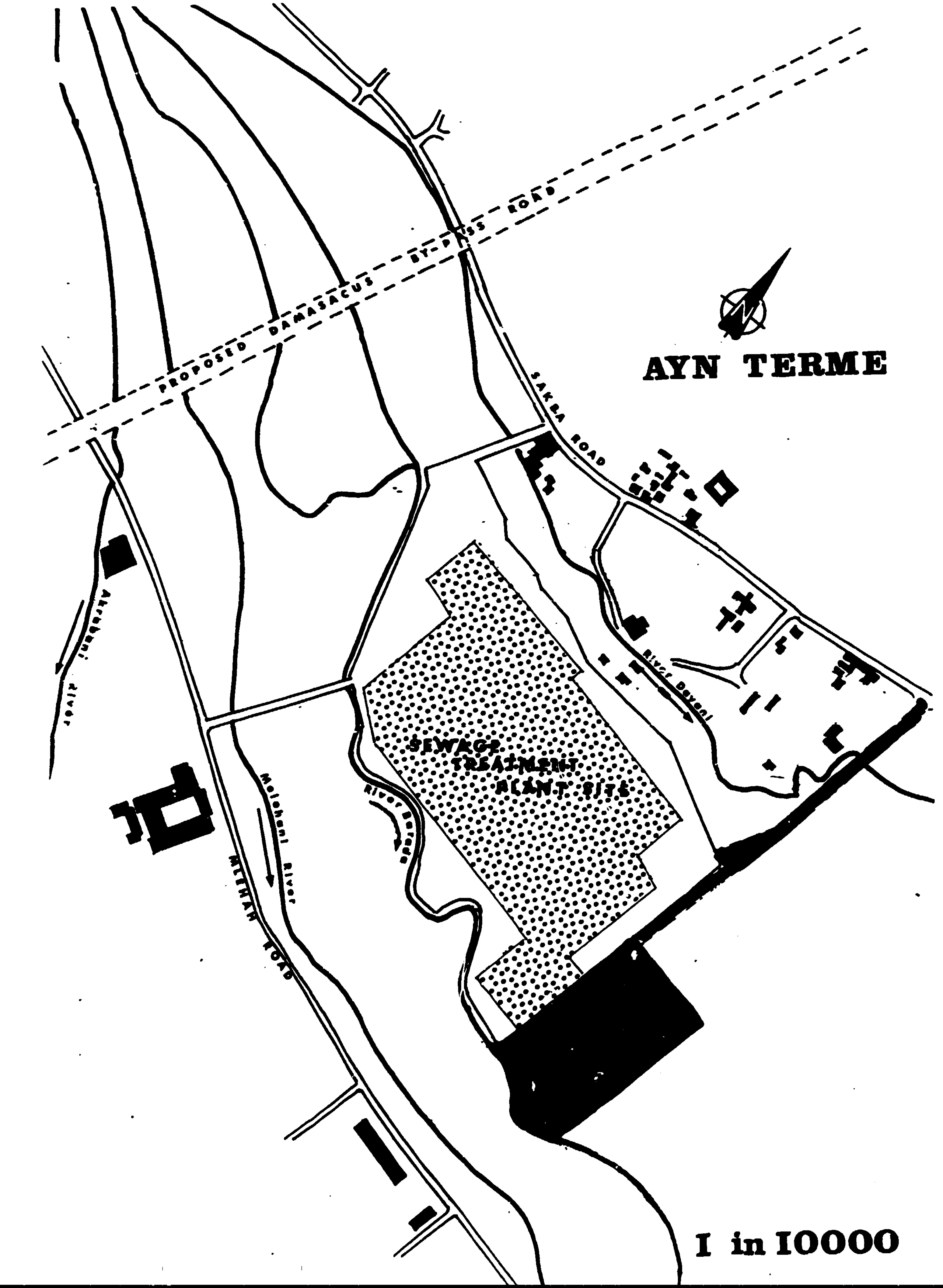
3.5. The site is without a satisfactory vehicular access at present.

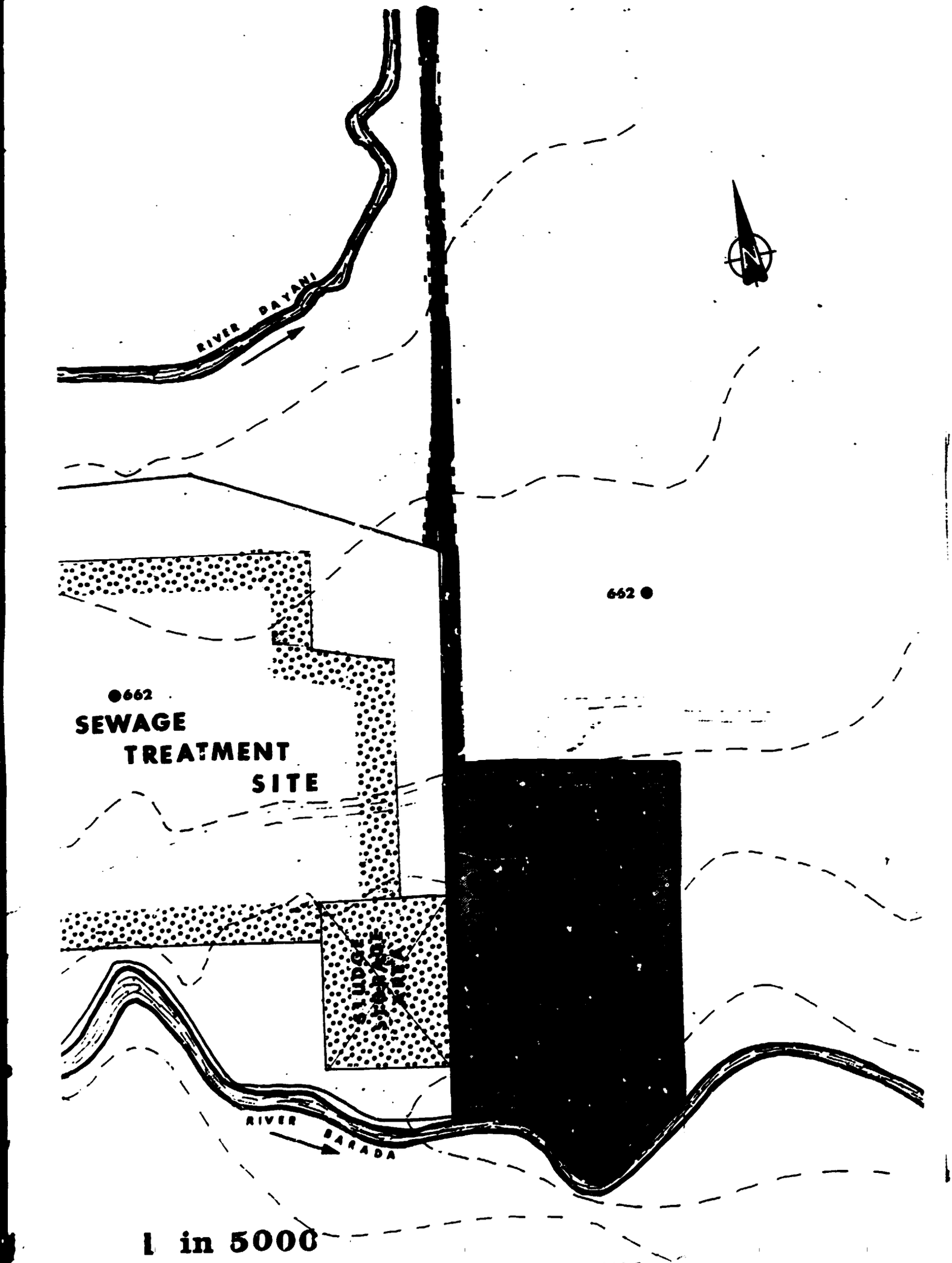
The sewage works proposals provide for vehicular access to that site at the north-west corner of the site and at a point 1.2 kilometres west of the composting site. There is available space in the sewage works site clear of operational areas along its northern boundary where an interconnecting road between the proposed sewage works access and the composting site could be constructed. For operational reasons how-ever this is not very desirable.

LOCATION·MAP



HAMEH
KOUDSAYA
MEZZAOUR
WEST DOUMMAR.
DOUMMAR
RABOUE
KASSIOUN CITY DEVELOPMENT APEA
OLD MEZZE
ROUKN EL DIYN
DAMASCUS
KAFAR SOUSSEH
KABOUN
OLD CITY
JOBAR
MIDAN
YARMOUK
AMTERMAA
COMPOST PLANT SITE
1 in 20000


PROPOSED DAMASACUS BY-PASS ROAD
SAKKA ROAD
River Dayeni
SEWAGE TREATMENT PLANT SITE
AYN TERME
I in 10000


RIVER DAYANI
662
662
SEWAGE
TREATMENT
SITE
RIVER BARADA
1 in 5000

3.6 Preliminary outline proposals exist to provide a vehicular access to the composting site alined in a north-south direction and connecting with the Damascus-Sakba Road which is situated about 900 metres north of the composting site. This proposal has considerable merit and it could CONVENIENTLY BE USED JOINTLY BY THE SEWAGE WORKS AND THE COMPOSTING PLANT.

3.7. Both plants will generate a considerable amount of vehicular traffic. The composting Plant at least 300 vehicles per day and the sewage works at least 100 vehicles per day. The details are:

Composting Plant	Sewage Works
175 Refuse Deliveries	75 Sludge Disposal
25 Reject Disposal	25 Service & Delivery
100 Compost Collection	

3.8. It is extremely important in view of the large traffic flows that the site layout for the composting plant makes ample provision for the parking of vehicles awaiting delivery or collection. Without such provision site congestion or the queuing of vehicles on the access roads can cause confusion and operational problems especially at peak periods.

3.9. As the current Specification provides for the reception of half the proposed sludge production from the proposed sewage works it is also important that proper vehicle access from the sludge filter press and the sludge storage area be provided so that sludge lorries can readily deliver the sludge directly to the reception inlet of the Composting Plant.

3.10 Great care is required in the layout and development of the site to achieve its highest potential.
The following area essential matters:

a - <u>A topographical and geo-technical survey of the site is an URGENT necessity, as this will form the basis for all other development decisions.</u>
This should have been available when tenders were invited.

b - The construction of a suitable vehicular access is a matter of the highest priority.

c.- Provision should be made in the final layout for

a - Adequate on-site parking for vehicles awaiting to make deliveries of refuse or to collect compost.

b - A proper vehicular access to sewage works.

d - In view of the fluctuating but general high level of the ground water deep excavations should be avoided.

IF a deep reception bunker forms part of the accepted scheme great care must be exercised to ensure that the bunkers

a - Resist flotation when they are empty

b - Remain completely water-tight at all times (Refuse in storage must be kept dry)

e - The foundations for vibrating machinery such as pulveriser mills must not be sited where "soft-pockets" exist unless special foundations are designed.

f - Drainage and other underground services should be planned and sited so that they can later be readily interconnected with those at the sewage works.

f. The Final Layout shall ensure the retention of the maximum number of mature and developing trees.

3.11. The cost of site acquisition is high, but it is certain that this will be proved to be in the long term a very wise and economically sensible decision.

It is a very EXCELLENT site in every respect, and particularily when considered in relation to traffic logistics and economy, operational efficiency, and environmental acceptability.

4. METHOD OF THE TECHNICAL APPRAISAL OF THE SUBMITTED SCHEMES

4.1. The examination of the technical files submitted in tne various "envelopes 2" was made at one of the offices of tue Consulting Engineers appointed for the Composting Project, namely:

" The General Company for Engineering and Consulting "

and in the presence of Mr Zouhair Wafa their Project Manager and En. Mohamad Yourness (Professor in Damscus University) their Consultant.

4.2. The essential technical data which I required for detailed examination and analysis was obtained from each of the submitted documents, and was later assessed by me, but no document submitted with the tenders was at any time removed from the office of the Consulting Engineer.

4.3. The method used for the technical evaluation includes:

a - Determining the system of composting which is submitted, and assessing the layout of the various elements of the plant, together with the disposition type and size of the various processing units.

b - Detailed examination and assessment of the technical data submitted with the schemes and especially

1- Technical Data Sheet No 1 - "Design Criteria used in the Design of the Plant"

2 -Technical Data Sheet No 7 - "Guarantees of Plant Performance"

This essential information was compared with accepted design parameters to determine the adequacy and competence of the submitted ptoposals

c - Scrutiny of the technical files to determine the extent of compliance with with all the ninety items contained in the Book of Specification

d - Ascertaining any design features which are questionable experimental, faulty, inadequate or are un-necessarily complicated.

4.4. The ELEVEN Tenders included a number of multiple submissions of variant or alternative scheres. These were each fully documented.

FOURTEEN complete schemes were examined (including one submission which consisted substantially of two schemes.)

5. SPECIFICATION BOOK

5.1. The Specification Book is a comprehensive, sound and professional document, and it is clear that the insistence on submission of detailed design criteria has resulted in a number of potential tenderers finding that they could not satisfy the precise demands of the document and in consequence did not submit offers.

5.2. This is a Turn-Key Lump Sum Contract and it is important that the finally accepted scheme satisfies completely all the requirements of the Governate of Damascus.

5.3 It is rare that in tendering for such a Contract any firm can prepare a 100 per cent perfect submission. Some items are overlooked or omitted, some do not comply with specification, and some elements of design may need later amendment to fully satisfy. Unless the ommisions are highly significant or serious it is possible to make a decision regarding the potential successful offer. The firm should then be required to submit a final scheme for approval as is required by Article 10 (c) of the Conditions of Contract.

5.4. In checking through the Specification Book I have found a slight difference in several places regarding the design capacity of the plant.

Annex VIII and Article 2 of the Conditions of Contract give the capacity correctly as being:

> 700 tonnes of refuse per 8hr day and 300 tonnes of sewage sludge (66.6% w/w water) per 8hr day and six days in each week

In Specification 3.1 there is an additional proviso to this capacity which could be misleading which states

> "or alternatively at will the maximum amount of liquid sludge (97%w/w moisture) which the volume of refuse can contain"

The intention of the proviso should have read

> "and additionally at will"

Liquid sludge (97% water) contains only 9 tonnes of solid matter in 300 tonnes of sludge and it was intended that this could be used in lieu of processing water. Sludge with a 66.6% water content contains 100 tonnes of solid matter in 300 tonnes of sludge and it has a solid volume of about 300 cubic metres.

Each scheme is being examined as far as possible to ascertain that it can accommodate the full capacity as intended by the

Specification book, but it is very IMPORTANT that this matter be agreed with the successful tenderer before a final contract is ratified.

6. GUIDESLINES FOR SCHEME SELECTION AND CONTRACT FINALISATION

6.1. To avoid un-necessary repetition when I report on my examination of the various submissions, it was thought desirable to explain a number of important factors which are essential in any scheme which will achieve successful commercial composting. These factors are in fact major guildelines in the selection of a suitable scheme and in the finalisation of contract details.

6.2. Composition of Feedstock

It is extremely difficult and practically impossible to obtain an accurate analysis of municipal refuse, as every load of waste is of a different composition to the next, and the composition of one days waste will not be the same as that on the following day.

Only one of the tenderers has taken the trouble to carry out his own independant investigation and refuse analysis. The results are in general similar to those contained in the Specification Book. The moisture content however is higher.

The data in the Specification Book was obtained from detailed studies extending over a period of six weeks, and it is therefore unlikely that the recent private survey could be as comprehensive.

Moisture content will vary widely according to season, and also the locality from which the refuse is generated. The composting plant must be capable of meeting the most adverse conditions and therefore the use of the lower moisture content for design purposes is very important.

The moisture requirements in terms of supply of processing water in the schemes submitted vary from 10,000 litres per hour to 70,000 litres per hour. An average requirement is 30,000 litres per hour.

It is important to ensure that all plants should have an adequate supply of processing liquid available should it be required -

the processing liquid can be either well water, river water, screened or settled sewage, or liquid sludge with a solids content which does not prevent it being pumped.

6.3 The Composting Process - Fermentation

The vital stage in the composting process is fermentation. It is the process whereby the organic matter present in the feedstock is converted by biological aerobic oxidative action to an accetable quality of compost. A composting plant must be designed to provide optimum conditions for the various micro-organisms (bacteria, fungi and actinomycetes) to flourish and so perform their essential task. The essential requirements are adequate but not excessive moisture and a good well distributed supply of oxygen.

Micro-organisms can only absorb nutrients in a liquid form, and as the moisture content of composting material falls below the optimum level of 55% w/w so does the growth of micro-organisms also decline; and this growth stops al-together when a moisture level of 14% w/w is reached. If the moisture level is greater than 55% w/w the interstices of the composting material become waterlogged and aerobic conditions can not be maintained.. The adjustment and maintenance of the correct moisture balance in the fermentation process is essential for success.

An adequate supply of oxygen is equally important and oxygen depleted pockets of composting material must be prevented.

A major aid to the fermentation process is the pre-shredding of the feedstock. Not only are bags, sacks and other containers (which are filled with refuse)broken and shredded,but the whole of the feedstock is reduced to a maximum particle size,which because of the considerable increase in the surface area of the material enables moisture to be quickly absorbed and micro-organisms to proliferate. The process of shredding also entrains within the shredded material a well distributed supply of oxygen which is sufficient to start the fermentation process.

If the fermenting material is left undisturbed it will increase in density by settlement and eventually it will be compacted to a

to an impearmeable and oxygen depleted condition. When oxygen falls below 12 per cent aerobic fermentation will cease and the process will become an-aerobic with disastrous results.

6.4. Systems of Fermentation

There are two principle methods:

Enclosed in which fermentation is carried out in digester towers or in rotary drums.

Windrow in which fermentation is achieved by natural methods (by stock-piling or windrowing the feedstock in the open air or preferably within fermentation hangars.)

The windrow method has three variations:

Standard Windrows These are turned at regular (usually seven daily) intervals.

Acclerated Windrows The windrows are mechanically turned and aerated at regular intervals under very controlled conditions.

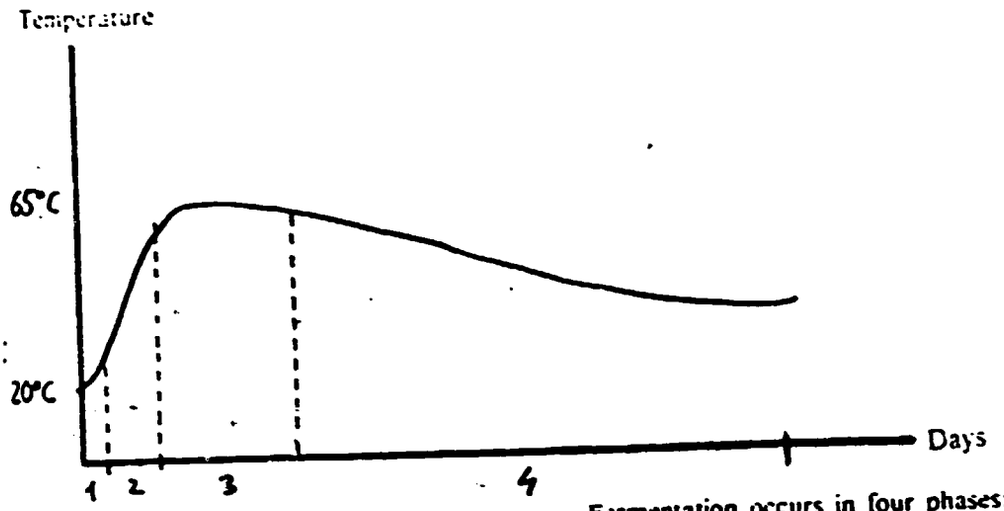
Static Windrows.
(Extended Pile Forced Aeration) Stockpiles of prepared feedstock are formed on a specially prepared floor or platform, and REMAIN UNDISTURBED DURING THE WHOLE FERMENTATION PERIOD.

The floor or platform is provided with vents and ducts through which air is forced or exhausted.

6.5. Enclosed Fermentation

This system is extremely expensive in terms of capital investment. Manufacturers have therefore attempted to design on the basis of shorter and shorter fermentation retention periods. The system can achieve excellent results PROVIDED THE PERIOD OF RETENTION IS SUFFICIENTLY LONG.

The Specification requires a continuous period of fermentation at a temperature of 60°C for four days (96 hours). The following graph shows that with any fermentation process there is a latency and a growth phase before a temperature of 60°C is attained. This period is never less than 24 hours and can be two days, so to satisfy the Specification a minimum retention period of FIVE DAYS is required



(1) = *latency phase*
(2) = *growth phase*
(3) = *thermophil phase*
(4) = *maturing phase*

Fermentation occurs in four phases:
(1) a latency phase covering the time required for colonization of the medium by micro-organisms (about one day):
(2) a growth phase accompanying the rise in temperature:
(3) a thermophil phase in which the temperature reaches 60°. It must not last too long for otherwise the organic content of the compost diminishes and only mineral components of no use for agriculture remain:
(4) a maturing phase taking place either on space set aside at the composting plant or, in certain cases, in the fields after spreading.
The diagram below shows the theoretical temperature curve for the aerobic conversion of refuse.

All Enclosed Fermentation Systems rely heavily on a long period of maturation or curing subsequent to the actual so called "fermentation stage. It is in the maturation process that the real biological action takes place.

None of the submitted schemes using this method have a retention period as long as FIVE days - (one scheme only retains the feedstock for 24 hours) To provide satisfactory fermentation the schemes would have to substantially increase the number of towers or drums.

A major weakness of the enclosed system is its lack of operational flexibility. The system has to be designed to rigid maximum inputs and it is impossible to increase that rate. If part of a plant is temporarily out of action the remainder cannot absorb the load.

W.H.O. has indicated that successful commercial composting should not, and need not, depend on the use of intensive mechanisation. The process is a biological one, and machinery should only be used to perform tasks

which are physically difficult or are arduous for manual labour. The use of machinery should therefore be restricted to such matters as shredding - mixing - screening - refining- and lifting, turning loading and transporting feedstock, composting material(at various stages) and final compost.

It is found in practice that the TOTAL TIME required to produce a good quality compost is much the same with both the methods of fermentation.

6.6. Accelerated Windrow Fermentation

The standard windrow system is wasteful of land especially when large throughput of feedstock is involved. The accelerated windrow system reduces space requirements and also reduces the time required for satisfactory fermentation.
The process consists of forming windrows either in the normal fashion within a fermentation hanger, or placing the prepared feedstock into specially constructed containing structures. The fermenting material is turned and mechanically aerated at regular intervals by special turning machines which can be operated automatically.

The system is a positive and flexible one and gives excellant results.

6.7. Static Windrow Fermentation (or Extended Pile Forced Aeration)

Several of the submitted schemes use this method of fermentation, and (as there is some doubt and controversy regarding its efficiency and reliability, especially where large throughputs of feedstock are concerned) it is important if such a scheme is favourably considered, that evidence should be presented indicating the operation of a successful composting plant, using the system, and processing a similar throughput to the Damascus Plant, and also operating under similar climatic conditions. An alternative course of action would be to negotiate for the conversion of the static windrow fermentation unit into an accelerated windrow unit. A few schemes are excellent in all respects except for the system of fermentation which has been adopted. Relatively minor adjustment would be necessary to effect the conversion and produce an unquestionably reliable composting plant.

In static windrowing the prepared feedstock is deposited in huge stockpiles which contain up to 25,000 cubic metres of material.

The height of the stockpile is up to 3.5 metres. The material rests on a prepared base (either in the open or in a fermentation hangar) and through the base, air is forced into the feedstock or exhausted therefrom. At least that is the theory. In practice it is found that much of the air movement is along the interface between the feedstock and its base and containing structure. Aeration of static material in bulk is extremely difficult to achieve, AS IN THIS SYSTEM NO MECHANICAL TURNING OF THE FEEDSTOCK IS PRACTISED. Any homogenous material placed in stockpile will slowly settle and increase in density, and mass aeration by induced air systems is not reliable and becomes more uncertain as the feedstock density increases.

It is possible that some composting plants with relatively small throughput of feedstock have given some acceptable results. In these cases it is relatively easy to manipulate the fermenting material. With large quantities this is not possible.

It is noteworthy that one scheme submitted a basic offer using this system, and also an alternative using the accelerated windrow system. The alternative system reduces the time required to produce compost by 14 days, it increases the yield of compost by forty per cent, and it results in a substantial reduction in the size and area of the fermentation unit.

All the schemes using Static Windrowing precribe long periods for subsequent maturation.

6.8 Moisture Adjustment of Feedstock

Most of the submitted schemes make satisfactory provision for adjustment of the moisture level of the shredded refuse. A few however are deficient in this respect. In one scheme no water is added until after the shredded refuse has been retained for ten days in the fermentation unit, and then water or liquid is only applied during the mechanical turning of the material. It is important in the early stage of fermentation to maintain a correct moisture balance in order to induce rapid fermentation (which is marked by a quick rise in temperature). The process of adding water during compost turning, results in a great loss of liquid by rapid evaporation, and the whole process is very in-efficient.

It is very important that all schemes have efficient means for moisture adjustment with a capacity great enough to adjust the moisture level of the driest refuse under the most adverse climatic conditions.

6.9. Compost Processing Loss

During the fermentation process the organic carbon contained in the feedstock in various forms (pectins, cellulose and lignins) break down at different speeds. The vegetable matter rapidly decays, and at a slower rate the paper, but woody materials are much more resistent. The micro organisms which effect the decomposition (bacteria, fungi and actinomycetes) utilise 30 parts of carbon to one of nitrogen.

The carbon is converted into heat which creates the pasteurising temperature of fermentation, carbon dioxide gas is produced and this is discharged naturally to atmosphere, and moisture is released by rupture of cell tissue and emerges as water vapour.

There is in consequence a considerable loss of weight in the feedstock. THIS IS UNAVOIDABLE.

Calculation of potential compost yield must take this factor into account. One submitted scheme has not done so.

In the schemes examined apart from two which are obviously in error, the range of composting loss is from 14%w/w to 20%w/w of the feedstock input. I have calculated a figure of 18%w/w from comparison of the Carbon/ Nitrogen Ratio of the feedstock and the potential C/N Ratio of the final compost.

One of the submitted schemes indicated there would be No composting loss and another gave a figure of 5%w/w both of which are manifestly absurd.

6.10. Yield of Compost

The efficiency of the fermentation process will to some extent influence the level of the Composting Processing Loss, but the mechanical efficiency of the refining units will determine the percentage of reject material. The average level of non-compostable material in the feedstock is 20%w/w but it is impossible to restrict the weight of reject material to that level. The refining units inevitably entrain some compost in the mass of the rejects so that the percentage of rejects will always be higher than the non-compostable material in the feedstock.

In the schemes submitted one gave the same value for rejects as that of the non-compostable material in the feedstock on which the design was based. This is quite unattainable. Design is generally based on 20% w/w non-compostable material in feedstock

and the range of actual rejects varies from 24% w/w to 38% w/w - The average for all schemes is 32% w/w.

It is reasonable to expect the reliable yield of compost will be (or ought to be) about 50% w/w of the original throughput. In the submitted schemes the predicted yield of compost ranges from 32% w/w/ up to 55% w/w/ (excluding the schemes where there is no allowance for composting loss and where an inaccurate compost processing loss is quoted). The average for all the schemes is 48% w/w.

6.11. Compost Production Time

The period required for full compost production varies considerably with each of the submitted schemes,and the range is 42days to 201 days.

The most rapid production is with accelerated windrow schemes and all the schemes with this system of fermentation are within the range of 42days to 50 days. I would expect any efficient scheme to produce good quality compost in a period not exceeding sixty days.

6.12. Sanitisation or Pasteurisation of Compost

Various international standards including the recommendation of the World Health Organisation is that compost made from refuse and / or sewage sludge shall be fermented for a continuous period of four days (96hours) at a temperature not less than 60°C, and this is a requirement of the Specification Book (Annex IX para a). As the pasteurising temperature is only reach after the first 24 hours of the fermentation process (under optimum conditions) this requirement means that all refuse must be fermented for a period of at least five days.

6.13. Mechanisation

The greater the number of units of machinery in a plant, the greater becomes the maintenance problem. A small number of larger units is far more reliable than a large number of small units. Large units are usually more robust in construction, provide greater reserve capacity, and resist wear and tear better than small units.

For this reason TWIN- FLOWLINE PLANTS are preferable to plants where there are three or more flowlines for the processing of the same feedstock throughput.

The most desirable composting plant is one with a clean and simple layout of its machinery, and which incorporates the minimum number of operating units. Conveyor systems can be complicated and one scheme which has been submitted provides 68 conveyors which have a total length of 1200 metres. This compares with another competent scheme which provides only 33 conveyors and a considerably shorter total length.

An engineering maxim is that every metre length of a conveyor is another potential maintenance problem. The Specification Book requires that conveyors shall be as short and as few in number as is reasonably practical.

The hammer mill type of pulveriser is an essential unit, as it not only reduces the refuse to a maximum particle size of about 150mm but its action destroys the eggs, larvea and pupae of flies with which most incoming refuse is innoculated.

There are many types of hammer mill(horizontal(single and double rotor) and also a vertical rotor type). The relative efficiency varies widely. Only a few makes of mill have the capacity required by this plant for twin flow line operation of a throughput of 50 t/hr for each line. In any plant which has to shred refuse the installation of the largest capacity mill available(within economic limits)is a wise investment. The large mill is of substantial and robust construction, it will adequately resist damage from extraneous causes and from normal wear and tear, it will provide useful reserve capacity and generally it is more reliable in action. A number of schemes have provided THREE or FOUR instead of two initial flow lines because the largest size of mill of the type proposed to be used is too small for a twin line plant. The effect of this has been to increase the number of conveyors and generally complicate the plant layout.

One scheme proposes as an alternative to the hammer mill shredder an impact crusher unit. This merely reduces the volume of the refuse but does not effectively shred it to a selected particle size which is necessary for efficient compost, and equally important it does not destroy the eggs larvea and pupae of developing flies.

6.14. Shredder Mill Maintenance

A mill should be capable of dealing with the whole of unsorted refuse (except for large extraneous objects), and tins and metal should not be removed until after the shredding process, as they act as a useful mill cleaning agent.

The hammers within a mill wear at different rates according to type and make of mill, but as they wear the efficiency of the mill declines and to maintain throughput they have either to be renewed or re-faced.

The cost of hammer maintenance and renewal is a significant item in the total operational cost of a plant.

The type and the number of hammers in different types of pulveriser mill vary widely. In the submitted schemes the number of hammers ranges from 12 to 96 per mill. Most type of hammers have a series of wearing faces and to bring them into use the position of the hammers has to be changed at regular intervals, or with one type of mill the worn hammers are refaced by a welding process. The tonnage of feedstock which can be shredded between each change of hammer or each re-facing varies with different makes of mill. Eventually all hammers have to be re-placed and the tonnage life of a set of hammers is important.

The time and man-hours required to effect a change of hammers or to re-face the worn ones determines to some degree the un-avoidable "down-time" of the plant.

In most respects the vertical hammer mill is the most efficient and least costly in this respect. It is designed that at the touch of a switch the rotation of the mill can be reversed and thus bring into operation new hammer faces, with a consequental fifty per cent saving in down-time.

In this type of mill the worn hammer faces can be re-faced by a welding process without the necessity of removing the hammers from the mill. Re-facing can be done up to ten times before new hammers are required.

6.15. Transport and Mobile Handling equipment

Efficient types of vehicle and mobile handling equipment are as essential to the successful operation of a composting plant as the major installation itself. The wrong types can result in un-necessary cost and inflexible and frustrating operation.

Standardisation of types is essential to ensure that they can be interchanged for various different duties. In one submitted scheme loading shovels of different motive power is proposed.

In a composting plant a considerable volume of material has to be regularily handled and moved, and these operations include:

a - Feeding the plant (by loading shovel);

b - Moving material from one processing unit to another;

c - Collecting and disposing of process rejects;

d - Stock-piling of materials and final compost;

e - Loading of finished compost into delivery vehicles.

Specification 5.10 requires that ALL transport and mobile equipment which is necessary for the efficient operation of the plant SHALL be provided. The specification details precise requirements for bulk transportation vehicles and for loading shovels. In most of the submitted schemes these requirements have not been observed.

Appendix 1 gives details of Bulk Transport Vehicles of various types together(for comparative purposes)of current operating costs in Britain

Only ONE of the submitted schemes has observed this Specification, the remainder have substituted Bulk Transport Vehicles of an inferior and operationally less flexible type than the ones specified.

The specification for the loading shovels was precise in its requirements that they should:

a - be four wheeled drive

b - Have buckets with a minimum capacity of 3 cubic metres

c.- Have the buckets fitted with retaining clamps to ensure a FULL bucket at each operation.

In almost all the submitted schemes, one or more of these requirements have been ignored. In one scheme the proposal is for a loading shovel with a bucket of 1.4 cubic metres and a power of 38 hp.

The NUMBER of Transport Vehicles and Loading Shovels is generally insufficient. At least one spare or reserve Bulk Transport Vehicle and Loading Shovel should be supplied.

The health of the drivers of loading shovels requires that the cars be dust proof and be air-conditioned.

6.16. Reception House Design

For public health reasons and in the interests of preventing environmental nuisance from dust, litter, noise, flies and insects, (this is the part of the plant where live flies contained in incoming refuse are released in large numbers), the discharge of refuse MUST be within a total enclosed building which is equipped with efficient dust-aspiration system and adequate fly and insect electrecutors.

Only a few of the submitted schemes have complied with the requirements of Specification Book para 4.10 which prescribes detailed and clear requirements. Some schemes meet part of the proposal except that the whole front of the building is provided with a series of access doo (11 or more) which when open do not conform to the idea of total enclosure. The doors are fitted with automatic closure devices, but at peak delivery periods it will be found that these doors are rarely closed.

6.17. Compost Refining & Cleaning Units

Mature compost must be cleaned and graded to make it commercially acceptable. Most of the submitted schemes include adequate refining plant, but in a number of cases some simplification is required to reduce the number and length of conveyor systems.

6.18 Traffic Movement

Considerable vehicular traffic will be generated by the composting plant and congestion will arise at peak periods unless provision is made within the site for the temporary parking of vehicles while they wait to make deliveries, or to collect compost. Only one submitted scheme has provided for this, despite the clear requirements of Specification 4.10

Although this was NOT specified the final scheme must provide for ade-quate vehicular access to the sewage works site to facilitate the delivery of sewage sludge to the composting plant.

6.19 Enforcement of Specifications

The Specification Book reflects the many principles and factors mentioned in this chapter. When the final contract is agreed it must be made clear to what extent the specifications will be enforced or (subject to negotiation) be suitably amended. If this is not done it can lead to contractual disputes at a later stage.

7. REPORT ON THE TECHNICAL EVALUATION OF INDIVIDUAL SUBMITTED SCHEMES

7.1 The reports on each of the schemes submitted is presented in a uniform manner to enable easy comparison of schemes to be made

7.2. The reports are presented in alphabetical order according to the name of the tenderer.

7.3. My examination of the submitted schemes has not included a detailed study of the civil, mechanical and electrical engineering features other than in respect of specific features such as Pulveriser Mills.

The architectural design of the various buildings has(other than in a superficial way) been dis-regarded.

These are all matters which are clearly the responsibility of the Consulting Engineers for the project. I have therefore confined my investigations to the Compost Processing Engineering Aspects.

7.4. It has however been necessary to check a few schemes purely for indicative purposes to ascertain the extent of mechanisation of the various submissions. Each unit of machinery and each metre of conveyor belt is a potential source for breakdown and consequent delay in compost production. A more detailed analysis of this should be done by the Consulting Engineers.

7.5. Simplicity in mechanisation and high quality machines are an essential ingredient of a successful plant.

7.5. The insistence of strict observance of the Specification for the Reception Hall is not merely to prevent environmental nuisance, but also to ensure reliability and flexibility. The alternative Grab Crane and Storage Bunker systems can in the case of blockage or mechanical fault stop production completely, whereas a defective loading shovel can be speedily replaced.

7.6 I have to strictly conform to the policy laid down by Unido for its Consultants to in no way infuence who shall be the successful tenderer. Therefore I shall not state my technical preferences by means of a grading system or in priority order but will list the schemes at the conclusions of this report in the following categories

a - Schemes suitable and satisfactory to meet local requirements.
b - Schemes which subject to amendment could be acceptable.
c - Schemes which are unsatisfactory.

7.6 From this classification of the submitted schemes, and after consideration of the tender prices one or more schemes may be selected for further negotiation and/ or amendment.

The preparation of the final scheme which will be the subject of the contract must be comprehensive in scope and competently executed. It should be technically assessed in considerable detail before being finally approved. This assessment need not require the technical expert to visit Damascus provided he is supplied with the necessary documentation and is at liberty to consult with the designers of the scheme. Any reports can be speedily transmitted by telex.

8. THE INDIVIDUAL SUPMITTED SCHEMES

8.1. The detailed reports on each of the individual submitted schemes appear in the following order:

1. - Andritz - Austria
2. - Bartolomeis - Italy
3. - B C Berlin - West Germany
4. - Buhler - Switzerland
5. - Daneco - Italy
6. - Degremont - France
7. - Milihouse - Syria (Basic Scheme)
8. - -do- (Alternative 1)
9. - -do- (Alternative 2)
10. - Segoure Freres - France
11. - Snamprogetti - Italy
12. - Thyssen Engineering - WestGermany (Variant 1)
13. - -do- (Variant 2)
14. - O .T.V. - France

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: ANDRITZ Vienna Austria

SYSTEM: Static Windrow (Ruthner) (Extended pile forced aeration)

ELEMENTS OF SYSTEM: Shredding - Mixing - Fermentation - Refining - Maturation
(NOTE: Refining precedes maturation)

NUMBER OF FLOW-LINES: TWO but only one fermentation unit.

QUALITY:

a - Technical Documents:	Reasonable
b - Site Layout:	Un-satisfactory - Cramped and restricted although 40% of site area not used
c - Machinery Layout:	Fairly simple and un-complicated.
d - Buildings:	Mediocre - Gatehouse includes telephone switchboard and weighbridge control

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent) 87

PROCESSING DATA:

a - Design Throughput (8hrs/day) As specified.

b - Rejects (% w/w of throughput)

Non-compostible in feedstock:	24	(Andritz design data)
Mechanical extraction loss	18	
Total Rejects	42	

c - Compost Processing Loss (% w/w throughput) 17

d - Total Yield of Compost (% w/w throughput) 31 to 51 AVERAGE 41%

e - Processing Time (days)

Fermentation:	21
Maturation and Curing	180
Total Production Time	201

f - Storage Facilities for Production: (months) 5

g - Constructional Period (Contract to Commercial Operation in months): ?

h - Processing Liquid (Litres per hour) 27,500

i - Electricity (kwh/8hrday) 12,200

j - Pulveriser Mill Maintenance:

Number of hammers:	30
Tonnage between change:	2500 (7 days)
Life of Hammers (tonnes):	25000 (3 months)
Labour to Change (Man/hours)	8

k - Total Personnel: 75

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - Fermentation is by means of *static* windrowing using the extended pile forced aeration system. There is one large fermentation Hanger with a complicated system of underfloor air ducts using 8000 M /hour of air for 24 hours per day

e - After fermentation the feedstock is then cleaned. Coarse compost ONLY being Screened. The CLEANED material is then taken to Maturation Storage WHERE MOISTURE is added (This suggest that the fermentation process is in-efficient) Medium and Fine Compost is matured within a storage building.

MAJOR OMISIONS FROM TECHNICAL SUBMISSION

None.

GENERAL ASSESSMENT

a - The site layout is cramped and restricted and extensions of the reception hall would be impossible. No on-site parking for delivery and collection vehicles is provided

b - The process for production of compost is too long and personnel requirements too high.

c.- The long maturation process indicates that the static windrow fermentation process is not reliable.

d - If consideration is given to adopting this scheme it is suggested that the static fermentation system be converted to a accelerated fermentation system by the supply of the necessary number of suitable windrow turning machines. The Maturation period can then be substantially reduced.

Other items which would require attention are:

1 - The various open air processing areas should be properly surfaced and drained - It is uncertain from the documents to what extent this is to be done.

2 - The Bulk Transport Vehicles and the Loading Shovels to comply strictly with Specification and be all of the SAME type.

3 - The Reception Hall to be TOTALLY enclosed (Not provided with multiple access doors) and a 15 air change per hour dust aspiration system provided - Insect Electrectors to be also installed.

4 - The site layout should be re-planned to provide for better distribution of buildings and plant, secure better trafic circulation and include adequate vehicle parking - Access to sewage works site to be included.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: de BARTOLOMEIS Milan ITALY

SYSTEM: Seperation and Static Windrowing (extended pile aeratio.

ELEMENTS OF SYSTEM: Iron removal, grinding - homegenising and classifying fermentation - Refing - Maturing

NUMBER OF FLOW-LINES: TWIN with 4 Classifer Drums and One Fermentation Unit

QUALITY:

a - Technical Documents: Unsatisfactory - Technical Data Sheets not supplied - Verbose

b - Site Layout: Satisfactory - only 62% site area used

c - Machinery Layout: Too great a degree of mechanisation

d - Buildings: Average

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 75 per cent

PROCESSING DATA:

a - Design throughput (8hr/day): As specified

b - Rejects (% w/w throughput);

Non-compostible in feedstock:	20
Mechanical extraction loss:	15
Total Rejects:	35

c - Compost processing loss (%w/w throughput): 14

d - Total yield of compost (%w/w throughput): 51

f - Processing time (days):

Fermentation:	21
Maturation & Curing:	35
Total Production Time:	56

g - Storage facilities for Product (months): 5

h - Constructional Period (contract to Commercial Operation in months) Not giv.

i - Processing liquid (litres per hour): 20,000

j - Electricity Kwh (8hr day): Data not supplied

k - Pulveriser Mill Maintenance:

Number of Hammers: Crushers are used instead of pulverisers

Tonnage use between change:

Life of Hammers (tonnes): Twin rotors are removed and replaced as needed

Labour to change (man/hrs)

l - Total Personnel: 24 (This is clearly inadequate)

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - This scheme is unusual. Instead of the customary shredding of feedstock in a pulveriser mill it substitutes a separation system as follows:

Metal Removal - Grinding in a Grinder/Crusher - Wet Pulverisation in a Rotary Homogeniser Drum (12.2M x 3.5M dia and 12 RPM) - Screening to remove all above 20mm particle size.

b. - The pre-treated and separated feedstock is then conveyed to a single large fermentation hanger where it is spread by overhead bridge gantry to form an extended windrow using the static windrowing method (see para 6.7) of forced aeration.

c - After fermentation it passes through the refining unit before it goes for final maturation.

MAJOR OMISSION FROM TECHNICAL SUBMISSION

All the Technical Data Sheets required to be submitted in the Technical File by Specification 2.6.c. have been omitted. The assessment of this scheme has therefore been more difficult and complicated.

GENERAL ASSESSMENT

a The pre-treatment system for feedstock is complicated and is not suitable for Damascus Conditions. It requires a great deal of machinery which would not be required with an efficient pulverisation system.

b The Static Windrowing Fermentation Unit is of fairly standard design for extended pile forced aeration but for reliability and speed of fermentation - windrow turning is desirable.

c The screening of feedstock before fermentation to a 20 mm size suggests that the quantity of rejects will be considerably greater than the stated figure, and that the yield of compost will according be very much lower than the stated figure.

d The refining of fermented material before maturation is unusual

e The following items do not comply with Specifications:

i - The Reception House is not Totally enclosed - it has multiple doors at the front. The dust aspiration system does not provide 15 air changes per hour

ii - Inadequate details are provided of the Transport and Mobile Equipment to be supplied.

iii - The loading shovels are too small and of inadequate power and design The bucket capacity is 1.5 M^3 instead of 3M^3

f - The Site access is from the proposed sewage works site.

g - No provision has been made for Heavy Vehicles Parking near to potential congestion points.

ALTERNATIVE FERMENTATION SYSTEM

a - An alternative to the above Fermentation Unit is the provision of an accelerated windrowing system in which the windrows are moved and turn by a system of sugers. This system is superior to the static method but auger windrow turners are not as efficient as other systems of windrow turning.

h. This scheme even with the alternative system of fermentation can not be recommended as suitable for the Damascus Plant.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: B.C.BERLIN CONSULTANTS GMBH D1000 BERLIN10 West Germany

SYSTEM: Accelerated Windrowing (Siloda Wheel)

ELEMENTS OF SYSTEM: Shredding - Fermentation - Maturation - Refining

NUMBER OF FLOW-LINES: TWO

QUALITY:

a - Technical Documents: Excellent - comprehensive but concise
b - Site Layout: Excellent - makes good use of site
c - Machinery Layout: Excellent - compact and simple
d - Buildings: Good

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 94

PROCESSING DATA:

a - Design throughput (8hr/day): Refuse only but option for sludge and 16 hour operation
b - Rejects (% w/w throughput);

Non-compostible in feedstock:	20
Mechanical extraction loss:	12
Total Rejects:	32

c - Compost processing loss (%w/w throughput): 14
d - Total yield of compost (%w/w throughput): 54
f - Processing time (days):

Fermentation:	8
Maturation & Curing:	42
Total Production Time:	50

g - Storage facilities for Product (months): 5
h - Constructional Period (contract to Commercial Operation in months) 20
i - Processing liquid (litres per hour): 30,500
j - Electricity Kwh (8hr day): 13.400
k - Pulveriser Mill Maintenance:

Number of Hammers:	30
Tonnage use between change:	2500 (7 days)
Life of Hammers (tonnes):	25000 (3 months)
Labour to change (man/hrs)	8

l - Total Personnel: 56

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - This is an excellent, efficient and flexible system and the scheme is well prepared.

b - The accelerated windrowing system is one of the best currently available.

c - The pulveriser mills are the most popular type in use for shredding refuse - they are highly efficient and very reliable.

c -The maturation and curing system employs pile forming and withdrawing machines which enable stock-piles to be formed to a height of 7 metres thus ensuring a tremendous saving in the use of site area and in the area of paved surface .

d - The rejects from the refining unit are returned to the inlet of the plant - thus ensuring the meximum yield of compost, and the smallest quantity of rejects.

MAJOR OMISSIONS IN TECHNICAL SUBMISSION

Sludge Feedstock is not included in basic design but is given as an / option

GENERAL ASSESSMENT

a - Subject to the inclusion for the processing of semi dried sewage sludge of the option detailed in the submission, this is a very excellent scheme which meets all the requirements for an economical, efficient, flexible and reliable composting plant.

b - The following matters must be considered:

i - The provision of a dust aspiration system giving 15 air changes per hour to be provided in the reception house. Adequate fly and insect electrecutors to be also provided.

ii - The Bulk Transport Vehicles to be of the type specified.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: BUHLER Uzwill SWITZERLAND

SYSTEM: Accelerated Windrow.

ELEMENTS OF SYSTEM: Shredding - Screening - Mixing - Fermentation/Curing

NUMBER OF FLOW-LINES: TWO

QUALITY:

a - Technical Documents: Excellent and comprehensive
b - Site Layout: Excellent Only 50 per cent site area utilised.
c - Machinery Layout: Excellent.
d - Buildings: Good

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 95

PROCESSING DATA:

a - Design throughput (8hr/day): As specified

b - Rejects (% w/w throughput);

Non-compostible in feedstock:	21.5 (Buhlers Data)
Mechanical extraction loss:	7.0
Total Rejects:	28.5

c - Compost processing loss (%w/w throughput): 17.7

d - Total yield of compost (%w/w throughput): 53.8

f - Processing time (days):

Fermentation:	) 43	(joint process)
Maturation & Curing:	)	
Total Production Time:	43	

g - Storage facilities for Product (months): 5

h - Constructional Period (contract to Commercial Operation in months) 27

i - Processing liquid (litres per hour): 21,100

j - Electricity Kwh (8hr day): 12,000

k - Pulveriser Mill Maintenance:

Number of Hammers:	24
Tonnage use between change:	2,500 (7 day
Life of Hammers (tonnes):	10000 (one month)
Labour to change (man-hrs)	12

l - Total Personnel: Not given - In envelope 3

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a. This is an excellent well planned scheme suitable in every respect to meet the requirements of Damascus.

b - The PulveriserShredders are very efficient double rotor mills.

c - Fermentation is in windrow which are set up and turned by efficient windrow turning machines which can be (optionally) automatically operated. The windrows are turned five times in six weeks during which process forced aeration is operated.

MAJOR OMMISIONS IN TECHNICAL SUBMISSION

a - No details of personnel required to operate the plant.

GENERAL ASSESSMENT

a - There are a number of matters where compliance with the specification is desirable :

1 - The Bulk Transport Vehicles do not meet requirements

2.- The Loading Shovelare of a typewhich do not comply with requirements;

i - The buckets are 2.5M^3 instead of 3M^3
ii - They have not four wheel drive
iii - The buckets are without retaining clamps
iv - The cabs are not air conditioned

3,- The ReceptionHouse is well planned but has multiple doors at the front. It should be totally enclosed with an access and an exit door.

4 - There is no indication if the stock-pile area is to be properly paved and surfaced

5. The site layout should provide parking for heavy vehicles near potential congestion points.

6 Vehicular access is required to the sewage works site.

b - There are several optionsall of which should be seriously considered

i - The provision of special equipment for feeding semi-dried sludge to the compost plant.

ii - The provision of a reserve windrow turning machine

iii - Automatic operation of windrow turning machines.

NOTE: This is the only tenderer which has carried out comprehensive technical investigations in Damascus before preparing the scheme. These investigations have included detailed refuse analysis.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: DANECO Buttrio ITALY

SYSTEM: Static Windrow in Open Air (Extend ed Pile Forced Aeratio.

ELEMENTS OF SYSTEM: Picking Belt, Grinders, Screens, Shears, Mixers - Fermentation - Maturation - Refining

NUMBER OF FLOW-LINES: Pre-treatment Plant FOUR Remainder TWO

QUALITY:

a - Technical Documents:	Well prepared but verbose
b - Site Layout:	Satisfactory
c - Machinery Layout:	Excessive machinery and conveyors
d - Buildings:	Good

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 90

PROCESSING DATA:

a - Design throughput (8hr/day): As Specified

b - Rejects (% w/w throughput);

Non-compostible in feedstock:	24 (Daneco Data)
Mechanical extraction loss:	11
Total Rejects:	35

c - Compost processing loss (%w/w throughput): 20

d - Total yield of compost (%w/w throughput): 45

f - Processing time (days):

Fermentation:	28
Maturation & Curing:	60
Total Production Time:	88

g - Storage facilities for Product (months): 5

h - Constructional Period (contract to Commercial Operation in months)27

i - Processing liquid (litres per hour): 70000

j - Electricity Kwh (8hr day): 19,800

k - Pulveriser Mill Maintenance:

Number of Hammers:	Shredder Mills
Tonnage use between change:	not employed
Life of Hammers (tonnes):	
Labour to change (man/hrs)	

l - Total Personnel: 47

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - This is by far the most highly mechanised of all the submitted schemes.

b - Its requirements of processing liquid and of electricity are substantially higher than for any other scheme.

c - The fermentation units (in the open air) require intermittent forced aeration 24 hour per day at a stated rate of 234,000 M^3 per hour. The units contain considerable feeder equipment and compost removal equipment. It is notable that after fermentatic a long period (60 days) of maturation is necessary - This does NOT suggest highly efficient fermentation.

d - The pre-treament section does not use standard pulveriser mills - instead grinder crushers and rotary shears are used. This requires two machines to carry out the task which one pulveriser can do. The capacity of the machines is such that FOUR feeder hoppers, four picking belts, four grinder crushers and four rotary shears are used - These could be replaced by two efficient pulveriser mills. The desirability of proper shredding is stated in Para 6.13

MAJOR OMMISIONS FROM TECHNICAL SUBMISSION

None

GENERAL ASSESSMENT

a. Irrespective of the system of fermentation this scheme is too highly mechanised, and it requires excessive inputs of processing liquid and electricity.

b. The fermentation units are of the static windrowing system (see para 6.7) and they could not easy be amended to the accelerated fermentation system, as no fermentation hangars are provided.

c. Other items which do not satisfy the specifications are:

i - The reception house is not provided with adequate fly and insect electrecutor,

ii - The Bulk Transport Vehicles are not of the type specifiec

iii - The number of loading shovels appears inadequate and none are fitted with bucket retaining clamps.

NOTE: It is stated that a composting plant of large capacity has been constructed some years ago in Dubai. It is stated to be substantially of this design. I have not been able to obtain any information regarding this although I know the situation in Dubai extremely well. I am sure that Mr Kamel Hammsa, the Director of Dubai Municipality would give any information regarding this on request. His Telex is Code 0892 - 45688 Baldyia.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: DEGREMONT S.A. RUEIL MALMAISON cedex France

SYSTEM: Enclosed Digester (Triga Fermentation Towers) (Hazemag Mills)

ELEMENTS OF SYSTEM: Shredding - Screening - tower digestion - standard windrow (open air) maturation, Curing - Refining.

NUMBER OF FLOW-LINES: 2 Shredders - 4 Towers - 4 Screens - 8 lines in Refining Unit

QUALITY:

a - Technical Documents:	Comprehensive
b - Site Layout:	Well planned
c - Machinery Layout:	Good but excessive conveyors
d - Buildings:	Good

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 94 per cent

PROCESSING DATA:

a - Design throughput (8hr/day): As Specified

b - Rejects (% w/w throughput);

Non-compostible in feedstock:	20
Mechanical extraction loss:	16.5
Total Rejects:	36.5

c - Compost processing loss (%w/w throughput): 14 (Stated 5% but clearly incorrect)

d - Total yield of compost (%w/w throughput): 49.5

f - Processing time (days):

Fermentation:	4 (in tower)
Maturation & Curing:	48
Total Production Time:	52

g - Storage facilities for Product (months): 5 months

h - Constructional Period (contract to Commercial Operation in months): not stated

i - Processing liquid (litres per hour): 60,000

j - Electricity Kwh (8hr day): 25,000

k - Pulveriser Mill Maintenance:

Number of Hammers:
Tonnage use between change:
Life of Hammers (tonnes):
Labour to change (man/hrs)
Data not supplied

l - Total Personnel: 36

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - The scheme uses four digester towers in which feedstock is retained for four days (the minimum should be five) it is then placed into open air windrows which are mechanically turned at

intervals during a period of 42 days. It is then cleaned, refined and graded in a unit which consist s of EIGHT flow-lines

It is unlikely that fermentation is complete when the material is placed in windrow where the process is completed. In view of the standard windrowing system (if this was extended the towers and associated machinery would be superfluous)

MAJOR OMMISIONS IN TECHNICAL SUBMISSION

a - Time Schedule for construction and completion of Composting Plant

b - Hammer Mill details as required by Specification 5.3

GENERAL ASSESSMENT

a - There is some inaccuracy in the design calculations - The figure stated for Compost Processing Loss of 5% of the Feedstock is obviously inaccurate. A more reasonable figure is 14% with the following result:

> The figure stated by Degremont for compost yield is reduced from 58.5 per cent of throughput to 49.5 per cent of throughput.

b - The gradual increase in the flow-line pattern from TWO flow-lines at the Shredder Mills, to four flow lines at the towers and screens and further to Eight flow lines at the refining unit results in an excessive amount of machinery and long and numerous conveyor systems. Despite this the material leaving the screens is intended to be moved to the windrow area by loading shovel.

c - The scheme is well presented but it is too highly mechanised to meet the desirable requirements of Damascus. Maintenance and operation will require highly skilled personnel, and the system is too in-flexible to meet changing circumstances.

It is expensive in power consumption (air blowers to towers operat 24 hours each day), water consumption is heavy also.

d - If consideration is given to adopting this scheme certain matters require attention:

- a - The site layout to providevehicle parking and also vehicular access to sewage works site;
- b - A septic tank system be substituted for the specialis sewage treatment plant included in the submission;
- c - The Bulk Transportation Vehicles and the Loading Shovels must strictly comply with the specification;
- d - The transfer of material from the screens to windrows should be conducted more efficiently than by loading shovel

I must emphasis that despite the quality of the presentation I cannot reccomend this scheme as being suitable for the circumstances in Damascus.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: MILLHOUSE DAMASCUS — BASIC SHEME

SYSTEM: Standard Windrowing (Open-air)

ELEMENTS OF SYSTEM: Shredding and fermentation/maturation in windrow followed by refining.

NUMBER OF FLOW-LINES: THREE

QUALITY:

a - Technical Documents: Competant and comprehensive

b - Site Layout: Good but access point presents problems.

c - Machinery Layout: Essentially simple but type of pulveriser and 3 lines make /complications.

d - Buildings: Good.

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 88 per cent

PROCESSING DATA:

a - Design throughput (8hr/day): Designed only for refuse - no sludge

b - Rejects (% w/w throughput);

Non-compostible in feedstock:	20
Mechanical extraction loss:	5
Total Rejects:	25

c - Compost processing loss (%w/w throughput): 20

d - Total yield of compost (%w/w throughput): 55

f - Processing time (days):

Fermentation: / Maturation & Curing:	90 (joint)
Total Production Time:	90

g - Storage facilities for Product (months): Limited

h - Constructional Period (contract to Commercial Operation in months) 25

i - Processing liquid (litres per hour): 20,000

j - Electricity Kwh (8hr day): 10,500

k - Pulveriser Mill Maintenance:

Number of Hammers:	96
Tonnage use between change:	1500 (5 days)
Life of Hammers (tonnes):	Not given
Labour to change (man/hrs)	4

l - Total Personnel: 50

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - This is an extremely simple open air windrowing system where the only pre -treatment of feedstock is shredding and metal removal.

b - Fermentation is by means of standard open-air windrows which are mechanically turned three times during the first month and once during the second. The compost stays in the windrows until the end of maturation. The site area allocated for windrowing appear to be inadequate.

c. Moisture adjustment of feedstock is done by the windrow turning machine at the time it is operating its programme of windrow turns. No moisture is added until 10 days after the feedstock is deposited This is very unsatisfactory (See para 6.8.)

d - It might be an excellent system for a small scheme, but it is not suitable to meet the requirements of Damascus. It is wasteful of land and necessitates extensive paved and surfaced areas to accommodate the windrows.

MAJOR OMISSIONS FROM TECHNICAL SUBMISSION

The plant does not include the sewage sludge feedstock prescribed.

GENERAL ASSESSMENT

a - The pre-treatment section is very complicated, This arises from the size and the type of the pulveriser mills which necessitates THREE flow-lines and three discharge lines. The height of the mill makes it difficult to instal it at a height to enable the shredded waste to be discharged into vehicle underneath or nearby.. Long conveyors are therefore used to supply shredded waste to three satellite vehicle filling stations.

The use of a larger capacity mill could have reduced the flow lines to two with considerable benefit. The use of a vertical rotor mill (because of its reduced height) would have enabled it to have been installed so as to feed direct into vehicles beneath or nearby.

b - The Reception House does not comply with the Specification as it is not totally enclosed. It is a complicated arrangements at two levels Vehicles discharge their loads from an upper platform and this falls into a room below fromwhere it is fed by loader shovels into the mill feed hopper. This hopper requires all refuse to be lifted at least three metres. This will dramitically reduce the feeding efficiency compared with a feed at floor level. The loaders have to operate at a level beneath that at which refuse is discharged with all the consequent danger that implies.

C - The Bulk Transport Vehicles and the Loading Shovels do not comply with Specification. The loaders require air-conditioned cabs and retaining clamps to buckets.

d. The throughput of the plant is restricted to 700 tonnes day of refuse No provision is made to receive sludge.

e. The conveyor system in the refining unit appears to be too complicated.

f - The Site Layout indicates access to the site from the sewage works site. For convenience it should be near the north west corner.

g - The proposals are not clear about intentions regarding the paving and surfacing of the areas to be used for windrowing.

i - The site area allocated for windrowing purposes appears to be inadequate.

NOTE: This scheme can not be recommended to satisfy the requirements of efficiently and economically processing the throughput specified Complete revision to provide more suitable pulverisers and a accelerated fermentation system would be necessary to make it technically acceptable.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: MILIHOUSE, Damascus, Syria - No 1 ALTERNATIVE SCHEME

NOTE This scheme is the same as the basic except for deep bunker reception

SYSTEM: Standard Windrowing (Open-air)

ELEMENTS OF SYSTEM: Shredding and fermentation/maturation followed by refining.

NUMBER OF FLOW-LINES: THREE

QUALITY:

a - Technical Documents: Competent and comprehensive

b - Site Layout: Good but access may cause problems

c - Machinery Layout: Simple but type of pulveriser and three flow-line creates complications

d - Buildings: Good

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 86 per cent

PROCESSING DATA:

a - Design throughput (8hr/day): Designed only for refuse - no sludge

b - Rejects (% w/w throughput);

Non-compostible in feedstock:	20
Mechanical extraction loss:	5
Total Rejects:	25

c - Compost processing loss (%w/w throughput): 20

d - Total yield of compost (%w/w throughput): 55

f - Processing time (days):

Fermentation:	90 Joint
Maturation & Curing:	
Total Production Time:	90

g - Storage facilities for Product (months): 5.

h - Constructional Period (contract to Commercial Operation in months) 25

i - Processing liquid (litres per hour): 20,000

j - Electricity Kwh (8hr day): 10,500

k - Pulveriser Mill Maintenance:

Number of Hammers:	96
Tonnage use between change:	1500 (5 days)
Life of Hammers (tonnes):	not given
Labour to change (man/hrs)	4 .

l - Total Personnel: 50

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - This is an extremely simple system of open air windrow composting in which the only treatment of feedstock is shredding and metal removal.

Sheet 2 MILLHOUSE ALTERNATIVE SCHEME 1.

b -, Fermentation is in windrows which are turned three times in the first month and once in the second. The material remains in windrow until it is mature after a period of 90 days.

c. Moisture adjusment is made during the windrow turning. The first application being 10 days after deposit. This is very unsatisfactory (see para 6.8)

d - The system might be suitable for a small plant but it is quite inadequate to satisfy the requirements in Damascus. It is wasteful of land and requires extensive areas of paved and surface windrow processing site. The windrow site area appear to be inadequate.

MAJOR OMISSION FROM TECHNICAL SUBMISSION

The plant does not include the prescribed sewage sludge feedstock.

GENERAL ASSESSMENT

a - The only difference between this scheme and the basic scheme is reception arrangements. In this scheme it is proposed to provide TWO deep reception bunkers of 1500M^3 each and use a Crane Grab to feed two mill feed hoppers from the bunkers.
The bunkers do not comply with the Specification which limits the depth to 6 metres. These bunkers are 11 mtres deep.

The Reception House itself does not comply as it is NOT totally enclosed, the whole of the front being a series of doors. (see para 6.16)

b - The pre-treatment section is complicated by the fact that the size of the pulveriser mill necessitates THREE flow lines and three discharge lines. The height of the mill makes it difficult to install it at a height to enable shredded waste to be discharged into a vehicle beneath or close by. Long conveyor have therefore to be used to supply shredded waste to THREE satekite Vehicle Feeding Stations.

Larger capacity mills would have reduced the flow-lines to TWO, and a vertical rotor mill (which is of limited height, would have enable it to have been installed at a height whereby shredded waste could be discharged to vehicles underneath or nearby.

c The Bulk Transport Vehicles and the Loading Shovels do not comply with the Specification.

d The Plant will only process 700 tonnes day of refuse - No provision is made for sewage sludge,

e. The conveyor system in the refining unit is too complicated

f The Site Layout shows the access from the sewage works site. For convenience it should be near the north wet corner.

No provision has been made for parking heavy vehicles near to potential congestion points.

g The proposals are not clear about intention regarding the paving and surfacing of areas to be used for windrowing.

i - The windrow site area appears to be inadequate.

NOTE: On technical grounds and for reasons of operational reliability this scheme cannot be recommended. To make it technically acceptable it will require major revision including the provision of more suitable pulverisers and the adoption of some system of accelerated windrowing.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: MILIHOUSE, Damascus, Syria ALTERNATIVE SCHEME No 2

SYSTEM: Enclosed Ssystem using Rotary Drum Digesters.

ELEMENTS OF SYSTEM: Crude Refuse fed to Rotary Drums - Windrow(open) fermentation/maturation followed by Refining.

NUMBER OF FLOW-LINES: SIX Rotary Digester Drums (44m x 4.25m dia) (SORBEA SYSTEM)

QUALITY:

a - Technical Documents: Competent and Comprehensive

b - Site Layout: Good but access to site may cause problems

c - Machinery Layout: Sophisticated

d - Buildings: Good

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 90 per cent

PROCESSING DATA:

a - Design throughput (8hr/day): Designed only for refuse - no sludge

b - Rejects (% w/w throughput);

Non-compostible in feedstock:	20
Mechanical extraction loss:	10.5
Total Rejects:	30.5

c - Compost processing loss (%w/w throughput): 19,5

d - Total yield of compost (%w/w throughput): 50

f - Processing time (days):

Fermentation:	3
Maturation & Curing:	57
Total Production Time:	60

g - Storage facilities for Product (months): 6

h - Constructional Period (contract to Commercial Operation in months) 25

i - Processing liquid (litres per hour): 10,000

j - Electricity Kwh (8hr day): 9,100

k - Pulveriser Mill Maintenance:

Number of Hammers:
Tonnage use between change: No Shredders installed
Life of Hammers (tonnes):
Labour to change (man/hrs)

l - Total Personnel: 31

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - This system uses SIX rotary Drum Digesters to act as "wet pulverisers to effect moisture adjustment and entrain oxygen in the feedstock, and generally to start the fermentation process. The retention time is restricted to THREE days (See Para 6.5.)

b - The material after removal from the Digester Drums is then subjected to standard windrowing in the open-air exactly as in the case of the Basic Scheme and Alternative Scheme No 1. It remains in windrow for a period of 57 days.

NOTE: The rotary drums operate continuously 24 hours each day The maximum speed is 1 RPM. The internal air supply and humidity correction must continue at all times.

OMISSIONS FROM TECHNICAL SUBMISSION

a - Data required by Specification 5.8. regarding the methods to control or prevent the formation within the rotary drums of long "suasages" of fibrous material and textiles, and how frequently these require removal, have not been supplied.

b - No provision for processing sewage sludge.

GENERAL ASSESSMENT

a - There would appear to be no logical reason for using this inflexible and very sophisticated system (See Para 6.5.)

b - The retention period within the rotary drums does not complete fermentation. The process has only realy started when the feedstock is placed in open air windrows. It may be claimed that the rotary drum renders the use of pulveriser mills obselete as it reduces the feedstock by "wet pulverisation". Wet processing is never as effective as positive shredding.

c. The Reception arrangements have again been altered in this scheme A single large bunker of 3000 M^3 capacity and 10 metres deep is proposed. There are no indepenant feed hopper whereby the bunker can be by-passed. The feedstock is fed directly by crane grab into elevated feed hoppers supplying the rotary drums. The bunker does not comply with the Specification which limits the depth to 6 metres and requires feed arrangements which by-pass the bunker. The Reception House does not comply as it is not a TOTALLY enclosed building .

d The Bulk Transport Vehicles and the Loading Shovels do not comply with the Specification.

e. The conveyor system in the Refining House appears to be unduly complicated

f. The site Layout indicates the access to the site from the sewage works site. For convenience it should be near the north west corner.

No provision has been made for heavy vehicle parking near to potential congestion points.

g The proposals are not clear about intentions regarding the paving and surfacing of the areas to be used for windrowing.

h I do not regard this scheme as being suitable to satisfy the requirements of Damascus.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: SIGOUR Frères s.a. 43309 ROANNE, France

SYSTEM: Standard Open-air windrows using mobile turning machines

ELEMENTS OF SYSTEM: Shredding - Screening- Fermentation - Refining - Curing

NUMBER OF FLOW-LINES: FOUR Milling Lines

QUALITY:

- **a - Technical Documents:** Poor
- **b - Site Layout:** Average -no exceptional features
- **c - Machinery Layout:** Average
- **d - Buildings:** Average

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 60%

PROCESSING DATA:

- **a - Design throughput (8hr/day):** As Specified
- **b - Rejects (% w/w throughput);**
  - **Non-compostible in feedstock:** 20%
  - **Mechanical extraction loss:** 20%
  - **Total Rejects:** 40%
- **c - Compost processing loss (%w/w throughput):** Stated as NONE - but calculated as 18%
- **d - Total yield of compost (%w/w throughput):** Stated 60% but calculated as 46%
- **f - Processing time (days):**
  - **Fermentation:** 42
  - **Maturation & Curing:** 90
  - **Total Production Time:** 132
- **g - Storage facilities for Product (months):** 3
- **h - Constructional Period (contract to Commercial Operation in months):** Not stated
- **i - Processing liquid (litres per hour):** 21,500
- **j - Electricity Kwh (8hr day):** 15,500
- **k - Pulveriser Mill Maintenance:**
  - **Number of Hammers:**
  - **Tonnage use between change:**
  - **Life of Hammers (tonnes):**
  - **Labour to change (man/hrs)**

  Data not supplied
- **l - Total Personnel:** 42

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - This appears to be a scaled up version of a smaller scheme

b - It provides FOUR flow lines with 4 pulveriser mills and

in consequence the number of conveyors and units of machinery are greater in number than would be necessary with a strictly twin Flow-Line installation.

c Fermentation is to be effected by retaining the feedstock for six weeks in 3 mtre high windrows in the open air. The windrows will be mechanically turned at 14 day intervals. This period is far too long and the interval between turnings should not exceed SEVEN days.

d - The specified output of the Windrow Turning Machines in the Technical Documents is conflicting. different values being given in different places 120 and 90 tonnes per hour respectively. Calculations made on the higher output figure indicates that the proposed THREE WINDROW TURNING MACHINES are inadequate to completelyfulfil the task and a FOURTH machine is essential.

MAJOR OMMISIONS IN THE TECHNICAL SUBMISSION

a - MANY requirements of the Specification Book have been ignored or have not been fully observed.

b - The Reception Hall does not comply with requirements as it is NOT a TOTALLY enclosed building.

c - The Design Criteria used by the Contractor as contained in Technical Data Sheet No 1 contains some important inaccuracies. The stated figures for yield of compost are clearly incorrect. The correct figure being much lower than the stated one.

d - The Transport Vehicles and the Loading Shovels do not conform with specified requirements.

GENERAL ASSESSMENT

a - The scheme is poorly presented, and much of the design data is of questionable accuracy so that it is not possible to have any confidence in the proposals.

b - The FOUR flow-lines complicates the plant layout and operationally it is not desirable to have so many un-necessary units of machinery.

c - The Open Air Windrow Fermentation system is wasteful of site area and is only of mediocre quality.

d - The tenderer has prescribed a limit to the guarantee period of SIX MONTHS

e - The training of personnel is inadequate providing only for two months overseas training for each of two persons

GENERAL CONCLUSIONS

On technical grounds I cannot reccommend this scheme for adoption and any amendment of the scheme by reduction of the number of flow lines would not materially improve its efficiency.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: SNAPROGETTI 61032 FANO ITALY

SYSTEM: Static Windrowing (extended pile forced aeration)

ELEMENTS OF SYSTEM: Shredding - Screening Mixing - Fermentation - Maturation - Refining

NUMBER OF FLOW-LINES: TWO

QUALITY:

a - Technical Documents: Excellent

b - Site Layout: Very good but greater space for extension between buildings is needed

c - Machinery Layout: Excellent

d - Buildings: Satisfactory

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 99 per cent

PROCESSING DATA:

a - Design throughput (8hr/day): As specified

b - Rejects (% w/w throughput);

Non-compostible in feedstock:	20
Mechanical extraction loss:	8
Total Rejects:	28

c - Compost processing loss (%w/w throughput): Refuse alone 33.5 With Sludge 17

d - Total yield of compost (%w/w throughput): Refuse 38.5 With Sludge 55

f - Processing time (days):

Fermentation:	21
Maturation & Curing:	49
Total Production Time:	70

g - Storage facilities for Product (months): 5

h - Constructional Period (contract to Commercial Operation in months) 21

i - Processing liquid (litres per hour): 15,000

j - Electricity Kwh (8hr day): 12,570

k - Pulveriser Mill Maintenance:

Number of Hammers:	30	
Tonnage use between change:	2500	(7 days)
Life of Hammers (tonnes):	25,000	(3 months)
Labour to change (man/hrs)	8	

l - Total Personnel: 39

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - Except for the adoption of static composting (by extended pile forced aeration) this is an excellent scheme.

SNAPROGETTI 2

MAJOR OMISSION FROM TECHNICAL SUBMISSION

None

GENERAL ASSESSMENT

a - This is a very good scheme but for absolute reliability (See para 6.7 the scheme should be modified to provide the windrows with efficient turning machines which would result in a reduction in the size of the fermentation hangars, and reduce the time of the fermentation process.

b - The option stated in the submission for providing a conveyor feed from the pre-treatment units to the fermentation hangars, and also providing overhead spreaders should be seriously considered The basic method is to move and spread the material with dumper trucks and loading shovels.

c - The transport is generally in conformity with the Specifications except that only ONE loading shovel is provided with the special refuse bucket and clamp - all machines of this type should be the same.

d - The Reception House is well designed except for the provision of multiple Doors at the front. To make it totally enclosed only TWO doors should be provided namely an entry and an exit.

e - Some of the processing buildings are relatively close together and this would cause problems should extensions be needed.

f - Site parking for heavy vehicles should be provided near potential congestion points, and a vehicular access be provided to the sewage works site.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: THYSSEN ENGINEERING GMBH — **VARIANT SCHEME No 1**

SYSTEM: Static Windrowing

ELEMENTS OF SYSTEM: Picking Belt - Iron Removal -Shredding - Mixing - Fermentation - Maturation - Refining.

NUMBER OF FLOW-LINES: TWO (but two mixer drums to each line)

QUALITY:

a - Technical Documents:	Excellent.
b - Site Layout:	Satisfactory.
c - Machinery Layout:	Good.
d - Buildings:	Satisfactory.

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 89 per cent

PROCESSING DATA:

a - Design throughput (8hr/day): As specified.

b - Rejects (% w/w throughput);

Non-compostible in feedstock:	20
Mechanical extraction loss:	13.5
Total Rejects:	33.5

c - Compost processing loss (%w/w throughput): 15.9

d - Total yield of compost (%w/w throughput): 50.6

f - Processing time (days):

Fermentation:	18
Maturation & Curing:	48
Total Production Time:	66

g - Storage facilities for Product (months): 5

h - Constructional Period (contract to Commercial Operation in months) 22

i - Processing liquid (litres per hour): 60,000

j - Electricity Kwh (8hr day): 10,200

k - Pulveriser Mill Maintenance:

Number of Hammers:	60
Tonnage use between change:	Data not supplied
Life of Hammers (tonnes):	Data not supplied
Labour to change (man/hrs)	12

l - Total Personnel: 32

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - The fermentation is conducted in two hangars with under floor ducts for static windrowing through which air is blown 24 hrs per day at a variable rate up to 30,000 M^3 per hour.

The feedstock is distributed in the fermentation sheds by means of overhead gantry bridge distributors. The feedstock occupies one continous stock-pile 3 m high and with a volume of 15,000 m^3.

b- After a period of 18 days the material is removed by loading shovel to the maturation area where it remains for a further 48 days. It is then taken to the refining unit by loading shovel.

MAJOR OMISSIONS FROM TECHNICAL SUBMISSION

a - Data relating to hammer mill wear required by the Specification has not been supplied.

GENERAL ASSESSMENT

a - This scheme has been well presented.

b - This system of static windrowing should only be adopted after confirmation of a successful LARGE composting plant using the system (see para 6.7 pages 17 and 18)

c - To ensure absolute reliability it is desirable that the system be converted to an accelerated windrow process. This can readily be done by providing a proper number of suitable compost windrow turning machines, and by reducing the area of the fermentation hangars, (as by reason of a shorter fermentation period the proposed capacity would be excessive).

Othe matters which require attention are:

1 - The type of hammer mill suggested does not appear to be very efficient. The alternate suggestion of substituting coarse crushers for pulveriser mills should not be considered (see Para 6.13 page 21) The pre- treatment unit would be greatly increased in efficiency if vertical rotor hammer mills were installed. This would then eliminate the proposals to provide picking belts and metal extraction on the flow lines prior to the mills; picking and iron extraction before shredding is not desirable.

2 - The Reception House does not comply with the Specification as it provides 11 doors at the front. These should be eliminated to ensure a TOTALLY enclosed reception hall.

3. The proposal to transport process material within the plant by means of loading shovel is a very inefficient method. The use of dumper trucks should be considered.

4 - The types of Bulk Transport Vehicle and Loading Shovel do not comply with specification. Some of the loading shovels are of different power from others - they should all be interchangable.

5. It would appear the the number of vehicles and mobile equipment to be supplied is somewhat inadequate. This matter should be determined and rectified.

6 - The site layout should be amended to provide parking at congestion points for heavy vehicles, and also access to the sewage works site.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: THYSSEN ENGINEERING GMBH (VARIANT SCHEME No 2)

SYSTEM: Enclosed Fermentation (Rotary Digester Drums)

ELEMENTS OF SYSTEM: Picking Belt - Ironremoval -Shredding - Tower Digester Maturation - Refing - Storage.

NUMBER OF FLOW-LINES: TWO (but 4 Rotary Digester Drums -40m x 4mdia

QUALITY:

a - Technical Documents:	Excellent
b - Site Layout:	Generally Satisfactory
c - Machinery Layout:	Reasonable
d - Buildings:	Satisfactory

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 90 per cent

PROCESSING DATA:

a - Design throughput (8hr/day): As specified

b - Rejects (% w/w throughput);

Non-compostible in feedstock:	23
Mechanical extraction loss:	14
Total Rejects:	37

c - Compost processing loss (%w/w throughput): 21

d - Total yield of compost (%w/w throughput): 42

f - Processing time (days):

Fermentation:	12 (24hrs in Drums)
Maturation & Curing:	40
Total Production Time:	52

g - Storage facilities for Product (months): 5

h - Constructional Period (contract to Commercial Operation in months) 22

i - Processing liquid (litres per hour): 45,000

j - Electricity Kwh (8hr day): 12,600

k - Pulveriser Mill Maintenance:

Number of Hammers:	60
Tonnage use between change:	) Data not supplied
Life of Hammers (tonnes):	)
Labour to change (man/hrs)	12

l - Total Personnel: 32

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - In placeof the mixer drums in Scheme Variant No 1 4 large rotary digester drums are substituted in which the feedstock has a retention period of 24 HOURS - The material is then taken to the same

type of fermentation hangar as for Variant Scheme No 1 but some forty percent less in area. It remains here for 17 days to"complete" the fermentation, and then goes to maturation stockpiles where it stays for a further40 days. The saving in production time between the two schemes is claimed to be 14 days.

b. The function of the rotary digester drums appears to be the thorough moisture adjustment andoxygen saturation of the feedstock. Para 6.5 indicates that the fermentation process can not have progressed to any great extent in a period of twenty four hours.

c. The advantages to be derived from this system compared with Variant Scheme No 1 appear to be economically doubtful.

d - ALL the observations given under this heading in respect of Variant Scheme No 1 apply equally to this scheme.

MAJOR OMISSIONS FROM TECHNICAL SUBMISSION

a - Data relating to hammer mill wear required by the Specification have not been supplied.

b - Data requested by The Specification 5.8. regarding the methods to control or prevent the formation within the rotary drums of long "sausages" of fibrous material and textiles, and how frequently these require removal, have not been supplied.

GENERAL ASSESSMENT

a - The whole of the observations in respect of Variant Scheme No 1 under this heading apply equally to this scheme.

b - No operational advantage can be assessed which will justify this scheme using rotary drum digesters.

TECHNICAL ANALYSIS AND EVALUATION OF COMPOSTING SCHEME

TENDERING FIRM: O.T.V. COURBEVOIE cedex France

SYSTEM: Accelerated Windrow System ("Siloda Wheel") in Fermentation /Hangar.

ELEMENTS OF SYSTEM: Shredding - Fermentation - Curing - Refining.

NUMBER OF FLOW-LINES: Two

QUALITY:

a - Technical Documents:	Comprehensive and competant
b - Site Layout:	Excellent
c - Machinery Layout:	Simple and uncomplicated.
d - Buildings:	Excellent

COMPLIANCE WITH 90 SPECIFICATION ITEMS (per cent): 93%

PROCESSING DATA:

a - Design throughput (8hr/day): Specified Refuse throughput- NO SLUDGE

b - Rejects (% w/w throughput); 20%

Non-compostible in feedstock:	20%
Mechanical extraction loss:	12%
Total Rejects:	32%

c - Compost processing loss (%w/w throughput): 14%

d - Total yield of compost (%w/w throughput): 54%

f - Processing time (days):

Fermentation:	8
Maturation & Curing:	42
Total Production Time:	50

g - Storage facilities for Product (months): 5

h - Constructional Period (contract to Commercial Operation in months) 36

i - Processing liquid (litres per hour): 30,500

j - Electricity Kwh (8hr day): 13,400

k - Pulveriser Mill Maintenance:

Number of Hammers:	30	
Tonnage use between change:	2500	(7 days)
Life of Hammers (tonnes):	25000	(3 months)
Labour to change (man/hrs)	8 man/hours	

l - Total Personnel: 56

TECHNICAL OBSERVATIONS ON COMPOSTING SYSTEM

a - This is a very efficient and flexible system and the scheme is well prepared.

O.T.V. 2.

b. The fermentation system is one of the best currently available.

c. The pulverisers mills are of the most popular of the types in use, they are highly efficient and very reliable.

d. The maturation and curing system by use of pile forming and withdrawing equipment enables stockpiles to be formed up to 7 metres in height with consequent saving of site area and paved surfaces.

d. The scheme includes the provision of twoweighbridges instead of the minimum one required in the Specification Book.

MAJOR OMMISIONS IN THE TECHNICAL SUBMISSION

a - The design is based on the throughput of REFUSE only and does not include the 300 tonnes per day of 66.6% w/w moisture content sewage sludge.

2. Personnel Requirements (May be in Envelope 3) .
NOTE: Data given for comparative purposes taken from an identical scheme submitted by another tenderer.

GENERAL ASSESSMENT

a - Subject to the inclusion of the specified sewage sludge (which could be agreed by negotiation) this is an excellent scheme which will be economical, efficient, flexible and reliable in operation.

b - The following matters require amendment in any final scheme:

1. The layout requires amendment to provide on-site parking for delivery and collection vehicles.

2 . The Reception Hall must be provided with a Dust Aspiratio System which will provide 15 air changes each hour.

3. The Transport Vehicles must conform to Specification 5.10.

OPTIONS OFFERED IN SUBMISSION

a - Deep Bunker Reception Pits These are not necessary. They will be costly having regarding to the high ground water table.

b - Roofing of Maturation Area This is not necessary. Stockpiled mature compost quickly forms its own protective and insulating surface layer of about 20 cm in depth which resists de-hydration and prevents rainwater gaining entry.

9. SUMMARY - CONCLUSIONS

9.1. Fourteen schemes have been examined, and one of the submissions substantially consisted of two schemes (Bartolomeis) by reason of an optional variation.

9.2. The schemes consist of the following types (see paras 6.4 to 6.7)

3 - Open Windrow
5 - Static Windrow (extended pile forced aeratio
4 - Accelerated Windrow
2 - Enclosed - Rotary Digester Drum
1 - Enclosed - Digester Tower.

9.3 To meet the desirable requirements for a composting plant of the throughput capacity proposed for Damascus the following are important factors.

a - The plant will reliably process the designed throughput in an eight hour shift.

b - Each of the flow-lines shall be capable of maintaining production by extended hours of operation in the event of other flow lines being temporarily cut of action.

c - The system of fermentation shall be POSITIVE in operatio and flexible to meet wide variations in feedstock composition. It should not require any manual or mechanical operation outside the normal eight hour working period each day.

d - The final compost shall be fully mature so that it can not damge the soil or growing crops.

e - The Refining and Grading of the final compost shall produce a commercially acceptable quality of compost.

f - The number of machinery units and conveyors systems within the plant shall shall be as small as is reasonabl practicable - Over mechanisation to be avoided.

g - The Transport and Mobile Equipment which form an essentia element in successful composting must be of the proper types and available in sufficient numbers.

h - The number of personnel required to operate the plant shall not be excessive, or on the other hand too few A reasonable estimate is about 50 to 60 persons to include the whole staff establishment.

h - The yield of compost shall be within the range of 50 to 55 % w/w of the original feedstock.

i - The quantity of processing rejects shall be within the range Of 27 to 33% of the weight of original feedstock.

j - The time required for the plant to produce final compost shall be as small as is reasonably practicable. The target period should be about 50 days (7 to 8 weeks),

k - The use of processing liquid and of electricity to be reasonable.

l - Systems requiring very specialised skill for their operation and/ or needing precision control should be avoided.

9.4 SCHEME COMPARISONS - OPERATIONAL DATA

FIRM.	REJECTS	COMPOST YIELD	PROCESS TIME	PROCESS LIQUID	ELEC/Y	PERSONNEL
	per cent	of throughput	days	l/hr	*kwh/day	No
ANDRITZ	42	41	201	27500	12200	75
BARTOLOMEIS	35	51	56	20000	**	* 24
B.C.BERLIN	32	54	42	30500	13400	56
BUHLER	28.5	53.8	43	21100	12000	**
DANECO	35	45	88	*70000	19800	47
DEGREMONT	36.5	49.5	52	60000	25000	36
MILLIHOUSE (BASIC)	25	55	90	20000	10500	50
MILLHOUSE (ALT No 1)	25	55	90	20000	10500	50
MILLHOUSE (ALT No 2)	30.5	50	60	10000	*9100	31
SEGCURE	40	46	132	21500	15500	42
SNAPROGETTI	28	55	70	15000	12570	39
THYSSEN (Variant 1)	33,5	50.6	66	60000	10200	32
THYSSEN (Variant 2)	37	42	60	45000	12600	32
O.T.V.	32	54	42	30500	13400	=56

* Obviously in-accurate ** Data not supplied = Estimated.

9.5 Of the submitted schemes only Three satisfy in general design the specified requirements. Four other schemes of the static windrow type can easily be converted to the accelerated windrow system and with substantial economies. One of the open windrow submissions contains some meritable elements but this would require major amendment and conversion to the accelerated windrow system

Seven of the submitted schemes do not satisfy the design parameters and can not be easily modified so to do.

The details of the systems offered and the required modification of certain schemes are as follows:

Firm	System	Possible Modification
ANDRITZ	Static Windrow	Convert to accelerated windrow system.
BARTOLOMEIS	Static Windrow	*Not suitable
B.C. BERLIN	Acclerated Windrow	Sludge Processing OPTION to be included.
BUHLER	Accelerated Windrow	Suitable
DANECO	Static Windrow	Not suitable
DEGREMONT	Enclosed Tower Digester	Not suitable
MILIHOUSE (basic)	Open Windrow	Major revision of feed-stock pretreament section and conversion to accelerated windrow scheme
MILIHOUSE (Alt 1)	Open Windrow	Not suitable
MILIHOUSE (Alt 2)	Rotary Drum Digester	Not suitable
SEGHURE	Open Windrow	Not suitable
SNAPROGETTI	Static Windrow	Convert to accelerated windrow system
THYSSEN (Variant 1)	Static Windrow	Convert to accelerated windrow system
THYSSEN (Variant 2)	Rotary Drum Digester	Not suitable
O.T.V.	Accelerated Windrow	Sludge processing to be included.

* In this scheme an alternative option provides for an Accelerated Windrow Fermentation unit in lieu of the basis Static Windrow System The Static Windrow Fermentation spredding machines will be used for placing the material in the Maturation Stock-yard.

10. TECHNICAL CLASSIFICATION OF THE SUBMITTED SCHEMES

10.1. Schemes which satisfy technical and operational requirements

a - B.C.BERLIN Subject to the offered option for inclusion of sludge.

b - BUHLER Satisfactory.

c - O.T.V. Subject to inclusion of sludge.

10.2. Schemes which could be satisfactory if modified

a - ANDRITZ For modifications see Para 9.5. and Page 28

b - MILLHOUSE (Basic) Major revision is required See Page 40.

c - SNAPROGETTI For modifications see Para 9.5 and page 48.

d - TYSSEN (Variant 1) For modifications see Para 9.5 and page 50.

10.3. Schemes which both technically and operationally are NOT satisfactory

a - BARTOLOMEIS Including also Alternate System offered

b - DANECO

c - DEGREMONT

d - MILLHOUSE (Alternative 1)

e - MILLHOUSE (Alternative 2)

f - SEGOURE

g - THYSSEN (Variant 2)

11. CONCLUSION

11.1 In view of the preparation of Contract Documents for Phase I of the Sewage Treament Scheme it is desirable that the necessary integration of the Composting Plant and the Sewage Treament Plant as mentioned in Paragraphs 2.4.15 and 3.6 be decided as quickly as possible.

11.2 Provision for the incorporation of the WHOLE of the sludge produced at the Sewage Treament work must be settled at the Final Contract stage for the Composting Plant so that appropriate adjustments can be made to design. It might not be necessary to instal equipment for processing sludge until such time as this becomes available, but unless provision is made in the initial design it may be impossible to make later adjustments. If the sludge can all be treated by composting this can effect considerable economies in respect of sewage treament, and can substantially increase the quantity and quality of the compost.

11.3 A very early decision is needed regarding the question of vehicular access to both sites. Are they to be seperate or not?.

APPENDIX NO 1

BULK TRANSPORT VEHICLES

1. The right type of vehicle is essential for flexible and economical performance and the type suggested is indicated on the attached diagram as TYPE A.

2. Most of the submitted schemes have proposed to substitute ROLL-ON-OFF type vehicles indicated on the diagram as Type B.

3. The reason is probably that the Type A Vehicles known as a REAR END LOADER has as yet not been introduced into Europe from America except in the case of Britain where it is rapidly displacing other types.

4. The Rear End Loader is fitted with hydraulic lifting equipment and with a large capacity reception hopper so that it can lift and empty into its hopper the contents of 12 M^3 open top containers. The vehicle has its own compaction and ejection equipment and this ensures that full loads of up to 20 tonnes can be secured. It is found in practice that one vehicle can accommodate up to twelve loads from containers before it is full. The vehicle is highly flexible in use and can pick up containers throughout a factory precinct at almost any point. It immediately empties the contents into the hopper and REPLACES THE CONTAINER in its original position.

5. The ROLL-ON-OFF Vehicles must haul the full containers to the disposal point so that spare containers are required to replace full ones. Additional space is also required as the empty container is placed into position before the full container can be handled The Roll-on-off containers may be open containers up to 30 or compaction container up to 20 tonnes capacity.

6. Attached are current costings of operating various types of vehicle in Britain - allowing for certain differences in the items the operational costs are not likely to be substantially different in comparative terms in Syria.

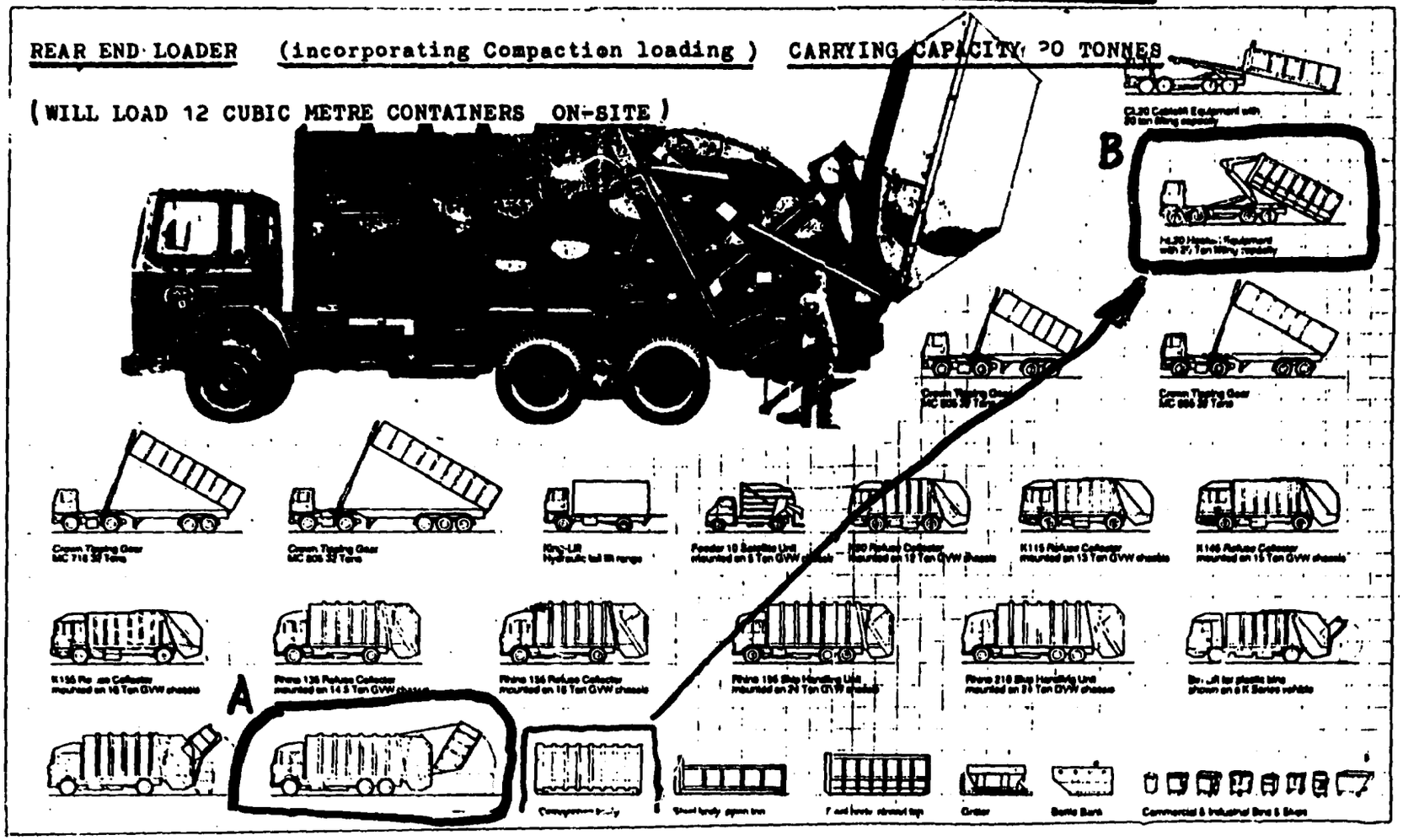
7. The current purchase cost in Britain of vehicles and containers is as follows:

   Rear End Loaders £65000 pounds sterling 12M^3 containers are £700 pounds sterling

   Roll-on-off Vehicles £50,000 pounds sterling 20 tonne Compaction Containers £2400 each

   30M^3 Open Containers are £1700 each

A TYPE OF BULK VEHICLE AS SPECIFIED **B** TYPE OF VEHICLE OFFERED



Transport costs

SUGGESTED OPERATING COSTS — JANUARY 1984

	4 x 2 Skip unit	6 x 4 Skip unit	8 x 4 roll-on-off	Front-end loader	Rear-end loader	2,000 gallon tanker	4,500 gallon artic tanker (25,000 miles)	4,500 gallon artic tanker (50,000 miles)
	£	£	£	£	£	£	£	£
Fixed costs								
Depreciation C/Cab and Unit	4200	5581	6681	10054	14000	5903	6805	6805
Licence and Insurance	980	1480	2320	2642	2400	1250	3290	3290
Overheads and Expenses	6010	8008	8979	8776	10953	6936	8092	10958
Drivers Wages	8175	9827	9827	10584	8048	11992	8500	8500
TOTAL FIXED COSTS	19365	24896	27807	32056	35401	26081	26687	29553
Variable costs								
Repair labour	2600	4700	4939	1476	2500	1440	2820	5280
Spares	1390	1920	2018	1000	1950	1145	2395	3765
Tyres and Tubes	1040	2961	3591	2100	4500	975	1958	3917
Fuel and Oil	3900	5564	6540	7248	7560	5038	7094	13983
TOTAL VARIABLE COSTS	8930	15145	17088	11824	16510	8598	14267	28945
TOTAL OPERATING COSTS	28295	40041	44895	43880	51911	34679	40954	56498
Interest on capital employed at suggested rates (20%)	5659	6697	8017	8776	11200	6936	8190	11300
TOTAL COSTS	33954	46738	52912	52656	63111	41615	49144	67798

SUGGESTED COSTS PER WORKING DAY, HOUR AND MILE

	4 x 2 Skip unit	6 x 4 Skip unit	8 x 4 roll-on-off	Front-end loader	Rear-end loader	2,000 gallon tanker	4,500 gallon artic tanker (25,000 miles)	4,500 gallon artic tanker (50,000 miles)
	£	£	£	£	£	£	£	£
Per working day								
Fixed costs	84.19	108.24	120.90	139.37	153.91	113.40	116.03	128.49
Variable costs	38.83	65.84	74.29	51.41	71.78	37.38	62.03	117.15
Total operating costs	123.02	174.09	195.19	190.78	225.70	150.78	178.06	245.64
Interest cost	24.60	29.11	34.85	38.16	48.70	30.16	35.60	49.13
TOTAL COSTS	147.63	203.20	230.05	228.94	274.39	180.93	213.66	294.77
Per working hour								
Fixed costs	8.42	10.82	12.09	13.94	15.39	11.34	11.60	12.85
Variable costs	3.88	6.58	7.42	5.14	7.17	3.73	6.20	11.72
Total operating costs	12.30	17.40	19.51	19.08	22.57	15.07	17.80	24.56
Interest costs	2.46	2.91	3.48	3.82	4.86	3.01	3.56	4.91
TOTAL COSTS	14.76	20.32	23.00	22.89	27.44	18.09	21.36	29.48
Per mile								
Fixed costs	0.77	0.99	1.11	1.28	1.41	1.04	1.06	0.59
Variable costs	0.36	0.60	0.68	0.47	0.66	0.34	0.57	0.54
Total operating costs	1.13	1.60	1.79	1.76	2.07	1.39	1.63	1.13
Interest costs	0.23	0.26	0.32	0.35	0.45	0.28	0.32	0.23
TOTAL COSTS	1.36	1.86	2.11	2.11	2.52	1.66	1.95	1.36
Working days	230	230	230	230	230	230	230	230
Working hours	2300	2300	2300	2300	2300	2300	2300	2300
Miles per annum	25000	25000	25000	25000	25000	25000	25000	50000

TECHNICAL DATA SHEET No 1 — DESIGN CRITERIA EMPLOYED BY THE CONTRACTOR — **ANALYSIS SHEET No 1**

	CONTRACTOR														
	FEEDSTOCK CHARACTERISTICS														
% w/w	Compostible														
% w/w	Re-cycleable														
% w/w	Non-compostible Rejects														
% w/w	Moisture Content														
kg M^3	Design Density														
Item	Seasonal Variations														
	THROUGH-UT IN 8 HOURS														
tonnes/ M^3	Full Plant														
Tonnes /M^3	Each Flow Line														
Tonnes/ M^3	Pre-Fermentation Plant														
Tonnes /M^3	Cleaning Plant														
Tonnes/ M^3	Bagging Plant														
	PERIODS OF RETENTION														
Hours	Moisture Adjustment														
Days	Fermentation														
Days	Maturation														
	QUANTITY OF REJECTS														
Tonnes/ M^3	Pre-Fermentation														
Tonnes/ M^3	Primary Screens														
Tonnes/ M^3	Cleaning & Grading														
Tonnes/ M^3	Magnetic Extraction														
	PROCESSING DENSITIES														
kg M^3	Reception storage														
kg M^3	After Shredding/Screens														
kg M^3	After Moisture Adjust														
kg M^3	Start Fermentation														
kg M^3	End Fermentation														
Kg M^3	End Maturation														
kg M^3	Final Compost														
	YIELD OF COMPOST														
%	Precentage of Rated Input														
	RECEPTION STORAGE OF FEED														
m^3	Volume														
Item	Method of Storage/feed														

TECHNICAL DATA SHEET No 1 — DESIGN CRITERIA EMPLOYED BY THE CONTRACTOR — ANALYSIS SHEET No. 2

		CONTRACTOR													
		CLIMATE													
°C		Temperature - Maximum													
°C		-do- - Minimum													
mm in		Rainfall Intensity													
km hrs		Wind Velocity													
		SOIL & SEISMIC DATA													
Tonnes M^2		Load Bearing Rating													
Item		Concrete Sulphate P/n													
cm		Depth of Water Table													
Item		Seismic Factors													
		PROCESS LIQUID													
Litres Hr		Maximum Provision													
Item		Degree of Salinity													
Item		Source or Sources													
		ELECTRICITY													
kwh		Total Installed Demand													
kwh		Total Absorbed Power													
V & Hz		High Tension Data													
V & Hz		Three Phase Data													
V & Hz		Single Phase Data													
		DESIGN STANDARDS													
		Reliability of Source													
		Comprehensive Cover													

ASSESSMENT OF COMPLIANCE WITH DATA SHEET No 1

Adequacy of cover - Rating

Reliability of Design Data - Rating

Important Defects or Ommissions

TECHNICAL DATA SHEET No 2

PROCESS DESCRIPTION, SUPPLY OF EQUIPMENT, AND SERVICE FACILITIES

ANALYSIS SHEET No 3

	CONTRACTOR														
	PROCESS DESCRIPTION Reception & Storage Feed to Plant Size Reduction Primary Screening Moisture Adjustment Fermentation Maturation Cleaning & Grading Disposal of Rejects Recovered Materials Distribution														
	FLOW SHEET REQUIRED DATA Time to produce Compost Yield per tonne Quantity of rejects Quantity Salvage System of Cleaning Personnel Establishment Power Consumption Facility for Extension Facility for Incr. Output														
	LAYOUTS Full Layout Site Plan Control Diagram Equipment Layout Electrical Diagram Process Water Control Panels Reception& Storage Feedstock Treatment Fermentation Maturation Cleaning Grading														

T S 2

PROCESS DESCRIPTION, SUPPLY OF EQUIPMENT, AND SERVICE FACILITIES

ANALYSIS SHEET No 4

	CONTRACTOR
	EQUIPMENT LIST Comprehensive Cover Individual Detail
	UTILITIES Water Supply Sanitary Water Fire & Alarm Sewage Disposal Surface Water Drains Telephone & Tannoy Overload and Em Stop Artificial Lighting T.V.Monitors Standby Generator Elec Distribution Elec Motors Power outlets Earthing Feedstock Moisture Dust Aspiration Weighbridge & Control Cleaning System
	ANCILLIARY BUILDINGS Offices & Laboratory Amenity Block Weighbridge Control Workshop & Stores Gate House Reception Hanger Processing Hall Fermentation Hangar Cleaning Unit Garage
	Lists - Equipment Furnishings servicing tools spares lab equipment chemicals

PROCESS DESCRIPTION, SUPPLY OF EQUIPMENT, AND SERVICE FACILITIES.

ANALYSIS SHEET No 5

	CONTRACTOR														
	MOBILE PLANT & VEHICLES														
	Loading Shovels														
	Bulk Transport (Compaction) Belt Conveyors														
	Rough Terrain Dumpers														
	Vans,														
	Platform Trucks														
	Fire Pumps														
	ENVIRONMENT PROTECTION														
	Dust														
	Noise & Vibration														
	Odours and Smell														
	Flies, insects birds etc														
	HEALTH & SAFETY														
	Cleanliness of Plant														
	Explosion Protection														
	Emergency Stopping														
	Climbing equipment														
	Warning Signs														
	Dust Control														
	Fly Supression														
	Mobile Plant Air Cond.														
	Maintenence equipment														
	Lifting -do-														
	Hoisting -do-														
	suspension -do-														
	MISCELLENY														
	Recovery Salvage														
	Storage Fuel Oils														
	Distribution Fuel														
	Pulverisers														
	Type of Hammer														
	Cost of Hammers														
	Time to Change														
	Tonnes between change														
	Protection damage														
	ASSESSMENT OF COMPLIANCE DATA SHEET No2														
	Adequacy - Rating														
	Reliability - Rating														
	Important Errors/Ommision														

TECHNICAL DATA SHEET No 4

TIME SCHEDULE FOR IMPLEMENTING EACH STAGE OF THE CONTRACT AND DELIVERY OF DOCUMENTS

ANALYSIS SHEET No 8

	CONTRACTOR														
	TIME SCHEDULE Adequacy of Bar Chart Times - Delivery FOB Start Civils Start erect plant Complete - Civils Mech/l Elec/l Initial Operation Commercial Operation														
	DOCUMENTATION PERIODS Process Equipment & Machinery Control and Monitoring Electrical Civil Engineering General														
	PROCUREMENT DOCUMENTATION List of Spares List of Vendors of Spares														
ASSESSMENT OF COMPLIANCE DATA SHEET No3 Adequacy - Rating Reliability - Rating Important Errors/Ommision															

TECHNICAL DATA SHEET No 4

TRAINING OF THE PURCHASER'S PERSONNEL

ANALYSIS SHEET No /

	CONTRACTOR														
	STAFFING Management Tecnical Operation Supervision Skilled Operatives Unskilled workmen Maintenance Functions & Categories														
	TRAINING Overseas Trainees Designation Training Period Subjects Place of Training TOTAL NUMBER														
ASSESSMENT OF COMPLIANCE DATA SHEET No4 Adequacy - Rating Reliability - Rating Important Errors/Ommision															

TECHNICAL DATA SHEET No 5

RATES, CHARGES AND PERSONNEL SERVICES

ANALYSIS SHEET No 0

	CONTRACTOR														
	HOME-OFFICE CHARGES														
	OVERHEADS & PROFITS %														
	EXPATRIATE CHARGES														
	LOCAL EXPATRIATE ALLOWANCE														
	EXPATRIATE OVERTIME Up to 54hrs/week % Above -do- Weekly & Public Holidays														
ASSESSMENT OF COMPLIANCE DATA SHEET No 5															
	Adequacy - Rating Reliability - Rating Important Errors /Ommision														

TECHNICAL DATA SHEET No 6

CIVIL ENGINEERING SPECIFICATIONS

ANALYSIS SHEET No 7

	CONTRACTOR														
	C.E.LIST Layout Plan - Complete Indexed Layout														
	SPECIFICATIONS Buildings Sizes Floor Area Construction Line Drawings														
	Roads and Paved Areas Levels and slopes Earthwork Areas Construction Layout plans														
	Machinery Foundations Adequate Sustained Loading														
	Underground Works Layout Plans Construction Drainage & S.Disposal Weighbridge														
	Misellany Fencing & Gates Windbreaks Landscaping Ext Lighting Traffic Flow Painting Schedule														
	DESIGN DATA Adequate Comprehensive Reliable														
ASSESSMENT OF COMPLIANCE DATA SHEET No Adequacy - Rating Reliability Rating															

TECHNICAL DATA SHEET No 7

GUARANTEES OF THROUGHPUT OF FEEDSTOCK AND PRODUCTION YIELD OF COMPOST ETC

ANALYSIS SHEET No 10

	CONTRACTOR													
	RATED THROUGHPUT													
tonnes	One eight hour shift - Full Plant													
cubic metres	-ditto-													
tonnes	One eight hour shift - each Flow-line													
cubic metres	- ditto-													
	Moisture to 55%m/m													
	PROCESSING REJECTS													
% throughput	Primary Milling /Screening													
-do-	Final Cleaning/Grading													
-do-	Salvage													
-do-	Other Rejects													
	COMPOSTING LOSS													
% throughput	Process loss													
	DURATION OF STAGES													
Days	Full Process													
Days	Fermentation Stage													
Days	Maturation Stage													
	COMPOST YIELD													
% throughput	Specification compost													
	ELEC ABSORBED POWER													
	8Hrs/maximum throughput													
	ENVIRONMENTAL PROTECTION													
	Noise & Vibration													
	Dust													
	Smell and Odour													
	Pest infestation													
	DEFECTS IN WORKS													
	ASSESSMENT OF COMPLIANCE WITH DATA SHEET No 7													
	Adequacy - Rating													
	Reliability - Rating													
	Import errors or omissions													

Spec No	Item
Annex VIII 3.1 (TDS 7)	THROUGH-PUT
4.1. 1	Identical Flow-lines
3	All Feedstock to Shred
4	Mill Size (50t/150M³/Hr)
5	LAYOUT
	Reception Hangar
	Reception Bunker
	Mill
	Fermentation Units
	Maturation
	Refining
	Optional Bagging Unit
	Disposal of Rejects
	Distribution of Compost
4.2.	SITE
	Use to best advantage facilitate extension
	Environmentally Sound
4.3.	PLANT & MACHINERY
	Reliable
	Attractive
	Economical in Labour
	Easy to maintain
	Clean and quiet
	Ancillaries satisfactory
	Economic and Viable
	Rejects minimum
	Environmentally sound
	100% conversion
4.4. 4	TRAINING
5	SPARE PARTS
6	ACCESS (Entry and exit)
7	TRAFFIC CIRCULATION
8	40 tonne Weighbridge
9	Artificial Lighting
10	RECEPTION HANGER
11	Extensions
12	COMPOST STORAGE
13	Alternate Storage
14	FERMENTATION

SPEC. 2.

Spec No		Item
4	15	MATURATION & STORAGE
		-do- (Covered)
	16	Cleaning System
	17	Wind Protection
	18	Pests and Nuisances
	20	ANCILLIARY BUILDINGS
		Workshop
		Stores
		Messroom
		Laundry
		Laboratory
		Managers Office
		Staff Offices
		Gatehouse
		Sales Office
		Weighbridge Office
4	21	MONITORING
		T.V.
		Tannoy
		Fire
		On-site Telephone
4	22	COMPOST TEST AREA
		Shade House (7 x12)
		Planting Area (0.25h)
		Greenhouse (4 x 5)
5	3	PULVERISER MILLS
		Change Hammers - Manhours
		Type & No of Hammers
		Cost per set
		Damage prevention
		Overload Control
		Feed Hopper ($20M^3$)
5	4	MOISTURE ADJUSTMENT
	5	SCREENS
	6	CONVEYORS
	7	COMPOST TURNING
	8	DRUM - Retention time
		-do- "sausages"
		REFINING (twin- lines)
		-do- (method)

SPEC. 3

Spec No		Item
5	10	MOBILE PLANT
		Bulk Reject Vehicles
		Loading Shovels
		Fire Pump
		Mobile Conveyors 3t Tipper Lorry
		Lifting Equipment
		Hydraulic Jacks
		(optional - Generator)
5	12	GRAB CRANES
		Number and type
		Dust proof controll kiosk
		Emergency Stop
		By-pass to crane
5	17	Cleaning - Vaccum and Hydrants
		Wander Lights
	18	Fire Control System
	19	Metal Press
	20	Weigh Ticket Printer
6	5	Process Water Reservoir 300M^3
		PROCESSING DEMANDS
		Electricty (kwh/8hrs day)
		Process Liquid (Litres/hr)