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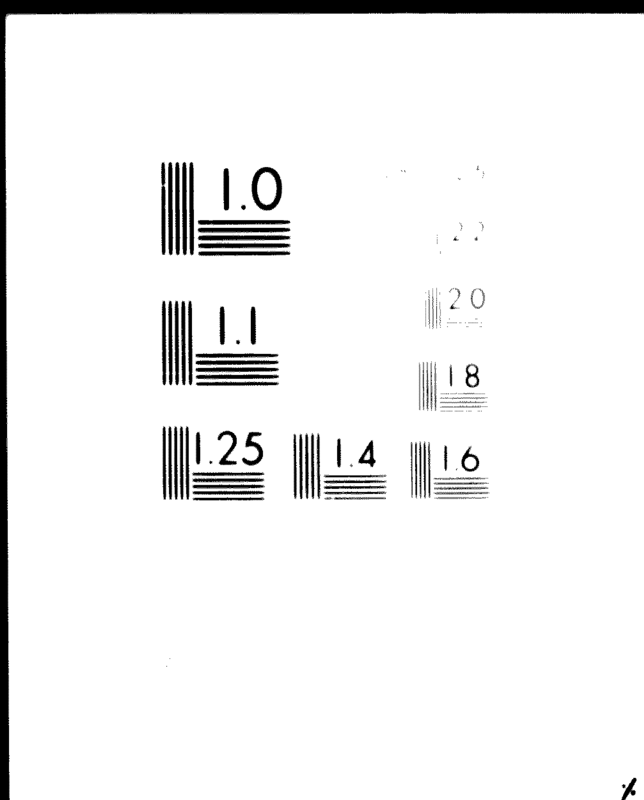

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Organic Fertilizer Plant Composting Town Waste of Conakry/Guinea

Feasibility Study

Final Report

Prepared by

AGRAR- UND HYDROTECHNIK GMBH
Consulting Engineers

Essen/Germany · December 1970

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I. INTRODUCTION

The feasibility study in question was carried out by Agrar- und Hydrotechnik GmbH, Consulting Engineers in Essen, West Germany, at the request of the Government of Guinea and the United Nations Industrial Development Organization.

The task was to determine whether the installation of a garbage composting plant in Conakry is feasible or not.

The solution to this problem can be linked with the hygiene problem resulting from the current method of garbage disposal and a common solution will prove profitable. The answer to this question will help the government of Guinea in solving the existing public health problem caused by the present method of garbage disposal. It is understood that composting might even allow a profit.

Three essential criteria had to be examined for the execution of this task in order to make a concrete statement on the feasibility of a compost plant for the waste material of Conakry.

- current method of garbage disposal
- possibilities of compost marketing
- general engineering of the compost plant

Two experts (an expert in refuse treatment and an agricultural economist) were sent to Conakry for two months to collect the existing basic data and to amplify them by their own investigations carried out in close cooperation with the government of Guinea and the regional government of Conakry. The analysis of the investigations and the composition of the report were done in the home office.

The feasibility study shows that

- the public health problem can be solved satisfactorily by the processing of the town garbage of Conakry into compost.

- The compost plant project will be feasible from the point of view to national and private economies. This is shown by examination of the factors concerning the others mentioned in the course of this study.

Last but not least we wish to thank again all the authorities concerned, especially the Direction de l'Industrie and the Administration Region of the Special Zone of Conakry with the Governor Mr. Albert Kourouma for their active help in obtaining the basic data for the realization of this study.

II. E X E C U T I O N

1. Raw material for composting

A pre-requisite for the succesful running of an industrial plant is the economic and regular supply of raw material.

As the solid waste material (products) of the communal refuse collection of Conakry will supply the raw material to the compost plant in question, it is necessary to examine its quantity and composition as well as its method of collection. It is necessary not only to examine the present situation, but also to submit proposals for a reorganization of the entire treatment of townwaste with respect to the future development.

The collection and disposal of the waste material is a hygiene problem, the solution to which is essential to public health. In most cases, however, it incurs important financial charges on the Municipal budget and this infers that the technical and economical aspect must also be considered.

1.1 Present situation.

1.1.1 Evolution of urban area and population.

The region of Conakry comprises an area of 3o8 Km^2 and extends in a south-westerly direction from the mainland onto a peninsula. It lies between the 9th and 1oth northern degrees of latitude and the 13th and 14th western degrees of longitude.

The entire territory of the district is divided into 8 Arrondissements; six of which come within the municipal area.
The IV Arrondissement comprises the Los-isles off-shore with the principal island of Kassa.
The VIII Arrondissement is an extensive rural area with a low population density. In the urbanisation plans on hand, the government has planned the VIII Arrondissement not only as a residential district, but also partly as an industrial area.

Conakry consists of Conakry I, the commercial and government district (Arrondissements I, II, III) and the "Banlieue" or Conakry II which has been listed as residential district but also as an industrial area.

On 31st August 1964 the total population of the Conakry region was estimated at about 172.5oo inhabitants and at the national census of 19th - 21st May 1967 it amounted to 197.267 inhabitants. The annual increase in population of 4,6 % is 1,6 % higher than the average increase for the entire territory of the Republic of Guinea. This above average increase of population can be attributed to the heavy immigration from the extensive Hinterland, especially into the outskirts of Conakry II. If the above average increase of population is concentrating in the "Banlieue" area - which was confirmed by the official government agencies - the increase shown in table 1 is expected for the future.

Table 1.

Movement of population in the region of Conakry.

Arrondissement	1967[1)]	1970[2)]	1975[2)]	1980[2)]
IV (Los-Isles)	4.891	5.350	6.200	7.200
VIII (Rural Area)	8.446	9.250	10.700	12.400
I, II, III (Con.I)	54.637	62.500	72.500	84.000
V, VI, VII (Con.II)	129.293	148.700	193.300	250.400
Total	197.267	225.800	282.700	354.000

1) National Census from 19th - 21st May 1967.
2) Estimates.

Source: Direction Nationale de la Statistique et de la Mécanographie, Conakry.

In the 14 years from the national census in 1967, to the year 1981, the population of the town may have been doubled. It is obvious that given this enormous increase in population, the resulting quantities of solid wastes and their disposal will present a serious problem to public health. Therefore, the responsible authorities should take the measures necessary to guarantee the hygienic and sanitary conditions for the town population.

1.1.2 Present method of garbage treatment.

The administration of the region of Conakry is responsible for the cleanliness of the roads of Conakry as well as for the organization of the garbage collection, and its sanitary disposal. For the execution of this task they have created a public institution which has been charged with the responsibility of streetcleaning as well as garbage transport and disposal. However, the so called "Voirie" is only a garage and repairshop which provides the vehicles and is repairing them if necessary.

It has delegated the task of the actual collection of garbage to the administrations of the individual arrondissements. There the vehicles are kept and the assignment of scavengers is arranged.

While "domestic refuse" generally means waste products from dwellings and households, such as left-overs and remains of fruit and vegetables, broken pottery, dust, old papers and packing material, like cartons, bottles, tins etc., it also includes here the waste products from the domestic refuse from public buildings and commerce. Street-sweepings, waste products from public parks and garbage from the markets are accumulated together with the rest of the waste, which is deposited in heaps on the sides of the roads by the population, and cannot be collected seperately from the domestic refuse.

Only the collection and disposal of the remains and waste products from industry do not go onto the municipal garbage transport. The garbage of industry is disposed of by the individual factories themselves. Therefore it will henceforth be disregarded, although it is absolutely necessary to obtain official control of the disposal for reasons of hygiene.

More or less regularly the domestic refuse as defined above - that is all waste products with the exception of garbage of industry - is picked up by the public refuse collection in the entire urban area. To cope with this task the "Voirie" can count on a total of 18 vehicles and 257 labourers, working daily - including sundays and holidays. Only a quarter of the vehicles consist of special units for dust-free removal of refuse with compression equipment and a loading volume capacity of 9 cu.m each. The maximum permissible loading capacity of these vehicles is 7 t. each. The remaining vehicles are open dump-type hopper trucks with a volume capacity of only 3 cu.m each. Table 2 gives a general view of the distribution of the trucks and personnel in the individual Arrondissements.

A comparison between container volume available for daily transport together with personnel, and the number of inhabitants to be served in the individual Arrondissements shows a marked difference between the centre of the city and the "Banlieue". This stems from the fact that the special trucks carry out 2 drives per day and they reduce the garbage volume by half, while in the dump trucks the garbage volume is not reduced and they must carry out 4 drives per day.

Calculations relating to the present and future amounts of garbage, are shown in table 3.

Table 2.

Numbers of trucks and personnel for the collection and disposal of garbage in Conakry.

Arronissement	number of vehicles			number of labourers		
	$9\ m^3$	$3\ m^3$	Total	garbage disposal	street cleaning	Total
I	o	3	3	9	37	46
II	1	2	3	15	15	3o
III	2	2	4	16	22	31
Conakry I	3	7	1o	4o	74	114
V	1	2	3	13	55	68
VI	1	2	3	14	3o	44
VII	o	2	2	6	25	31
Conakry II	2	6	8	33	11o	143
Total	5	13	18	73	184	257

Source: information from "Voirie" of Conakry from 28th March 197o.

Table 3.

Transport capacity and labour assignment per 10.000 inhabitants per day.

Arrondisse-ment	inhabitants 1970	transport capacity m^3/10000 inh.p.day	labour assignment garbage transport	street clearing
I	23.300	15,5	3,9	28,8
II	12.600	42,6	11,8	11,8
III	26.600	36,1	6,0	8,[illegible]
Conakry I	62.500	30,7	6,4	11,8
V	46.800	12,8	2,8	11,7
VI	49.300	12,1	2,8	6,1
VII	52.600	4,6	1,1	4,7
Conakry II	148.700	9,7	2,2	7,4
Total	211.200	15,9	3,5	8,7

Table 3 clearly points out, that as distance from the centre of town increases the container volume and labour provided by the municipal garbage transport also decrease. This can be partly explained by increased production of garbage per head of population in the centre (more commerce and market garbage). From the volume ratio of 3 : 1 between Conakry I and Conakry II it can be concluded that waste material collection in the suburbs is neglected.

A regular transportschedule for individual journeys in the arrondissement does not exist. After on the spot observations and inquiries in different quarters and with the drivers of the garbage trucks it was found that in the centre of the town transport is daily and quite regular.

On the other hand, in the suburbs waste is collected 1 to 3 times per week. This is attributable not only to a shortage of vehicles but also to the unsatisfactory assignment of scavengers and vehicles.

Hygienic aspects apart, there are technical and economic factors concerning the productivity of the garbage loader to be considered. The calculation showed that at full wage rate of the dump trucks the daily productivity of a loader varied between 4,o and 4,3 m^3 per day. However, when working on the special garbage truck this productivity increased to 6 m^3 per loader per day or by almost 5o %.

The collected waste material is transported either to the public dumping place in Kénien - about 1o Km from the centre - where it is dumped in a disorderly fashion in a former stone-pit or it is taken directly to the country side around the VIII Arrondissement where it is distributed haphazardly by the inhabitants as a fertilizer on fallow grounds. It was learned from drivers of the garbage vehicles that 1/4 to 1/3 of the total amount of garbage goes to the country side without control. The possible dangers of this kind of garbage disposal will be dealt within the next chapter.

There are no existing data concerning the costs of the present garbage transport and disposal. Although the "Voirie" was created by the region and works more or less as an autonomous institution with its own administration and office, no fixed sum is listed for it on government's budget. Therefore the experts had to arrive at their own estimates. Further details are given in section 1.4.

1.1.3 Present and furture quantities of waste material.

The quantity of town waste is the most important item for the solution of the disposal problem. This is valid not only with respect to the volume but also in respect to the weight. The amount of waste material not only determines the collection and disposal system but also relevant to the possible recovery of the usable waste to form compost.

Besides seasonal fluctuations in the quantities of waste material the amount also differs according to the structure of the town, the living standard and habits of the inhabitants of different countries and even between those of different towns.

Whereas seasonal fluctuations in Conakry occur they are of only minor significance. However, it can be seen from table 3 that the quantities of waste material in the individual districts of the town do vary to some extent.

In the densely populated centre [illegible] by- separated [illegible] [illegible] over [illegible]. In the residential [illegible] Conakry [illegible] are less densely [illegible] at least part [illegible] in a more or less [illegible]. In addition the [illegible] lower [illegible] in the household [illegible] head. As population [illegible] living standards rise [illegible] will also increase [illegible].

Exact data [illegible] in the area of Conakry [illegible] weighing or volume determination [illegible] carried out. The impression [illegible] and fiscal authorities [illegible] volume ratio of the waste material [illegible] between 2[illegible] Kg/m^3 and 800 Kg/m^3. The [illegible] service tended to stress [illegible] efficiency and put toward the [illegible] and the greatest [illegible] garbage accomplished per day. The corresponding government agencies which are responsible [illegible] the distribution of public funds estimate the lowest values for the weight volume ratio as well as for the number of journeys. Because of the contradictions in the statements and lack of decent statistic the experts were obliged to arrive at the quantities of waste material from their own observations and statements of the drivers of the garbage-vehicles. The results arrived at were, that the spec[illegible] of loosely loaded waste material is about 25o Kg/m^3. In the special [illegible] trucks at the present method of [illegible] about 5oo Kg/m^3 [illegible].

The compress[illegible] material and the [illegible] lare should make it [illegible] garbage in the trucks [illegible]. According to the techni[illegible] trucks the compression increases as [illegible]. The load volume of the trucks [illegible] completely exploited in the [illegible].

From the data in table 3 [illegible] on a weight volume of 25o Kg/m^3 one must arrive at the following quantities of waste material:

Conakry I	48 t/day	corresponding to	17.5oo t/year
Conakry II	36 t/day	corresponding to	13.2oo t/year
Total	84 t/day	corresponding to	3o.7oo t/year

For this calculation it was assumed that the garbage trucks are employed for the garbage transport only and are not involved in other work.

Relating the total amount per year with the number of inhabitants present production amounts to

145 Kg/inhabitant per year.

The population increase is not the only important factor in the future development of the annual quantity of waste material. As the population density increases the possibilities of the garbage utilization decrease and the rising living standard resulting from the growing purchasing power of the population gives rise to an increase in the garbage quantity per head. The experts assumed an increase in per capita production of 1,2 % per annum for the further calculations. The present waste material quantity per head is low in comparison with highly developed industrial countries but the annual increase will be higher than in industrialized countries.

Under these circumstances the following future prospects are projected in table 4.

Table 4.

Projected development of garbage production in Conakry.

Year	1970	1975	1980
Number of inhabitants	211.200	265.800	344.400
per capita production in Kg	145	154	163
Total amount of garbage in tons	30.700	41.000	55.000
Daily collected garbage quantity in tons 1)	102	138	183

1) at 300 working days per year.

It is assumed that the weight volume of the garbage will not change within the next 1o years. So for transport an uncompressed garbage, a volume of

550 m^3 per working day in 1975
72o m^3 per working day in 198o

will have to be handled.

To arrive at the area required for the garbage deposit it is assumed that the garbage can be compressed to 8oo Kg/m^3.

Therefore the necessary deposit volume is

for 1975 about 53.000 m^3/year
for 198o about 69.000 m^3/year

Assuming that the size of the area for an organized deposit is about 5 Ha, this area would be covered with a garbage layer of about 3o m high in the course of the coming 2o years.

1.1.4 Composition of the waste material.

The garbage quantities are of basic importance for the organization of refuse collection and disposal as well as for planning the size of the installation for recovery of the usable components. The composition of the garbage is a further important basic factor for the determination of the recovery rate at composting.

The waste material of Conakry defined in section 1.1.2 can be subdivided into compounds which are compostable or not compostable , depending on its quality. Compostable components are mainly:

- kitchen and garden garbage
- straw and leaves
- paper and textiles

non-compostable components are:

- stones, glass, pottery
- wood, leather, rubber and synthetic products
- iron and non-iron metals.

Moreover, the waste material of a town contains an element which cannot be defined exactly in a sorting analysis because of its fine granulation. It contains a compostable fraction to be added to the other compostable material, which consists of finely granulated organic material such as food residues and parts of plants.

In both weight and volume the largest part of the waste material of Conakry consists of vegetable matter such as leaves, parts of plants, fruit-peels and fruit-rests.

Street sweepings and market refuse contain more than 9o % leaves and plant parts. Sand and other fine particles remain on the unpaived sidewalks and roadsides.

Plants and vegetable residues form the main part of the garbage from dwellings, that is domestic refuse in the original sense. But this part is decreasing considerably because of the bigger share with other materials such as glass, pottery, earthenware sherds, bottles, tins, wood, leather, rubber, plastics and paper.

The commercial non-household wastes finally consist of packing materials, wastes of handicraft enterprises such as taylors, hairdressers etc.

As a regular analysis could not be carried out because the lack of time, personnel and resources, the composition of the garbage of Conakry was **estimated** by random sample investigations as follows:

- plant-, fruit- and food residues	7o %)	85 % compostable
- paper and textile garbage	5 %)	
- fine waste material	1o %)	
- glass, pottery	8 %)	15 % non-compostable.
- wood, leather, rubber, plastics	4 %)	
- iron and non-iron metals	3 %)	

In the composition of the waste material-about 85 % compostable material and about 15 % non-compostable material- no essential change will take place in the near future. The share of packing material surely will increase, but on the other hand also the share of the food and plant rests will increase with the rising living standard.

Composting of the town waste of Conakry will give a good compost recovery because of the especially high share of its organic matter.

At present and in the near future there is no market for the non-compostable part of the waste material. The population in the neighbourhood of the present dump collects some materials and objects for their own use such as fire wood, tins for oil lamps and bottles to store various liquids (oils, petroleum, paint etc). Industries such as iron-mills, glass-mills and papermills which could use by-products of composting as raw materials, do not exist. Nevertheless the government's planning offices are considering the recovery of iron- and other metals and to have them pressed in a scrap-press.

So when installating a compost plant it must be realized that about 12 % of the total waste material must be deposited at a dump. This should be an ordered and hygienically acceptable deposit. According to conditions mentioned in the preceding chapter the following volumes are to be deposited:

1975 6400 m^3 of a total of 53.000 m^3/year
1980 8300 m^3 of a total of 69.000 m^3/year

1.2 Evaluation of the present garbage treatment.

1.2.1 Hygienic aspects.

Generally spoken the present treatment of waste material in Conakry is most unhygienic.

This does not only constitute a serious danger to the health of the personal employed at the garbage disposal service but also to the whole population of Conakry. We will show in short the inconveniences in the different stages of the garbage treatment in order to underline especially the importance of the problem.

The inhabitants of Conakry are getting rid of their waste material by depositing them in form of small heaps on the pavement and along the side of the road. This habit is a danger to public health. Food- and fruit-rests start fermenting soon under influence of the warm and moist conditions of a tropical climate. Its odors do not only bother the inhabitants but the refuse forms an excellent culture-medium for all kinds of bacteriae. The numerous garbage heaps also serve as favoured breeding places for mosquitos and flies. They are quite attractive for mice and rats, looking for food. Domestic animals like poultry, dogs and cats walk over the garbage heaps looking for food and also have their share in the dissemination of seeds of weeds and bacteriae, not mentioned the bad smelling and the unesthetic picture of the waste heaps. Like rats and mice they play an important role in transferring diseases.

Just before the [illegible] sweepers sweep street [illegible] out by the wind and [illegible] bacteriae and [illegible] spread in a wider circle. [illegible] are spread by the [illegible], filling the baskets [illegible] them on open trucks. [illegible] are intensively [illegible] full of germs. It should be [illegible] that this personnel needs [illegible] (suitable working [illegible]) as well as regular medical [illegible].

Similar unhygienic conditions and dangers but even much more [illegible] at the actual disposal of the waste materials. The garbage trucks and lorries are emptied without any system, somewhere on the municipal dumping place. The dumped material was leveled and compacted more or less by a caterpillar as was noticed during a pre-investigation performed in 1968, but at present this is not done anylonger. The unfenced dumping place is a playground for children, whereas domestic animals, such as pigs are searching for food. Inhabitants from the neighbourhood collect objects for their own use as well as for barter.

The [illegible] material varies considerably [illegible] and [illegible] rect [illegible] materials. [illegible] it [illegible] reading the [illegible] VIII,

- [illegible] hurt [illegible] - [illegible] material

- [illegible] are [illegible] ence [illegible] ors, [illegible] land [illegible] present

- Germs of human disease, [illegible] other organic [illegible] serious danger with regard [illegible] and infection of the [illegible] water. Pollution can block the [illegible] using the water for domestic [illegible] period.

- Furthermore [illegible] causes the danger of fire, especially in the [illegible] season. At the present [illegible] is [illegible] possible to extinguish [illegible] fires. In that case, which is not unrealistic, even the inhabitants of farther neighbourhoods are endangered and bothered by dust, smoke and bad smellings.

1.2.2 Technical and economic aspects.

The hygienic nuisances, as mentioned above, of the garbage treatment in Conakry are caused by a lack of adequate technical means as well as by inadequate organization. Garbage disposal is more or less regarded as an unevitable evil, costing much money and not rendering much visible benefits. Lack of information or perhaps misunderstanding of the big threats to the health of the population might be reasons that in the State and District budget no funds are reserved to be used for the organization of an unobjectionable waste disposal. It must be borne in mind that in the highly-industrialized countries about 2o % of the municipal budgets is spent for the collection and deposit of solid waste material only (WHO-technical report series No. 367, Geneva 1967).

The lack of suitable technical equipment as well as an inadequate organization because of too much decentralisation, are the actual reasons for the efficient and expensive waste disposal. That means, that with the same expenditures for the town's cleanness and for public health there could be done more than at present. It is possible to organize an acceptable waste disposal at even lower costs. (See section 1.4 and table 5). For the analysis of its technical and economic aspects one should start with the present presentation of the garbage for collection and transport.

From the garbage production in the house-holds till the loading on the collecting trucks the garbage is heaped three times:

- by the inhabitants themselves, getting rid of the garbage in this way.

- by the scavengers, sweeping together the heaps spread by wind and animals.

- by the dustmen, filling their baskets with the heaps and emptying them on the trucks.

More than a half of these activities could be avoided by the provision of a sufficient number of dustbins to be filled with domestic refuse and street sweepings and to be emptied directly into the trucks. These household's work would remain unchanged. Labour productivity of both scavengers and dustmen would be higher and then work more effective. That means that the same personnel could clean the streets daily, instead of the actual 2 or 3 times a week. The threat to the health of population and cleaning personnel would be limited essentially by the use of garbage bins.

The lack of a sufficient number of special garbage trucks and of spareparts for the existing special trucks (of a total of 2o trucks only 5 are more or less usable) has lead to the fact that for the garbage collection and transport totally unsuitable lorries are used without a compression installation and with a too small loading volume.

As these trucks are not fit for dustfree transports, they have to be rejected from hygienic point of view, apart from their technical and economical disavantages. The scrope of this failing organization becomes especially clear by the fact that a special garbage truck of the type used in Conakry carries 6 - 7 times as much waste as a smaller lorry. But its purchase price is only two times the price of a hopper trucks. Given the 5o % higher loading capacity of the dustmen (see section 1.1.2) and the reduction of transport kms to less than 2o % to the same garbage volume, even an outsider can understand that financial means could be saved by using proper equipment and by strong centralization. The obtained savings could be used for financing the dustbins and for the sanitary installation of the dump site.

Because at present nothing is done for the maintenance of the public dump site and because no financial means appear on the budget no investigation of the technical and economic aspects is necessary. But it should be mentioned that considerable investments are needed for a controled and orderly waste deposit and composting in order to fulfil the hygienic exigeances, especially with regard to the fast growing population.

1.3 Proposals for waste treatment.

A reorganization of the garbage disposal and treatment is proposed giving better health protection and not overcharging public funds.

The main principles of the proposals are:

- an organisactional and technical centralization of the garbage disposal of the whole town area.
- a daily refuse collection in all parts of the town.
- a dustfree transport of the waste material.
- a hygienically acceptable disposal of the garbage.

1.3.1 Preparation of garbage.

The municipal authorities have already made an encouraging start with the consequent application of the above mentioned principles. In the city's centre they have placed about 600 dustbins to be used by households and scavengers for a temporary deposit of waste. These dustbins are oil barrels cut in halves. They are equiped with simple handles and have a volume of about 115 l. They are especially suited for the disposal of bulky materials because of their diameter of 55 cm and they can be easily emptied into the openings of the special garbage trucks. The purchase costs are low and the construction costs of the bins also remain within limits.

Given the daily amount of waste (shown in table 4) and a volume weight of about 200 Kg/m^3 then it is concluded that

are [illegible]
annual [illegible]

must [illegible]

The [illegible]
with [illegible]
the [illegible]
product [illegible]

Certainly, [illegible]
does not [illegible]
industrial [illegible]
are very [illegible] hand
because [illegible]
cheap and [illegible]
reign [illegible]

1.3.2 Transport [illegible]

An explicit [illegible] transport
is use [illegible] means:

- higher [illegible]

- higher [illegible] track

- reduction of the number of transport vehicles

- reduction of the transport kilometers

- economic use of lorries for other transports.

With regard to the total number of trucks necessary it is advisable that trucks be used for the same type as those already used at present (i.e. special garbage trucks with compression installation and a loading volume of [illegible] m^3. Uniformity of trucks is important for the use of standard spare parts, it assures the exchange possibilities of spare parts and simplifies the maintenance and repair of the vehicles. It is assumed that the waste material is compressed to a specific transport weight of 600 kg/m^3 and that two trips are accomplished per day and per truck.

Required is a number of vehicles for

1970: 1[illegible] vehicles
1975: 13 vehicles
1980: 17 vehicles

In order to guarantee daily garbage transport in all streets of Conakry it is proposed to keep one reserve vehicle. The reserve vehicle makes it possible that regular servicing of the trucks can take place, which essentially will influence the life span of all vehicles.

At present 18 vehicles are regularly used for the garbage transport including 5 special trucks.

Together they perform 72 daily journeys from various districts of collection to the dump site,but a regular daily garbage collection in all streets is not guaranteed. At an average distance of 7 km between the collection district and the dump sites the total number of kms. daily covered amount to about 1ooo kms. This total decrease to 28o daily kms. - i.e. less than a third - after changing the present collecting system, and warranting a daily garbage collection for all parts of the town. In fact the transport costs do not decrease proportionally with the covered day-kilometers to drive, but yet cost savings of 28 % are quite interesting (compare section 1.4 and appendixes 1 and 2).

1.3.3 Garbage disposal.

There exist three prinicpal methods for the hygienic and sanitary handling of the collected waste:

- the organized, controlled dumping
- the incineration
- the composting.

The first two methods consist of more or less simple disposal of the waste, whereas by the third method the organic matter can be returned into the natural growth circle. Undoubtedly, the organized and controlled dumping is the cheapest solution.

However, in order to be acceptable the method has to fulfil the following conditions:

- The dump should not influence and contaminate ground- and surface water.
- The dump should be isolated from neighbourhood and planned outside the living areas.
- The dump should be fenced off against people and domestic animals. To prevent flying of paper, development of dust etc. the dump should have suitable windguards.
- The area should be protected against insects and the annoyance of smell and the danger of fire. This can be done by bringing up alternate layers of the waste material and soil.

Without being able to investigate all the facts, it is clear that the conditions for an organized and controlled dumping do not exist.

With regard to the strong increase of population, however, a solution for the waste problem is urgently needed. Now the question becomes important, whether the needed reorganization of the garbage disposal can at the same time imply a more economical use of the organic matter present in the garbage. Because of that the composting method needs to be analyzed. However, the question is only then of interest when the additional expenses for composting as compared with the other methods are be covered by the sales revenues of the compost.

Since the construction a compostplant will eliminate the necessity for a garbage dump, it is of course acceptable that the amount required the alternative of an organized waste dump be accounted to the compostplant to cover the expenses.

This is justified in so far as the compost plant takes over the task of a sanitary and hygienic disposal of the non compostable materials.

However, before a final conclusion is made, the question has to be cleared if actual markets exist for the compost, at sales prices justifying the high investment costs of the compost plant.

1.4 Present and future costs of garbage disposal.

As stated above the collection and disposal of the town's waste is in the first place a problem of hygienic. However, as its solution is linked with considerable charges to public funds hand, the problem should be solved in the economically most advantageous way.

At present the expenses for garbage disposal are not especially indicated in the budget of Conakry. The region's administration assigns financial means to the individual Arrondissements which spend them according to their most urgent needs. Therefore concerning explicite expenses for garbage treatment no data were available in spite of repeated efforts at the different offices. So the current yearly exploitation expenses had to be calculated at the basis of data on operation costs and average wages, gathered on the spot. (see appendix 1).

In the same way the annual operation expenses were estimated to be incurred after the proposed reorganization, as well for the present year. (See appendix 2).

By the uniform evaluation in table 5 for the different years it is possible to make a first comparison of costs, although the figures as such cannot pretend absolute completeness and exactness.

Table 5 shows the result of these calculations.

Table 5.

Annual costs of garbage treatment for the present and in the future (in 1ooo FG per year).

Year	197o	197o	1975	198o
Phase of treatment	present situation	after reorganization		
PREPARATION OF waste material	5o.37o	51.795	64.575	83.84o
COLLECTION AND transport	57.191	41.281	52.539	67.55o
DEPOSITION	-	4.746	5.121	8.185
Total	1o7.561	97.822	122.235	159.575
Specific costs per ton of waste (FG/ton)	3.5o4	3.186	2.981	2.9o1
per inhabitant and per year (FG/Inh./Y)	5o9	463	46o	477

By changing from a 7-days' week to a [illegible]-days' week, for which the number of scavengers has to be increased accordingly, and by the installation of more dustbins it appears that costs rise insignificantly with less than 3 %. Collection and transport costs will be reduced with 28 %. However part of the obtained costs savings will have to spend for an orderly dumping of the waste, or in the case of the construction of a compost plant will have to be accounted as share of costs at the valuation [illegible] waste material. Still real cost savings [illegible] [illegible]0 % annually result.

The change of the entire garbage disposal will considerably improve the hygienic circumstances and cleanness and will beautify the town-view of Conakry.

The later can be obtained, when the means saved by the change are used for the purchase of compost and for the improvement of the public parcs and squares. More than a third of the planned compost production could be used for this function.

However, the larger part of the future compost production has to reach a market. Therefore in the following part of this report the marketing possibilities in agriculture will be examined more in detail.

2. Possibilities for the Compost Market.

Before discussing the possibilities for the future compost market it is necessary to examine the quality and quantity of the compost to be produced in Conakry in order to make an economic evaluation possible. Only when quality and the real agricutural value of the compost are determined, it will be possible to analyse application possibilities and potential markets.

2.1 Quality and evaluation of the compost.

Generally speaking compost is a product used for soil conservation and improvement. Because of its high content of organic matter it

- improves the soil structure
- increases the air supply into the soil
- increases the water-holding capacity
- decreases erosion
- decreases the loss in soil fertility caused by climatic influences
- improves the fixation of the nutritive substances from the application of chemical fertilizers.

The content of real nutritive substances in compost is not very important in industrial countries but it should not be underestimated in the developing countries, where chemical fertilizers are scare and expensive. Furthermore continiously to the plants than chemical fertilizers do and has therefore a more profound influence on the quality of the crops.

In Guinea no research results are available on the soil improving effect of compost and its yield increasing effect, and therefore these factors cannot be considered here. But to get a certain idea about the effect of compost some results from other countries will be stated. It is reported for example from Malta that compost application in an experiment with 20 types of tomatoes had proved a yield increase of more than 70 % as compared to the exclusive use of chemical fertilizers in the first year. Grape yields increased by about 30 % after application of compost as compared with a parcel without any fertilizer (reference: Information of the Land and Water Section Department of Agriculture, Malta 1968).

According German data the yield surplus value for different crops per ton of compost are as follows: (reference: Dr. Stickelberger; Treatment and utilization of town garbage, Vol. 3 page 33, Heidenheim 1968).

rape seed	DM 9,50	corresponding with	630 FG
sugar beet	" 10,10	" "	670 FG
wheat	" 15,00	"	990 FG
potatoes	" 23,[illegible]	"	1540 FG

Only the yield surplus of the first year was reported. But it surely can be assumed that a yield surplus can be obtained in the following years as well.

An other way of evaluating compost is the estimation of the market value for the nutritive substances contained in compost.

Table 6 gives a general view of the main nutritive compost substances according to analyses from different countries.

In Guinea no research data exist on the application of compost, as already mentioned. Therefore the economic evaluation of compost is based on the prices of the equivalent nutritive-substances contained in the chemical fertilizers without regarding the soil improving effect of compost. The result of this valuation is shown in table 7. The value of nutritive substances of 2260 FG per ton of compost forms the basis for further calculations and comparisons.

2.2 Possibilities for the sale of compost.

The transports of compost is very expensive especially because compost has to be applied in large quantities to be effective. So the market area is limited by the high transport costs. The railway transports on the contrary are relatively cheap: about 7 FG per km. But because of the lack of waggons compost transport on rail cannot be recommended. The farmers have no means of transports at their disposal. Therefore the compost transport will have to be done by hired trucks at a price of about 25 FG per ton/km. By these high transport costs the maximum delivery distance is reduced to 25 - 30 km as will be shown later on.

Table 6.

Results of a chemical analysis of various compost samples in different countries.

contents / origin	Guinea [1] Conakry	Senegal [2] Dakar	United States [3]	Netherlands [4] Soest-Baarn	Germany [5] Duisburg
	%	%	%	%	%
water	.	25-35	17,5	24-37	28-6o
organic matter	24,5[c]	2o-35	43,8	9-3o[b]	32-55[c]
Nitrogen (N)	1,14[c]	o,4-o,8	1,12	o,45-o,6o	o,47-1,o[c]
Phosphate (P_2O_5)	1,23[c]	o,4-o,6	2,7o	o,25-o,4o	o,41-o,6o[c]
Potassium (K_2O)	1,26[c]	o,3-o,6	o,83	o,15-o,35	o,35-o,45[c]
Lime (CaO)	5,3o[c]	4-9	3,24[a]	2,o-3,3	5,2-6,7[c]
Magnesium (MgO)	.	.	.	o,3-o,4	o,6-1,2[c]
Oligoelements	.	.	.	o,15	.
pH	.	.	.	.	7,6-8,4

[a] =Ca only, [b] = organic matter active or utilizable, [c] = dry subst.

Sources:

1) Eeckelaers, M. Traitement des Ordures Ménagères; Déc. 1964
2) O.D.A.; Dakar/Sénégal, 1964 (?)
3) Toth, S.J., Chemical Composition of Seven Garbage Composts Produced in the United States in: Compost Science, Vol.9, No.3, Emmaus, Pennsylvania 1968, p.27
4) Kumpf-Maas-Straub, Handbuch der Müll- und Abfallbeseitigung, Berlin (s.a.)
5) Information from the compostplant in Duisburg.

Table 7.

Nutritive value of compost of Conakry.

Nutritive substance	contents in %	kgs/ton	price per kg of nutritive substance in FG	fertilizer to compare with	Value per ton in FG
N	o,91	9,1	1o1	techn.urea/ ammonium sulphate	92o
P_2O_5	o,98	9,8	5o	superphosphate	49o
K_2O	1,o1	1o,1	43	potassium chloride	43o
CaO	4,24	42,4	1o	calcium oxide	42o
			Total value per ton	=	2.26o FG

So the potential compost purchasers live only in the area of Conakry and the region to produce the agricultural products lies within the maximum distance.

The possibility of compost purchase by the municipal administration was already mentioned in section 1.4. The Governor of the region of Conakry affirmed his willigness to purchase and use compost in parks and on public squares.

But it should be realized that even through compost application in order to beautifying the town view forms a production outlet, this is an unproductive use from the economists point of view.

The compost used in agriculture will have a higher productivity to private and national economy. Thus compost can be used for the augmentation of crop yields because of its capacity to improve the soil structure and because of its nutritive contents.

2.3 Review of the present conditions of agricultural production

There exist unfortunately only very incomplete data, in particular almost no statistical material is available for an analysis of the present production conditions. The few available data have been completed by own inquiries, by interviews with the authorized organizations and persons concerned, and by journeys into the area of investigation.

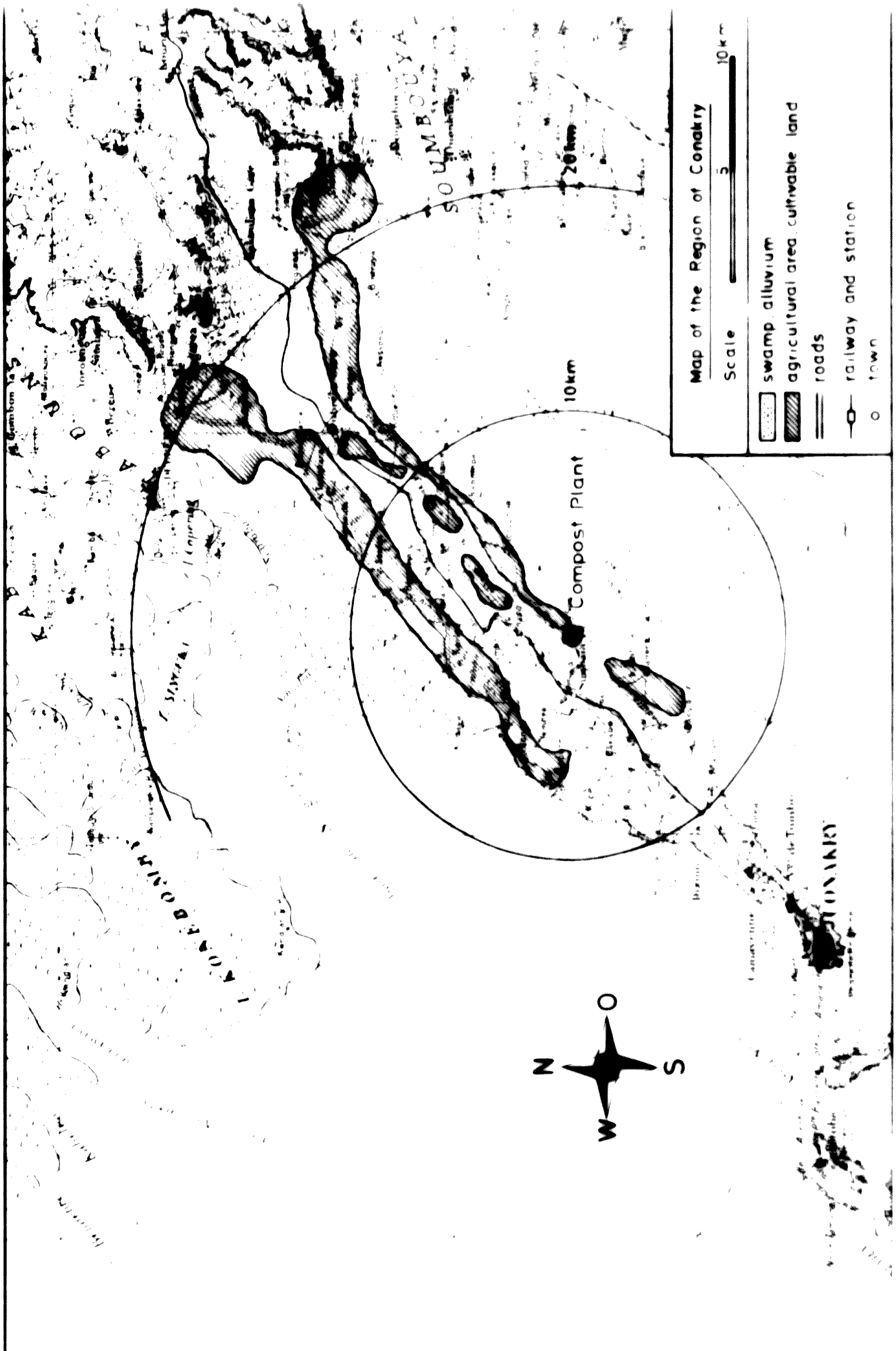
2.3.1 Area of investigation

It has already been concluded that compost can only be sold within limited distances from the compost plant and considering the fact that waste material of the Capital must be manufactured as near as possible to the town, it results that only the near surroundings of Conakry is suitable for the compost plant. As elaborated in section 3.2.2 the optimal location of the compost plant is at the national road, no. 1, km 19. The market of compost will consequently be limited to a distance of 25-3o km from the factory (compare fig. 1). The following observations are furthermore limiting the area of investigation:

- The output of a compost plant is limited by the amount of collected waste or by its compostable components, thus determining the area to be supplied regularly with compost.

- Compost is heavy and voluminous with regard to the contents of nutrients, so that the resulting high transport costs per kg of nutrients and per km make long transport distances uneconomical.

- By the use of compost a certain increase in crop yields is expected, which could be advantageously exploited not far away from an ex-



Source Carte de Conakry C 28 XI
Institut Geographique National Paris (VII)

FIG 1

panding consumer market (e.g. fresh vegetables for Conakry)

- The mainroads, though generally in good condition permit only limited transports; e.g. it is seldom possible to leave the mainroads with a charged motor lorry to collect farm products. This is true for the dry season and even more for the rainy season.

- Compost is a novelty for the farmers. A well organized extension service is needed for the first years of compost introduction. The extension service can work most effectively nearby a town.

Fig. 1 showns the area of investigation as a circle, situated between the centre of Conakry I and the Hinterland. This is a low coastal area with elevations up to 2oo m above sea level, in a North eastern direction (watershed "Back of Guinea").

2.3.2 Soil and climate.

The coastal strip is very flat and consists of fertile humid soil of alluvial origin. Some simple dikes are built for protection against floods and in the polders rice is cultivated. These soils, which are especially favourable to the cultivation swamp rice, hardly come into question for the use of compost.

By increasing elevation, the areas off the coast, are loosing [illegible] their alluvial character, being of a permeable [illegible] soil type. Its colour is bright red and hardly contains any clay and humus. The [illegible] consists of coarsly granulated material, mixed with gravel and rocks. Because of the [illegible] permeability of these areas the average dry season of [illegible]-6 months works out very unfavourably [illegible] the vegetation, which almost completely [illegible] expected the pH-values and the [illegible] nutrients plants of these soils [illegible]. Humus and other organic matter are [illegible] in small quantities. The clay is [illegible] than that of the temperate [illegible] a very limited exchange capa[illegible] and a strong propensity of [illegible] fixation. The supply of soluble phosphate is transformed into a form which is relatively insoluble.

The natural vegetation of the area has been destroyed by human activity and a secondary vegetation appears in the fallow period.

At present a certain improvement of the soil is practised by the farmers already now, by manuring with foliage. However, by a continous shortening of the fallow period the secondary growth does not produce sufficient organic matter to be able to improve the soil structure effectively.

The climate of the area is the typical hot and humid tropical climate with a dry season of about 5 months and intensive rainfall during the rest of the year. The occurring heavy showers (35o mm in 24 hours) are in part the cause of strong soil erosion of over 2o T/Ha and per year. Data on rain distribution and monthly temperatures for the surroundings of Conakry may be taken from table 8.

The utilization of compost could improve decisively the water holding capacity of the soil, so that the vegetation period could be extended up to the first months of the dry season. Given climatic soil and conditions, erosion and a permanent deterioration of the soil fertility and crop yields could be mitigated by the application of compost.

2.3.3 Agrarian structure

In this report the agrarian structure is of interest only in as much as the existing management and property forms in agriculture would react to the introduction of the new means of production (i.e. the compost) or in other words, in as much as the farmers can be considered as potential purchasers at all. Statistical data on farm sizes, on the property and cultivation methods of the soil, are not available, so that in this respect the analysis is limited.

In the following we will shortly describe the present form of management.

The most general form of agriculture in the area is subsistence farming, the extent of the cultivated surface depending on the family size and the available manpower. The surface the more fertile river valleys (with permanent agriculture such as bananas, maize, potatoes) is relatively limited. On the higher situated lands and on the slopes manioc, maize and mountain rice are main crops. The system of bush-burning is practised after every 3-4 years of production during a 5-6 years of fallow period. However, because of the increasing population the fallow time is constantly becoming shorter which is leading to permanent deterioration of the soil fertility in the area of investigation.

The soil is cultivated only by means of a hoe. Up to now the use of chemical fertilizers is unknown. However, the use of leaves as organic fertilizer is generally known, although the practice has become less important. This is caused by the prevailing shortening of the fallow time with its consequent more limited supply of leaves.

According to our own estmations about 8o % of the total agricultural surface of the area is cultivated on subsistence base.

Table 8.

Climatic data of the Conakry region.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Yearly average
1. Temperature (°C)													
Conakry	26,5	26,9	27,2	27,8	27,[illegible]	25,9	24,6	24,7	25,[illegible]	25,9	26,7	26,3	26,3
2. Relative humidity of the air (% rel.)													
Conakry	74	71	70	70	78	85	89	91	88	84	83	74	80
3. Precipitation mm													
Conakry	1	2	6	19	159	553	1327	1105	714	334	119	13	4.352
Coya	1	4	16	35	162	504	1023	1154	653	390	114	16	4.1[illegible]2
Dubreka	-	-	5	32	139	432	1024	1206	683	389	173	8	4.091
4. Precipitation maximum/24 hours													
Conakry	14	14	57	40	80	164	228	360	300	155	97	57	-

Source: Service Nationale de la Météroloqie, Conakry (numbers = averages of 1931 - 1960).

The largest part of the expected compost quantities must be supplied to these farmers. Supposedly the farmers will react positively upon the use of compost since the importance of the organic substance has already been understood (See use of leaves and fresh waste).

Concerning the fixation of the compost prices attention has to be paid to the necessary financial requirements. From the few inquiries, made in several villages, it could be concluded, that about 6o % of the subsistence farmers received an additional income from non agricultural activities, i.e. occasional employment in handicrafts and industries in the region of Conakry.

About lo % of the remaining surface is cultivated with permanent cultures (mango, oilpalm, citrus). The existing farming is that of the plantation type, developed from the subsistence farms. Often these plantations are less eroded "islands" in the higher situated areas.

Actually organic material is only used in the plant holes. As this cultivation practice and its economic value are becoming more important it is to be expected that part of the compost could be sold to these farmers.

A part of the remaining surface is cultivated by a special form of agricultural management the so-called "College d'Enseignement Révolutionaire" (C.E.R. - fermes scolaires). These are state-farms, ancillary enterprises of polytechnical schools and which should influence positively and directly the surrounding form of agriculture by demonstrating more modern methods.

In the area of investigation other forms of agriculture do not exist or don't have acquired any importance, as e.g. agricultural production co-operatives.

2.3.4 Marketing of agricultural products.

As on the one side the use of compost must lead to the increase of the agricultural production, and on the other the cost of the utilization of compost can only be covered by the proceeds of the marketable products, an analysis of the supply and demand situation is required.

According to the very few data which are available, it is almost impossible to present a quantitative picture of supply and demand, (neither for local need nor for the export market).

At the local markets, especially in the area of investigation in Conakry, only the occasional surpluses of the surrounding traditional farms are offered and there it was not possible to find examples of cash crop production for the Conakry market.

Unfortunately it was just as impracticable to make a specific product demand analysis in order to find out special supply rates. However, from the general marketinquiry the conclusion is drawn that the supply to the Conakry market of fresh vegetables and other vegetable products does not come from the farmers which are living near the market in the area of investigation, but for the largest part from the area around Kindia which is situated at a distance of [illegible] km.

This observation leads to the question whether the site of the compost plant in the area of investigation (that is in the market area of Conakry), has been well chosen or that,

- the area is generally unsuitable for intensive cultivation

- the local farmers do not know how to profit from existing market possibilities

- The neighbouring town offers easier and more profitable ways of earning money apart from farming.

These questions will even become more important if the growth of Conakry will continue in its actual way. In the near future the growing demand for agricultural products, cultivated in distant areas, will create increasing transport problems.

The increasing market demand will certainly have its impact on the area of investigation but will only then lead to a production increase, if the soil capability (which is actually poor) can be ameliorated by the application of means of production (compost, fertilizer). One should be aware that the farmers know how to profit from the occurring market possibilities. This is concluded from the following observations. The export price for certain products has been fixed by the government and is valid for the whole year indepently of offer and demand. However, at the local markets the prices for the same products are fluctuating considerably as shown in table 9.

Table 9.

Prices of selected products at the export and local market.

Product	Prices in FG/KG: export prices 1) Harbour of Conakry	Prices in FG/KG: price on the local market 2)
bananas	35	3o-7o
pine-apple	9o	3o-13o
citrus	23	15-6o
mango	1oo	125-15o
avocado	55	3o-8o

1) price fixed by the state.

2) own inquiries.

The fluctuations on the local market are leading to the fact that also the products of export quality are offered at the local market, as soon as local prices are rising above the export price. Also the reserve is true. The sale on the local market is carried our partly directly (producer - consumer), partly via agents or through the Stateorganizations O.C.A. (Office de Commercialisation des Produits Agricoles) and ALIMAG (Enterprise Nationale pour l'Alimentation Générale) which also take care of the transport (e.g. Kindia - Conakry).

The export of agricultural products is exclusively in Lands of GUINEXPORT which as a government's company, is subordinated to the Ministry of Commerce. The products destined for export must comply with a certain standard quality. Table lo gives a picture of the actual exports.

2.3.5 The market for agricultural means of production

Contrary to the inland trade of agricultural products, the trade of agricultural means of production is completely in hands of state companies. All the agricultural means of production are import products (chemical fertilizers, pesticides, equipment etc) as far as the distribution of these means of production state-, semi-state-school farms and cooperatives are favoured in such a way that for the individual farmers nothing is left. Apart from this, the individual farmer can hardly act as a purchaser because of liquidity problems.

This doesn't mean that the effect of fertilizers is unknown to the farmers. If a sufficient quantity of fertilizer would be at their disposal, a small part of the farmers would spend money for fertilizer. (See point 2,3.3).

In table 11 the quantities of fertilizers are shown which have been imported in recent years. The quantities shown in table 11 are not complete because the imports of large customers, as well as the quantities received from Technical Assistance, are only partly included. Any way it is clear that the imported fertilizers are neither in composition nor in quantity in accordance with the real demand.

2.4 Evaluation of marketing possibilities of compost in agriculture.

The market possibilities of compost are depending on a number of factors. Especially the price of compost, the relevant areas, its effect on productivity and the organizational problems, like extension and transport, are of great interest.

2.4.1 The price fixation for compost.

In this case the fixation of compost prices plays a keyrole and therefore has to be considered from different angles.

Table 1o.

Export of agricultural products.

years	1960		1965		1966		1967		1968		1969 2)	
products	Q 1)	V 1)	Q 1)	V 1)	Q 1)	V 1)	Q 1)	V 1)	Q 1)	V 1)	Q 1)	V 1)
fresh bananas	54864	1.145745	43522	1.o322o2	54117	1.198551	33176	7992o6	26422	63o333	24.657	862.882
fresh pine-apples	5476	786683	4581	46314o	7955	7o2647	6187	581635	67o2	754484	8738	876361
almond palms	22968	918725	19o47	682o18	2o166	742998	15124	538766	17219	631881	.	.
green coffee	16o34	2.116946	3551	4628o1	12716	1.717949	2269	318542	4616	621o68	.	.
other vegetable products	- 3)	38o939	-	344275	-	219169	-	55432	-	168539	-	.
animal products	-	1o7786	-	53188	-	9o537	-	68375	-	5o537	-	.
Total	-	5.456824	-	3.o37624	-	4.671851	-	2.361956	-	2.856842	-	.

1) Q = Quantity; V = Value in 1.ooo FG (= about US $ 4,25) 3) . - = no indication.
2) 1.1o.68 - 3o.9.69.

Source: Direction Nationale de la Statistique et de la Mécanographie, Conakry 197o.

Table 11.

Imports of chemical fertilizers (value in 1.000 FG).

fertilizers	1960	1965	1966	1967	1968	1969	1970 (prognosis)
nitrates	58.250	29.735	57.206	10.138	111.704	142.900	130.000
phosphates	884	-	529	-	4.507	-	-
potassium	33.681	149.454	132.778	60.054	131.462	-	-
mixture (15/15/15 or 17/17/17	14.111	-	-	600	-	86.408	192.000
others	330	-	3.134	29	4.440	-	18.000

Source: Direction Nationale de la Statistique et de la Mécanographie, Conakry 1970.

(numbers probably exact).

- The price must be low enough to draw the attention of the farmers especially during the introduction period and may not exceed the financial possibilities of the cultivators.

- The price must be high enough to cover the total costs of the compost plant.

- There must exist a reasonable relation between its nutritive value and its yield increasing effect.

Apart from this it should be taken into consideration that using compost means higher additional costs for the farmers (distribution, storing, auxiliary means, transport etc). Concluding the descriptions in chapter 2.1 of the nutritive value per ton compost can be evaluated at 2.260 FG, which is comparable to the prices of chemical fertilizers. However, for the individual farmer the compost should be cheaper, so that he will be able to bear the necessary additional expenditures for distribution (estimated at about 300 FG/ton of compost) and transport. For transport costs one should count upon 25 FG/ per ton/km. Up to a distance of 22 km, transport costs amount to 560 FG per ton, so that the price ex factory could amount to 2.260 FG - (560 + 300) = 1.400 FG/ton of compost.

This price of 1.4oo FG/ton of compost seems reasonable to be recommended also from the view of the compost plant's economy. In the first years of operation, production costs per ton of compost will be above 1.4oo FG/ton, but when the operating capacity increases the production costs per ton of compost will decrease below 1.4oo FG so that soon an equalization of the accrued losses will be reached and later-on a profit can be obtained (see table 15).

2.4.2 Areas suitable for compost application.

The application of compost is not unknown in the investigated region. Numerous farmers asserted that they would buy compost if the possibility was there as the existing "compost piratery" shows. This expression comes from the State Hygienic Service and means the illegal utilization of various solid waste material from the refuse-dump. For one truck-load (4 tons) of this not quite decayed material in which many metal and glass pieces up to 4.ooo FG is paid. Main consumer are the Municipal Parks Service and owners of private gardens. Newly gathered waste is sold by the garbage truck drivers to different farmers around Conakry. As the compost surely will be more expensive than the illegally bought and relative poor waste, there will remain the liquidity problem for the farmer.

According to our own investigations, the agricutural acreage suitable for compost application is relatively small and will hardly exceed lo % of the total area, the remaining 9o % not being cultivated.During the dry season, 5o % of the existing agricultural acreage can be reached by trucks.

In order to underline the influence of the compost application on the crop yields and at the same time not to exceed the financial capacity of the farmers. An amount of compost of 3o tons/ha is recommended for a three year period.

The areas accesible by trucks nearly correspond with the areas in which compost application is needed. With the increasing general development it can be assumed that the traffic accessibility will improve, or else that the compost application per ha could be increased in the course of time. Besides 3o tons/ha in a 3 year term is considered to be a minimum. Table 12 contains a comparison between the compost quantity and the disposable acreage.

The required areas stated in table 12 must be served otherwise possibility of an economic application of compost is hardly possible. If it will be necessary to include the more distant regions for compost utilization, where transport costs will increase and automatically the compost price will rise.

If, during the first period the amount of compost consumed in agriculture would be less than its supply, we propose to make use of the possibility of compost application in the municipal region (as shown in the chapters 1.4 and 2.2).

2.4.3 The feasibility of compost application to different crops.

For the feasibility analysis it is necessary to know the specific yield increasing effect of compost application to different crops (net yield surplus of compost). In spite of intensive efforts it is impossible for the expert team to state any data from research or local experience concerning the use of fertilizers. The competent institutions do not dispose of such data. The only results of research come from a rice-project in the alluvial coast plains but they are of no use for the compost application in higher situated regions.

In table 13 the inverse way is taken. On the basis of data of some selected crops, it is shown which minimal yield surplus has to be obtained in order to compensate the surplus costs of compost application. A comparison is made between cultures such as rice and maize, as well as cash crops like potatoes and pine-apples, which are not yet cultivated on large scale in the investigated region.

Table 12.

Amount of compost and required agricultural acreage (supply and demand)

	1973	1974	1975	1980
Garbage production				
Tons/year	36.500	38.500	41.000	55.000
Compost production[1]				
tons/year	23.200	24.600	26.100	35.000
Required area				
(ha)				
application = 3o tons/ ha/3 years	2.32o	2.46o	2.61o	3.5oo
application = 5o tons/ ha/3 years	1.39o	1.47o	1.57o	2.1oo
Potential area				
(ha)				
existing areas[2]	4.6oo	4.6oo	4.6oo	4.6oo
accesible for trucks[3]	2.4oo	2.5oo	2.6oo	3.5oo

1) Amount of compost = amount of town waste minus 15 % (non compostable ratio), rest minus 25 % composting losses.

2) At present according to own estimations and in accordance with the agricultural institutions, not more than lo % of the total investigation of area can be used for agriculture.

3) At present about half of the agricultural area can be reached by 5 tons trucks at least in the dry season. It is assumed that with continuing general development the traffic situation will improve.

Table 13.

Yields and costs of the application of compost.

culture	gross yields kg/ha/year	FG/KG Ø	gross yields FG/ha/year	costs of the application of compost 3o ton/ha 1)	necessary surplus of yields to compensate the costs of application of compost in % of column 2 or 3
1	2	3	4	5	6
1. Mountain rice	9oo	85	76.5oo	64.5oo	85
2. Maize	4.5oo	. 2)	8o.ooo	"	81
3. Agrumen	12.ooo	2o	24o.ooo	"	27
4. Manioc	18.ooo 3)	15	27o.ooo	"	24
5. Peanuts	1.1oo	24o	275.ooo	"	23
6. Taro	8.ooo 3)	45	36o.ooo	"	18
7. Bananas	18.ooo	4o	72o.ooo	"	9
8. Potatoes	4.2oo	22o	946.ooo	"	7
9. Pine apples	2o.ooo 3)	7o	1.4oo.ooo	"	5

1) The costs of the application of compost are composed with the purchase price of 1.4oo FG/ton the transport costs of 45o FG/ton (18 km à 25 FG) and 3oo FG/ton charge for work.

2) Sold normally as green corn cobs.

3) Calculations based on one year harvest 12 to 18 months after planting.

Table 13 should not be regarded as an exact economic comparison because each crop poses different demands on f.i. fertility of the soil and amount of work. Yet it is shown which facts must be taken into consideration with regard to the application of compost under the circumstances in the investigated region. The following conclusions can be started:

- For the compensation of the costs of compost application a considerable yield surplus must be obtained. The surplus differs according to the various crops. It should be all the higher, the lower the present gross yields (yield x price) are.

- Especially the substence cultures demand extremely high yield surplus to compensate the costs of compost application. But if for compensating compost costs a yield surplus above than 25 % is needed, the compost application as a single measure scarcely will suceed.

- The application of compost could be feasible especially for cash crop products. But these crops are not yet generally cultivated in the higher situated regions (potatoes, tomatoes, cucumbers, carrots, lettuce etc).

So the problem arises that f.i. for 1975 about 87o ha (see table 12) will be needed to take care of the produced amount of compost, (26.1oo tons of compost : 3o tons/ha = 87o ha/year).

But the largest part of this area is still cultivated with subsistence crops for which feasibility hardly can be reached (according to table 13).

At this place it is useful to discuss the market situation once more.

According to our numerous discussions with the competent institutions we can conclude that at present the market of Conakry is not sufficiently supplied with and that therefore the high transport costs from Kindia (a distance of about 15o km) become profitable. The high population increase (4,6 % per year) will especially accentuate this tendency for those products already supplied in unsufficient quantities such as potatoes, tomatoes and carrots.

The cultivation of these products at natural conditions can only be expanded in the investigated region when soil improving measures are executed. The application of compost comes in the first place because of its simultaneous fertilizer and soil improving effect. Apart from this the waterholding capacity is increased and the soil erosion controled. In other words the marketing possibilities of vegetables can only be realized after the application of compost. Likewise the application of compost becomes profitable by the cultivation of vegetables. In this process of change the extension service will be of great importance.

2.4.4 The importance of agricultural extension.

An intensive professional advisory board of the farmers by an extension service does not exist or else has newly been established (the really useful extension work done by the municipal officials cannot replace the professional counseling by an expert team). Its actual staff and its provision with means is so limited, that a change of present farming behaviour can hardly be expected. However, indications exist that the population is in fact extension minded as the rice project at the mangrove coast of the Conakry peninsula is showing.

As far as the application of compost is concerned it will be inevitable to have a small expert team study this problem. Such a group should start with experiments in order to get experience and to make the application of compost more popular. In this way right after the start of the compost production there will be an actual compost demand.

Apart from their professional preparation the farmers should also financially be enabled to buy the compost. As the experiments with fertilizers will show, the application of compost will be more a liquidity then a feasibility problem.

Several possibilities exist:

1. The compost can be subsidized at a decreasing rate by the Government of Guinea during the first 3-4 years. For instance:

   1st year : The farmer pays 1oo FG/ton "Approval tax" plus transport costs.

2nd year : 6oo FG/ton plus transport costs.
3rd year : 1.ooo FG/ton plus transport costs.
4th year: all costs included.

2. The compost is delivered wholly or partially on government credit. The farmers will therefore be obliged to

   a. agree to a detailed cultivation programme
   b. effect repayment by delivery of products at harvest time or by cash payment after the harvest.

   For the first few years the state will guarantee the purchase of the products at fixed minimum prices and assure viability for the farmer.

The introduction of compost use will be means of field demonstrations, pilot-plots and a general extension service.

2.4.5 Transport problems.

Current transport costs of 25 FG/ton/km are included in the calculated purchase price of the compost.

Table 14 shows that 4-6 trucks are needed for the transport of the compost. It is assumed that transport is possible 25o days a year if well organized.

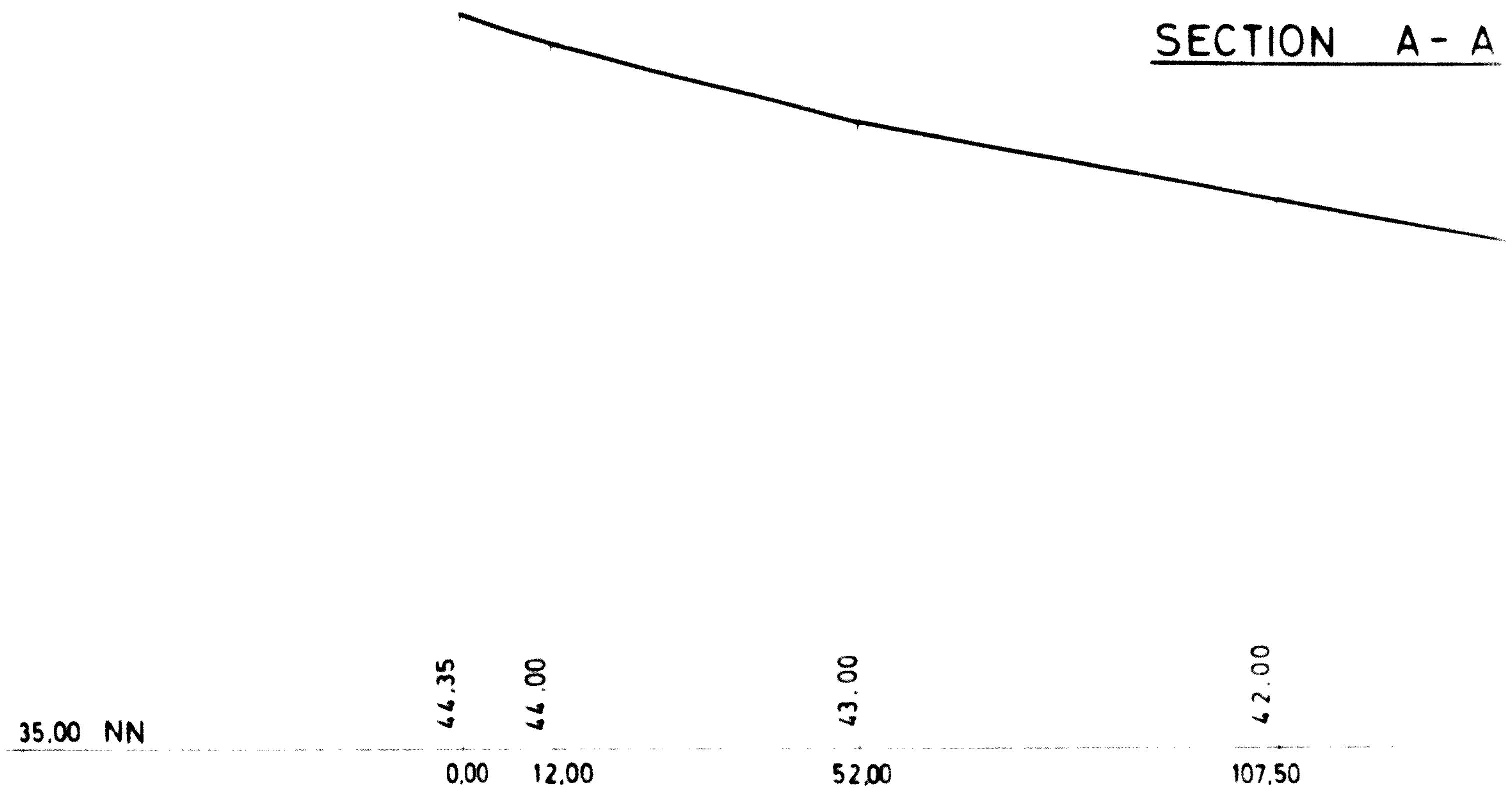
Table 14.

Transport volume for compost delivery.

Year	Qty of compost/ year (in tons)	annual required trucks-loads (à 5 tons)	covered raod distance per year (35 km per trip)	number of trips/day (25o days /year)	number of trucks (5 trips/ day
1973	23.2oo	4.64o	162.4oo	19	4
1975	26.1oo	5.25o	184.ooo	21	5
198o	35.ooo	7.ooo	243.ooo	28	6

Inquiries have shown that at present no private enterprise exists which is capable of supplying the required transport capacity mentioned above. There are sufficient private transport firms which would accept longterm transport orders - even for less than 25 FG/ ton/km, but their trucks are in such a bad condition that they cannot be relied upon for permanent use.

For these reasons the experts propose to leave the sale of the compost to the plant which should distribute it with its own vehicles (a minimum of 2 trucks) at least partially and give temporary limited contracts to local transport firms.


SECTION A-A
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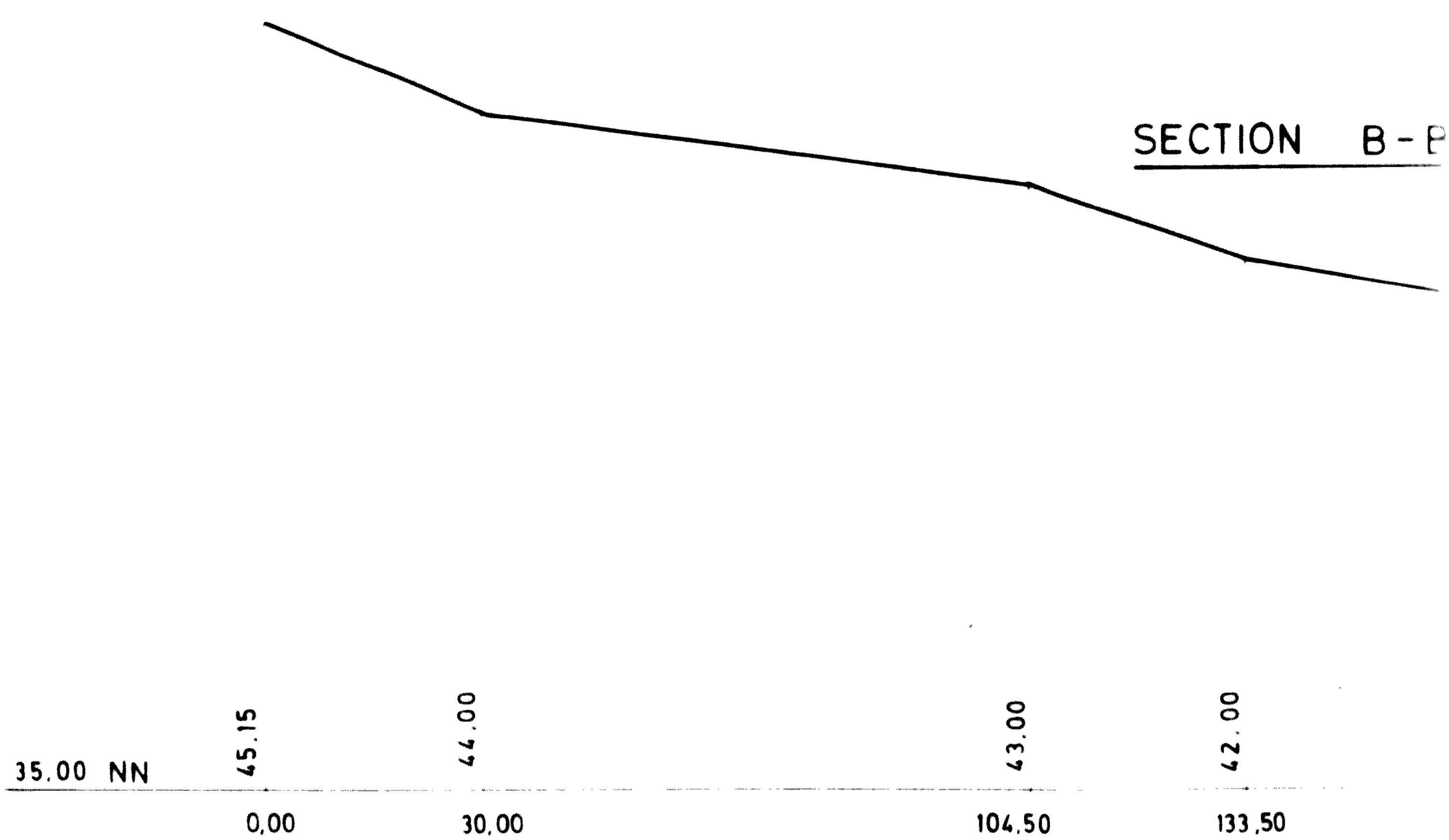
44.00
43.00
42.00
35.00 NN
0,00
12,00
52,00
107,50

SECTION 1


SECTION B-B
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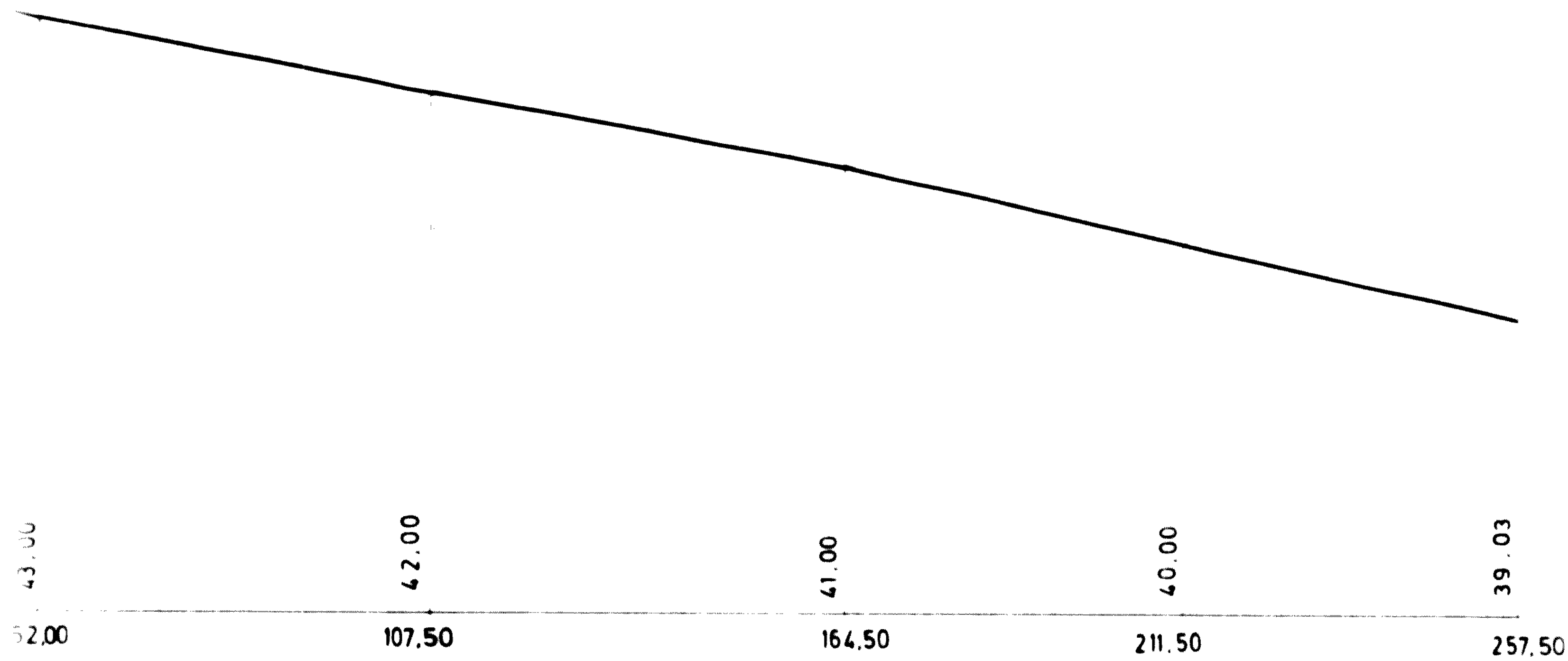
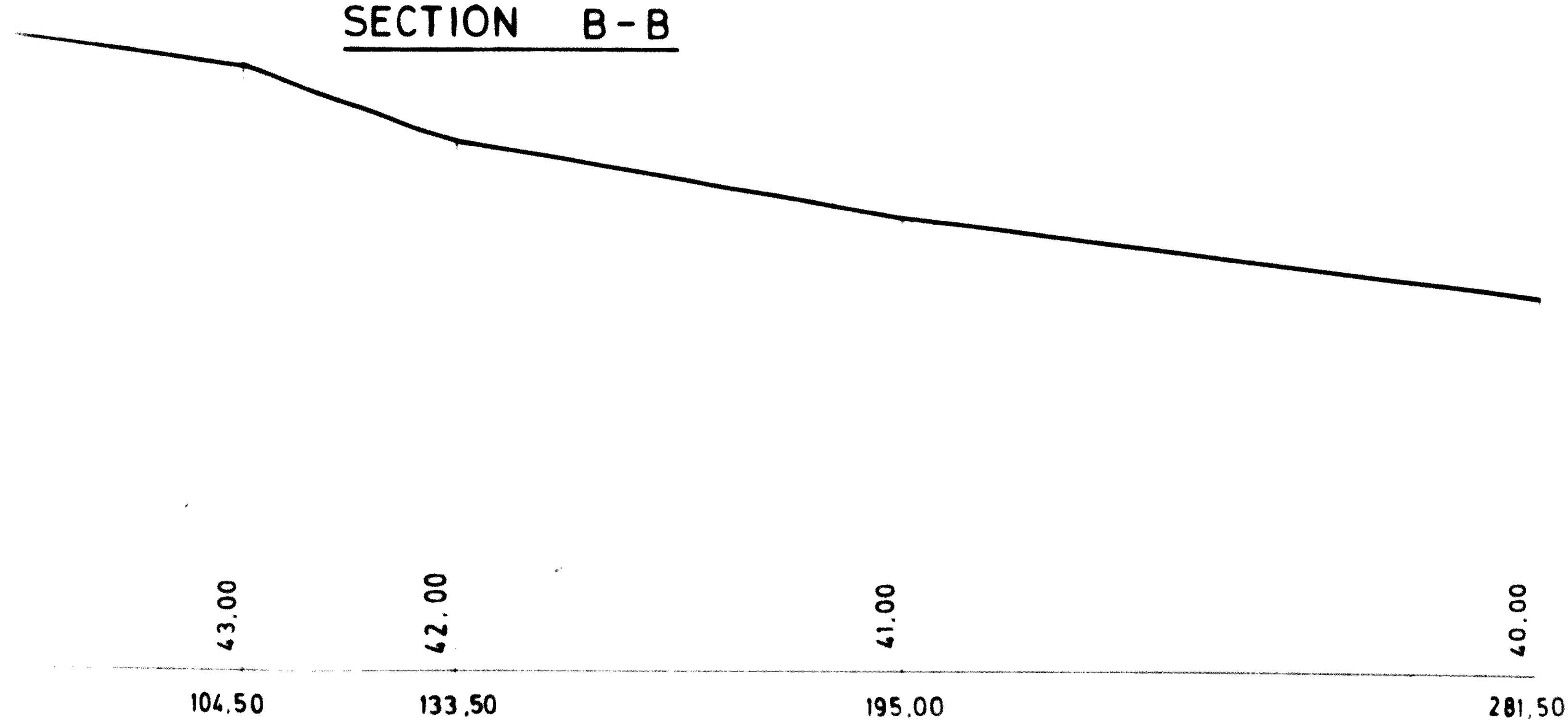
133,50

SECTION A- A



SECTION 2

SECTION B-B



Scale 1:1000
1:100

FIG.3

In this way the risks of delivery shortages at peak periods will be minimised and at the same time private transport enterprises will be able to participate.

The marketing of the compost is essentially a transport and extension problem. It should be solved by the compost plant in cooperation with the regional agricultural instructions.

3. The compost plant.

In chapter 1 and 2 the basis for the planning and lay out of a compost plant for [illegible] town refuse has been investigated and elaborated with particular attention to the plant's raw materials and the market for the final product. It has been shown that the composition of the raw material is very suitable for composting and that the utilization of the final product is possible mainly in agriculture.

In the next chapter it is intended:

- to select the most favourable composting method for the prevailing local conditions.
- to select a plant site, suitable for the receipt of the raw material as well as for the sale of the final product.
- to investigate the necessary investment costs.
- to calculate the annual operation costs.

3.1 Selection of the composting method.

3.1.1 The principles of composting processes.

The composting of the waste materials can be compared with the natural decomposition of organic substances thereby they are broken down under the influence of bacteria, algae, fungi and other soil micro organisms and transferred into a stabilized form. From this form they can be reassimilated into the natural cycle of organic matter.

Two courses of the natural decomposition process can be distinguished. An aerobic decomposition and an anaerobic putrefaction. In the aerobic decomposition process the organic matter of facultative aerobic and mainly thermophilic micro organisms is transformed into a stable form of humus. Considerable quantities of oxygen and energy are respectively assimilated and produced. The organic matter is not objectionable since it is rendered aseptic, under the influence of the developed heat and can be used in agriculture with excellent results.

In the absence of oxygen the dead organic matter is transformed by anaerobic putrefaction whereby the organically fixed nitrogen is transferred into organic acids and ammonia. A considerable part of the organically fixed carbon escapes as methane. At the same time the unpleasant smelling gas hydrogen sulphide is formed. Only a small quantity of heat is produced under the anaerobic putrefaction process and bacterial 'purity' of the material cannot be assured.

Compared with the natural process of decomposition of organic matter composting has the considerable advantage that the decomposition process can be controlled by biological and physical measures. Therefore the purposes of composting town waste are:

- to make the material aseptic by controlling the temperature range.

- to produce a high quality product for agricultural use by controlling the decomposting process.

- to accede the natural decomposition and fermentation process.

3.1.2 Possible methods of composting.

All of today's composting methods can be fundamentally traced back to two main systems:

- The system of windrow composting
- The system of composting in closed fermentation cells with the control of temperature, moisture or air.

The advantage of the fermentation cell composting lies in the system's independance of the external climatic conditions, in its small spatial requirements and in its comparatively limited labour requirements. In addition, the processing of substances normally slow to decompose is speeded up. The control of the decomposition process requires considerable technical expertise, since complicated technical equipment is necessary, requiring a corresponding investment. The minimal duration of the waste material in the cells is governed by the time needed to sterilize such material. Therefore the capacity of this type of plant can only be increased by the installation of additional fermentation cells, with all the required technical accessories.

The technical requirements for windrow composting are essentially less. This system uses natural climatic for the decomposition process. The slower operation of this composting process gives rise to a greater spatial requirement than that of cell-composting. Material left to decompose in windrow requires frequent turning which gives rise to a comparatively higher labour requirement. The capacity of windrow composting does not depend so much on the duration of the actual composting process but rather on the capacity of the preparation plot. However the capacity of these plots could be doubled or even tripled without installing additional units by a change to shift-work. Labour requirements will increase accordingly which may be favouable in countries with underemployment.

For the selection of the most suitable method for a certain town there is a number of criteria, to be considered. The most important are:

- the composition of the waste material
- the prevailing climatic conditions
- the area available for the foundation of plant
- the availibility of labour
- the potential extension capacity.

Most of the Conakry's waste material consists of plant residues, which are easy to compost in natural way, after adequate preparation and decomposting.

The warm humid tropical climate contributes to the comparatively rapid decomposition of the organic matter. Even in the dry season when the humidity, necessary for decomposition is approaching minimum, the process can continue. Low population density and low soil fertility in the Conakry area make available large areas of land for the process.

In the future the unemployment now prevalent in Conakry, will increase through intensive immigration from the Hinterland. The industrialization meant to absorp the immigration flow in the region is developing only slowly so that the creation of additional employment is always welcome.

Given the general shortage of foreign currency in Guinea, the degree of utilization on imported equipment is of special importance and it is advantageous to future imports of machines and equipment in favour of local and labour. All mentioned criteria and local conditions support the choice of using the windrow composting system for the town refuse of Conakry.

3.1.3 Technique of windrow composting.

The proposed composting system for Conakry-town the actual composting process is preceded by the technical preparation of the waste material. Its purpose is to separate from the town waste those elements which cannot be composted.

By reducing the dimensions of the compostable matter so that a large contact-surface is offered to the microorganisms, the decomposition activity of the material should not be reduced to such an extent that it will compact in the compost windrows and thereby exclude the oxygen needed for the decomposition activity of the microorganisms. It this happens the aerobic decomposition process will change into the anaerobic putrefaction process with its disadvantageous and unpleasant symptoms.

The separation of the bulky, non-compostable elements e.g. wooden and metal parts, bottles, heavy stones etc. can very well be done by hand at a conveyor belt, so that the succesive units are not overloaded. Tins and other small iron parts can simply be separated by electro-magnets and made into parcels by small scrap-presses.

Although no sales market for by-products exists at this moment (compare 1.1.4), the Government of Guinea considers it desirable to collect the pressed iron scrap and non-iron metals for occasional sales (either for export or as raw material for future ironsmelting works in Guinea).

The preselection of material obviously unsuitable for composting is followed by the pulverization of remaining material and the screening of the larger, non-compostable elements. Finally after screening the heavy and non-compostable elements e.g. stones, glass and of china pieces are separated (by means of a centrifugal machine) for storage.

The screened material then consists almost exclusively of compostable organic matter, which has then been prepared for the actual composting process.

The composting of the prepared material takes place on the composting grounds in the open air. The material is piled up in windrows of 1,5 m to 1,8 m high and any length with triangular cross section. Here the first decomposition process takes place and the heat generated renders the material aseptic. It is generally sufficient for temperatures of 6o - 7o°C to be maintained for 4-5 days.

The decomposition activity of aerobic microorganisms requires a quantity of oxygen which infiltrates into the loosely piled windrows with the air. However, during the storage period the material is compacting more and more and this affects the absorption of oxygen. As an oxygen deficiency can lead to a change from aerobic to anearobic decomposition with its unpleasant by-products: formation of methane, hydrogen sulphide, and ammonia) it is necessary to turn over the windrows periodically, so that the material is supplied with oxygen. As the decomposition process causes a reduction in volume, 2 windrows can be piled together to make one single windrow.

After having turned over the organic substance 2-3 times is decomposed enough to produce a stabilized numus, which can be used successfully in agriculture. Depending on the season (dry and rainy season) in Conakry the period for the active stabilization of compost should take about 4-6 weeks. However, as the compost cannot be utilized regularly over the whole year, it is necessary to construct a compost storage area next to the composting ground, where the compost remains until final sale.

3.2 Selection of the plant site.

3.2.1 Essential local requirements.

Selection of the composting procedure automatically raises the question of a suitable site for the plant. However, before solving the site problem the necessary ground space requirements have to be determined.

Gotaas (Harold B. Gotaas, Composting, Sanitary Disposal and Reclamation or Organic Wastes, WHO - Geneva 1956) states that ground space requirements for windrow composting with a daily capacity of 5o tons consists of a minimum of o,6 ha for buildings, factory' and roads and o,4 ha for composting. For each extra 5o ton of daily capacity local requirements for buidlings and streets will increase by o,1 ha and for composting grounds by o,4 ha.

Stickelberger (D. Stickelberger: The waste material of a settlement, its disposal of utilization, trial of a representation of the relations, Heidenheim / Brenz 1966) arrives at similar results, suggesting that o,15 m^2 is needed per kg of waste-capacity per day.

However, these data should be considered minimum requirements. In the data no area is included for the sanitary storage of non-compostable elements. When the storage of the remaining non-compostable substances is projected on the site of the composting plant, as planned for the city of Conakry, this deposit area must be added to the local area requirements for the composting plant. Furthermore the annual increase of waste should not be neglected in the planning. As the capacity of the plant proposed for Conakry, could be doubled by the introduction of a second shift, the corresponding additional composting and deposit area should be projected, although the final layout of the planned area can be designed later on.

When one accepts the norm of o,2 m^2 per kg of delivered refuse per day for the composting plant including deposit area for non-compostable substances, then a surface of about 2 ha is enough for the tune being. However, the requirements will increase with the increase of the town's refuse programme (compare Table 4):

for 1975: 2,8 ha
for 198o: 3,7 ha.

To have enough available space for the future, an area of about 5 ha should be reserved to be prepared for the foundation of the composting plant for Conakry.

3.2.2 Examined plant sites.

For the installation of the composting plant 3 locations were proposed by the government of Guinea for a closer investigation:

- the area of the present refuse dump in Kénien.
- a surface depression in the neighbourhood of the village Koloma.
- a site in the proposed industrial area in the neighbourhood of the village of Matoto.

The acreage of all 3 locations would be sufficient for building the composting plant as well as the installation of a well-ordered deposit for the residue materials during the immediate future.

The site is characterized by an excellent location for the collection of the waste material. The maximum transport distance for waste material does not exceed lo km, and the roads to the refuse dump are in good condition. The services necessary for the composting such as electricity and water are available in the immediate neighbourhood thus minimizing service investmentcosts. The only technical disadvantage of this location is the comparatively long distance to the compost consumers.

The hygienic aspects present more serious disadvantages. The refuse dump is situated in the center of a residential area and the village's extend close to the edge of the quarry. A still denser population of this area is planned. The town planning department and the public health service are both interested in eliminating this refuse dump. Even if the present unpleasantness were eliminated from the dump through the installation of a composting plant, the departments mentioned are afraid that the inhabitants will be disturbed by noise, dust, [illegible], bad smellings and by the increased traffic. They have stated that they will not agree to the installation of the composting plant on this site.

A surface depression in the [illegible] of the village of K[illegible] has been [illegible] by the planning departments as an alternative location. The main argument for this proposal is the low population of this district. In addition this district is not planned as a residential area for the future. In relation to the question of the choice of the plant's location, there are certain technical and economic facts which suggest that the simultaneous use of the site, as a dump as well as a composting plant, is unadvisable.

The road to this site over a distance of 6,8 km, is in such a terrible condition, that it only can be used during the dry season by cross country vehicles. During the rainy season the access cannot be guaranteed at all. Comparatively high investment would be necessary to eliminate this disadvantage if the traffic into and out of the factory is to be guaranteed.

In addition the site is on a 15 % incline towards the river which supplies the villages of Kolo, Caloum, Hamdalaye and the state research farm of Ratoma with drinking and domestic water. About 2oo m downstream there is a line of wells for the municipal water supply with a pumping station which is pumping the water from the wells to the town-network of Conakry. Pollution of river and well water cannot be definitely excluded because of possible high daily rainfalls and the installation of a refuse dump and a composting plant cannot be recommended at this site.

The third possible site, proposed by the Government of Guinea, is situated in the VIII arrondissement of the Conakry region and planned to be an industrial development zone. The exact location is not fixed yet. The proposed industrial area lies south of national road No. 1 and starts directly behind the airport G'Bessia at km 16. It is about 8 km long and about 5oo - 1ooo m wide. In the south east the industrial area is bordered by extensive swamps which partially comprise an inundation zone of the Atlantic Ocean.

As far as km 19 the industry has already been installed and the sites are reserved and for two more industrial projects surveyed. The reserved areas are destined for the installation of pottery factory and the new municipal garage buildings. Because the pottery factory will be built at the side of the national road and does not need the whole width of the industrial zone, the southern neighbouring area is well suited for the installation of a compost plant and the deposit of the non-compostable parts of the town waste materials.

The conditions for the installation and the management of the compost plant are almost ideal:

- The road and traffic conditions are very suitable for traffic into and out of the factory. The approach to national road No. 1 is good as far as the pottery factory. An approach to the compost plant is planned at the west-side of the future pottery factory. This street will serve only the traffic to and from the compost factory, so the intensity of use will be low. Although the bearing-capacity of the soil is sufficient (rocky subsoil covered by erosion material), a bitumenlayer is proposed because of the dust problem during the dry season. At a street length of 15o meters, a one-lane approach will be sufficient with a lay-by halfway down.

- The supply of water for the factory is guaranteed by a water-pipe (diameter 3oo) traversing the northern part of the proposed plot, coming from the Kakaelima district. Although this originally surface water is not chemically prepared, it has been filtered.
  The comparatively small quantities of water needed for the factory (for cleaning purposes, occasionally humudifying the compost and for fire-services) can easily be taken from this pipe. Originally the pipe was made for the water supply of Conakry, but a few years ago, it was replaced by a pipe with a higher production capacity (diameter 7oo).

- The electrical power can be taken from a draw-off cable from the main circuit from Grand Chutes to Conakry. This circuit passes only 8o meters from the west border of the factory plot and has a voltage of 1o.ooo. The carrying capacity is more than 5oo kVA, which is much higher than needed for the compost plant. The alignment of the feed cable to the factory can follow the inspection road for the water pipe. Originally the draw-off cable to the factory was meant for a quarry plant. The latter plant has been taken out of operation.

- No direct danger to man and animals exist by soil- and surface water pollution from the compost plant. The soil is very permeable and quickly absorbs the rain-water.

The waterflow direction follows the general inclination of the area: north south to the Atlantic Ocean. The area between the plant and the ocean is a swamp area and uninhabited. Problems of smell and dust are not expected at the planned size of the plant and method of composting.

The advantages and disadvantages of the different locations were discussed together with the Ministry of industry, the Health Service and administration of the region Conakry and it was decided that the location in the industrial zone should be reserved for the installation of the compost plant as the most suitable site. At the same time the topographic department was charged with the survey of the location. The map and cross sections of the field proposed for the compost plant are shown in figure 2 and 3.

3.3 The layout of the compost plant.

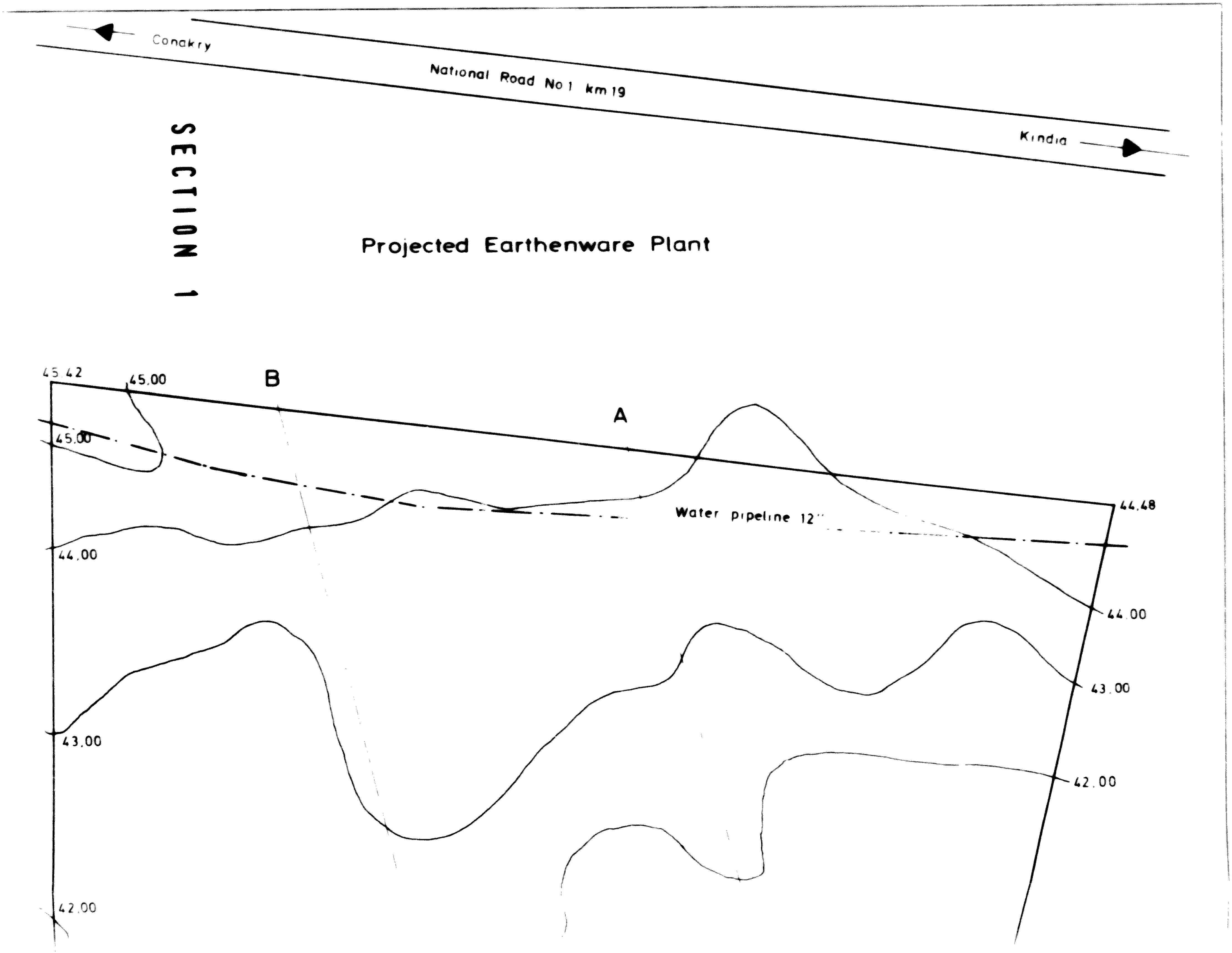
3.3.1 The layout of the technical equipment.

The criteria for the layout of the compost plant are:

- the size of the available lot.

- the required capacity of the compost plant.

The size of the area which had been reserved by the Government of Guinea for the compost plant is about 6 ha and will be sufficient for composting in the next decades as well as for the deposit of the non-compostable residue.



Conakry
National Road No 1 km 19
Kindia
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SECTION 2

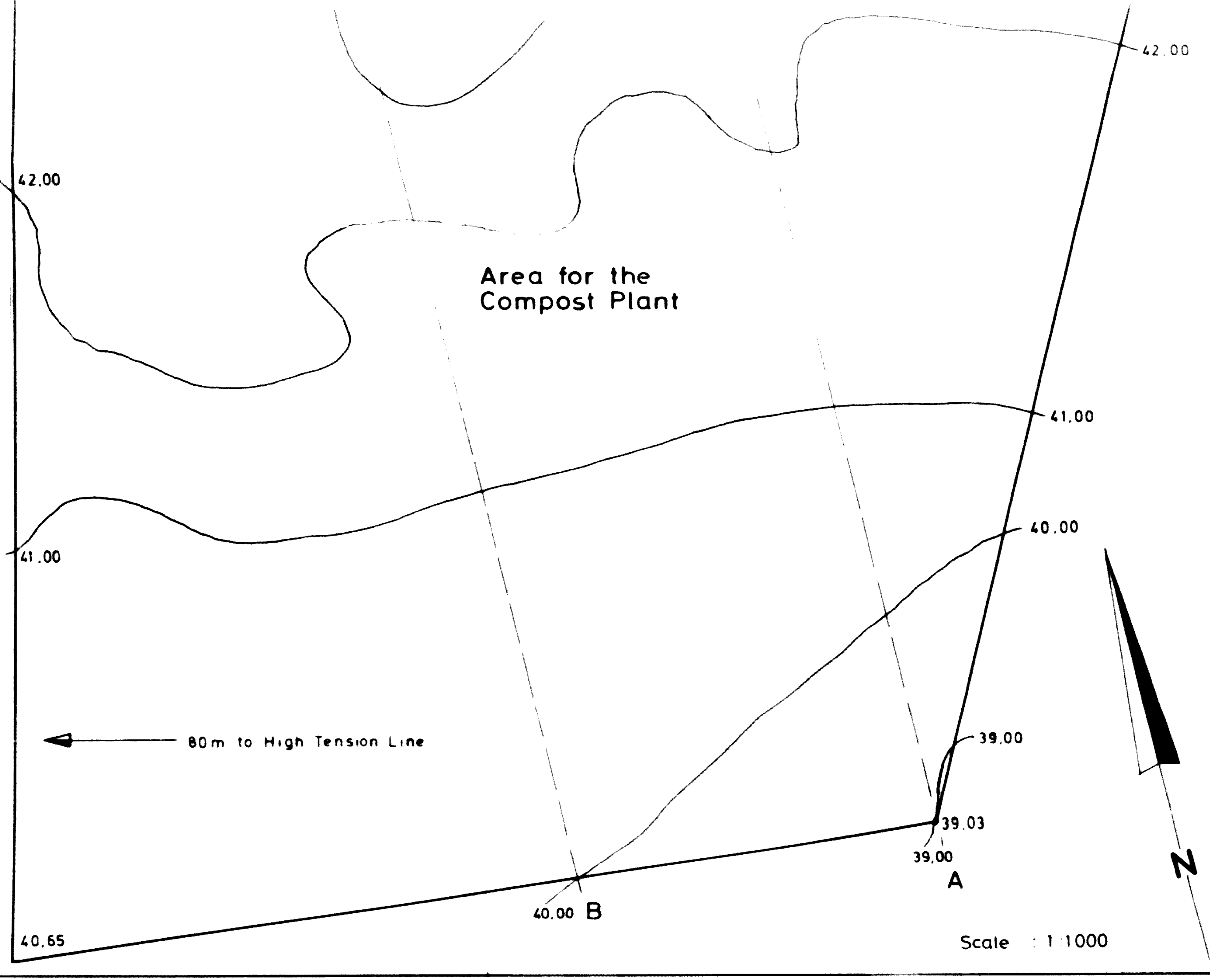
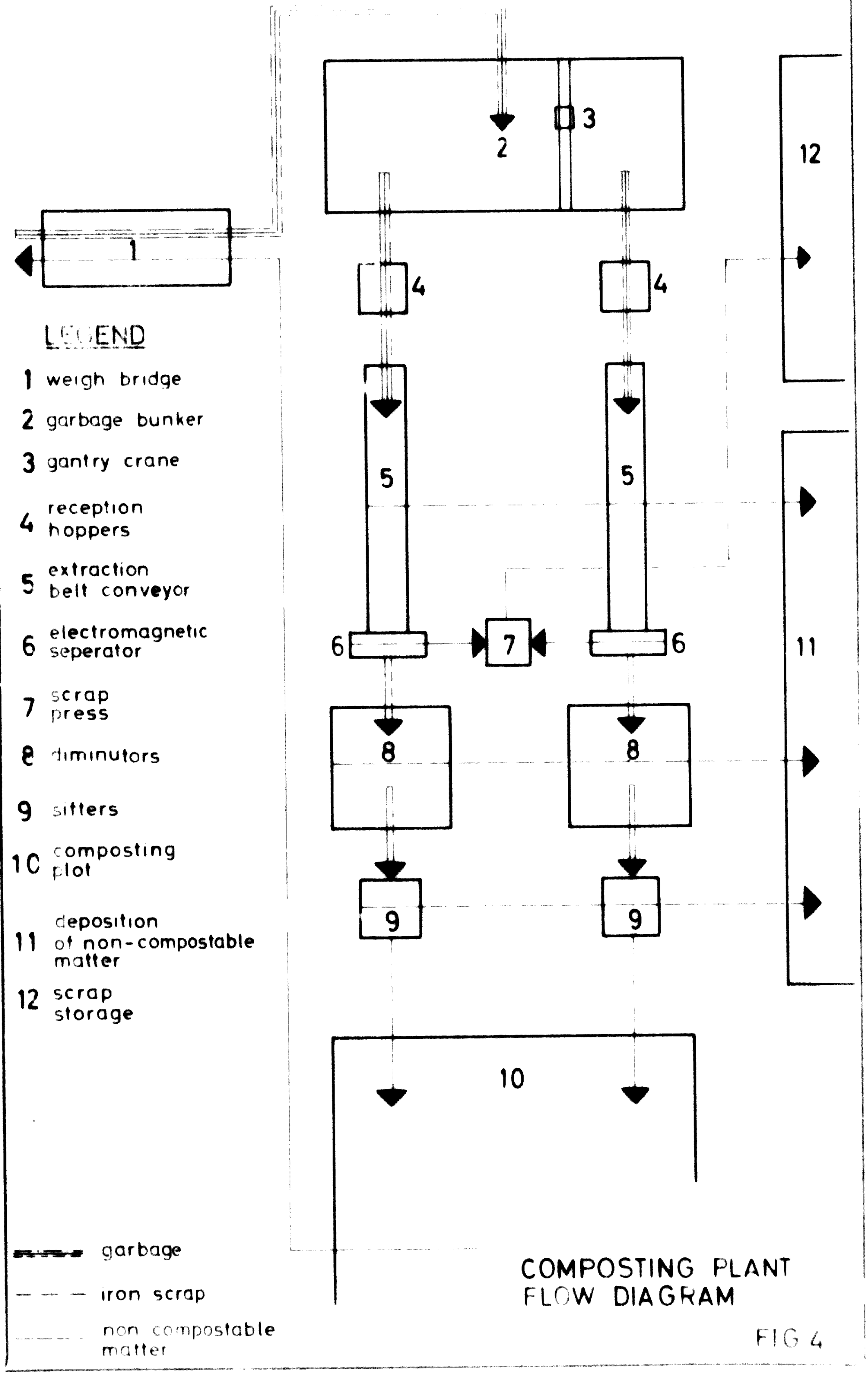


FIG. 2

In regard to the increasing quantity of waste material it is proposed to plan the compost plant for a shift capacity of 15o tons of refuse. Then the total exploitation of the shift capacity will be reached in the year 1977. If the quantity of waste material increases in subsequent years a second working shift will have to be established. The preparation of the garbage for the composting should be done in two parallel process-lines in order to guarantee that there is no halt to the whole treatment-process if single machines are temporarily defective. A corresponding flow sheet is shown in diagramm 4.

On arrival at the plant the total waste material is weighed on the weigh-bridge and the weigh recorded. These records of garbage quantities form the basis for all further investigations by the management. By weighing the compost which is leaving the factory one can obtain a good measure of the compost yield. At the same time the record of the weights form a basis for the cleaning system between the compost plant and the administration of the region. The compost plant requires 14o FG per ton of town waste (see section 4.1).

After recording the waste materials are dumped from the collecting trucks into the deeper garbage bunker. The garbage bunker forms a stabilization reservoir between waste material supply and waste material processing.



COMPOSTING PLANT FLOW DIAGRAM

FIG 4

With its aid it is possible to control the waste material supply which is spread unequally over the whole day into a continuous flow for the treatment (as mentioned before the treatment of the waste material for the proceeding composting is carried out in two different parallel processes with a capacity of lo tons waste material per hour each). The volume of the garbage bunker must be sufficient to contain a whole day supply of garbage. On the other hand the waste material bunker must not be too large, as the garbage will rapidly start to ferment under the local climatic conditions if left in the waste material bunker for some days. A waste material bunker with a volume of about 4oo m^3 will be sufficient for the waste material quantity in Conakry.

By means of an excavator which can reach every spot in the bunker the garbage is brought into the dispatch funnels of the two process-lines. Under these dispatch funnels shaker conveyors or other similar distribution elements are placed, which supply the sorting conveyor-band with an equal and continuous quantity. Solid waste material parts can be removed by hand. Iron parts can be removed by electro-magnets fixed beyond the end of the sorting conveyor belts and via a chute they reach the filling funnel of the scrap press which is the same for both treatment lines.

From the sorting conveyor belts the sorted waste materials reach the pulverizer and screening installations which form the main part of the real preparation process. Larger parts of the garbage are partially pulverized and separated as non-compostable residue materials. The screenings from 6-8 cm diameter pass a second screening device where particularly non-compostable solid materials such as stones, glass and earthern-ware are separated from the compostable material.

3.3.2 Construction lay-out

The soil of the area planned for the compost factory consists of rocky- and coarse-grained material with a satisfactory carrying capacity. The contructional arrangement can be divided into 4 main(elements excluding supplementary constructions for the plant-area such as fences and roads).

- The weigh-bridge-house
- The waste material bunker
- The machine hall
- The compost deposit.

Technical notes and details are to be found in appendix 6.
The weigh-bridge-house should be situated right at the entrance to the proposed plant area so that the whole administration of the compost plant can be housed besides the weigh-bridge room. The night watchman's hut should also be located here. The proposed construction is a one floor building, possibly made of prefabricated parts and with a basal surface of about 2oo m^2. (dimensions 1o x 2o m)

The garbage bunker is situated in front of the machine hall and occupies the whole width. It should be contructed as deep bunker with reinforced concrete. Its depth must be calculated so that the required volume of about 4oo m^3 is lying beneath the supply ramp where the waste material trucks dump the garbage. (dimensions 2o x 6 x 3,3 m)

The support constructions for the grab excavator, which supplies the two treatment process-lines with waste material will have to be above the garbage bunker. The operational area of the excavator reaches over the entire bunker surface and is sheltered by a roof and side shields against the weather.

The treatment process machines must be placed in a substantial building which can be of steel construction. The size of the machine hall must be such that the central control stand of the whole plant, a transformer, a small work-shop, a washing-toilet and a recreation room for the crew can be situated in the machine hall. The surface area of this part of the plant is about 6oo m^2. (dimensions 2o x 3o m)

The largest part of the area of the compost plant is taken up by the composting place where the compost sections are built. While the proposed area of the compost plant consists of solid ground, a

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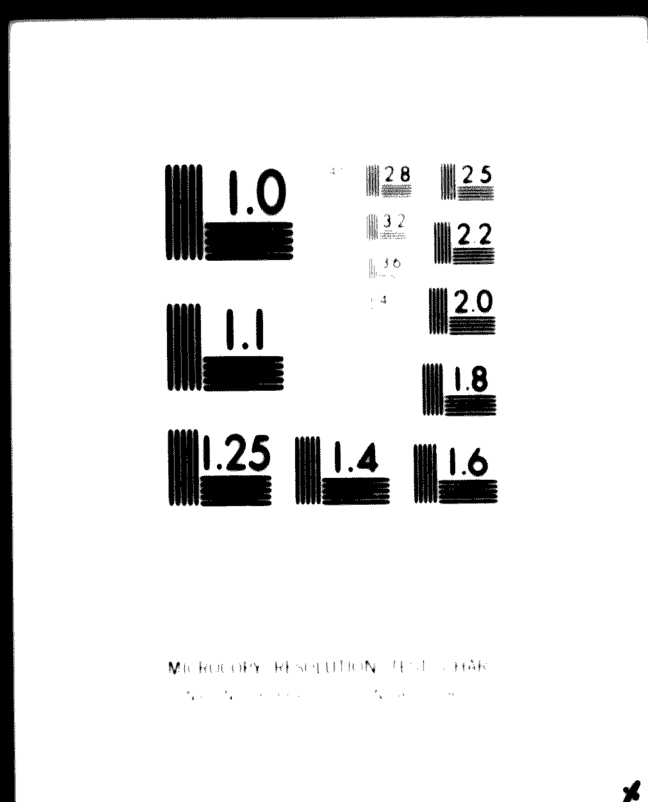
1.0
2.8
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1.6
MICROCOPY RESOLUTION TEST CHART

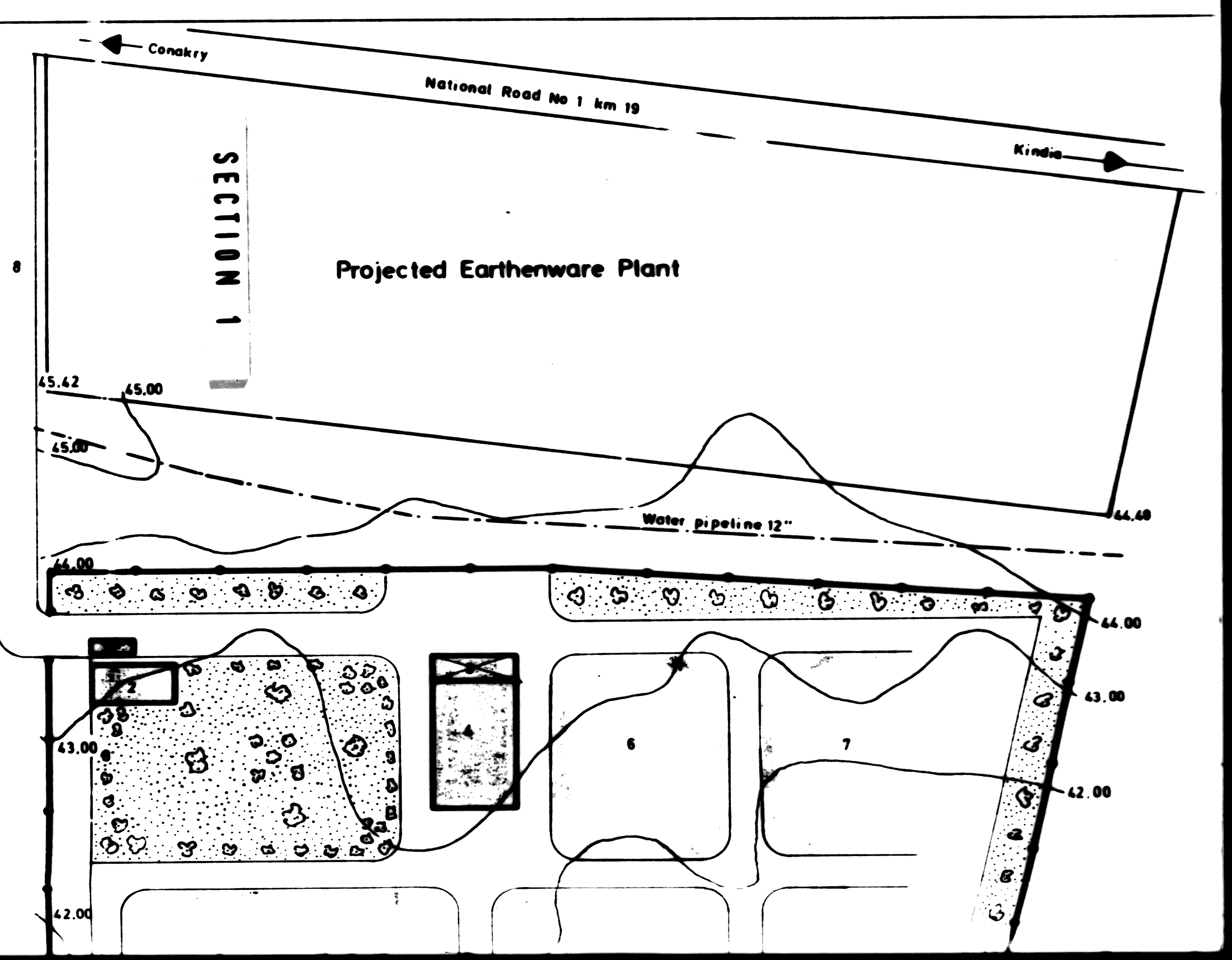
24x
E

level, bituminous layer is planned for the compost place so that the production can be maintained fully during the rainy season, and "drowning of the compost section will not occur. The total area to be leveled is about 2o.ooo m^2, including streets. The compost place must have an inclination of at least 2 % to guarantee the run off of surface water.

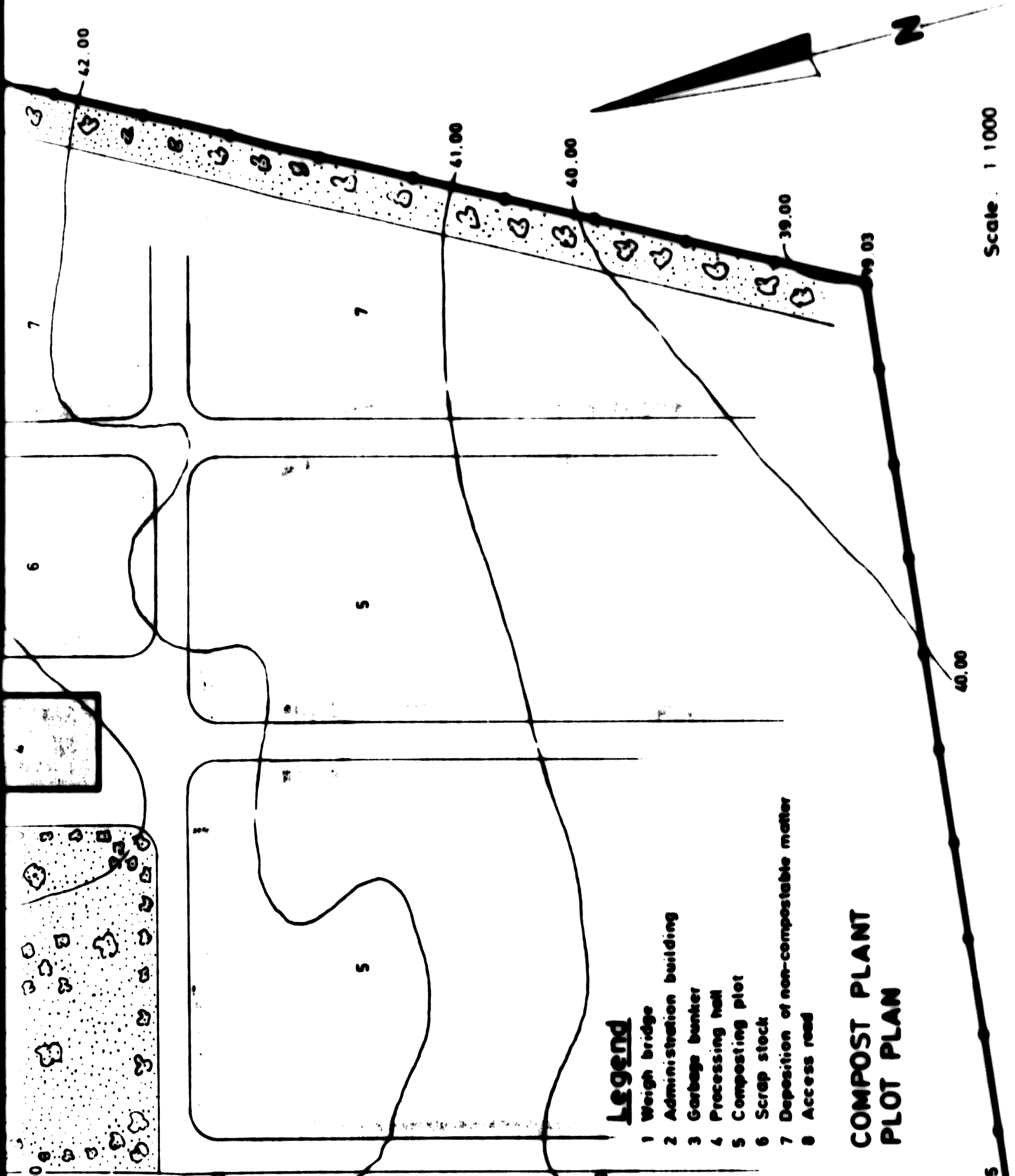
The arrangement of the whole compost plant, in the area porposed by the government of Guinea, is shown in diagram 5.

3.4 Estimate of costs

For the feasibility calculation of the compost plant an estimate of the investment and operation costs is necessary. In order to complete this calculation the costs of the composting must be compared with the expected amount received at the compost market plus the amount paid by the region to the compost plant for the removal of the twon waste. The cost estimates are based on costs and prices pertaining in Conakry as well as on the experience of the experts arising from the installation of similar plants. The building costs, salaries, wages and prices of the necessary resources are derived from local conditions in Conakry, the costs for the technical equipment of the factory from experience.



Conakry
National Road No 1 km 19
Kindia
SECTION 1
Projected Earthenware Plant
8
45.42
45.00
45.00
44.40
Water pipeline 12"
44.00
44.00
43.00
43.00
42.00
42.00
2
4
6
7



SECTION 2

FIG. 5

It is assumed that the technical equipment for the factory can be imported tax-free. The Ministry of industry of Guinea does not expect difficulties in waiving import tax since the compost plant is an installation which will benefit the country as a whole.

3.4.1 Investment costs.

The statement of the investment costs is based on the supposition that the investment capital needed for the installation of the factory can be obtained on the free market of an annual rate of 5 %. Different redemption periods must be considered in order to calculate the annual capital charge of the compost plant and therefore the investment costs were detailed as following:

- construction part
- technical equipment of the factory
- internal means of transport.

The construction part of the compost plant consists of:

<u>Fencing of the plant</u>
hight 2m. length approx. 9oo m including one entrance

<u>Earth removal</u>
for garbage bunker and weigh-bridge foundation approx. 7oo cu.m. (digging and transport)
seeping pits for processing wall and administration toilets approx. 5o cu.m. (digging and transport)

Weigh-bridge foundation

approx. 4o cu.m of re-inforced concrete
(delivery and construction)

Watchman's office (including house)
and administration office

possibility in pre-fabricated construction elements
single storey buildings, approx. 1o x 2o m completed

Garbage bunker

approx. 16o cu.m reinforced concrete
(delivery and construction)
gantry for crane (delivery and montage)
roofing material approx. 12o m^2
(delivery and montage)
outside-wall surfacing approx. 3oo m^2

Machine shed

steel construction including roofing material,
wall surfacing, space sectionning, floors
and machine foundations, measure circa 2o x 3o m
(complete construction)

Site- and road improvement

approx. 2o.ooo m^2 (levelling and bitumen layer)

Electric power

power connection of approx. 8o m from high voltage
powerline to plant site (1oooo V, 5oo kVA, 5o Hz)

Water supply

water supply from city water NW 3oo. Construction
of water distribution network on the plant site.

Total costs for above mentioned constructions estimated at 88.15o.ooo FG

Although the execution of the constructions can be in the hands of local firms, it should be realised that apart from some basic items all of the construction materials have to be imported and therefore be paid in foreign currency.

Labour is present in sufficient quantity. Wages at 6 working days a week, 7,5 hours daily,

skilled labour	approx.	2o.ooo FG/month
unskilled labour	approx.	1o.ooo FG/month

Additional costs amount to 94o FG/month and child. Annually 3o days of paid vacation should be included.

Prices of construction material as indicated by the Department of Industries

sand for construction	3 5oo FG/m^3
cement	4 ooo FG/m^3
corrugated roofing material	14 4oo FG/m^3
and wall surfacing	1 ooo FG/m^3

For complete building construction including delivery of materials following data were presented by the same source:

housing		35 - 4o ooo FG/m^2
industrial buildings	appr.	25 ooo FG/m^2
halls and wall surfacing	"	2o ooo FG/m^2

The equipment of the factory consists of all technical installations necessary for the operation of the whole plant; for example weigh-bridge, excavator, feeding devices, conveyor belts, sorting and pulverizing machinery, electrical equipment etc. The total investment including installation amounts to .... FG 16o.85o.ooo

Technical details can be found in Appendix 6.

The means of internal transport will be trucks and loading machines which can be used for the internal compost transport as well as for the loading of the compost and to deposit the residue materials.

The amount needed is:	FG 13.ooo.ooo
Total investment costs amount to:	FG 262.ooo.ooo

3.4.2 Operation costs

The operation costs of the compost plant can be divided into fixed and variable costs. Whereas the fixed costs are the same amount each year regardless the garbage quantity handled, the variable costs differ according to the garbage quantities processed annually.

If a single operation is maintained, fixed costs will be:

- maintenance and repairs
- salaries and wages.

The variable costs are concerned mainly with the costs of the means of operation (water, electricity, fuel and lubricants) which were calculated on the base of the garbage quantity manufactured.

The Ministry of Industry has indicated that the land for the compost plant can be used free of charge. The calculations of the operation costs are based on this supposition.

The calculated fixed costs are:

capital expenditures	FG 23.719.35o/year
maintenance and repairs	FG 5.5o2.ooo/year
salaries and wages	FG 5.19o.ooo/year
	FG 34.411.35o/year.

The costs of the means of operation included under variable costs amount to 2o2 FG/ton of garbage.

A detailed statement of the operation costs is shown in appendix 3.

At maximum exploitation of the given plant capacity in a single shift operation (= 15o tons of garbage per day) the annual operation costs amount to:

fixed costs	FG 34.411.35o
+ variable costs (2o2 FG/ton x 15 ton/day x 3oo days/year)	FG 9.o9o.ooo

Total operation costs at a capacity of 15o tons of garbage/day	FG 43.5o1.35o

So the processing costs per ton of garbage amount to 967 FG.

4. The economy of the compost plant.

The handling and removal of domestic waste is essential for hygiene and must be considered part of necessary are government expenditure. Its economic aspects may be considered secondary. At the same time it is clearly understood that the tight national budget calls for economic solutions. As the application of the principle of profit maximisation is not possible for the public sector, the principle of cost minimisation should be applied. In this case it should be first determined which system of garbage removal will be cheapest and economically most advantageous: simple waste destruction or refuse conversion. The necessary economic analysis must concentrate on the following aspects:

- The cost of organized garbage dumping
- The economic viability of a compost plant
- The impact of a compost plant on the national economy also with regard to imports of fertilizers etc. (foreign exchange problems)
- The private economic benefits of compost utilization in agriculture.

The costs of garbage collection are not considered here, because these costs are unavoidable.

4.1 The cost of an organized garbage disposal.

Section 1.4 shows the problems of garbage collection, and in appendix 2 (c) the costs specified assume that garbage should be dumped in an appropriate way.

From table 4, and appendix 2 the following cost are estimated:

	197o	1975	198o
Garbage (tons per year)	3o.7oo	41.ooo	55.ooo
Dump cost per year	4.746.ooo	5.121.ooo	8.185.ooo
Dump cost per ton	155	125	149

The operating expenses will increase slightly in the years 197o - 1979, whereas the amount of garbage will increase considerably. The cost per ton of garbage is therefore decreasing. From 198o onwards a second bulldozer will be necessary and the cost per ton of garbage will rise to 149 FG/ton. After that the cost per ton will decrease again.

For purpose of simplification an average price of 14o FG for the dumping per ton of garbage will be used. The annual variations of this figure can be considered small.

4.2 The economic perfomance of the compost-plant.

The calculation of the economic outcome of the compost plants arises from a confrontation of annual costs and benefits. The presentation of annual current costs and capital expenditures were done in chapter 3.4.2 and appendix 3 and repeated here.

For the estimation of the receipts the market-price per ton of compost is the critical datum. The explanation for the price-level at 1.4oo FG/ton is given in chapter 2.4.1.

The presented costs and prices are based on the proceeding economic calculation for the composting plant. It was supposed that the composting plant could start its production not before 1973. Table 15 shows that the operation costs of the composting plant can be completely covered at the assumed prices, costs and compost volume to be sold. This means that for the current operation of the compost plant no extra subsidies are needed. However, exploitation surplus is sufficient to cover annual capital expenditures fully from the start. As a result a deficit on paper will be obtained the first 4 years' period. Given this fact sufficient arguments can be found for concrete negotiations for financing by the inclusion of a grace period or by phasing capital expenditures. When the compost plant realises the estimations of costs and benefits as shown in table 15 the internal rate of return will be about 8,5 % based on an redemption period of 2o years not considerating contribution to the national economy.

This figure returns are under rather than overestimated for on the benefit side the substitution effects for fertilisers and food imports are not considered.

SECTION 1

[illegible]
[illegible] in 1.000 FG

	1974	1975	1976	1977	1978	1979	1980	1981
	86	91	96	101	106	[illegible]	100	100
	-	-	-	-	-	-	22	51
[illegible]	[illegible]	26.100	27.300	[illegible]	[illegible].300	32.700	[illegible]	[illegible]
[illegible]	[illegible]	36.540	38.220	[illegible]	[illegible].420	45.780	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].700	
[illegible]	[illegible]	[illegible].280	[illegible]	[illegible]	[illegible].084	52.962	[illegible]	[illegible]
[illegible]	[illegible]	[illegible].196	5.196	6.228	[illegible]	6.228	[illegible]	[illegible]
[illegible]	[illegible]	[illegible].502	5.502	[illegible].502	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	47.600	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible].150	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	18.074	[illegible].354	16.800	21.345	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible].306	[illegible].760	[illegible]	[illegible]	30.870	[illegible]	[illegible]
[illegible]	[illegible]	23.719	[illegible].719	23.719	23.719	[illegible]	23.719	23.719
[illegible]	[illegible]	[illegible].357	15.857	15.857	[illegible]	15.857	15.857	15.857
[illegible]	[illegible]	- [illegible]	1.[illegible]	2.[illegible]	[illegible].020	7.151	10.141	[illegible]
[illegible]	[illegible]	- 7.[illegible]	- [illegible].054	- [illegible]	+ [illegible]	+ 7.186	+17.327	+21.[illegible]
[illegible]	[illegible]	1.[illegible]40	1.000	985	945	890	845	825

SECTION 2

[illegible]

These effects will be discussed later on. On the other hand, on the side considerable replacement investment will have to be made during the last 5 years (see appendix 4).

Furthermore it may be of interest to the regional administration of Conakry how the alternative costs per ton of garbage on the waste material deposit plan compare with those of the composting plant.

In section 4.1 deposit costs per ton of garbage were fixed at 14o FG/ton. These costs can be considered to be constant though certain minor fluctuations occur. Since waste material quantities increase, constantly total expenditures for an orderly deposit are expected to increase accordingly (see table 15). A comparison has to be made with the decreasing processing costs per ton of garbage minus the deposit costs and the proceeds of the compost sales fixed 14oo FG per ton.

It is shown that the garbage disposal by means of the deposit would be cheaper in the first three years. But from 1976 on the garbage treatment in the compost plant would become very profitable. By increasing the plant's capacity after 1981 and by the resulting increased sales returns, the compost plant will become even more profitable as compared to the garbage deposit. The above calculations are based on accounting procedures concerning the economic performance of the compost plants.

Table 16.

Comparison of disposal and composting costs per ton of garbage.

Year	processing costs/ ton of garbage 1)	minus: deposit-costs/ton	minus: sales proceeds/ton 2)	surplus / ton of garbage
1973	1145	140	895	-110
1974	1095	"	"	- 60
1975	1040	"	"	- 5
1976	1000	"	"	+ 35
1977	985	"	"	+ 50
1978	945	"	"	+ 90
1979	890	"	"	+ 145
1980	845	"	"	+ 190
1981	825	"	"	+ 210

1) data taken from table 15
2) 1 ton of garbage = 0,639 ton of compost, at 1.400 FG/ton.

As the compost constitutes at the same time a home produced fertilizer a further comparitative economic calculation can be made with regard to imported fertilizers and food quantities produced as a result of their use.

4.3 The financial impact of the compost plant on the general economy.

For the general economic evaluation of the compost plant two starting points can be found.

From the fact that the increase of agricultural production in Guinea is of utmost importance in the future, it is obvious that the provision and application of nutritive material for plants is one the first and most important measures to be taken by the government.

In this respect the only alternative considerations therefore should be

- whether the necessary nutritive material can be produced within the country or whether imports are cheaper.
- whether imported food is cheaper than home produced food.

The problem of foreign currency is an important element in these considerations.

4.3.1 General economic value of the nutritive material.

The value of the nutritive material obtained from 1 ton of waste material is equivalent to 1.44o FG (value of the nutritive substances of 1 ton of compost = 2.26o FG, see table 7).

Because the eliminated deposit costs should be counted as returns, the value of the produced nutritive material (including the saved deposit costs) shows a surplus over the processing costs per ton of garbage (as shown in table 17).

Table 17.

Processing costs compared with the value of the nutritive material at import-prices.

Year	Processing costs FG/ton of garbage	Deposit-costs FG/ton of garbage	Value of the nutritive substances FG/ton of garbage	value-surplus of the nutritive substances as compared with processing costs
1973	1145	14o	144o	435
1974	1o95	"	"	485
1975	1o4o	"	"	54o
1976	1ooo	"	"	58o
1977	985	"	"	595
1978	945	"	"	635
1979	89o	"	"	69o
198o	845	"	"	735
1981	825	"	"	755

Table 17 clearly shows that the economic value of nutritive compost material valued at import-prices for fertilizers is greater than the processing costs per ton of waste material. This ratio becomes even more favourable with an increased exploitation of the given capacity.

Table 18 relates the production costs per 100 kg of nutritive material in compost to the costs of 100 kg of comparable plant nutritive elements in imported fertilizers. This calculation leads to the conclusion that the nutritive material can be produced more cheaply in form of compost than by the import of fertilizers.

Real economical savings would be obtained if the imported quantities of plant-nutritive elements could be reduced by the equivalent quantities of compost. So the differential value of production and import costs per 100 kg of nutritive elements, given the (projected) production quantity, should be regarded as a national economic return. The basic supposition is that the nutritive elements contained in the compost would have to be imported if not home produced.

According to table 7, 1 ton of compost contains 9,1 kg N, 9,8 kg P_2O_5, 10,1 kg K_2O and 42,4 kg CaO which gives a total of 71,4 kg of nutritive substances for the plants. In order to obtain 100 kg of nutritive substances of the same composition, 1,4 tons of compost are required.

Table 18.

Costs of loo kg nutritive elements in compost and in (imported) fertilizers.

	kg contained in 1,4 tons compost	production costs of the nutritive substances in compost	import-price per kg nutritive substances in FG	import-price of the same quantity of nutritive substances in FG
N	12,74	for corresponding	lol	1287
P_2O_5	13,72	production	5o	686
K_2O	14,14	values see	43	6o8
CaO	59,36	table 15	lo	594
Total nutritive substances loo		See table 19		3175

As the production costs per ton of compost will vary in the course of time, the calculations in table 19 were made for a comparison. Calculations are based on values per loo kg of nutritive elements as found in compost.

Table 19.

Comparison of the costs of the nutritive elements in compost and the imported nutritive elements per loo kg and the resulting savings.

Year	production costs per loo kg nutritive elements of the compost	price per loo kg imported nutritive elements	cost advantage per loo kg nutritive elements of the compost	in total produced quantities of the nutritive elements of the compost in loo kg	savings per year when the own production should be imported in FG 1.000
1973	2.52o	3.175	655	16.57o	1o.853
1974	2.39o	"	785	17.57o	13.792
1975	2.3oo	"	875	18.64o	16.31o
1976	2.21o	"	965	19.5oo	18.817
1977	2.17o	"	1.oo5	2o.57o	2o.672
1978	2.o9o	"	1.o85	21.64o	23.479
1979	1.96o	"	1.215	23.36o	28.382
198o	1.86o	"	1.315	25.ooo	32.875
1981	1.8oo	"	1.375	26.86o	36.932

The actual benefits from the compost production must be assumed to be even higher, because the ameliorating effect of the humus has not yet been mentioned. Furthermore the nutritive elements of compost are not washed out as rapidly as those in the form of chemical fertilizers. The table above also shows clearly that actual fertilizers price on the world market should than 2o % in 1973 and in 1981 even more than 4o % to make fertilizer-imports more advantageous than the compost production as far as the prices are concerned (not taking into account transport costs).

Given the existing market practices for fertilizers the savings can actually be regarded as savings to the national economy. At present fertilizers are given free of charge to state-farms and growers of export crops by a State purchase and sales company which also buys the agricultural export products. The company has to finance the fertilizer purchases from the difference between export and producer's price.

At constant export- and production prices the return for the state purchase and sale's company will be increased when they can buy their fertilizers more cheaply than at world market prices in the form of compost. However, in reality the compost will be in part intended for other purchasers and above all it will be distributed differently.

Nevertheless its effect on the economy will be the same or even more favourably, because the private farmers will pay a compost price, which will be at least covering costs. In addition the state trade company need not buy the fertilizers and the profit margin of agricultural export products remains constant the same if production prices are not increased.

It was not possible for the expert team to make an adequate study of the price-cost structure of the fertilizer distribution system and of the marketing of agricultural products to make a cost-benefit analysis part of which should be the eventual taxing of different product groups.

Because of mentioned reasons only the savings effect (as shown in table 19) can be considered as concrete monetary value showing on the benefit side and generally suitable to underline the advantage of the compost plant.

A further point of economic relevance is the influence of the compost plant on the foreign currency budget.

4.3.2 Influence of the compost plant on the foreign currency budget.

Table 2o.

Shares of foreign currency investment expenditures and current costs.

Investment expenditure

	total in mill. FG	share of foreign currency %	mill.FG	annuity in %	capital commitments in foreign currency / year in mill. FG
Construction costs	88,15	5o	44,o8	6,5	2,87
factory equipment	16o,85	95	152,81	9,6	14,67
means of transport	13,oo	95	12,35	19,6	2,42
			2o9,24		19,96

Current costs.[1)]

	total in mill. FG	share of foreign currency %	mill.FG	annuity in %	capital commitments in foreign currency / year in mill. FG
maintenance costs + repairs	5,5o	5o	2,75		2,75
wages and salaries	7,47	-	-		-
means of operation	11,92	5o	5,96		5,96
					28,67

1) for the year 1981 when full capacity exploitation is about to be reached.

If the nutritives produced by the compost plant had to be imported in form of chemical fertilizers, in 1981 the foreign currency expenditure would amount to 85,3 mill. FG.

In the same year foreign currency expenditure for the compost plant only is 28,7 mill. FG so that savings of foreign currency of 56,6 mill. FG/year are obtained by the installation of the compost plant.

4.3.3 Economic evaluation from the point of view of food production.

According to the population growth as shown in section 1.1.3 a considerable increase of food demand can be expected, which must be met by production increase in the country or by increasing imports. If the realizable increase of the home production by means of the compost plant (fertilizer effect !) is cheaper than the costs of equal food imports, economic profitability can be proved.

The problem which a calculation for increased food production encounters, is the fact that in the course of the data collection in Guinea it was not possible to obtain any information on likely increases in yields (marginal yield) caused by the compost. The only data of this kind concern an experiment with swamp-land rice and mineral fertilizers which are not relevant to the soil- and crop groups discussed in this place.

4.3.4 Private economics of compost application.

The private economic profitability is derived from the comparison of marginal costs (costs of nutritive substances + additional costs for application and transport) and marginal benefits (surplus yield x market price - additional transport - and harvest costs). This is fundamental and it does not matter whether chemical fertilizers or compost are used.

As already mentioned in the preceding chapter data about marginal returns are available for the region therefore an analysis of the industries economics is not possible.

Table 13 concludes that the application of fertilizers or compost to subsistence cultures as cultivated at present is not profitable from the point of view to private economics.

On the other hand the population of Conakry will increase from 211.2oo to 344.4oo in 198o and will need an improved supply.

However, it should be remembered that

- the area used by agriculture in the perimeter of the town is limited.

- there exist a constant deterioration of the condition of the soils resulting from the shortening of fallow time caused by the already obvious population pressure.

From the information already available it therefore seems that the requirements for the near future are that

- a change in the structure of the present cultivation system is necessary to meet the increased demands of Conakry especially for fresh vegetables etc. Therefore fertilizers (compost) must be used. An increased production through the use of fertilizers (compost) will only be profitable for the individual farm with a corresponding change from subsistence farming to cash crops.

- The expected shorter fallow time will lead to a further deterioration of the production conditions which only can be stopped by improved cultivation methods, especially the supply of humus.

4.4 Conclusions.

It is shown that the installation of the composting plant should be promoted for national economic reasons namely the conservation of soil fertility.

In connection with the paragraphs above the profitability for the individual farm will be also assured although exact results cannot be calculated at present.

The general attitudes of the farmers around Conakry suggests that they are considering the application of compost favouably for the reasons mentioned above.

But it should be remembered that satisfactory application of the compost can be reached only in conjunction with an efficient extension service.

III. SUMMARY

The present method of disposal of the town waste in Conakry constitutes a serious sanitary danger to public health. Taking into account the high population increase of about 4,6 % per year and additional increase of waste production per head and per year of about 1,2 % the public health problem in the future will grow more and more serious. The solution of this problem, however, is connected with important financial burdens on the municipal budget. Therefore, besides the hygienic aspects economic aspects also must be considered as far as is possible.

In the present study it is concluded that the entire garbage treatment has to be reorganized to meet the hygienic as well as the economic demands. Before taking final decisions in this matter it should be considered whether this reorganization and utilization of the organic substances available in the garbage in the form of hygienic compost is possible and feasible.

The investigations on the spot proved that a weight ratio of about 85 % of the town garbage is compostable. Because of the extraordinary high proportion of organic substances the town waste is a suitable raw material for composting.

The market research for the compost indicates that the soil, particularly in the surrounding area of Conakry, is in a very poor condition. It has a considerable need for humus, which under the predominant climatic conditions and the present system of cultivation will be permanent. The area suitable for compost application is large enough to absorb in the future the total compost production.

To sell the compost in agriculture it will be necessary to quote a price lower than the value of the equivalent nutritive substances in chemical fertilizers. This is to enable the farmers to bear the additional costs for distribution and transport of the compost. These costs are estimated at about 86o FG per ton of compost. Therefore the ex factory price of compost will be 1.4oo FG/ton.

In the first years the production costs per ton compost will be above 1.4oo FG/ton. But with increasing use of the total capacity the production costs will decrease so that a compensation for the accrued loss can be met after a short period.

In order to make compost application profitable it is necessary for the farmers to have an adequate yield increase. Although no investigation results concerning the yield surplus for different cultures are available, it can be stated that the greatest success will be reached through the cultivation of saleable products such as potatoes, tomatoes, carrots etc. A demand for this kind of vegetable occur on the local market in Conakry, and it will expand in the future through the increase of population and the standard of living.

On the other hand about 80 % of the area suitable for compost application is at present occupied by subsistence farming and a change to the cultivation of vegetables has to be undertaken. In this process of change intensive professional advising of the farmers will be of great importance. In this field of activity a close cooperation with the Ministry of Agriculture is desirable.

Another handicap for sale of compost is the actual lack of funds of the subsistence farmers. But if they have changed to market crops they also will have cash to buy compost. For the transition period several solutions of the problem are possible.

Concerning the compost plant the most favourable composting method with respect to the prevailing local conditions is the system of windrow composting. This method is easy to handle and the capacity of the plant can be doubled without installation of further equipment by introducing a second working shift.

Also the hygienic requirements in the treatment of garbage can be complied with by this composting method.

A suitable plant site for the construction of the composting plant should be found outside the town of Conakry. Within the industrial development zone an area with about 6 ha is still reserved by the government of Guinea for this purpose.

This square area is adapted to contain the compost plant as well as the dump for the non compostable materials. Since the industrial zone is thinly populated annoyance of inhabitants by the compost plant is not anticipated.

The general lay-out of the compost plant will handle a capacity of 15o tons of garbage per shift. This capacity will be reached with the waste production of Conakry in the year 1977.

The investment costs for the construction of the composting plant are calculated at approximately 262 mill. FG.

The operation costs, including capital expenditires, amount to 34,411 mill. FG per annum (fixed costs) plus 2o2 FG per ton of garbage (variable costs).

If the compost plant starts production in 1973 the real operation costs will be completely covered by the receipts of the first year of production. But the surplus obtained is not high enough to cover the capital expenditures. With increasing employment of the capacity, the capital will be covered after 3 years of plant operation and after 1978 the accumulated profit will exist.

For the national economic evaluation of the compost plant 2 main points are investigated. It can be stated that the production of nutritive substances for plants by composting is cheaper than to import chemical fertilizer. The augmentation in food production by application of compost is cheaper than the costs of equal food imports.

These two facts influence the foreign currency budget in a favourable way. Many savings in foreign currency will be made.

Concerning the profitability on farm level it is found that the application of compost will be advantageous with a corresponding change from subsistence farming to market crops.

Weighing all facts resulting from the investigations the installation of the compost plant in Conakry is feasible and recommended.

C Garbage disposal

At present there are no costs for the maintenance of the dumping site

Total of annual costs	107 301 000 FG

Specific costs

costs per inhabitent and year	509 FG
costs per ton of garbage	3 304 FG

Appendix 2

Annual costs of the proposed garbage treatment in 1970, 1975 and 1980 (300 working days per year)

A Garbage preparation

1. Capital service

   Dust bins

   1970: 4 700 pieces at 1 000 FG each
   1975: 6 300 pieces at 1 000 FG each
   1980: 8 400 pieces at 1 000 FG each

   time of amortisation: 5 years

   interests: 5 % per year

   annuity: 23 % per year

1970	1 081 000 FG
1975	1 449 000 FG
1980	1 932 000 FG

2. Maintenance and repairs

   (2 % per year of investment costs)

1970	94 000 FG
1975	126 000 FG
1980	168 000 FG

3. Salaries and wages

1970: 225	scavengers	40 500 000 FG
1975: 280	at each	50 400 000 FG
1980: 350	180 000 FG per year	63 000 000 FG

   Administration (25 % of wages)

1970	10 120 000 FG
1975	12 600 000 FG
1980	15 750 000 FG

1970	51 795 000 FG
1975	64 575 000 FG
1980	83 840 000 FG

B Garbage collection and transport

1. Capital service

   Special trucks

   1970: 11) pieces
   1975: 14) at each
   1980: 18) 7 800 000 FG

time of amortisation: 6 years

interests: 5 % per year

annuity: 19,6 % per year

1970	16 817 000 FG
1975	21 403 000 FG
1980	27 518 000 FG

2. Maintenance and repairs

(8 % per year of investment costs)

1970	6 864 000 FG
1975	8 736 000 FG
1980	11 232 000 FG

3. Salaries and wages

1970: 11 drivers at 200 000 FG p. year 44 dust men at 180 000 FG p. year	10 120 000 FG
1975: 14 drivers at 200 000 FG p. year 56 dust men at 180 000 FG p. year	12 880 000 FG
1980: 18 drivers at 200 000 FG p. year 72 dust men at 180 000 FG p. year	16 560 000 FG

Administration (25 % of wages)

1970	2 530 000 FG
1975	3 220 000 FG
1980	4 140 000 FG

4. Means of operation

(1 500 FG per truck and per day)

1970	4 950 000 FG
1975	6 300 000 FG
1980	8 100 000 FG

1970	41 281 000 FG
1975	52 539 000 FG
1980	67 550 000 FG

C <u>Garbage disposal</u>

1. Capital service

a. Fencing (3 000 000 FG)

time of amortisation: 1o years
interests: 5 % per year
annuity: 13 % per year
197o, 1975, 198o — 39o 000 FG

b. Garage and lodging (1 25o ooo FG)
time of amortisation: 2o years
interests: 5 % per year
annuity: 8 % per year
197o, 1975, 198o — 1oo ooo FG

c. Bulldozer (7 8oo ooo FG)
time of amortisation: 5 years
interests: 5 % per year
annuity: 23 % per year
197o, 1975 — 1 794 ooo FG
198o (installment of a 2nd bulldozer) — 3 588 ooo FG

2. Maintenance and repairs

a. Fencing (1,5 % per year of investment costs)
197o, 1975, 198o — 45 ooo FG

b. Garage and lodging (1 % per year of investment costs)
197o, 1975, 198o — 12 ooo FG

c. Bulldozer (1o % per year of investment costs)
197o, 1975 — 78o ooo FG
198o — 1 56o ooo FG

3. Salaries and wages

197o: 1 foreman at 2oo ooo FG p. year
1 driver at 2oo ooo FG p. year
3 laborers at 18o ooo FG p. year — 94o ooo FG

1975: 1 foreman
1 driver
4 laborers — 1 12o ooo FG

1980: 1 foreman 2 drivers 4 laborers	1 320 000 FG
Administration (25 % of wages)	
1970	235 000 FG
1975	280 000 FG
1980	330 000 FG
4. Means of operation	
1970 1 500 FG per day	450 000 FG
1975 2 000 FG per day	600 000 FG
1980 2 800 FG per day	840 000 FG
1970	4 740 000 FG
1975	5 121 000 FG
1980	6 185 000 FG
Total of annual costs	
1970	97 822 000 FG
1975	122 255 000 FG
1980	139 575 000 FG

Specific costs

1. Costs per inhabitant and year

1970	465 FG per inhabitant and year
1975	466 FG per inhabitand and year
1980	477 FG per inhabitant and year

2. Costs per ton of garbage

1970	3 186 FG per ton of garbage
1975	2 981 FG per ton of garbage
1980	2 901 FG per ton of garbage

Appendix 3

Annual operation costs of the composting plant

1. Capital service

   a. Construction part
      (investment costs 88 150 000 FG)
      time of amortisation: 30 years
      interests: 5 % per year
      annuity: 6,5 % per year — 5 792 750 FG

   b. Operating equipment
      (investment costs 160 850 000 FG)
      time of amortisation: 15 years
      interests: 5 % per year
      annuity: 9,6 % per year — 15 441 000 FG

   c. Internal transport means
      (investment costs 13 000 000 FG)
      time of amortisation: 6 years
      interests: 5 % per year
      annuity: 19,6 % per year — 2 548 000 FG

   Total: 23 719 550 FG

2. Maintenance and repairs

   a. Construction part
      (0,5 % of investment costs per year) — 440 750 FG

   b. Operating equipment
      (2,5 % of investment costs per year) — 4 021 250 FG

   c. Internal transport means
      (8 % of investment costs per year) — 1 040 000 FG

   Total: 5 502 000 FG

3. Salaries and wages

1 manager	84o ooo FG
1 accountant	45o ooo FG
1 electromechanician	26o ooo FG
2 foremen	4oo ooo FG
1o laborers	1 8oo ooo FG
6 drivers	1 2oo ooo FG
2 watchmen	24o ooo FG
	5 19o ooo FG
Total of fixed costs	**34 411 35o FG**

4. Means of operation

a. water

o,5 m^3 per ton of garbage at 34 FG per m^3

17 FG per ton

b. electricity

1o kWh per ton of garbage at 15 FG per kWh

15o FG per ton

c. fuel and lubricant — 35 FG per ton

Total of variable costs — 2o2 FG per ton

Calculation of the internal rate of return in 1 000 DM[1)]

Year	Investments	standing charges	brut proceeds	net proceeds	Net present value discountrate 8 %	10 %
0	262 000			- 262 000	- 262 000	- 262 000
1		18 065	37 590	19 525	18 080	17 748
2		18 469	39 700	21 231	18 194	17 536
3		18 974	42 280	23 306	18 504	17 502
4		19 354	44 114	24 760	18 198	16 911
5		20 860	46 648	25 788	17 561	16 014
6	13 000	21 345	49 084	27 739	17 475	15 644
7		22 092	52 962	30 870	17 997	15 856
8		22 840	56 700	33 860	18 284	15 812
9		24 894	52 640	27 746	13 873	11 764
10		25 722	56 537	30 815	14 267	11 894
11		29 335	59 673	30 338	13 015	10 618
12	13 000	30 123	63 168	20 045	7 957	6 594
13		30 951	66 841	35 890	13 207	10 408
14		31 819	70 694	38 875	13 217	10 224
15		32 749	74 816	42 067	13 251	10 054
16	160 850	33 718	79 116	- 115 432	- 33 711	- 25 168
17		34 748	83 686	48 938	13 213	9 089
18	13 000	38 434	88 524	37 090	9 272	6 676
19		39 560	93 638	54 046	12 862	8 863
20		40 798	99 008	58 210	12 515	8 673
rest value				145 140	31 205	21 625
				capital value	+ 16 436	- 27 083

1) The standing charges and the brut proceeds up to the year 9 (= 1981) see table 15. For the following years (1982 - 1992) see appendix 5.

Ap.endix 5

Cost - benefit calculation from 1980 to 1993

year	population	wastes prod. p. head p. year kg	total wastes tons	maintenance and repairs 1 000 FG	salaries and wages 1 000 FG	standing charges 1 000 FG	quantity of comp. tons	brut proceeus 1 000 FG	net proceeds 1 000 FG
1980	344 400	163	56 100	5 502	6 228	22 840	35 000	53 767	30 927
1981	360 242	165	59 400	5 502	7 474	24 894	37 600	52 640	27 746
1982	377 814	167	63 100	5 502	7 474	25 722	40 384	56 537	30 815
1983	394 147	169	66 600	5 502	10 380	29 335	42 624	59 673	30 338
1984	412 278	171	70 500	5 502	10 380	30 123	45 120	63 168	33 045
1985	431 243	173	74 600	5 502	10 380	30 951	47 744	66 841	35 890
1986	451 080	175	78 900	5 502	10 380	31 819	50 496	70 694	38 875
1987	471 829	177	83 500	5 502	10 380	32 749	53 440	74 816	42 067
1988	493 533	179	88 300	5 502	10 380	33 718	56 512	79 116	45 398
1989	516 236	181	93 400	5 502	10 380	34 748	59 776	83 686	48 938
1990	539 983	183	98 800	5 502	12 975	38 434	63 232	88 524	50 090
1991	564 822	185	104 500	5 502	12 975	39 586	66 880	93 632	54 046
1992	590 804	187	110 500	5 502	12 975	40 798	70 720	99 008	58 210
1993	617 981	189	116 800	5 502	12 975	42 070	74 752	104 652	62 582

Appendix 6

Engineering specifications for a

Garbage Composting Plant
using the windrow composting system for the
City of Conakry - Guinea.

I. Local facts and requirements

The Conakry town wastes will be treated by windrow composting. The size of the projected plant area is about 6 has, so that non-compostable remainders can also be deposited. Metals and scrap will be separated, pressed into solid packs, and then stored separately.

The capacity of the composting plant will be

150 tons of garbage per shift of 8 hours

or

20 tons of garbage per hour,

and the specific weight

250 kgs per cu.m.

The following composition of the garbage is assumed:

Remains from vegetables, fruit, and kitchen waste	appr.	70 %
Paper and textiles	"	5 %
Ashes, sweepings, dust	"	10 %
Glass, stones, broken	"	8 %
Wood, leather, rubber, plastic	"	4 %
Iron and metals	"	3 %
		100 %

The soil of the plant site consists of rock and coarse gravel, and therefore offers no problems.

Electric power can be taken from a 10.000 volts line running 80 meters away from the plant site. Available power is up to 500 kVA.

Along the border of the site, there is a water pipe line of 12" dia. The water comes from the Kakoulima mountains, is filtered but not chemically treated, and its quality therefore is sufficient for the operation of the plant. Drinking water, however, must be provided for by an usual domestic water filter.

The climate is humid-tropical with a dry season of 5 months and heavy rain from May to October which may be so much as 350 millimeters in 24 hours.

Average temperature over the year	26,3°
relative humidity (average the year)	80 %
yearly rainfall (average)	4350 millimeters

The site of the compost plant is shown on plot plan Fig. 5. There is about 900 meters of fencing to be erected and about 20.000 square meters to be paved (roads and aprons).

Labour is present at Conakry in sufficient quantity. Wages at 6 working days a week, 7,5 hours daily,

skilled labour	approx.2o.ooo FG/month
unskilled labour	approx.1o.ooo FG/month

Additional costs amount to 94o FG/month and child. Annually 3o days of paid vacation should be included.

Prices of construction material as indicated by the Department of Industries.

sand for construction	3 5oo FG/m^3
cement	4 ooo FG/m^3
corrugated roofing material	14 4oo FG/m^3
and wall surfacing	1 ooo FG/m^3

For complete building construction including delivery of materials following data were presented by the same source:

housing		35 - 4o ooo FG/m^2
industrial buildings	appr.	25 ooo FG/m^2
halls and wall surfacing	"	2o ooo FG/m^2

Three complex buildings will be erected:

1. Building with porter hall and weigh bridge, administration offices and flat for the night guard. Dimensions about 10 by 20 meters, one storey, possibly from prefabricated parts.

2. Concrete garbage bunker with gantry crane (grab), dimensions about 6 by 20 meters, capacity 400 cu.m. Reinforced concrete plus supporting steel structure for crane rails, roof and upper walls from corrugated iron.

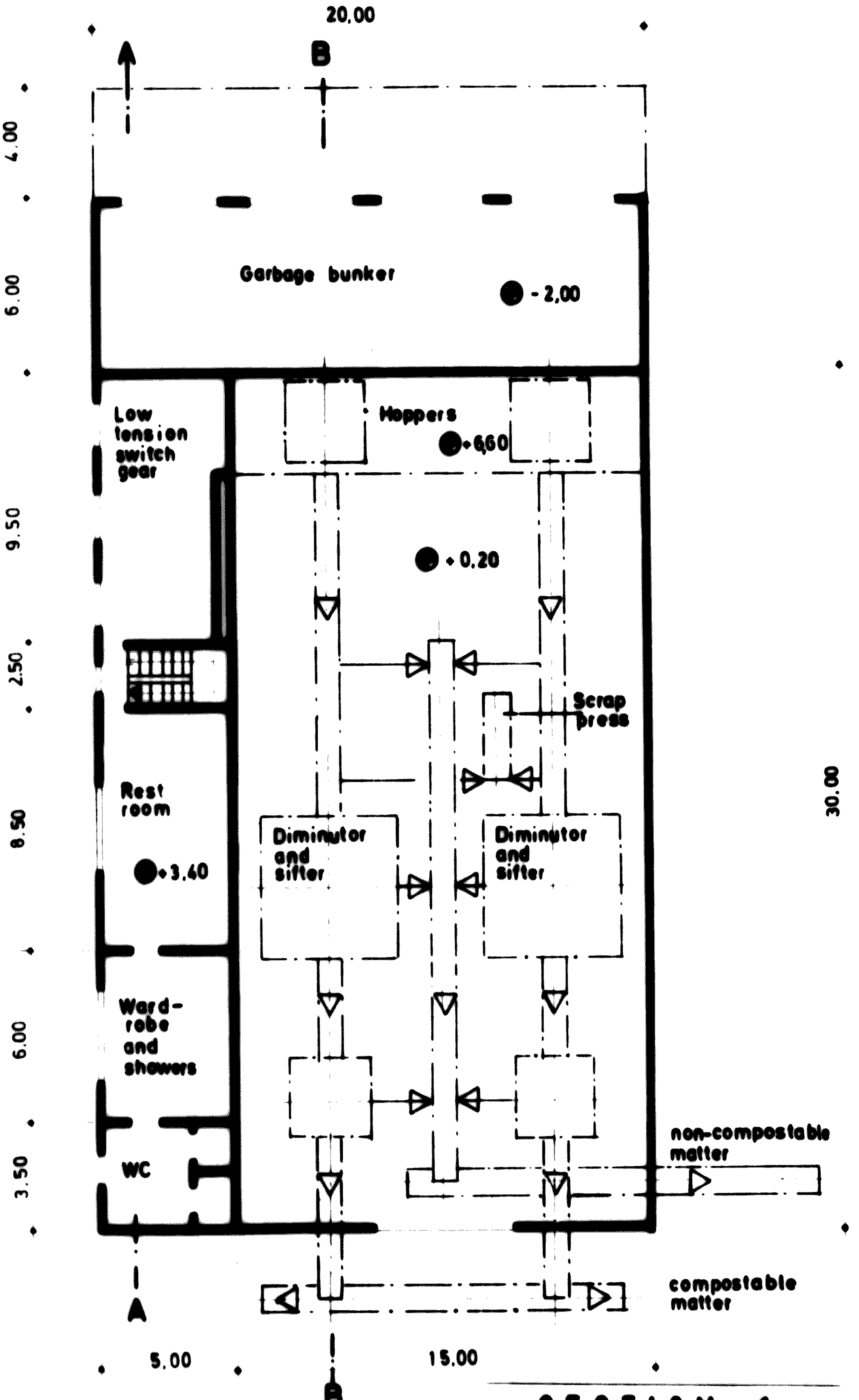
3. Processing hall including adjacent sheds for transformers, switch gear, process control, workshop, personnel and sanitary rooms, cars for internal transport;
   dimensions about 20 by 30 meters, steel structure with concrete filling; concrete flooring and foundations for equipment, corrugated iron roof.

   The lay-out of the hall is shown on drawing Fig. 6.

   Particulars may change according to dimensions of equipment.

Inspections during manufacture of equipment, work certificates, test runs and final acceptance certificates as well as performance tests at the job site and guarantees for a certain operation period will provide for good performance of the plant.

All dimensions in meters



Elevation + 3,40 meters above level

SECTION 1

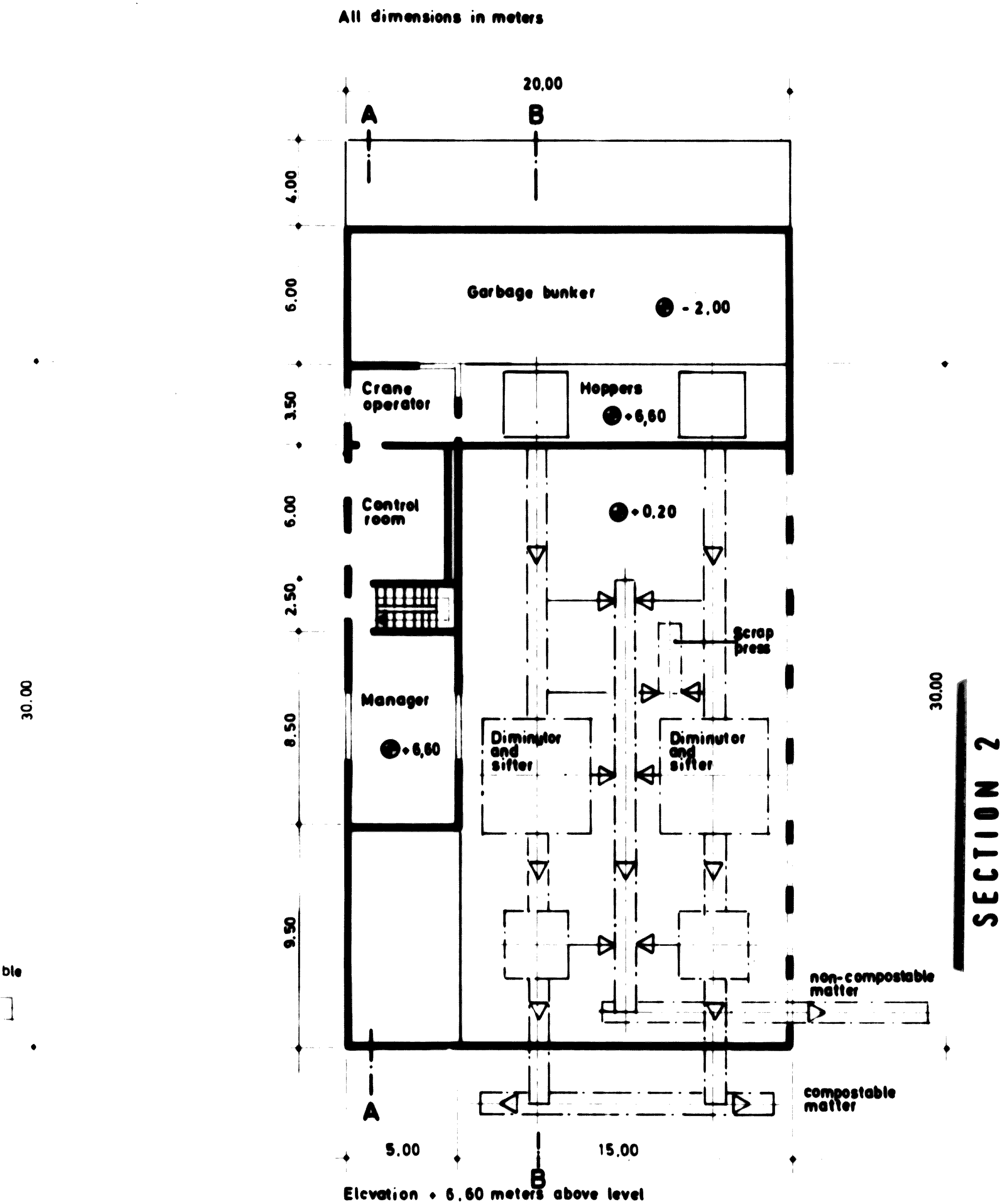
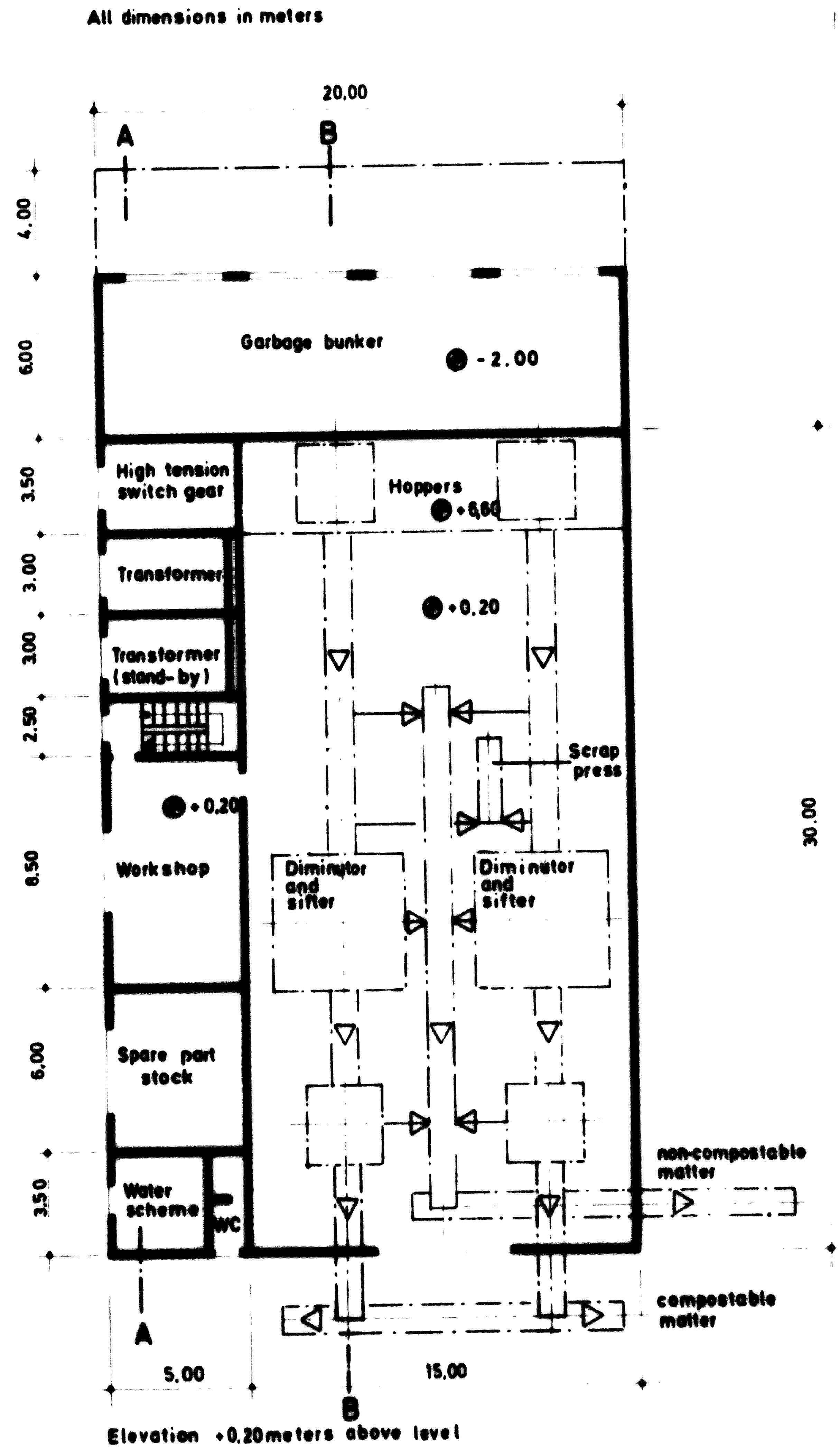
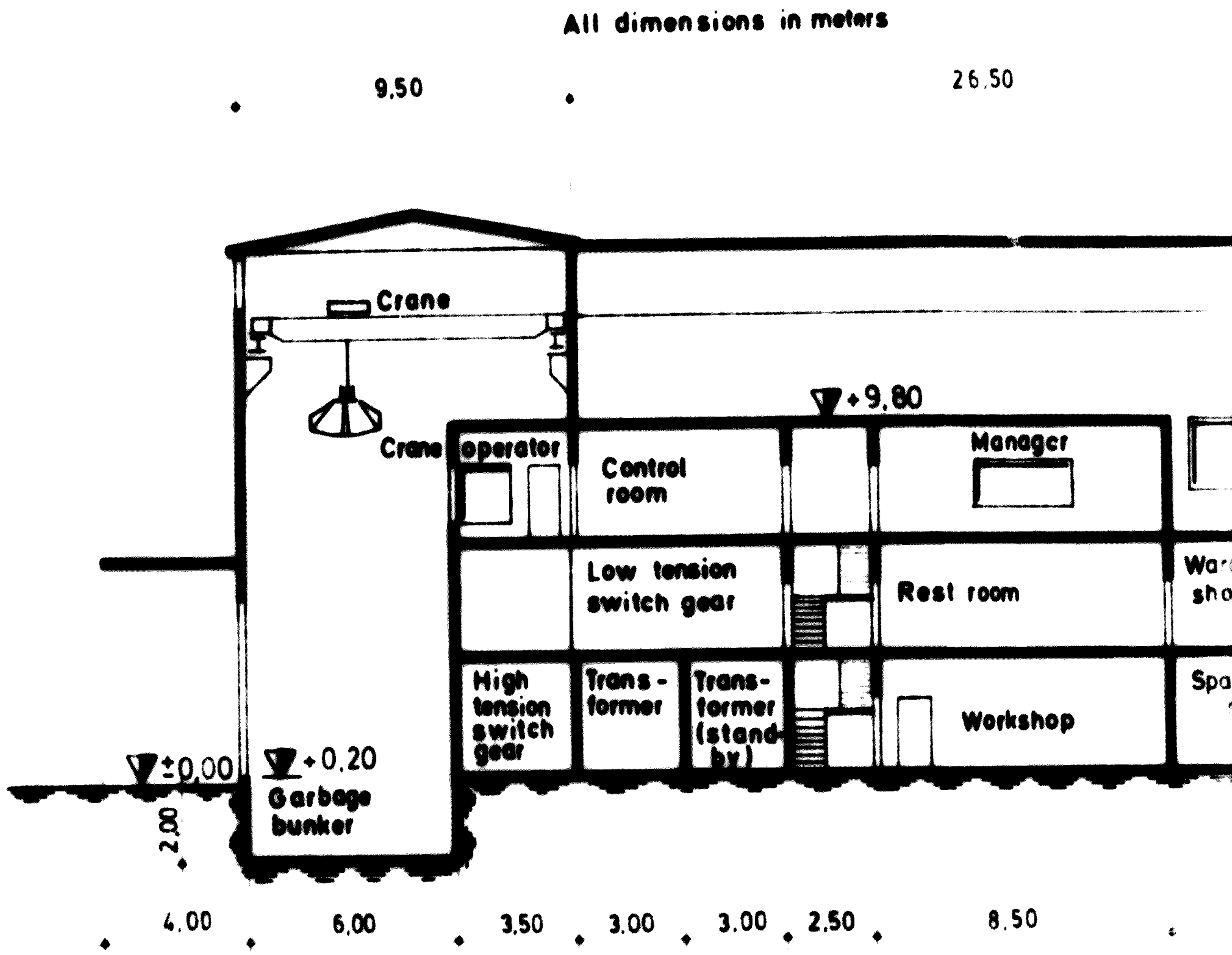
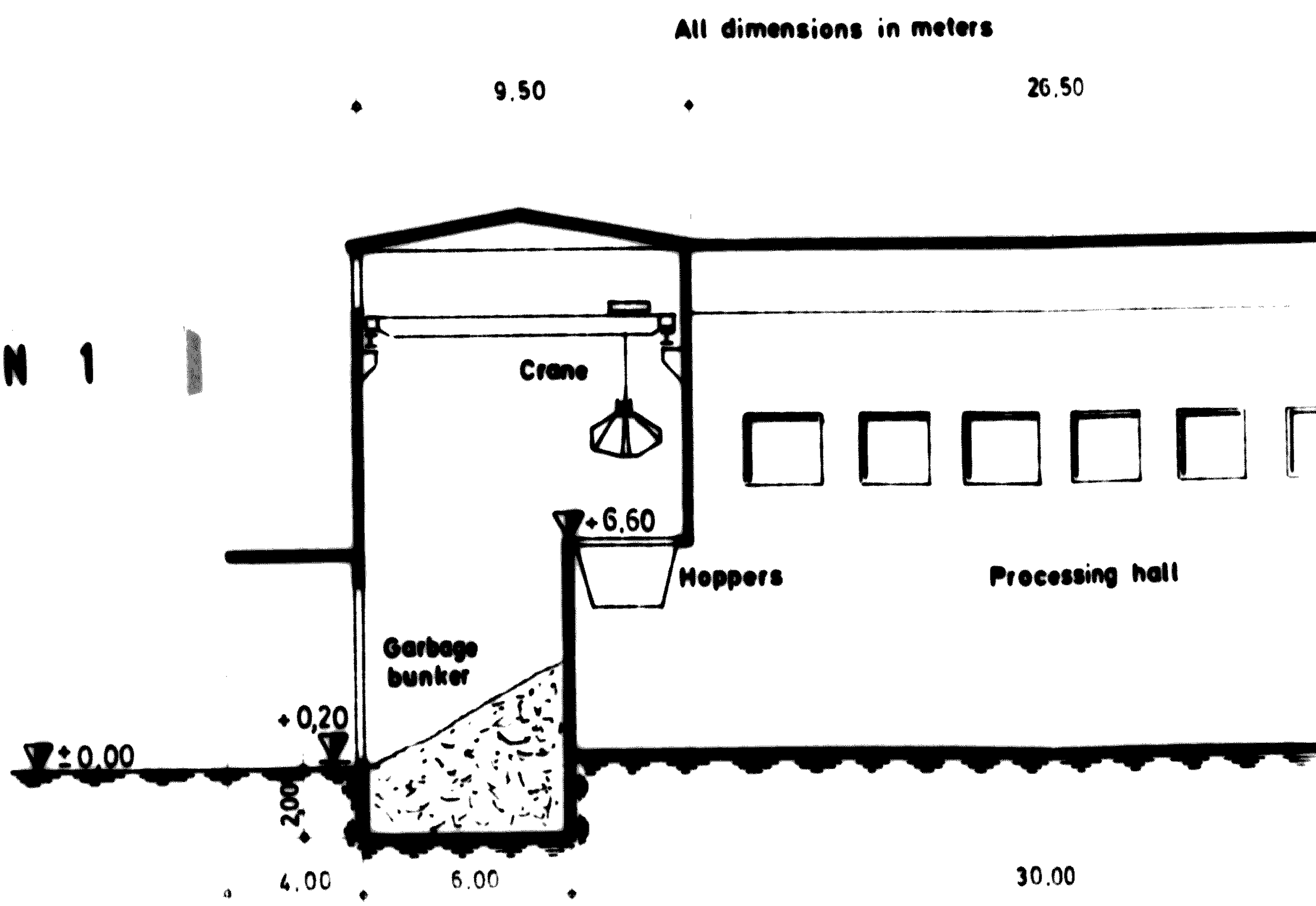

All dimensions in meters
20,00
A
B
4.00
6.00
Garbage bunker
- 2,00
3.50
Crane operator
Hoppers
+ 6,60
6.00
Control room
+ 0,20
2.50
Scrap press
30.00
8.50
Manager
+ 6,60
Diminutor and sifter
Diminutor and sifter
9.50
non-compostable matter
compostable matter
5,00
15,00
Elevation + 6,60 meters above level
SECTION 2

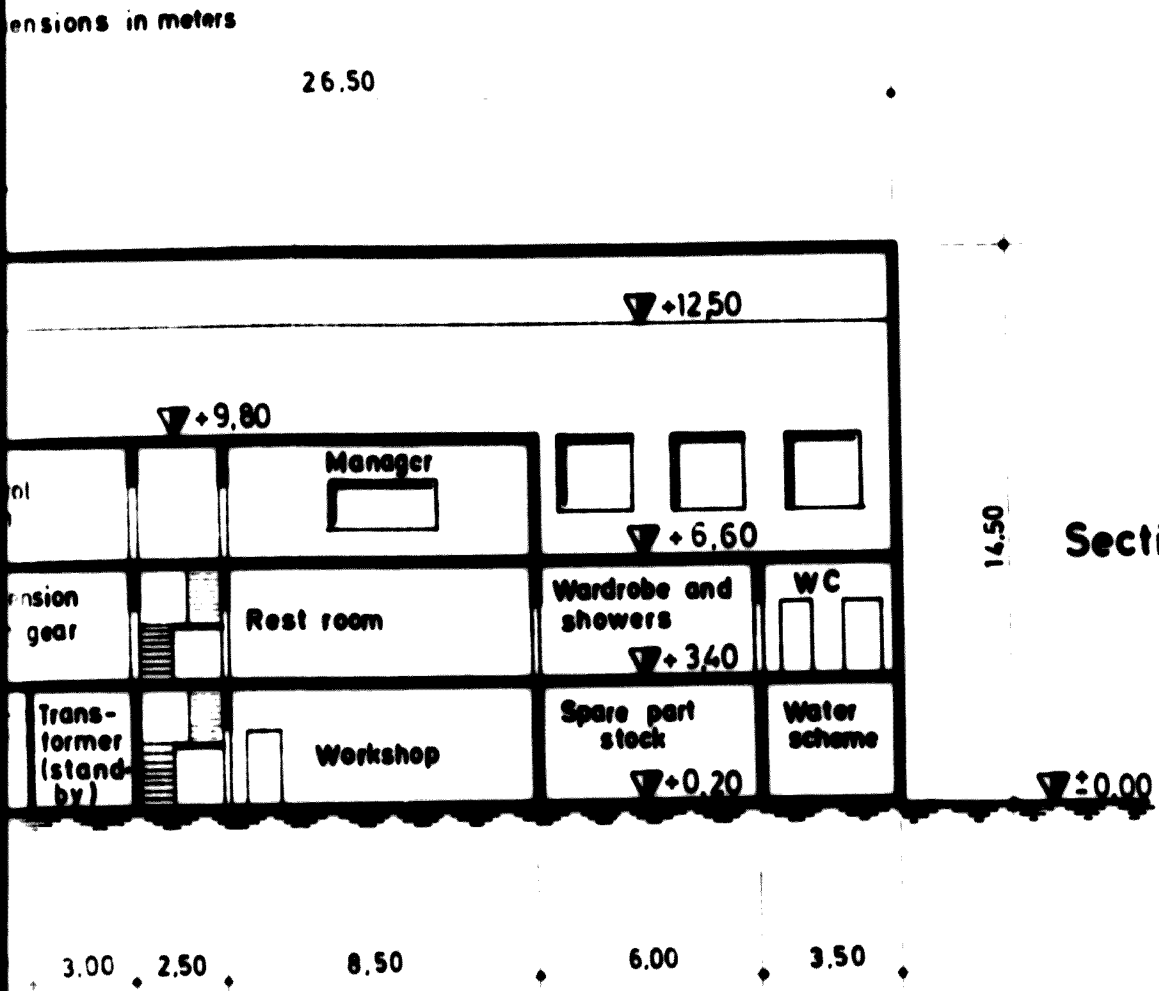
FIG. 6a


All dimensions in meters
20.00
A
B
4.00
6.00
3.50
3.00
3.00
2.50
8.50
6.00
3.50
30.00
Garbage bunker
-2.00
High tension switch gear
Hoppers
+6.60
Transformer
+0.20
Transformer (stand-by)
Scrap press
+0.20
Workshop
Diminutor and sifter
Diminutor and sifter
Spare part stock
non-compostable matter
Water scheme
WC
compostable matter
A
5.00
15.00
B
Elevation +0.20meters above level


All dimensions in meters
9,50
26.50
Crane
+9,80
Crane
operator
Control room
Manager
Low tension switch gear
Rest room
High tension switch gear
Trans-former
Trans-former (stand-by)
Workshop
±0,00
+0,20
Garbage bunker
2,00
4,00
6,00
3,50
3,00
3,00
2,50
8,50

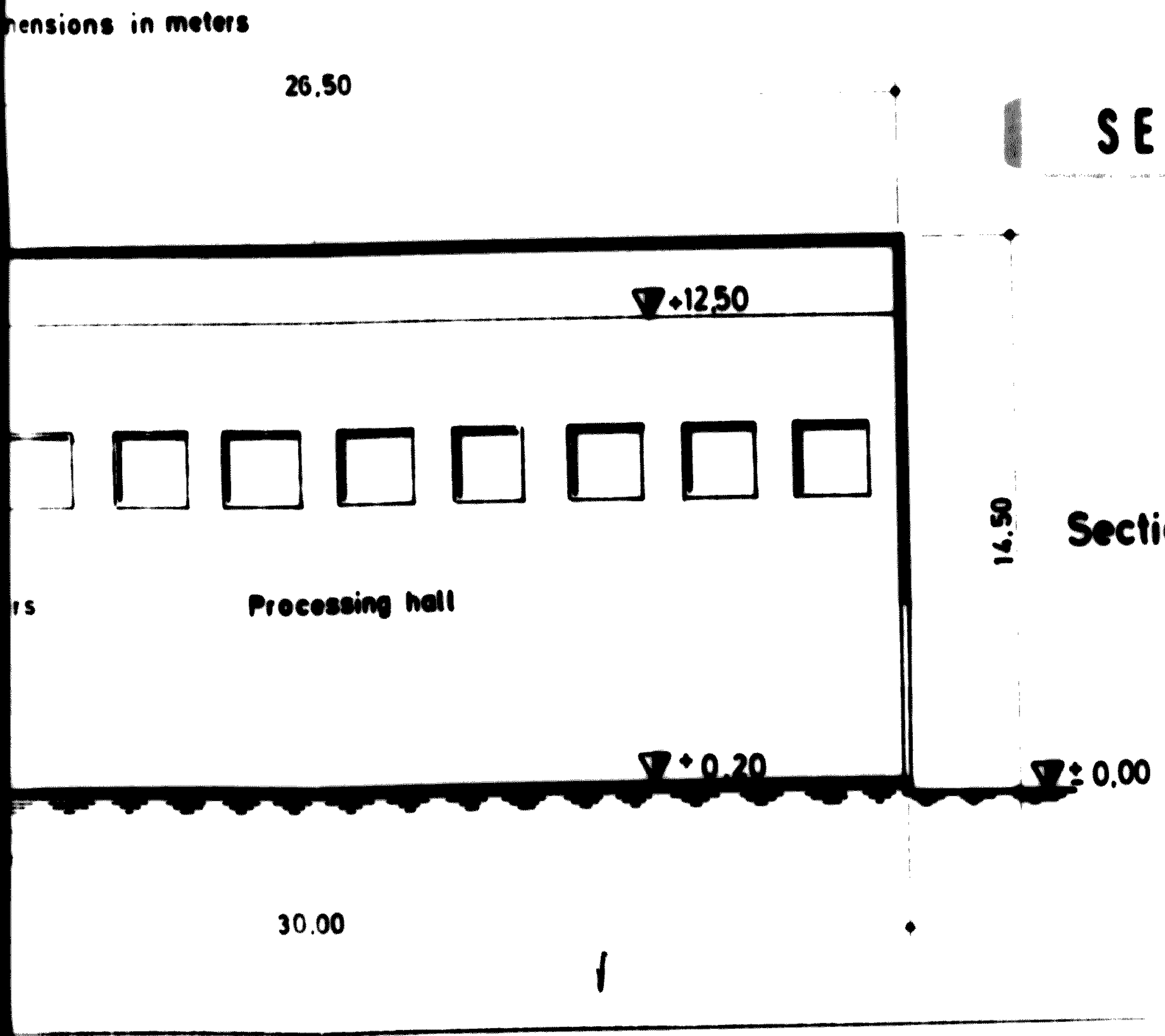
SECTION 1


All dimensions in meters
9,50
26,50
Crane
+6,60
Hoppers
Processing hall
Garbage bunker
+0,20
±0,00
2,00
4,00
6,00
30,00



Section A-A

SECTION 2



Section B-B

FIG. 6 b

All electric equipment (insulation) must resist the humid tropic climate and work at 220/380 volts A.C.,50 cycles/second.

II. Process

The composting process is shown on the flow diagram Fig. 4.

On the arrival at the plant site the garbage will be weighed on the weigh bridge (1) and then dumped into the bunker (2). From here, the rail crane will serve the two processing lines (3 - 9) with garbage at a rate of 10 tons per hour.
Each line consists of one hopper with rate control at the outlet serving continously one conveyor belt where unusable matter is picked out. An electromagnetic device above the belt will pick up iron parts and take them to a common scrap press (7). Each belt then leads to a diminutor and a sifting device (8). The rejects from the sifters are eliminated. The broken matter up to 6 to 8 centimeters size will then be conveyed to the separators (9) where non-compostable parts of hard matter with high specific weight are eliminated, they, as well as the rejects from the sifters (8), represent the uncompostable part of the garbage and will be deposited separately somewhere at the plant site.
The garbage treated for composting and leaving the separators (9) will be taken, by means of conveyor belts, on to the lorries and then to the composting place (10).

III. Equipment list

A	1 weigh bridge
B	1 rail crane with gripper
C	2 garbage treatment lines at 10 tons of garbage per hour each
D	1 complete electric equipment incl. switch gears
E	1 water supply scheme
F	1 group of transport units within the factory
G	1 workshop
H	1 fire extinguishing outfit
I	1 sanitary equipment

IV. Technical specifications of equipment

A 1 weigh bridge

Maximum load 45 tons, weighing range 0 - 30 tons, bridge dimensions appr. 10 x 3 meters

comprising

1 remote weighing (indicating and printing) cubicle at a center to center distance from the weigh bridge of appr. 10 meters in lateral direction

1 weigh bridge outer framework

1 supporting steel structure

1 set of bumpers

1 spare set of toggle links

complete with installation and adjustment on foundations made according supplies to drawings by subcontractor.

B 1 gantry crane with rails and 1 grab for the feeding of the 2 garbage processing lines with 10 tons of garbage each.
Load capacity of the crab 4 tons max. span appr. 8,5 meters

comprising

1 gantry, steel structure with rails appr. 20 meters long

1 mobile bridge with electric drive and wheels, remote control

1 complete crab with electric drive and grab for max 4 cu.m of capacity, rope winch, remote control

1 low tension switch gear and all connection and control cables for full operation, and

1 operator's desk
both switch gear and operator's desk installed within the operator's room.

Complete with installation and adjustment on foundations made according to supplier's drawings by subcontractor.

C. 2 identical garbage processing lines
each preparing 10 tons of garbage per hour for subsequent composting,
both together comprising

2 garbage reception hoppers, capacity each appr. 16 cu.meters, including supporting steel structure

2 vibrating conveyors at the outlet of the hoppers, with adjustable throughput around an average of 10 tons per hour each, with electric drives and supporting steel structure,
feeding the following

2 conveyor belts adapted to manual extraction of refuse out of the garbage at a speed of 40 cu.m of garbage per hour, with electric drives and supporting steel structure,
and

2 electromagnetic device above the belts which pick iron scrap out of the garbage

2 diminutors combined with sifters which split up the reduced matter in non-compostables bigger than 8 centimeters and compostables smaller than 8 centimeters, complete with electric drives and supporting steel structure
followed by

2 belt conveyors complete with electric drives and supporting steel structure for the transport of the compostable garbage from the sifters (smaller than 8 centimeters) to the

2 densimetric separators where hard matter such as glass, stones and broken ceramics are taken off by means of horizontally rotating cylinders, complete with electric drives and supporting steel structure

2 belt conveyors at the compostable material outlet of the separators, complete with electric drives and supporting steel structure
and

2 common lateral belt conveyors, reversable action, for truck loading at both ends, complete with electric drives and supporting steel structure

1 common longitudinal belt conveyor for bulky refuse from manual selection and coarse refuse from the sifters as well as hard and heavy stuff from the separators, complete with electric drives and supporting steel structure

1 common lateral belt conveyor for the truck loading with the above mentioned bulky, coarse and hard refuse, complete with electric drives and supporting steel structure

1 hydraulic scrap press, with reception hopper, electric drive, size of the compressed packages appr. 40 x 40 x 20 centimeters at about 20 kgs.

Complete with installation, adjustment and test runs, foundations according to supplier's drawings by subcontractor,

- all electric drives resistent to tropical conditions according to I.E.C. Standards
- all turn-overs for conveyors if necessary
- all conveyors with adjacent guides
- all scaffolds, platforms, railings, ladders gangways a.s.o. for proper operation and service
- the first oil-fill for all bearings, gears, a.s.o.
- Inspections during manufacture of equipment, work certificates, work test runs, and final acceptance certificates, whatever is appicable, are required.

D. <u>1 complete power supply scheme comprising</u>

1 high tension (10.000 volts) cable connection between high tension line adjacent to the plant site (see plot plan no.5) and the high tension switch gear and transformer station in the processing hall.

1 high tension switch gear unit in the processing hall

2 identical transformers (one stand by) 10.000/220/380/volts 3 phases, 50 cycles, each one 300 kVAs.

1 low voltage switch gear for the entire processing hall including illumination

1 low voltage switch gear unit for the administration building and porter hall

1 central control panel with all process controls, monitors, interlock and alarm system for all drives.

1 telephone set, to be connected to the urban network, with operator's desk and 10 extensions spread over the plant, with all connections above ground

1 lot of cables, wires, pull boxes, switches, fuse boxes, housings and other electrical material and supports necessary for the installation of the electric power supply scheme and the telephone network (For the individual lengths and locations, see plot plan Fig. 5 and drawings Fig. 6).

Complete with installation, small installation materials, single test runs and acceptance test run.

E. <u>Water Supply Scheme</u>

<u>comprising</u>

1 6" galvanised steel screwed main line from the tap on the 12" cast iron Kakoulima - Conakry water main at the norther border of the plant site to the water distribution station in the processing hall (see plot plan Fig. 5) with gate valve at the top, couplings, flanges with bolts and nuts.

1 centrifugal booster pump, inlet flange 6", outlet flange 4", differential pressure 5 atmospheres max. working pressure 10 atmospheres, cast speroid iron, with electric motor 3 phases 380 volts 50 cycles tropical insulation, single throw switch actuated by pressure switch, on common base plate, with by-pass 4", by-pass gate valve, companion flanges, 2 pressure indicators (inlet and outlet), and check valve

1 surge drum of appr. 5 cu.meters, working pressure 10 atmoshperes, with 4" inlet and outlet nozzles, flanged pressure switch, safety valve, manhole, gauge glass and supporting saddles mounted at the roof of the processing hall.

1 closed circuit main 4", 3" laterals spread over the composting plot with 1" taps every 50 meters,

1/2" taps in buildings, processing hall, sanitary and personnel rooms

3 nozzles for fire hydrants (2 on the composting plot, 1 in the processing hall)

3 1" hoses, 50 meters long, with unions for the taps on one end and sprinklers on the other, on reels

complete with installation, small installation material and fittings, and tightness and pressure test.

All piping and fittings to be from galvanized steel.

F. 1 Group of Transport Units

for inner transport of compostable and non-compostable matter and compost for sale
comprising

3 dump lorries, loading capacity each 5 tons

2 bulldozers, capacity of the loading shovel appr. 1 cu.meter

complete with tools and spare wheels

G. 1 workshop

The equipment comprises

1 work bench with

2 vices

1 tool locker for mechanics

1 drilling machine, vertical on support for diameters up to appr. 23 millimeters

2 manual drilling machines for diameters up to 12 millimeters

1 electric welding set for electrodes from 1,5 to 3,5 millimeters diameter, with accessories and welder's equipment

1 acetylene welding equipment unit with accessories

H. 1 Fire Extinguishing Equipment

comprising

1 mobile booster pump, centrifugal with Otto-motor drive (gasoline), traction by hand, 3" couplings and suction hose, for standard fire hydrants, fuel tank

2 standard fire hydrants surface mounted for 3" couplings and hoses, together with gate valves (for composting plot)

1 standard fire hydrant, wall mounted, with gate valve

2 mobile fire hoses 3" with couplings at one end and jet nozzle at the other, 75 meters long each, on reel and small cart, traction by hand

6 portable extinguishers, each containing appr. 6 kgs of extinguishing powder, with wall mounted supports

I. Sanitary equipment

comprising

a) in the processing unit

4 hand-basins
2 showers
3 WCs
3 urinals

16 lockers for wardrobe
1 first aid outfit

b) in the administration buildings

1 hand-basin
1 WC
1 urinal
4 lockers for wardrobe

complete with installation, installation material (piping, fittings, supports)

R e m a r k s

on

IV. Technical specifications

All equipment A through I must be furnished together with

- 4 copies of all foundation drawings
- 4 copies of assembly drawings
- 4 copies of dimensional drawings
- 4 copies of ckeck list of all individual items
- 4 copies of spare part list
- 4 copies of assembly instructions
- 4 copies of operation manuals
- 4 copies of lubricating instructions
- 4 copies of list of recommendable spare parts for one year's operation

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