DESIGN PROPOSAL FOR SOLID WASTE RECYCLING PLANT CHANCHAGA NIGER STATE, WITH EMPHASIS ON NOISE POLLUTION CONTROL.

BY:

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CERTIFICATION

This thesis titled " **design proposal for solid waste recycling plant, with emphasis on noise pollution control**" meet the regulation of the award of the **MASTER OF TECHNOLOGY (M.TECH)** in Architecture degree of the Federal University of Technology, Minna and is approved for its contribution to knowledge and literacy presentation.

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DECLARATION

I do hereby declare that the work presented in this thesis for the Master of Technology, Architecture degree(M.TECH) has not been presented either partially or wholly for any other degree.

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ABSTRACT.

"People need to be friendly with their wastes, because you would never know when you would meet it again"; a health minister in England said this in the 1940's when an epidemic of cholera broke out in the southern part of that country.

What he said still applies today of course, in a different context. The need to reuse certain materials used before is getting greater, with environmentalists shouting and calling to halt mining and felling activities. The need to preserve our planet for the next generation is getting greater; this is because of the irresponsible way we went about it in the beginning. Trees cut down to make paper were not re-planted and people just moved on to other forests, but now with the depleting earth resources, people are beginning to take notice of the little things we can do to help Recycling is one of them.

This project is to help set up a network in Nigeria where solid waste can be recycled and reused in order to preserve the few natural resources we have left. Paper is the most widely used material in the world today; this is due to education, and global networks where the person doesn't have to be there any more but send a fax Message. These activities are taking a toll on the paper producing industries to produce more paper and in turn cut more trees. But if paper that was used before can be treated so that it can be used again, this would solve a lot of things including saving the number of our trees and even production cost.

Developing countries are usually the last to catch on to the happenings of the world, and recycling is no exception (solid of course). These wastes can be collected, sorted, graded, treated to be able to be reused. This would go along way in helping us make the earth better.

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2.2 *A BRIEF HISTORY*

Early humans did not have a solid waste management strategy per se simply because the hunter – gatherer existence did not require one never staying in one place long enough to accumulate any significant amount of solid waste, as well as a need to utilize scare resources to their highest decree, probably did not create any concern or action. However, as humans began to settle in permanent communities with higher concentrations of waste- producing individuals and activities, the need for waste management became evident. Although this occurred around 10,000 B.C in some places, it occurred much later in others and remains much less a concern in the less populated and rural areas of the planet even today.

By 500 B.C. Athens organized the first municipal dump in the western world, and scavengers were required to dispose of waste at least 1 mile from city walls. This imperative continued from place, going forward and backward relative to the desires and ability of governments. During the middle ages waste disposal continued to be an individual responsibility commensurate with the lack of enlightened authority by government.

In 1388 the English parliament banned waste disposal in public waterway and ditches. A few short years later in 1400, garbage was piled so high outside the Paris gates that it interfered with the defense of the city. These examples are citied because they indicated a desire on the part of the government to assume responsibility for this element of the health and safety of the community primarily when other responsibilities such as drainage and defense were involved. This growth in governmental concern for health and safety with regard to waste disposal lead to additional regulations and

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CHAPTER ONE

1.0 INTRODUCTION

There are now almost three times as many as were on the earth (approximately 6 billion) as there were less than a century ago. This population increase combined with the shift from an agrarian (farming) society to an individual one over the last century has led to the creation of environmental problems previously unknown. The ever – increasing material needs of our technological economy have created enormous pollution problems that must be solved if humanity is to survive.

The need for certain naturally occurring materials have more than doubled in the last two decades. These materials include metals: - gold, silver, copper, brass tin, platinum, paper made from certain trees, and glass manufactured from several elements. To keep up with this need, man has gone deeper into forests, and lower into the earth. This has caused a lot of damage and environmental degradation; we have seen what several minning companies have done, polluting the waters around them, and releasing untreated hazardous waste into the environment. These wastes destroy everything they come in contact with. Forests that had taken centuries to develop have been entirely wiped out in decades. Most of them cannot be regained in our lifetime.

The increase in population have not only destroyed our natural resources and natural beauty, but also generated wastes both solid and liquid, that man has found very difficult to get rid of safely. The waste generated be man cannot just be thrown away, it needs to be treated and re-used if possible the battle of what to do with mains ever – increasing waste products

has been raging for centuries now, and just when it looks like man is winning, the waste do a lot more damage than imagined.

Fortunately, there are several solutions to these problems, but the most effective and widely used solution is recycling. Recycling means to pass materials through a series of changes or treatment to make it possible to be used again. This method has been in use in many developed countries but developing countries are just getting the full impact of the environmental problem, therefore the solutions are just getting to countries like South Africa, Kenya, Sri- lanka and even Nigeria.

Recycling has a lot of advantages in that it reduces the world's wastes products; it also reduces the dependence of humans on fresh resources. The methods of recycling are also cheap and can provide jobs especially in developing countries.

1.1 MOTIVATION

Every man, woman, and child generates garbage. Our businesses, factories, and institutional establishments generate garbage. The question is not whether we will or will not generate garbage but how much, what kinds, and whether there is day secondary use for solid waste before we decide to bury or burn it.

In the United States (which we are using as a broad case study), there has been a steady increase in the solid waste stream over the past 30 years this can be seen in figure 1.1 As can be seen, annual solid waste generation in the United States has steadily increased from an estimated 82 million tons in 1960 to an estimated 155 million tons in 1990, by 1997, this had risen to 176 million tons. This averages out an increase of approximately 2 percent per year over the 30 years. Our propensity to produce and discard more has

put an ever – increasing burden on our society to effectively manage our solid waste stream.

In order to face up to this challenge we need to know what constitutes our solid waste stream. This is the only way we can plan environmentally sound disposal and more importantly, efficient and effective resource management and recycling programs.

Most countries in Europe and North America have integrated recycling in their way of life to enable them reuse materials that are either scarce or that are made from natural resources that are fast disappearing from places inhabited by human beings. In Africa, especially Nigeria, this concept hasn't caught up yet only a few countries in Africa actually have a fully utilized recycling program. It is true that Africa and indeed Nigeria is blessed with numerous natural mineral resources that are being exploited both in outside the continent, if this is not checked and helped by recycling, our natural resources could be lost forever.

This is why I have chosen to design a recycling plant to help in the recycling of paper, glass, aluminum and plastics. They are things that we use everyday and with proper care and treatment can be reused again and again. Building recycling plants, and implementing educative programs in strategic states and locations of the country, would save our natural resources from extinction because the already recycled products would meet the demand of these products. This would also same the cost and time increased in importing these materials.

1.2 AIMS AND OBJECTIVES

The aim of this project is to provide:

a). A standard recycling plant that has been well designed and properly studied to suit on environment, and that would recycle paper, glass, aluminum and plastics.

b) To educate Nigerians on the enormous advantages of recycling and set up programs educating them on how easy it is to get used to recycling.

c). To encourage us to get involved in recycling.

d). To save our natural resources.

The objectives are: -

a). To integrate the design of an individual building with its environment and to control noise pollution.

b) To use my knowledge of acoustics to provide a well equipped building.

1.3 SCOPE OF WORK AND STUDY.

The subject of recycling brings together various professions and branches of physics, chemistry and architecture. The scope I am covering is from the architectural point of view of acoustics in industrial buildings. I am going to look for the best way to contain the noise generated from machineries and trucks involved in the running of a standard recycling plants. This project would also cover the collection, treatment, recycling and reintroduction of paper, glass, plastics and aluminum.

The facilities that are to be provided are divided into groups: -

(1) The administrative block: - which would have the people involved with the day to day running of the recycling plant, offices would be provided.

- ❖ Canteen / restaurant
- ❖ Rest rooms
- ❖ Data collection offices,
- ❖ Technician's offices etc.

(2) The main recycling plant, which would include: -

- ❖ Treatment plant
- ❖ Chemical processing area
- ❖ Waste treatment area
- ❖ Thermo cooling room
- ❖ Quality control room

(3) Auxiliary and support facilities.

CHAPTER TWO

LITERATURE REVIEW

2.1 RECYCLING DEFINED

The recycling perplexity.

Recycling? This is a seductive word to the environmentally aware among us. But what it is? What does it mean? What it is all about? Who does it? Why should I? These questions seem endless, some have simple answers, many others are a part of a much more complex issue. Many more are yet unresolved and others are only now evolving. Just addressing the question of definition becomes an evermore-complex issue as almost every government entity; industry and commercial trade organizations, professionals associations, academics, and practitioners attempt to define what it is. Because each how a different perspective and goal, each has slightly different definition. Even a dispassionate search for a bias – free definition is difficult perhaps because of the circular nation or the subject.

When does the cycle begin or end? Does it ever? Does paper recycled for use as a raw material in making boxboard constitute a virgin material? What about the boxboards trimming that were made from recycled materials? Are they waste again? What recycling is today?

Recycling today is and must be understood as, a solid waste management strategy. A method of solid waste management equally useful as land filling or incineration is environmentally more desirable. Today it is clearly the environmentally preferred method of solid waste management.

practices. A rapid expansion in understanding the long-term impacts of ground water and air pollution began to demand even greater regulation of disposal practice. In many areas of the nation both open burning of solid waste at dumps and ocean disposal remained an acceptable practice well into the 1970's.

Solid waste management law was the solid waste disposal act (S.W.D.A.) of 1965, which authorized research and provided state grants. Three years later in 1960 President Johnson commissioned the National Survey of community solid waste practices. It provided the first comprehensive data on solid waste on a national basis. Two years later the solid waste Disposal Act was amended by the Resources Recovery Act, and the Federal government was required to issues waste disposal guidelines.

The year 1970 also saw the passing of the clean Air Act, which established Federal authority to combat smog and air pollution leading to the shutdown of many solid waste incinerators and the elimination of open burning of solid waste. Significantly the first Earth Day was celebrated the same years on April 22, 1970. Indicating a world wide heightened environmental awareness including that of the solid waste disposal dilemma Within a year Oregon become the first state to pass a bottle bill, thereby creating a procedure for government regulation covering the reuse and recycling of designation portions of the waste stream during peace time without the imperative of wartime economics. Although all the 50 States in America had some kind of waste regulation by the mid- 1970's, it was the Resource conservation and Recovery Act of 1976 (R.C.R.A) that created the first truly significant role for the Federal government in solid management. The act emphasized conservation of resources, particularity energy conservation, and recycling as preferred solid waste management program,

recognizing the detrimental effect of hazardous waste on solid waste management alternatives as well as the environment in general.

The stimulus of the Arab oil embargo, the public utilities Regulatory Policies Act of 1970, which guarantees markets for small energy producers, and R.C.R.A combined to encourage on explosive growth for waste – to – energy plants and to some extent the recovery of methane for fuel from land fills. However, others industry the state of Florida, do not consider the burning of and recovery of energy from solid waste as recycling. Ever today the debate continues with positions taken on both sides as to whether or not waste to energy is legitimately considered recycling.

All of those considerations have led both a public and a legislated demand for recycling as the preferred solid waste management strategy today and in the future. The willingness of government to require and subsidize recycling when necessary has grown to enormous proportions. Significantly the dominant theme of Earth Day 1990 was recycling.

2.2. b Defining Recycling

Recycling remains, however, one of those elusive concepts about which every one thinks they have a clear understanding until they begin to practice it. Although most people understand the relatively simple tasks required by individuals in order for them to participate, the subtleties necessary for the interplay of both the public sectors needed those materials to industry as materials and the methods employed to do so require definitions other than common language and as a method of law. In addition, the concept gives rise to other terms required to fully implement the concept. The terms recyclable materials, recovered materials, and recycled materials all are needed to define concept of recycling and usually require definition in

various state regulations. Therefore, only a dictionary definition of recycling can convey a general concept of a term that has been, and will continue to be, defined though committee discussion, contractual negotiations, and legislation designed to meet specific needs.

2.2.c Public Perceptions.

Although rapidly changing in respect to local public awareness campaigns, the general publics perception of what recycling is remains largely limited to those visible elements including curbside programs, recycling centers, and a vague understanding that this is good for the environment because these materials do not go to a land fill or incinerator. This view also usually incorporates a demand for recycling a greater variety of materials than is practical or economically possible at this time or a misunderstanding about what can or cannot be recycled.

2.2.d the why's of recycling?

Recycling occurs for three reasons: - altruistic reason, economic imperatives, and legal considerations. In the first instance, protecting the environment and conserving resources have become self-evident as being in everyone's general interest. Second, the avoided cost of environmentally acceptable disposal of waste has risen to a level where when combined with the other costs associated with recycling. It now makes economic sense to recycle many materials. Finally, in responding to both public demand and a graving lack of alternative waste disposal methods, government is requiring recycling for a wide variety of economic and civil penalties and incentives in order to encourage recycling.

2.3 PROGRAM OPTIONS

Whether anyone wants to recycle for altruistic reason or because 'the law makes us do it', a wide variety of options for recycling are available. Although each option is discussed in details in the later part of this chapter, a central issue that must be considered to that no single option yet available provides all the answers. It is most likely that there is no simple option that is best for everyone. There is, however, a best option or combination of options for everyone when a careful evaluation is made to determine what is available to meat specific needs and circumstances.

Recycling debate has evolved into several broad configurations for which examples can be rapidly found in operation today. Innovation, creativity, and practically provide many variations.

Both residential and commercial establishment can participate in recycling in separating materials before they are mixed with wastes. In these programs recycled materials are kept separate in a variety of containers whether in the home or in the workplace. At appropriate intervals, they are placed for collection or transported to centralized collection and / or processing facilities.

2.3.a Curbside Collection

Curbside programs after serve single – family residential units. These programs may require residents to use one or more containers to separate and store recycled materials that are diverted from the normal waste stream. The type and number of containers can vary dependent on the variety of materials collected and degree of separation decided. The design, capacity and construction of the containers also vary. Some programs provide

containers and others do not. Containers may be rigid, specialized plastics, paper or plastic bags, or even bundled or contained at the participant's discretion.

2.3.b Commercial Collection

Similar programs are also used for multidwelling residential units and commercial applications. However, of necessity these programs do not include curbside collection. These programs required recyclable materials to be placed in specialized containers of the type traditionally used in those applications. Therefore, if a multidwelling unit residence is normally served as a single- family unit for waste, then it can be served as a single family for recycling service. Similarly, if it is served as a commercial establishment for waste collection, then it will probably require recycling service in a similar manner.

Commingled or source- separated? In both residential and commercial applications, the degree of separation may vary significantly. A great deal of commingling can be allowed or required in all instances if a centralized processing facility is not available, single-family residential units can always be allowed to commingle materials by using a truck side sort collection method this method requires the collector to manually separate the material in the containers and keep them separate in the collection vehicles units delivered to markets or intermediate processing facilities.

2.3.c Material Recovery Facilities.

The use of material recovery facilities (M.R.Fs.) serving commingled programs is rapidly gaining popularity. Commingled programs used in a

molted welling unit or commercial application can allow collection methods where space available for placement of collection containers is limited.

2.3.d Drop – off/ Buy – Back centers.

Voluntary participation in recycling programs is often related to the ease with which an individual can participate. Therefore drop; off centers that depend on altruistic motivations add a degree of inconvenience that can reduce participation. These centralized locations where recyclable materials are collected are easier and less expensive to implement than curbside programs. They are especially effective in where regular waste collection is not required or available.

Buy – back centers offer all of the benefits of drop off centers and the increased incentives of monetary benefits to participants. They are, however, more expensive, to operate because they must be staffed, secured, and handle cash.

Waste may also be segregated and collected by broader categories such as wet and dry, putrescrible and nonputrescrible, household waste or yard waste, etc., prior to recycling. It can still be recycled to greater or lesser extent ever if it is mixed.

Recycling at waste – to – Energy Facilities Waste-to-energy facilities increasingly employ separation systems to recover non-organic recyclable materials. The degree and type of material recovery depends, largely on whether the materials are recovered prior to or after incineration. Recovery of material after incineration, known as back-end systems, is frequently used with mass burn waste- to energy facilities. They can recover high percentages of ferrous and non- ferrous through the use of simple technology. Although the quality and quantity of the recovered materials

may be diminished, back- end systems can offer a relatively inexpensive retrofit for existing facilities.

Front- end separation systems that remove recyclable materials prior to incineration are used in facilities that prepare a refuse- derived fuel by removing the inorganic fraction of the waste prior to incineration. These materials are then recycled or, when no markets, land filled with other non-processible materials.

Although many front- end designs and technologies are available, they are all more complex and therefore more expensive to construct and operate than back- end systems. However, they offer a greater opportunity to recover a wider variety and higher quality of recovered materials.

Composting

The methodologies and technologies used in separating materials from mixed waste can also be used in the preparation of compost: Long championed as the solution to the solid waste dilemma, the composting of mixed waste has mat with limited success. Although easy to do on small scale, its success has been hindered by a lack of markets and other applications in large quantities. Compost from mixed waste has recently fallen in to disfavor with some environmental groups on the basis that it discourages other kinds by several states because of the potential negative consequences of contaminants such as heavy metals that may be present in compost made from mixed waste. Higher degrees of separation of and other contaminants will be necessary for successful composting of mixed waste in the future. Programs for composting clean yard waste and other homogenous maternal office greater promise. Although still limited by a lack of markets, they are enjoying a much lighter degree of success.

2.4 LEGISLATIVE EVALUATIONS IN THE UNITED STATES FEDERAL LEGISLATION

Recycling legislation has been national law since 1970's National Environmental policy Act (NEPA), which focused on government's responsibility to maintain harmony between people and the environment. Section 4331(a) declares that it is the continuing policy of the federal Government, in cooperation with state and local government public and private organizations, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic and other requirements of present and future generations of Americans. Since 1970, maintaining the delicate balance within our environment has been of congress's broad mandates.

Section 4331 (b) states that it is also the responsibility to the federal government to "(6) enhance the quality of renewable resources. And approach the maximum attainable recycling of delectable resources" section 4331 also addresses the government's continuing responsibility to act as the "trustee of the environment" using all "practical means".

Reacting to both public outrage and the realities of the solid waste disposal problem, congress has begun to focus renewed attention upon waste reduction and recycling. A plethora of waste reduction and recycling legislation has been sponsored in the last 2 years. Proposed legislation follows directly from responsibilities dictated in the 1970 NEPA act. As of January 1990, 50 bills pertaining to recycling and senate. Outlines of some of the most important bills follow.

2.4a STATE LEGISLATION

Many states have been actively studying the solid waste problem and deli eloping solutions that include recycling, composting and waste reduction strategies. These states have been moving aggressively to develop and fund programs to reduce the solid waste stream. These laws are designed to change the individual solid waste management behavior of every citizen in the perspective state The impetus for legislation in many cases was the lack of available landfill capacity, the not- in-my backyard (NIMBY) syndrome, the escalating expense of waste disposal, and the environmental consequences of disposal. Some states have replication portions of laws from, other states that have developed viable solutions. A summary of 16 state laws follows.

2.4.b California.

In 1989 the state of California passed 17 bills relating to waste management and reduction through reuse, recycling, and composting. One bill-Assembly Bill 939- created the integrated waste management Board, whose six members will supervise the development and implementation of country wide integrated waste management plans. The general provisions of the new law promote the following waste management practices in order of priority: -

(1) Source reduction

(2) Recycling and composting

(3) Environmentally sound transportation and environmentally safe land disposal.

"Transportation" as defined in the California legislation means incineration, pyrolysis, distillation, gasification, or biological conversion other than composting. Before July 1991, each city was to have prepared a solid waste plan.

Table 2.1 *State Recycling Goals*

State	**Recycling goal, %**	**Years**	**State**	**Recycling goal, %**	**Year**
Alabama	25	1995	Nebraska	25,50	1994-
Arkansas	30,40	95-	Nevada	25	2000
California	25,50	2000	New	40	1994
Connecticut	37	95-	Hampshire	60	2000
District of	20	2000	New Jersey	25	1995
Columbia	30	2010	New Mexico	50	1995
Florida	25	1991	New York	25,40	1997
Georgia	25,50	1994	North	25	1993-
Hawaii	25,50	1996	Carolina	50	2001
Illinois	35,50	95-	Ohio	25	1994
Indiana	25,50	2000	Oregon	15	2000
Iowa	25,50	97-	Pennsylvania	25	1997
Kentucky	25	2000	Rhode Island	25,50	(N0 year)
Louisiana	25,50	95-	South	25	1997
Maine	15,20	2000	Carolina	40	1996-
Maryland	23,46	94-	South Dakota	40	2000

Massachusetts	30	2000	Tennessee	10,25	1995
Michigan	35	94-	Texas	50	1994
Minnesota	25	2000	Vermont	20,50	2000
Mississippi	40	1992	Virginia	10,30	1991-
Missouri	25	92-	Washington		2000
Montana		1994	West Virginia		1995
		92-	Wyoming		1993-
					2000
					1991-
					1993

* Greater than 100,000 population.
+ Less than 100,000 population.

not indicated on table

Source: - National Solid Waste Management Association.

Consistent with the above hierarchy. The state program emphasizes implementation and will include the following.

(1) A waste characterization component.

(2) A source education component.

(3) A recycling component.

(4) A composting component.

(5) A solid waste facility capacity component.

(6) An education and public information component.

(7) A funding component.

(8) A special waste component.

(9) A household hazardous waste component.

The law requires the city or country to divert 50 percent of its waste stream by January 2000 through sources reduction, recycling, and composting activities. The interim goal is 25 percent by 1995.

Senate Bill 1221 increased the redemption fee 2020 program for beverage containers to improve redemption percentages. Assembly Bill 4 will stimulate the market for recycled products by setting procurement preferences for recycled materials for all state (23) agencies.

To increase the demand for recycled goods, Assembly Bill 1305 requires newsprint consumers – publishers – to increase their recycled paper content usage to 25 percent by 1991. A series of increases will raise the requirement to 50 percent by January 2000.

Table 2.2 State Disposal Bans.

State	Lead-acid batteries	Yard waste	Unprocessed Tires	Used oil	Large appliances	Others
California	.					
Connecticut	.	. A		.		B
Florida	.	.	.	.	.	C
Louisiana	.		.	.	.	
Maine	.					
Michigan	.					
Minnesota	.	.	.	.	.	D
North	.	.	.	.	.	
Carolina	.	.				
New York	.		.			E

Oregon	.	. A	.			
Pennsylvania	.		.		.	
Rhode Island	.					
Washington	.	.	.	.	.	F
Wisconsin						

(a) Yard waste disposal bans only apply to leaves

(b) Nickel – Cadmium batteries

(c) Construction and demolition debris.

(d) Dry cell batteries that contain mercuric oxide or silver oxide electrodes, nickel – cadmium or sealed lead acid. Mixed unprocessed waste in metro area.

(e) Recyclable material that already been separated.

(f) Aluminum, plastic steel and glass containers, corrugated paper and paperboard, form. Polystyrene packaging magazines, newspaper and officer paper are banned from disposal unless municipalities are certified as having an effective source separation program.

Source: - National solid wastes management Association.

The state also enacted a fine of $1000 for each violation as an enforcement measure. This action is dependent upon recycled stock meeting specific quality standards, as well as being competitively priced.

Senate Bill 432- Assembly Bill 1308 created tax credits as incentives for investment within the private sector. Tax credits up to 40 percent encourage buyers of machinery or equipment used to manufacture products made of recycled materials. Credit is capped at $250,000 for each piece of equipment and expires after November 1994. Additional legislation creates a

25-cent tire disposal fee to support tire recovery, while another bill mandates the coding of all rigid plastic containers by 1992.

2.4.c New York.

The state of New York's chapter 70 Bill, passed in May 1988, appropriated & 61 million for solid waste management throughout the state. By September 1992, all municipalities in the state are required to pass a mandatory source separation ordinance with a diversion goal of 50 percent by 1997. Each municipality is responsible for enforcing recycling ordinances. The state will regulate all municipal and solid waste facilities, issuing permit only after recycling plans have been approved and implemented.

As of 1990, the state's Department of Environmental conservation granted nearly $8million to 88 county and local Governments for recycling programs. Funds are appropriated in five sections. A total of $6 million was set aside for small-scale, low technology resource recovery programs plans called for another $6 million to be added $2 million in oil overcharges and designated for the Local Resource, Reuse and Recovery program.

Counties and municipalities will be reimbursed up to 75 percent of their start up administration costs for recycling programs. Additional funds will cover curricula, educational videos, and advertisements as well as investigations of market strategies.

The state is instructed to provide $7.5 million to countries or multiple townships for assistance in the development of their solid waste management plans. The Department of Economic Development is directed to use $3.5 million to establish secondary markets for recyclable materials. Any remaining must cover the DEC'S administrative costs.

Governor Cuomo and major newspaper publishers in the state of New York have established a voluntary agreement where by publishers will use a total of 11 percent recycled content paper in 1992, 23 percent by 1995, and 40 percent by the year 2000. If newspaper publishers are unable to meet the voluntary goals, it is likely that mandatory legislation will follow.

2.4 CHARACTERIZATION OF WASTE STREAMS

Impact of characterization Results over the past, say, 20 years, a considerable amount of attention has been given to planning for the disposal of the municipal solid waste stream. Our effects have focused primarily on the quantity of solid waste generated and to a lesser extent the compositional breakdown of the solid waste stream.

In the past, solid was characterization was typically one component of a solid waste quantification study. The major concern focused on quantity and not quantity. Through the years, however, an increasing awareness as to the composition of the solid waste has been found to be essential for effective long- term solid waste management. As a result, solid waste characterization continues to be an essential element to adequately assess the feasibility of various disposal technologies.

The quantity and composition of the solid waste stream has a direct impact on the technologies selected for management and disposal. For example, the evaluation of waste-to-energy technologies requires a through understanding of the solid waste stream, including its value as a fuel source. The composition of the solid waste stream will ultimately determine it higher heating value as a fuel for generating power. The higher heating value (which is the measurement of the amount of energy released from a fuel, in

this case solid waste, when burned) will have a direct effect on, first, the feasibility of a waste-to-energy technology: whether the solid waste burn; and, second, on the sizing of the waste-to-energy facility: as solid waste burns hotter, its processing rate decreases. As a result, the rate throughput at a waste-to-energy facility is adjusted based upon the higher heating value of the solid waste stream being processed.

The composition of the solid waste stream is also used to assess the potential environmental impacts associated with disposal. The old adage is true; you get out what you put in. again, using our waste-to-energy example, knowing the constituents of the solid waste stream to be processed in a waste-to-energy facility allows scientist to determine what chemical compounds and gases are likely to be formed during and after the combustion process. This knowledge then enables engineers to design state-of-the-art air pollution control systems capable of mitigating potential adverse environment impacts. In the instance of landfill disposal, the composition of the solid waste to be buried has an impact on the assumed in-place density, which in turn affects landfill capacity or landfill life expectancy. The solid waste characterization data are also used to determine what potential chemical compounds are likely to be released in the form of leachate as rain percolates through the landfill. This again enables scientists and engineers to design appropriate leachate collection and treatment systems to mitigate potential adverse environmental impacts.

In the past, solid waste characterization studies tended to be structured to address a limited number of solid waste management issues. The studies typically addressed an overall strategy for waste disposal. Let us call this the macro approach, when conducting a solid waste quantity and

characterization study; the macro approach would typically identify the following solid waste constituents:

Paper and Paperboard	Glass
Metals	Plastic
Rubber and leather	Textiles
Wood	Food waste
Yard wastes	other wastes

Miscellaneous inorganic wastes.

Although a solid waste composition study must characterize these solid waste constituents at a minimum, it has become essential that a micro approach be adopted to analyze each waste constituent by subcomponent. The micro approach identifies solid waste constituents by subcomponent. The micro approach provides information that enables the assessment of various recycling and materials marketing strategies as well as detailed information necessary to plan comprehensive waste management systems. The following is what the breakdown of solid waste subcomponents might look like:

- Paper: newsprint, corrugated, books, magazines, tissue-towels, commercial printed, office paper, packaging.
- Glass: container glass (clear, green, amber), other glass.
- Metals: aluminum cans, aluminu8m foil, ferrous, tin.
- Plastics: polyethylene tetra phthalate (PET), Polystyrene, clear high-density polyethylene (HDPE), colored high density polyethylene (HDPE), Polyvinyl chloride (PVC)
- Food waste

- Rubber
- Leather
- Textiles: Fabrics, clothing
- Wood: stumps, pallets, furniture
- Yard wastes: leaves, grass, limbs
- Ceramics
- Construction and demolition debris
- Tires
- Waste oil
- Other wastes
- Miscellaneous inorganic wastes.

Reliability of characterization study.

Although a solid waste characterization study is based on statistical reasoning, the results are estimates. We can, however, develop a study protocol to achieve a level of confidence such that the data obtained would be within 5 to 10 percent of the true mean for the samples taken.

We can know within a reasonably tolerable margin of error the composition and characteristics of a particular solid waste stream. When disaggregated into its subcomponents, the solid waste stream under study can provide the solid waste planner with sufficient information to maximize the efficiency and effectiveness of solid waste recycling and disposal systems. Fluctuations in solid waste generation patterns, however, particularly on an annual basis, can still affect waste characterization study results. Thus, any solid waste composition study must be designed to allow data obtained during 1 year to be analyzed in later years to estimate predictable changes resulting from changing economical or socio-economical conditions.

2.5.a Characterization Helps Solid Waste and Recycling Planning.

The underlying purpose of a solid waste characterization study is to provide useful information to enable the solid waste planner to assess feasible options for solid was reuse, recycling and disposal. If this were purely an economic analysis the least costly alternative would always be the preferred option. Garbage, however, has become a major political issue, exacerbated by public perception that goes far beyond pure economics; the least costly option is not always the preferred option. As a result, the characteristics of the waste stream become increasingly important as the solid waste planner develops reuse, recycling, and disposal options, seeking the most efficient and effective alternatives outside of a pure economic model.

The environmental idealist might say that all solid waste ("garbage") is recyclable. But a simple test of taking one home ration of solid waste from your home and separating it into potential recycling categories reveals that this is not true. Although a significant portion of the waste stream can be recycled, ultimately a greater portion is likely to require disposal. For years, one perception held was that what one individual discarded as worthless was another individual's fortune one of the best example of recycling effectiveness can be found in developing countries where the "gold in garbage" myth may be dispelled once and for all. In developing countries, recycling typically occurs at every state of the solid waste generation, transfer, and disposal process. The generator carefully screens what is being disposed and removed materials that may have any secondary market value. The solid waste collective crews will then handpick through the waste before

collecting it. Collection crews typically carry personal containers that are used to separate recyclables. Then as part of their daily collection route, the crews will stop at various market places to sell any materials of value that they have gathered. It is not common for a collection crew work all day at particular collection location, say a market place, segregating marketable recycler and bringing such materials to a known recycler for a fee.

When the collection of crew has finally made it to the disposal location, for example, a municipal landfill, scavengers, sometimes numbering in the hundreds, await to pick through the garbage yet again. In the end, every piece of material that had any minimum value as a secondary marketable material has is removed from the waste stream. Regardless of the inefficiencies of such a recycling system, it is effective in removing more than 50 percent of the solid waste stream. In a previous discussion of the efficiency and effectiveness of this type of recycling system for National Development Magazine, November 1989, I wrote "if there were gold in garbage, the who scavenge city dumps for valuable, reusable or recyclable materials would park their Cadillac's at the base of the landfill every morning and could afford the equipment they need to protect their health as they work. If there were gold in garbage, the economics of the business would create a worldwide network of entrepreneurs, brokers and markets capable of recycling the world's wastes. Recycling would not be a government and environment- driven business

The fact remain that although recycling is essential in any solid waste management system, garbage is ultimately just that- garbage. Its composition must be understood before the proper technology can be developed for its disposal. Understanding that our priorities are to maximize

reuse and recycling with the knowledge that a significant amount of the solid waste generated will ultimately require disposal, we can develop solid waste planning processes, including solid waste characterization studies that provide solid waste planners with essential information necessary to develop integrated solid waste management system capable of providing the maximization of reuse and recycling, and environmentally sound disposal options.

2.6 METHODS AND PRACTICES

Developing Study Parameters.

Understanding the ultimate objective of solid characterization study methods. For example, if the study area desires to initiate waste reduction, the solid waste characterization study must include micro approach to packaging. All types of packaging must be disaggregated and an analysis conducted as to what effect the reduction of various packaging components could have on the entity waste stream.

Another example would stem from a particular study area's concern over the effectiveness of existing recycling programs and / or "bottle bill" legislation. In this case, the solid waste characterization study must include an assessment of the amounts of recyclable materials remaining in the waste stream received at the disposal location after recycling was to already have taken place. The solid waste characterization study would therefore have to

include an evaluation of solid waste generation and disposal patterns. This approach would also require an analysis of individual regions within the study area where recycling effectiveness can be studied on a case-by-case basis. This would allow data to be extrapolated across wider population strategy. As can be seen by just these few variations, the micro approach must be modified for different scenarios to gather information beyond basic waste stream characterization. However, prior to designing the various modifications to the micro approach, there must be a fundamental consistency to the basis approach. Consistency in the solid waste characterization study methods and procedures is an essential if we are ever to have the capability of comparing and extrapolating solid waste characterization data between various regions and populations across the united states and abroad.

2.6.a Manual Sorting Procedures

To prepare a sort area, a trap or a sheet of plastic sheet is surrounded (and held down) by the containers used to hold the solid sorted materials. The number of containers should be in approximate proportion to the expected waste composition. Corrugated cardboard may be too bulky to place in the containers, so a separate area should be identified for corrugated storage. The containers should be located around the sorting area so that, where possible, containers for the same component are located on opposite sides of the sample pile to provide easy access for the sorting crew. A sorting table can be used for the manual sorting process. A table makes the sorting process easier for the field crew members and enables the identification of fine materials that may be lost if sorting were to take place on the floor. Tables can also be designed to include cutouts where screens of

various sizes can be used to allow fine material to fall through into containers for later evaluation.

The sort containers are weighted empty to obtain tare weights. The containers are labeled or numbered and the tare weights clearly marked on each container. The tare weight corresponding to each container label or number is recorded for future reference. The containers should be cleaned periodically to ensure a consistent and accurate tare weight.

To begin the sorting operation, the portion of a sample is brought to the sorting area and dumped onto the main sorting table. The crewmembers begin sorting the sample by hand. The crew supervisor oversees the operation, checking each container for separation quality and assists in classifying questionable items. When about 90 percent of the first portion of the sample has been sorted, another portion of the same sample is dumped on top of the first portion and the sorting containers.

All components are sorted manually, after the entire sample has been sorted, the fines on the sort table are dumped into a container. The table is removed and the sheet is picked up at the concern and the contents are examined and placed into appropriate containers.

The plastic sheet is then cleaned and placed back on the ground. The filled containers are weighed, and the gross weighs recorded. The containers are emptied and placed in their appropriate locations for the next round of sorting.

Sample selection and sorting in this manner can be performed in approximately one hour. Time reductions can be achieved when.

- ❖ The next sample to be sorted is being selected while the previous sample is being sorted.
- ❖ Multiple sorting areas are provided adjacent to one another and additional staff is provided.

When the sorting of one sample is completed and all data compiled, additional comments on the characteristics of the material may need to be recorded following visual analysis. For example, the approximate percentage of sheet stock and castings might be noted for the aluminum fraction. Similarly, a higher than normal moisture content in the newsprint or aluminum categories should be noted as well as weather conditions. The results of the survey, however, should be recovered with no adjustments for moisture characteristics, and so on

. *Incoming solid waste survey*

As part of the solid waste characterization study, it is important to quantity all incoming solid waste to the facility from which the sampling is taking place. Data should be collected related to all incoming waste quantities. Sufficient personnel should be made available to staff the solid waste facility scale house to collect information on waste quantity. Every incoming truck (to the extent possible) will be studied, weighed, and the driver surveyed. The drivers are queried as to the type of waste carried (commercial, residential, mixed, etc.), the area where the waste was collected, the type of establishment where the waste was generated, and percentage of the vehicle full in addition, drivers if mixed loads are asked to estimate the percentage breakdown of the load by waste type.

- The amount of waste entering the solid waste entering the solid waste disposal facility is quantified according to its point of origin and generator segment (e.g. residential, commercial, or industrial). Additionally, every vehicle will be quantified as to its weight or volume and density. The quantity data for solid waste generated within the study area shall be defined within the following framework:

- Quantity of waste types by geographic points (origin)

- Specific route information, if available.

- Weight or volume and corresponding density characteristics expressed in terms of daily, average, peak, and minimum flow to the solid waste facility for the seasonal sampling in question and for the year as a whole.

- The total quantity of waste for the region, by type shall be clearly depicted in the results. Weight, volume, and corresponding density characteristics expressed in terms of regional daily, average, peak, and minimum flow for seasonal periods and for the year as a whole.

2.7 Containers for source Separation.

Source separation requires home storage containers. The type and capacity of container (or multiple containers), and who provides them, depends to a large extent on the collection system.

2.7.a who should supply the containers?

Containers are usually provided by the municipality (through a contract with a container supplier). If a private company is doing the collecting, that company may provide the containers. Sometimes, the participants supply containers particularly if collection is through drop-off centers.

The main argument for the public provision of containers (as opposed to having the private collector provide them) is that since a very large number of containers will be required (at least one per house hold), government procurement may be cheaper. There are several arguments for having containers provided by one entity (whether it be the municipality, a single collection company, or other supplier under contract to the municipality), is opposed to having the containers provided by the participants.

1. Having one entity responsible for containers assures uniformity of appearance, capacity, design and recognizability.

2. Collection methods and equipment can be standardized if only one type of container is use.

3. Uniform containers can be an excellent vehicle for publicizing the collection program at the point of start up.

2.7 b ***TYPES OF CONTAINERS***

Four types of containers are employed for aggregating recyclables: -

i. Single containers

ii. Stackable multi container system

iii. Wheeled carts.

iv. Recyclable collection bags.

What type of containers is best? Clearly, if the collection program is of the one-sort, all-recyclable- commingled type, then a single container is the most efficient option.

i) Rectangular bases are proffered over round buckets by both participants, and collection crews, in addition to ease of collection; they are less susceptible to being blow away by high winds. They are somewhat more expensive, however.

ii) Containers should have holes in the button to release liquids

iii) Containers should have lids (for ease of collection and cost)

iv) A flyer should be distributed along with each container, including basic information about acceptable materials, method of preparation and setout, collection schedule.

2.7.c ***SCAVENGING.***

No discussion of separation and collection would be complete without an acknowledgement that scavenging occurs. In societies where reliance on highly mechanized relies collection and disposal is not widespread,

scavenging is the primary means of recovery valuable resources. For example, in Egypt, 15,000 people live in a recluse ghetto, paying for the privilege of collecting recluse in the city using donkey cants for collection vehicle. These themselves entirely by the handpicking and sale of salvageable goods. Sorting is done in their front yards.

Although chard has an extensive state – controlled waste recovery administration extending down to the neighborhood level, widespread informal scavenging takes place on the streets and at the dumps of other Asian cities like Calcutta, Bali.

2.7.d ***PROCESSING EQUIPMENT***

INTRODUCTION

Today's recycling equipment serves diverse situations: factories and distribution centers compress and bundle waste papers; shopping malls have aluminum collection sites; automobile manufacturers incorporate their own recycling centers. Also, more and more recycling facilities group together various types of equipment. The centers process varieties of material at once.

Over the years, technical innovations have enhanced processing equipment with higher accuracy, better safety features, a more economical use of energy, with higher accuracy, better safety features, a more economical use of energy, and greater speed. This has led to the development of peripheral types of equipment shredders shred and pretreats materials prior to baling or compacting. Conveyor systems transport material quickly through all aspects of the recycling process.

In addition, more, specific types of technology have developed in response to various materials markets; for example, can flatteners involved because of the need to compress beverage cans for transportation. Also, glass crushers are popular because they produce a form of glass called cullet, which resemble small glass pebbles (cutlets is the preferred form of glass with glass manufacturers).

Most recently, recyclers have seen very sophisticated processes developed due to the growth of the recycling industry as a whole. These processes further improve accuracy and speed, especially in the areas of sorting. Eddy current separators pull nonferrous metals from a conveyor line. Similarly, option glass separation systems sort according to color. Optical plastic separation systems also sort plastic according to type. These techniques have come a long way from recycling's humble beginning.

In the twenties and thirties, recycling machinery was very labor-intensive. Balers were often hand-cranked, and it wasn't until the thirties that electrical baling units outsold hand-operated machines. Crude by today's standards, the machines relied on a series of ratchets and chains to bale materials.

Throughout the thirties, forties, and fifties, electromechanical machines were produced that were large and durable. As a testament to this durability, some of

*i. 2.7.e (1) **CONVEYORS***

Conveyors set the pace, so to speak, at most processing centers. They move recyclables from one point to another, facilitating the flow of unloading,

sorting, processing, bundling, and finally, transportation or storage. Conveyors ensure that this flow is constant.

Different types of conveyors serve many different industries, but for recycling purposes only two types are prominent the slider- bed conveyor and the direct – drive conveyor. Slider-bed conveyors are usually smaller and less powerful than direct- drive conveyors. Both types have their disadvantages, and it's important that the right conveyor be used for the right situation.

2.7 e (2) Slider- Bed Conveyors

A slider-bed conveyor is basically a belt that runs a certain length between two or more pulleys-from a few feet to hundreds of feet the recyclable material sits on the belt, which moves along as the pulleys turn. A motor turns the pulley via a reducers unit, which is a geared mechanism that applies torque to the pulleys. A frame holds the motor, reducers, belt, and pulleys secure.

The slider-bed conveyor incorporates a rubber or synthetic belt, stretched taut, running the length of the conveyor. These conveyors rely on friction between the head pulley or drive shaft and the belt to provide movement for the conveyor.

Drive units are located either near the discharge end or in the middle of the conveyor belt. The discharge or "head-shaft" unit, consisting of a motor and reducer unit, powers the conveyor from the point where it expels its material. Thus the motorized unit pulls the belt upward. The middle

location or "center-drive" unit drives the conveyor from beneath the middle of the conveyor's length.

2.7 e (3) ***SHREDDERS***

Shredders, as their name implies, digest a vast array of objects into much smaller pieces. These objects include scrap metal, plastic, aluminum, and wood. The shredder's versatile "diet" has led to its use in other areas besides recycling. For example, they now serve in construction and demolition for breaking down building materials. On a small scale, this often involves confidential papers or store coupons. On a larger scale, shredders destroy damaged or used products that could be redistributed under a warranty claim. Shredder to huge shredders that devour flattened automobiles at the rate of one per minute. One of the advantages of shredders is that their by-products fill other needs, such as shredded newspaper for animal bedding or wood chips for a garden or compost.

All the different shredders in use today can be classified into two different categories: high-speed, low-torque versions and low-speed, high-torque versions.

2.7 e (4) ***COMPACTORS***

Compactors become popular in the 1960's, as a reaction to increased hauling and disposal rates. At that time, businesses began searching for a more effective way to dispose of their wastes. The answer was the compactor.

Stationary and self-contained compactors. The first stationary compactors compressed material into roll-off boxes, large metal structures

usually measuring 8x 8x22ft when enough material was accumulated that no more could be added, a hauler detached the box and hauled it away to a landfill.

This system was ideal for dry wastes. Some industries, such as restaurants and hospitals, disposed of partial liquid wastes, however. This presented problems. Because the compactor was separate from the container, liquid waste resulted in spills and residue. This residue left an odor and often attracted animals and insects. Consequently, the self-contained compactor was introduced Self-contained compactors were simply a compactor and a roll-off box housed together on the same platform. For hauling, the electrical power unit was separated from the assembly. These self-contained units included a liquid retention area underneath the compactor to prevent spillage.

Glass crushers pulverize all types of glass, usually containers, into the gravel-size pieces called cullet. Cullet is a preferable form of glass for recyclers because it is denser. This fluid form simplifies transportation and is furnace-ready. Thus glass companies more readily accept cullet because it is one step further along in the meltdown process.

There are several different types of glass crushers on the market today. These vary in complexity from a simple sledgehammer and 55-gal drum device to sophisticated conveyor-fed units. The latter types incorporate conveyors, which drop material onto either a set of rotating blades, a rotating hexagonal drum, or a series of rotating chains. There are several brands of conveyor-fed glass crushers offered on the market today, and prices range from $2500 to $5,000 Conveyor-fed glass crushing units is electrical.

The motors are small, usually under4hp. Because glass is such an abrasive material, these machines require periodic crushing mechanism replacements. As with shredders, part replacement and careful maintenance come with the territory.

2.7 e (5) CAN FLATTERNERS AND BLOWERS

Can flatteners are a means of flattening beverage cans for ease of handling and transportation. Most machines are geared toward aluminum can flattening because aluminum has a higher value. Can flatteners are conveyor-fed and they use a magnetic charge to separate aluminum cans from steel and bimetal cans. The magnet is contained in the head Steel Cans.

2.7e (6) CAN DENSIFIERS

For large- scale recycling operations, a more practical method of processing steel and aluminum cans is the can densifier. The can densifier forms the cans into a brick that weighs about 18.lb and measures a cubic foot (14x 12x 8 in) in dimension. These bricks are stacked on a skid for transportation to an aluminum smelter or metals- processing facility.

At one time, metal companies paid a premium for the more densely packed material, because it was furnace- ready. Correspondingly, densifiers grew in popularity. Today, the premium is no longer the rule but the exception. The metal companies began to find impurities in the blocks of material. Also there were sometimes high moisture contents in the materials, due to the cans' previous contents. Flattened cans usually have lower moisture content after being transported through an air blower and stored in trailers.

*2.7e (7) ALLIGATIOR **SHEARS***

An alligator shear is a large machine for cutting metal. A hydraulic cylinder moves the shears up and down when an operator pushes on a foot pedal. The shear is used to cut and prepare miscellaneous pieces of metal, such as plumbing valves or aluminum siding, for further processing. Most commonly, scrap metal yards rely on these machines for preparing large amounts of material.

Formerly, alligator shears operated continuously through a fly- wheel assembly. Materials were fed through the rapidly moving blades. Unfortunately, the machines had no safety features, and losses of linings and lives occurred. Today, these shears incorporate a foot pedal and hydrauhcs in order to ensure safety. These features have also led to higher prices and today alligator shears start at $9000 and go up to $30,000 or more, depending on size.

Both blade and cylinder sizes are variable. Blades lengths start 4 inches for small valve- processing applications, and continue on up to 36 inches.

*2.7e(8) **HIGH- TECH MACHINERY***

The term "high tech" here describes those "cutting – edge" processes that are past the development stage and yet aren't in wide spread use. One of the most promising recycling developments today involves the automatic separation of aluminum, plastics, and glass.

Eddy current separator.

An eddy current is a device that applies eddy current, or magnetic field, to commingled recyclables on a conveyor line. This current repels aluminum the way two magnets repel each. When applied to mixed material, the eddy current separator will quickly and efficiently remove all aluminum from the other materials more efficiently, perhaps, than humans. In the short term, however, the cost of the eddy current system is considerably higher than labor costs: between $80,000 and $150,000.

On the other hand, potential buyers will need to weigh the economical aspects. Sorting commingled material is an unskilled, low- paying occupation with a high turnover rate. Eddy current separators do not quit their jobs or fail to show up for work. Nor do they file workers' compensation claim or require heavy insurance. And, as this technology progresses, less and less expensive versions of the system should appear on the market. Eddy current systems will probably play a large role in commingled separation, but the verdict is still out, as the machines haven't existed long enough to precisely establish operating costs or production rates.

*2.7e(9) OPTICAL **COLOR SCREENING***

Another recently developed recycling technology is the sorting of plastics and glass based on optical screening. In the case of glass, the sorting is by color- green, brown and clear. Traditionally, workers on an assembly like conveyor lire carried out this job. Needless to say, this type of work is also

:dious. Reliable workers generally don't stick around a long time. Once gain, it's too early to tell if the system will justify its costs. The technology s considered in its prototype stages.

A good estimate of future prices for such a system would be in the $250,000 to $300,000 range.

Some potentate drawbacks exist with optical glass sorting. First, if glass is dirty or stained, the optical sorter may provide a false reading. A clear glass container might be sorted in with the brown glass. Second these, glass objects configuration. This proves tricky and time consuming when dealing with huge quantities of containers in different sizes and shapes. A similar system for sorting plastic containers is being developed. Plastics are sorted by chemical composition: PET, HDPE, and PVC. As with glass, the optical sorting system will determine the makeup of a container and sort accordingly. At this stage, the system is in the prototype phase. Future price estimates are similar to those of glass-sorting systems. It is estimate that only large-scale operations (10 tons per hour or more) could justify such costly Pulley of the conveyor. As the materials around the head Pulley, Ferrous containers remain on the belt. Aluminum containers, which aren't magnetically attracted, simply fall into the flattening device. After the other cans pass around the head pulley they fall into a reject chute underneath the conveyor.

Once in the flattening area, the aluminum cans are crushed either by a wheel rolling against a stationary plate or two wheels counter rotating against each other. Following this operation, the flattened cans are simply expelled into a

blowing tube. This tube transports the cans up into a storage bin via a strong current of air.

As with glass crushers, there are several manufacturers of can flatteners in the market today. The market prices for a can flattener with blower range between $5000 and $10, 000. Most brands feature motor sizes under 10hp. Since the process is abrasive, identifying which units are most durable is an important concern. Maintenance for these units consists mainly of lubrication. While the machine may not be as maintenance-intensive as a shredder, for example, one should routinely inspect the unit's condition.

Most can flatteners today are manufactured to process aluminum but not steel, because the head roller is magnetic and difficult to change. Even without the magnet, one encounters difficulties with oversized institution cans. The problem is that the can will not fit into crushing mechanisms and will simply bounce around above them as they turn. Fortunately, some manufacturers are creating units specifically for high-tech expenditures.

2.8 PAPERS

Paper is approximately 40percent of Nigeria's solid waste and almost all of it is turn, burnt or scavenged. Only a small percentage (about 5percentage) is reused by people such as women selling fried yams and 'kosie'. In the United States they reclaim about 78% of thin paper waste. This is an achievement.

2.8a NEWSPAPER

Newspaper is approximately 10percent of Nigeria's total waste stream. Because of the economic down turn in the country, the production of newspaper has dropped sharply. The newspapers find their way into thousands if not millions of homes and offices everyday in Nigeria and virtually all of these are either used in the house or burnt. In America about 52 percent of their newspaper is recycled and commitments are getting their ways into society.

2.8b GENERATION

- The three primary means of generation of newspaper for recycling are:
- Over issue (over runs) at the publisher.
- Municipal residential source separation
- Commercial recovery.

Recycling efforts often include dry combination of these as well as individual initiatives.

Newspaper publisher usually recycle over/used paper and send it directly to decking mills or insulation manufacturers. It permits the recovery of relatively high quality materials because it is available immediately following the residents' use.

Drop-off sites are effective in residential areas predominated by multi family dwellings. Drop-off sites may be staffed or not. They usually consist of

containers clearly marked to indicate which material is to be placed in each container. The containers might be barrels, front-end, or rear-end lord dumpsters,

2.8c separations

To ensure quality and maximize handling and processing, old news should be separated from all other wastes at or as close as possible to its source of generation. End users will reject entire shipments of ONP where there is dry evidence the paper was, at daytime, commingled with municipal solid waste. Quality, vector and odor control measures would be too costly to permit acceptance to paper contaminated in this manner. Care must be taken to keep ONP separated from glass, metal and plastic containers. Contamination from food or beverage products can render the paper unusable.

2.8 d Cost and Avoided Costs.

Recycling compares, large and small, will always operate with profit as the primary goal. Sand business planning and procedures will achieve that goal. Federal and State Governments are the least successful in generating revenue and saving sufficient to recover the cost of thin ONP recycling programs. A cost benefit analysis is a realistic means of evaluating the success of a Local Government effort. Start up and continuing costs will include. Market research

- ❖ Promotional activities
- ❖ Public education programs
- ❖ Stating
- ❖ Equipment
- ❖ Collection and Transportation
- ❖ Equipment and Maintenance and Fuel
- ❖ Panting and Publish.

2.8e PAPER RECYCLING PROCESS.

When the paper arrives the plant, it is sorted out using teetered and grin of the paper. These owe than kept different comportments and treated separately with several chemicals to help dissolve ink, pent and the stadiums on the paper. The pulping process starts of the digesters. This process is essentially the treatment of the paper in personated vessel under controlled conditions of tine, liquor concentration and temperate. The purpose of this is to dissolve the fiber- bonding materials, thus leaving behind the purified cellulose fibbers, which are afterwards washed free of the diversion chemicals.

The digester is discharged to a blow tank of the end of the cooking cycle.

A considerable amount of heat is released during the discharge vessel and used for heating wash water at the brown stock washers.

2.8f PULP WASHING.

The cooked pulp from the digester is minced and washed with water to remove the black liquor that would contaminate the end product of the pulp and to recover the maximum amount of spent cooking chemicals with

minimum dilution both as a matter of economy, and to minimize stream pollution. Washing is done in vacuum washer- a wire-covered cylinder, which rotates in a vat containing the pulp, the lower section of the drum being submerged in the pulp. The black liquor drains from the pulp as a result of the washer action. This operation is a continuous 3 stage washing system using rotary filters. The pulp and fresh water flow counter current to each other. Fresh water is sued to wash the pulp only on the last stage of the washing sequence. Finally the pulp is removed by means of the edge of a strip of plastic or metal called 'Doctor'. It is then passed through perforated screens to remove it completely cooked chips together with other foreign matter and dewatered in other vacuum filter and stored in high-density tower.

2.8.g STOCK PREPARATION.

Stock preparation is the process of preparing paper fibers and incorporating additives to give the fiber several desired characteristics. Even though the pulp fibers are saturated with water, they do not cohere well when the sheet is formed and dried and paper of low tensile and bursting strength results. In order to develop good fiber bonding and high paper strength, it is necessary to beat or refine the fiber. This is the first stage in stock preparation.

Many grades can be made from stock which has been processed in the pulper but however, many stronger, finer, and better paper and bonds require a further shortening of fiber length, reduction of fiber lumps and more hydration. Such stocks are most efficiently treated in a refiner which subjects the fibers too much more intense mechanical action under carefully controlled conditions.

2.9 SETTING RECYCLING GOALS AND PRIORITIES

INTRODUCTION

Strategic planning is critical to the success of recycling programs. Numerous technical and institutional components need to be coordinated and managed ensure smooth program start-up and eventual expansion. The central issue facing planers will be how to incorporate recycling in to an existing solid waste management system. As with any new venture, slot and long- term goals need to be developed so that the process can be guided and monitored along the way.

In general short- term goals for a recycling program will be on ended to no and planning and implementation. These will include developing a recycling plan, determining which recyclables will initially be targeted and low the residential, commercial and institutional sectors of the community will be served, and securing market agreements and processing capacity.

Long-term goals will usually pertain to program expansion and attainment of mandate or self imposed waste reduction-recycling goal. Typical short and long term goals are presented in fig.2.The development of recycling program across the United States has borne out one enduring principle, there is no one program that works for every community each community has its own geographic and demographic identity, a particular waste collection and disposal network, a unique set of legal and financial constraints and specific market requirements. The most successful recycling programs then are

planned with each of these local variables in mind. Priorities or goals are established according to the particular needs of a given community.

TABLE 4.1 Typical short and long-term recycling goals

Short-term goals	**Long-term goals**
Draft and Complete recycling plan	Achieve and surpass diversion goals
Determine target recyclable to be collected	Secure long-term processing and marketir
Secure marketing arrangements.	capacity.
Secure processing capacity	Continue to explore method to reduce costs.
Design and initiate public education/ Promotional campaign	Expand list of targeted recyclables.
Plan and implement first phase of Residential curbside program	Identify additional markets.
Initiative outreach-technical assistance Plan for commercial sector.	Monitor program effectiveness.
Select communities for expanded curbside Program.	Review need for mandatory legislation ar implement if necessary.
Determine need for and hire recycling staff.	
Develop and institute record keeping system	

2.9a REVIEWING EXISTING PRACTICES

Recycling program planning for any community begins with a careful examination of the existing solid waste management pictures. This includes understanding the types and amounts of solids waste generated. A waste stream analysis should serve as the basis for determining the sources, quantities and characteristics of a community solid waste. This type of detailed assessment yields valuable information on available recyclable and

serves as tool for planning the most appropriate collection, marketing, and processing options for these materials.

The current waste stream may be analyzed in one of two major ways. The more accurate, yet costly and time-consuming, way is to physically sort composite samples of municipal solid waste into designated sort categories. Representative seasonal samples of waste may be taken at the landfill or transfer station, at another disposal or processing facility, or at curbside. Examples of sort categories are shown in Table 4.2. Alternatively, when faced with cost of time constraints, a community may decide to use existing data (i.e. information from communities with similar demographics and waste sources, existing state or country planning data) combined with local knowledge (local haulers and facility operators) to develop a snapshot of the types and amounts of waste generated in the area.

Existing collection practices determine, to a large extent, how a recycling program is instituted. Since collection is frequently the most costly component of a local waste management system, recyclables collection needs to be incorporated in as cost-effective a manner as possible. Program planners need to know the following.

2.9b IDENTIFY AND EVALUATE INCENTIVES TO PARTICIPATE

The ultimate success of recycling programs depends, in large part, on public participation. If sufficient quantities of high-quality recyclables are to be recovered and diverted from the landfill, every resident, employee, and business owner needs incorporate recycling into his or her daily life. Incentives to participation will spring from a desire to "help the

environment." For most, legal or economic incentives will be deciding factors.

The recent dramatic increase in state waste reduction legislation, designed to encourage communities to recycle, has served as powerful imperatives for the development of recycling programs. A growing number of states have set mandatory recycling goals ranging between 20and 50 percent to be meet by the year 2000. These legislative initiatives differ in their approach. Some mandate that Local Government (municipalities) pas ordinances requiring citizens and business within their jurisdiction to source. Separate and recycle a specified number of material others require Local Governments to provide citizens with recycling services but do not mandate that they adopt ordinance Oregon's 1983 opportunity to recycle Act was a early example of this type of legislation. A third variety of legislation mandates only that Local Governments reach a certain waste reduction-recycling goal.

In communities with an open collection system, where residents contract with a private hauler of their choice for garbage collection, the municipality may not have a strong economic incentive to recycle. In this case, the Local government may pass an ordinance detailing the level of recycling services that each hauler must provide for its customers and require that hauler licensure be contingent on the provision of these services. The Local Government, in turn, can provide financial assistance by providing curbside collection containers, containers, funding some or all of the promotional costs, or the processing and marketing of the recovered recyclables.

Increasingly, communities are beginning to consider volume-based waste disposal fee as a way to encourage recycling and source reduction. Under

these pay-per-container systems, residential waste generators pay according to the amount of garbage they generate. Residents can presumably be expected to attempt to minimize their bills, in this case by generating less garbage and availing themselves of recycling opportunities, which are offered at reduced, or no charges. Several options are available for implementing variable-rate collection systems, including charging customers based on the number of containers set out, the frequency of collection, or the weigh collected.

2.9c MARKET RESEARCH AND IDENTIFICATION.

In order for any comminuted to achieve its recycling goals, it must ensure that markets are available to absorb recovered recyclables. Over the years, many communities have experience setbacks in their recycling programs due to the faltering of one or more markets. In some cases, separated materials were stored in anticipation of short – term changing of market conditions and land filled when markets did not improve. For some materials, markets will naturally grow as new supplier become available. For others, the public and private sectors must work together to promote growth in industries that can rely on secondary materials in their production processes.

Planners should keep in mind that many markets (especially for lower grade materials) have had a cyclical history with fluctuating prices.

In the absence of existing studies, a local government may need to conduct it's own research in order to identify and secure recyclable materials markets. Two types of market should be investigated: intermediate and final. Intermediate markets include both processors and brokers of materials,

which they purchase from industrial and private sources as well as municipal ecycling programs. They accumulate, process, store and transport the ecyclables into new products. These markets usually handle only one naterial to produce one type of product (i.e. glass bottles, metal cans, ıewsprint, etc).

Market identification can be systematically accomplished with the ıelp of a variety of resources. The yellow pages in the Local Phone book contain a wealth of information. Following is a listing of some of the ıeadings that can be referred to:

Table 2.3

Recycling Centers	Nurseries
Waste Paper	Lawn Maintenance
Rubbish and Garbage Removal	Garden centers
Thrift Shops	Mulches
Junk dealers	Sod and Siding service
Scrap metals	Automobile Wrecking
Land scapers	

Group on their interest in providing recycling services involve them in the planning process.

It a community decides to allow existing halers to provide recycling services, they must still monitor the program and retain some control (especially in states with strict diversion mandates). Reporting, verification, and inspection requirements are key components in a system that relies ıeavily on private- sector initiatives, and these components place burdens on the local government to see that claims and reports are accurate. In these

situations, the local government may wish to in clued recycling services and reporting in licensing requirement.

2.9d IDENTIFY POTENTIAL FOR WASTE REDUCTION AT THE SOURCE.

Source reduction activities focus on preventing the generation of solid waste in the first place, generally by decreasing the volume and toxicity of materials produced and consumed. Methods of reducing waste in clued reducing the use of non-recyclable materials reducing packaging, minimize yard waste generation, establishing volume- based garbage rate structures, and increasing efficient use of materials (including paper predicts, glass, metals, plastics and other materials).

Some states have established reduction goals as part of recycling legislation a. These goals gene- rally range from 5 to 10 percent of the municipal sol- vaster (MSW) stream. Legislation also exists to require or encourage roasts reduction addressing the methods mentioned above.

Planners need to be a ware of any incentives that are already in place as well as to identify existing consumer rareness campaigns and local reuse or sewage industries. These types of activities can have positive effect on a palmed recycling program.

2.9e IDENTIFY MATERIALS TO BE RECYCLED

A common goal of recycling programs is to divert substaritial quantities of material from the waste stream; an accompanying goal is to offset recycling system costs with material revenues to the maximum extent possible. There fore, the materials a community selects for recycling depend

in parts on available markets. Larger communities have well- developed markets for paper, metal, and glass recyclable. Yard waste, which usually represents a significant portion of the municipal waster stream and is increasingly being prohibited from disposal, can contribute significantly to the achievement of recycling goals, however, a community must commit to the development of yard waste processing facilities to handle projected amounts these materials as well as markets and uses for the finished products. Plastic containers {high-density polyethylene (HDPE) and polyethylene tetraphalate (PET) are easily targeted portion of the waste stream, but their high volume to weight ratio makes cost effective collection difficult. With the advent of on-board compaction equipment and specialized recycling vehicles, however, plastics are being included in a growing number of recycling programs. Other types of plastics (i.e. polyvinchloride (PVC), mixed polymer containers, and film plastics) are experiencing increase market demand and are being included in residential and commercial recycling programs.

There are many other materials that may be collected in recycling programs, including textiles, batteries, food waste, household ferrous scrap and reusable items- A recent survey investigated the materials most commonly included in municipal recycling programs. The results are tabulated in table 2.

Most popular materials included in municipal Recycling programs by percent

Table 2.4

Materials %		Material %	
Newspaper	96. 2	Waster oil	46. 2
Glass	93. 9	High- grade paper	41. 3
Aluminum	88.3	Mixed paper	32. 2
Plastic bottles	67. 0	Other (batteries, tin)	15. 2
Card board	60. 6	Rigid plastics	11.0
Scrap metal	52. 3	Chip board	6.4
Yard waste	47. 3		

Source: public Administration Review, may- June 1991, based on 264 recycling coordinators' responses to a survey conducted by David Ht. Folz, university of Tennessee, Knoxville.

Program planners should keep in mind that collecting a material without having secured a market can result in unexpected storage or disposal costs. In addition, public opposition may arise if recyclables are dropped from the program due to lack of markets. Established habits and practices are difficult to change.

2.9 f EVALUATE COLLECTION METHODS

Many alternatives are available for collecting recyclable materials from the municipal solid waste stream. The collection system is usually the most expensive component of a recycling program. Therefore, careful

consideration must be given to providing reliable and convenient collection services in a cost effective manner.

Factors affecting the collection of recyclable materials from the generator are often quite similar and in some cases the same as those affecting collection of regular refuse. General factors affecting both recyclables and waste collection include crew size, Vehicle size, and maintenance issues. Community – specific factors affecting residential collection of both recyclables and refuse include community size and housing density, quantities of waste and recyclables to be collected, present collection system and available equipment, traffic patterns, weather, and institutional issues such as wages to be paid to collectors, frequency of collection, and point of set – out (curb side, back door, etc.) In most cases, the collection of recyclable materials I a community will be superimposed upon an existing waste collection approach, either municipally or privately operated. The most economical approach is to integrate the two collection approaches, maximizing the benefits associated with regular refuse amounts decreasing as recyclables set- outs increase.

2.9 g RESIDENTAL CURBSIDE COLLECTION

Curbside collection of recyclables has become a standard approach to the recovery of recyclable materials from the residential waste stream. Like regular curbside refuse collection, this method of collection provides participating residents with a convenient and consistent method of recovering recyclables for processing and marketing. Furthermore, properly operated and publicized curbside programs that provide residents with regularly scheduled pick up of recyclables (often on the same day as regular

sh collection) have been demon started to be effective in capturing large nounts of recyclables.

The way in which recyclables are set out at the curb, and the ntainers used for home storage and placement at the curb, vary from ogram to program. In general, there are three main approaches to setout d collection, commingled setout commingled, commingle setout curbside rting of materials, and source-separated setout with separated collection. he amount of sorting – either at the curb or at a centralized processing acility will be determined at least in part by the conditions under which cally available markets will agree to purchase recovered materials. If, for xample, no local market is available for mixed – color glass, color eparation will need to take place in the home, at the curb, or at a processing acility.

The type of home storage container used will vary with the setout approach chosen. Containers for commingled setout need to be sized appropriately to store to store expect quantities of target mater. These containers typically costless than multiple bin systems, however, costs associated with sorting at the curb or at materials processing facilities may offset the savings. Commingled collection is considered by some to maximized participant convince and minimize the presence of bulky containers in the household, thereby increasing the likelihood of participation.

The decision to use bags in some communities has been based on several factors. Bags are usually purchased by the system users (residents and business), where as bins are often provided by the municipality. Residents might leave bins at the curb after collection, resulting in a higher residence of theft and damage. Whether a community chooses to use plastic

bags affects other components of the recycling system such as types of collection vehicle used, the amount of material separation required, and the types of processing equipment or capacity needed. There is no hard and fast rule for a community to apply when considering bags versus bins- careful analysis and discussions with other communities that have faced similar decisions will be useful.

Frequency of collection is also a major consideration when designing a residential recycling program. Weekly collection has become the standard for curbside, although some communities institute every other-week collection as a cost-saving measure. Twice monthly collections can reduce operational costs, but require more extensive promotional efforts to remind residents of their collection day. Participation may suffer with a month collection since residents may not want "trash"-even recyclable trash-accumulating in their homes. Further more, if residents miss a collection day, they may decide to dispose of recyclable that may have flowed in the storage containers in order to avoid the nuisance.

2.9 h MULTIFAMILY COLLECTION

The principle behind collection recyclables from multifamily residential dwellings is no different from curbside collection from single-family residences- maximize ease of participation for the resident. Planning for the collection of recyclables from multifamily units must take into account the existing programs for refuse disposal (residents may take their waste to an outside dumpster).

Home storage of recyclable materials need to be considered. An apartments typically have small kitchens and limited storage space. Commingled collection is generally advisable under such settings-one

storage container takes up less space than three. Residents would then deliver the commingled recyclables to the setout point, where they may be required to sort the materials into appropriate bins or place them in a single large container. Each multifamily situation will present Wright challenges. Creative, flexible approaches to collection may be more appropriate than a strictly prescriptive approach.

2.9 i RESIDENTIAL DROP-OFF COLLECTION

Drop-off recycling programs are the most common recycling collection systems currently in operation in the united stages. Drop-off centers may be publicity or privately operated or a by non-profit community groups, and may offer a buy-back component for some or all materials. Systems rarely are capital intensive or require high operation costs; they present a relatively loro and flexible way for recycling programs to be designed to fit the specific needs of the community.

In communities where the majority of residents take there refuse to0 the landfill or a transfer station; the placement of drop-off centers at these sites may be the most appropriate way to recover recyclables. In other communities, however, planners need to weigh the benefits of a drop-off system (reduced capital expenditures and lower operating and maintenance costs) against potential drawbacks. Drop-off systems generally achieve lower diversion rates than more convenient separate from other refuse but deliver these materials to the drop-off facility during it's hours of operation.

2.9 j COMMERCIAL WASTE STREAM COLLECTION

When designing recyclables collection systems for the commercial sector, it is critical to understand what can be efficiently recovered from the commercial waste stream. Industry typically recovers and recycles a large amount of pre-consumer scrap. Many other post consumer commercial recycling activities exist, however, the most prevalent programs recover paper products, mostly corrugated cardboard. Office at paper ad commercially generated pass and cans also present a commercial sector recycling opportunity.

Designing a system for the collection of recyclables from a commercial establishment must take into consideration how the waste stream is generated and how it leaves the generator. Incentives for separation can encourage recovery rates. For example, in a corrugated recovery program, tipping fees could be reduced for corrugated-rich loads and / or the generator could be paid for the materials. Private paper dealers and / or haulers may put baling or storage equipment on site to encourage separation, collection, and storage of the target material.

The collection mechanism for recyclables in the commercial sector will probably vary little from the collection of garbage. Typically collection is mechanized. Sometimes adding a separate container for cardboard is all that is necessary. If cardboard makes up the largest component of the waste stream, a smaller container for non-cardboard materials may be the only adjustment needed. Buyers of recovered office paper, on the other hand, may provide for separate collection from centrally located setout points. Obviously, local markets, processing capabilities, and many other factors must be considered in starting a commercial collection system

2.9 k INSTITUTIONAL – GOVERNMENTAL COLLECTION SYSTEMS.

Institutions can be major solid waste producers, and significant quantities of recyclables can be removed from institutional and governmental. To successfully implement recycling programs in institutions, three issues must be addressed, either collectively or on an individual basis: (1) obtaining reliable markets and transportation for recyclables collected (2) developing a well-organized and convenient internal recyclables, collection program accessible to employees and those being served by the institution, and (3) providing adequate educational and promotional support for the program. Many of the same principles involved in commercial recycling programs apply to institutional systems.

2.9 l COLLECTION EQUIPMENT

- A properly designed collection system with the most suitable collection vehicles forms the backbone of a successful recycling program. Selecting the most appropriate collection vehicles for a recycling program requires careful consideration and analysis of the entire program structure. The collection vehicle is vital to obtaining the best collection efficiency available; given the particulars of home storage systems market requirements, transportation routes, and processing capabilities. In some communities, existing equipment can

be used or modified, resulting in substantial cost savings. Other communities, however, may need to invest in the purchase of dedicated recycling collection vehicles. When selecting appropriate equipment, program planners should keep the following considerations in mind:

- Total system cost can be minimized if programs are designed with interchangeable equipment.
- Curbside collection vehicles for separate collection should be designed with a low materials loading height, sufficient capability for full collection routes, readily accessible cabs, and quite off-loading of materials
- Commercial collection vehicles should be able to maneuver well in tight areas near participating businesses.

2.9 m PROCESSING ALTERNATIVES

A system (including one or more facilities) to receive and process recyclables generated by residential and commercial- institutional sectors is a critical element in an efficient, comprehensive recycling program. To ensure that the recycled materials are marketable, the systems have the capability to upgrade materials to a variety of specifications. It must also have the flexibility to adapt to new specifications should new markets be engaged. Meeting marked specifications can be ensured to the greatest extent possible by processing the materials in a materials recovery facility (Mrs.). The MRF receives collected recyclables, recovers prohibited contaminated materials, and provides for storage and load out of large quantities so that economies of transportation to markets are achieved. As neighboring communities begin to recycle it will become increasingly

important to process and up grade a large flow of material to meet a range of current and future market specifications. Another strong argument for developing a MRF is that it allowed haulers flexibility in the type of equipment they can use for collection. Large haulers with specialized recycling vehicles can accommodated as easily as smaller haulers with trailers, stake-body trucks, or compactors.

After deterring current and anticipated processing needs for their program, planners must decide if public or private facilities will be used. Ownership, financing, and operation options range from full private, and include a hybrid version comprising public and private elements. There is generally some correlation between privatization and the allocation of risks and rewards. The owner and operator of a processing facility will generally bear a greater proportion of the risks while expecting a greater share of the rewards of reveres.

With a full-public facility, the public section can be expected to bear the material delivery and marketing risks but would also garner the benefits of a strong market. A publicly owned, privately operated facility normally has some sharing of risk and reward. This often is accomplished through some kind of revenue-sharing arrangement. Decision makers should be aware, however, that the vendor community has as yet shown only limited willingness to share recyclables delivery or marked price risk. The general vender view is that they should be protected against loss for events beyond their direct control. Delivery of recyclables will in many cases be a governmental responsibility. Although vendors should be held accountable for meeting market specifications, they are not generally willing to run much risk with respect to severe drops in market prices.

There are a number of important risks associated directly with the nstruction and operation of a processing facility, for these risks, ownership of lesser importance than operation. With full-public option, the public tity operating the plant is completely responsible for most things that may wrong. In theory, problems resulting from faulty design or construction ıould be the responsibility of the party that designed and built the facility. ı practice, however, it is quite difficult to establish blame clearly or to ecure a satisfactory remedy. While this may not be a very important onsideration for many routine governmental functions, it should certainly ɔe of concern in such a relatively untested area.

2.9 n MEDIA RESOURCES TO PUBLIZED PROGRAM.

In order to encourage and sustain a commitment to recycling in the community, an aggressive educational program of institutional and motivational messages have been identified, the messages likely to educate and motivate those populations can be developed. Selling the concept of recycling will be no less strategic than selling a product, and traditional marketing practices can be applied, promotional and educational materials should be consistent, clear, colorful and creative, representing an understanding of the technical issues and an appreciation of the needs of the target audiences.

CHAPTER THREE

RESEARCH AREA

ACOUSTICS

3.0 Introduction

Acoustics is defined as a science of sound and hearing; acoustics is an art and a science. It was an art with the Greeks, as mechanics was an art with the medieval builders of Gothic cathedrals. Both Grecian amphitheaters and medieval vaulting demonstrate the same intuitive principles.

The design of industrial buildings itself is the province of acoustic architecture. Echoes and excessive reverberation must be prevented least speech be unintelligible and noise from machines be sustained; yet controlled reverberation must exist, for like the resoning chamber of the violin it is essential to the volume and richness of the sound. Indeed present day acoustical engineers consider a working environment as having an intimate art in the production of orchestral tone.

The acoustic phenomena, generation of sound and its transmission is very important. The solutions to acoustic problems would be outlined and discussed in form of sound absorbing materials, panel absorption, cavity resonators, space absorbers, air absorption, sound absorption of openings, mounting and distribution of materials. Sound insulating materials and room dimensioning is also treated in lieu of proper analysis of the study of behavior of sound in enclosed spaces.

3.1 ARCHITECTURAL ACOUSTICS

Introduction

Although the acoustics of enclosed spaces has been of obvious importance ever since people first began to gather in large auditoriums or churches. It was not until after the institution of qualitative measurement of Sabine in 1895 that the maze of superstition concerning the subject began to be replaced by a firm foundation of scientific knowledge. Through extensive experimental study of acoustical properties of the room, Sabine arrived at empirical relation between the reverberation characteristics of an enclosure, its size and the amount of absorbing materials present. His definition of reverberation time T of an enclosure i.e. the time in seconds required to reduce the intensity from a level body above the threshold of audibility to the threshold, it is the most important single parameter used in studying the acoustical quality of a room.

When we speak on the subject of acoustics nowadays, it is rather like speaking of engineering or economics. The words describe fields of study rather than specific topics. Acoustics has grown far and its range now includes such divers disciplines as medicine, psychology through to solid state Physics and mathematical statistics. Somewhere in between lies a comparatively new and rapidly growing technology, which is coming to be known as noise control engineering.

Engineers, Architects, town planners, public health and factory inspectors will sometimes be asked, "How can we make less noise"? Other branches of acoustics include:

i.) Ultrasonic – which deals with sounds above audible frequencies

ii.) Underwater acoustics – which deals with sounds underwater.

iii.) Audiometry – deals with testing of ears to know if you need hearing aids.

iv.) Architectural acoustics – which deals with sounds in buildings, that is transmission of sounds through structures, behavior of sounds in closed spaces and how building designs may be used to optimize sound conditions.

3.2 FUNDAMENTALS OF VIBRATION.

In a broad sense, acoustics may be defined as the generation, transmission and reception of energy in the form of vibrational waves in matter. As the atoms or molecules of a fluid or solid are displaced from their normal configuration, an internal elastic resolving force of stiffness arises. Typical examples of such a force include the tensile force produced when a spring is stretched, the increase in pressure produced when a fluid is compressed into a lesser volume and the transverse restoring force produced when a point on a stretched wire is displaced in a direction normal to its length. It is the action of this elastic restoring force, coupled with the inertia of the system, that enables the matter to particulate in oscillatory vibrations and thereby generate and transmit acoustic waves.

3.3 ACOUSTIC PLANE WAVES

The acoustic waves that produce the sensation of sound are but one of a variety of pressure disturbances that can be propagated through any compressible fluid. In addition there are ultrasonic waves whose frequencies are above the audible limit, high intensity waves such as those present in the

immediate vicinity of jet engines and missiles, which may produce a sensation of pain rather than sound, and explosions and high-speed aircrafts generate single pulse shock waves.

3.4 PROPERTIES OF SOUND (VELOCITY, WAVELENGTH & FREQUENCY)

The word sound is used to describe two different but closely related occurrences:

Sound could be the sensation a person feels in his / her ear or vibrations transmitted through material e.g. air. Sound is vibrational or mechanical energy.

Sound is propagated by the transmission of energy from one disturbed element to the next. Because sound is oscillatory motion, it is necessary that the medium, which the sound propagates, is elastic. Without elasticity oscillatory motion cannot take place.

For the velocity of sound: if the air was at 20^0 , it would take 1 second to compress the air in an element of 344 meters down a tube which of course defines the velocity of sound (v) in air at $20\ ^{0\,C}$. it is important to realize that air is not the only medium and that the same process can take place in any medium that has elasticity which includes virtually all liquids, gasses and most solids. Certainly common building materials like concrete, timber, masonry, steel and glass can all carry sound waves. In fact it is their ability to carry the sound that presents the most problems.

The important parameters that determine the velocity of sound in a material are its modulus of elasticity (E); its density (ρ) and it can be written:

$$V = K\sqrt{E/\rho}$$

Consequently sound travels faster in material of high elasticity and low density.

The distance between successive waves of the same size is called the wavelength of sound in medium, denoted by λ.

Another fundamental parameter, which describes a sound, is its frequency normally denoted by f, this is the number of waves, which pass by a fixed oscillation point per second. Frequency is also the number of complete cycles of pitons movement per second.

The loudness lever of a sound does not mach an instantaneous maximum at the onset of a sound. Its magnitude increases rapidly for a brief interval slowly for long duration sounds. Since the mechanical elements of the ear one believed to be too highly damped to account for the deserved rate of growth of loudness level, it is probably determined by the response characteristics of the neutral components of auditory system.

3.5 BEHAVIOUR OF SOUND IN ENCLOSED SPACES.

1) Echo: - is a sound that is reflected from a boundary example if one is standing near a mountain and he shouts, the sounds will, be reflected and after a few seconds it would be heard again this second sand is the reflected wave and is distinct and normally takes place 1/10 of a second interval, the minimal distance to hear an echo is 17m.

Types of echo include: -

a) ***Single echo***; - This is one distinct reflection.

b) ***Overlapping echo:*** - This is reverberation.

c) ***Multiple echo***: - This is distinct repeated echoes resulting from one initial sound.

d) ***Diffused echo***: - scattering of sound causes this by many small objects.

e) ***Flutter echo***; - Like multiple echoes, they are distinct but rapidly repeated

2) REVERBRATION: - This is the persistence of a sound in a room after the initial source has been put off. By definition reverberation time is defined as the time taken by the sound intensity to decrease by 60dB. The rate of decay will vary with the properties of the room.

Factor affecting reverberation time include; -

1) Volume of the room.

2) Absorption ratio of the room.

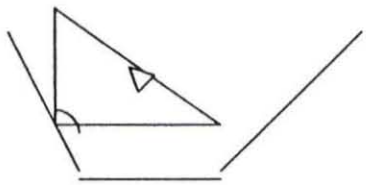
3) Degree of occupancy.

4) The nature or type of furniture within the room (whether padded or unpadded seats) knowing fully well that padded seats would absorb the sound in the room which is not used to its maximum capacity.

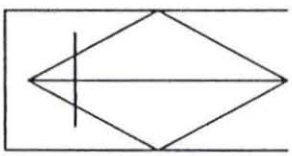
5) Air absorption: - This is in adulation to absorption at surfaces and it decreases with reverberation time.

3.6 ROOM GEOMETRY

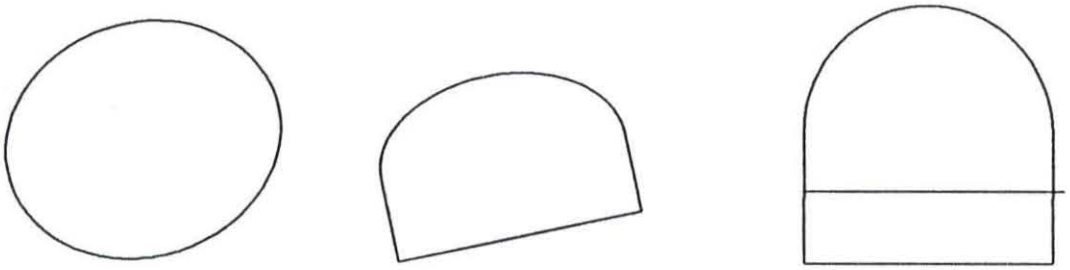
a) ***Fanning out walls: -*** These bring about uniform distribution, the angles at which it hits the wall is always greater them 90^{o}, the difference between the direct and distributed sound time is usually minimal



b) When the walls are parallel and they are smooth and opposite the ceiling and the floor are mostly parallel. The possibility of long delay, reflection between parallel walls may give rise to standing waves and flutter echoes. Since the floor is parallel to the ceiling serious low frequency resonance and flutter echoes may be present.



c) When the walls are circular or semi circular, we may have focusing of sounds at particular spots. If a cured rear wall is used we must ensure that this focusing is outside the building.



Geometrically the acoustics demonstrates rather clearly that floor plans having circular or elliptical shapes should be avoided because of their focusing properties and consequent violation of the requirement that the sound pressure level be uniform throughout. If focusing is significant that echo may by very strong at focal point a circular plan is also prone to produce the phenomena of creeping, focusing and creeping effect can be over come by treatment of the walls with convex surfaces. Also treatment of the walls, floors and ceiling with absorbent material will worsen the harmful effect

3.6.a SPECIFIC BULDINGS

1) Rooms for speech and music

- External noise be kept to minimum
- Insulation would be required
-Select suitable site
- If room is exposed to noise, use double construction
- Avoid direct air passages to external noise
- Use doors that close quietly and quickly
- In a complex of several rooms use noise zoning

2) Noisy buildings e.g. factories, pubs, community halls, churches and mosques

- Select suitable site

- The need to keep in noise by having heavy external walls
- Consider double doors
- Planning of the access routes and ensures that they do not pass near sensitive areas
- For factories, noisy areas may have to be given special treatment

3) Hospitals, housing estates, Campuses.

- Site selection is of paramount importance
- Noise zoning
- Each building may then be given appropriate treatment determined by its use.
- In hospitals, soft furnishing may not be allowed in certain areas e.g. PVC tiles may have to be used instead of carpets.

4) Recording studios

- Here the room requires sound vibration isolation as well as insulation.
- Select suitable site
- Noise zoning
- Double wall construction may be used
- Padding of the wall with sound absorbent material to prevent noise from entering or leaving the studio
- Finishes should be soft e.g. carpet except for walls where wood finishes are excellent.

5) Entertainment theaters

- Should be well located on site.

3.7 GENERATION OF SOUND

Sound is generated from various sources, these include, machinery, humans, doors e.t.c. Noise is mostly generated from inside buildings these can be from televisions, radios, fans, and human's e.t.c.

3.7.a TRANSMISSION

Sound is transmitted through a medium, air. Airborne sound is generated from a source then neighboring air particles are set in vibration, the process continues until the sound dissipates, this depends on the reverberation time, shape and size of the building.

3.7b SOUND REFLECTION

When sound energy strikes a hard, rigid and flat surface such as concrete, brick, stone of glass it is reflected. Since the incident and reflected sound waves lie in the same plane and the angle of incidence equals the angle of reflection (law of reflection) the wavelengths of sound waves are small compared to the dimension of the reflecting surfaces. This means that the application of this law must be very critically considered for low frequency sounds.

Convex reflecting surfaces tend to disperse and concave surfaces tend to concentrate the reflected sound waves.

3.7 c SOUND ABSORPTION

This is the transmission of energy from one medium to the other. The absorption of materials varies according to texture of surface and color. Temperature changes also play a big role in sound absorption. The amount of heat produced by the conversion of sound energy is extremely small. The speed of the traveling sound wave is not affected by absorption.

3.8 ELEMENTS THAT CONTRIBUTE TO SOUND ABSORPTION

1. Surface treatment of walls, floors and ceilings.
2. The content of the building e.g. machinery, people.
3. The circulation area.

The efficiency of sound absorbing materials is related by the sound absorption coefficient. The sound absorption coefficient of a surface is the fraction of energy of the incident sound absorbed or not reflected by the surface. It is denoted by the Greek letter δ. The value can vary between 0 and 1. It is usually the practice to list sound absorption – coefficient value at representative standard frequencies throughout the most important part of the audio frequency range of 125hz, 250hz, 500hz, 1000hz, 2000hz, 4000hz, and 8000hz.

In architectural acoustics, information sheets are usually published by manufacturers and dealers, commercial acoustical materials are sometimes characterized by their noise reduction coefficient (NRC), which is the arithmetic average of sound absorption coefficients at the frequencies, 250 and 500hz expressed to the nearest multiple of 0.05.

3.8.a SOUND DIFFUSION

Sound diffusion is the dispersion of sound energy in any space. When sound pressure is equal throughout a room, the sound diffusion is said to be homogenous. Major ways of ensuring a good diffusion include:

i. The use of surface irregularities.

ii. Alternate application of reflective and absorptive surface finish.

iii. Random distribution of materials with varying absorption coefficients.

3.8.b SOUND DIFFRACTION

It is the bending of sound waves at the corners of any barrier or obstacles within a space. It is more pronounced in low frequencies. The barriers include corners, columns, walls and beams. Diffraction is more pronounced for lower frequencies than higher frequencies, thus proving that the laws of geometric acoustics are inadequate for a precise prediction of the behavior of sound in enclosed spaces because the obstacles usually encountered in room acoustics are too small in comparison to the wavelengths of the audible sound waves.

Geometric acoustics is the useful approach in dealing with problems related to high frequency sounds. It is hardly applicable to frequencies below 250hz. Low frequency sounds will not respect the laws of geometric acoustics if they encounter architectural elements of small dimensions.

3.9 SOUND ABSORBING MATERIAL

Almost all building materials and surface treatments used in the construction of industries have the ability to absorb sound to a certain degree. Sound absorbing materials used in construction of industries can be classified as:

i. Porous materials.

ii. Panel or membrane absorbers.

iii. Cavity resonators.

3.9.1 POROUS MATERIALS

The acoustical characteristics of all porous materials such as fiber boards, soft plasters, mineral wools and isolation blankets is a cellular network of interlocking pores. The incident sound energy is converted into heat energy within those pores. Cellular materials with closed and non-interlocking cells such as foamed resins, cellular rubbers and foam glass are poor sound absorbers.

Porous materials are available commercially in three categories:

1. Prefabricated form.
2. Acoustical plasters and sprayed on materials.
3. Isolation blankets.

3.9 b PANEL OF MEMBRANE ABSORBERS

Any material that does not allow sound to pass through, tied on a solid backing but separated from it by an air space, will act as a panel absorber and will vibrate when struck by sound waves.

Panels of this kind are efficient low frequency absorbers. Panel absorbers contribute to a uniform reverberation characteristic over the entire audio frequency range.

3.9 c CAVITY (OR HELMHOLTZ) RESONATORS.

These are also used as sound absorbers. They are enclosed in a body of air confined within solid walls and connected by a small opening (called the neck) to the neighboring space in which the sound energy travels.

A hollow resonator absorbs many sound waves in a small region of the low frequency band as an empty jar acts as a hollow resonator.

Hollow resonators can be used as:

1. Single units.
2. As row of holes and panel resonators.
3. As opening resonators.

3.9.d SPACE ABSORBERS

These sound absorbing materials are usually suspended as single units from the ceiling. They are easy to assemble and do not disturb any existing fixtures or equipment.

They are made up of perforated sheets (these can be steel, aluminum or hardboard) in the shape of panels, prisms, cubes, spheres and cylinders. These shapes are usually filled with sound absorbing materials such as rock wool or glass wool. The acoustical efficiency of the space absorbers depends on their spacing.

3.9 e CHOICE OF SOUND ABSORBING MATERIALS

Materials used for architectural acoustics should combine the function of absorption and interior finish. The finishes must be selected that will give uniform absorption characteristics throughout the audio frequency range, if the main reason is to obtain a constant reverberation time over the entire audio frequency range (to eliminate echoes, too long delayed corner reflections). Reflecting surfaces should be treated with acoustical materials of a highly absorptive behavior. The following details should be considered in the selection of sound absorbing materials:

- Fire resistance
- Sound absorption coefficients
- Assembly costs
- Installation costs
- Durability, resistance to wear and tear
- Light reflectance
- Maintenance cost
- Thickness and weight
- Resistance to dampness
- Thermally insulated

3.9.5 SOUND CONTROL

It is very difficult or almost impossible to control sound entering a building but it could be considerably reduced with proper planning, land development removal of industries outside the town e.t.c.

The value of any sound insulating material enclosing a space structure is expressed in terms of the amount of noise in decibels (1db is the smallest change in sound energy that the average ear can detect). Means of noise control may be divided into active and passive measures.

1. ACTIVE MEASURES

This implies the direct protection against noise pollution. These measures are the measures that would be taken by everybody involved. These measures include: closing the doors, grouping or zoning of noisy areas to the same place.

2 PASSIVE MEASURES

The passive measures are those taken by the designer (architects, engineers) to help reduce the effects of noise pollution both by machinery noise, and external noise. These measures include: design location of machines, specification and type of walls floor and ceiling finishes.

CHAPTER FOUR

CASE STUDIES

4.0 AIMS OF THE STUDIES.

This chapter deals with the study of solid waste recycling stations in order to find out their proper working conditions. A solid waste recycling station is a relatively new development especially in developing countries like Nigeria and Ghana, so there is the need to look to those who have these stations or plants to learn various lessons in order a learn from their mistake in order for us to design a well balanced and all round recycling plant which would carter for the need of the state as well as the country. The case studies are mostly from outside the country since Nigeria does not have such a facility at this point.

4.1 CASE STUDY ONE:

RECYCLING PLANT IN FITCHBURG, MASSACHUSETTS.

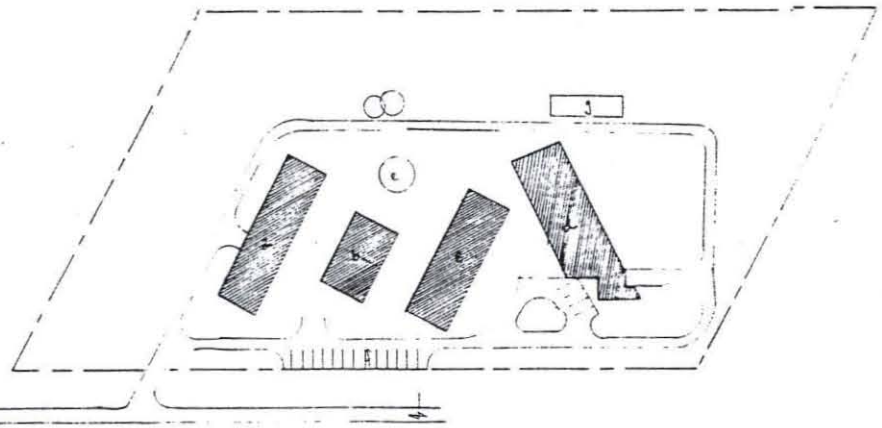
For years this site in Fitchburg, Massachusetts, at the headwaters of the Nashua River, served as a sludge holding pond for paper wastes from local mils. When it was drained, a 10-foot-think blanket of wet pulp remained and had to be removed prior to construction. The stream that fed the pond was rechaneled to the edge of the site. What remained was a named site depressed at one end and bounded on two sides by water.

CASE STUDY

RECYCLING PLANT AT FITCHBURG

INFORMATION

THE RECYCLING PLANT IN FITCHBURG, MASSACHUSETTS, WAS DESIGNED BY JOHNSON - HOYDEN - ROBERT FITZBURY THE ENGINEERS WERE CAMP DRESSER AND MCKEE INC. WITH THE CONTRACTOR BEING FOTAINE BROTHERS. THE ARCHITECTS DEVISED A MEANS OF DIAGONAL PROCESS FLOW PATTERN IN RESPONSE TO THE SITE GEOMETRY AND LET THE BUILDINGS FALL LOGICALLY. STEEL PLAYED A MAJOR PART IN THE CONSTRUCTION AND WAS USED EXTENSIVELY THROUGHOUT THE SITE.



KEY

a	ADMIN BLOCK
b	METALS
c	PAPER AND PLASTICS
d	TREATMENT PLANT BLDG
e	SHREDDER
f	CAR PARK
g	

SITE PLAN

MERITS

- NOISE POLLUTION IS COMBATED BY USING ACOUSTIC MATERIAL IN THE BUILDING.
- THE SITE IS WELL LOCATED AND PLANNED IN SUCH A WAY THAT THERE IS SCALE FOR FUTURE EXPANSION.

DEMERITS

figure ?

4.1a ARCHITECTURE

The architects were Johnson-Hotvedt-Robert Pillsbury. The contractor Fontaine brothers, the Engineers were camp Dresser & McKee, Inc.

The architects, Johnson – Hotvedt, working with engineers camp Dresser & McKee, devised a diagonal process flow pattern in response to site geometry and let the building fall logically, at the end of both the flow and the site. The architects enclosed the filters for the paper recycling in a weathering steel structure that reflects the diagonal site geometry both in plan and elevation. The pattern of the X-bracing was used to produce glazed opening in the siding that expose the rested carbon cylinders and admit natural light in large doses. Other materials were selected with a view toward durability and easy maintenance: glazed block for interior partitions and seamless epoxy flooring.

The west Fitchburg plant is a simple but convincing argument for architect/ engineer cooperation in this neglected building type. Working in tandem, they achieved together what neither has achieved alone.

4.1b MERITS.

a) The site is well planned and located so that there is space for the future expansion, as the content to be recycled increases, the plant is equipped for the in flow of more solid waste.

b) Using materials on the walls of the plant itself combats noise pollution; these include walls, linings in the ceiling and floors two.

4.2 THE RECYCLING PLANT AT PLATTSBBURGH.

The Plattsburgh recycling plant is located adjacent to one of the nicest neighborhoods in Plattsburgh. A high aesthetic standard was adapted for the design. The basic treatments and machines include: - Conveyor belts, compactor and can flattener. The root structure is waffle slab with all piping and ducting left exposed. The engineering firm who handled the job was O'Brien and Gene while the architects were McKnight and Krimmer with the contractor being Mcelwfe Courbis contractors.

4.2a MERITS

a) The exterior and interior finishes of the recycling plant are well used to solve both the problems of combating noise pollution, and the high aesthetic value of the building. Treatments given to the walls include the walls being treated with wool before timber was now placed over the wool.

b) The site is well planned and located

c) The exposure of all piping and ducting makes the identification of problems in this area relatively easy.

d) Timber boards are attached to concrete forms to aid insulation.

CASE STUDY

RECYCLING PLANT AT PLATTSBU

H

INFORMATION

THE PLATTSBURGH RECYCLING AND WATER PURIFICATION PLANT IS LOCATED ADJACENT ONE OF THE NICEST NEIGHBOURHOODS IN TOWN. A HIGH AESTHETIC STANDARD WAS ADOPTED FOR THE DESIGN. BASIC TREATMENTS AND MACHINES INCLUDE: CONVEYOR BELTS, COMPACTOR, SHREDDER AND CAN FLATTENER. THE ROOF STRUCTURE IS WAFFLE SLAB WITH ALL PIPING AND DUCTING LEFT EXPOSED. ENGINEERS ARE O'BRIEN AND GERE, ARCHITECTS ARE MACKENZIE, KIENNISE, WHILE CONTRACTORS ARE MCELWEE COMPANIES CONSTRUCTION.

MERITS

- THE SITE IS WELL PLANNED AND ORIENTED.
- THE EXTERIOR AND INTERIOR FINISHES ARE EASY TO MAINTAIN.
- THE EXPOSURE OF ALL THE PIPING AND DUCTING MAKES IT EASY FOR RELATED PROBLEMS TO BE IDENTIFIED.
- TIMBER BOARDS ARE ATTACHED TO CONCRETE FORMS TO AID NOISE INSULATION.

DEMERITS

1. RECYCLING PLANT IS LOCATED IN A RESIDENTIAL AREA.
2. AERATION SECTION IS TOO CLOSE TO THE ADMIN BLOCK.

KEY

a GLASS PROCESSING
b PAPER PROCESSING
c ADMIN BLOCK
d PLASTICS AND
e METAL
f PAT PADS
g UNDISPOSED WAR

SITE PLAN

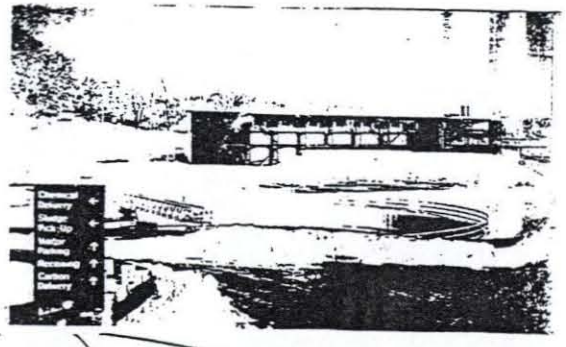


figure 7

4.2b DEMERITS

(a) The separation of the buildings makes it a problem for trucks to load and off load the waste treated at different buildings to the next stage of treatment.

(b) The recycling plant is located in a residential area. This presents a problem because of noise pollution in the area and the high traffic volume when the residents are at work.

4.3 COCA COLA DEPOT / PLANT KADUNA.

Coca cola is the most popular soda drink in Nigeria if not the world. They have several depots around the country with the major ones being in Lagos, Kaduna and Port Harcourt. The plant in Kaduna was built in the early 1980's and it sees to the manufacture of the liquid contents and also the containers (bottles) in which they are put.

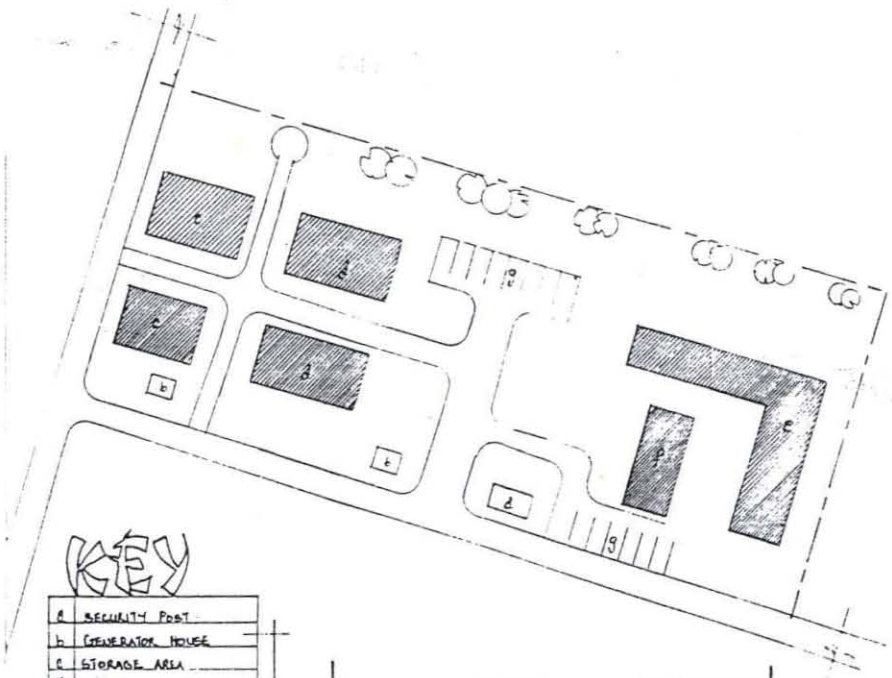
The reason why I chose this as my case study was because of the bottle (glass) recycling facilities that they had. The plant is located in the industrial part of Kaduna in Kakari and it is well situated. The buildings are made of portal frames made of steel, and aluminum sheeting used in covering the rest of the parts. The glass recycling area is a small part of the building 'g' (as seen in the site plan). It consists of a loading on / off loading bay, conveyor belts and glass blowing equipment.

4.3a MERITS

a) The site is well planned the roads allowed for the trucks to load off load them products without too much turnings.

CASE STUDY

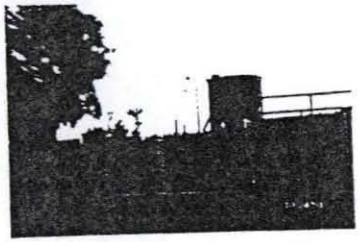
COCA COLA PLANT KADUNA

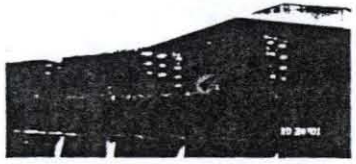


KEY

a	SECURITY POST
b	GENERATOR HOUSE
c	STORAGE AREA
d	
e	PRODUCTION AREA
f	BOTTLE RECYCLING AREA
g	CAR PARK

SITE PLAN





INFORMATION

THE COCA COLA PLANT IN KADUNA IS LOCATED AT THE INDUSTRIAL LAYOUT OF KADUNA IN KAKURI OFF ROAD. THIS IS WHERE COCA COLA IS PRODUCED. THE REASON WHY I TOOK THIS CASE STUDY IS BECAUSE OF THEIR GLASS BOTTLE RECYCLING FACILITIES.

MERITS

- THE SITE IS WELL PLANNED
- NOISY BUILDINGS ARE GROUPED TOGETHER
- THERE IS AMPLE SPACE IN THE PRODUCTION HALL.

DEMERITS

- ONLY BOTTLES ARE RECYCLED, AND THESE ARE MOSTLY WASHED AND RE-USED.

figure 7

b) Noisy buildings are grouped together and this helps ease the problem of noise pollution.

4.3b DEMERITS

a) The number of parking spaces available are not enough for the workers and visitors, so that the visitors now have to park outside the site and walk in

b) They do not engage in Major glass recycling most of the bottles are just washed and reused.

4.4 SOLID WASTE DECOMPOSING PLANT LAGOS

The plant is located at the Lagos- Badagry express way near charity bus stop .The plant is mainly an incinerator, which is designed for decomposing solid waste generated at both the local and international airports. The plant is a massive structural steel construction. It makes good use of steel sections in beam and frictional grip butt other materials used in construction include reinforce concrete and contain walls.

4.4a MERITS

a) The structure makes good use of natural and artificial lighting.

b) Adequate circulation space is provided in the processing area.

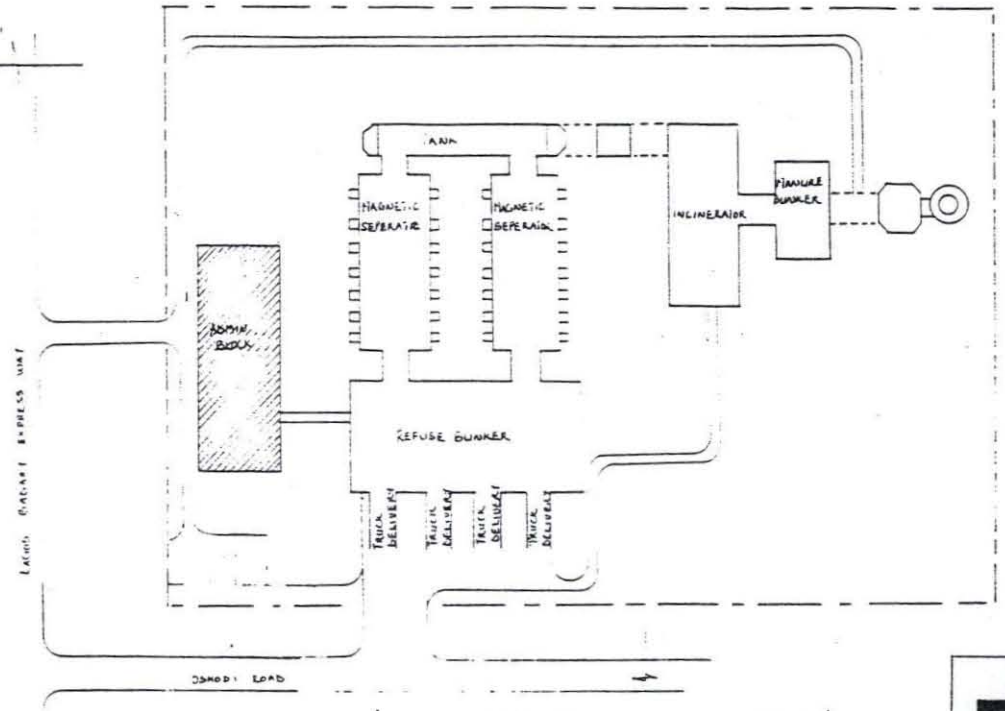
c) Proper functional flow.

d) There is adequate provision for supporting facilities.

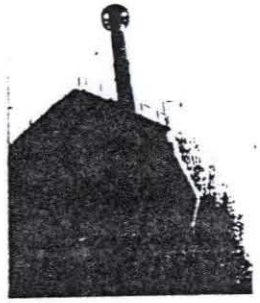
4.4b DEMERITS

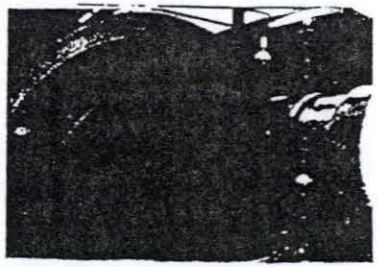
a) Poor security network on the site.

b) The plant adds to air pollution from the incinerator.



SITE PLAN





MAGNETIC SEPERATOR

INFORMATION

THE PLANT IS LOCATED AT BARITY BUS STOP OSHODI, AT THE JUNCTION OF THE LAGOS - BADAGRY EXPRESS WAY. THE PLANT IS AN INCINERATOR WHICH IS DESIGNED FOR DECOMPOSING SOLID WASTE GENERATED AT THE INTERNATIONAL AND LOCAL AIRPORTS. THE PLANT IS A MASSIVE STRUCTURE OF STEEL CONSTRUCTION. IT MAKES GOOD USE OF STEEL SECTIONS IN BEAM AND FRICTIONAL GRIP BUT OTHER MATERIALS INCLUDES REINFORCED CONCRETE AND CURTAIN WALLS.

MERITS

- THE STRUCTURE MAKES GOOD USE OF NATURAL AND ARTIFICAL LIGHTING.
- ADEQUATE CIRCULATION SPACE IS PROVIDED IN THE PROCESSING AREA.
- GOOD FUNCTIONAL FLOW.
- ADEQUATE PROVISION FOR SUPPORT FACILITIES.

DEMERITS

- POOR SECURITY NETWORK.

PLANT ADDS TO AIR POLLUTION FROM THE INCINERATOR.

figure 7

CHAPTER FIVE

5.0 CLIMATIC CONDITIONS

INTRODUCTION.

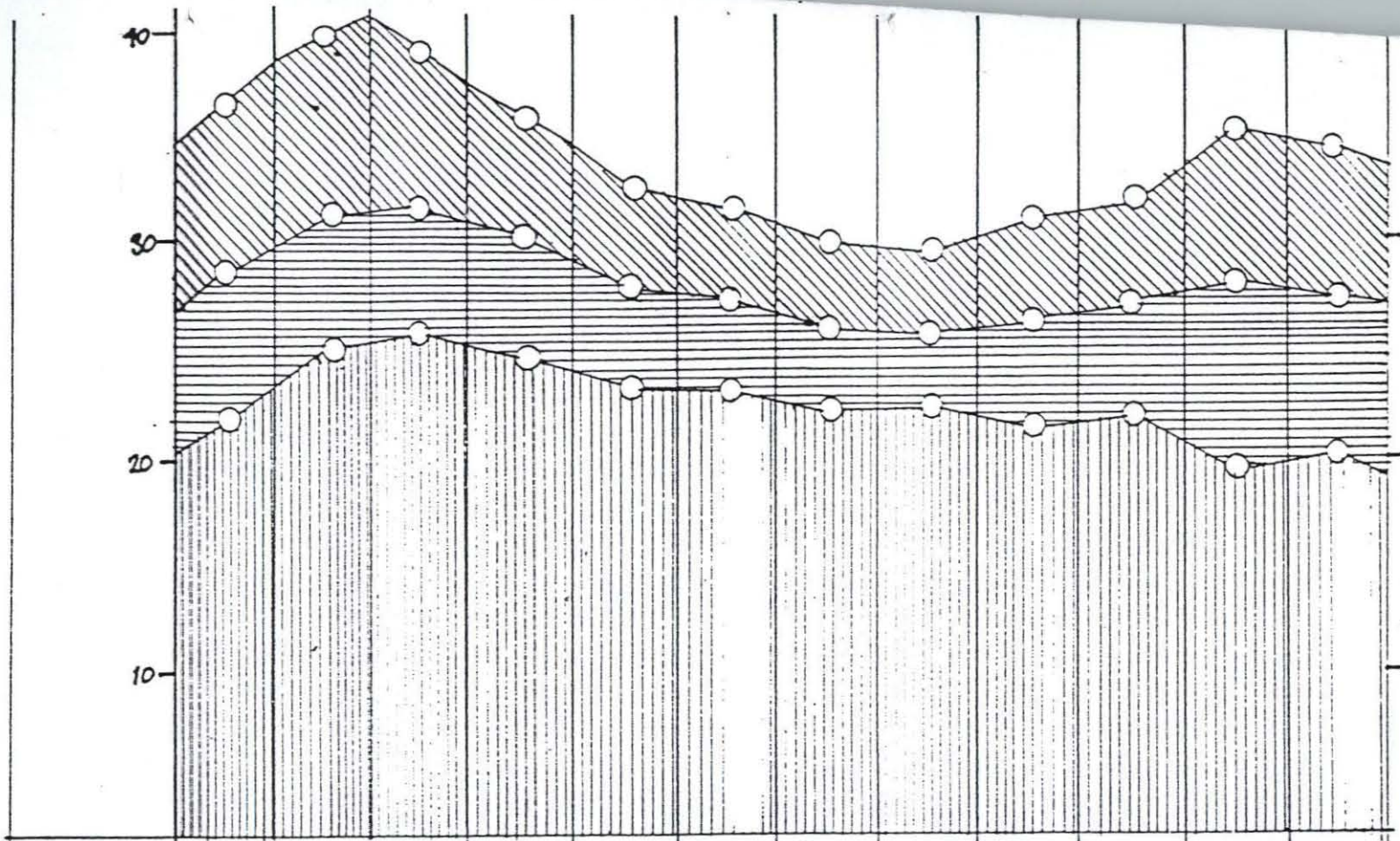
Nigeria is at the equator of the world, where the regions there are the tropical regions. The climatic of Nigeria is divided into the wet and dry seasons. This classification or division uses rainfall as the only meteorological element by which the climate is defined. However, where other meteorological elements such as temperature, mind, solar radiation, cloud amount, cloud base, visibility and local topography are considered, we can then comfortably derive three distinct weather patterns which are:

- The hot dry season
- The cold dry season
- Warm humid season

The length or period of each season varies according to other geographical factors like location, topography and ground cover.

5.1 TEMPERATURE

There is a general fall in temperature during the warm humid (raining) season, due to dense cloud cover, increased blossoming of vegetation cover and evaporative cooling. This is evident in the mean monthly temperatures which records it's lowest in the month of August at 22.2^0c. The diurnal annual range is also much lower during this warm humid season, sometimes no more than 7^0c (in July and August). The mean monthly temperature is highest in March at 39.2^0c. The months of March, April, May and June are generally hot and dry, although there is occasional precipitation in May and



MONTHS	JAN.	FEB	MAR	APRIL	MAY	JUN.	JUL	AUG	SEP	OCT.	NOV.	DEC
MAX. TEMP. °C	35.4	37.4	39.2	37.6	32.8	31.6	29.7	23.0	30.8	31.7	35.4	34.1
MEAN TEMP. °C	28.4	31.0	31.6	30.0	27.4	27.1	25.9	25.6	26.0	26.6	27.4	26.8
MIN. TEMP. °C	21.4	24.6	25.6	24.4	23.0	22.8	22.1	22.2	21.1	21.6	19.5	19.6

MAX. TEMP. °C

MEAN TEMP. °C

MIN. TEMP. °C

TEMPERATURE DATA

Table ?

June which heralds the coming of heavy down pours from July to October. These hot and dry conditions must be into serious consideration in the architectural design stages, from the pre-design stage by utilized existing trees on site or planting more create a micro climate that generally aims at site cooling by increase vegetation cover and the evaporation cooling offered by plants.

5.2 HUMIDITY.

Humidity is the amount of moisture present in the air. Human sensibility to air and its temperature is greatly affected by relative humidity. The amount of moisture present in air particles and the speed of such air coupled with its temperature have a direct influence on thermal comfort of human beings. During the hot dry season, relative humidity falls in the afternoon to as low 20 percent. This low relative humidity, coupled with the high afternoon temperature account for the desiccating effects of the season. In the raining season, the relative humidity is much higher, especially in the morning hours when it can get as high as 95 percent. Even though temperature is slightly lower, the effect causes a heat trap, when this occurs it can get uncomfortable hot.

5.3 WIND-DUST.

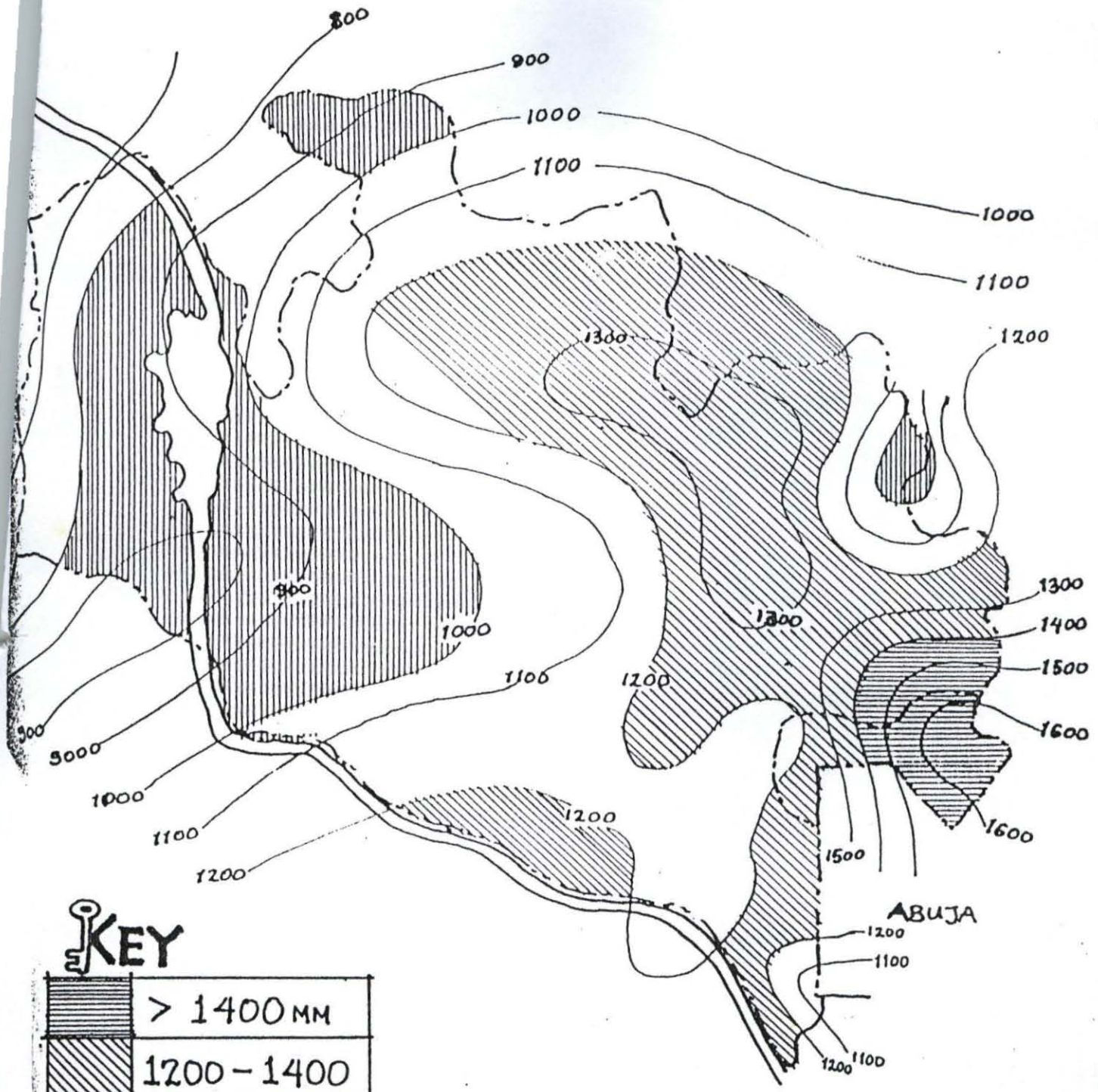
The two major air masses that dominate the Minna climate are the tropical maritime air mass and the tropical continental air mass. The tropical maritime is formed over the Atlantic Ocean to the south of the country and is therefore warm and moist. It moves generally inwards in a southwest to

northeast direction. The tropical continental air mass on the other hand, is developed over the Sahara Desert and is warm but dry and blows in the opposite direction to the maritime air. It is the Oscillation of these two predominant air masses that produces the highly seasonal characteristics of weather conditions in the country and indeed the sub continent. The tropical maritime mass is associated with the wet / humid seasons while the continental mass is responsible for the dry season. The intensity and duration of each type of wind over a particular place vary due to the interface of these two masses.

When the southwest monsoon winds dominates the months of July to October, it bring a lot of rain, but by November, the Northesterlies prevail, bringing with dry cloud less but dusty conditions of harmattan: the days of harmattan are quite hot but cloudlessness implies that at night there is considerable loss of heat by radiation from the earth. The temperature drops sharply, often to dew point, giving rise to early temperature inversions and early mist or fog. The situation gets more complicated by the setting of dust particles, which have the effect of reducing Visibility to a hundred meters. By day time, renewed solar onslaught or insulation clears the mist or fog, although the dust particles continue to float in the air and tend to settle as a thin film over furniture and other objects.

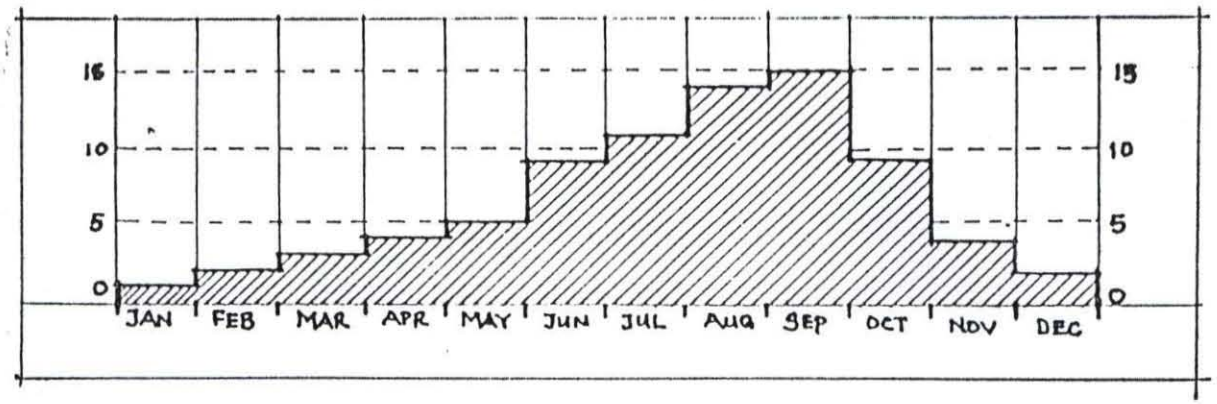
5.4 SUNSHINE / SOLAR DATA.

The hours of sunshine increases as one moves upward from the Atlantic coast to the semi-arid states of the far North. The amount of sunshine range ranges from a minimum of 1,300 hours in the Niger Delta, to over 3,200 in the extreme Northeast of the country and Maboguije (1977) The Minna area to exposed to about 2,500 hours of sunshine annually. As the rainy season



MEAN ANNUAL RAINFALL (in MM)

figure 7



AVERAGE MONTHLY RAINFALL (IN INCHES)

figure 7

approaches, the tendency is for cloud cover to increase. The decline in sunshine hours becomes more intense as the rainy (warm humid) season progresses and reaches it's lowest values in the month of August. Solar data should be taken into consideration in the design.

5.5 GEOLOGY AND TOPOGRAPHY

The geology of Nigeria shows that the rocks of the various units of the geological succession range in age from the pre-Cambrian to the quaternary as the basement complex, this basement-complex constitutes the oldest exposed rocks in Nigeria and they have a very long history, during which they underwent varying degrees of alternation by heat and pressure, were folded, crumpled, raised into maintain range and eroded. The rocks underlying the Minna area are undifferentiated basement-complex rocks and will not present any geo-technical constraint to the types of structures proposed on the site, as majority of them are of medium to high strength. Nigeria is a country of a variety of landforms and its land surface is classified into three broad physical units (The major relief features). These are the plains, the highlands and the troughs and valleys.

The slopes are gentle slopes, these defines the topography of a place. Minna generally does not have a high altitude because the land is almost flat tilting about 30 Degrees in the steepest places.

5.6 VEGETATION.

The ecological zones of Nigeria indicate the distribution of natural vegetation of different types under specific climatic influences. These different types are differentiated mainly on the basis of their gross structural

features in presence or absence of trees, shrubs and grasses and the spatial relationship. These zones do not necessarily indicate homogenous belts of vegetation rather they present a mixture of types, each zone being characterized by the most prominent type which occurs within it. However much of the natural vegetation of Nigeria has been altered cultivation, grazing and fire over a long period of time especially in the densely population areas.

The vegetation of minna can be described as park savannah. Park savannah is defined as a mixed formation of grasses, shrubs and trees. The grasses are tall and perennial which dominates a lower stratum that supports annual incidences of burning. Shrubed vegetation is predominant on flatter plains and undulating terrain, comprised of shrubs with well-developed grass layer and few scattered trees. Savannah woodland occurs in isolated areas on steeper slopes.

Vegetation Type will normally affect: -

- Site micro climate
- Solar radiation
- Wind
- Humidity
- Sound travel
- Purity of air

5.7 SOCIO – CULTURAL LIFE.

In Nigeria, north of the Niger, the major units of traditional administration have been empires, emirates and kingdoms. The advent of Islam before the era of colonization however titled the control of such areas into the Emirate systems where the ruling Emirs exercised religion and judicial power over

their subjects as a result of the socio political nature of Islamic law and culture. These traditional administrative units formed much of the basis of modern / sub colonial boundaries for two main reasons.

1) The traditional units contained ethnic groups of similar cultural background except where certain powerful kingdoms / Emirates have subjected same of their less powerful but different groups.

2) Other administrative units often had certain sentimentalities engendered by common historical experiences and aspirations.

The ethnic groups that dominate and inhabit the tingle area of Minna are Hausa, Nupe and Gwari people with other minorities being Igbo and Yorubas and some other ethnic minorities, which are too diverse, and many to mention have.

5.8 ECONOMIC AND COMMERCE.

Most of the people around the Tunga area engage in subsistence agricultural practices. However, a lot of the people in that also go to their various places of work in town. Some of the commercial activities that take place includes:

-

- Furniture making
- Petty shops
- Grinding machine

5.9a TRANSPORTATION AND TRAFFIC FLOW

Transportation pattern in this area is mostly by bus and motorbikes. The main road, shiroro road is a major road so buses take commuters to their different places including Tunga market, and Mobil area. The motorbikes

are more individual because they take commuters from the remote places that buses and taxis don't go and take them either to the main road or to town.

5.9b EXISTING LAND USE AND FUTURE TRENDS

The site that I have chosen is located in the industrial part of Minna. (This is because I am designing an industry). The land has been allocated for industrial use. Although there are no working industries there yet I see that development is about to improve with the building of a new fertilizer plant in the year 2002.

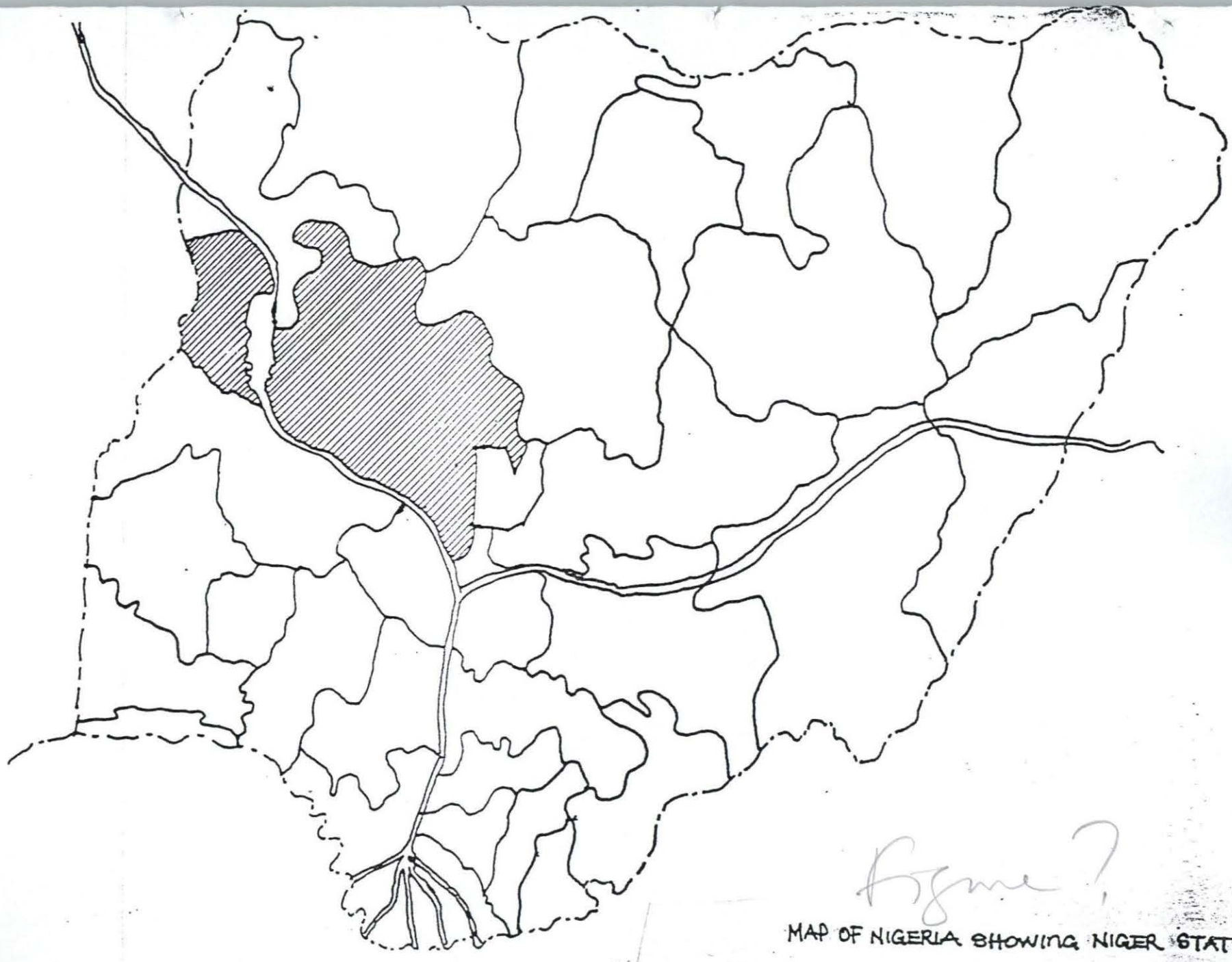
The future trends would have to be for more industries to be located in this area to help reduce noise pollution and environmental degradation.

CHAPTER SIX

SITE ANALYSIS.

6.0 INTRODUCTION

In simple terms, a site could be regarded as a geographical location that defines the dimensional limits within which development is to take place. An analysis of a site is vital for the designer (architect) at the pre-design stage in order to ascertain the advantages and disadvantages of the site, and how to take full advantage of the position aspects and find or device means of contracting the negative aspects. Physical site analysis involves the analysis of the type of soil, to determine the best foundation or substructure design. Existing water bodies, underground streams (and their flow patterns) aridity, drainage and surface run-offs are analyzed. Ecological analysis relates to the prominent plant animal communities, self-regulation and adaptability, and determining the trees to be retained and other useful vegetative ground cover, which should all be clearly mapped out. Cultural analysis of a site refers to the studies of resident population. Infrastructural analysis of a site deals with existing development on the site e.g. building, roads, and utilities like electricity, sewage pipes, telephone lines and water lines and environmental problems like air pollution. Aesthetic site analysis is a study of peculiar site characteristics like view points, horizontal outlines and visual sequences. Acoustic site analysis involves the identification of possible or existing noise sources and ways to minimize or eliminate this problem.



MAP OF NIGERIA SHOWING NIGER STATE.

6.1 CRITERIA FOR SITE SELECTION.

A project with area of concentration as a recycling plant has not been undertaken in Nigeria before. Nigeria is among the countries that haven't caught up with idea of recycling their solid waste. Niger State is in the middle belt and is of the largest states in the country (land mass). A recycling plant located here would have all the space they need to set up an industry like this.

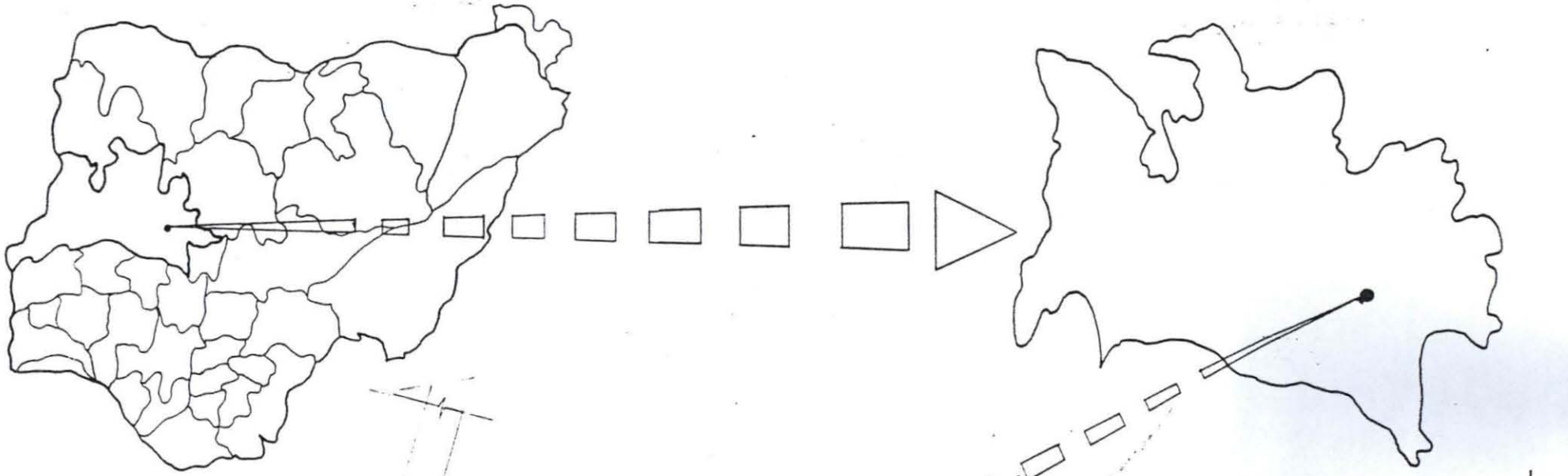
Another reason why I located my site in Minna (Niger State Capital) is because of its proximity to Abuja (The Federal Capital). A lot of waste is being generated in Abuja and as the population increases so would the solid waste. A recycling plant in Minna would help in alleviating the disposal problem faced by the municipal council. Trucks can be loaded with the waste and transported to Minna (which is about 2 hours away from Abuja). To be recycled and sent back as varies products.

The site in Minna is located in the industrial part of the town; this is to help reduce the noise pollution that would be generated in the plant. The industrial area is also not in the town, so the problem of traffic jams and congestion is greatly reduced. The trucks that transport this waste would not have a hand time getting to the site.

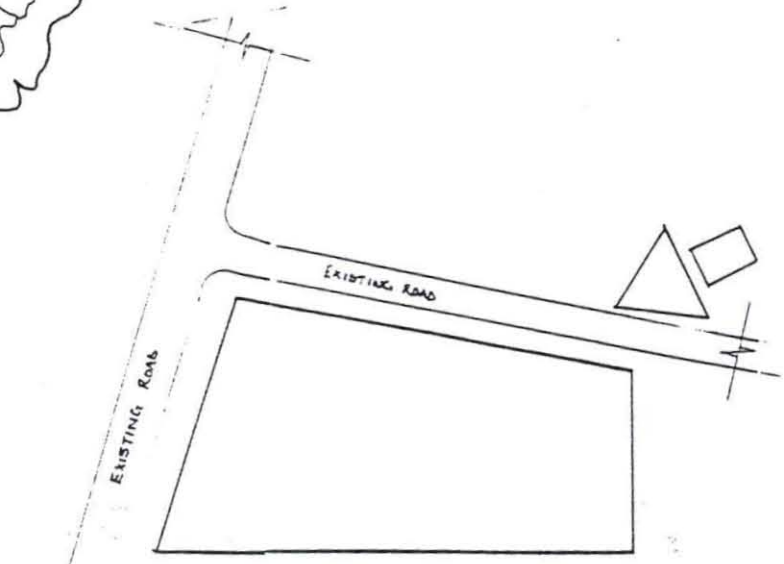
6.2 LOCATION OF SITE

As mentioned before, the site is located in Minna, the capital city of Niger State and is located in the industrial area at the Sauka Kahuta area of Chanchaga Local Government area. This is where the medium and heavy industries are located in Minna. The main street is the Shiroro road before branching off to the next road.

SITE LOCAT



NIGER STATE



PROPOSED SITE

fine?

6.3 SITE CHARACTERISTICS (INVENTORY)

The site as with most land in Niger State which is located in the guinea Savannah region of Nigeria, and seasonal alternation occurs between dominance of moist air masses and dry continental tropical air masses of the gel-tropical high pressure belt.

The temperature of the site and Minna as a whole also depends on the trade winds but on the average the temperature is 29oc.

The soil type is hard beaten loamy soil. The word soil is a natural surface layer containing living matter and supporting or capable of supporting plants. Substance of the soil includes both inorganic (mineral) matter and organic matter, the latter both living and dead. The hard beaten soil normally retains water during the wet season and loses it in the season and even crack in severe temperature. Shrinkage of day occurs both horizontally and vertically so there is a tendency for the walls on the building to be drawn out wards in addition to setting and for cracks to open the soil between the day and sides of the foundation.

The topography of the site refers to the rise and fall of soil of the site. The site is basically leveled in the middle with a gentle slop but there some gullies and steep slopes on the southern part of the site.

The site is doted by trees and shrubs. The predominant vegetable over range from various grasses to shrubs and scattered clutters of frees. Some of the species of ground cover are listed below: -

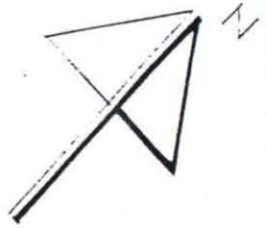
1) Spear grass.
2) Mango tree.
3) Neem tree.

SITE ANALYSIS

THE SUN SETS IN THE WEST BTW 6:14 AND 6:40 IN MUMBAI

ACCESS ROAD

THE SITE HAS TWO ACCESS ROAD WHICH I INTEND TO USE FOR ENTRANCES



NORTH - EAST TRADE WINDS

THESE WINDS ARE POPULARLY KNOWN AS EARNATAN. THEY ARE CHARACTERISE BY DRY DUSTY WINDS WITH THE DURATION FROM NOVEMBER TO MAY

ACOUSTICS

THE TWO ROADS THAT BOUND THE SITE ARE GOING TO BE A MAJOR SOURCE OF NOISE SO TREES WOULD BE PLANTED TO REDUCE THE NOISE

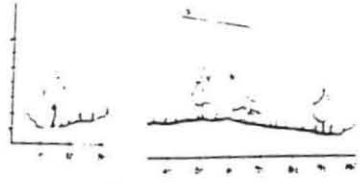
THE ENTRANCE TO THE SITE WOULD BE LOCATED AROUND HERE THIS IS TO THE PLANT AND TO ENABLE THE TANKER EASY ACCESS

VEGETATION

THE VEGETATION OF THE SITE IS SPARSE THE SITE IS DOTTED BY TREES SUCH AS MANGO AND NEEM SHRUBS AND BUSHES ALSO ADORNED THE REST OF THE VEGETATION

SOUTH
WEST
TRADE WINDS

THESE WINDS ARE THE ONES RESPONSIBLE FOR BRINGING RAIN AND HEAVY, DARK CLOUDS WITH THE DURATION FROM EITHER LATE JUNE, OR EARLY JULY, TO OCTOBER.



TOPOGRAPHY AND SOIL TYPE

THE SLOPE OF THE SITE IS ALMOST FLAT WITH A FEW GULLIES. THE SOIL TYPE IS RED BEATEN LATERITE ROCK

THE SUN RISES IN THE EAST 6:25 AND 6:36 IN MUMBAI

figure ?

SCALE 1:1000

MENTOR

DATE DECEMBER 2006

4) Acacia.

5) Locust beam tree (oarkia Biglobosa)

6) Khaya.

6.4 ACCESS AND CIRCULATION.

The access to the site is from the main Shiroro road, which is a truck B Government road, the next branch off is a state road but it is also tarred. The site is going to be accessed by these two roads, the first road would be used by the trucks to get the plant itself, while the other road would be used to get to the administrative block of the plant.

Circulation within the site itself will be by well tarred road and paved walkways the material to be used for the pavement would be concrete slabs with sizes about 600mm by 600mm square.

6.5 UTILITIES

The site is equipped with water pipes and there seems to be a steady flow of water to the site. Electric cables also run parallel to the site. The last telephone pole I saw was on the main road so more poles have to be obtained for us to have telephone services on the site.

6.6 SCENERY AND MAN-MADE FEATURES

The scenery is a mainly trees and shrubs that can be seen as far as the eye would allow. This is because very little development has taken place here in the last 10 years. There are a few buildings far off on the northern and eastern part of the site but that is just about all that can be seen.

6.7 ENVIRONMENTAL PROBLEM

Because this is an industrial area, there is bond to be environmental problems but this area has not been utilized at all and it is still fresh and the air is clean I intend to make my design safe enough to avoid environmental problems.

CHAPTER SEVEN

DESIGN CONCEPT AND CONSTRUCTION

7.0 INTRODUCTION.

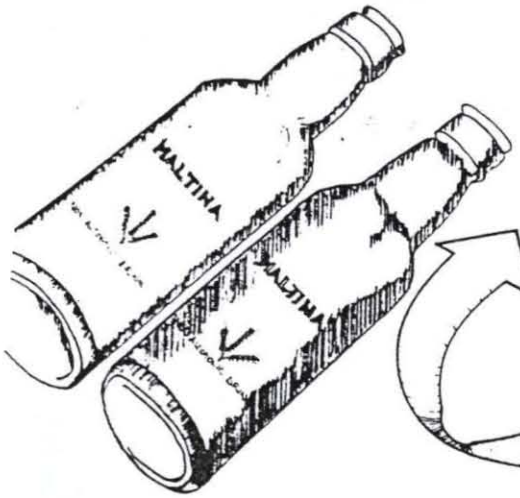
For every building to function, as it is intended, planning has to be done from different perspectives and angles in order to see the best possible way to solve certain problems peculiar to the design. The concept of a design has to be thought of long before the design of the building itself. This is to enable the designer and even ordinary people connect the function to a particular part of the building, or even the whole building.

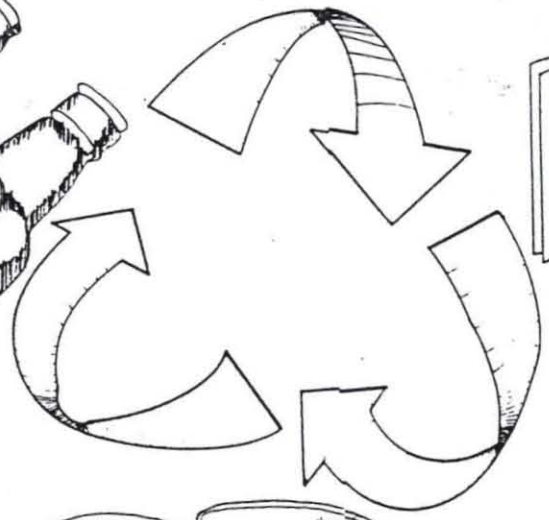
7.1 DESIGN CONCEPT.

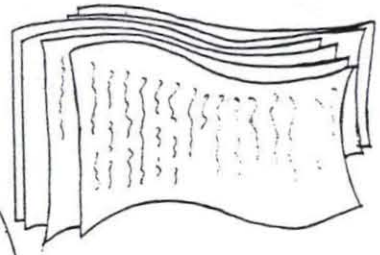
The way waste travels after being discarded (thrown away), by its users is very alarming. As the name implies, nobody wants responsibilities of such materials after it has been used and soiled. It's a result of the attitude that heaps of wastes are lying in various places in parts of this country useless and rotting away causing unpleasant odors and diseases.

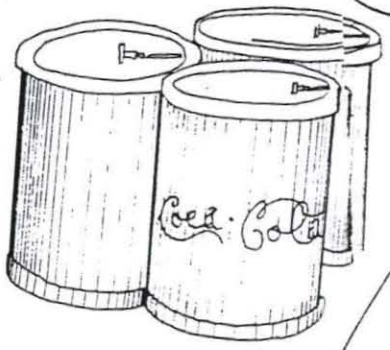
The concept of the design is to show people that these materials can be useful (once again) with a little help. Paper and glass are among the most commonly thrown away solid wastes that are why I am concerned about them.

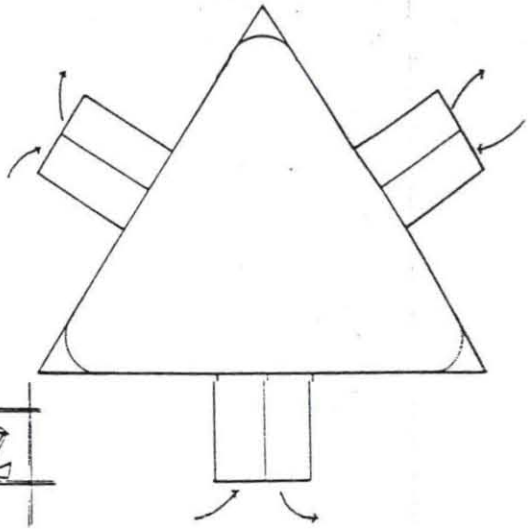
CONCEPTUAL ANALYSIS



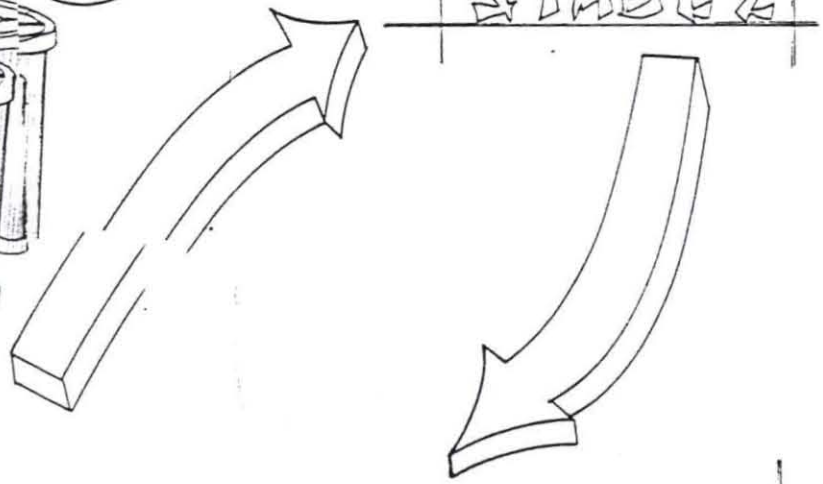






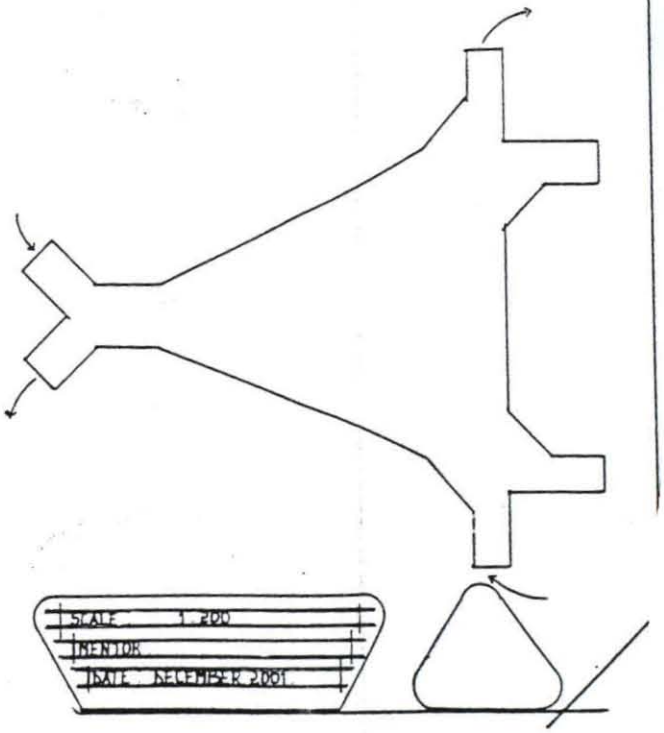


STAGE 2



STAGE 1

FINAL STAGE



SCALE	1:200
MENTOR	
DATE	DECEMBER 2001

Figure 7

7.2 MATERIALS AND CONSTRUCTION.

Buildings are made up of several building materials that make each building unique.

Materials to be used in building: -

1) Glass
2) Reinforced concrete
3) Sand Crete blocks
4) Burnt clay brick
5) Long span aluminum sheets
6) Ceramic tiles for finishing bathroom interiors
7) Finishing materials like cement screed and planter for floors and walls
8) Carpets and rugs of appropriate textures, colors and sizes

7.2.a GLASS

Glass is going to be used extensively in this design. I am using several types of glass for sound insulation, and solar radiation. These would be discussed later but first we would talk a little about glass.

Glass is a uniform material, a solidified liquid. The molecules are in a completely random order and do not form a crystal lattice. That is why glass is transparent. As it consists of a combination of various bonds, there is no chemical formula. Glass does not have a melting point but instead upon applying heat, gradually changes from a solid state to a plastic- viscous to many other crystals, whose properties depend on the direction in which they are measured, glass exhibits amorphous isotropy, i.e. the properties are not depending on direction

The type of glass I am using for the plant itself is the channel shaped ass. Channel shaped glass is a profiled glass element with texture surfaces hich are produced by casting. After leaving the melting tank, a narrower, ven more malleable ribbon of glass is passed over months so that the ages are bent upward at 90 degree. The finished glass element has a u-shape and is supplied in long pieces. The dimension and composition of channel glass shaped are specified in European standard EN 572 channel shaped glass is installed without transoms and is popular not only for industrial applications. It may be erected as a single-skin system, as single-skin sheet pilling systems or as double-skin systems. The fracture pattern correspondent with that of flat glass with narrow dimension. Channel shaped can be produced with a wire mesh insert like wired glass.

7.2 a.1 SOUND INSULATION

The sound insulation index Rw (expressed in decibels, dB) is still an integral description of a theoretical measured value, of the sound insulation to DIN, 52210 as well as the new EN 20717 part 1. To determine the values, weighted scales are available for all building materials and components. The sound insulation R of the component to be tested is measured over the frequency range 100 –3200HZ in one-third octane bands and compared with the required curve according to a prescribed method. This value can prove excellent for monolithic building materials but is inadequate in practice for insulating glass units with small cavities.

In an insulating glass unit consisting of two or three separate panes with cavities in between, the glass does not act alone as a mass but instead as an

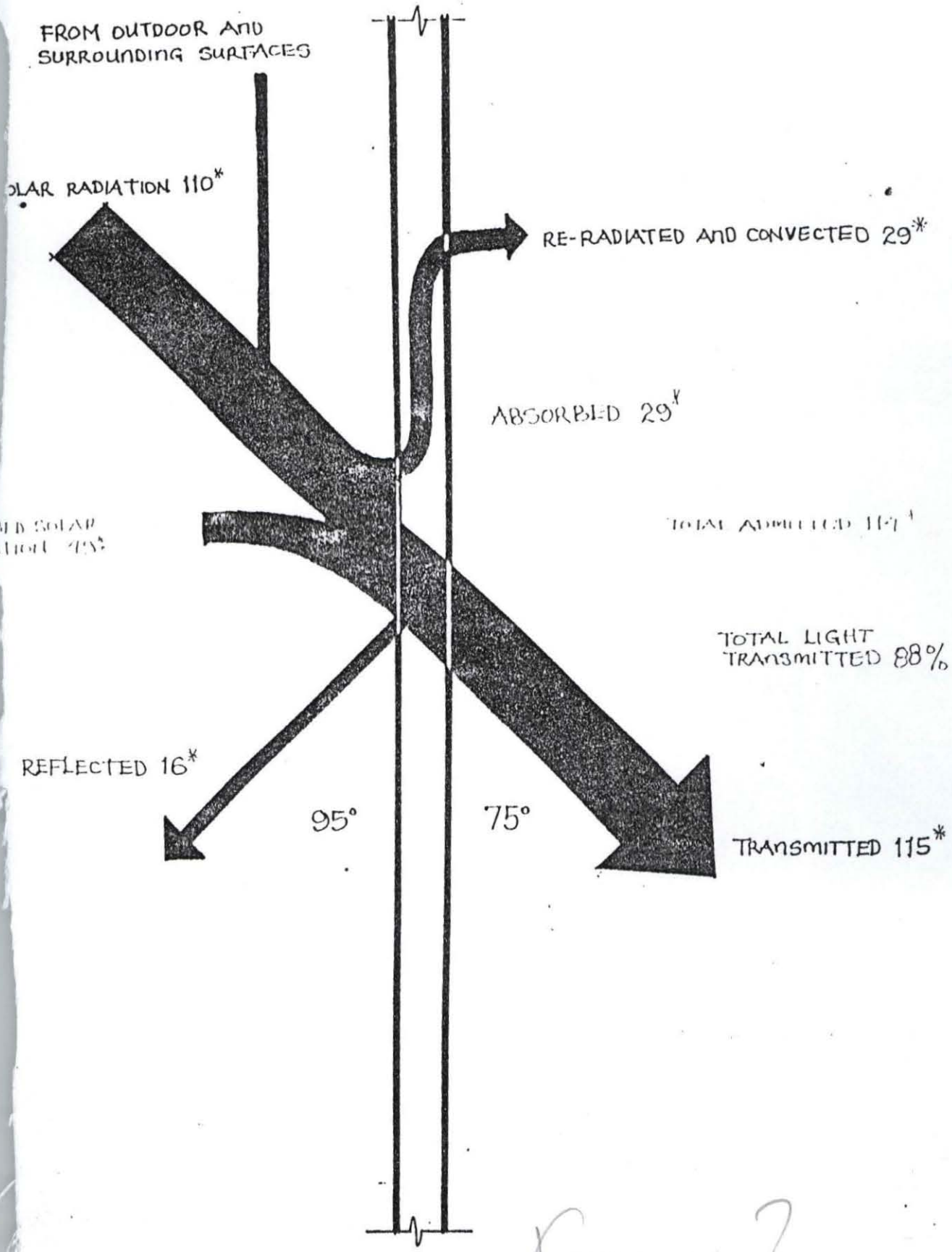


figure ?

THERMAL BEHAVIOUR OF A REGULAR PLATE GLASS

* FIGURES ARE IN BTU/FT² OF VERTICAL SURFACE PER HOUR

(BTU/FT² => BRITISH THERMAL UNITS PER SQUARE FOOT)

oscillating mass-spring-mass system with a natural frequency and a resulting sound insulation value.

7.2.b REINFORCED CONCRETE

As the name implies, this is concrete that has been reinforced (Fortified) to make it stronger. This is done by using that rod of varying diameter depending on the size of the pillar or beam. This is a mix of cement, water, sand and gravel and the introduction of the steel rods, which are laid in a cast before the concrete mix would be cast and left to cure. The curing process can vary from 4days to 2 weeks depending on the desired strength. These are used in beams, pillars, and over or under openings.

7.2.c SANDCRETE BLOCK

This is block made from a mixture of cement and sharp sand and water. These are casted moulds and then left to dry. There are various thicknesses of blocks, the most common ones being 6 inch (150mm) and the 9-inch (225mm) blocks. They are going to be used extensively in this building project.

7.2 .d CONSTRUCTION

Before construction work can be started on the site, the site must be cleaned and leveled (If necessary). Trees and shrubs uprooted, rocks moved and other things all cleared for the setting out to commence.

❖ ***Setting out:*** -setting out can then be started with formwork placed at each end of the wall and ropes and strings of different colors be used to show different in level and end walls.

❖ ***Foundation:*** -The depth of the foundation should be well established by the site engineers before the digging starts. The excavated topsoil would be used later for filling. Depth of trench must not be less than 750mm. A smooth and the leveled layers of concrete base should be poured to a thickness of about 50mm. The thickness should correspond with the width of the foundation wall, while width should be three times the thickness of the wall.

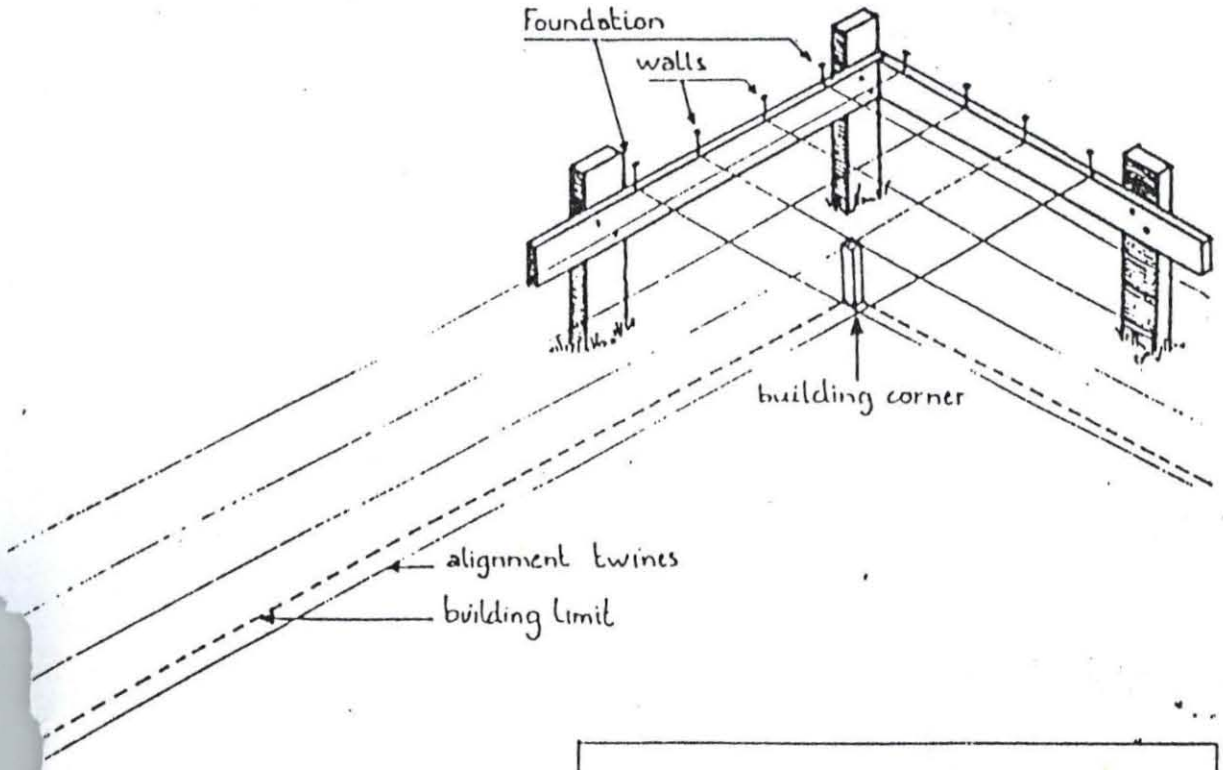
❖ ***Floor slab:*** - The floor slab is usually 150mm concrete. I would use this for my administrative building but for the plant I would use 300mm concrete flooring. This is because of the machine that would be anchored to the floor. Bolts and nut have to be driven into the floor (of course these places would be marked during foundation stage). This is to help in the sound insulation.

❖ ***Scaffolding:*** - this can be made up of any material as long as it is strong enough to carry the workmen and materials to the next level. The common one is timber, but bamboo and steel can then be used where bundant.

❖ ***Lintel:*** - Reinforced concrete lintel can be cast over all the openings especially arches. These can be pre cast or cast- in- situ but I would choose o have none cast in-site. The iron rods should be 8mm. The iron rods should go approximately 15mm into the mortar.

SETTING OUT

Place formworks for setting out at the end of each wall and use nails to place the different lines showing the position of the foundation and wall.



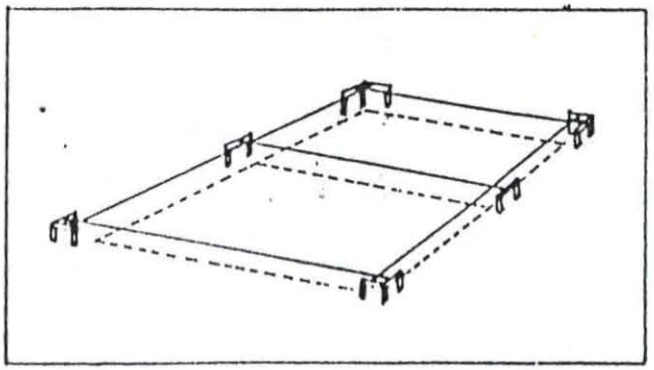


Figure 7

7.2.e FINISHES.

These are treatment given to walls, floors and roofs to enhance its beauty or/and to help in insulation against cold, and noises

.

❖ ***Plastering:*** - Sand/cement plaster can be applied on exposed walls and on poor quality walls. To reduce the risk of cracking or peeling. Plasters can be reinforced with wire netting.

❖ ***Painting:*** - Sand Crete blocks can be painted after plastering. Emulsion or oil paints can be used but the oil or gloss paints should not be used use in areas exposed to dampness as they will not allow evaporation of humidity and will peel off within a short time.

7.2 f Sound insulation for walls: - The last two finishes mentioned would be used extensively in the administrative building, but for the recycling plant, the wall would have to be treated to combat noise. The use of hollow clay blocks plastered on one side would help reduce noise greatly. This is done by using this hollow clay blocks between the portal frame to be used for the plant.

7. 2 g Portal frames: - In portal frames the structural roof members are rigidly connected to columns or posts so that the post and rafters of the frame act as one continuous structural member. The advantages of this system of framing are that the structural continuity of posts and rafters, which withstand bending, obviate the need for a lattice of struts and ties

inside the roof space. In consequence the whole of the space inside the frames can be utilized for production or storage. Freedom from latticing members provides a neat internal appearance.

The symmetrical steel portal frames are fabricated from standard solid web beam sections welded together or with a lattice of light steel angles, flats or tubular welded or bolted together. Solid web steel portal frames have the advantage of clean internal appearance with plain surfaces easy to paint and with few ledges to collect dust. Channel or 'I' section steel purlins are bolted to the portal rafters at centers to suit corrugated sheets or lightweight roof decking.

7.3 SPACE REQUIREMENTS

Space requirement refers to the minimum amount of space a room with a certain function can have. In order to achieve a very functional diagram, it is necessary to establish reliable relationship pattern between the different functions in the building. This can easily be achieved by plotting a relationship diagram where various functions and spaces are related.

The two units would be dimensioned to show that adequate spaces have been provided for. The units are the recycling plant itself, and the administrative block.

A. THE RECYCLING PLANT

	OFFICE	BREATH (m)	LENGTH (m)	AREA (m^2)
1	Temperature regulating room	8	19	152
2	Technical office	6.5	5	32.5
3	Quality control office	10	5	50
4	Machine monitoring office	10	5	50
5	Technical workshop	10	5	50
6	Setting	6.5	5	32.5
7	Mechanical engineer's office	5	5	25
8	Repair room	13	5	65
9	Data room	10	4	40
10	First aid room	10	4	40
11	Engineer (paper)	10	5	50
12	Stair case	7	5	35
13	C C TV room	4	5	20
14	Storage room	5	5	25
15	Fire office	5	5	25
16	Stair case	7.5	5	37.5
17	Computer room	10	5	50
	Store	5	5	25
	Senior supervisor office	10	5	50
	Stair case	7.5	5	37.5
	Engineer (glass)	6.5	5	32.5
	Engineer (aluminum)	5	5	25
	Corridor 1 (2)	2	67	268
	Corridor 2 (2)	5	15	150

Table 7

25	Corridor 3	1.8	26	140.4
26	Production hall	117.20x50 5860	85x117.20	58, 277, 700
			TOTAL	58, 279, 209

B. ADMINISTRATIVE BLOCK

	OFFICE	**NO. Of OFFICE**	**BREATH (m)**	**LENGTH (m)**	**AREA (m^2)**
1	Director of paper and secretary	4	5	7	140
2	Director office (glass)		5	10	50
3	Secretary		5	7	35
4	Research did for recycled products	1	15	18.5	27.75
5	Conference room	2	14.5	12.5	362.5
6	Data room	1	10	9	90
7	Maintenance Office	1	7	9	63
8	Electrical Engineering Department	1	11	9	99
	Mechanical Engineering Department	1	10	9	90
	Managing Director's Office	2	10	13	260
	Waiting room	2	10	6	120
	Secretary's office	2	10	6	120
	Lobby and Enquires	1	24	17	408
	Display area	2	24	17	816

Table 7

15	Stair case	2	5	6	60
16	Fire department	1	7	7	49
17	Maintenance office	1	7	7	49
18	Security office	1	8	6	48
19	C C TV room	1	8	5.5	44
20	Computer room	1	10	15	150
21	Engineering office	1	10	7	70
22	Workers lounge	1	12	23.5	282
23	Canteen	1	18.5	17.5	323.75
24	Office	3	7	12	253
25	Consulting room	1	7	8	56
26	Side bay	1	7	8	56
27	Toilet	4	5	5	100
28	Legal office	1	7	5	35
29	Cash office	1	5	5	25
30	Bursars office	1	7	5	35
31	Computer room	1	10	8.5	85
2	Data room and archives	1	9	8.5	76.5
	Meeting room	1	10	10	100
	Office	1	7	9	63
	Engineering department	1	6	9	54
	Maintenance department	1	6	9	54
	Finance department	1	6	9	54
	Marketing department	1	6	9	54
	Workshop	2	9	10	180
	Media office	1	6	6	36

Table ?

41	First aid room	1	6	6	36
42	Storage area	1	11	8.5	935
43	Corridors				550
				TOTAL	684, 425

CHAPTER EIGHT

DESIGN SERVICES

8.O INTRODUTION

A building cannot survive without services to keep the building up and running. The search for alternative methods in the design of energy conscious building cannot be over emphasized in an age where conservation and recycling of resources have been elevated from the back pages to major headlines of the 21st century media. A building needs to be powered by electricity either by generating from the popular dams (used all over Nigeria) or from alternate energy source (wind, solar).

8.1 ELECTRICITY AND LIGHTING

Electricity to be building would be provided by N.E.P.A. Unfortunately the promise of a steady and adequate supply of electricity in Nigeria still remains a distance view to the 'promised land'. Because of this, large generators would be required to power the building during the absence of N.E.P.A. Two generators would have to be provided to the whole complex of buildings.

8.1 LIGHTING

Adequate lighting is already provided for every room in the building except two secretary offices, which would be lighting artificially along with the other offices. All the offices would be fitted with lamp holders for both

the to watts bulb and florescent lights. Users would be educated about the benefits of using the 40 watts florescent lighting as against the heat generating 60 watts bulbs. This is to minimize the level of interior heat generation.

8.3 WATER SUPPLY

The building that houses the recycling plant would need a lot of water. There would be boreholes placed at strategic locations to be able service the needs of the industry. The boreholes would be fitted with electric powered pumps that would pump water from the underground into surface or overhead storage tanks.

Distribution: - The distribution of the water stored in the overhead tank would be used widely by the recycling plant (which would use 80% of the water on the site). The administrative block would be provided their own tanks from which water would be sent to the various sanitary appliances for use.

❖

8.3 PLUMBING

Pipes in the walls saves costs and materials but in most cases, it is not advisable because in case a problem arises, getting to the pipes adds an even greater problem. All the plumbing should be kept accessible to facilitate maintenance. Water exits should be provided in rooms that can be flooded. Floors must be adequately sloped for drainage. Showers, baths and sinks

must stand away From walls, which must be protected with a ventilated waterproof coating (e.g. ceramic tiles).

8.4 DRAINAGE AND SEWAGE DISPOSAL

A sewage system may be separate to accept foul sewage only, all surface water being discharged either to a separate surface water sewer or direct to soak ways. It may be partially separate accepting foul sewage and some surface wastewater with the balance discharged as above or it may be combine in a single sewer would be used.

Soak-away must be built on land lower than or sloping away from buildings and must be kept at a safe distance from the building. Fig 8.4a and 8.4b shows two soak-away types for surface water and wastewater and for foul or soil water from soil appliance respectively.

8.5 REFUSE DISPOSAL

These buildings deals extensively with waste from other places so; their waste should be treated better here. For recyclable products, generated in the building, they would be placed in their respectively marked boxes to be collected and taken to the recycling plant.

Other wastes that cannot be recycled would be collected by refuse trucks and taken to the dumping sites.

8.6 FIRE SAFETY

Fire safety should be provided in every building. This building is not an exception. There is an extensive fire station in both building with fire preventing and protecting measures taken. Fire extinguishers would be

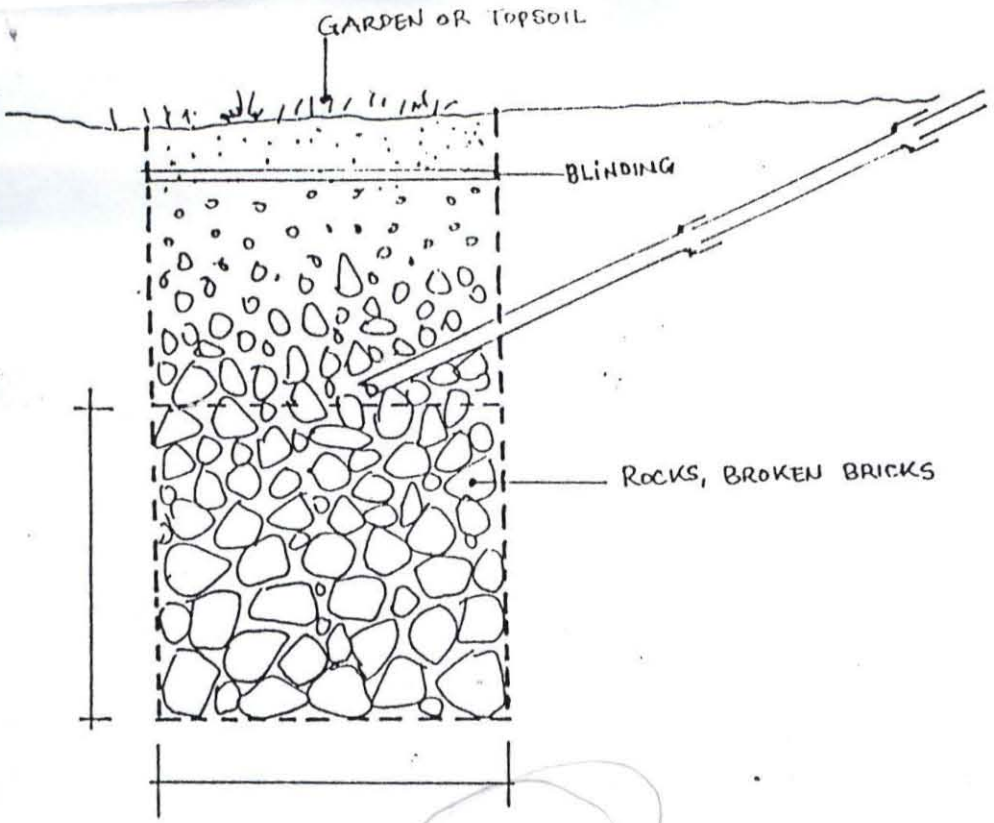


FIG. 9.3A, SMALL FILLED SOAKAWAY FOR WASTE WATER FROM DRAINAGES AND WASTE APPLIANCES.

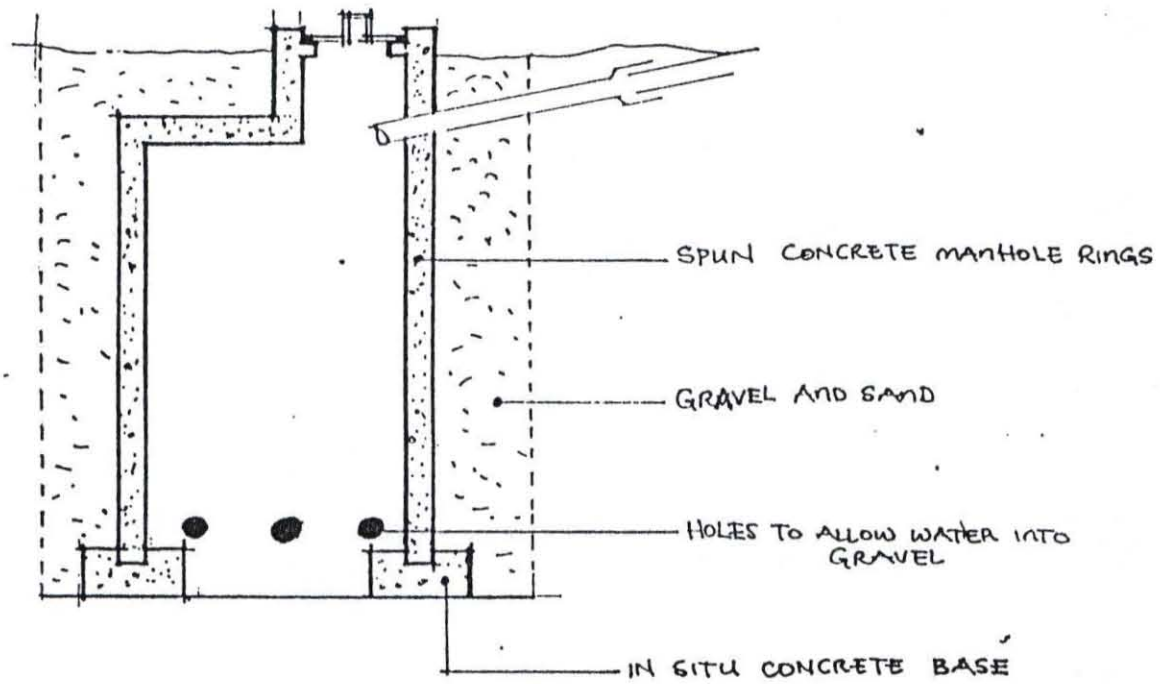


figure 7

SOAKAWAY PIT WITH RIGID LINING FOR SOIL/FOUL WASTE.

provided 25 meters apart from each other. For the recycling plant, stand pipe and hose system would be provided in case of any fire out breaks. Smoke detectors would be located especially in the recycling plant.

Non-combustible material like fibrous plasterboard with wood wool slabs is also used in the design. Exit signs would also be provided incase of a need to use it.

8.7 SECURITY

All buildings must be secured from external forms of unwanted entry. All windows should be secured with burglary proof frames designed to specification. Security checkpoint should be 50 meters apart on the site and the doors, especially to workers allowed into these restricted areas.

The site is of course going to be fenced with two openings where there would be security posts before entry the compound.

8.8 MAINTENANCE

A building used would begin to show signs of wear and tear. As the building is made of different building materials with different durability's, the building has to be checked as early as 6 months after construction to see where problems are likely to develop e.g. cracks in the walls, plumbing problems, windows panes, lighting. All these should be fixed or reported to the maintenance department in the administrative block. This is to ensure the physical appearance and indeed the performance of the building kept as high as possible.

CHAPTER NINE

CONCLUSION.

This project was aimed at finding out the amount of solid waste generated in Minna (Niger state), the best way of collection and taking to the plant, where these would be sorted and recycled,to be used in the community that threw it away in the first place.

The need to reuse materials arises when man noticed that what he does everywhere he moves to is to destroy the natural resources there. And because we want to preserve our natural resources, there is the need to find alternate means to get energy and even many natural occurring materials.

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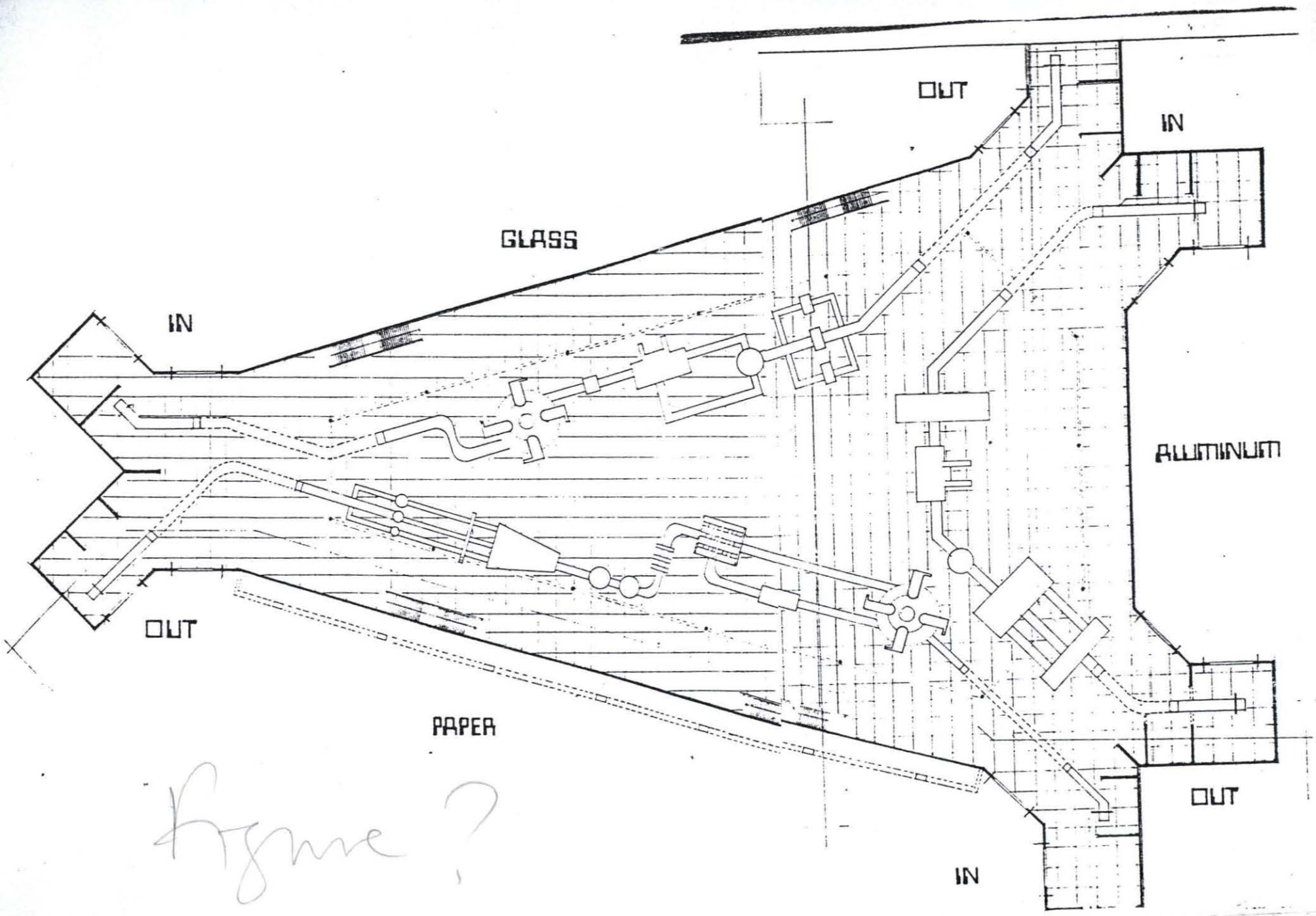
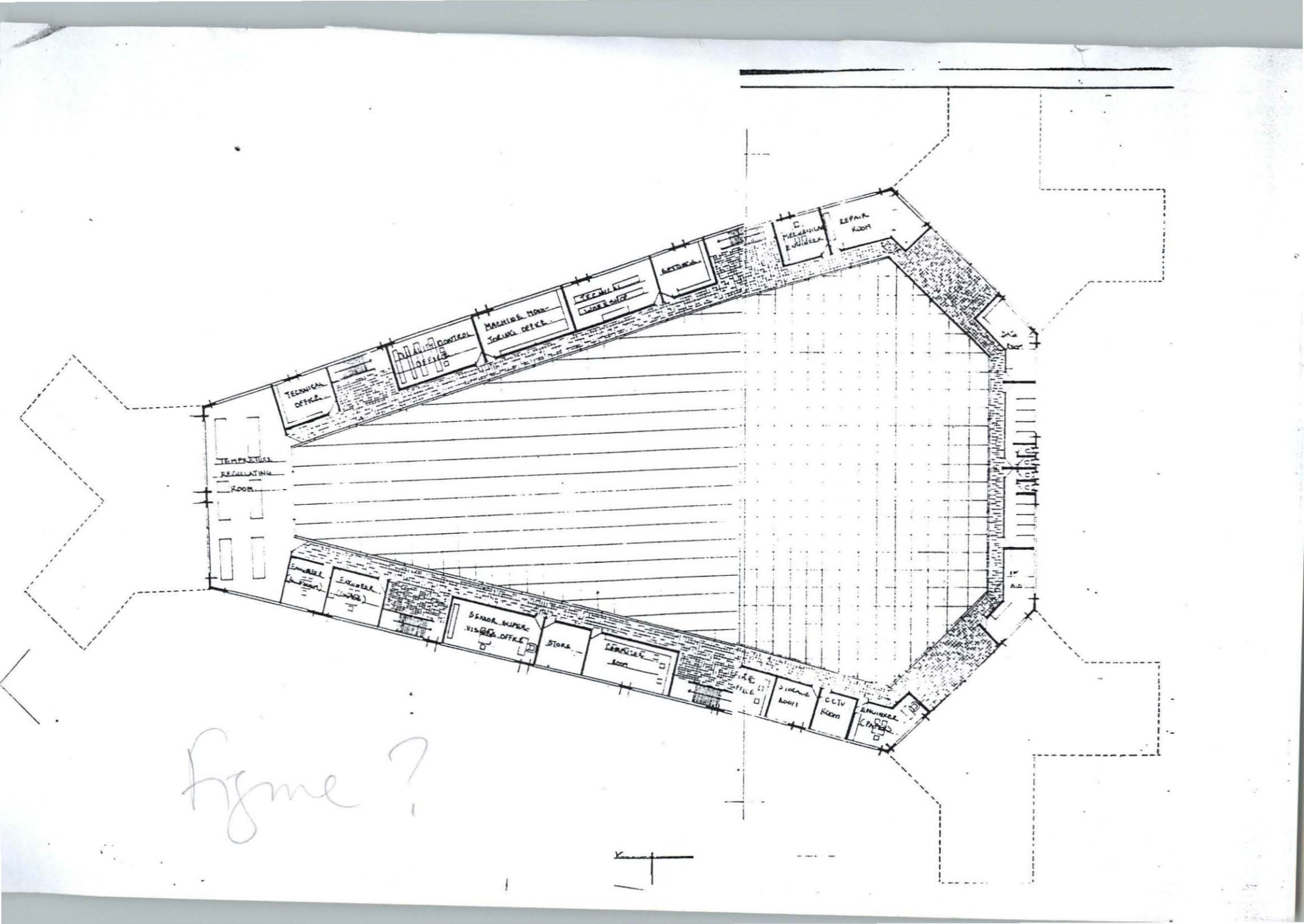
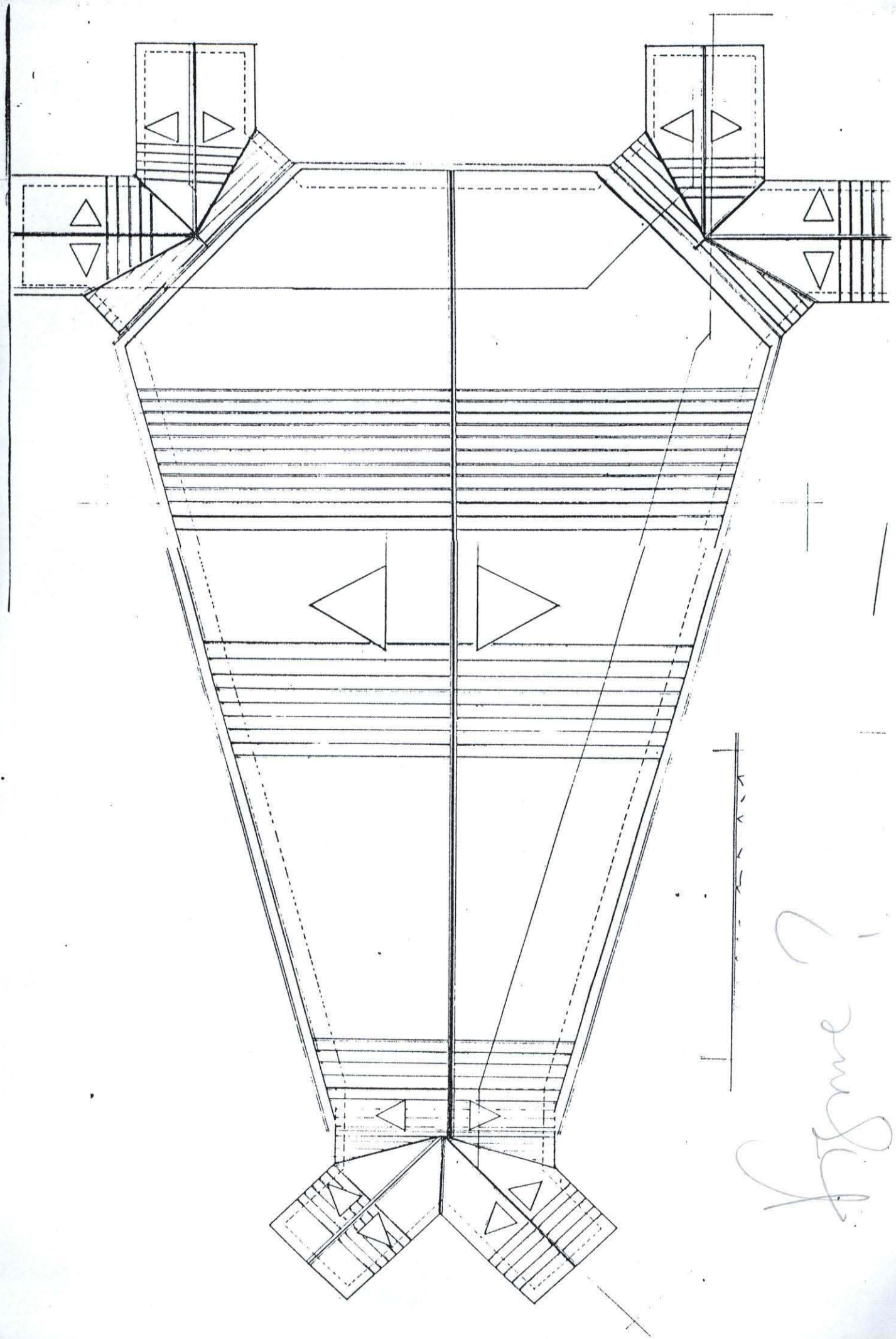
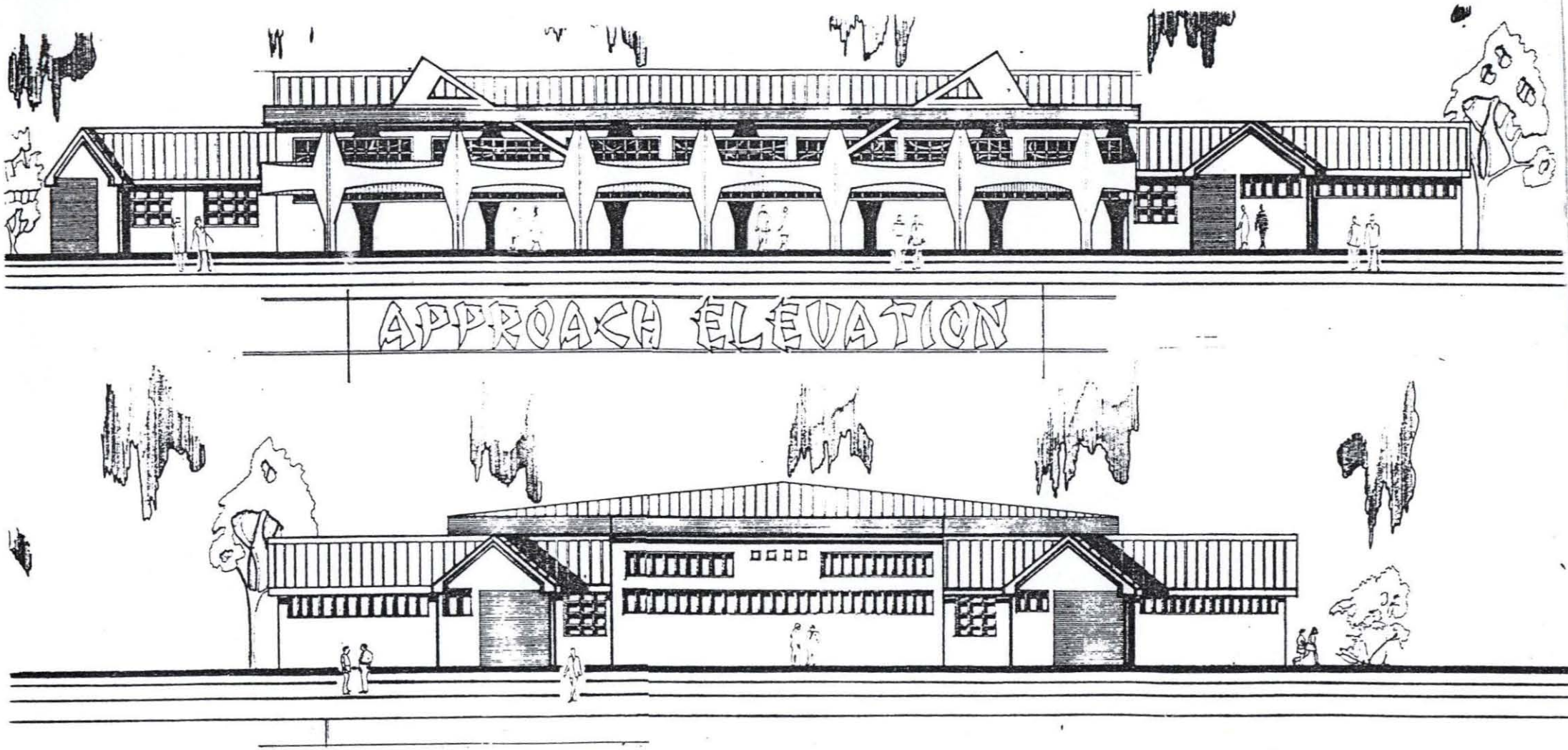


figure ?


TECHNICAL OFFICE
TEMPERATURE REGULATING ROOM
MACHINE TOOL JOBBING OFFICE
REPAIR ROOM
SENIOR SUPERVISORY OFFICE
STORE
FIRE OFFICE
CCTV ROOM

figure?





APPROACH ELEVATION

Figure 7

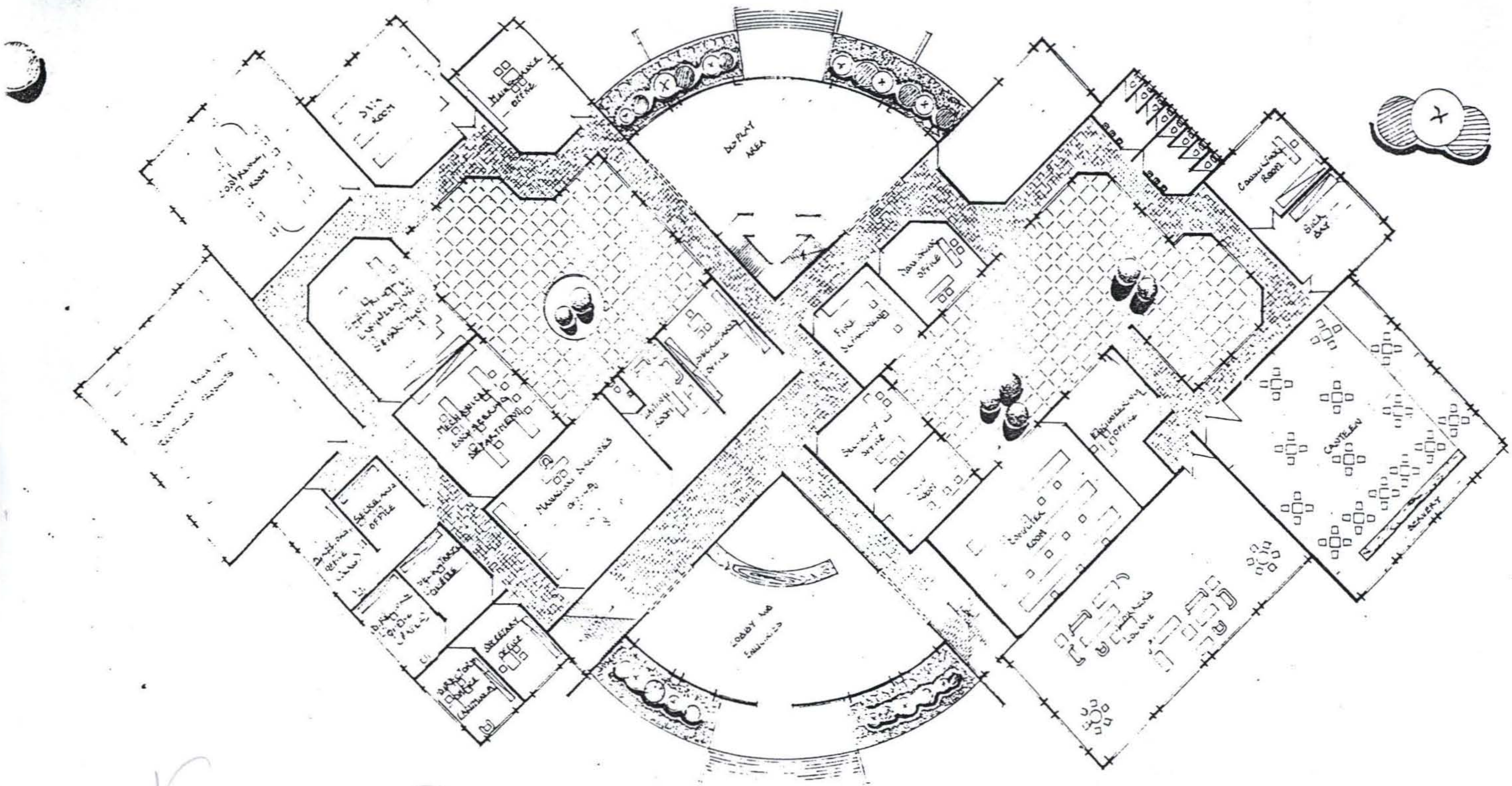

DISPLAY AREA
CANTEEN
MECHANICAL ENGINEERING DEPARTMENT
SECRETARY OFFICE
MAINTENANCE OFFICE

Figure ?

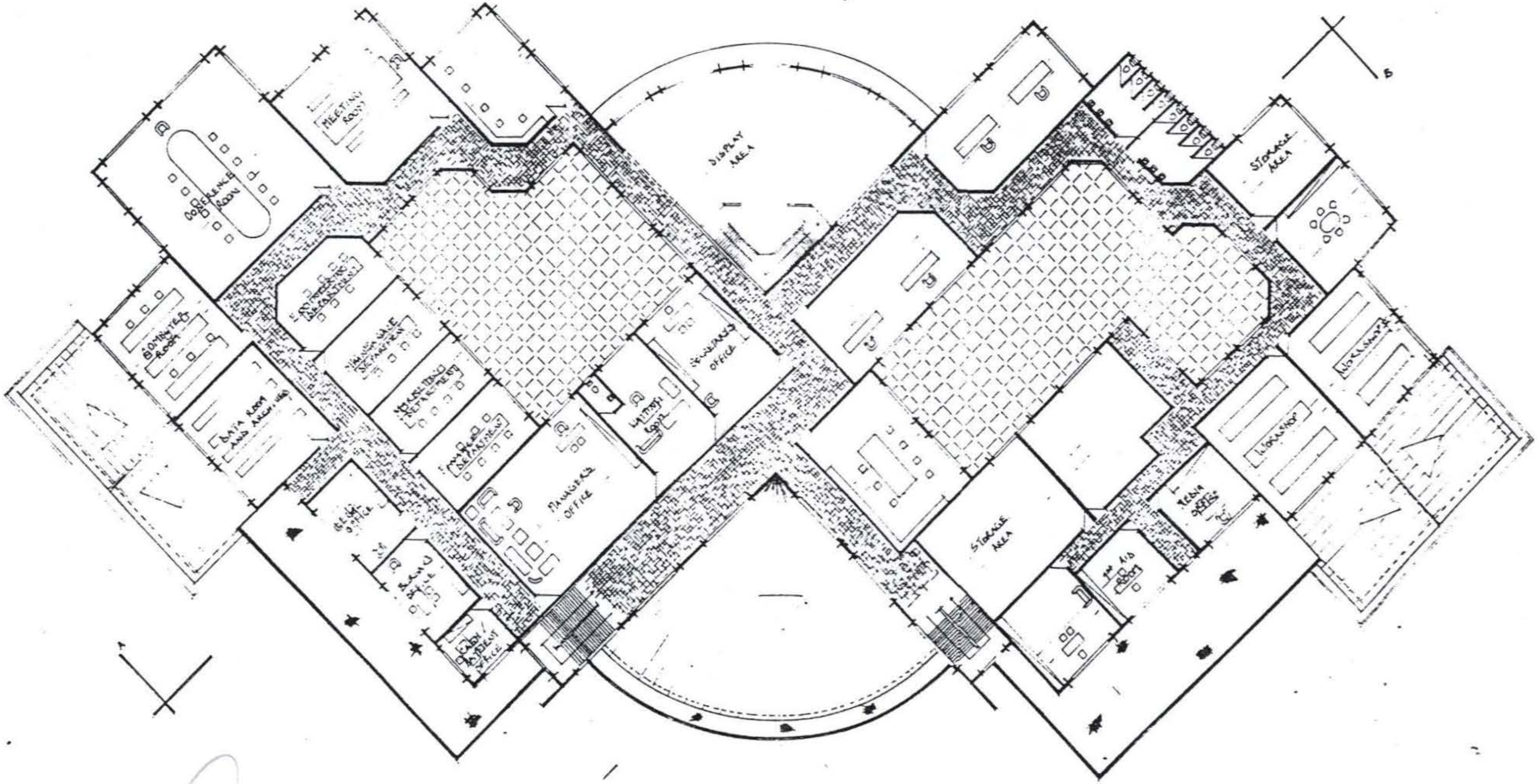

CONFERENCE ROOM
MEETING ROOM
DISPLAY AREA
STORAGE AREA
STORAGE AREA
WORKSHOP
WORKSHOP
MANAGER'S OFFICE
SECRETARY OFFICE
WAITING ROOM
DATA ROOM AND ARCHIVES

figure 7

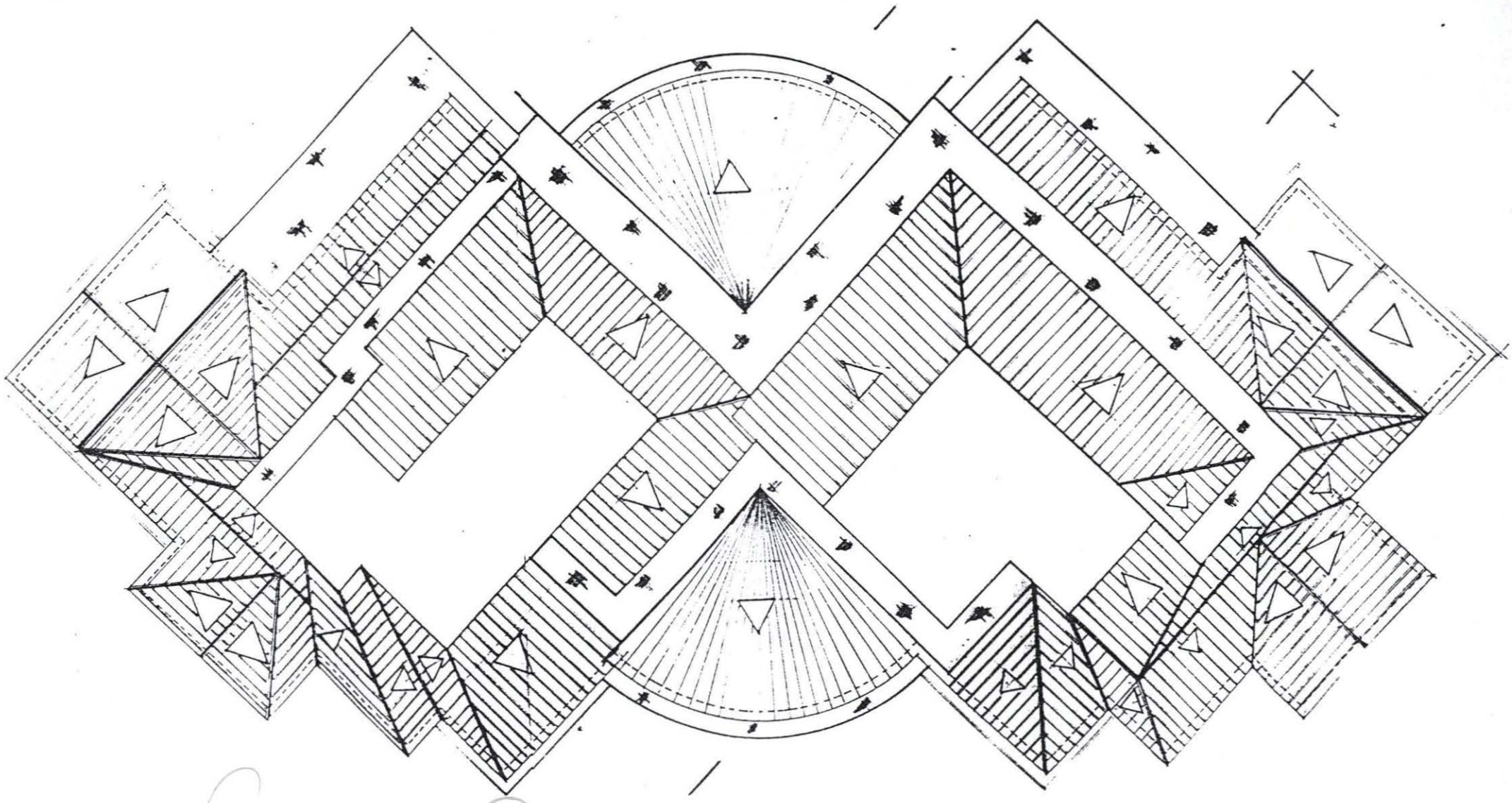
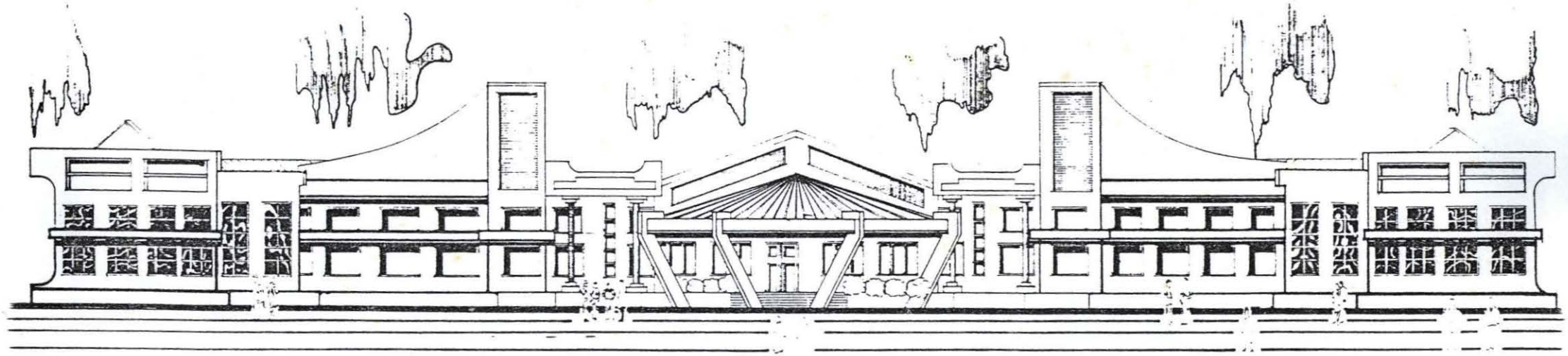
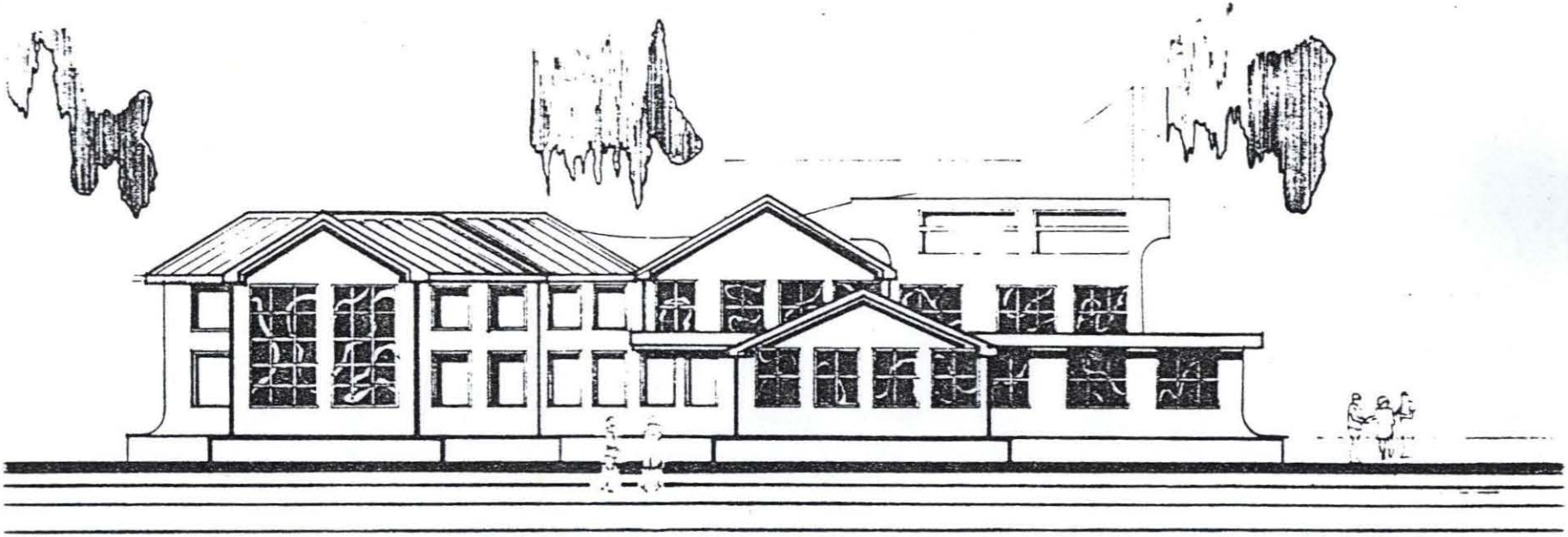
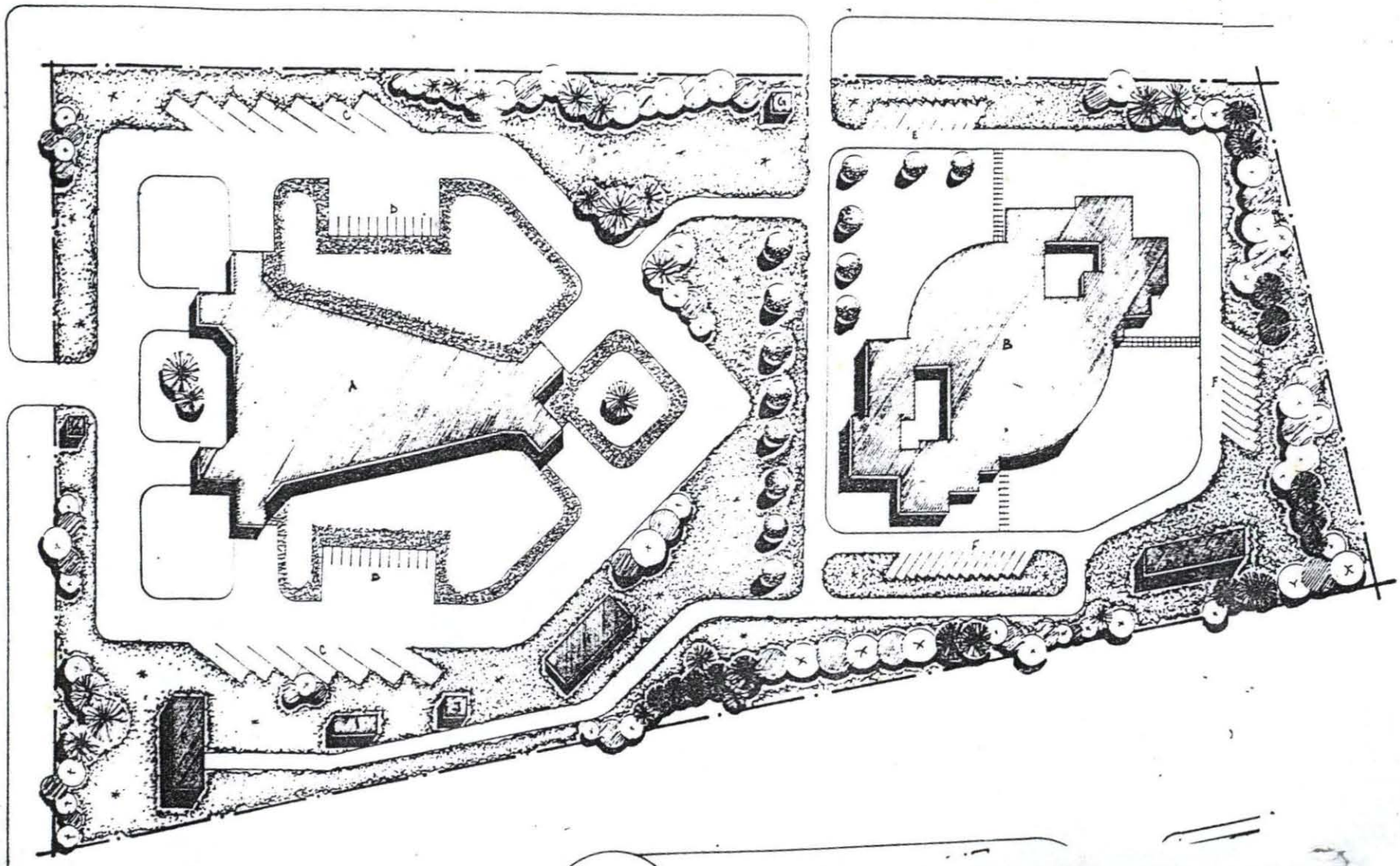


Figure 21



APPROACH ELEVATION




A
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