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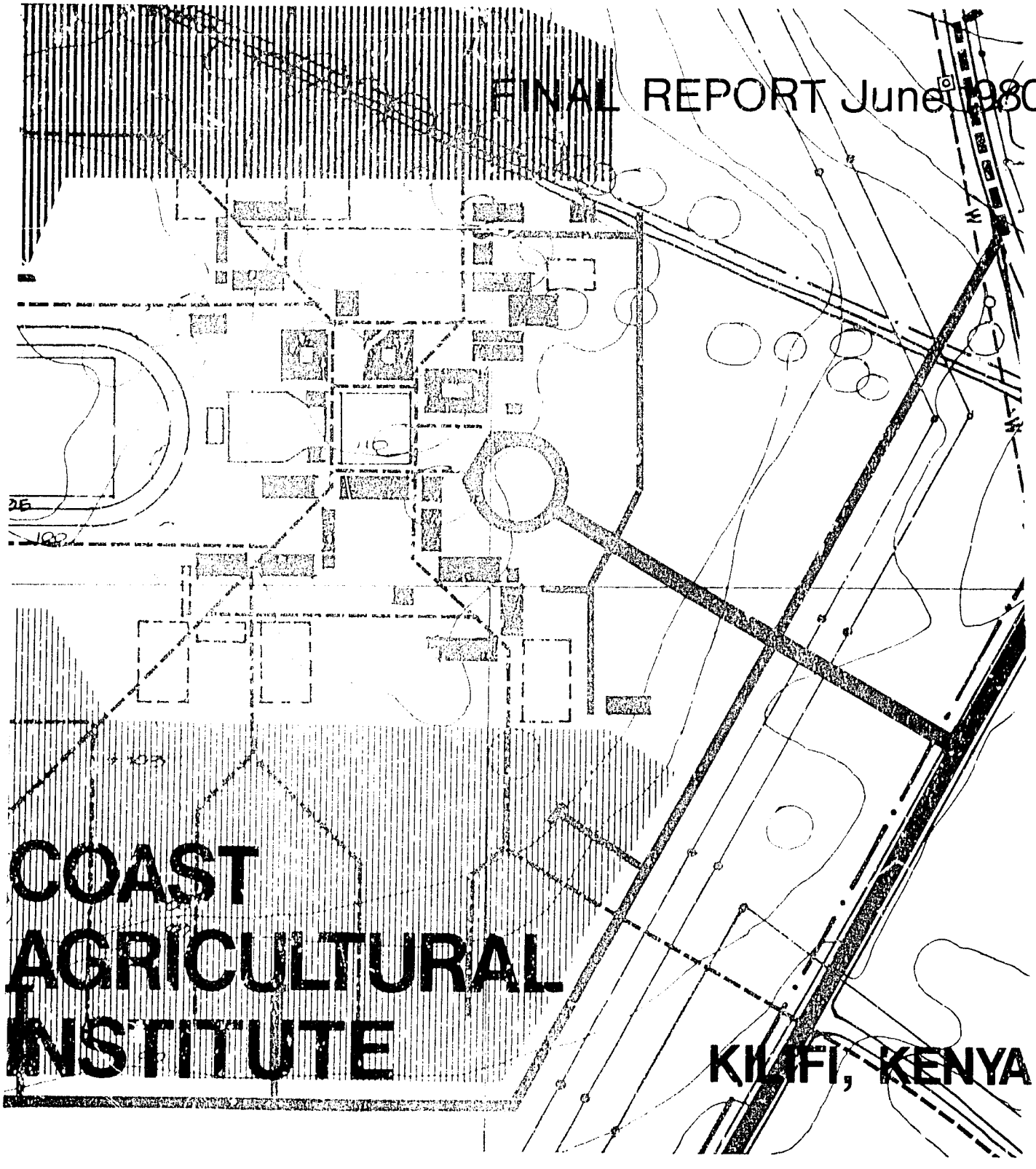
ACADEMIC AND TECHNICAL FEASIBILITY

FINAL REPORT June 1980



COAST AGRICULTURAL INSTITUTE

KILIFI, KENYA

PACIFIC CONSULTANTS
WASHINGTON, D.C.

COAST AGRICULTURAL INSTITUTE

KILIFI, KENYA

ACADEMIC AND TECHNICAL FEASIBILITY FINAL REPORT

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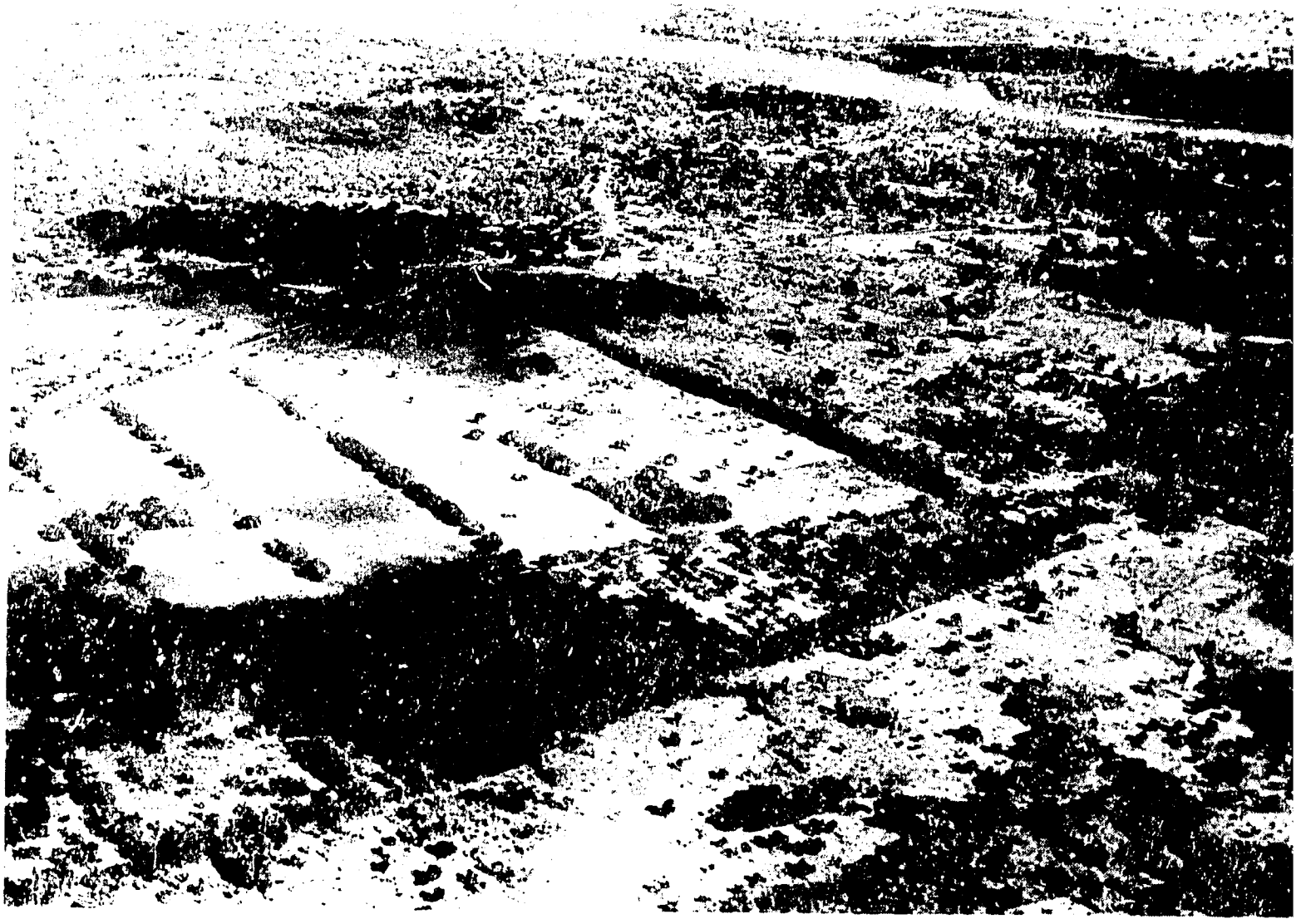
TABLE OF CONTENTS

		Page
PREFACE	Purpose of Educational and Technical Feasibility Studies, Methodology, Use of Documents	1
SUMMARY	Findings of Feasibility Studies, Recommendations	5
INTRODUCTION	Need and Rationale, Assumptions, Issues, Principles, and Objectives	17
EDUCATIONAL PLAN	Training Objectives, Curriculum, Courses, Students, Staff, Facility Requirements	29
CONTEXT	National, Regional, Coastal Sector, Kilifi District, Local Setting	41
SITE ANALYSIS	Overview, Description, Development Constraints, Development Potentials	61
CAMPUS PLAN	Alternative Concepts, Land Use, Proposed Campus Plan	75
BUILDING DESIGN	Space Requirements, Schedule of Accommodation, Organizational Parameters	85
OUTLINE SPECS	Alternatives Examined, Construction Techniques, Specifications Selected	117
EQUIPMENT	Selection, Procurement, Maintenance, Itemization	129
INFRASTRUCTURE	Road Network, Walkways, Sewage Treatment, Potable Water, Electric Power, Telephone System, Irrigation Potential	137
CODE ANALYSIS	Legal Constraints, Government Standards	155
PROCEDURES	Professional Services, Contract Documentation, Tender Procedure, Project Development Schedule	159
COST ANALYSIS	Basis, Cost Allowances, Foreign Exchange, Equipment and Furnishing Costs, Cost Analysis,	165
BIBLIOGRAPHY		177
APPENDICES	(Separate Document)	



AERIAL VIEW LOOKING SOUTHEAST WITH KIBARANI FARM IN FOREGROUND, KILIFI TOWN AND KILIFI CREEK IN BACKGROUND. MOMBASA MALINDI ROAD CROSSES IN UPPER THIRD OF PICTURE FROM RIGHT TO LEFT. SOKOKE ROAD THROUGH FARM CROSSES DIAGONALLY OUT OF LEFT-HAND MID-POINT OF PHOTOGRAPH.

PREFACE

PREFACE

Purpose of Study

In 1979, the Government of Kenya requested USAID assistance in conducting a feasibility study and preparation of recommendations for the development of an agricultural institute in the Coast Province. The request was aimed toward translating the need for a new two-year certificate level agricultural institute into appropriately detailed recommendations for courses and curriculum, staffing patterns, and the construction of a campus and building facilities. Also required was a development schedule and detailed project costs to determine capital loan needs for implementing the project.

To determine the academic and technical feasibility, including the probable costs of planning and constructing a new educational institution, implies a necessity to investigate a wide range of issues. In this case, an agricultural institute has been proposed for a limited site on the Kenya coast at Kilifi. The site has a number of handicaps, which together could cause one to conclude other alternative sites should be investigated before proceeding with detailed studies of this location. On the other hand there are a number of amenities associated with this site, as compared to others considered, which could outweight the disadvantages. Also, there is the possibility that the handicaps could be overcome. Thus, there is a necessity to investigate issues ranging from the esoteric level of cultural and political concerns down to very practical questions such as, is sufficient land availabile of the types that would provide the desired educational experiences for the students?

The Educational Planning Team devoted the period between January 1 to March 15 to development of a rationale for the establishment of the Coast Agricultural Institute in terms of national manpower requirements, academic nature of the institute, numbers of students and staff, and facility and equipment requirements. Space utilization studies were translated into a brief listing of room area needs.

The Technical Feasibility Team devoted the period February 25 to April 25 determining the appropriate physical envelope (buildings) for the spaces listed, deriving a feasible organization of building relationships on the site, describing the necessary roads and utility services necessary for the buildings to function,

and conducting an environmental assessment leading to an "Initial Environmental Examination Report." The team also prepared detailed estimates of the probable total costs of development, and outlined the procedures and schedule required to procure them. (See Team Responsibilities.)

The overall intention and purpose of this study project was to discover whether the proposed new institution could be built on the selected site in the environmental setting, with all necessary facilities, and for a reasonable cost; and whether the impact of this development would be significantly positive or negative.

Pacific Consultants of Washington, D.C., under contract #AID/afr-C-1614, were issued the following summarized scope of work for the Academic and Technical Feasibility Teams:

Academic Team (Educational Planning)

1. Review curricula at existing agricultural institutes in Kenya, review recommendations of the ATAC Report, Professional and Sub-professional Agricultural Manpower in Kenya, and prepare a proposed curriculum for the new Institute.
2. Evaluate and make recommendations concerning space utilization requirements for instructional and administrative facilities, student and staff housing. Prepare schedules of proposed space utilization acceptable to GOK and USAID.
3. Provide recommendations (lists) for all major built-in equipment, movable furniture and equipment.
4. Prepare proposals (schedules) for development of the Institute's staff, training programs for new staff, and number and qualifications of U.S. technical assistance teaching staff which may be required during the institution's development.
5. Prepare terms of reference.

Technical Feasibility Team

1. Evaluate and recommend an appropriate site in the Coast Province.
2. Evaluate and make recommendations concerning requirements for potable water, irrigation water, waste water treatment, electrical power and communications.
3. Prepare floor plans of proposed buildings (single line drawings).
4. Prepare site plan(s) showing the location of existing (if any) and proposed buildings, water supply system, electrical power supply, communications, waste water system, site grading, access and interior roads.
5. Provide locations for all major built-in equipment.
6. Provide an outline of specifications for construction, including equipment, defining particularly those standards of quality which will have a significant impact on the cost of construction.

7. Provide preliminary cost estimates for the construction of buildings (based on cost per unit area), site works, engineering and construction supervision, equipment, furniture, and maintenance, all to be disaggregated between local currency and foreign exchange costs. Appropriate inflation and contingency factors must also be included.
8. Provide a list and cost estimates for all proposed major construction materials which are not of local source and origin.
9. Prepare a construction schedule.
10. Prepare an environmental analysis of the proposed site development, in accordance with procedures applicable to AID and to the World Bank.

Methodology

The academic and technical feasibility studies were divided into a series of aspects, each a prerequisite to that which followed, as a set of stages in the investigation of the project feasibility:

1. Understanding the academic problem and outlining it in a draft "Educational Plan" was the first step. This involved visits to existing sister institutes at Bakura and Embu, discussions with administrators and teachers at those institutions. It involved review of existing courses and curricula and testing the appropriateness of the Bakura and Embu models in a coastal setting.
2. Collecting information from many agencies and individuals at national, provincial and district levels was accomplished through questionnaires and interviews. (See "Interviews" in Appendix.)
3. Mapping and recording the information in usable form followed assimilation and categorization.
4. Conducting an environmental and site analysis provided the basis for decisions in the planning process.
5. Preparing building floor plan functional diagrams followed the study of various alternatives.
6. Studying land use and campus plan alternatives culminated in synthesizing a recommended plan.
7. Investigating site infrastructure alternatives preceded recommending systems to compliment the selected campus plan.
8. Analyzing alternative building structural and materials systems, for relative performance and cost, provides data for an intelligent choice of optimums.
9. Preparing detailed and adjusted project cost estimates, based on the recommended proposals, provides a realistic basis for decisions in establishing the project budget and necessary funding.
10. Establishing procedures and a timetable, for project implementation, provides guidelines for what is feasible in the Kenyan context.
11. Compiling draft reports, "Educational Plan," and "Technical Feasibility Study Report," provided an opportunity for review, revision, and refinement before combining into this final report.
12. Presenting the studies orally to MINAG, USAID, and IBRD, facilitated a more efficient comprehension of the recommendations and their basis.

Use of Document

Rather than a narrative, which one must read from front to back, this document is intended to be used as a reference. The Summary should be read next to understand the conclusions and recommendations growing out of the study. The Introduction should follow to provide an understanding of the background for the recommendations. Context should be read next, to understand the setting for the proposed institution. Thereafter, reference can be made to any section as necessary, to obtain the detailed information desired. The Appendices are provided in a separate "Appendix" to this document. Reference data, detailed calculations for infrastructure systems, basis for space requirements, and other analytical information is provided for use in the following stages of the design and development of the Coast Agricultural Institute.

SUMMARY

Academic and technical feasibility studies have produced the conclusion that a proposed new Coast Institute for Agriculture is needed, is appropriate, and can be successfully developed, on the proposed site near Kilifi, which includes the government Kibarani Farm. When in full operation, as proposed, the Institute would have an enrollment of 640 students, including 480 men and 160 women. The curriculum would be nearly identical to those at the other Institutes of Agriculture that offer the same certificates (Embu Institute for Agriculture and Bukura Institute for Agriculture). Practical sessions would be oriented toward crop and animal production characteristic of the region. The Institute would offer two-year programs leading to the Certificate in General Agriculture and the Certificate in General Agriculture and Home Economics.

Type of Institute and Training

The Institute of Agriculture operate under the aegis of the Ministry of Agriculture of the Government of Kenya. Policy dictates that the Coast Institute would have national status, rather than being regional, recruiting students from across Kenya.

Training of graduates from these Institutes is directed toward making up a serious shortfall in manpower requirements for extension agents. The importance of agriculture to the economy of Kenya and the focus of inputs in accelerating the effectiveness of the small farmer has created a large demand for Extension Service Technical Assistants. Currently, there are far more applicants for seats in the existing Institutes than can be accommodated. The need for increasing the intake is clear. The Government decision is to do this both through expansion of the existing Institutes and the addition of a new one.

Size of Institute

Controversy is associated with the optimum size for the Coast Institute. The terms of reference for this study stipulated the 640 student size and the academic and technical feasibility investigation was based upon that number.

Some studies were conducted of the implications of a two-stage Project, with an initial accommodation for 320 students provided in the first phase. A suggestion for an Institute of 400 students came after the study was virtually complete. It was not possible to consider the implications of that size within the terms of reference of this study. This Report and data generated from the study would make it relatively easy to develop a revised program for a different size Institute.

Staff Requirements

An analysis of the academic needs for 640 students has resulted in recommendations for an instructional staff of 7 heads of department, 8 lecturers, 15 assistant lecturers, and 10 demonstrators. In addition, there would be 47 professional, administrative and other support staff. A total of 91 farm labourers and domestic staff will be required. The staff complement for the Institute and Farm will be 178.

Building Space Requirements

The space requirements for the Institute were evolved from the courses and curriculum using "educational worksheets." All necessary instructional spaces are provided to carry out the curriculums in an effective manner. It was determined that the program would require 12 classrooms, 4 basic science laboratories, 2 home economics laboratories, an extension lab, and 2 engineering workshops. Additional common facilities, such as administrative and staff offices, library, student common rooms, kitchen, dining halls, laundry, student halls of residence, staff housing, sports and farm facilities are also required.

Equipment Requirement

The equipment requirements for the Coast Agricultural Institute were obtained after detailed study of the Curriculums. The eventual work to be done by the graduates was also considered. Other considerations were climatic factors and maintenance and spare parts availability. The total cost of equipment was estimated at US$1,855,000.

Technical Assistance Requirements

In order to assist the GOK in the initial start-up period and until full operation is attained, a technical assistance component has been recommended. This will enable Kenya staff members to undertake participant training while the posts are filled by the technical assistance team. As the Institute reaches full operation and as the Kenyans return from participant training, the technical assistance team will be phased out.

The technical assistance component should consist of 23 person/years of long-term teaching staff, 30 person/months of short-term consultant services 67 person/years of U.S. participant training, 33 person/years of Kenya training, and $341,000 for commodities to support the technical assistance team.

An illustrative budget for the Institute at full operation was estimated at K£348,725 (Equivalent U.S. annual budget $918,000, 1980 prices).

Pre-Conditions

The feasibility of developing the Coast Institute as described, on the selected site at Kilifi, is dependent upon the following pre-conditions:

1. The 145 hectares of contiguous private land must be acquired as promised by the Ministry of Agriculture, to provide a total of approximately 250 hectares, including the Kibarani Farm.
2. The private land acquired must be the identical land described and demarcated in the drawings of this Report.
3. The Sokoke Road should be relocated along the north boundary of the Farm to eliminate conflict, dust and noise from the new Institute. This would also provide an improved traffic pattern for the Kilifi locality, and permit development of Campus Plan Alternative B if it is selected later.
4. The 3 hectare parcel of land directly south of the Secondary School, that was allocated to the school by MINAG, should be re-assigned to the Institute to permit the possible development of Alternative B, if designers so choose.
5. A direct connection to the new Sabaki water main service that runs through the site has been assumed. If the Institute were required to pay for a service from the main tank in Kilifi, the system would be feasible, but costs would be out of proportion in the project.
6. Reservations for connections and demand loads for an ultimate campus community of approximately 2,000 people should be confirmed, immediately, for water, power and telephone. The technical feasibility and costs of these loads being accommodated has been established through the study.

7. The impact and demand generated for goods and services from Kilifi Town merits further study.
8. The Ministry of Agriculture must commit additional operating funds for farm development for several years beyond the initial capital project, if the Farm is to reach its full potential. Land-shaping, forestry and landscape development, livestock and crop development take time. The initial project would not complete the development task.

Context

A survey of the national, regional, and local setting provided a data base for the studies. An "environmental examination" of the data and site observations provided guidelines for decision making. A formal report of the Examination using USAID guidelines is included in the Appendices.

The initial examination suggests minimal negative and substantive positive impacts as a result of the establishment of the Institute.

The proposed site is 50 Km north of Mombasa, next to Malindi Road, on the north side of Kilifi Creek, adjacent to Kilifi.

The town, though small, has District Offices and important community services available, with plans and space for growth. There are several major Settlement Schemes near the site, along with a number of large ranches and plantations along the Coast. The important Ministry of Agriculture Mtwapa Research Station is about 40 KM south. Thus, linkages with institutions and a variety of agricultural development activities nearby, suggests the choice of location may be a good one.

The development objectives and strategy for future development of Kilifi District has a primary agricultural base; and the establishment of the Institute in this location would match that strategy.

Seasonal monsoons affect the rainfall patterns, with most of the annual moisture of 1100 mm coming in April, May, and June. Long dry periods occur from September to February with the major deficit month being January. This pattern creates a difficult agricultural cropping schedule, without irrigation to ensure a crop during the dry period. With temperatures varying

from 22° to 30°, and periods of high humidity, there are long periods of uncomfrotable climate. These factors, combined with the land characteristics of topography, soils, vegetation and patterns of use were critical in the decision-making process.

Land Use

Only about half of the Kibarani Farm is currently being used productively for a few crops, a nursery, and livestock. The other half is underutilized bush, as is nearly all of the private land proposed for acquisition. Squatter farmers cut and burn the bush for one seasonal poor crop, but otherwise the land is idle.

A study of existing land use on the Kibarani Farm, an analysis of land use at Embu Agricultural Institute, a site soils analysis, and discussions with several agriculturalists led to a recommended land use plan for the Institute Farm. The plan proposes putting highly dessicated areas into forest and plantation crops to reclaim the land. Existing uses are retained to the extent possible and all of the idle land is assigned a purpose. The campus, including student and staff housing occupies approximately 22 hectares or nearly 10% of the total land area.

Campus Plan

Of alternative campus plans investigated, two were identified as most feasible and desirable:

Alternative A - "Near Kilifi South"
Alternative B - "Central Kibarani"

Alternative A was selected for developing and costing during the study, because it has several distinct advantages over Alternative B, and the costs are estimated to be at least Ksh.1,000,000 less than B.

The concept for the campus layout envisions a campus that is sensitive to the land and climate and observes a set of universal principles of order in organization, form, and character. It is designed for convenience and efficiency, as well as comfort and esthetic appeal. It is compact for short walking

distances and nice spatial definition, yet is open to allow for breezes and possible future infill development. Buildings are arranged outward from a central core in a hierarchy determined by frequency of use.

Buildings

The buildings are proposed as single storey, simple, one-room width and open, with wide overhangs to be as comfortable as possible. Climatic conditions were a major influence.

A series of alternative construction techniques were investigated, as well as variable combinations of materials to arrive at initial low cost, low maintenance facilities. A Schedule of Accommodation showing areas of individual spaces for all Institute Buildings, including student and staff housing, totals just over 20,500 m^2 (220,000 $ft.^2$). Scale floor plan diagrams of all buildings show general configuration and location of major items of equipment.

Infrastructure

The addition of a campus community of 1200 growing to 2,000 people next to a small place like Kilifi would have created major service problems were it not for fortuitous circumstances. Infrastructure development problems and costs for the proposed Project were mitigated by propinquity of new enlarged, ready to be commissioned sources of supply for potable water and electric power. Plentiful water for domestic use is available from the new Sabaki water main running directly through the site to serve Kilifi Town. Electric power is available from a newly completed power substation with a capacity of 15 Mva. located at the southeast corner of the proposed site. Telephone service is also available from lines on the site, out of the Kilifi exchange.

A comparison of problems and costs of sewerage disposal systems revealed that of two appropriate methods, community oxidation ponds were less costly, more maintenance free and provide a better opportunity for re-use of wastewater, when compared to septic tanks. Proposed use of maturation ponds can reduce the BOD level to an acceptable standard for restricted field irrigation through the dry season.

The road network is minimized by the compact campus plan and costs are kept low through use of existing field roads and limiting additional ones only to what is necessary to serve the various farm fields. The campus entry road, loop service road and parking areas should be surfaced, whereas field roads would simply be graded to a standard necessary for farm machinery to serve the fields.

The walkway system begins at the heart of the campus at a central plaza created out of concrete. Walkways radiate outward from the central plaza serving all buildings, and reaching finally to the edges of the farm. In the central areas they would be concrete, averaging 2 m in width.

Consumption level standards for power and water are much below European and American levels. Use of passive means of cooling and solar hot water heating, as well as generation of methane from livestock wastes is encouraged to conserve scarce and costly resources in Kenya.

U.S. Consulting Engineer's Independent Assessments

In response to comments from USAID Nairobi, regarding possible desirable alternatives, particularly for the proposed electric power system and potable water system, independent opinions were sought from reputable consulting engineers in the United States. Their comments are included here:

Paul R. Egbert, Professor Electrical Engineering
University of Illinois, Champaign, Illinois, USA

"Relative to the Electric Power portion of the proposed infrastructure for the Coast Agriculture Institute, the following comments are applicable to a Feasibility Report prepared by others:"

"In general, the plan is good and should supply adequate power with good reliability. Three distribution transformers would be cheaper to install than one central distribution transformer. One transformer installation would demand 26.5 times larger wire than installation of three 11KV/415V transformers as near to the load centers as possible. Two transformers as proposed would be cheaper than one for the same reasons."

"The 15MVA, 33KV/11KV substation can supply 15,000 Kva which obviously can supply the 100 Kva demanded by the levels. It is assumed there will be other demands on this substation."

"Using Underground cable for the 415 volt distribution is very desirable from a safety and reliability standpoint. The metering arrangement is satisfactory electrically and seems to be designed around local needs and codes."

"This plan, in my judgement, will prove very satisfactory if completed as proposed."

R. W. Russell, Russell Engineering Assoc.
Urbana, Illinois, USA

"The following observations stem from an independent review of the Infrastructure section of a draft 'Technical Feasibility Study Report' for the Coast Institute for Agriculture, Kilifi, Kenya."

"The proposed waste treatment system utilizing the stabilization ponds is the best method to use for this project, assuming that proper thought has been given to future expansion beyond the 2,000 college population. That is so that the site picked for the lagoons would have sufficient area available for any projected growth and/or consolidation of treatment facilities that may be needed."

"The Report mentioned the possible use of the effluent as a source of irrigation. The use of treated lagoon effluent is an excellent method of irrigation, but there is no indication as to where the effluent would be discharged if not used in this manner. It was clear that the quality of effluent would be such as to allow discharge into lakes and rivers, but no specific stream was mentioned. This determination should be clarified. Since the area chosen for the lagoons is a low-lying area, there should also be an evaluation of any flooding that may occur in that area."

"The routing of the gravity sewer line through an area which would require an excavation of 4.0 m to 6.0 m or more is not desirable. If this routing is necessary, then there must not be any PVC or other plastic pipe buried at those depths. If this were being constructed in the U.S., lift stations would be considered because of the difficulty of making such deep excavations. However, because of the added maintenance in Kenya, their use may not be feasible. Other alternative sites should be considered to eliminate the problem of such deep excavations if at all possible before proceeding with final design."

"Utilizing the proposed new water supply for the Kilifi area to supply the new campus is the correct approach. There should be no problems with making the connection into the bulk supply pipline as recommended, especially since the tap-in is to be properly supervised by the Ministry."

"The quantity of water to be provided, while based on the recommendations of the WHO Study Report #4, seems to be low. More thought should go into requirements for ancillary buildings before final design is made. The livestock watering system should be an entirely separate system, but it is not clear if this is to be done or how it will be accomplished."

"The proposed domestic system is to be supplied by an elevated storage tank with a 6.0 m head to provide 'a tap pressure of at least 8 psi.' It is assumed that 'tap pressure' is the same term used in the U.S. to denote the pressure at the most remote faucet or water outlet. If this is true, then it is difficult to see how an 8 psi pressure at the base of the tower will be 8 psi at the most remote tap. The average flow per minute with an average daily consumption of 80,000 gallons is 55 gpm. This flow in a 4" pipe has a pressure loss of 0.10 psi/100' and 3" pipe has a pressure loss of 0.50 psi/100'. A straight run of 8,000 ft. of 4" would reduce the pressure to near 0 psi or a combination of 2500' of 4" and 1388' of 3" would do the same. Thus, in order to have an acceptable pressure at each tap, the 6.0 m head alone would not provide it."

"Adding to this problem, an average usage of 80,000 gallons per day does not guarantee an average 55 gpm since there will be periods of high usage. Therefore, the supply piping must be sized and head provided for this peak demand. This does not seem to have been considered, but should be during the design process."

"There was no mention of the pressure which will be provided in the bulk supply pipeline where the campus connection is to be made. Indications are that it is a reasonably high pressure line. If the main pressure is 70 to 100 psi, which would seem likely, considering the difference in elevation, the proposal to lower the domestic line pressure to what is suggested would be poor economics. The storage tank should be elevated to a higher level to increase the domestic pressure."

"There is no mention of how the fire-fighting reserve quantity was determined. An average fire nozzle in the U.S. operating at 40 psi will provide a flow of 180 gpm. If two hoses are used to fight a fire, the flow would be 360 gpm. If the fire had to be fought for 4 hours, the usage would be approximately 86,400 gallons. The 50 m^3 or 13,150 gallon storage proposed would not supply two hoses for one hour."

"The fire-fighting standard in the U.S. as recommended by the American Insurance Association for a population of 2,000 is 1,500 gpm for a period of six (6) hours or a storage capacity of 600,000 gallons. While this standard is based on a very different building mix and is recommended for a country with an abundant water supply, it still serves to show the very limited water reserve proposed for this project."

"The hydrants with a separate hose box (fire box) could be changed to what are called "Hose Houses" in the U.S., which contain a fire hydrant with a fire hose attached to the hydrant coiled, ready for immediate use. These boxes would contain other fire-fighting equipment for easy access. Usually, the hydrants in these boxes have the valve wrench attached to the valve control for ready use. The hose houses should be so arranged that two 80 m (250 ft.) hoses could provide streams to any part of the buildings involved."

"The following summarizes recommendations for a potable water:"

"1. The quantity of domestic water supply should be checked further before proceeding to the final design phase."
"2. The domestic water supply pressure should be reevaluated to assure a good safe water supply, perhaps raising the main pressure to 30 to 35 psi."

"3. The peak water demand should be checked to assure adequate sizing of supply lines."

"4. The need for the 100-gallon residential tanks should be evaluated. With a properly designed system, perhaps the by-law requiring these could be waived. The solar heating system could be designed without them as well."

"5. The fire-fighting reserve should be reconsidered. It is recommended that a minimum of 300 m^3 should be provided for this purpose."

"6. The use of hydrants with separate hose boxes (fire boxes) should be compared to the use of a combination hose house with hydrants."

"7. The location of these hose houses should be determined, based on good fire-fighting requirements. A maximum hose length of 75 m (250 ft.) is one consideration."

"8. The suggested two-line system for domestic and fire lines should be more thoroughly investigated. If possible, the fire pumps should be eliminated. A single 6" loop system serving both the domestic and fire requirements would be better. A 20 m to 25 m (75'-80') elevated storage tank should be located on the highest elevation available. The tank capacity should be at least 900 m^3 or 240,000 gallons, 600 m^3 for domestic and 300 m^3 for fire-fighting reserve. Controls could provide for the use of the reserve only on an increased flow in the 150 mm (6") main during fire emergencies."

Project Capital Costs

Project costs are based on March 1980 tender prices, escalated to the estimated tender dates at approximately 16% per year. Costs are given in Kenyan shillings (KSh.), along with the U.S. Dollar equivalent at the current exchange rate of Ksh.7.60/US$1. Probable foreign exchange content has been included for each item, and various allowances have been made for preliminaries and contract contingencies (total 10%). Professional fees of 10% have also been included in the total costs.

Cost comparisons were made of the alternative construction methods and different materials. Building materials account for 60% of all building elements.

Comparison of total costs of Campus Plan "Alternative A" relative to "Alternative B" revealed a relatively minor difference of less than 1% of the total Project cost; primarily due to increased costs of service runs and an extended access road for Alternative B.

Reduction of the Project initial costs was examined by phasing enrollment beginning with 320 students instead of the 640. This reduction could be achieved primarily through reducing student housing by half, and proportionally reducing some classrooms and staff housing.

The long-range cost of phasing to reach the 640 student level would, of course, be higher. The cost of the first phase of a two-phase Project is estimated at Ksh.81,800,000 ($10,800,000) as contrasted with the cost of building the total Project in one phase for a cost of Ksh.116,000,000 ($15,300,000). Most common buildings could not be reduced in size, and most of the Infrastructure should be installed in the initial Project.

The initial saving of Ksh.34,000,000 ($4,500,000) in a reduced Project is not what it seems to be. Reducing the capacity of the Institute by 50% actually results in an increase in initial capital cost from $24,000/per student $34,000. If the Institute will need to grow in the next decade beyond the 320 size, the most efficient and economical way to do so is to build the 640 student size in one Project. Even that is small for an Institute of higher education. The chances are that the long-range costs will be greater than estimated, and it is certain that development in stages will be disruptive of campus activities in the process.

In a developing country such as Kenya, the long-range need for educational facilities will continue to outstrip their availability. Wisdom from experience would heavily influence a decision to build the 640 student Institute in one Project.

Cost Summary (Does not include land acquisition

- FULL DEVELOPMENT (640 student capacity by 1983)

		KSHS.	U.S. $ Equivalent
Alternative A			
Local Cost	Sh. 85,240,400		
Foreign Exchange Cost	Sh. 30,553,000		
Total Cost		115,793,400	15,236,000
Alternative B			
Local Cost	Sh. 86,300,000		
Foreign Exchange Cost	Sh. 30,500,000		
Total Cost		116,800,000	15,368,500

- PHASED TWO-PART DEVELOPMENT (320 by 1983, 640 by 1986)

Alternative A			
Local Cost	Sh. 94,425,600		
Foreign Exchange Cost	Sh. 30,639,000		
Total Cost		125,064,600	16,455,900
Phase One Total Cost		81,797,200	10,763,000
Phase Two Total Cost		43,267,400	5,693,000

- ANNUAL MAINTENANCE COSTS

At March 1980 Prices		1,674,800	220,400

INTRODUCTION

INTRODUCTION

Need and Rationale

The need for an additional two-year certificate level agricultural institute located near the coast has been established by the Ministry of Agriculture (MINAG) of the Government of Kenya. The concept is supported by USAID, as evidenced by the funding of the Coast Agricultural Institute Educational Plan and the Technical Feasibility Studies. Developing a "rationale" for the need, size, nature, timing of establishment, training of staff, operations and funding was the first step in the study leading to this Report.

The current population of Kenya (1980) is estimated at 15 million. The rate of population growth is estimated at 3.9 percent, indicating a population of some 31 million people by the beginning of the 21st Century. This population growth puts increasing pressure on the agricultural sector to produce enough food for the burgeoning population.

A very high rate of population growth results in a large population under 15 years of age compared to the population aged 15 years and over. This causes a need to divert more resources to consumption, leaving less available for savings and investment. At the same time, economic development has its own impact on fertility and mortality through the introduction of programmes to improve education and other health services. Furthermore, the improvement in the quality of education and other social services imposes an increasing burden on the relatively small economically active population.

Agriculture accounts for more than one-third of Kenya's Gross Domestic Product (GDP). From 1975 to 1977, Agriculture almost doubled its contribution to GDP at current prices. However, because coffee and tea are important to Kenya, a drop in world prices as in 1978 can greatly reduce agricultural income. Thus, improvement in agricultural output, either subsistence or commercal, is of vital importance.

The rural population of Kenya in the 1969 census was reported as 9,944,683 of the total of 10,942,705, or 91 percent of the total population. It is

estimated that the 1980 population is divided into 85 percent rural (12,750,000) and 15 percent urban (2,250,000). Of the rural population, there are some 10 million people living on approximately 1.7 million smallholdings. These 1.7 million smallholders are the major target group of the extension service of the Ministry of Agriculture. Most of the extension service employees have been or will be trained in the agricultural institutes.

The goal of the Fourth Development Plan (1979-83) is the alleviation of poverty. Five target groups are identified in the plan, three of which are of direct concern to the primary production sector. These three target groups are: small farmers, landless rural workers, and pastoralists. The plan traces the poverty of these groups, particularly the small farmers; to lack of access to land, water, markets, credit and modern technological innovations. Small farms must be made more productive; and arid and semi-arid lands must be developed for the use of small farmers, as well as for indigenous pastoralists.

Planners state that the resources of land and labour are under-utilized. During the fourth plan period, efforts are being made to increase land use intensification and to apply improved technologies to agriculture, particularly smallholder agriculture. Research and extension services are being oriented to alleviate the production constraints in smallholder farming systems. In order to meet the objective of poverty alleviation, a major effort is being made to incorporate those smallholders, with below average incomes and below average size holdings, as beneficiaries of development projects and programmes.

Improvement in the performance of the nation's 1.7 million farm holdings is the basis for achieving the targets of the fourth plan. The plan is directed to more productive private farming. Increased private initiative in agriculture, particularly by the smallholders who command the greater part of the nation's agricultural resources, depends on Government action in three major fields:

1. The setting of a framework of incentives and regulations in terms of prices, market regulations and rules, and legislation concerning land and labour policies, which mobilize and guide private farm level initiative.

2. The provision of agricultural services for agricultural production development which supply knowledge, inputs, credit and market services, etc.

3. The implementation of specific programmes and projects limited in time and area which concern major investments of capital and personnel.

During the plan period, agricultural extension and information services are being strengthened by the introduction of new programmes. The object of these programmes is to provide a significant change in the target group of rural farmers through the introduction of new techniques and through better use of available research findings. To date, most of the beneficiaries of these services have been progressive farmers and those who hold above average-sized holdings. This represents a small proportion of the farming community. The emphasis on poverty alleviation and the preparation of specific development programmes for farmers with below average-sized holdings requires major changes in organization, control and extension techniques. The effective use of research results, particularly for the small farmers, requires continuous contact between the extension agent and the farming community and vice versa. This can only be facilitated with the assistance of appropriately trained extension agents, primarily the basic level personnel graduating from the Agricultural Institutes. There are two major aspects to the solution of the personnel problem: (1) upgrading the training of currently existing extension service personnel, and (2) increasing the number of graduates from the Agricultural Institutes.

In 1976, the GOK requested USAID assistance in undertaking a manpower survey of the agricultural sector. In 1977 the American Technical Assistance Corporation (ATAC) fielded a team to conduct a manpower survey of the agricultural sector, to examine agricultural education and training facilities and programmes currently in operation, to review the utilization of agricultural manpower in the Ministry of Agriculture, and to make recommendations for alleviating identified problems. The ATAC manpower projections indicated the greatest need for additional manpower in the sector of agriculture was at the certificate level. The study also showed that the maximum output capacity of the three existing certificate level institutes was 375 per year (1978) as compared to a demand by conservative estimates for certificate level workers of some 6,390 by 1983 and 14,052 by 1988.

According to the ATAC report, the agriculture sector started with unfilled requests for certificate holders of nearly 3,500 in 1977. District Officers have indicated that current staff is inadequate (in numbers and in preparation) to serve existing clientele at present productivity levels. One indicator of this lack of personnel is that the extension service reaches only about one-half of the approximately 1.7 million smallholder households in Kenya. The certificate level employees (Technical Assistants - TA's) are the main contact point between the extension service and the smallholders.

The ATAC study indicated that possible increases in TA productivity through better deployment, training and supervision, might not express itself in numerical savings in staff, but rather by an increase in the number of smallholders who will be provided with better services.

A redirection of much of the national agricultural assistance programme to smallholders is underway. Appropriate ratios between the large number of client farmsteads and the size of the extension staff should be maintained. That ratio in 1977 was 129 rural households for each contact agent (TA or JTA). Furthermore, the Ministry is replacing JTAs (largely untrained junior Technical Assistants) with certificate holding TAs. The Ministry currently employs almost 7,000 JTAs, who are to be retired or retrained over the next twenty years.

As a part of its contribution to the development of Agricultural Education in Kenya, in 1978 the World Bank included agricultural education funds in the Fourth Education Loan. The funds provided for the expansion of the Bukura and Embu Institutes of Agriculture and a new Animal Health and Industry Training Institute. Facilities were provided to increase the annual output of certificate holders to 200 each at Bukura and Embu and 180 at the new AHITI. In addition, the existing AHITI at Kabete will produce 125 certificate holders each year. The Institutes would be expected to reach full production in 1987.

As previously indicated, the ATAC Report projected a need for 6,390 additional certificate holders by 1983, and 14,052 by 1988. With the increased output made possible by the World Bank financed expansion, there would be a shortfall of

6,500 by 1983 and almost 10,000 by 1988. The ATAC study recommended the establishment of four new certificate level institutes. However, it was decided to open only one at this time, to forestall the possibility of over-production of graduates in later years (see Table for output and need figures for 1977-1988).

OUTPUT OF AGRICULTURAL INSTITUTES OF KENYA - 1977-1978

Year	Embu	Bukura	Kabete Ahiti	New Ahiti	New Coast	Total(1)	Need(2)	Shortfall
1977	85	84	97			266		
1978	120	115	100			335		
1979	122	120	125			367		
1980	125	125	125			375		
1981	130	130	125			385		
1982	135	135	125			395		
1983	150	150	125	-	180	605	-	-
1983 (cum)	867	859	822	-	180	2,728	6,390	3,662
1984	160	170	125		180	635		
1985	180	185	125		320	810		
1986	200	200	125		320	845		
1987	200	200	125	180	320	1,025		
1988	200	200	125	180	320	1,025		
1988 (cum)	940	955	625	360	1,460	4,340	14,052	9,712

(1) Output figures from IBRD Fourth Education Sector Loan Report.

(2) Need figures from ATAC Report, Table 9.

Assumptions

In order to provide an understanding of the foundation for the studies leading to this Report, it is well to explain a series of assumptions that preceded the study, to point out a few issues that may or may not have answers, and to list a set of principles that guided the analysis of possible alternatives.

1. It was assumed that GOK MINAG and USAID accepted the proposed Educational Plan for the Institute as a correct basis for the Feasibility Study, including size and location.

2. It was assumed that MINAG appropriately represented the GOK in the planning process and that other agencies, such as the Minstry of Education were appropriately not included in the discussions during the study period.

3. It was assumed that being asked as specialists to come from outside Kenya implied that there is concern that planning a new institution deserves special attention. This suggests there is recognition of an opportunity to improve upon Bukura and Embu Institutes by looking at the problem in a fresh and creative way.

4. It was assumed, therefore, that GOK policy makers are committed to the implementation of the recommendations stemming from this study.

5. It was assumed that GOK commitment to a Coast Agricultural Institute ensures that adequate funds are available for the purchase of necessary additional land this year. Until clear title to the land is available, it would be unwise to invest in further architectural planning.

6. Though the objectives of the new institution would remain virtually the same as Bukura and Embu, it is assumed that location in a different agro-climatic zone of the country should influence important differences. Administrative methods, the curriculum, operational policies, and particularly the nature of land use and physical facilities would be different. The variations should be in response to a significantly different cultural context; a more severe climate; other soils, and thus other crops and agricultural practices.

7. It was assumed that the new institution should be designed initially to accommodate the 640 student capacity within three years after being opened. Also, in recognition of the fact that national institutions of higher education almost always grow beyond their initially planned size, it was assumed this study should allow expansion capability.

8. Because sister institutes at Embu and Bukura have less than 400 students each, it was assumed that further study could possibly suggest a smaller first stage for the Coast Institute, particularly since most students would actually be coming from Central and Western provinces, anyway. Therefore, the feasibility study also briefly addresses the implications and possible savings of beginning with a first stage of 320 students (though designed to reach the 640 student size in a subsequent stage). This would, of course, require a higher initial per student cost for facilities.

9. It was assumed that the Government of Kenya is prepared to provide the necessary operating budgets, which will be at a higher level, initially, in order to complete the land, livestock, forestation, landscaping and other longer range development of supporting elements for the Institute.

10. It was assumed that a feasibility study should investigate possible alternatives for each aspect of the project, and that the recommendations should mention more than one option if available and desirable for later consideration.

Issues

A number of major issues were identified and addressed during the study. Since not all of them could be resolved in a feasibility study, and might not be decided until the next phase of design, they are listed below:

1. Size of Institute - The ATAC report indicates the national need for additional manpower at the certificate level. However, no detailed rationale for establishing a new institution at the coast for 640 students was provided for this study. The USAID project paper simply states that the GOK was "interested in establishing a fourth institute, in Coast Province for approximately 660 students" (the GOK wants to increase both Bukura and Embu to the same level in the future). The question should be investigated, "Is the investment in a new Institute at the Coast likely to obtain significant benefits that would or could not be obtained through further expansion of the existing institutions?" Before initiating development planning, the issue of size should be determined more carefully by comparing the following alternatives:

   (a) Increase the size of either Embu or Bukura, or both, to take care of the manpower requirements.

   (b) Plan the Coast Institute to match the currently planned increased sizes of Bukura and Embu.

   (c) Proceed with the proposed 640 student Coastal Institute, but with a more detailed analysis of student origin, student transportation costs, and student adjustment to a perhaps less desirable climatic and different setting.

2. Location of the Institute - Again, no clear and definitive rationale was provided for a location on the Coast, though there are obvious geographic and political reasons for establishing the fourth certificate level institution in the Coastal Province.

   The question of whether there are better places in Coast Province for such an institution has not been answered adequately. Included in the Appendix is a statement from MINAC listing the alternative sites investigated by a committee, before the Technical Feasibility Team arrived in Kenya.

   Two sites were examined by both the Educational Planning Team and Technical Team. One is at Kwale, a 283 hectare parcel of land in the Shimba Hills and part of a forest reserve, a few miles inland south of Mombasa approximately 50 kilometers. The chosen site is at Kilifi, encompassing the 100 ha. Kibarani Farm (Ministry of Agriculture) on the coast 50 kilometers north of Mombasa. At the time of the first visit to the two sites, the team was informed that the Kwale site was in fact not available, since the Ministry of Natural Resources would not release it. No time was wasted in comparative site studies, since virtually only one option was provided to the Team.

However, for the record, the Kilifi site has several advantages over the Kwale site. Accessibility, site services, soil characteristics, and potential visibility are superior at Kilifi. Of most significance was reluctance to supplant a forest reserve at Kwale. This study, then, was restricted to determining the feasibility of one site at Kilifi. "Recommending an appropriate site in the Coast Province," as stipulated in the contract scope of work, was limited to one site whether most appropriate or not.

3. Land Requirements - No authoritative source provided a comprehensive program of land needs for the unique situation at the Coast. The Technical Feasibility Team devoted a major portion of their study to investigating this matter. The recommendations grow out of an exhaustive study of how the existing land has been used and is now being used, the apparent educational needs, possible future variations in the curriculum, soil characteristics, and topography and the experience and advice of a number of agriculturalists familiar with coastal agriculture. The nature of the land available contiguous to the Kibarani Farm, including developability and possible natural edges, also influenced the decision about land requirements and the proposed boundaries of the site.

4. Land Acquisition - At the time of writing this report, verbal assurances were given by the Ministry of Agriculture that procedures had been initiated for the acquisition of the recommended additional private land required for the Institute. Though requested, no written statement to that effect was provided.

   Initiation of procedures and the act of budgeting for the acquisition has been accepted as equivalent to a commitment that through laws of compulsory acquisition (eminent domain), the GOK would have the land when required.

   Since the favored plan concept recommended in this Report requires clear title to the private land to be acquired, there is the possibility of the project being delayed through protracted litigation or court procedures. This issue will need to be continually addressed to see that it does not at any point cause the project to become nonfeasible on this site.

   Proposed property boundaries were discussed with the Commissioner of Lands to obtain concurrence on the precise description, so that there would be no misunderstandings later on.

5. Institutional Differences - Desirable and appropriate differences between the existing sister institutions and the new Coast Agricultural Institute have not been adequately addressed; nor has adequate policy information been provided to assist in influencing the recommendations of this study. Therefore, considerable time and effort was expended to reach an understanding of the cultural and physical setting, so the recommendations of this study could indicate the differences.

6. Nature and Extent of Impacts - Determination of technical feasibility is very much related to the potential impact the establishment of an institution will have on a particular site, locality, and region. If the impact

has negative aspects, necessary mitigation steps and probable costs must be examined. An "Environmental Examination" using USAID guidelines and format was conducted and the report is included in the Appendix. Until the design of the institution is underway, it is difficult to accurately predict all social, economic and physical impacts. Though the initial examination suggests minimal negative and substantial positive impacts, it would be important to follow up with a verification of actual impacts at the design proposal stage.

7. Institutional Growth and Change - Because the history of institutions of higher education everywhere in the world shows that by nature they inevitably grow and change over time, it would be unwise not to test the feasibility of this occurring in the Coast Institute. Without a program of probable growth, or even a suggestion that this might occur, it was difficult to arrive at an appropriate basis for such an investigation. The suggested campus plan concept allows for growth and change, with a doubling of the institution possible with no difficulty. Staff housing would begin to replace farm land at some point in time. Being an agricultural institute with substantial land resources, this concern is somewhat mitigated.

8. Staff Housing consumes approximately a third of the institutional development costs; therefore, it is always worth investigating several alternatives. No housing policy or rationale for providing staff housing for the new Coastal Institute was available, other than a listing of numbers of various GOK categories matching the staff status and numbers. MINAG and USAID advised that the GOK MOW standards should be followed in planning and costing for staff housing. Though it would appear that there are no alternatives to investigate, this is one area where there is considerable potential for creative study that could substantially improve staff housing in various ways.

   For example, socially, there is surely a better way to provide housing for staff in an institution without segregation by class. Economically, there are ways to provide variety and flexibility for less cost if a design is not forced into fixed categories. Physically, a more homogeneous community with spontaneity and variety is more attractive than the segregated monotony resulting from following strict government practices.

   Embu provides an example of the kind of homogeneity and variety that is possible in staff housing, probably because it was developed over many years and no rigid controls affected the nature of the community. Though not a model of land use and organization, nevertheless it demonstrates a kind of desirable social single community feeling.

9. Location of Primary and Secondary Schools - The existing schools, located on land granted from the Kibarani Farm, occupy choice sites in the context of what was the original Farm. Recently, even additional land was granted to the schools as well as to the school for the deaf and children's home. The total granted was approximately 25 hectares (60 acres). One particular plot of land recently granted to the secondary school of 3

hectares (7.5 acres), starting about 50 meters south of the existing secondary school buildings, is critical to the development of one proposed concept of campus organization for the Coastal Institute. Because of its strategic location, even for the Institute farm development, it should be reclaimed by the Ministry. There is sufficient land remaining to support the secondary school potential expansion. Reclamation has been requested in a letter from MINAG to MINED, and is supported by everyone involved, including the Headmaster.

Land has been set aside for new primary and secondary schools across the Malindi Road east of the site as part of the proposed Kilifi development plan. The question was raised as to whether this would be a better location for the schools, rather than the existing farm sites. In discussion with the Headmasters, there is a strong preference to remain in the existing location. Reasons are that the constituency is much larger than just Kilifi town, the rural setting is preferable for a proper training environment, and now there is the potential of sharing of facilities of the Coastal Institute.

It is desirable that this whole issue be addressed in more depth in the next phase of planning, since the addition of the Institute community will create a substantial increased demand upon the primary and secondary schools.

10. Conservation and Re-use of Resources - there has been a deliberate effort during this study to minimize the demands caused by the establishment of the Institute upon power, water, telephone and other critical services. The possible re-cycling of waste-water for use in irrigation, use of solar energy for water heating, use of food wastes for livestock feed, and possible bio-gas generation have been tentatively examined.

    However, in a feasibility study it is not possible to cover the research and design necessary to establish the actual cost savings that could grow out of further investigation. The principle is established, but further investigation in subsequent stages of planning is essential.

Principles

There are a number of universal planning principles related to institutions of this type. Also, there are some obvious principles relative to the specific problem and site. The following is a list of those principles that influenced the conduct and recommendations of the study:

1. Sufficient land for long-term growth and change is a first prerequisite for any institute of higher education.

2. The nature of the land should be typical of the region to provide the kind of educational experience desired for the students in the coastal context.

3. The site should provide a wide variety of soils, varying topography, land use and capability for mounting a complete range of agricultural experience models, for the particular region.

4. The site should be easily accessible by road and should be well served with public utilities, sufficient for the relatively large campus population.

5. The site should be near an established urban center so that Institute staff and students would have community services available.

6. The site should have the potential for development of an "imageable" institution, visible and attractive from a major transportation route.

7. Walking students and staff should be the major factor in determining the organization of the campus. Roads would be provided for access and service, but not to disrupt the pedestrian walking system.

8. Land parcels should be designed as reserve for future buildings, respecting the system of growth established in a master plan.

9. Buildings should be related to each other in a hierarchical pattern, growing out of a study of frequency of use and convenience of location, with common facilities generally located at the center of the campus.

10. Individual building design should grow out of the specific needs of a given stage of development and the particular characteristics of the designated site.

11. The character and scale of buildings should be in harmony with each other.

12. Height of buildings should not exceed two storeys and in the coastal rural setting, single storey may be most appropriate, though comparison of comfort and cost should be made in the design process to determine which is actually better.

13. Buildings should have an open quality in the coastal environment, responding to the climatic context to provide comfortable shelter.

14. Long-range maintenance costs, as well as initial costs, should have an influence on the selection of building materials.

15. Buildings should be simple, frugal, indigenous in character, yet provide efficient and comfortable shelter for student and staff living and learning activities. This implies virtually no dependence upon mechanical means of comfort, but rather upon passive means of correct building orientation, natural ventilation and sun-shielding.

EDUCATIONAL PLAN

The Coast Agricultural Institute would be established to train students in agriculture and home economics to certificate level. Graduates of the institute would be granted either a Certificate in General Agriculture, or a Certificate in General Agriculture and Home Economics. A two-year program would be offered with a curriculum virtually identical to those at the Bukura and Embu Institutes of Agriculture. Since the Coast Institute is intended to be a national institution, rather than a regional one, national policy dictates that this pattern be followed.

This section describes the basis for the curriculum, course descriptions, the characteristics of the students and the recommended sizes for classes and practical sessions.

Training Objectives

In order to provide clarification of the role of the extension worker, a curriculum development workshop for Bukura Institute of Agriculture was held at the Institute of Adult Studies, University of Nairobi, in 1974. One of the outcomes of this workshop was a Job Description of a Technical Assistant. Since the largest majority of the graduates of the institutes find employment as Technical Assistants, the job description was employed as one of the major determinants in shaping the curriculum.

The objectives of the extension service, as they relate to the activities of a technical assistant, include the following:

1. Identification of agricultural needs and problems in the community and among individual farmers.
2. Advising on solutions to problems and needs, either through improvements in existing practices, or through the introduction of new ideas and practices.
3. Facilitating the decision-making process at the individual and community levels to accept recommended solutions to problems and needs.
4. Assisting with the implementation of accepted recommendations.
5. Evaluating results of extension service efforts.
6. Implementing government policy in agriculture as outlined at the national level (e.g., acreages for crops).

A checklist of knowledge and skills required by a technical assistant was also developed in the workshop. This checklist was based on the objectives of extension listed above. Key items in the list of 34 items included the following:

1. Sufficient technical knowledge of crops, livestock, farm management and home economics.
2. Be able to apply proper communication strategies and skills.
3. Be able to demonstrate technical and manual operations in agriculture.
4. Be familiar with the duties and responsibilities of other field workers, departments and local projects in order to facilitate co-ordination and support.
5. Be able to identify sources of agricultural inputs.
6. Be familiar with sources of agricultural information and know how to use them.
7. Be able to adapt agricultural information to fit local situations.
8. Be able to use available cheap agricultural materials in the area.
9. Be able to understand the problems and strategies of integrated rural development and the relationships between agricultural development and other aspects of rural development (for example, employment, population, nutrition and health). The curricula of the agricultural institutes were developed on the basis of the foregoing elements.

Curriculum

There are two existing certificate level institutes in Kenya, established to train technical assistants in agriculture and home economics. These institutes are located at Embu in Central Province and Bukura in Western Province. Both institutes have two-year programs, offering courses leading to a certificate in General Agriculture, as well as a certificate in General Agriculture and Home Economics. The Certificate in General Agriculture requires 1,240 lecture periods and 325 practical sessions (1,560 hours). The Certificate in General Agriculture and Home Economics requires 1,280 lecture periods and 415 practical sessions (1,790 hours). Each student also spends eight weeks of field attachment to the Ministry of Agriculture.

As national, rather than regional institutions, both Bakura and Embu receive applications and select students from all areas of Kenya. There appear to be three major reasons for this policy:

1. To equalize educational opportunity, insofar as possible,
2. To mix people of different cultural backgrounds, thus helping to achieve a national identity,
3. To bring together students from different agricultural regions, and with different agricultural backgrounds and experience.

The curriculum for the Coast Institute would be the same as that of the other two institutes, except that the practical sessions at CAI would, of necessity, be somewhat different from those at Bukura and Embu. The major differences would occur in crop production practical sessions because of differences in crops of the coastal region. For example, tea and wheat cannot be grown in the hot and bio-climatic zone. A system of exchanging students between institutes should be devised so that all students would be given an opportunity to become acquainted with the major crops produced in Kenya. Other than the practical sessions, the curriculum for Coast Institute would be virtually the same as those at Bukura and Embu, as prescribed by the Ministry of Agriculture.

In developing the requirements for staff and facilities at the Coast Institute, the following characteristics of the curriculum were considered:

1. Due to the general nature of the training, a large number of different subjects must be offered.
2. Most of the subjects studied require both a theory and a practical component.
3. Due to the limited time available and the large numbers of practical subjects to be studied, highly specialized laboratories and workshops are not indicated, instead, multipurpose practical facilities will be required in order to make more effective use of facilities.
4. In order to provide an optional educational experience where there is adequate student-lecturer interaction, the use of classrooms not exceeding 40 students is recommended. The nature of the program and the entry level skills of students discourages the use of large lecture classes and extensive independent study. However, for more efficient use of teaching staff, there is a place for some larger lecture spaces.

Courses

The following table summarizes the courses that would be offered by each department for each of the six terms. The course designation is expressed as an alpha-numeric code which indicates the department by a two-letter identifier, the term by the first number of a three-digit number code of which the last two numbers identify the particular course within the department. Practical or theory sessions may be further identified by the use of P or L. The course codes form an open-ended system which will allow for future courses to be added or deleted without affecting the overall system description. These codes in turn have been used to set forth a typical schedule for terms 1 and 4. A detailed sample of classes is contained in the Appendix, Section 1.

COURSE DESIGNATION		TERM					
No.	Course Name	1	2	3	4	5	6
AP 01	Animal Breeding	AP101	AP201				
AP 02	Pastures	AP102					
AP 03	Animal Nutrition			AP303			
AP 04	Animal Production		AP204		AP404	AP504	AP604
AP 05	Dairy Technology						AP605
AP 06	Animal Health					AP506	AP606
CP 01	Horticulture	CP101	CP201	CP301	CP401	CP501	CP601
CP 02	Prin. of Crop Prod.	CP102	CP202		CP402		
CP 03	Crop Protection			CP303			
CP 04	Crop Husbandry				CP404	CP504	CP604
CP 05	Student Plots	CP105	CP205				
EX 01	Ext. Educ. & Rural Development	EX101					
EX 02	Rural Sociology		EX202				
EX 03	Communication in Ext. Ed. (I)			EX303			
EX 04	Communication in Ext. Ed. (II)				EX404		
EX 05	Ext. Program Planning & Evaluation					EX505	
EX 06	Field Services						EX606
EX 07	Field Survey (Inter-session Field Project)			EX107	(I)		
FM 01	Economic Theory & Prod. Econ.	FM 101	FM201				
FM 02	Farm Records & Accounts			FM302			
FM 03	Farm Planning & Budgets				FM403		
FM 04	Farm Labour & Mechanization					FM504	
FM 05	Management of Farm Enterprises					FM505	
FM 06	Agric. Marketing & Cooperatives					FM606	FM606
BS 01	Botany	BS101	BS201	BS301			
BS 02	Chemistry	BS102	BS202				
BS 03	Soil Science	BS103	BS203	BS303			
BS 04	Zoology	BS104	BS204	BS304			

No.	Course Name	TERM 1	2	3	4	5	6
EN 01	Mechanics	EN101					
EN 02	Farm Workshop Practice	EN102					
EN 03	Electricity		EN203				
EN 04	Farm Power		EN204				
EN 05	Ox Cultivation			EN305			
EN 06	Farm Machinery (I)			EN306			
EN 07	Farm Machinery (II)				EN407		
EN 08	Surveying				EN408		
EN 09	Farm Structures					EN509	
EN 10	Soil & Water Conserv.					EN510	
EN 11	Irrigation & Drainage						EN611
EN 12	Rural Water Supply & Sewage Disposal						EN612
HE 01	Human Foods & Nutrition	HE101	HE201				
HE 02	Clothing & Textiles	HE102	HE202	HE302	HE402	HE502	HE602
HE 03	Home Management			HE303			
HE 04	Child Care				HE404	HE504	
HE 05	Home Econ. Exten.					HE505	HE605
HE 06	Health & Sanitation				HE406	HE506	
HE 07	Home Maintenance			HE307	HE407		
HE 08	Arts and Crafts						HE608
HE 09	Family Life Education				HE409	HE509	
HE 10	Home Management Practicals				HE410	HE510	HE610

An outreach program offered at both Bukura and Embu has been designed to enable students to have contacts with local farmers in the vicinity of the institute. In this way students can acquire first-hand experience of dealing with farmers while still in training. This program has been integrated with the total educational program in such a way that it does not appear as a specific course but rather becomes part of the existing practical sessions previously described. It is strongly recommended that a similar outreach program also be established at the Coast Institute.

Student Requirements

The Agricultural Institutes select students who apply from among form IV leavers with an East African Certificate of Education (EACE) and with a minimum of strong division 3 grade. Other minimum requirements include:

1. Should not be lower than 7 in both English language and mathematics and,
2. Should not be lower than credit 6 in Biology and Physical Science. A pass 7 in Biology combined with pass 7 in agriculture may be considered in lieu of a credit 6 in Biology. It should be noted that the minimum requirements for enrollment are usually exceeded. A credit 6 in General Science is acceptable in lieu of the other credits above.

These students are from all across Kenya, but the largest number are from Central, Nyanza, and Eastern Provinces. The Agricultural Institutes have many times more applicants each year than can be accepted. In 1977 there were 29,194 students who passed the EACE with a Division 3 or better grade. There was space for only 5,240 in form V, leaving some 24,000 qualified EACE holders competing for places in the technical, teacher training, agricultural institutes, and other schools requiring completion of form IV and, or the EACE for admission.

All applicants meeting the minimum requirements are invited for interviews. Interview centres for the agricultural institutes are located throughout the country, and include Nairobi, Kisumu, Mombasa, Kitale, Nakura, Embu, and Nyeri. The interviewing panel includes representatives from the Directorate of Personnel, Public Service Commission, Ministry of Agriculture, and the Institutes of Agriculture.

In 1979, Embu Institute of Agriculture had some 5,000 unscreened applications. After the applications were reviewed, 928 were invited for interview. About 700 of the invitees actually appeared for interview, of which 150 were invited to enroll for the 1979-80 school year. Less than 10 percent of those selected failed to appear for enrollment. They are replaced by alternates who had been selected in the interview process. Bukura Institute had similar experiences in numbers of applications, and number interviewed for selection.

It is obvious there is no shortage of qualified applicants for enrollment in the Institutes of Agriculture.

Staff Requirements

Teaching staff requirements were estimated by consideration of the prevailing class work loads in effect at Bukura and Embu Institutes. The number of class contact hours per week was 12 for department heads, 15 for senior lecturers, 18 for lecturers, and 24 for demonstrators. Using these values, and by completing educational worksheets (see Appendix), the total instructional staff required was estimated to be 40. For 640 students this provides a student-teacher ratio of approximately 16:1 which is in line with similar institutions.

Administrative, support, and service staff necessary to serve an institution and to run an associated farm enterprise also were estimated from experience at Bukuru and Embu. The following table summarizes the proposed Institute staff.

Teaching Staff	
Lecturers	8
Assistant Lecturers	15
Demonstrators	10
Others	7
	40
Administrative and Support Staff	
Principal	1
Heads of Department	7
Other Administrative	5
Secretarial and clerical	15
Technicians, drivers, watchmen, etc.	67
Farm staff	44
	138
TOTAL	178

Kenyan Institute staff will come from a variety of sources. Two major sources will be staffs at the existing institutes of agriculture and also experienced and well-qualified ministry staff who are intimately familiar with the problems of extension workers.

Facility Requirements

Typical facility utilization ratios were obtained from Embu and Bukura Institutes for use when calculating ratios for the Coast Agricultural Institute. In this way facilities at the Coast Institute would be roughly comparable to those at Embu and Bukura, after consideration was given to the differences in the overall size of the Institutions. The recommended class schedule consists of 7 periods per day, 5 days per week. Terms I and II have 11 weeks each, while Term II is 13 weeks.

"Schedule of Accommodation--Educational Worksheets" were prepared, setting forth the information necessary to calculate the number of instructional spaces required. The curriculum employed in the development of the facility estimates gave the number of lecture hours and practical sessions required for each course. The first and fourth terms were selected as a basis for determining what facilities would be required and a complete schedule of classes was prepared to validate the results arrived at on the educational worksheets. The worksheets are included in the Appendix, together with a detailed sample schedule of classes and facilities. In summary form, the instructional facilities required are as follows:

Unit	No.	Periods Available	Periods in Use	% Utilization
Classrooms	14	490	360	74
Science Labs	4	140	64	46
Home Economics	2	70	50	71
Engineering Workshops	2	70	48	69
Extension Room	1	35	16	46

It should be noted that the present schedule at the existing Institutes provides 55 minute periods for theory classes and 2-hour periods for practical sessions. The instructional program is planned around 20 courses for males in the first term of the first year, 21 courses for females in the first term of the first year, 14 courses for males in the first term of the second year, and 19 courses for femles in the first term of the second year. When this

number of theory and practical sessions was computed for the 640 students at the coastal institute, it was found that 454 class groups must be accommodated during the first trimester of the year (see Chart next page). Further complicating the scheduling problem is the need to schedule practical sessions concurrent with the presentation of the relevant theory. The complexity of the scheduling process thus prevents a higher degree of utilization of the laboratories, workshops and special extension room.

It should also be noted that the utilization figures given in this report represent only those periods formally scheduled. On a campus of 640 students, all of whom live on campus, there would be considerable utilization of otherwise vacant classrooms and laboratories for class-related activities.

Curriculum Revision Effects on Facilities

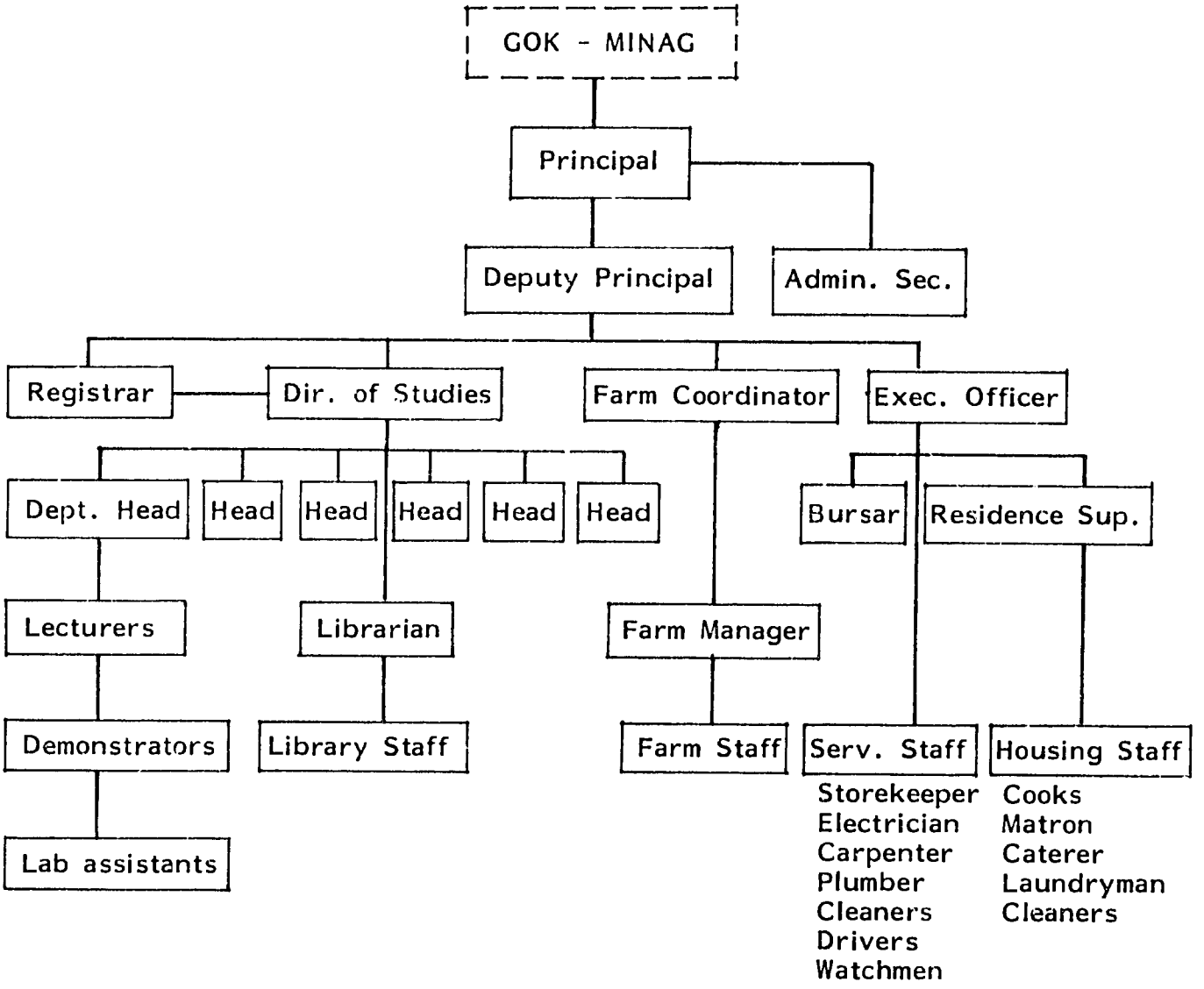
In reviewing the existing curriculums used at Embu and Bukura it became evident that efficiencies in the use of staff and facilities could be made by limiting the numbers of different courses through a rationalization of curriculum content. This would amount to re-packaging the courses in order to streamline the schedule. However, it was recognized that such a revision could not be made without the joint assistance and agreement of all three institutes and was not possible within the scope of this study. The basic issues that lead to the recommendation that this problem be studied arise out of the following:

Currently, students are required to study a large number of courses for a short period of time each term. It would be more effective to study fewer courses for more hours per week as this would enable the student to concentrate his study efforts.

Currently, difficulties are being experienced in scheduling theory and practical classes for best effect. The large number of different classes leads to problems of co-ordination. This could be overcome through fewer courses per term.

The lecture periods should be scheduled for 50 or 55 minutes, depending upon the required time between classes for transit. In this way, scheduling of theory and practical sessions would be facilitated as periods would be of equal length and practical class sessions could be stacked to give sufficient time for the activities planned. This move would require the lengthening of the school day by 85 minutes, i.e., classes would run from 8 a.m. to 5 p.m.

PROPOSED INSTITUTE ADMINISTRATIVE ORGANIZATION CHART



Other Considerations for Academic Facilities

In constructing the sample schedule of classes for the Coast Agricultural Institute it was observed that with 10 specialist committed instructional areas (Library, Science Labs, etc.) some difficulty was experienced in scheduling. Consideration was given to the possibility of assigning classrooms to specific departments or specific teachers. It was concluded that additional classrooms would need to be added to enable the scheduling to take place. The schedule of classes was also studied on the basis of grouping in sizes larger than 40 students, as suggested by the staff at Embu and Bukura. It was found that group sizes larger than 80 made it impossible to have the large group disperse to take lab work at the same time, or at a reasonable time following the lecture presentation (i.e., a group of 80 contains 4 lab classes of 20 that could be assigned, say to the two Chemistry labs and the two Biology labs). Also, the problem of devising a suitable schedule would become increasingly more difficult with more specialized spaces. If both large group and specialized spaces were adopted, it would necessitate a larger number of classrooms and practical areas to enable scheduling of all classes to take place.

The location of staff offices relates to a perception of the functions performed by each of the staff members. In the case of a department head it would be desirable to locate his office close to administration, to other members of his department, to print facilities and in a convenient place for student counselling.

The instructors (lecturers and assistant lecturers) will need to be located near students, near the library and within easy reach of instructors from other departments. Demonstrators will need to be located near the lecturers, the practical areas that they look after, and the students.

Common Facilities

The Bukura and Embu models were again used to understand educational and operational policies that require supportive facilities. Other than classrooms, laboratories, and workshops, certain "common" facilities are necessary to support the educational programs. Because of their common and frequent use by everyone, they should be mostly located centrally on campus. A detailed

"Schedule of Accommodation" is found in the section titled Building Design. The following is a listing of those facilities:

Library
Administration
Clinic
Laundry
Dining Halls
Kitchen
Servery

Print Room
Student Common Rooms
Sports Store and Changing
Central Stores
Estates
Outdoor Amphitheater
Sports field

Farm Facilities

The coastal setting would require some differences in the nature of farm facilities, though the categories would be virtually the same as those at Bukura and Embu. The following is a simple listing of those facilities required for educational purposes:

Animals	Covered Teaching Area Feed Store Milking Parlour Calf Shed Poultry House	Pig Sheds Goat Sheds Hay Storage Cattle and Sheep dips, spray race, crush, fencing and gates
Crops	Covered Field Teaching Area Demonstration Shed Greenhouse Screenhouse	Horticulture Store Horticulture Market Shop Silkworm House

Since government policies require students to live on campus, all students would be accommodated in student housing (dormitories or hostel units), with approximately 90 students per unit being a standard used at the existing institutions.

Since government policy is to provide subsidized housing for staff that need it, a major part of the development problem would be to provide such housing. Since higher categories of staff would need to be brought from elsewhere in Kenya, only the lowest categories of supporting staff would be resident locally and would not need housing on campus. (See "Schedule of Accommodation" in Building Design section.)

Requirements for service utility systems such as roads, water, power, telephone and sewage disposal are found in the "Infrastructure" section.

CONTEXT

National Setting

The Republic of Kenya is located in East Africa on the Equator, fronting on the Indian Ocean to the east. The country encompasses an area of approximately 528,000 Km^2, about the size of Texas, U.S.A. The geography is extremely diverse, ranging from snow-covered mountains to deserts and humid tropical lowlands along the coast.

The climate is as varied as the geography. In spite of the equatorial location the temperatures are generally mild and pleasant. Nairobi the capital is located in the Central Province in the highlands area at an elevation of 5,000 feet. It has a very agreeable climate with few extremes. Annual mean maximum temperatures are about 24°C.

With a population of 15,000,000 and a growth rate one of the highest in the world of about 3.5 percent, the demographic profile reveals a country of young people. Approximately 43 percent of the population is under age 15.

Nairobi and its environs represents the most densely populated portion of Kenya. The two other areas with heavy concentrations of population are Kisumu in Western Kenya near Lake Victoria and Uganda, and Mombasa, at the Coast. These three areas are linked by a main hard-surface road system and the railway. This route represents the major link through Kenya to the interior of Africa from the East.

Kenya is divided into seven provinces plus the Nairobi area. The Coast Agricultural Institute is proposed to be located in the Coast Province, at Kilifi. With the Bukura Agricultural Institute in the Western Province and the Embu Agricultural Institute in the Central Province, this provides a good geographical and political distribution. Egerton College, which offers a three-year agricultural studies program is located at Njoro near Nakuru in the Rift Valley Province. (See Diagram 1 for these locations.)

Because of the diversity in climate, geography, topography and the rainfall cycles, there is great variety in the agricultural productivity of the various

areas of the country. Generally speaking, this pattern is consistent with the ecological potential zones as developed in the Atlas of Kenya which in turn are generally synonymous with the climatic zones. (These are illustrated in Diagram 2.)

Regional Influences

The Coastal Province comprises the section of Kenya fronting on the Indian Ocean from Tanzania to the south to Somalia to the north. The boundary inland to the west varies but, averages 120 kilometers from the coast. The Province includes a portion of Tsavo National Park East.

Within the Province there are six districts including Mombasa, Kwale, Taita, Tana River, Lamu, and Kilifi. Within each district there are divisions, locations, sublocations, and townships which serve as the sequence of organization for governmental jurisdictions.

The Coast Agricultural Institute is proposed to be located in the Tezo-Roka location of the Central Division of Kilifi District. Kilifi Town, adjacent to the proposed Coast Agricultural Institute site, is the Kilifi District headquarters. (See Diagrams 3 and 5.)

Mombasa is the major urbanized area within the Province, linked directly to Nairobi by a major highway and rail line with daily freight and passenger service. It is the second largest city in Kenya with a population of about 280,000, located approximately 50 Km south of Kilifi. It is served by a major international airport with jet service to all parts of East Africa. The city is full of history, being one of the earliest settlements in coastal East Africa, and having served as the capital of British East Africa until 1904, when the capital was moved to Nairobi.

Mombasa is an island and possesses a natural harbour and deep water channel. It continues to serve as a major port for goods and commodities for Kenya and all of East Africa.

Urbanized areas other than Mombasa include Lamu, also an historic area in the extreme northeastern area, Malindi, approximately 75 Km north of Mombasa,

NATIONAL CONTEXT

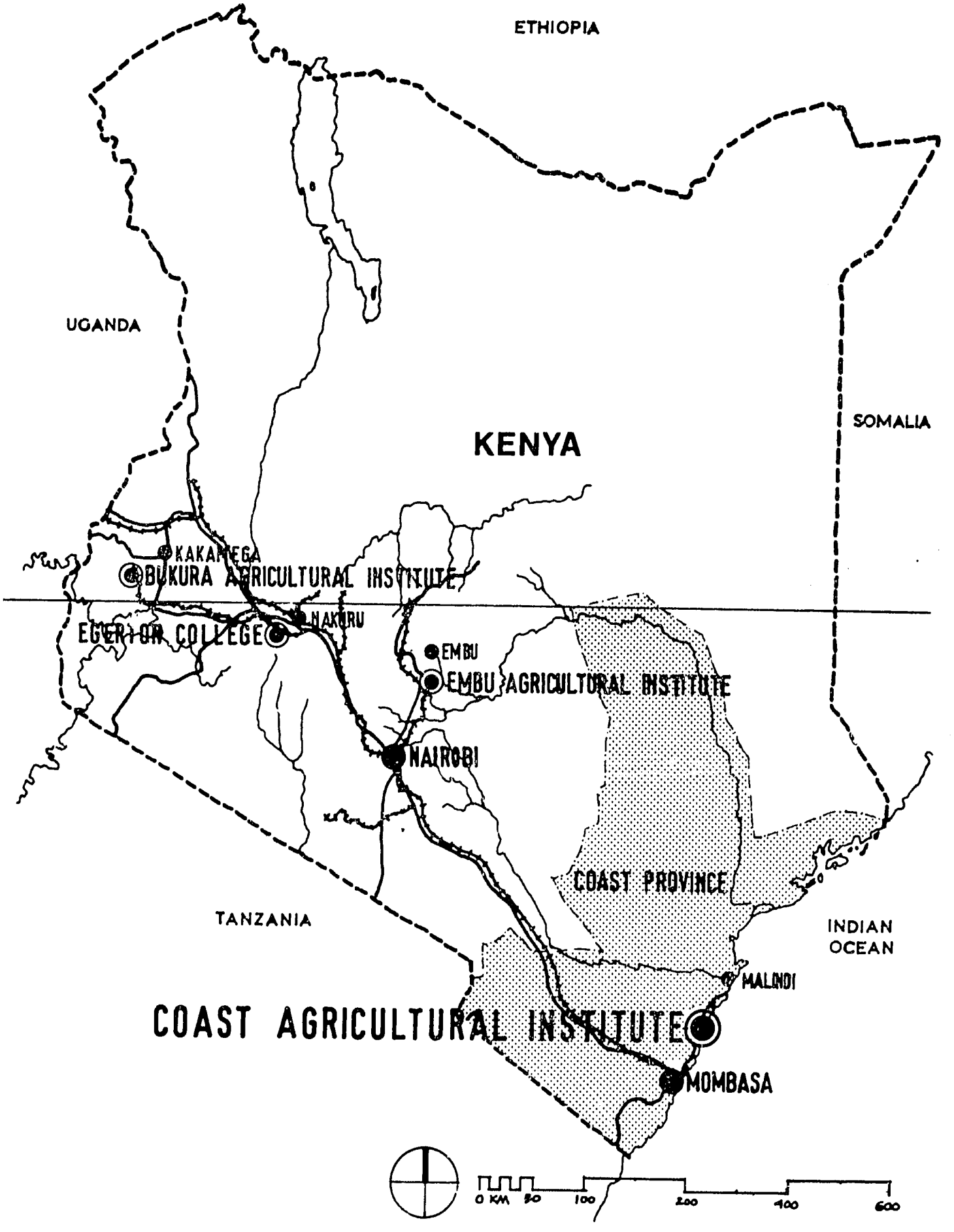


DIAGRAM 1

and Voi located 150 Km west. Voi and Malindi have been identified in the Coastal Province Physical Development Plan as centres for new infrastructure to support development of the province.

The coastal area of Kenya is known for its beautiful white beaches and sunny warm climate. It has developed into a major tourist area with many fine hotels, clubs, and beach resorts all along the coast.

Coastal Kenya is an area of generally low relief rising gradually from the Coast to the west. There are two major physio-graphic regions, the coast and the plateau foreland. (A more detailed division is shown on Diagram 4 with six distinct physiographic regions.) Drainage is generally to the east-southeast. There are four major river systems. Tana river is northernmost adjacent to Somalia. The Sabaki river intersects the coast at Malindi. The Goshi river flows out of the Voi, becomes the Rare, and connects at Kilifi creek. The Ramisi river is the fourth and is located south of Mombasa near the Tanzania border.

The weather within the Coastal Province is largely influenced by the tropical monsoon air currents of the Indian Ocean. From November to March there is a broad low pressure belt along the equator.

It is the southeasterly monsoon which brings the major rains to the area, in April, May, and June. A short rain period begins in November with intervening periods of very low rainfall. This secondary rainfall pattern varies dramatically, however, at various locations along the Coast. The overall rainfall pattern further inland is similar, but with a much lower total annual rainfall than immediately along the Coast.

The temperature is consistently high all year-round at the Coast with April the hottest period, averaging 31°C during the day, and August the coolest at 28°C. There is a very low diurnal temperature range of about 5°C. The relative humidity is consistent and high, averaging about 80 to 85 percent.

The capabilities of the land to support agriculture and wildlife is directly related to the climatic conditions, topography, and soils, with rainfall as the

NATIONAL CONTEXT

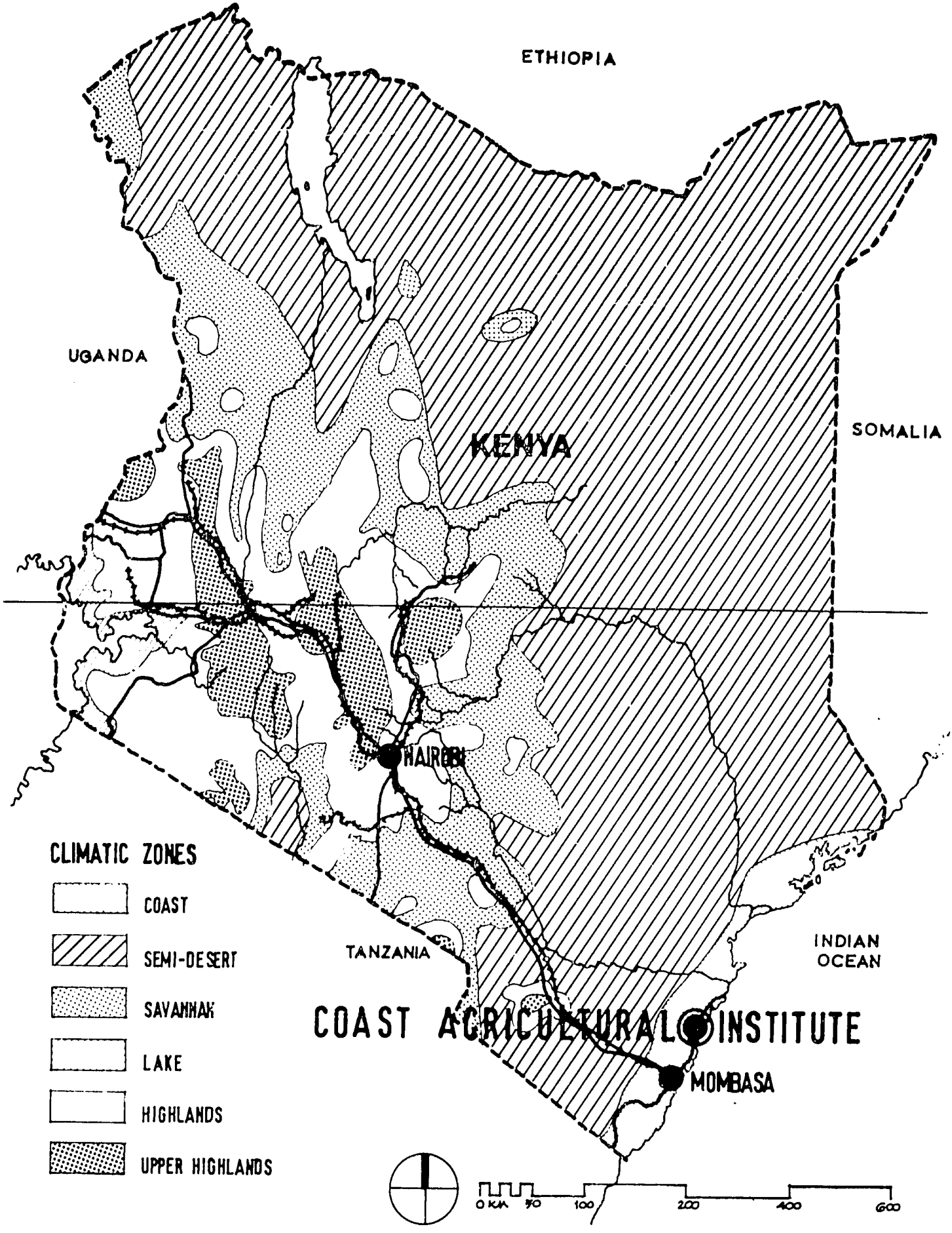


DIAGRAM 2

primary determinant. Generalized ecological potential zones based on rainfall, evaporation and vegetation patterns have been developed. The Kenya Soil Survey (Michieka et al., 1978) has further refined the process, using rainfall evaporation ratios to delimit bio-climatic zones, as illustrated in Diagram 3.

Most of southeastern Kenya lies in the low to very low potential zone. A small area from north of Mombasa south has a medium high to high potential for agriculture. There is a 40 Km wide strip all along the coast which is rated as medium-low. The proposed Institute site lies within this zone which would be most typical of the coastal sector.

A generalized map of vegetation types found along the coast is shown in Diagram 6 (Moomaw, 1960). Existing major forest areas are also shown in the same diagram.

Coastal Sector

The portion of the coast from Mombasa to just north of Kilifi Town is characterized by numerous small towns and villages. The Mombasa-Malindi road is the main vehicular route and the only paved road in the area. The major population concentration is along this road and adjacent to the coast (see Diagram 5 for the political jurisdictions).

Of particular importance to this feasibility study are the various agricultural operations and resources in the Coastal sector. There are several Farm Settlement Schemes, which are programs operated by the Department of Settlement under the auspices of the Ministry of Agriculture. Four of the schemes Vipingo, Mtwapa, Tezo and Ngerenyi are near Kilifi, involving approximately 3,000 settlers with farm sizes averaging 4.8 hectares. They have been located in underutilized farmland owned by the government. The program allocates small plots of 4 to 6 hectares to farmers for their use. The government supports them by providing credit for the purchase of fertilizer seed and other materials, as well as the development of the required infrastructure such as roads, water supply and marketing.

REGIONAL CONTEXT

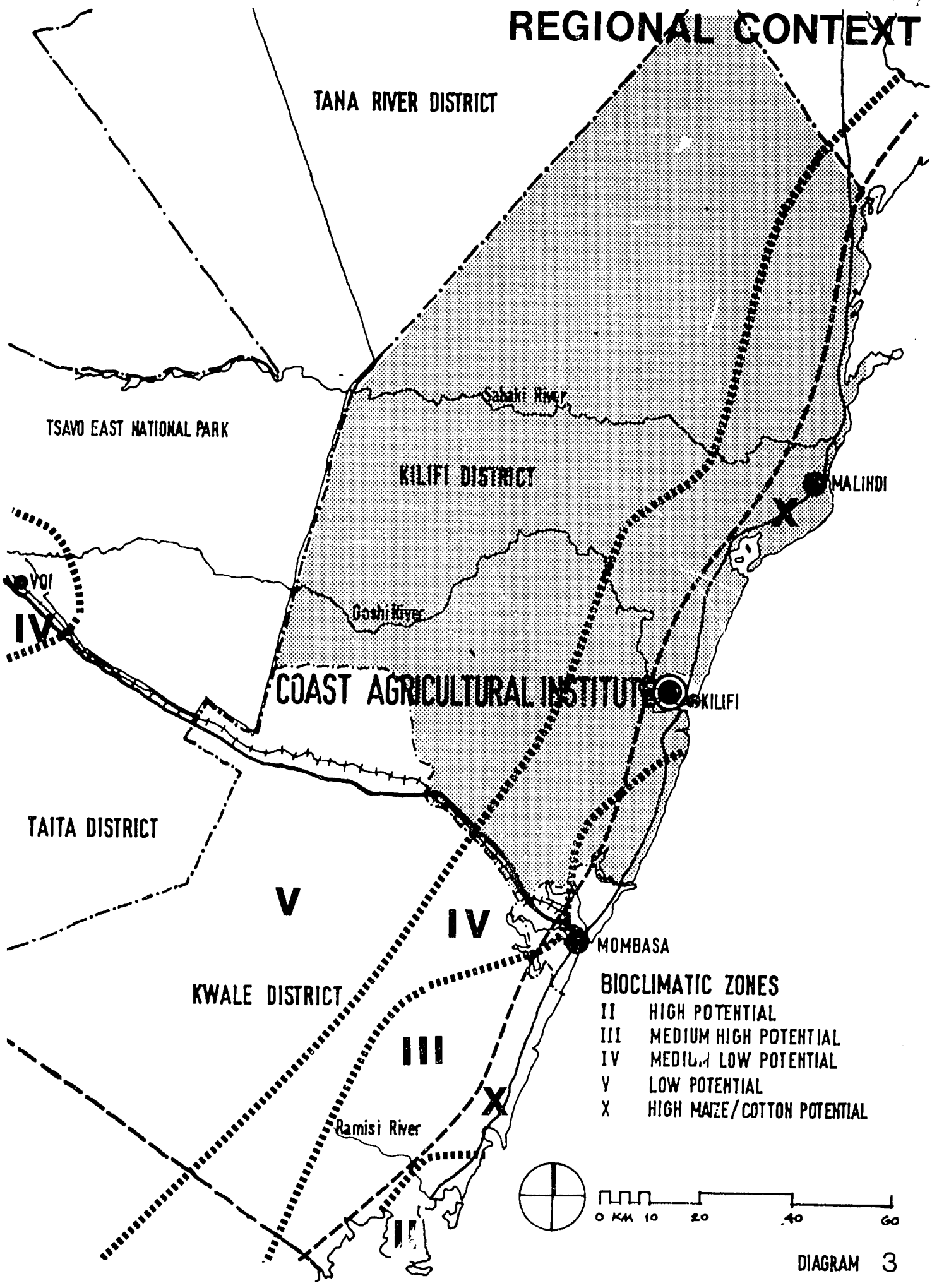


DIAGRAM 3

To date the agricultural output is well below the land potential. Major deterrents continue to be poor practices, such as late planting and poor land preparation, as well as lack of capital and slow infrastructure improvement.

In addition to the settlement schemes there are numerous private estates, ranches and plantations. Two of the largest near the project are Kilifi Plantation of approximately 2,000 hectares across Kilifi creek to the south, and the Vipingo estate, which is even larger, approximately 15 Km south. The Kilifi Plantation is primarily a dairy farm with some sisal, while the Vipingo estate is a larger and apparently well-managed sisal plantation.

The Ministry of Agriculture operates an agricultural research station at Mtwapa, immediately north of Mombasa. The emphasis there is on tropical crop development and livestock research. It is the most important agricultural research station on the coast, and would have the strongest linkage with the new Coastal Institute.

Baobab farm at Bamburi, adjacent to the cement factory, is located on land from which minerals have been excavated. An unusual and extensive reforestation and wildlife reclamation program has been achieved under the direction of Mr. Rene Haller. Within ten years the trees have achieved considerable commercial value. An impressive research and development program in fish farming is also being conducted, indicating the great potential for diversified agriculture at the coast even on poor land.

Kilifi District

The strategy for the future in the Kilifi District is to seek continued growth in agricultural production emphasizing the smallholder farmer. The land is an underutilized and relatively untapped production resource. In spite of the intensity of the climate and the extreme variations in rainfall and water availability, there is much evidence to suggest that the environment can be made quite productive.

REGIONAL CONTEXT

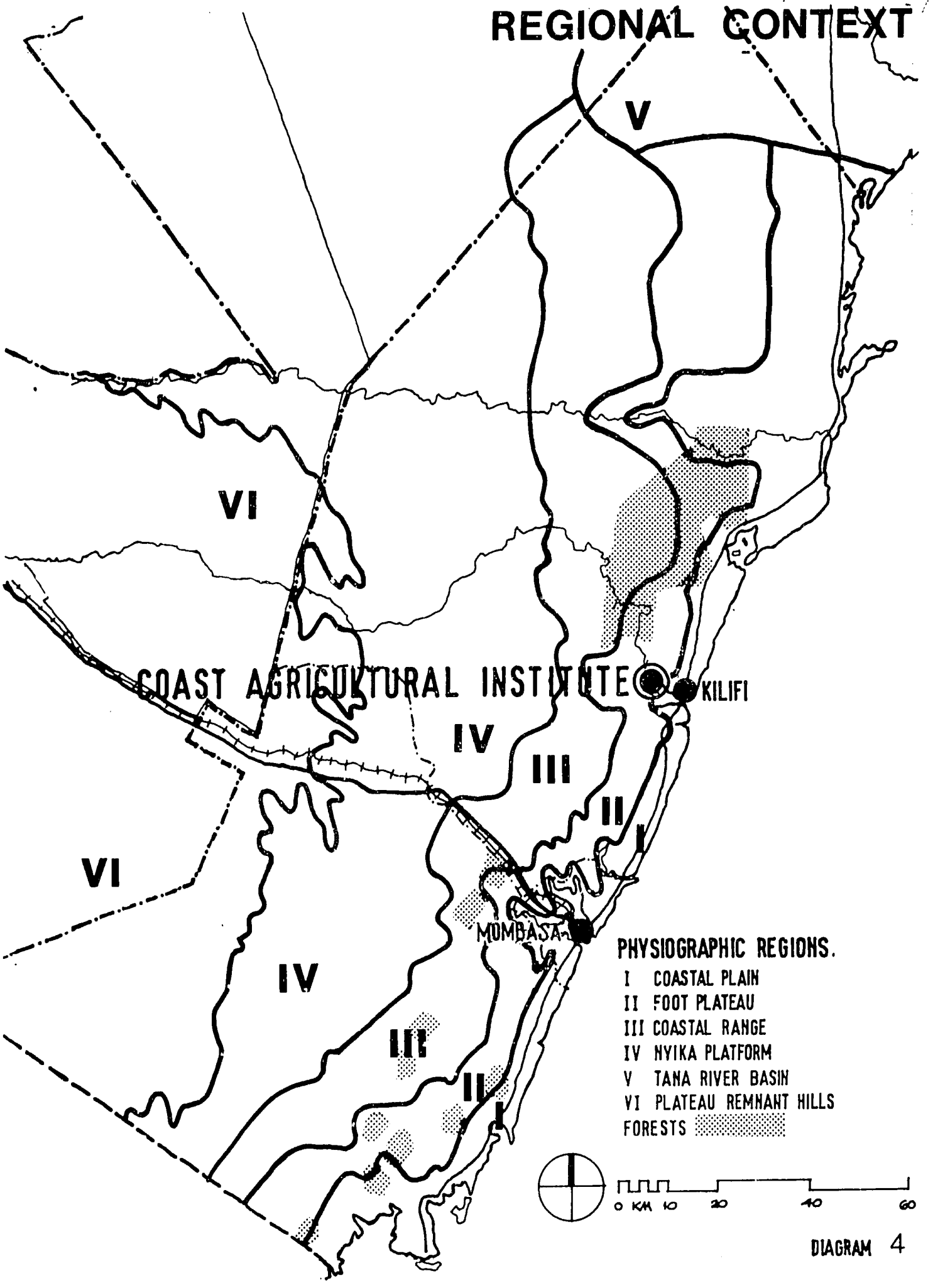


DIAGRAM 4

Progress has been slow and there is much to be done. The majority of the households in Kilifi District are at the subsistence level. Smallholders, pastoralists and people in related informal non-farm activities with an annual estimated income of 1,000 K.sh. make up 82 percent of the households. (Kilifi District Development Plan - 1980 - draft.)

Currently, crop production comprises over 80 percent of the smallholder farm output in Kilifi District. Cash crops include cashew nuts, coconut, cotton, simsim, citrus, sisal and mango. Food crops include maize, cassava, cow-peas and fodders. The majority of the tree crops are cashew and coconut (45%), while maize is the primary cultivated crop (double that of any other single crop grown).

A major objective of the Coastal Agricultural Development Program is to raise the level of incomes of farmers by increased product output. Better management of the land, improvement in farming practices, and introduction of new and higher yielding crop and livestock methods are basic to this goal.

New programs are underway emphasizing increased tree crop production, cotton production, cassava and pineapple. Improvement in livestock development is also being pursued through research on breeding, disease treatment and control and water supply (District Development Plan).

The government established programs of improved technology, infrastructure development, capital support, and delivery of extension services are vital elements for the immediate future. Perhaps the major obstacle is that of effecting change in the attitudes and outlook of the rural population; and that is why various efforts of continuing education through field extension services is of utmost importance.

Local Setting

The proposed site for the Coast Agricultural Institute is immediately adjacent to Kilifi town, and includes the Ministry of Agriculture Kibarani Farm of 100 hectares. Kilifi lies on the north bank of Kilifi Creek and fronts on the Indian Ocean to the east. Traffic to Kilifi from Mombasa must cross the Kilifi

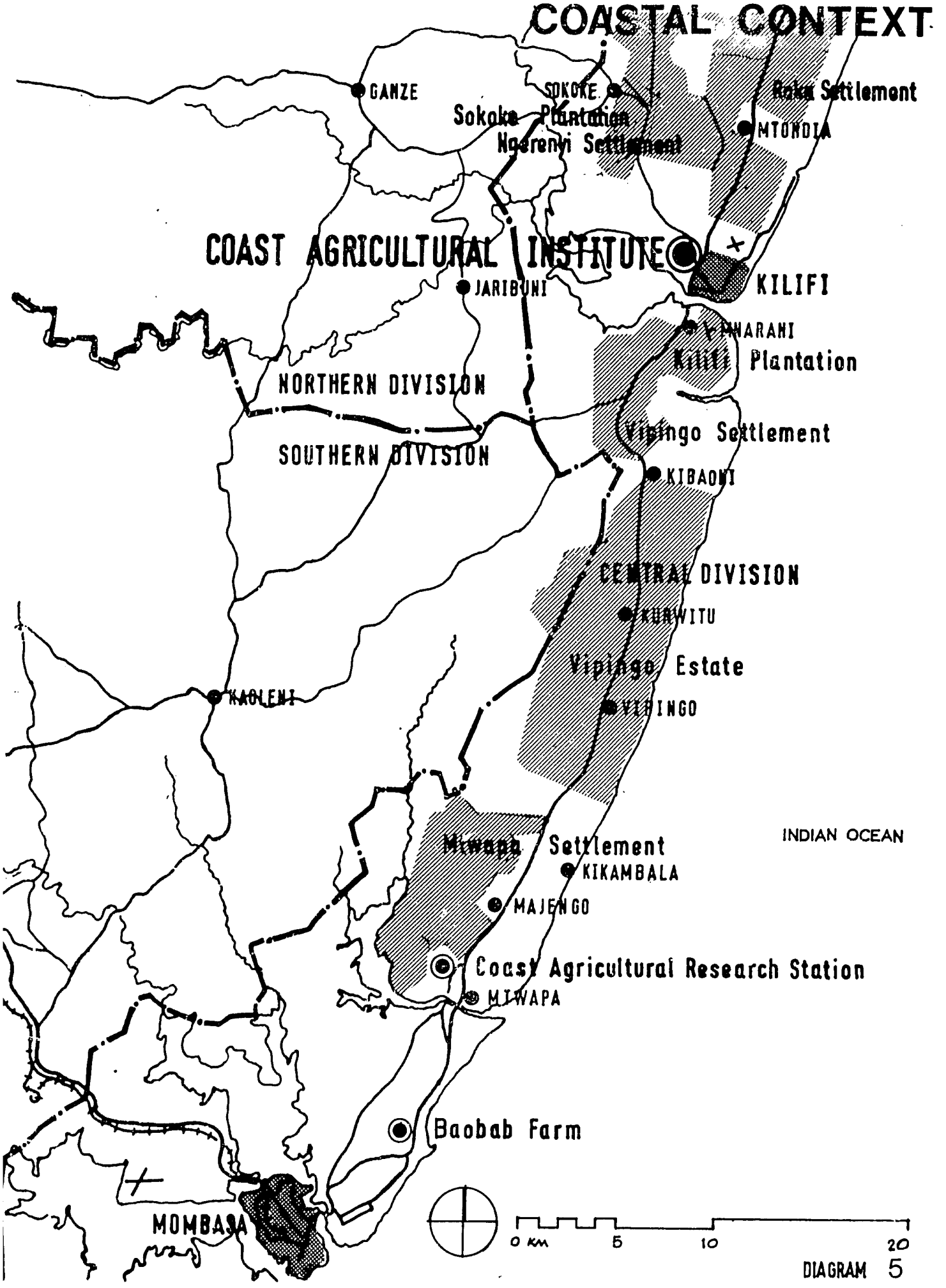

COASTAL CONTEXT
GANZE
SOKOKE
Sokoke Plantation
Ngerenyi Settlement
Roka Settlement
MTONDIA
COAST AGRICULTURAL INSTITUTE
JARIBUNI
KILIFI
MWARANI
Kilifi Plantation
NORTHERN DIVISION
SOUTHERN DIVISION
Vipingo Settlement
KIBAONI
CENTRAL DIVISION
KURWITU
Vipingo Estate
KAOLENI
VIPINGO
INDIAN OCEAN
Mwapa Settlement
KIKAMBALA
MAJENGO
Coast Agricultural Research Station
MTWAPA
Baobab Farm
MOMBASA
0 KM
5
10
20

DIAGRAM 5

creek by means of a ferry, which operates on a regular basis. A new bridge is planned to cross just east of the ferry landing to replace the ferry (see Diagram 7).

Kilifi town is a rural trade center with a population of 6,816. The area surrounding the town is generally rural with predominately smallholder farming except for the settlement farms to the north at Mtondia.

The area is known for white sand beaches and offshore coral reefs. As a result of these attractions Kilifi is developing into a resort area. There are presently two hotels, Mnarani and the Sea Horse. Future development plans provide locations for two additional hotels, while privately owned land along the ocean to the north could produce additional such developments.

Kilifi has a well-balanced economy at present and prospects for the future are bright. The average household income for residents of the area is slightly above average for the Central Division. This is due to the existing tourist activities, the District governmental offices and new industry, cashew nut processing. Kenya Cashewnuts Ltd., has a modern processing plant owned and operated by the government and located just north of the proposed Coast Agricultural Institute site. It operates at full capacity, processing 5 tons per day, and employs over 1,600 workers. The presence of the factory and its demand for new material is an incentive for farmers in the area to grow more cashew nuts.

Two dirt airstrips are located near Kilifi. One at Mnarani, south of the creek, is privately owned and in regular use, being part of the resort operation. The other, just north of Kilifi, is also privately owned and in active use.

There are 5 elementary schools in the immediate area, serving a combined population of 2,600 students. One elementary and one secondary school are located adjacent to and partially encompassed by the proposed Coast Agricultural Institute site.

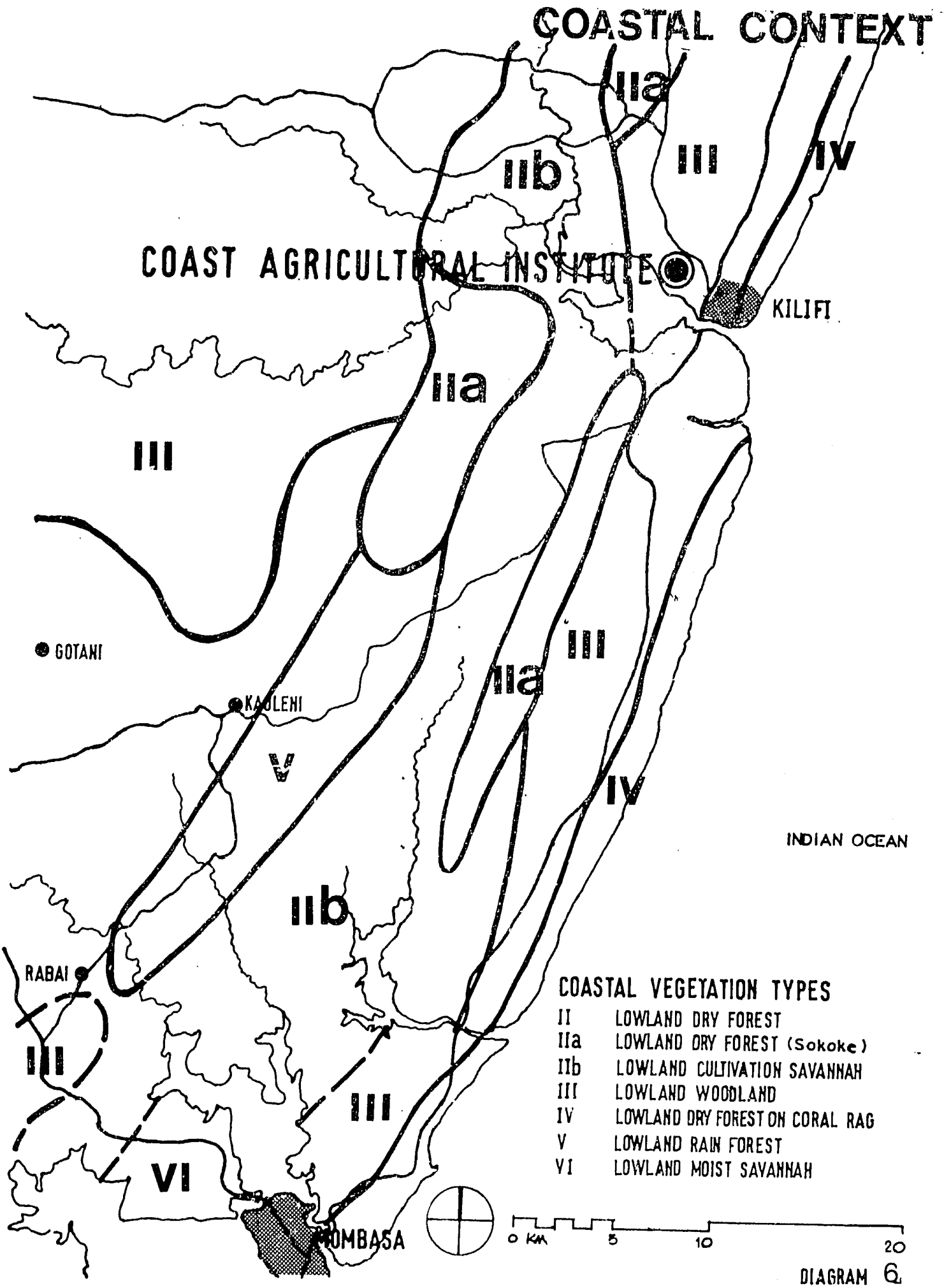

COASTAL CONTEXT
COAST AGRICULTURAL INSTITUTE
KILIFI
GOTANI
KAULENI
RABAI
MOMBASA
INDIAN OCEAN
IIa
IIb
III
IV
V
VI
COASTAL VEGETATION TYPES
II LOWLAND DRY FOREST
IIa LOWLAND DRY FOREST (Sokoke)
IIb LOWLAND CULTIVATION SAVANNAH
III LOWLAND WOODLAND
IV LOWLAND DRY FOREST ON CORAL RAG
V LOWLAND RAIN FOREST
VI LOWLAND MOIST SAVANNAH
0 KM 5 10 20

DIAGRAM 6

The secondary school currently has a student enrollment of approximately 240 students. After next year there will be 320 students. It functions as a boarding school, being the only government secondary school between Malindi and Mtwapa.

Two major utility systems have recently been constructed to serve the local area, both of which encroach on the proposed Coast Agricultural Institute site. A new 15 MVA electric power substation has been constructed at the southeast corner of the site. Two 33 KV overhead power lines run north and northwest from the substation, bisecting the Kibarani Farm. A new high pressure water main to Kilifi from the Sokoke river reservoir to the northwest has been installed. It runs parallel to the Sokoke Road running diagonally through the Farm. Other water supply sources near Kilifi consist of three hand-dug open wells, one at Mtondia, one in the centre of Kilifi, and one private well on the east edge of Kilifi. The water is saline, but potable. Several boreholes in the area are not being used because of the high saline content (see Appendix for water quality test data).

Until recently, detailed information on soils in the Kilifi area has not been available. However, in 1979 a Dutch Pedology Training Project was begun. The results of this training project were made available for this study by Dr. IR T. de Meester, leader of the soil survey project (see Diagram 8). A more complete discussion of the soils by Dr. de Meester is contained in the next section, Site Analysis, and in the Appendix to this report.

The soils found in the vicinity of the proposed Coast Agricultural Institute site are developed on the coastal sands (kilindini sands). They are well drained, generally very deep, sandy to sandy loamy soils. The subsoils are sandy clay loams or sandy clay.

Drainage characteristics vary from well drained to poorly drained in areas of seasonal flooding. The soils are of generally low fertility and have poor physical properties, being medium to coarse in structure, slightly hard to hard when dry, firm to friable when moist, slightly sticky and plastic when wet (Pedology Training Project, draft report February 1980).

LOCAL CONTEXT

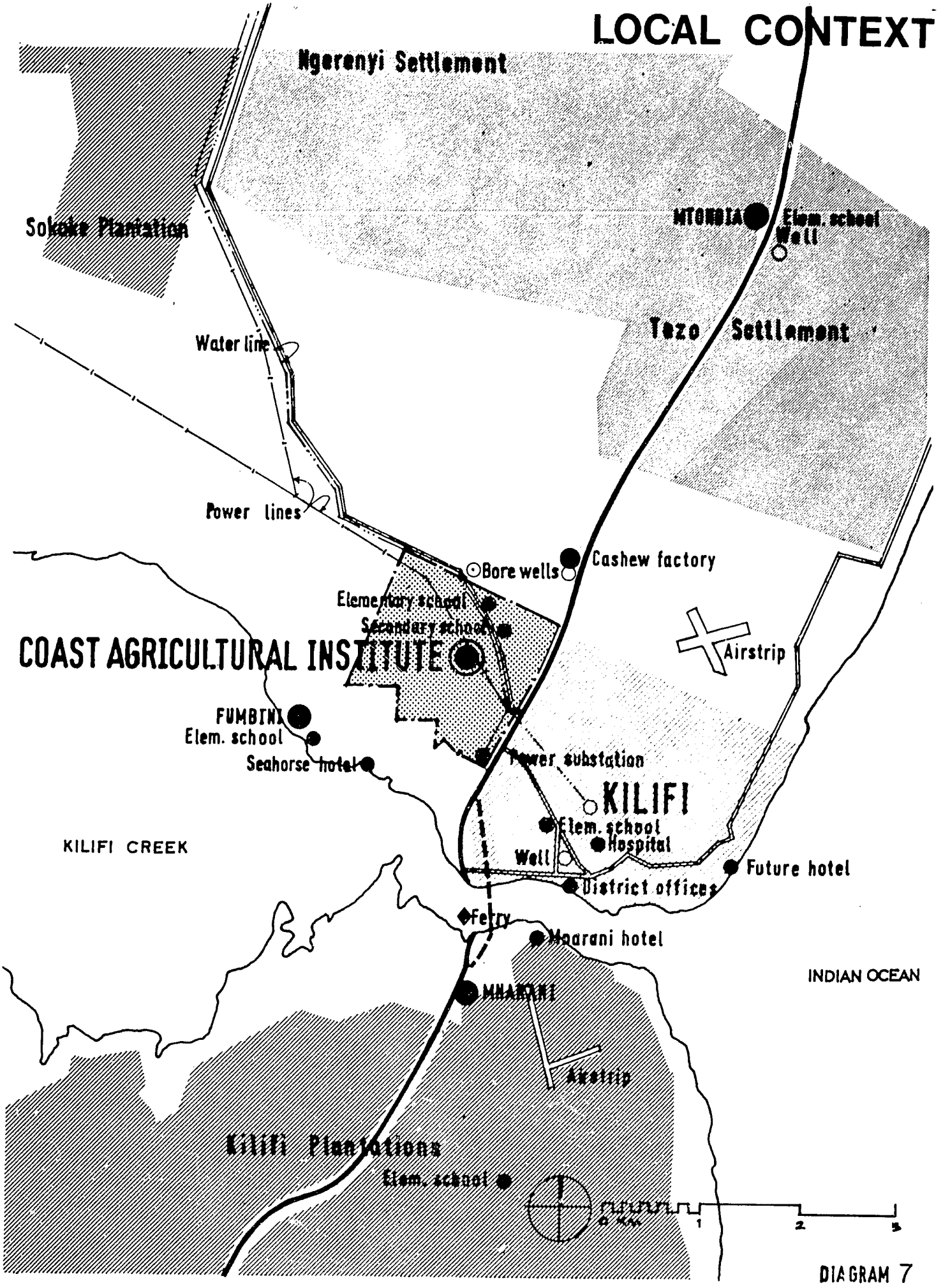


DIAGRAM 7

The bio-climatic zone categorization, as developed by the Kenya Soil Survey for the Kilifi area, indicates that the proposed Coast Agricultural Institute site would be in zone IV, with an r/E. ratio of 40 to 50, placing it in the medium-low potential category for arid farming (r/E. is the ratio of rainfall to rate of evaporation which is used as a measure of the agricultural productivity. See Diagram 3). The vegetation zone within which Kilifi and the project site would lie is the farmland dry forest, although only a few remnants of the indigenous vegetation currently exist (see Diagram 6). Some of the important species of this vegetation type (AFZELIA CUANZENSIS, BRACHYLAENA HUTCHENSII, TRACHYLOBIUM VERRUCOSUM) are hardwoods suitable for use in furniture, floor blocks, firewood, doors, frames, etc. Cultivated vegetation species such as cashew, banana, sisal, mango, and coconut are commonly found as well.

The context within which the proposed Coast Agricultural Institute must fit is one of great opportunity counter-balanced by an even greater need to overcome the poverty which exists and which will surely grow given the present population growth rates. The mix of need, potential and accomplishments to date would appear to affirm the appropriateness and timeliness of the proposed project within the Coastal Province. The proposed site at Kilifi is representative of the most typical agricultural land along the coast. The existence of a relatively well-developed infrastructure of facilities and services in the area, plus a wealth of government and private agricultural operations, should serve well as supportive resources once the Institute program is underway.

LOCAL CONTEXT

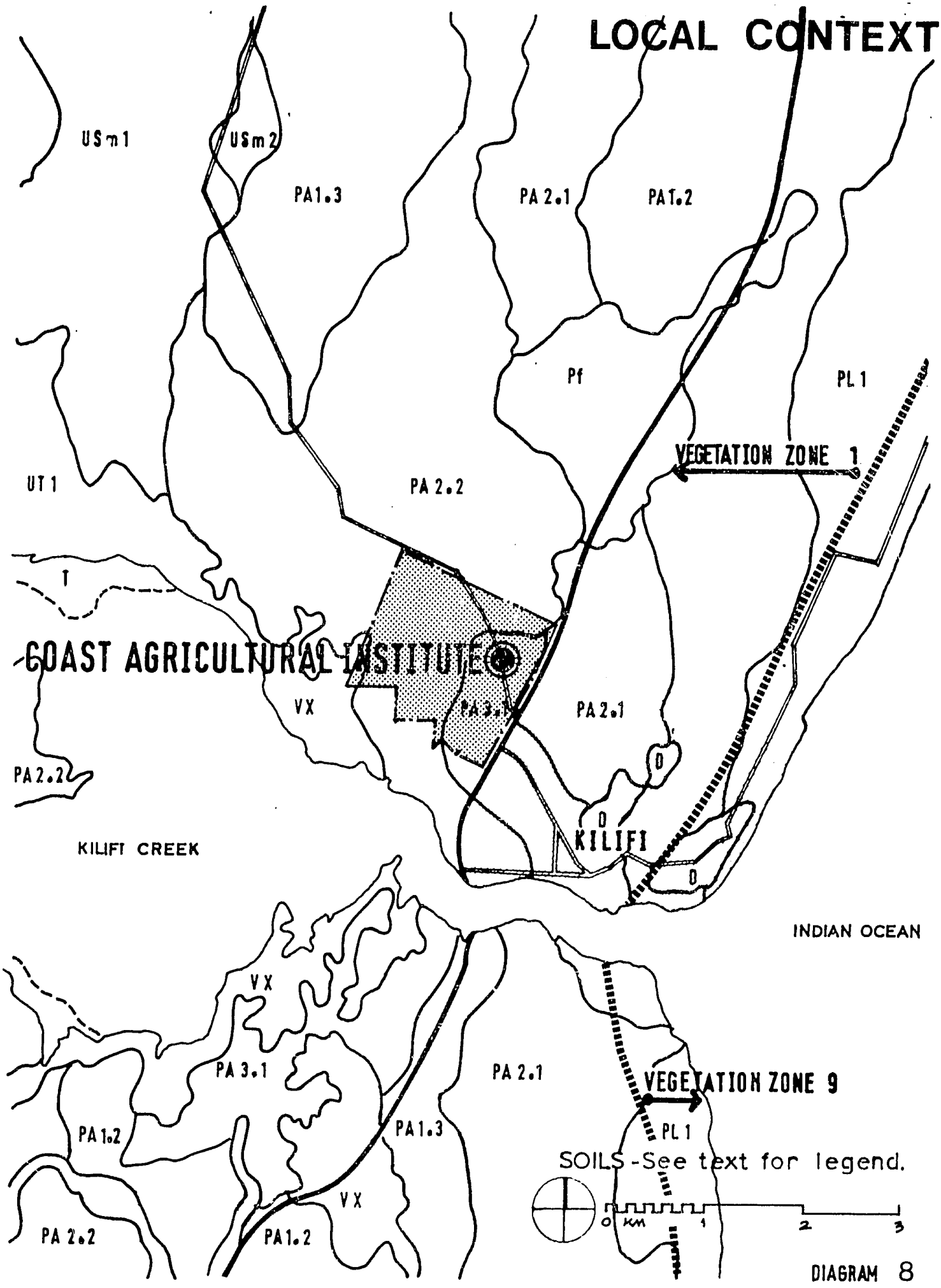
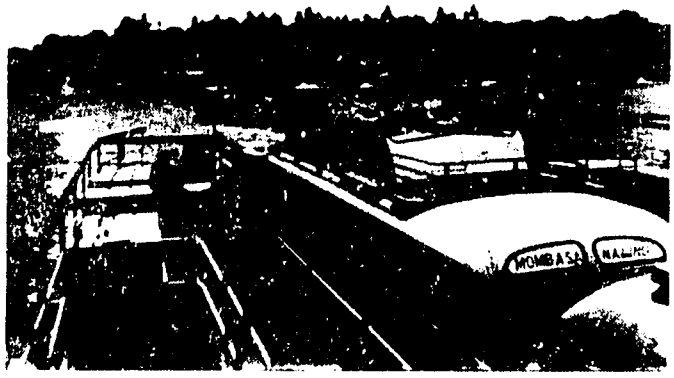
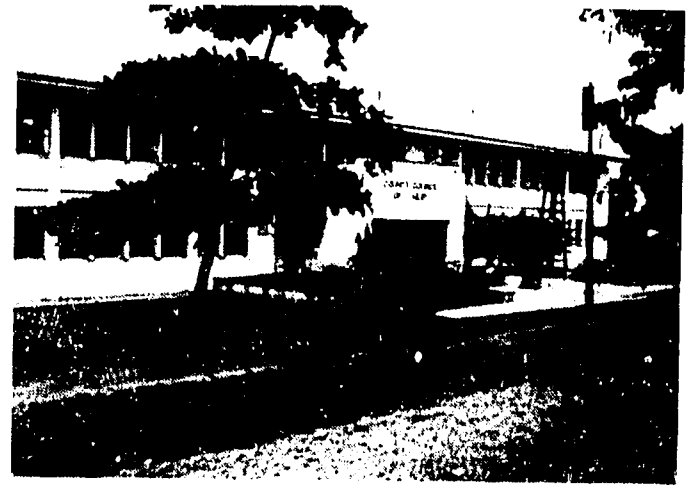


DIAGRAM 8



KILIFI CREEK FERRY



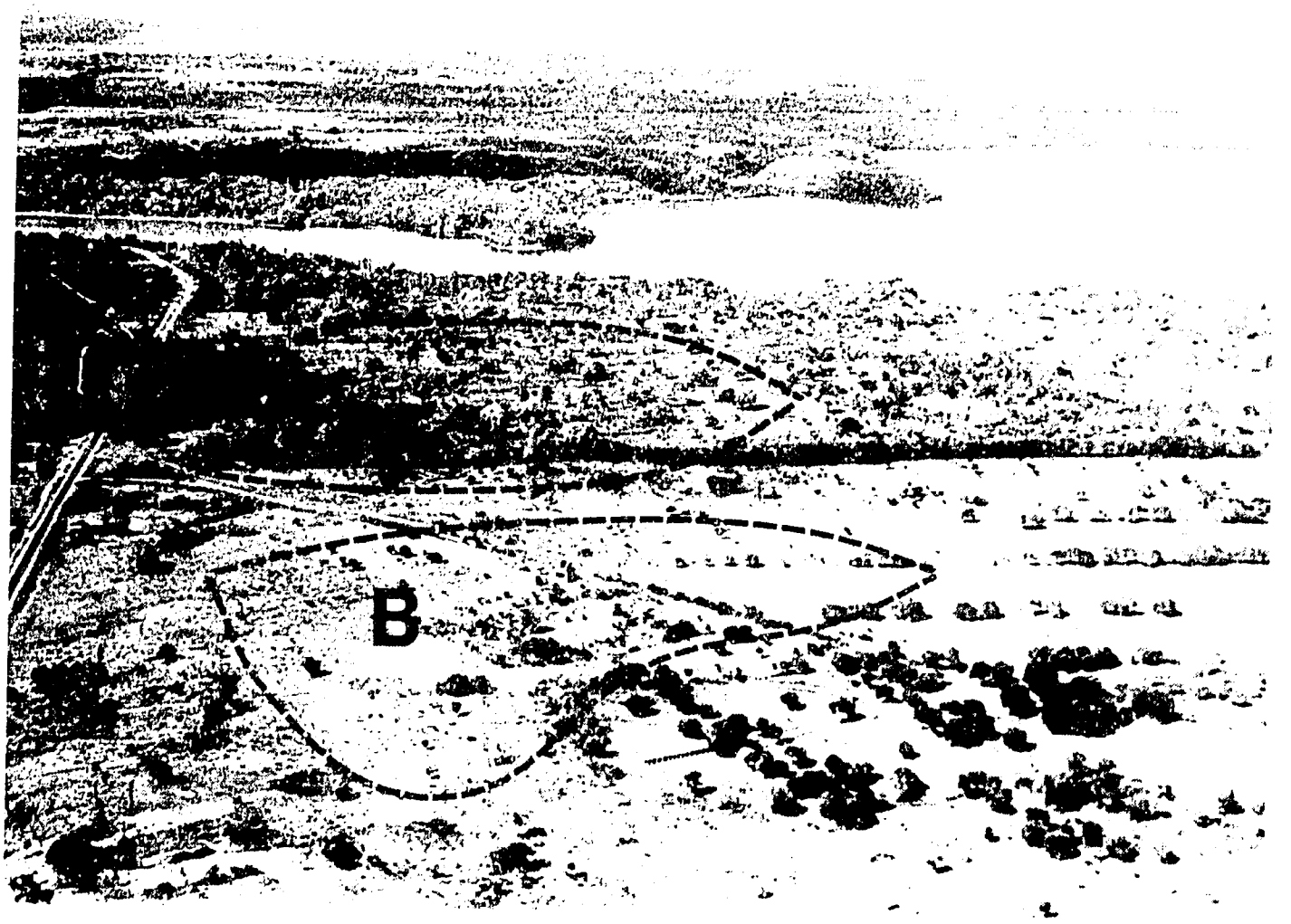
KILIFI COUNTY COUNCIL

KILIFI DISTRICT OFFICES

TOWNSHIP SECONDARY SCHOOL

KILIFI COMMERCIAL AREA

KILIFI MARKET



AERIAL VIEW LOOKING SOUTH TO KILIFI CREEK SHOWING SITE ALTERNATIVES

CAMPUS SITE ALTERNATIVE A

TYPICAL FARM AREA

SITE ANALYSIS

The establishment of the Coast Agriculture Institute would have significant long term effects on the selected site and the Kilifi area. Therefore, it is important to analyze the possible implications of these effects so they can influence the design and future quality of the environment.

The site analysis has been conducted in two parts, the first being site description and the second, interpretation of the various aspects of the site that would influence design decisions. These aspects include natural factors such as climate, vegetation, soils, subsoil, and topography. They also include man-made elements such as buildings, roads, and utilities, as well as characteristics such as land use and visual qualities. These aspects, factors and characteristics are shown in Diagrams 9, 10, 11, and 12, "Existing Land Use, Development Constraints, Development Potentials, and Climate. Taken together, they serve as a constraints and potentials framework from which the proposed land use and conceptual campus plans could be formulated.

Another composite "Development Determinants," (Diagram 13) provides information as site forces to guide planning and design feasibility studies of the immediate campus and adjacent student and staff housing areas

Existing Land Use (Diagram 9)

The first major task of the assignment was to recommend an "appropriate site." The first exercise in the process of studying site feasibility is an investigation of land use. In order to do that it is necessary to understand land use requirements for an agricultural institution to be operational, to understand current land use of the proposed site and to identify factors that influence decisions in developing a recommended land use plan.

Unfortunately, no authoritative source was available to provide guidelines for the nature and amount of land necessary to adequately support a 640 student certificate level agricultural institute. Apparently the best model in Kenya is Embu Agricultural Institute. However, even with 230 acres,

Embu must make use of the 600-acre government farm at Ndombo, 26 Km distance.

In discussions with the administration at Embu, it was apparent they are handicapped by limited land resources, particularly in the area of pasture for livestock. If Embu were to expand to the 640 student size, this handicap would become magnified. Therefore, the process of determining land requirements began imperically, based upon intuition and experience. Property maps and aerial survey maps were combined to produce accurate scale basemaps upon which information about all aspects of the area around the prospective site were recorded. A study of property boundaries, land topography and existing land use led to an early assumption as to the additional land need. The land to be acquired belongs to one private landowner, and is contiguous to Kibarani Farm.

To the west within the proposed Institute boundaries are approximately 100 hectares, formerly a large coconut plantation. In all but the northern edge of this area the coconuts have died and the land is tilled by landless squatters.

To the south within the proposed boundaries are approximately 45 hectares classified as bush. This area contains scattered tree and shrub vegetation. Some of the land has been partially cleared, mostly by squatters who plant field crops by hand or use the land for cattle and goat grazing.

Using legal property boundaries and natural edges such as roads, the area was determined. Subsequently, more detailed information and discussions with several agriculturalists has confirmed the correctness of the proposed area and configuration.

A detailed study of the historical and current use of the land instituted a process of learning from history. Much of the current use of the Kibarani Farm is adaptable to the needs of the Institute.

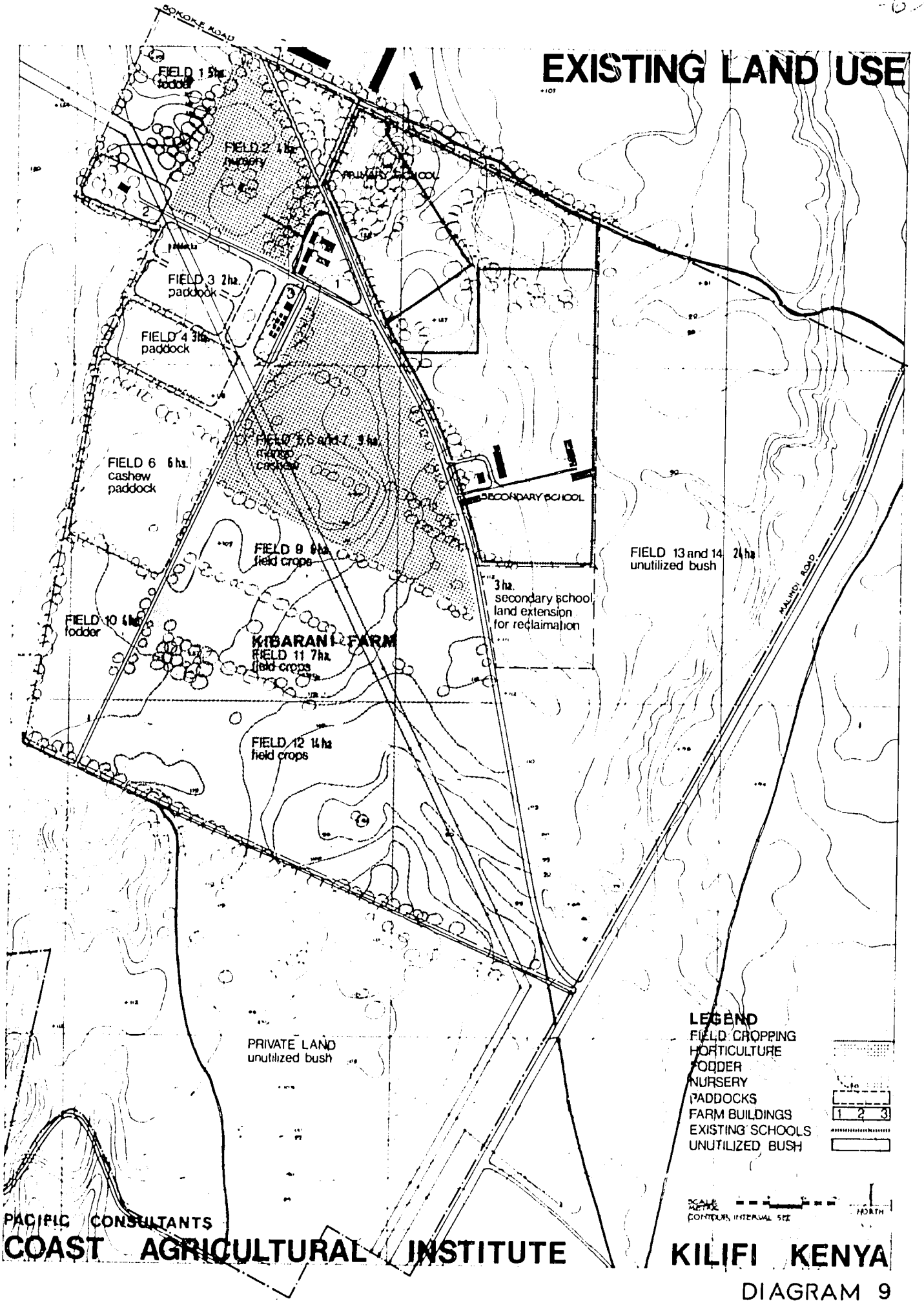


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DIAGRAM 9

A portion of the Kibarani Farm is currently under limited agricultural production. This consists of four field crop plots, five plantation plots, one of which incorporates a small nursery, and a livestock paddock area, totalling approximately 45 hectares. The plantation crop areas are also used for grazing of livestock. There are currently 20 milking cows and 10 calves on the farm.

Development Constraints (Diagram 10), Development Potentials (Diagram 11)

Existing features and community resources constituting the built environment in the Kilifi Town, campus area; along with vegetation, topography, and other natural aspects; are documented in these diagrams. Also, those factors which would be major influences in design decisions are noted on the diagrams and discussed in the following paragraphs:

Roads - The main tarmac road from Mombasa to Malindi runs north along the eastern boundary of the project site. About midway along this boundary the Sokoke road intersects and runs diagonally northwest through the site, then westerly along the northern boundary of the site. This is an unsurfaced murram road. A third dirt road along the southern boundary of the site runs to the west to Fumbini and the Sea Horse Hotel. Other minor single track service roads occur on the Kibarani Farm.

Power service - A new 15 Mva electrical sub-station has been constructed at the southeast corner of the site adjacent to the main road. Two 33 Kv overhead powerlines run north from this point to the Sokoke road, then northwesterly through the site for about 1,400 meters, then more westerly again, generally paralleling the road. Easement width is 30 meters.

Kilifi Town is to the east across the main road about 1½ Km south to the town center. Kilifi has a number of facilities and resources that would be of importance to the Institute. It has a small market retail center, a 200-bed full facility hospital, three to four churches, a mosque, and an

DEVELOPMENT CONSTRAINTS

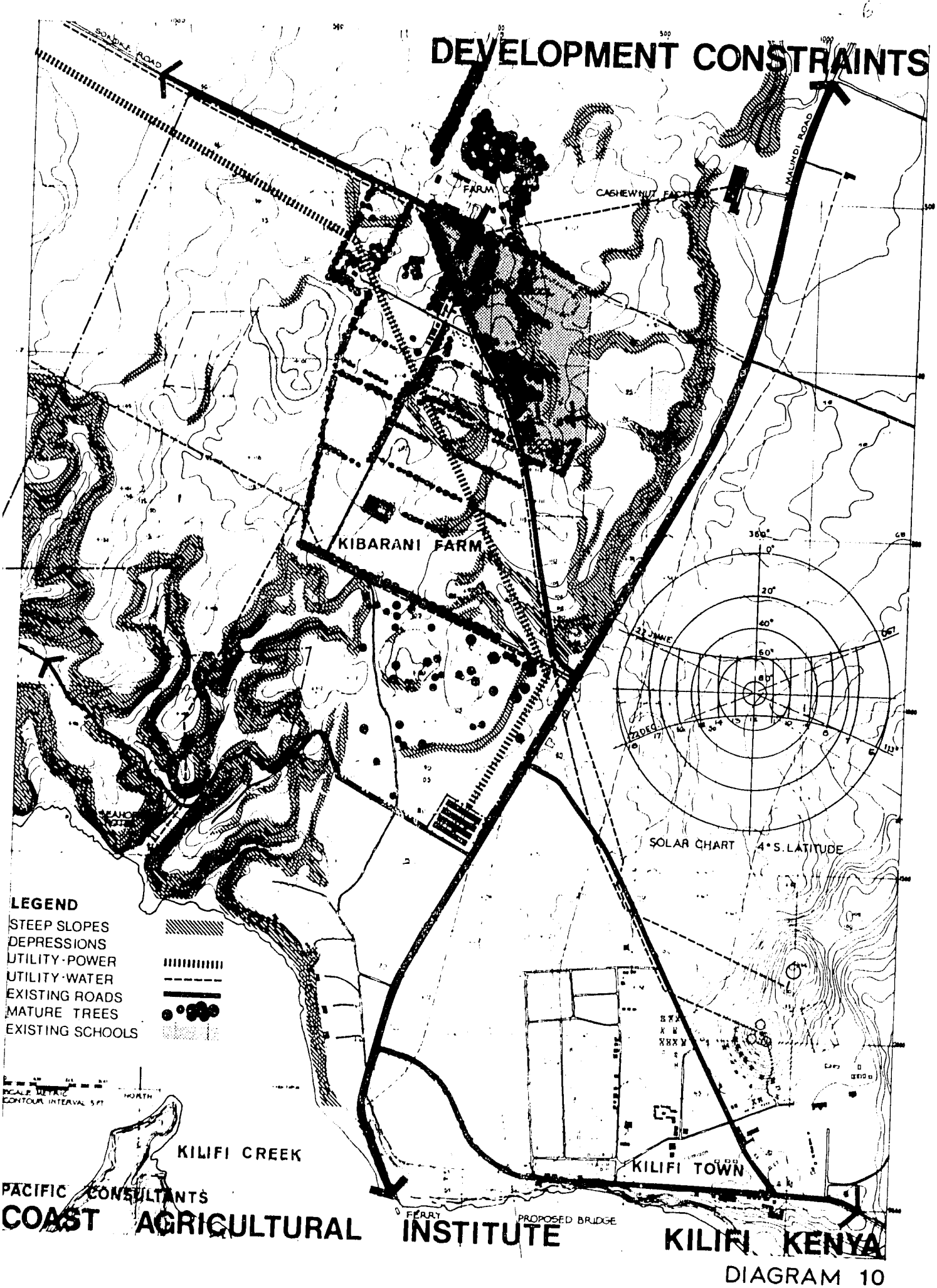

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DIAGRAM 10

elementary school. The Kilifi District Offices include District Commissioner, Education Office, Agriculture Office, Development Office, and Health Office. There is also a small police station, a post office, a telephone exchange, doctor's offices, road, water and power maintenance centers, and a bus depot. Development plans for Kilifi call for expansion and modernization of the town. Future government-aided housing sites have been located in Diagram 11, as well as a new site for the police station and the post office. The outline of Kilifi town as it exists is illustrated, showing relationships to the proposed site. Future plans call for expansion to the north. Along the north edge of Kilifi Creek to the south of the Project site is an area of privately owned residences and the Sea Horse Hotel.

Approximately 24 hectare's of land was subtracted from the original 124 hectare Kibarani Farm and granted to an elementary school of 770 students, a secondary school of 240 students and a small school for the deaf. This parcel of land, the Sokoke Road, and the utility easements through the Farm have cut severely into its potential use and are a handicap to planning options.

Vegetation - Major tree patterns on the site were derived from existing aerial photographs provided by the Survey of Kenya (1958 and 1972), by on-site inspection, and through aerial reconnaissance conducted by the Technical Feasibility Team. The vegetation shown in Diagram 10 illustrates patterns of existing mature trees. These are of mixed species, including baobab, mango, cashew, coconut, kapok and neem, as well as others. The trees shown range from 30' to 100' in height with a spread of 20' to 60'. Individually and collectively, they represent a valuable resource from the standpoint of shade, temperature mitigation, and aesthetic appeal.

Topography - The topographic characteristics of the site are derivatives of the geomorphology of its location in the Coastal Plan, one of three major geomorphological zones in the coastal area.

DEVELOPMENT POTENTIALS

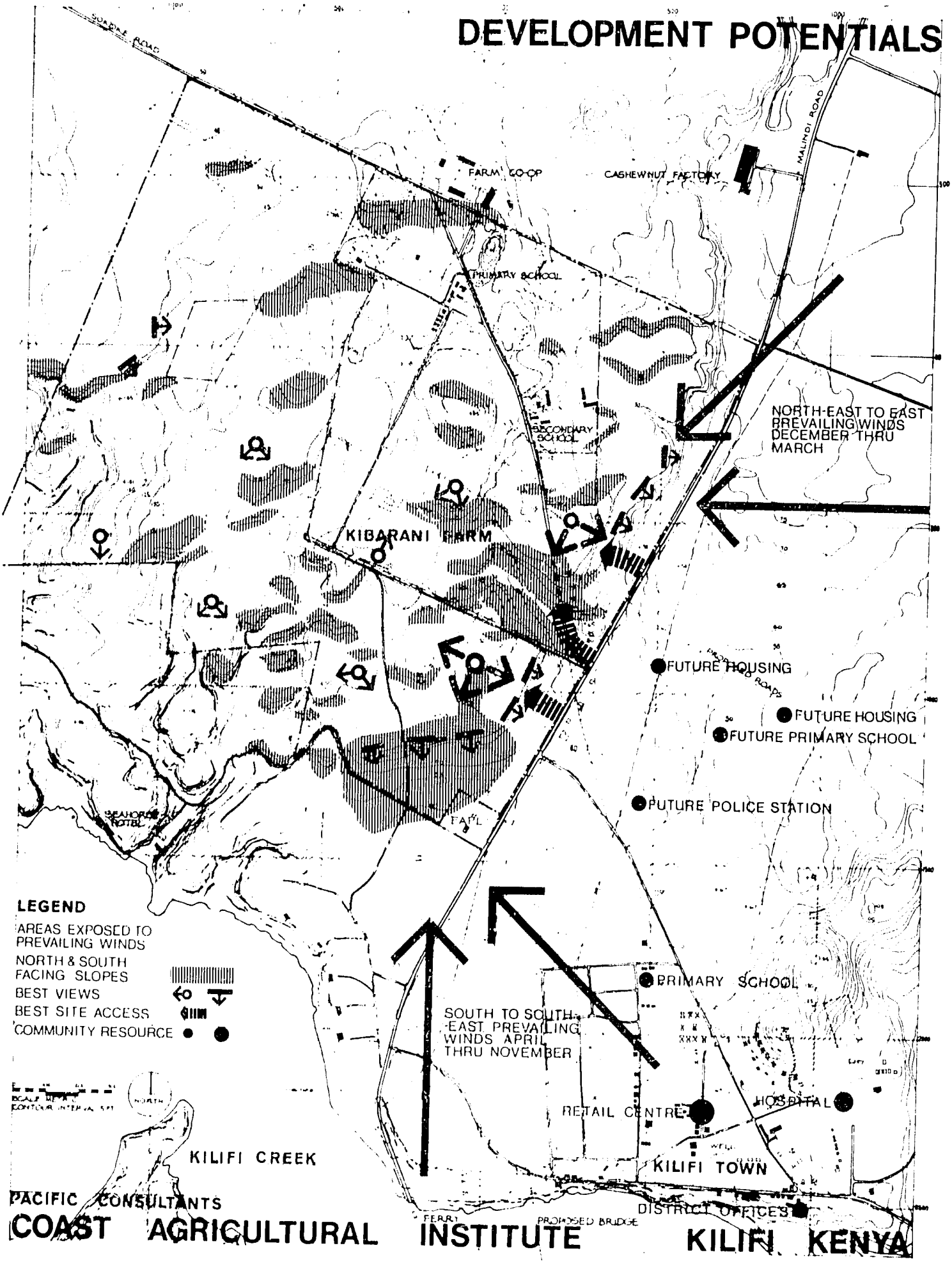

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DIAGRAM 11

The Coastal Plain is flat to gently undulating, with sediments of varying origin from the Pleistocene and Holocene age. It begins with an abrupt and well-defined cliff at the ocean edge and runs parallel to the ocean and inland to a scarp at an elevation of approximately 60 meters (200 ft.) some distance west of the project site.

Within this plain there are three distinct marine terraces, the lower two on coral limestone and the upper on sandy mars (Netherlands Pedology Training Project Report draft, 1980). The plain is disected periodically by tidal creeks running generally west to east and perpendicular to the ocean. Kilifi Creek just to the south of the site is one of these. The topography on the site includes two distinct and well-defined ridge lines along the eastern edge of the site in a north, north-easterly direction and a northerly direction, respectively, and merging at the point of the intersection of the Sokoke and Malindi roads. The elevation at the top of the second terrace is approximately 36 meters. The project site is located on the upper front edge of the second terrace.

Along the southern edge of the site there are three major gulley systems, each with minor tributaries. The plain extends to these areas and then drops steeply into them. The flat areas above the ridges and gulleys are generally flat to undulating. There are numerous depressions or sinkholes, both large and small. These apparently have resulted from the evolution of the sub-surface of limestone, coral, windblown sand, and other sediments. No current subsidence of these depressions is known.

The topography of the site is divided into three categories of slope which provide convenient land use planning determinations. They are:

Flat	(0% - 5%)
Slight to moderate	(5% - 15%)
Moderate to steep	(15% - over--illustrated in Diagram 10)

The depressions and sinkholes are noted in Diagram 10, and high areas exposed to breeze and north and south facing steeper slopes are illustrated in Diagram 11.

Soils - The following information is derived from a study of the site by Dr. Ir T. DeMeester. The complete report and soils map is in Appendix 11. The soil series of the surveyed area are categorized into the following six types:

1.1 Well-drained, red, sandy clayey soils with no or shallow sandy surface soil.
1.2 Well-drained, deep, yellow loamy soils (mainly mod. deep, sandy surface soil).
1.3 Well-drained mod. deep, dark, heavy, clay soils (no sandy surface soil).
1.4 Well-drained mod. deep, brown loam soils.
2 Poorly drained loamy and clayey soils.
3 Escarpments and steep valley slopes (miscellaneous land types).

The red and dark clayey soils (1.1 and 1.3) comprise together about 40 percent of the total area. They have in common a low permeability, although red clays have a higher intake rate than the dark ones. Both are extremely hard when dry, and sticky when wet. Their water-holding capacity is fair.

Chemically, the red clays are much poorer than the dark clays. The red clays have a low pH (5), a low cation exchange capacity (CEC) and a low organic matter content. Data on dark clays are not available, but pH and CEC are definitely much higher.

The Yellow loams with their sandy surface soils comprise about 50 percent of the total surveyed area. These soils, with their nearly level topography and sandy surface are favorable for tillage with hand tools. Their intake rate is rapid. However, after persistent and heavy rain the less permeable subsoil caused waterlogging, resulting in structural collapse of the surface soil. This is important to note in view of irrigation.

The poorly drained soils occupy only about 8 percent of the area. Their significance is that they remain more or less moist in the dry season.

The soil survey indicates that about 90 percent of the surveyed area is suitable for agricultural practices as applied at present by the local farmers. However, special techniques such as the use of heavy machinery or irrigation should be considered only after further studies on several

physical properties of the soil such as intake rate, subsoil permeability, aggregate stability and Atterberg values.

Micro-climate (Diagram 12)

Climatic data for the coastal area has been compiled and summarized by the Housing Research Unit of the University of Nairobi. The information for Malindi, about 40 km north of the site is illustrated, since data is not available for Kilifi. The data are similar to and representative of the characteristics at Kilifi.

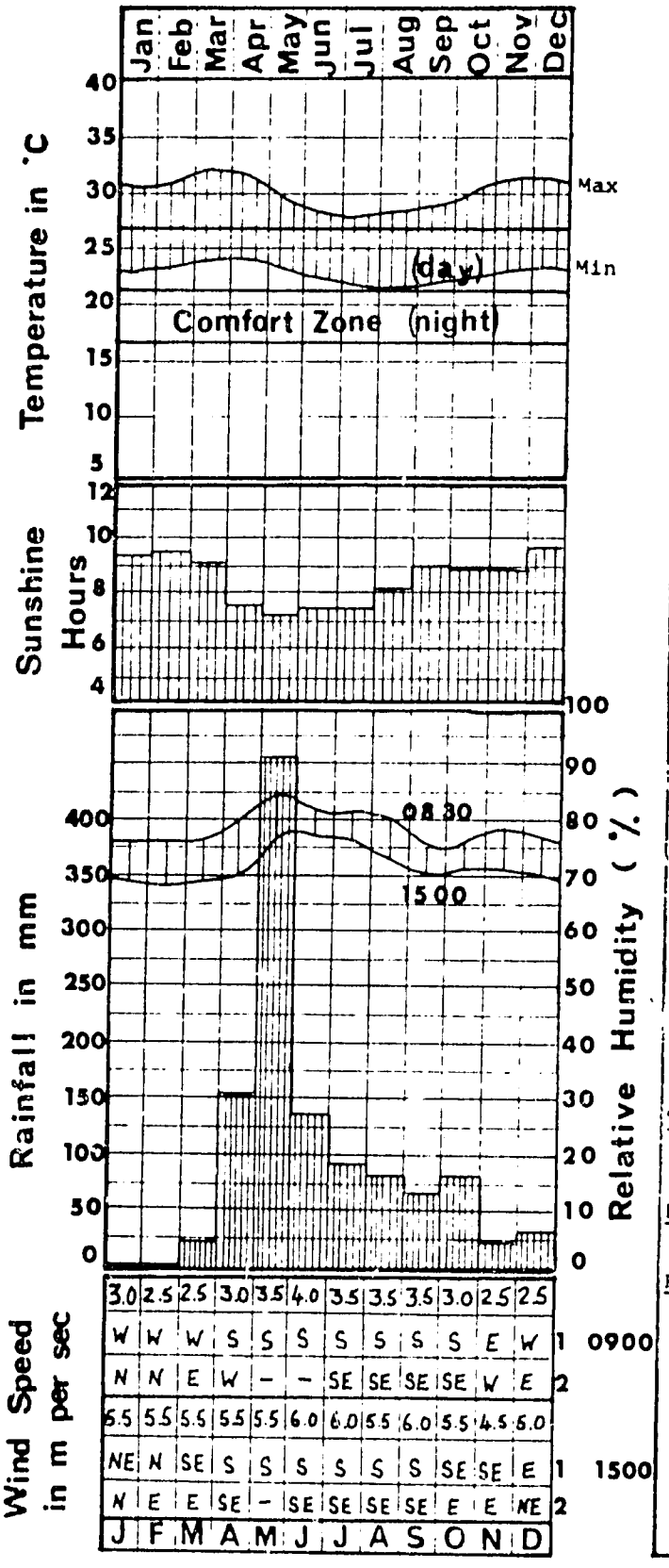
The two most important climatic considerations are solar radiation and prevailing breezes. Due to the sun pattern there is very little seasonal variation in solar angles or in compass points for sunrise and sunset. North and south facing slopes consistently receive much less solar radiation than those facing east or west during morning and afternoon periods when the sun is at a low angle. Therefore, buildings oriented linearly to the east and west and parallel to the north or south facing slopes are subject to much less heat gain from the sun, and can be easily shaded with roof overhangs. The preferred north-south facing slopes are indicated in Diagram 11.

Prevailing breezes in Kilifi originate from the northeast, December through March, and from the south to southeast, April to November. The portions of the site exposed to the prevailing breezes from these directions are those which are on high ground. Fortunately, the general terrain rising in terraces toward the west opens much of the project site to the breezes.

The sinkholes or depressions on the terraces create areas where still air pockets could easily occur (see Diagram 10). As such, they are undesirable for human occupancy and buildings should not be located within them.

Design Determinants (Diagram 13)

This diagram at a larger scale focuses upon those factors illustrated in Diagrams 11 and 12, which are major determinants in decisions about location of the main campus. Other decisions such as access into the campus,



Zone: Coast

MALINDI

altitude: 20 m
latitude: 03°13′ S
longitude: 40°07′ E

Malindi is a seaside resort facing Eastwards across the Indian Ocean.

Temperature

Temperatures exceed 30° and 32°C on 166 and 28 days per year.

Winds

During the SE Monsoon (April-Sept) a steady S wind prevails throughout the day.

During the NE monsoon and transitional months (Oct-March) winds are lower and sea-land and land-sea breezes become of dominant importance.

Annual Means

Temp.	Max.	30.2°C
	Min.	22.8°C
	Range	7.4°C
Humidity		08.00 H 83%
		15.00 H 72%
Rainfall		1148 mm.

CLIMATE APPROXIMATES CONDITIONS AT KILIFI -- DIAGRAM 12.

location and orientation of buildings for optimum comfort and views, and location of roads and other services are also influenced by the factors illustrated.

There are both positive and negative features in any environment, obviously both should be determinants in the design decision-making process. There are distinguishing features which are visually apparent to the observer. These visual cues vary in scale from mountains to delicate forms of vegetation. The tree masses and terraced topography of the site provide a spatial character that is quite well defined. The sharp ridge lines serve a dual purpose visually, creating a spatial edge or boundary when viewed from the lower level, and providing a plateau with excellent views outward from the upper level. The mature trees existing on the site can be construed as both positive and limiting features simultaneously. They are limiting only to the extent that all possible means should be pursued to retain them. They provide shade, lowering air temperatures and acting as natural air conditioners. They serve as definers of space in the same way as building groupings, and existing in strongly defined fence row lines, they can strongly influence the functional and organizational structure of the Campus Plan.

Perhaps the major negative visual impacts on the site are the high voltage powerlines and the sub-station. The location of these elements is unfortunate because of the aesthetic distraction that would occur on entering the campus, as well as the obstruction of views outwards from the site. These elements cannot be relocated. Easements must be provided, within which no permanent construction can occur.

Existing roads are also generally fixed components of infrastructure which cannot easily be altered. Such is the Malindi road. The Sokoke road through the Farm is a major limiting element, but since it is in an unsophisticated condition, the possibility exists to relocate it along the northern boundary of the site, freeing up a larger area for more unified development.

DESIGN DETERMINANTS

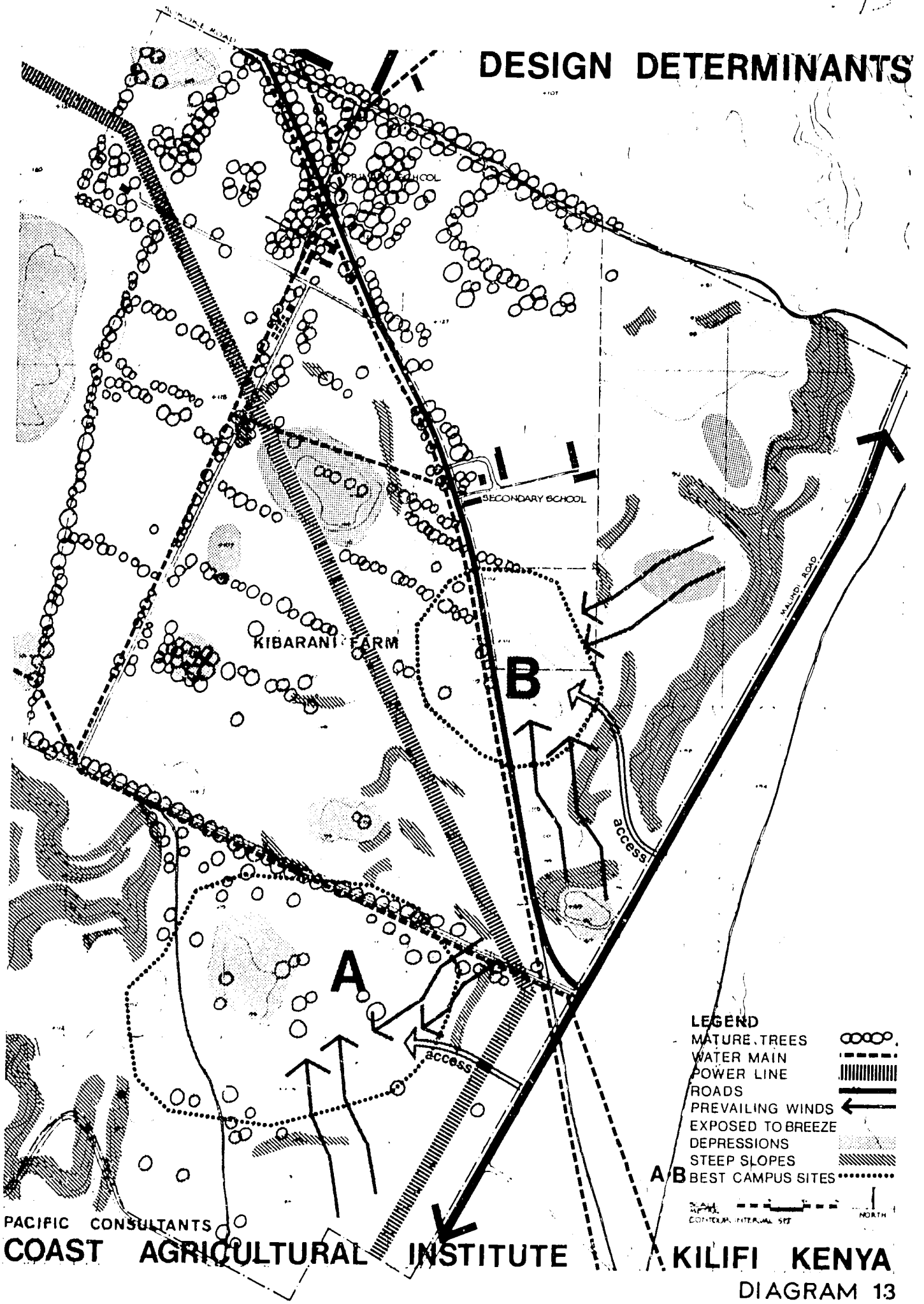


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DIAGRAM 13

Several other features of the site are limitations as well. The steeper slopes should be avoided for construction, due to the increased cost and possible erosion control difficulties. Most of these areas are already heavily eroded and are poorly oriented relative to solar orientation, adding to their inappropriateness for development.

Along the southern boundary of the site the well-defined gulley areas should be avoided for any physical development due to the steep terrain, marginal soil stability, and susceptibility to flooding and wash-out.

Each of these features in and of itself can be disregarded or manipulated to lessen its limitation. When taken together, however, they generate a forcible pattern not easily disregarded relative to the shaping of the final physical plan if it is to be in harmony with its setting.

CAMPUS PLAN

Alternative Concepts

In the context of this study "campus plan" means the organization or arrangement of buildings on the site, with all services like roads and utilities laid out to scale, but in a somewhat diagrammatic form. To test the feasibility of developing the Coast Institute on the chosen Kilifi site, and to be able to provide reasonably dependable cost estimates, it was important to investigate alternative concepts and compare them.

The process of arriving at a campus plan involves working from two directions; from inside out, from specific to general; and from outside in, or from the general broad picture down to specifics. From inside out, scale floor plan diagrams were prepared from information derived from the Educational Plan. (Refer to "Schedule of Accommodation," division, BUILDING DESIGN.) Origin - destination studies, frequency of use, and functional relationships were the major influences used to organize various campus plan systems. Then, from the outside in, site forces growing out of the site analysis; such as topography, soils, land use, vegetation, climate, easements, access and visual characteristics influenced the general location of the 25 hectare campus on the 250 hectare farm.

It was concluded that two general locations were most suitable over all other possibilities. It was decided to proceed as far as possible with both alternatives until it was found that one or the other was more feasible and/or desirable.

The two alternatives are referred to as follows:
Alternative A - "Near Kilifi South"
Alternative B - "Central Kibarani"

Each of the two concepts would require approximately the same 25 hectares of land for academic buildings, student and staff housing, and external open space.

Each could be organized approximately the same way and the accompanying "Diagram Campus Plan" is representative of either one. In either case, the center of the campus would be set on a dome of high ground, with Alternative B slightly higher. In both cases, imageability from the Malindi Road would be good, view is fine, exposure to prevailing breezes would be about the same. Access from Malindi Road would be easy and direct in both cases.

Alternative A--"Near Kilifi South"

Realization of this concept depends upon early acquisition of private land adjacent to Kibarani Farm to the south, since nearly the whole campus would be located on this high and gently sloping parcel of land nearest to Kilifi Town. There are a number of apparent advantages in choosing this location over Alternative B. Geographically, it is closer to Kilifi, making it more convenient for staff to use Kilifi community facilities. Topographically, it is a more gently sloping larger area than is the B site, making construction easier and somewhat less costly. It takes up less than does B of the most desirable farm land. Main service lines have shorter runs than B, reducing their costs to a minimum. There are fewer constraints such as road and utility easements through the site as there are in B.

Alternative B--"Central Kibarani"

The major advantages of this concept over Alternative A are, first, that it lies entirely within the Kibarani Farm, already owned by the Ministry of Agriculture. Second, the title "Central Kibarani," implies that it is somewhat more centrally located to all parts of the total Institute site. The children of staff families would live very near to the existing Primary and Secondary Schools on the Farm.

Disadvantages of this concept have already been implied in indicating the advantages of Alternative A. The major disadvantages are that the Sokoke Road and two water main easements run right through the center of the proposed site. The 33 KVA powerline easement crowds what would be the area for student housing. Road access is longer, sewer and power mains

would be much longer, and more costly. This concept is also dependent upon utilizing the 3 hectare land parcel that was granted to the Secondary School. Thus, reclamation of this parcel, relocation of Sokoke Road, and avoiding construction over the water line easement would be essential prerequisites to planning the campus at this location.

At the time of writing this report, it became apparent that the advantages of Alternative A seemed to outweigh those of Alternative B, and the rather distinct disadvantages of B influenced a decision to base the recommendations and costings on Alternative A, the "Near Kilifi South" concept. However, in order to keep open the possibility of implementing Alternative B, for strong reasons determined during later planning stages, each section of this report provides a cost variation for Alternative B, in most cases the costs are additional.

Either way, relocation of Sokoke Road is essential to remove traffic and dust from the Institute Farm. As already mentioned, reclamation of the 3 hectare parcel from the Secondary School is in process, to make farm operations more accessible and convenient.

Land Use

The major influence in final determination of land use was the site analysis, particularly the influence of the results of the soils investigation carried out by the Dutch consultants. Aside from the location of the 25 hectare campus "Alternatives A and B," as previously discussed, the other major determinant was the topography. Generous areas of the site (approximately 40 hectares) mostly on the southern edge and the eastern edge along Malindi Road are very steep and highly dessicated. These areas are designated for plantation crops and forest crop development. The recommended property boundaries and land use are illustrated in the accompanying proposed "Land Use Plan" (Diagram 14).

The following Chart records the current land use distribution at Embu Agricultural Institute, and for comparison, the proposed land use for the new Coast Institute for Agriculture.

DESIGNATION	EMBU INSTITUTE	COAST INSTITUTE
Campus (incl. housing)	13 hectares	22 hectares
Farm centre	2 "	2 "
Livestock paddocks, pens	5 "	14 "
Student plots)		
Horticulture)	6 (incl. nursery)	16 "
Field Crops	26 hectares	34 "
Pasture	25 "	64 "
Fodder	0 "	14 "
Plantation & Forest	7 "	62 "
Model Farms	0 "	(3) 12 "
Misc. roads, rocks, ponds	8 "	6 "
	92 ha. (227 a.)	250 ha. (617 a.)

The total land area proposed for the Coast Institute is approximately 2.75 times greater than at Embu, for a student population that is double. As mentioned, Embu has insufficient land, and is depending on Ndombo Farm for additional support. Note that the major increases in land allotment are for:

(a) Plantation and Forest - additional 57 hectares, due to highly dessicated steep sloping areas of the site and the potential importance of land reclamation through forestry on the Coast.

(b) Pasture - additional 39 hectares to provide capacity for additional livestock in a seasonal, potential overload environment.

(c) Fodder - need for seasonal zero grazing and the potential for experimentation and demonstration of livestock supplemental to small farmholders on Coast. Becoming increasingly important.

(d) Model Farms - total additional 12 hectares (3 farms average of 4 hectares each). Because of the series of major settlement schemes along the Coast in the vicinity of Kilifi, model farms would be of great significance as demonstration tools for extension trainees, who will be working with the newly settled small farmholders.

The "Proposed Land Use Plan" retains as much of the current active use of the Kibarani Farm as possible. The large horticultural area now planted to mangos and cashews would be retained and developed as shown for "Horticulture." The large and profitable "Nursery" should continue to be used, with improved efficiency. The series of fenced paddocks along the western edge of the Kibarani Farm are proposed to continue as such with their appropriate cashew shade trees. The crop fields would continue as

PROPOSED LAND USE PLAN

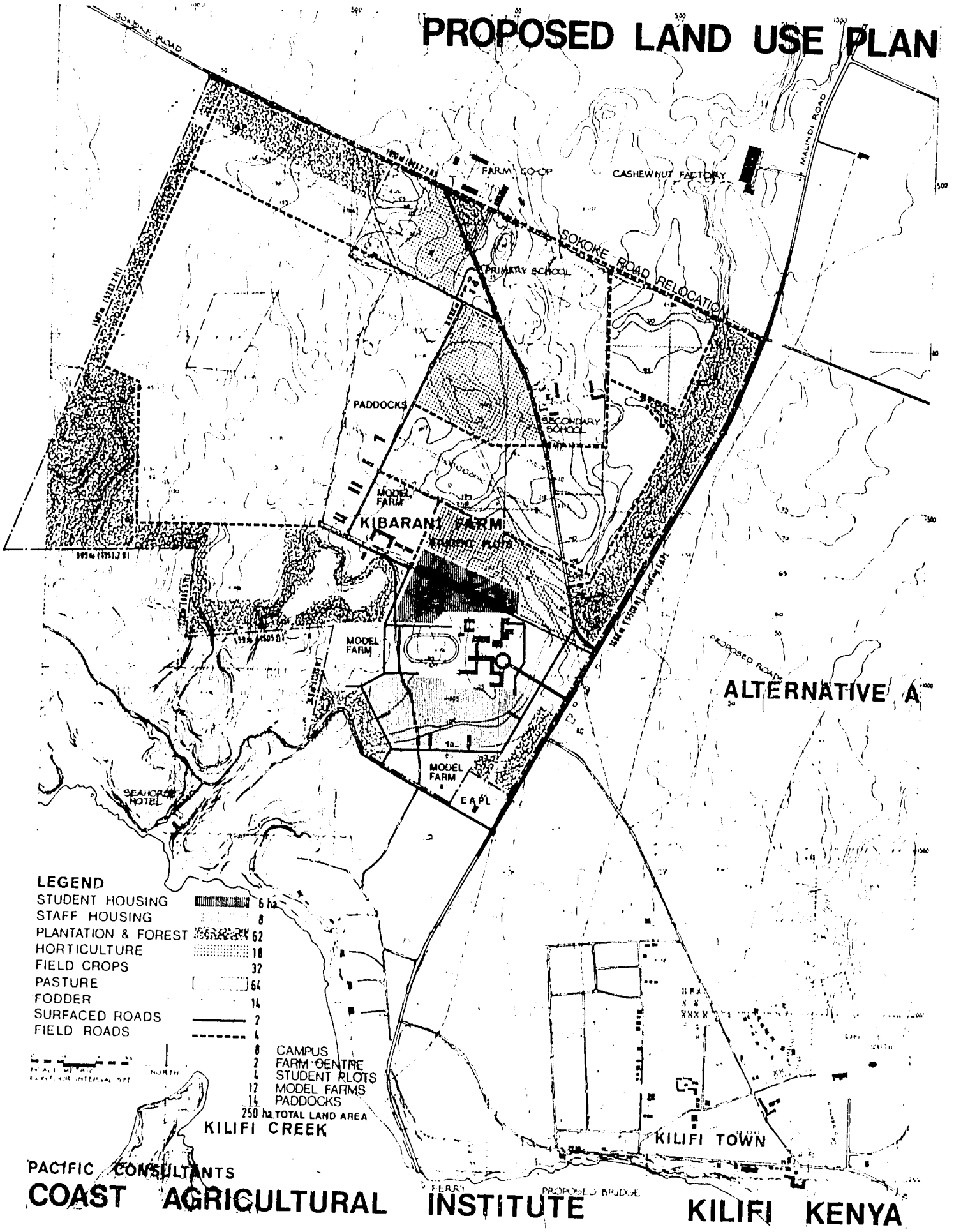

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DIAGRAM 14

such, with unused areas on the east along Malindi Road being brought into cultivation. The variety of soil types provide a good distribution for a range of both food and industrial crops.

Student plots are located adjacent to student housing on good cropland, easily manageable.

Proposed "Campus Plan"

The chosen organizational concept, Alternative A, proposed for the Coastal Institute is illustrated in "Diagram Campus Plan" (Diagram 15) and "Campus Plan" (Diagram 16). The concept grows out of principles stated in the Introduction to this report as explained below:

Imageability - The centre of the campus is placed at the highest point of a large domed area in the southeast corner of the site near the main road and nearest to Kilifi. When the new bridge is built across Kilifi Creek, the Institute would be right on axis as one crosses the bridge going north toward Malindi, providing a positive visual communication of location.

Accessibility - Being near the Mombasa-Malindi Road, a short direct access road would permit visitors to arrive by vehicle right near the heart of the campus, at the front door and reception, the Administration Building.

Branching service roads easily access buildings needing daily service, without crossing the campus.

Efficiency - The buildings are shown organized compactly around a heart or core, a central plaza in a hierarchical relationship determined through studies of frequency of use. (Refer to BUILDING DESIGN section for method.) Common facilities most frequently used by everyone are placed centrally, with classrooms and laboratories growing out of the core radially. The buildings are organized on a system of walkways and open spaces that create pleasant campus areas to be landscaped.

Close into the heart of the campus directly opposite the entry are the assembly and sports areas, proposed simply as outdoor spaces, carefully shaped out of the land. These public spaces are provided with parking for visitors cars, reached via a campus outer loop road to the back of the campus.

DIAGRAM CAMPUS PLAN

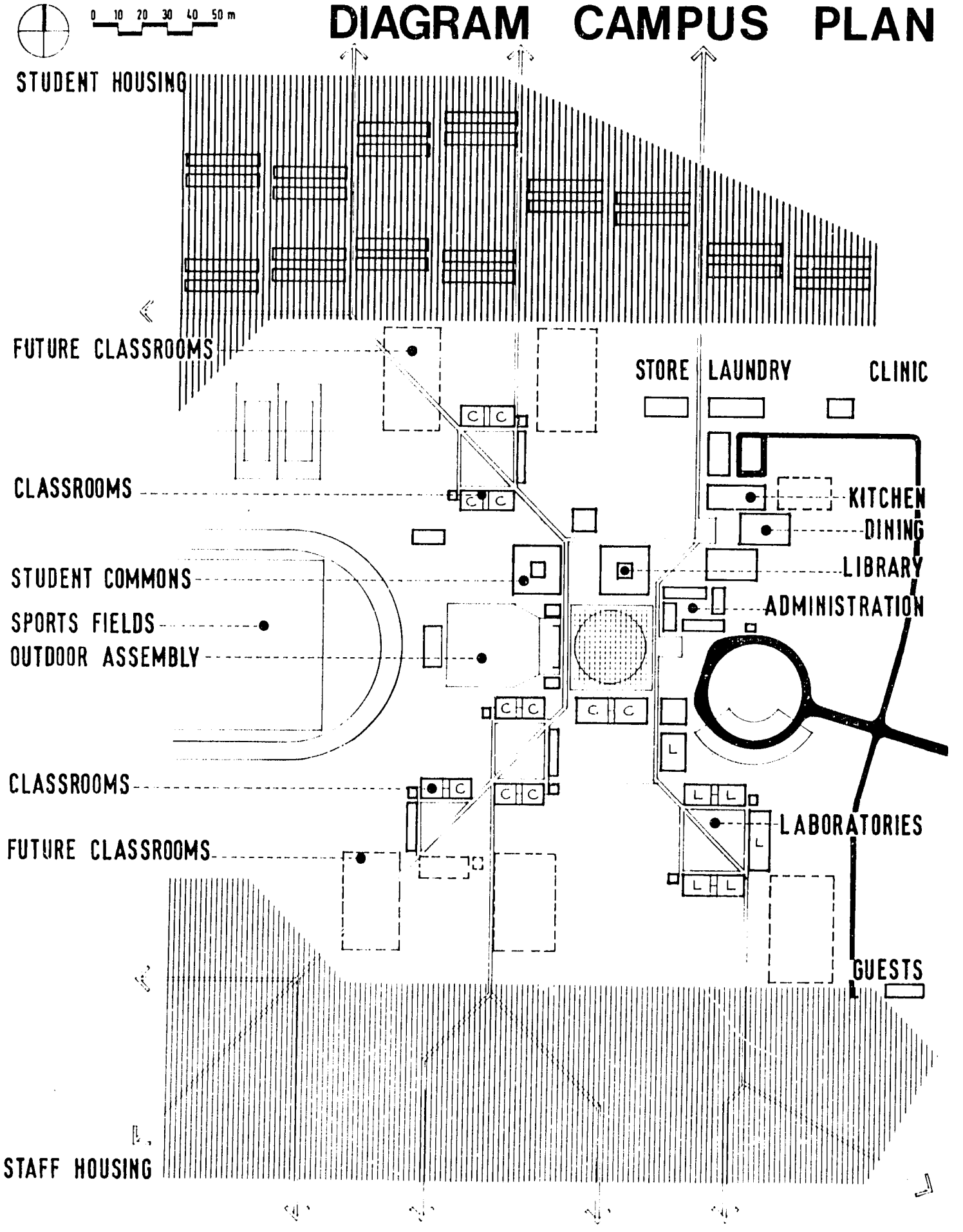

DIAGRAM 15

Convenience - Extending the radial-walkway network outward, to the north, the student housing is reached within five-minutes walking time. Beyond is the Farm Center within another five-minute walk, and beyond are the various areas of the Institute Farm.

Extending the walkway outward to the south, the staff housing is reached, also within five-minutes walking time. Extending the walkway further southeast leads within twenty minutes to Kilifi Town.

Harmony - The scale and character of all buildings should be consistent, through choice of materials, construction techniques and form (see Section BUILDING DESIGN). The Campus Plan proposes arranging the buildings for efficient movement between them, yet so there is fundamentally only one room width facing the breeze from any side. Relationships between buildings are consistent, so that each is a part of one total system, and the whole is greater than the sum of individual parts.

Flexibility and Expandibility - Though efficient and closely knit together, there is ample provision in the total campus area for additional building units to be added, and the nature of the proposed buildings provides maximum flexibility in their use.

Environmental Sensitivity - Oriented to minimize heat build-up from sunlight, located to maximize the potential for catching air movement, situated for good surface drainage and accessibility of service lines; the concept is a direct outgrowth of understanding the forces in the setting and on the site.

Minimizing Conflict - The concept is organized around the pedestrian, with walkways being the major principle. Roadways are deliberately kept on the perimeter to avoid conflict and disturbance, yet provide access and service.

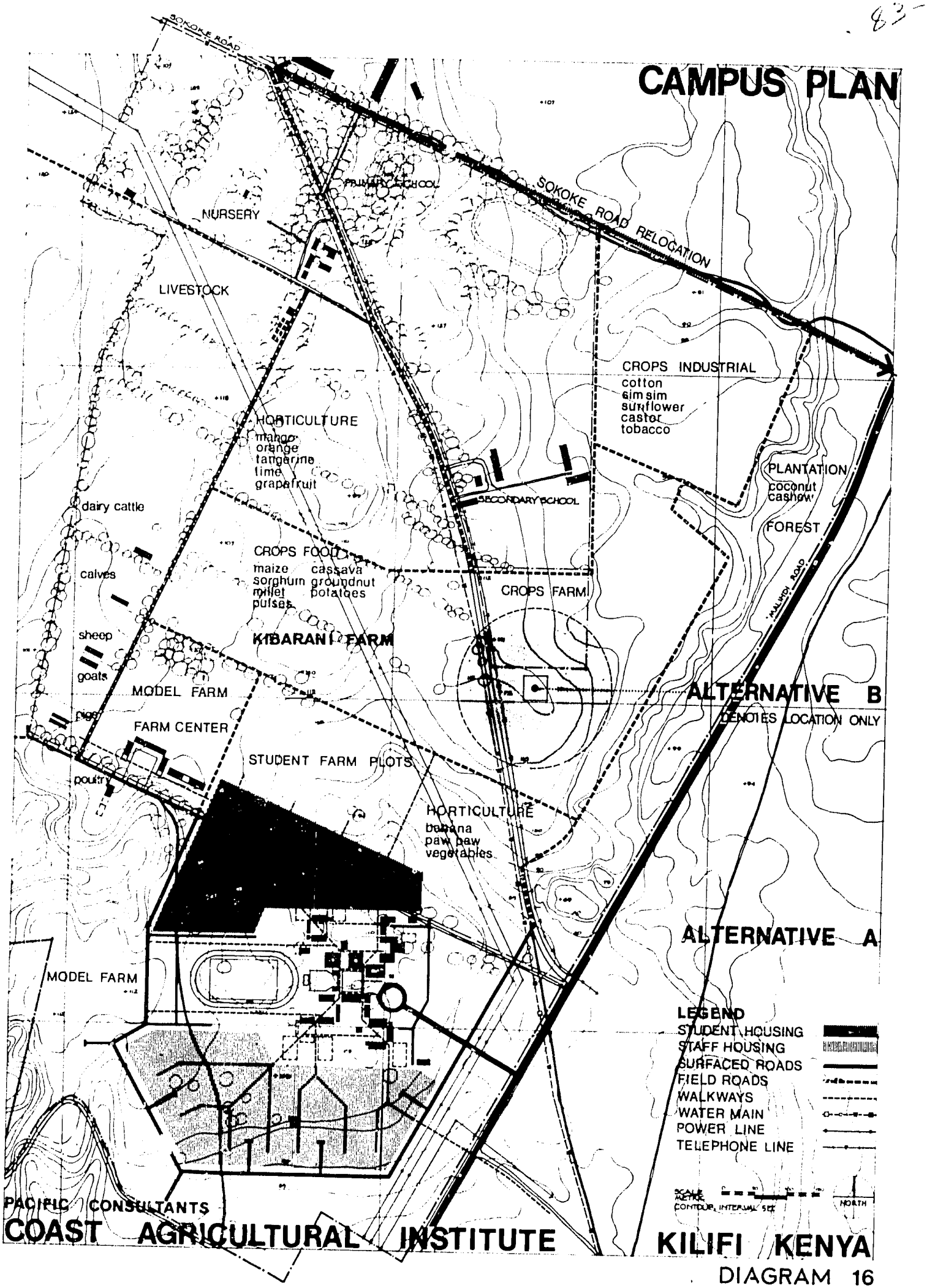
CAMPUS PLAN
SOKOKE ROAD
SOKOKE ROAD RELOCATION
PRIMARY SCHOOL
NURSERY
LIVESTOCK
CROPS INDUSTRIAL
cotton
sim sim
sunflower
castor
tobacco
HORTICULTURE
mango
orange
tangerine
lime
grapefruit
PLANTATION
coconut
cashew
SECONDARY SCHOOL
FOREST
dairy cattle
calves
CROPS FOOD
maize
sorghum
millet
pulses
cassava
groundnut
potatoes
CROPS FARM
MALINDI ROAD
sheep
KIBARANI FARM
goats
MODEL FARM
ALTERNATIVE B
DENOTES LOCATION ONLY
pigs
FARM CENTER
STUDENT FARM PLOTS
poultry
HORTICULTURE
banana
paw paw
vegetables
ALTERNATIVE A
MODEL FARM
LEGEND
STUDENT HOUSING
STAFF HOUSING
SURFACED ROADS
FIELD ROADS
WALKWAYS
WATER MAIN
POWER LINE
TELEPHONE LINE
SCALE
METRIC
CONTOUR INTERVAL 5M
NORTH
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DIAGRAM 16

BUILDING DESIGN

Space Requirements

The Educational Worksheets prepared for the draft "Educational Plan" calculated the number and seating capacity of all academic buildings, based upon the 640 student size institution (see Appendix 2). From these calculations the Educational Planning Team established minimum building space requirements. These were examined and where necessary modified by the Technical Feasibility Team.

The examination and modification process was based on the following:

1. Comparison with relevant legislation (see Bibliography).
2. Comparison with space standards for other similar buildings in Kenya, namely, Embu Agricultural Institute, Egerton College, Kenya Technical Teachers' College, and the Mombasa Industrial Training Institute. Where necessary, value judgements were made to adjust space standards to suit the level of education and training to be given at the Coast Agricultural Institute.
3. Comparison with Kenya Government standards and policies.
4. Preparation of diagrammatic plan layouts to examine furniture, equipment and circulation patterns, and to determine critical dimensions and room shapes.
5. Examination of activities not referred to in the Educational Plan, generally service and support facilities.
6. Discussions with the Educational Planning Team, with the Principle and Registrar of Embu Agricultural Institute, and with officials of MINAG, Government of Kenya.

Building Space Requirements for feasibility and costing are summarized in the following "Schedule of Accommodation."

Schedule of Accommodation

BUILDING TYPE	NO.	UNIT AREA m²	TOTAL AREA m²
Academic			
1. LECTURE CLASSROOM (80 students)	2	96	192
2. CLASSROOM (40 students)	10	72	720
3. LABORATORY (20 students) (Chem., Soils, Botany, Zoology)	4	72	288
4. HOMEC FOODS LAB (20 students)	1	96	96
5. HOMEC CLOTHING LAB (20 students)	1	96	96
6. HOMEC MODEL HOME (20 students)	1	62	62
7. EXTENSION LAB (20 students)	1	96	96
8. METAL WORKSHOP (20 students)	1	160	160
9. WOOD WORKSHOP (20 students)	1	160	160
		Net Total	1,870 m²
Common			
10. LIBRARY		400	400
11. ADMINISTRATION		500	500
12. CLINIC	1	64	64
13. LAUNDRY	1	130	130
14. DINING HALL (Seat 160 students)	2	240	480
15. KITCHEN	1	450	450
16. SERVERY	1	50	50
17. PRINT ROOM	1	60	60
18. STUDENT COMMON ROOMS	1	300	300
19. SPORTS STORE & CHANGING	1	80	80
		Net Total	2,514 m²
Student Housing			
20. HALLS OF RESIDENCE (40 students)	16	240	3,840
		Net Total	3,840 m²

BUILDING TYPE	NO.	UNIT AREA m²	TOTAL AREA m²
Staff Housing			
21. TYPE B STAFF HOUSING	1	140	140
22. C " "	11	120	1,320
23. D " "	26	90	2,340
24. E " "	23	50	1,150
25. F " "	25	40	1,000
26. GUESTHOUSE			130
27. GUESTHOUSE			80
		Net Total	6,160 m²
Animal Facilities			
28. COVERED FIELD TEACHING AREA		80	80
29. FEED STORE		30	30
30. MILKING PARLOUR FOR 8		55	55
31. CALF SHED (estimated)		40	40
32. POULTRY HOUSE FOR 1500		80	80
33. PIG SHEDS FOR 20		80	80
34. GOAT/SHEEP SHEDS FOR 10/50		20/75	95
35. HAY STORAGE, CATTLE & SHEEP DIPS, SPRAY RACE, CRUSH, FENCING, GATES		60	60
		Net Total	520 m²
Crop Facilities			
36. COVERED FIELD TEACHING AREA		80	80
37. HORTICULTURE STORE and MARKET SHOP		25/25	45
38. DEMONSTRATION SHED		15	15
39. GREENHOUSE		30	30
40. SILKWORM HOUSE		20	20
41. SCREENHOUSE		50	50
		Net Total	240 m²
Utility			
42. VEHICLE/IMPLEMENT SHED FOR 12 VEHICLES			180
43. VEHICLE & EQUIPMENT MAINT.		220	220
44. ESTATES (Buildings & Grounds)		220	220
45. CENTRAL STORES		200	200
		Net Total	820 m²

BUILDING TYPE	NO.	UNIT AREA m²	TOTAL AREA m²
Other			
STAFF OFFICES (not included above)			200
PREPARATION ROOMS, SERVICE AREAS, STORES			250
STUDENT and STAFF TOILETS			120
ADD 20% for WALLS, CIRCULATION			4,000
		Gross Total	20,534 m²

The following is a listing of staff offices that are located as conveniently as possible in the buildings scheduled above:

Administration Building			
1. PRINCIPAL	1	20	20
2. DEP. PRINCIPAL	1	15	15
3. REGISTRAR	1	15	15
4. DIR. OF STUDIES	1	12	12
5. ADMIN. SECRETARY	1	10	10
6. BURSAR	1	10	10
7. EXEC. OFFICER	1	10	10
8. SECRETARY	3	15 (2 per office)	45
COPY TYPISTS	3		
9. ACC. CLERK/CLERKS	4	30 (4 " ")	30
10. TELEPHONE OPERATOR	1	8	8
Academic Buildings			
11. HEADS OF DEPT.	7	10	70
12. LECTURERS	8	10	80
13. ASST. LECTURERS	15	15 (2 " ")	120
14. DEMONSTRATORS	10	(Offices not provided)	
15. LAB. ASSISTANTS	4	(2 per PREP. LAB)	-
16. LIBRARIAN	1	10	10
17. GAMES OFFICER	1	10	10
18. RESIDENCE SUPERINT.	1	10	10
19. MATRON	1	8	8
20. HEAD CATERER	1	8	8
21. HEAD LAUNDRYMAN	1	8	8
22. STORE KEEPER	1	8	8
23. FARM MANAGER	1	10	10
24. FARM COORDINATOR	1	10	10

Floor Area Summary

CATEGORY	UNITS	NET AREAS
ACADEMIC	12 classrooms, 7 labs, 1 model home, 2 workshops	1870 m^2 (20,000 $ft.^2$)
COMMON	Library, Administration, Clinic, Dining Hall, Kitchen Laundry, Student Commons, Sports	2514 m^2 (27,000 $ft.^2$)
STUDENT HOUSING	16 units of 40 students in rooms of 4 students each	3840 m^2 (41,300 $ft.^2$)
STAFF HOUSING	86 units and 2 guesthouses (5 categories)	6160 m^2 (66,300 $ft.^2$)
FARM FACILITIES	For livestock, teaching, storage, demonstration, marketing	760 m^2 (8,200 $ft.^2$)
UTILITY	Estates, Vehnicles, Stores	820 m^2 (8,800 $ft.^2$)
OTHER	Service Areas, toilets, miscellaneous	4570 m^2 (49,000 $ft.^2$)
	TOTAL	20534 m^2(221,000 $ft.^2$)

Building Layout Plan Diagrams

The following series of drawings (Diagrams 17-32) show possible layout plans for the scheduled buildings, based upon the design criteria discussed in the following subsection, "Design for Comfort."

Design for Comfort

To produce optimum comfort conditions, the design of each building should be guided by the following principles:

a) Natural lighting, ideally multi-directional
b) Natural through ventilation
c) Limiting the effects of solar heat gain
d) Limiting reliance upon artificial lighting, mechanical ventilation and other services.

Generally, rooms should be arranged single-depth, with windows on two opposite sides facing north and south and protected by generous roof overhangs. The room depth should be limited to ensure an adequate level of lighting in the centre of the room. Gable walls and the roof should be designed to prevent a temperature build-up in the room.

BUILDING BLOCK PLANS

90

academic

classrooms 10

lecture rooms 2

biology 2

chemistry 2

metal

homec 2
laboratories

extension

wood workshop

library

dining halls 2

student common rooms

kitchen + laundry

administration

student housing

stores

estates

estates

vehicle shed

clinic

sports

student housing 16

misc

guests

farm

feed + hay

calf + goats

dairy

pigs

type f 24 houses

teaching

shop

screenhouse

poultry

type e 24 houses

staff housing

type c 11 houses

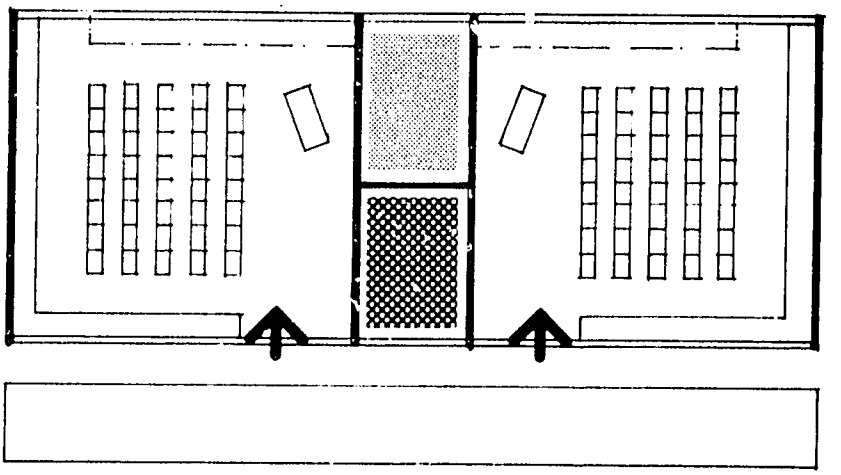
type d 26 houses

1:2000

note : servants quarters, toilet blocks and service areas are not shown . see schedule of accommodation

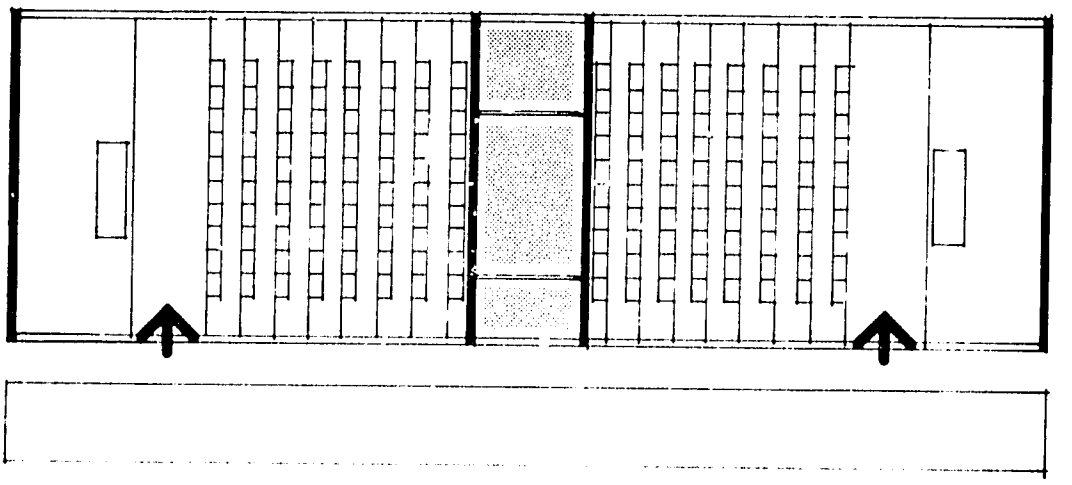
DIAGRAM 17

CLASSROOMS



5 units of 2

classroom 40 students



1 unit of 2

lecture 80 students

scale 1:200

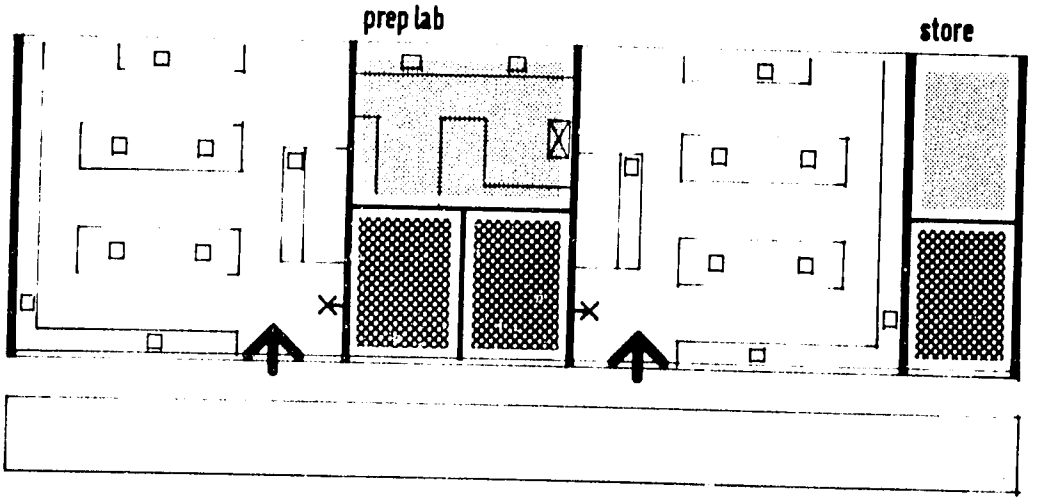
key

service areas

offices

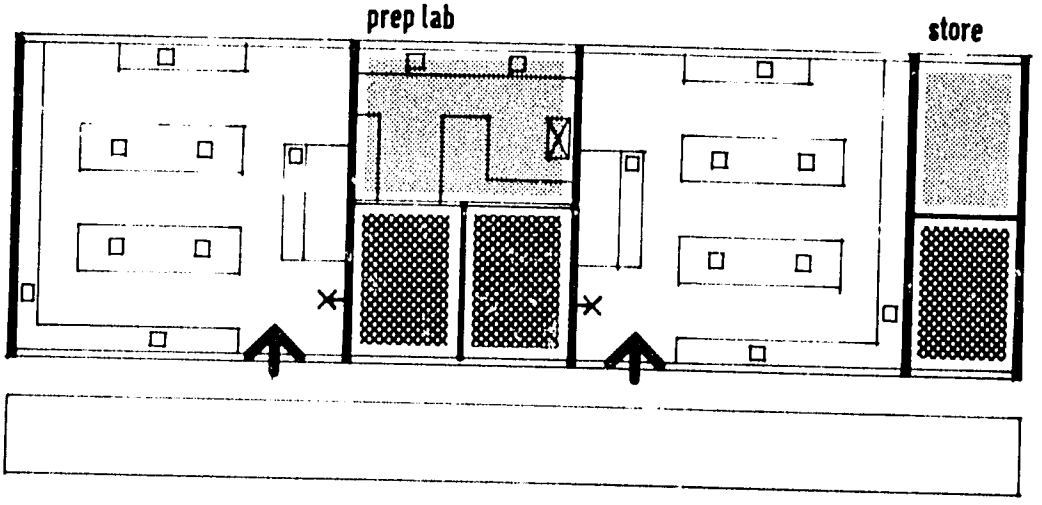
DIAGRAM 18

LABORATORIES



1 unit

biology 20 students



1 unit

chemistry 20 students

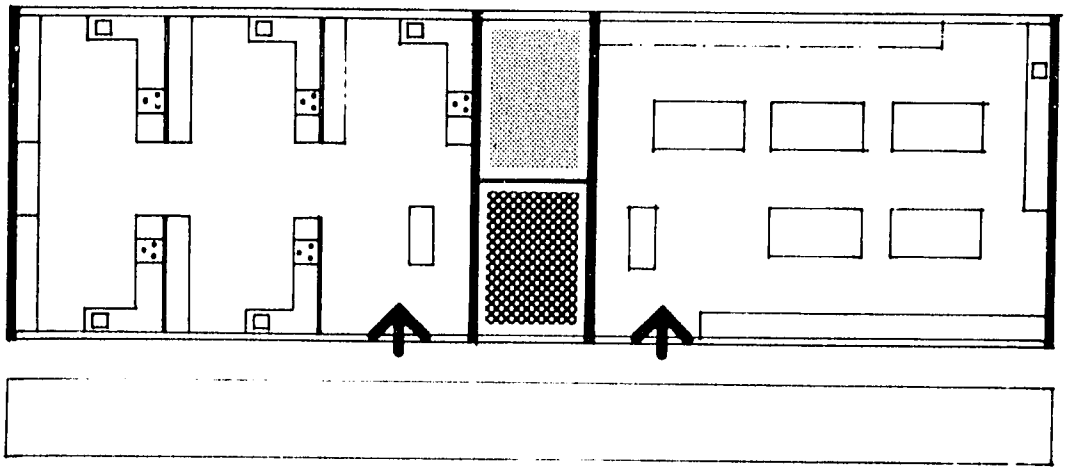
scale 1:200

key

- service areas
- offices
- sink
- fume cupboard
- emergency shower

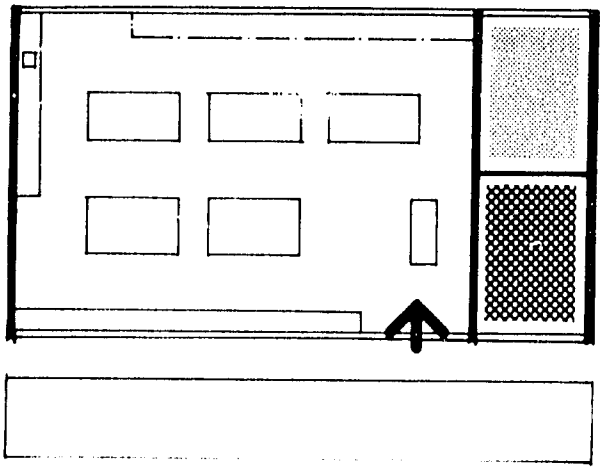
DIAGRAM 19

LABORATORIES



1 unit

home economics 20 students



1 unit

extension 20 students

scale 1:200

key

service areas

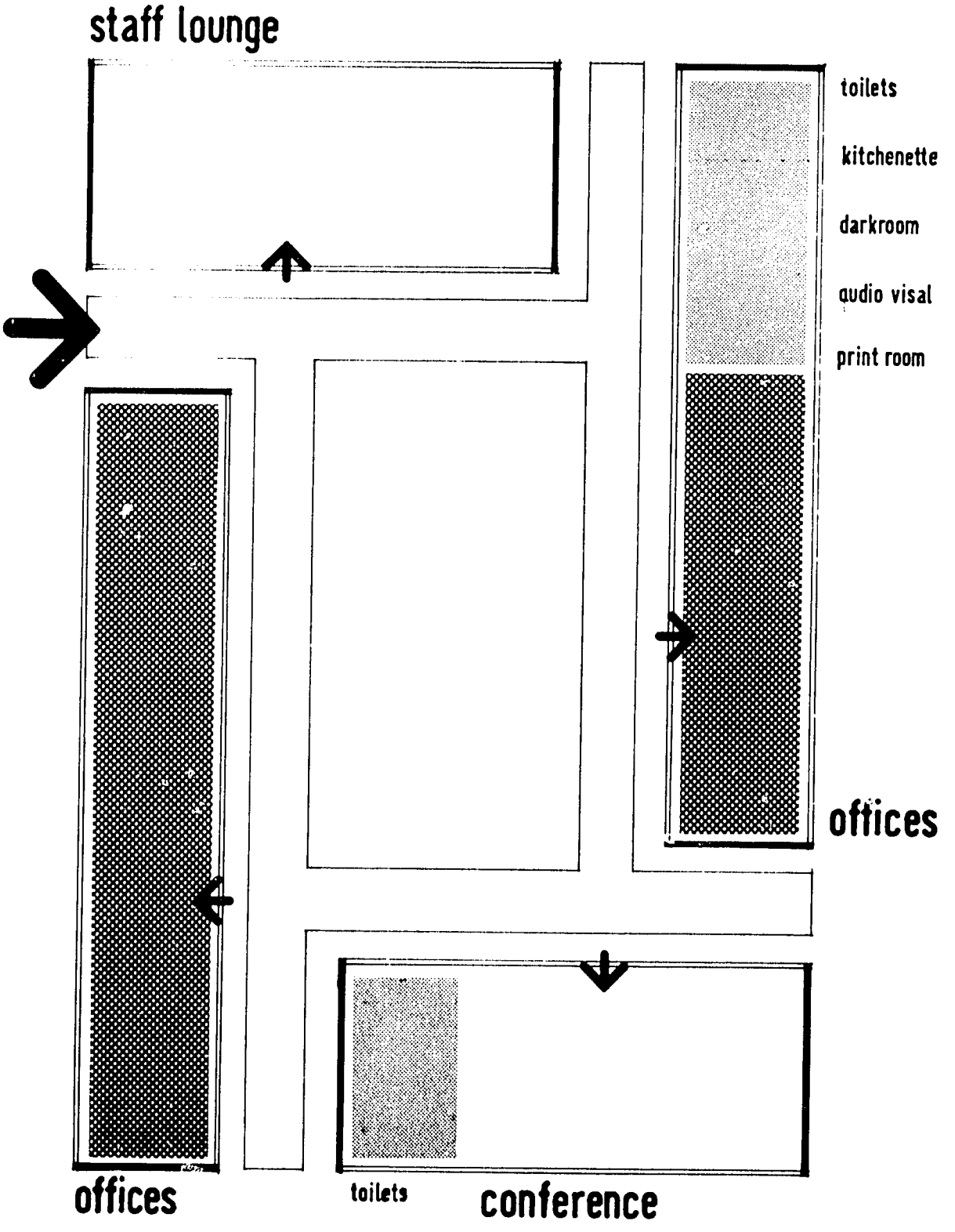
offices

cooker

sink

DIAGRAM 20

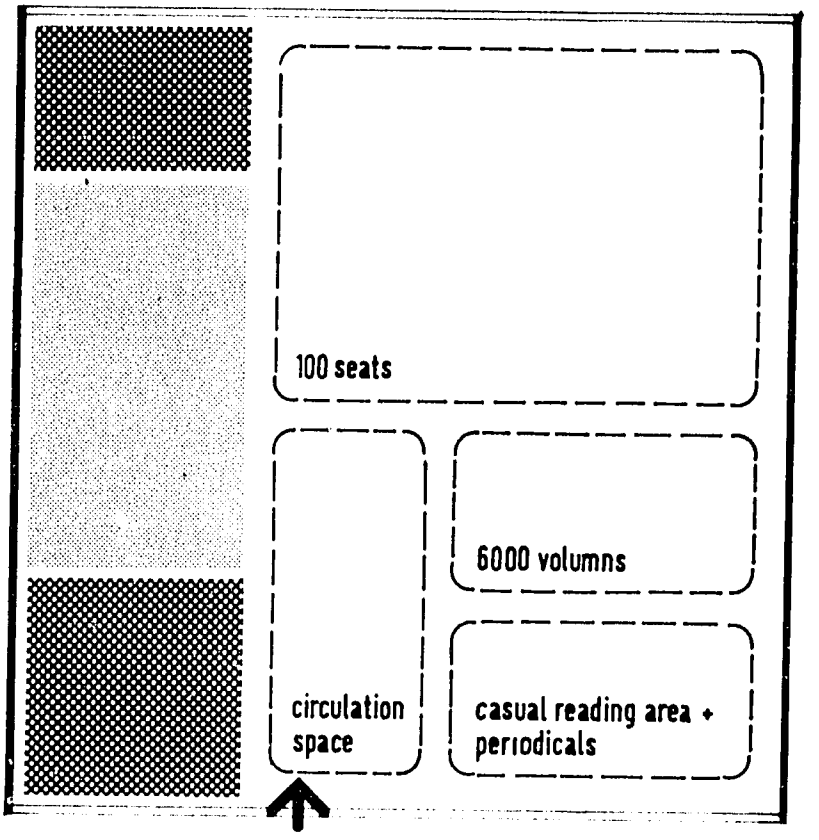
ADMINISTRATION

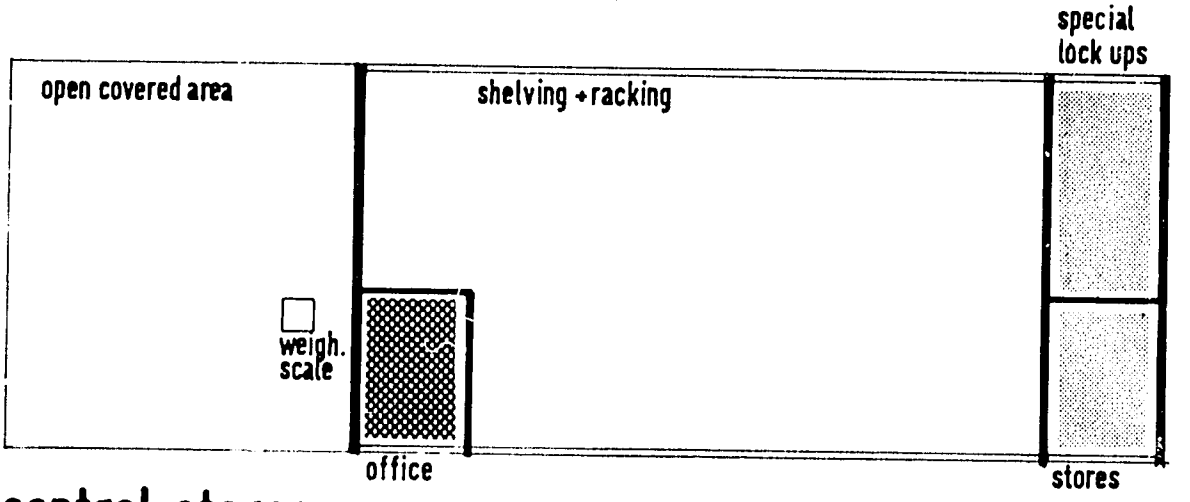


scale 1:200

DIAGRAM 21

LIBRARY

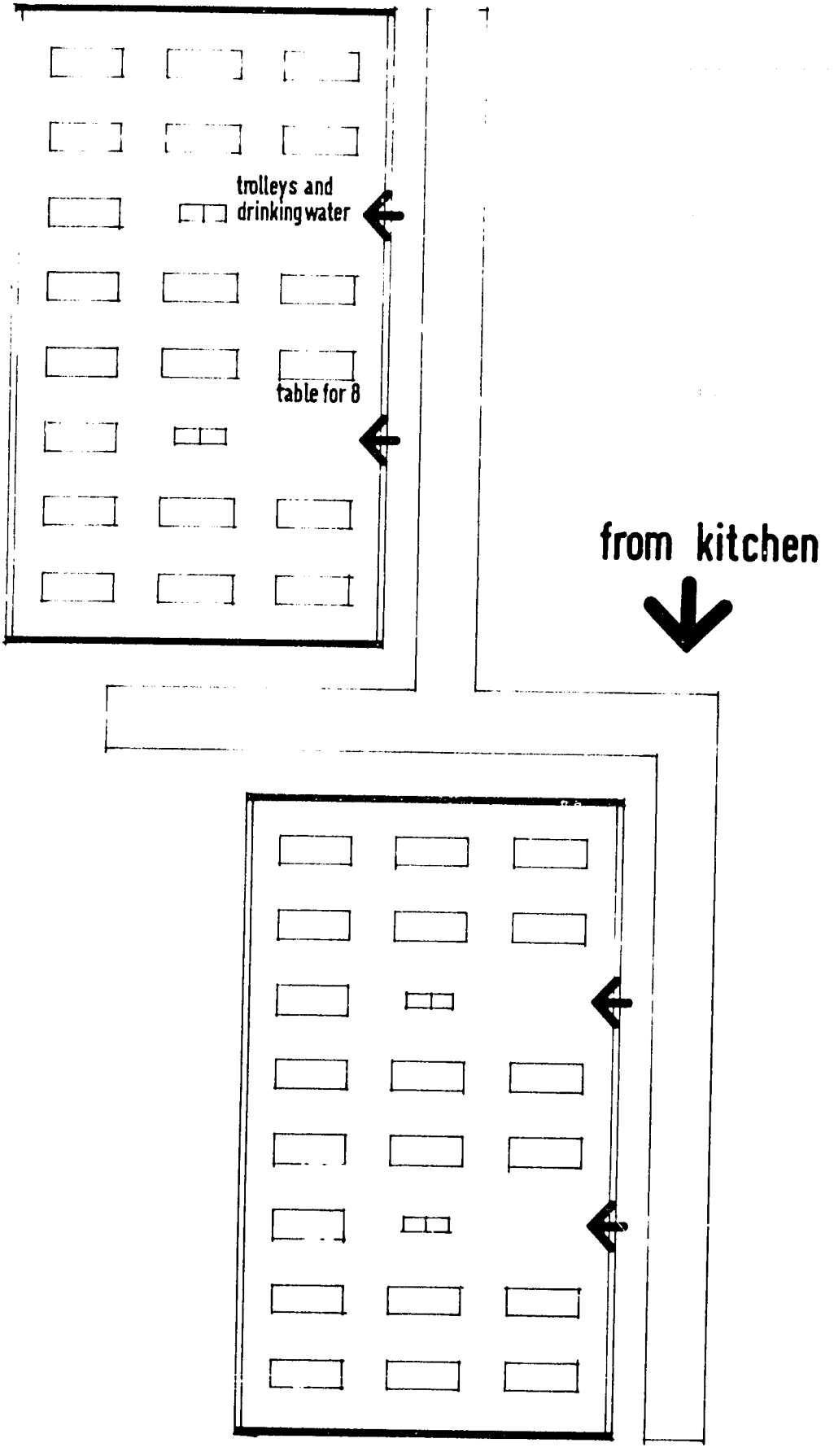




central stores

DIAGRAM 22

DINING HALLS



dining 160 x 2

DIAGRAM 23

KITCHEN + LAUNDRY

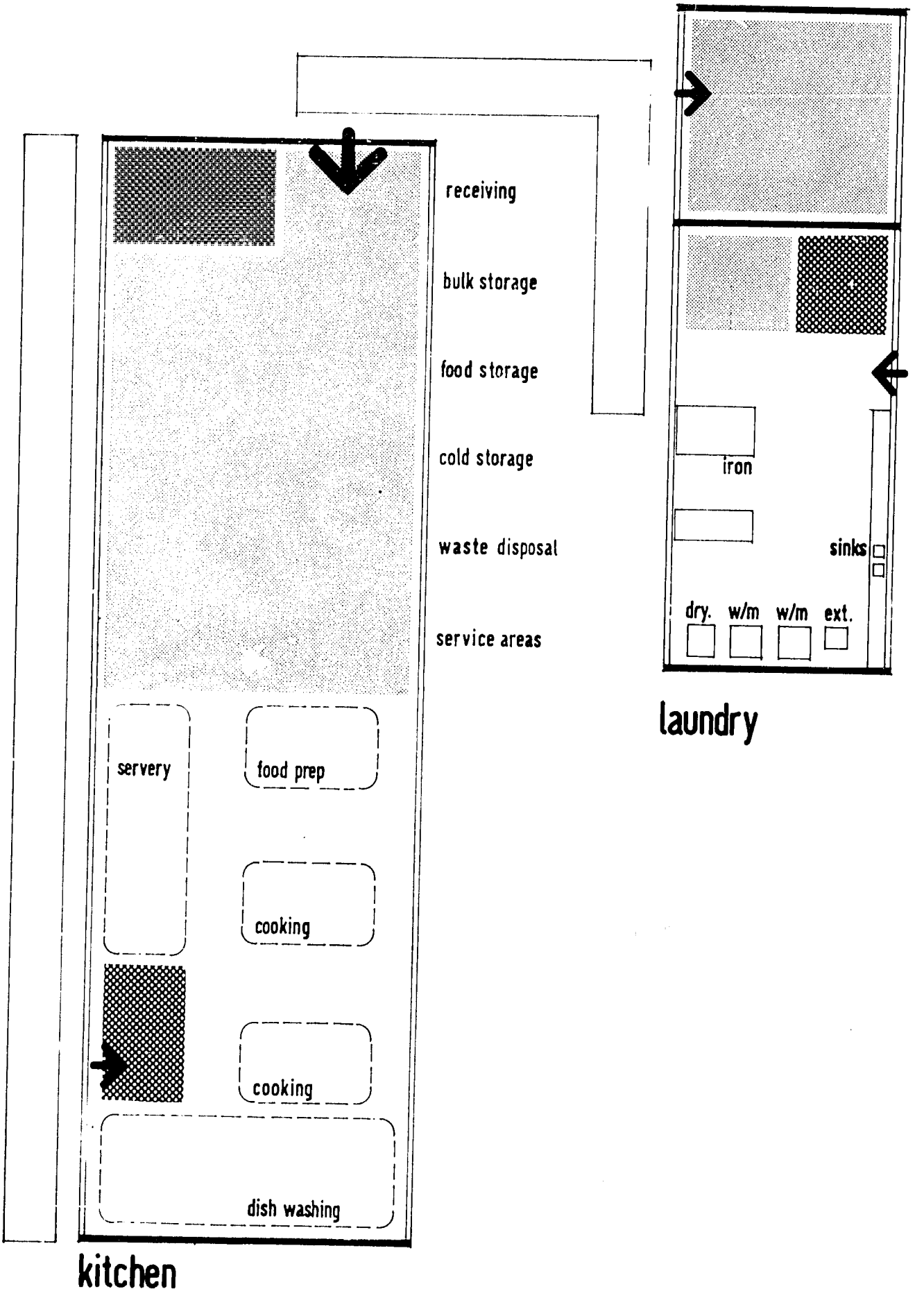


DIAGRAM 24

STUDENT COMMON ROOMS

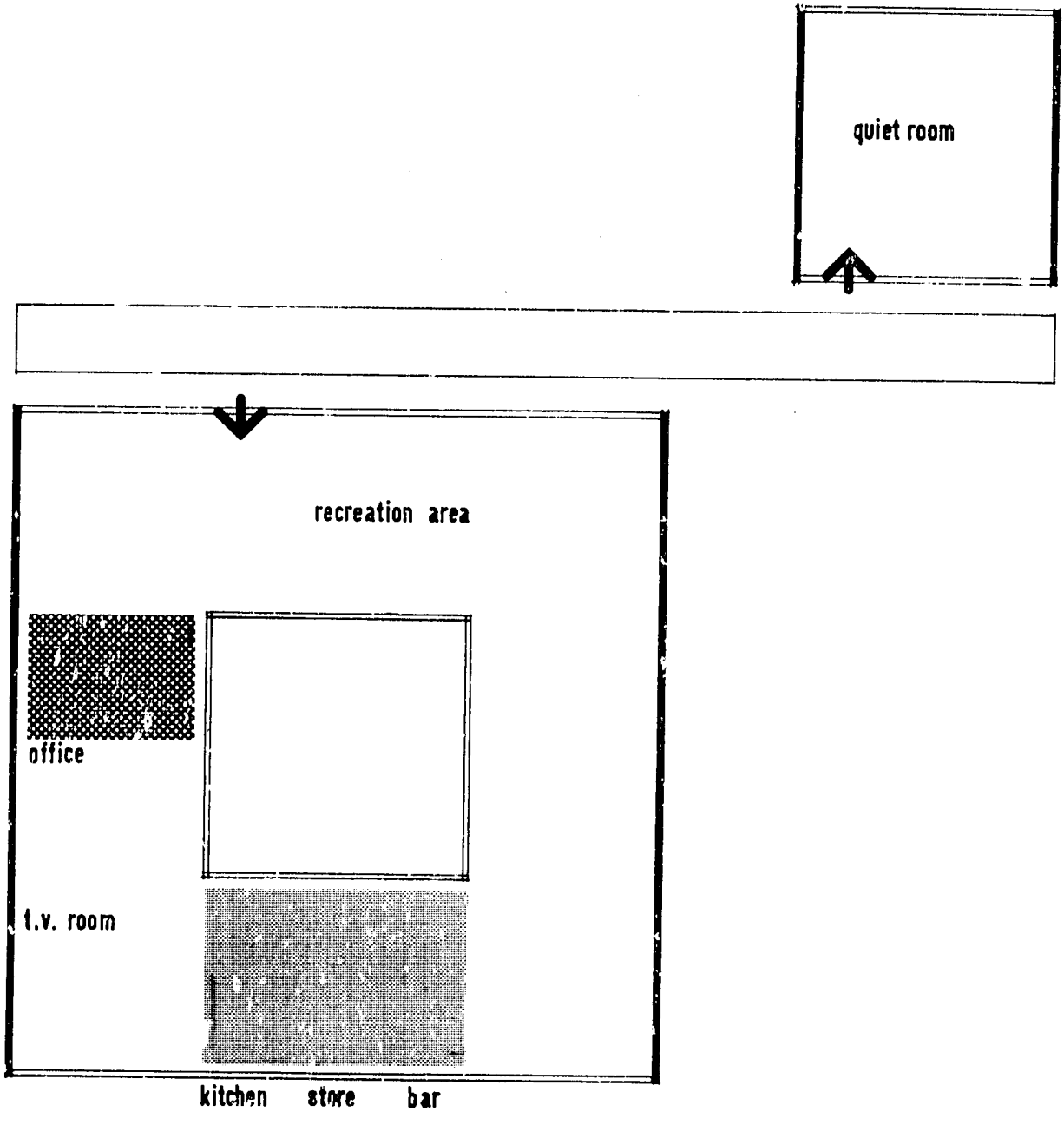
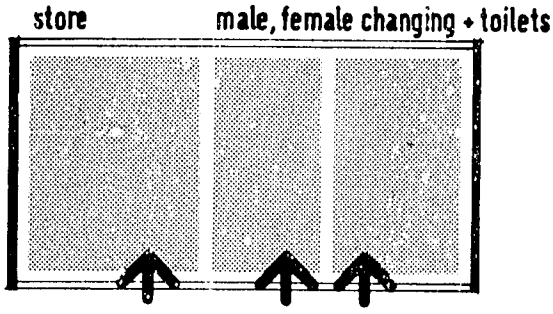
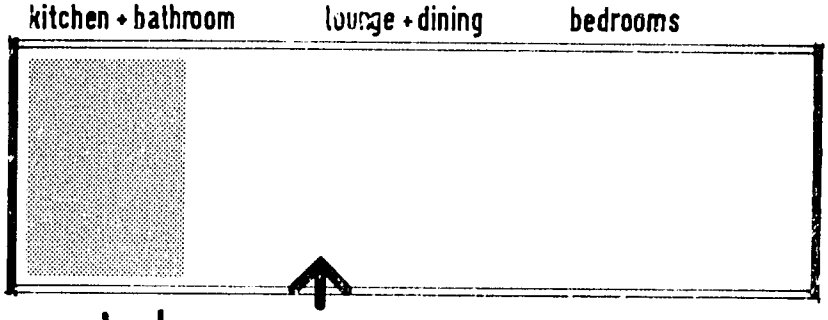


DIAGRAM 25

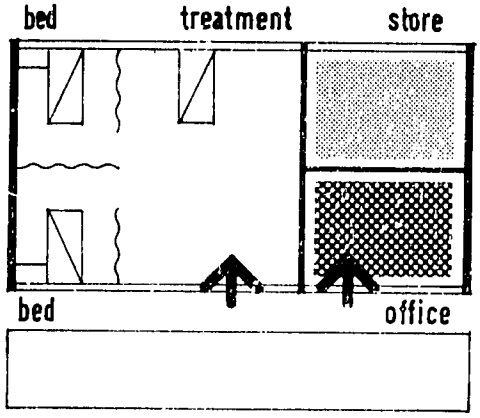
OTHER COMMON FACILITIES



sports



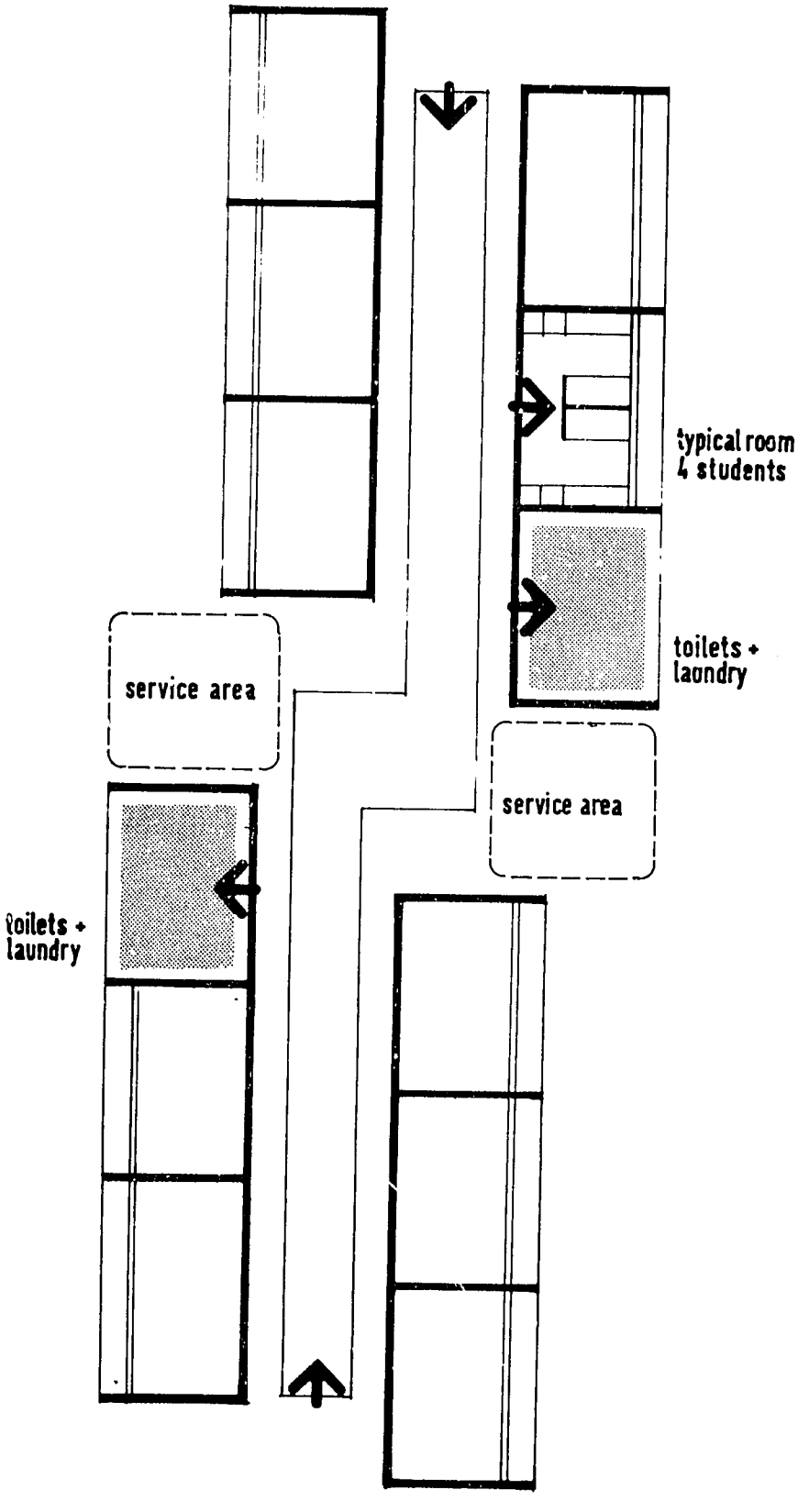
guest house



clinic

DIAGRAM 26

STUDENT HOUSING

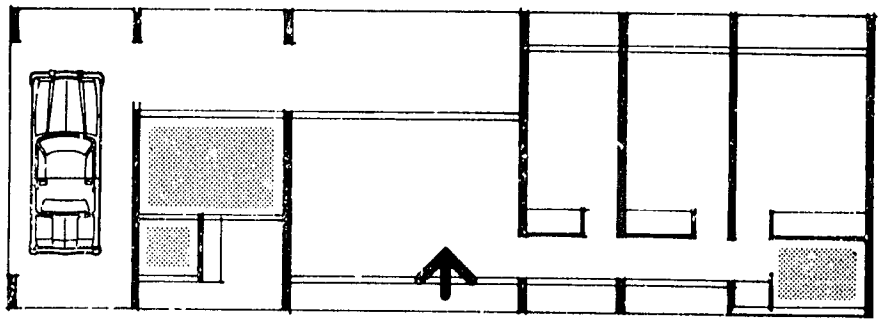


typical hall 40 students

16 units

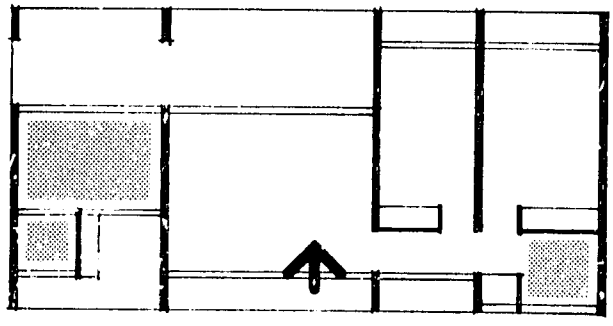
DIAGRAM 27

STAFF HOUSING



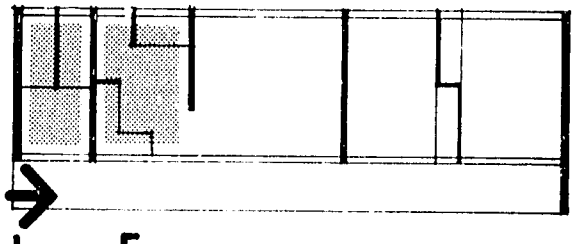
11 units

type C senior staff



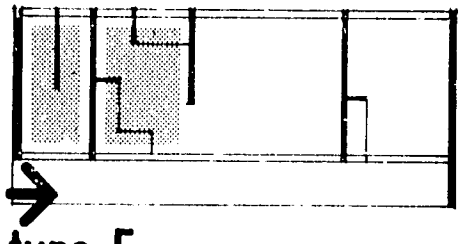
26 units

type D junior staff



24 units

type E intermediate staff



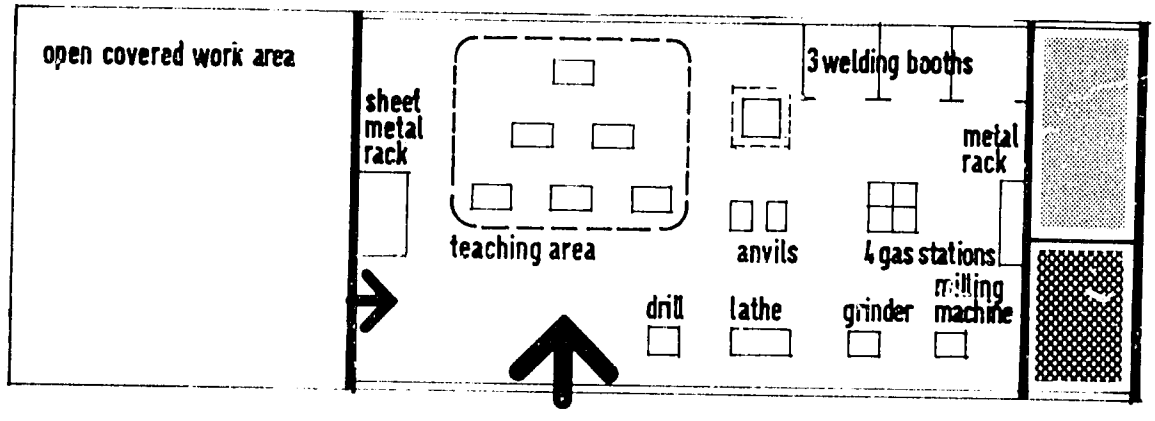
24 units

type F subordinate staff

note: 1 type B and 12 type G houses not shown.

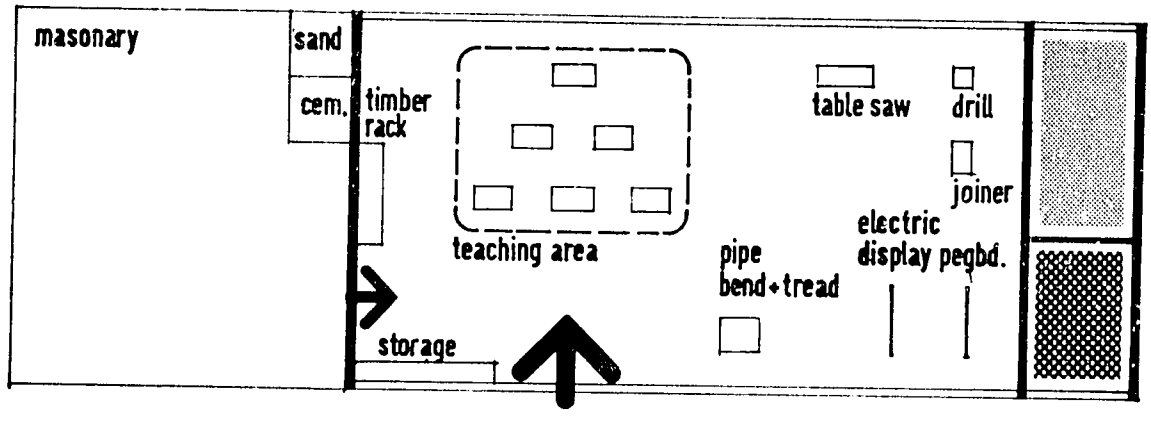
scale 1:200 DIAGRAM 28

WORKSHOPS



1 unit

metal and machines workshop 20 students

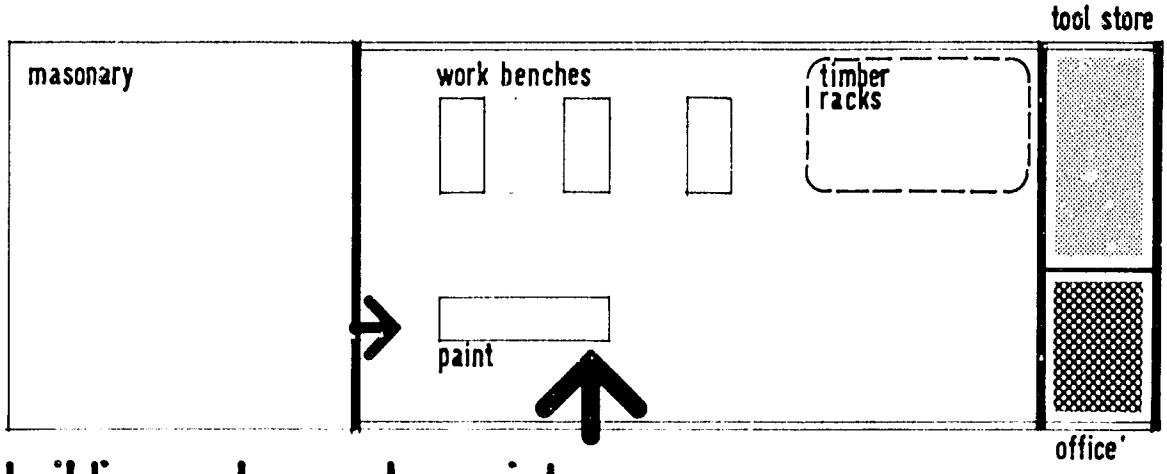


1 unit

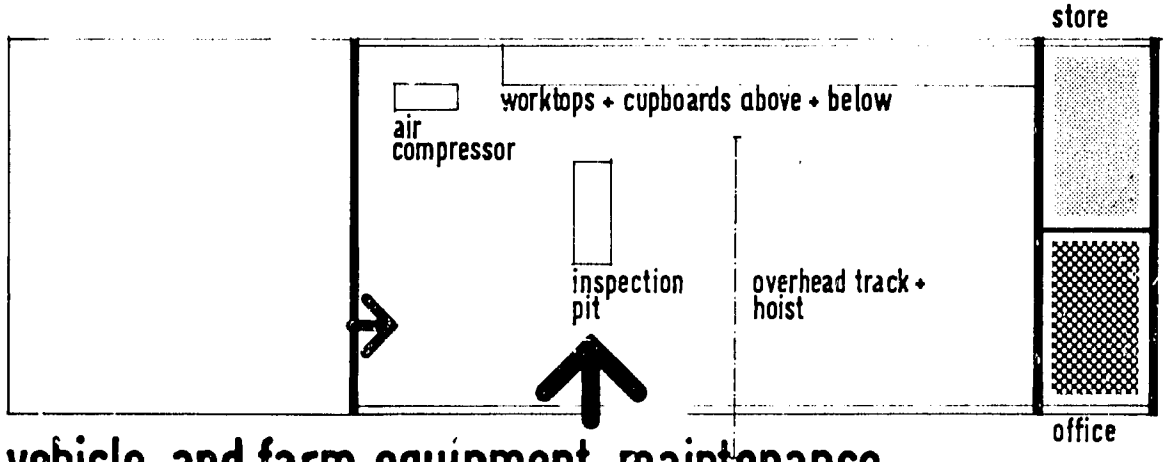
farm structures and wood workshop 20 students

DIAGRAM 29

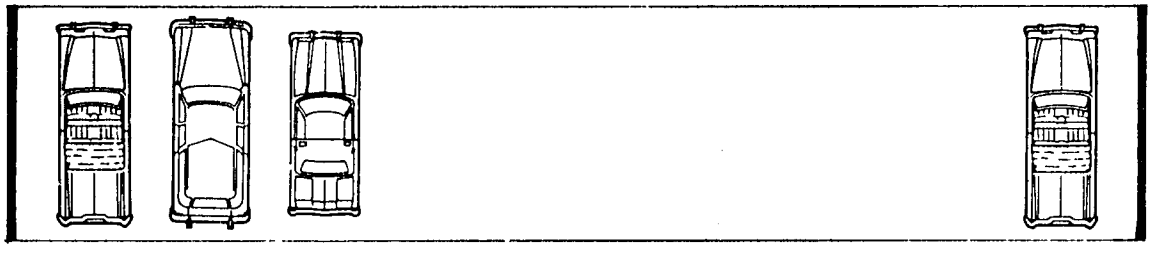
ESTATES



building and grounds maintenance



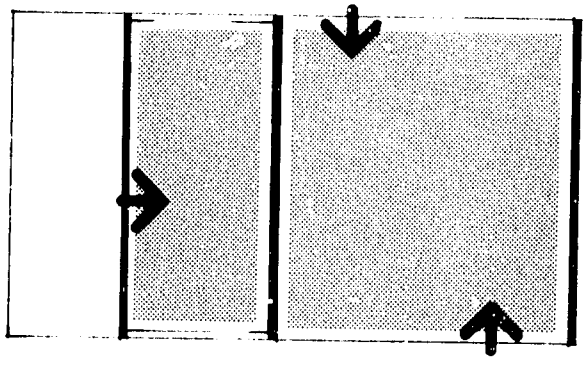
vehicle and farm equipment maintenance



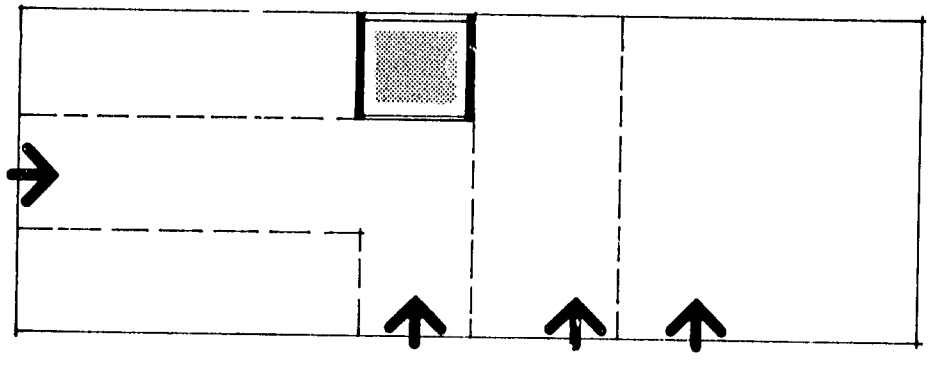
vehicle sheds

DIAGRAM 30

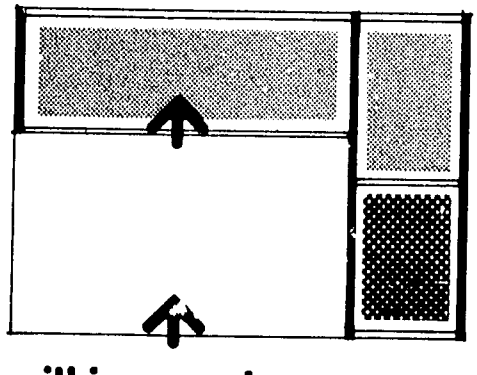
FARM



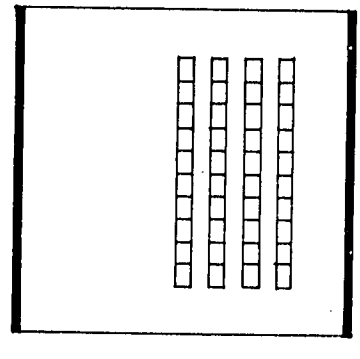
feed store hay store



calf pens goat + sheep pens



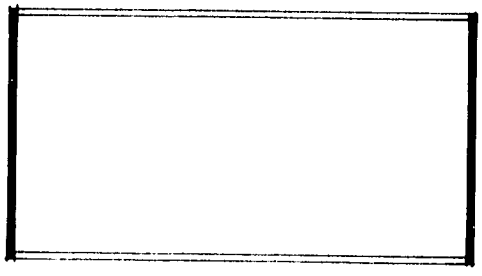
milking parlour



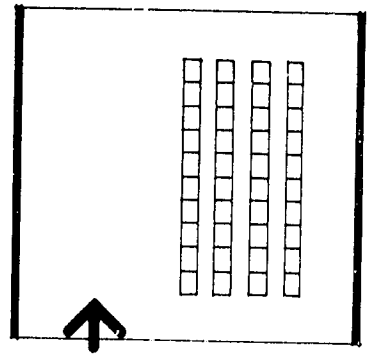
teaching area

DIAGRAM 31

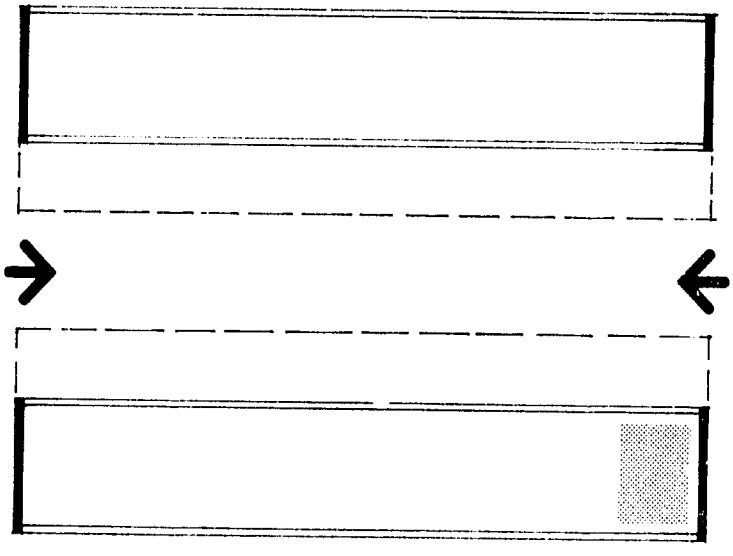
FARM



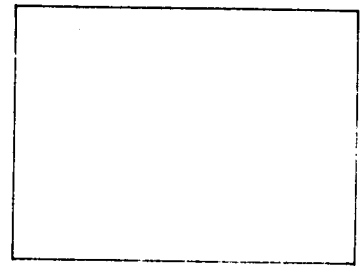
poultry



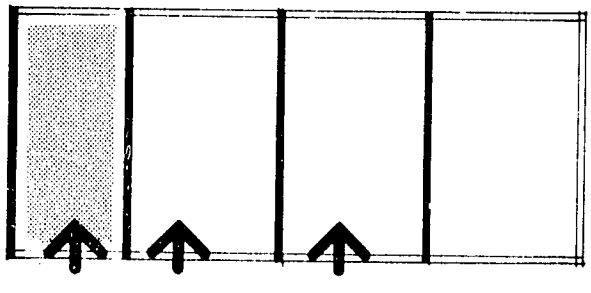
teaching area



pigs



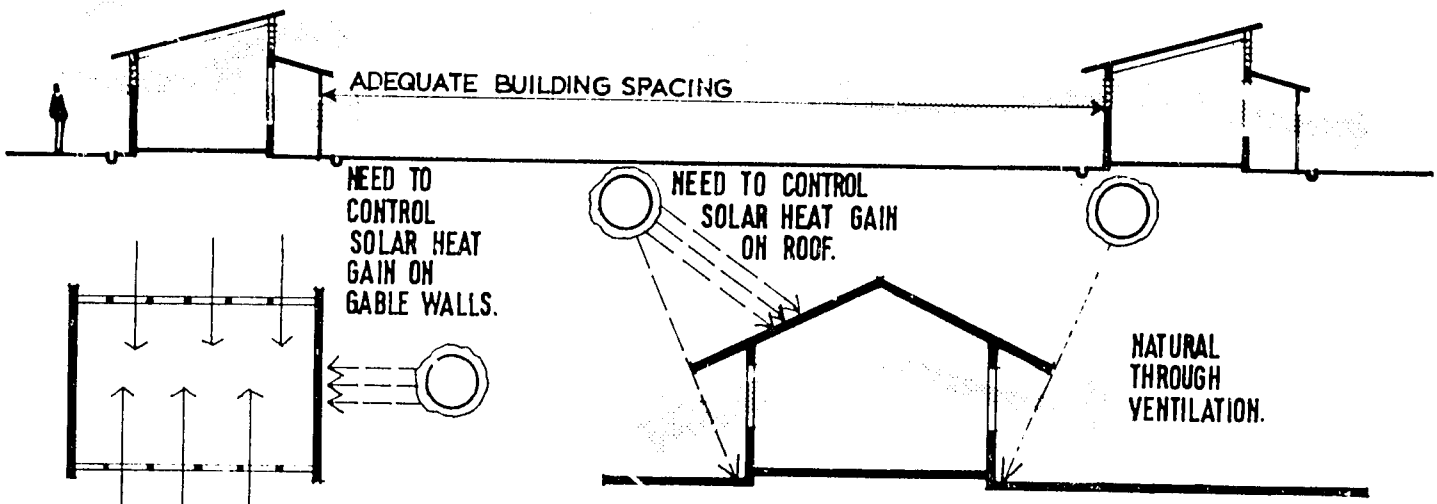
screenhouse



demo produce shop silkworms

DIAGRAM 32

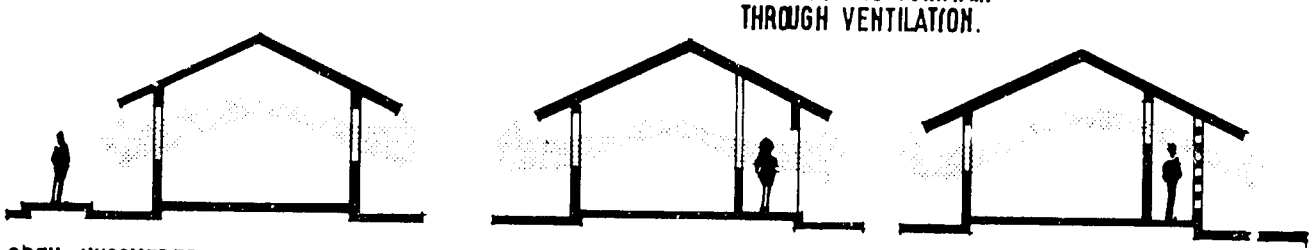
CLIMATE CONTROL



NATURAL LIGHTING FROM OPPOSITE SIDES.

EAVES OVERHANG: DESIGNED TO KEEP SUN OFF WALL.

ESSENTIAL TO MAINTAIN THROUGH VENTILATION.

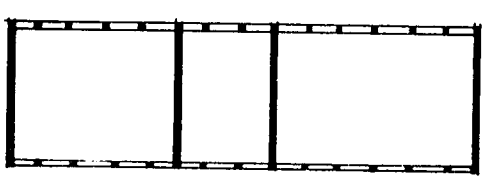


OPEN, UNCOVERED CIRCULATION.

OPEN, COVERED CIRCULATION.

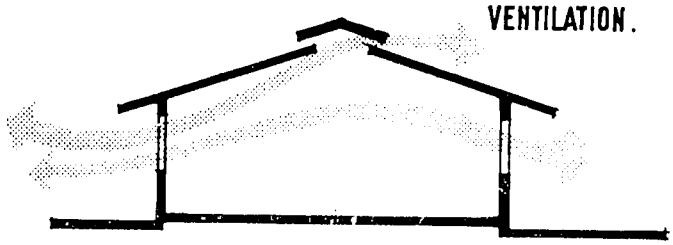
ENCLOSED, COVERED CIRCULATION.

EAST / WEST AXIS.



OPEN, COVERED WALKWAY.
LONG RECTANGULAR PLAN FORM WITH GABLE WALLS.
LIMITED IN AREA.

THROUGH VENTILATION.



INTRODUCTION OF VENTILATION AT RIDGE FOR DEEPER PLAN BUILDINGS WHERE SUITABLE FOR FUNCTION.

DIAGRAM 33

Design for Comfort (continued)

Particular care should be given to insulation and thermal capacity of wall and roof elements (see alternative construction techniques examined). By arranging rooms side by side on an east-west axis, a long, narrow plan form evolves where the limited room depth automatically limits the gable wall areas which are exposed to much of the sun's radiation.

The following is quoted directly from "Design for Climate Guidelines for the Design of Low Cost Houses for the Climates of Kenya," in reference to the Coastal context.

Day Comfort - "Ventilation that facilitates convective and evaporative cooling of the body is essential for comfort both during the day and night. Therefore, the prime design objectives are to provide free air movement through the house while preventing internal surface temperatures from rising above the outdoor shade temperature. Nevertheless, during hot afternoons it is always likely that cooler conditions will prevail under a large shade tree than indoors."

Night Comfort - "Nights, which are often still and sultry, bring little or no relief to the heat of the day. In fact indoor conditions are often more oppressive at night than during the day. The minimizing of discomfort at night is of utmost importance if sleep is not to be disturbed." "Houses must therefore be designed so that indoor temperatures closely follow even small drops in the outside temperatures at night."

Living habits - "Muslim influence is strong at the Coast and this is borne out by the importance that the coastal peoples attach to privacy in the home especially for women. The Swahili people are, however, adaptable as evidenced by those who have adjusted, albeit not always out of choice, to living in multi-storey flats."

"Lunch, tea, and, mosquitoes permitting, supper are commonly taken out-of-doors whether on a verandah or balcony, or in a courtyard. Internal rooms are in fact little used during the day except perhaps by women resting after completing their daily duties or by men for entertaining when no shaded space outside is available. Nonetheless, the use of internal rooms is increasing and will continue to do so. On the hottest nights some like to sleep out in a courtyard, while others will rest outside on the front baraza (wall seat) until the approach of mid-night before moving indoors to sleep."

Housing layouts - "Housing schemes should be laid out in a manner that creates the minimum of obstruction to winds. This usually implies a well-spaced layout. The generous spacing of houses is also advantageous with respect to noise, since it reduces the degree of disturbance between one house and another. Breezes should not be blocked by houses but rather channelled from one to another."

"Compact layouts that severely restrict air flow, long apartment slabs that block prevailing winds and thereby create large areas of calm in their lee, and long rows of houses lining straight streets that tend to channel breezes along are to be avoided. Informal layouts, that are freely grouped and that are substantially independent of the alignment of main roads, are preferable."

Spacing of houses - "Rule of thumb guides - e.g., that the distance between buildings, which are at right angles to the prevailing wind, should be at least seven times their height - can be used, but they do not replace the need for a careful understanding and predictions of air flow patterns in and around buildings."

Space between houses - "As the inhabitants of this zone spend most of their day outside, the intensively used living spaces between houses should be adequately exposed to prevailing breezes. Boundary walls should, if possible, be avoided. If, however, some kind of property demarcation is necessary, they should be in the form of open-spaced fences or perforated screens rather than solid walls."

Trees and plants - "The planting, or retaining of shade trees, especially mangoes which are noted for their excellent shade-giving properties, should be given high prioroity when planning housing layouts."

"Trees help to reduce glare from bright overcast skies and their leaves provide a degree of evaporative air cooling. Grass and plants are advantageous in that they minimize soil erosion--the erosion caused by water running off gutterless roofs has been known to seriously undermine foundations."

House form - "The form of houses at the Coast is primarily determined by the requirements that all habitable rooms plus the kitchen be cross-ventilated. This is most readily achieved in single-banked houses."

Orientation - "In spite of the prime importance of good ventilation, the orientation of houses should be determined by the predictable movement of the sun rather than by much less predictable and variable wind movement." "It is rarely if ever justifiable to vary significantly from a north-south orientation."

Courtyards - "Courtyards are traditional to the swahili house, the predominant urban house form at the Coast. They are intensively used by women for working and relaxing, by men for sleeping out on hot nights, by young children for playing by the whole family for eating, for cooking, and for drying clothes." "Courtyards within new houses, however, should be less enclosed and more exposed to prevailing breezes than are the courts in the swahili type houses."

Verandahs - "Verandahs have a significant advantage as outdoor living spaces over courtyards since being in the open they can be expected to be more airy. Verandahs should preferably be located on the north and south sides of houses, where they will provide shade both in the morning and evening." "Besides functioning as shaded outdoor living spaces, verandahs also perform the highly important function of shielding walls and

openings from the sun and the rain, besides virtually eliminating sky glare from interiors."

Ceiling height - "Large open roofs are useful if they facilitate the free flow of air through the house. The influence of the ceiling height itself, however, on the indoor climate tends to be grossly over-estimated. It is the ceiling's heat and not its height that is the decisive factor in determining internal comfort. There is minimal thermal advantage in having ceiling much higher than 2.4 meters."

Lightweight structures - "House structures in this zone should be light. Walls and roofs should have the minimum possible thermal storage capacities so that indoor temperatures at night can closely follow even small drops in outdoor temperature." "If heavy walls must of necessity be used they should be protected from solar radiation so as to minimize the quantity of heat absorbed and retained."

Walls -"The principle functions of walls in this zone are the exclusion of rain from interiors and the provision of a visual and possibly a mosquito barrier while permitting air to flow freely into the house. Light frame structures clad with some form of jalousie or lattice panels are appropriate, as are perforated block walls."

Driving rain - "When selecting wall materials and finishes it should be borne in mind that driving rain probably constitutes more of a problem at the Coast than elsewhere. Once a wall has become saturated, drying out is liable to be slow due to the high coastal humidity."

Choice of roof sheets - "Research studies have shown that the thermal performances of aluminium and asbestos sheets are superior to those of galvanized iron sheets and clay or concrete tiles."

Surface finishes - "Walls and roofs exposed to direct sunlight should be finished in a light colour, that is reflective to solar heat."

Area of openings - "Since air movement is so important for comfort at the Coast, the greater part of north and south elevations should, if possible, be open or openable."

Location of openings - "Adjustable louvre windows that can be opened to a few degrees beyond the horizontal are the most appropriate window type for use at the Coast. In bedrooms the lower louvres should be of an opaque material for the sake of privacy."

Louvre shutters - "Timber louvred shutters perform excellently at the Coast for, when shut they allow for the free entry of air while excluding sunlight and providing excellent security and privacy."

Permanent openings - "Since the demands of comfort require substantial air movement, as well as air change, all permanent openings should be of a generous size. All low level vents require screening to exclude rats, cats, snakes, etc. Some high level permanent ventilation, which might take the form of fixed timber louvred openings over doors and windows, is needed to prevent the build-up of hot air under the ceiling."

Security - "Occupants of low-cost dwellings regard security before comfort. Louvre windows should as a matter of course be fitted with horizontal security bars."

Flyscreens - "Flyscreens, in spite of their restricting effect on air movement, are probably welcome, cost permitting, for excluding mosquitoes, except on sites close to the open sea where stronger breezes keep their number down."

Building Grouping Determined by Frequency of Use

An analysis of the Educational Worksheets gives the frequency of use of the various classrooms, laboratories and practical areas, expressed as a percentage of the total academic day. (The table and chart, next page, sets out the analysis and the hierarchy of relationships developed). The hierarchy is based on the desire to limit walking distances and produce a relatively compact campus where, for greater convenience, those buildings in most frequent use are located near each other.

However, this analysis does not take into account the various other activities on site such as student housing, meals, sports, private study, etc. A typical student day has therefore been analyzed to put the academic activities into context.

Building Grouping Determined by Typical Student Day

An analysis of a typical student day to arrive at activity times as a percentage of a whole day has been carried out with a view to establishing a hierarchy of building use (see tables following pages).

ANALYSIS OF FACILITIES PROGRAMS W.C.P. = Weekly Class Periods

FACILITY	YEAR 1 W.C.P.	TERM 1 %	YEAR 2 W.C.P.	TERM 2 %	AVERAGE %
CLASSROOMS	174	44.2	186	55.4	49.8
CHEMISTRY LABS.	32	8.1	-	-	4.0
BIOLOGY LABS	32	8.1	-	-	4.0
HOMEC LABS	20	5.1	30	8.9	7.0
EXTENSION LAB	20	5.1	16	4.8	5.0
METAL WORKSHOP	12	3.0	12	3.5	3.3
WOOD WORKSHOP	24	6.1	-	-	3.0
FIELD ACTIVITIES	80	20.3	92	27.4	23.9
TOTAL	394	100	336	100	100

BUILDING HIERARCHY BASED ABOVE PERCENTAGES

1ST LEVEL	CLASSROOMS	49.8%
2ND LEVEL	FIELD ACTIVITIES	23.9%
3RD LEVEL	HOMEC LABS	7.0%
	EXTENSION LAB	5.0%
	CHEMISTRY LABS	4.0
	BIOLOGY LABS	4.0%
4TH LEVEL	METAL WORKSHOPS	3.3%
	WOOD WORKSHOP	3.0%

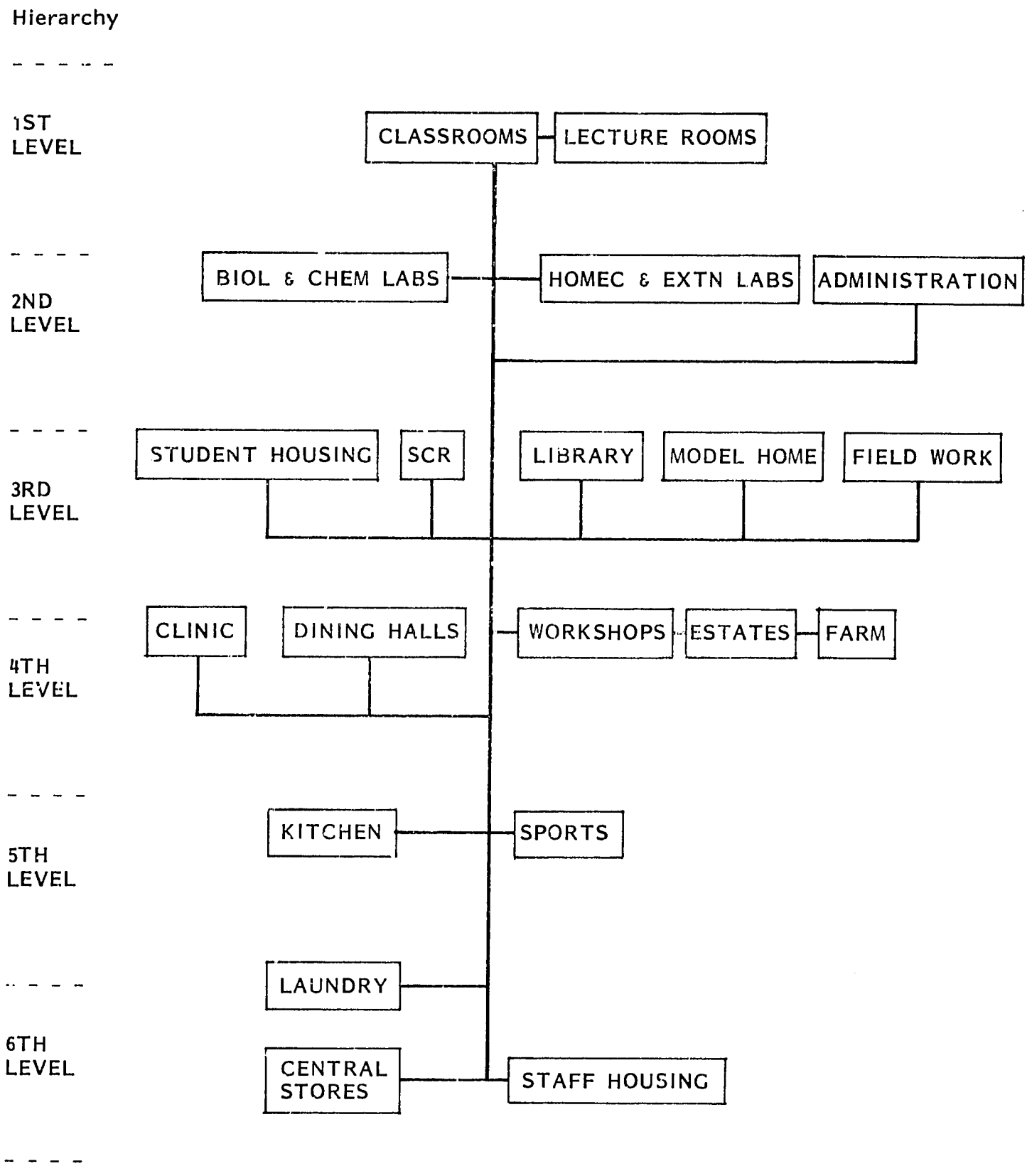
ANALYSIS OF TYPICAL STUDENT DAY

ACTIVITY	HOURS	TIME HRS.	% OF DAY
RISE, SHOWER & DRESS	6.30 - 7.00	0.5	2.1
BREAKFAST	7.00 - 8.00	1.0	4.2
MORNING CLASSES	8.00 - 12.30	4.5	18.7
LUNCH	12.30 - 1.30	1.0	4.2
AFTERNOON CLASSES	1.30 - 5.00	3.5	14.5
MISCELLANEOUS	5.00 - 5.30	0.5	2.1
SPORTS OR VEG. PLOTS	5.30 - 7.00	1.5	6.3
SHOWER & CHANGE	7.00 - 7.30	0.5	2.1
DINNER	7.30 - 8.15	0.75	3.1
JCR & STUDY	8.15 - 10.00	1.75	7.3
SLEEPING	10.00 - 6.30	8.5	35.4
TOTAL		24	100

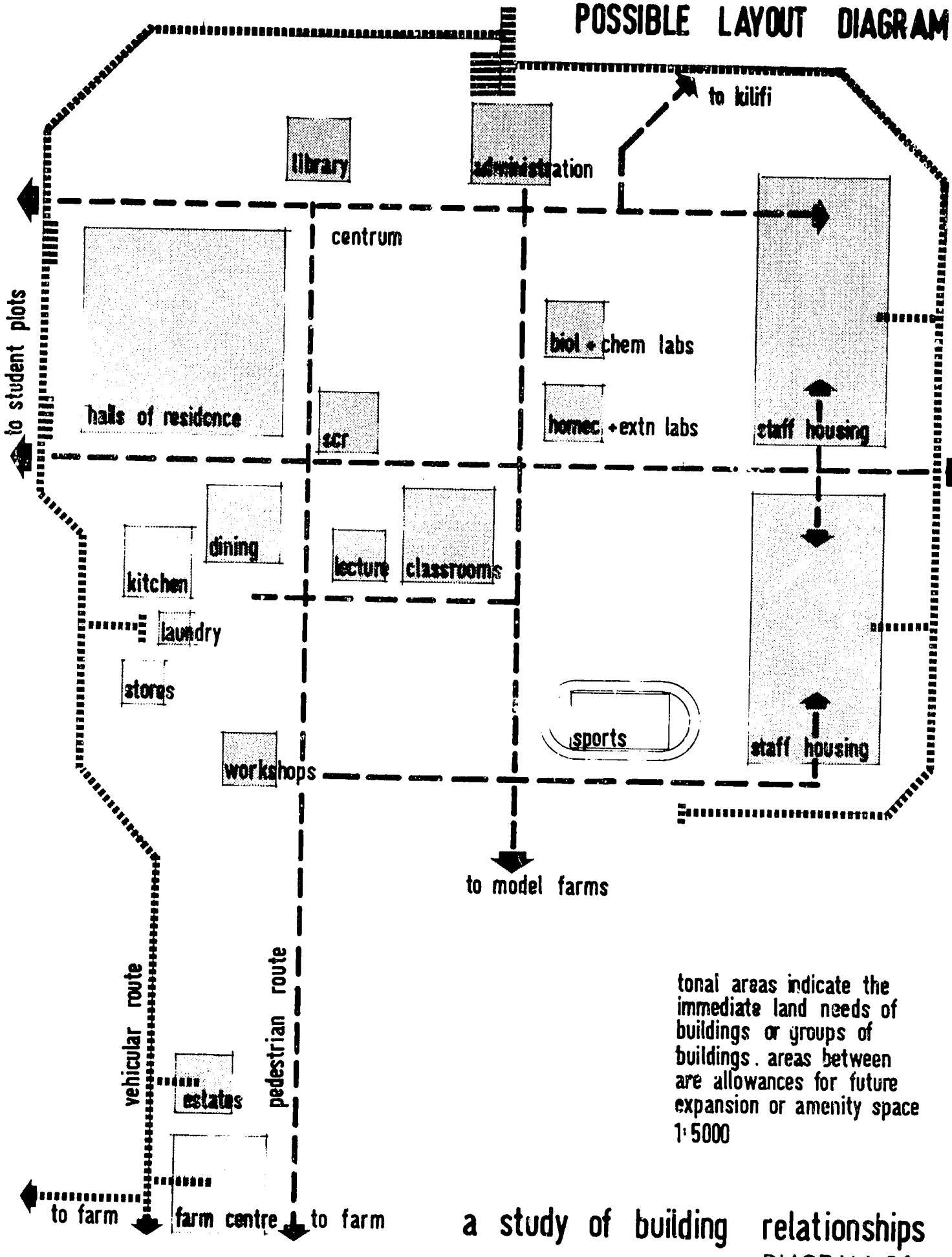
BUILDING HIERARCHY BASED ON ABOVE PERCENTAGES

1ST LEVEL	HALLS OF RESIDENCE	35.4%
	CLASSROOMS	33.2%
2ND LEVEL	DINING HALL	11.5%
3RD LEVEL	JCR &/OR PRIVATE STUDY	7.3%
	SPORTS &/OR VEG. PLOTS	6.3%
4TH LEVEL	SHOWER & CHANGING	4.2%

COMPOUND CHART OF BUILDING RELATIONSHIPS



POSSIBLE LAYOUT DIAGRAM



tonal areas indicate the immediate land needs of buildings or groups of buildings. areas between are allowances for future expansion or amenity space
1:5000

a study of building relationships

DIAGRAM 34

Land Around Buildings

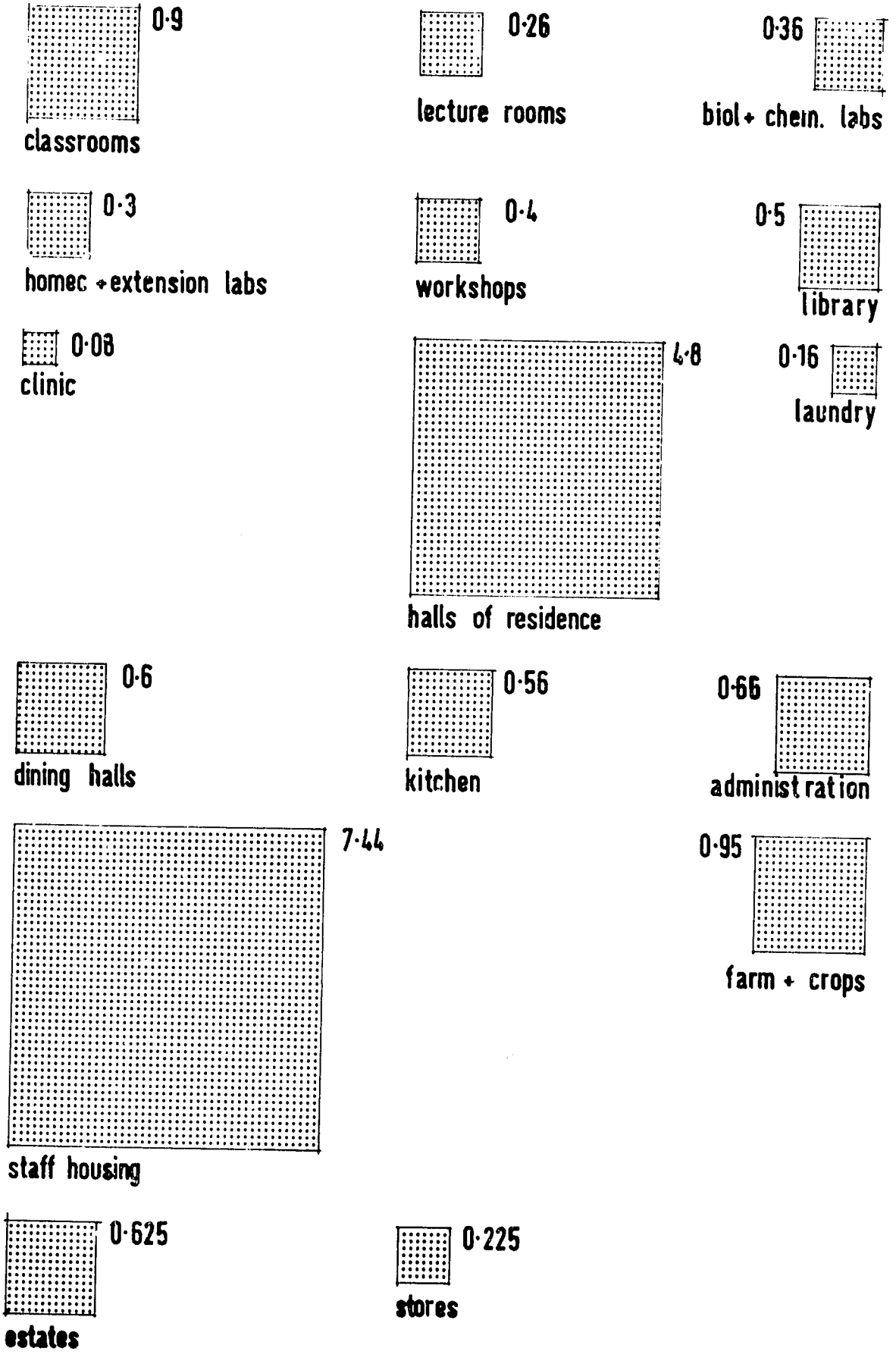
Yoshinobu Ashihara has formulated the "one-tenth" theory which stated that " . . . in the design of exterior space, a scale that is about eight to ten times that of interior space is adequate." The higher proportion was adopted to calculate the approximate land needs for the buildings. See table below.

LAND NEEDS

BUILDING	BUILDING AREA m^2 GROSS	LAND AREA m^2	DIMENSION OF SQUARE PARCEL OF LAND
1. LECTURE CLASSROOMS	360	3,600	60 x 60
2. CLASSROOMS	900	9,000	95 x 95
3. CHEM & BIOL LABS	360	3,600	60 x 60
4. HOMEC & EXTN LABS	300	3,000	55 x 55
5. HOMEC MODEL HOME	19	190	14 x 14
6. WORKSHOPS (M + W)	400	4,000	63 x 63
7. LIBRARY	500	5,000	71 x 71
8. ADMINISTRATION	660	6,600	81 x 81
9. CLINIC	80	800	28 x 28
10. LAUNDRY	160	1,600	40 x 40
11. DINING HALLS	600	6,000	77 x 77
12. KITCHEN	560	5,600	75 x 75
13. SERVERY	60	600	25 x 25
14. HALLS OF RESIDENCE	4,800	48,000	219 x 219
15. STAFF HOUSING	7,440	74,400	273 x 273
16. FARM + CROPS BUILDINGS	950	9,500	98 x 98
17. ESTATES	625	6,250	79 x 79
18. STORES	225	2,250	47 x 47

Note: Small Service buildings have been excluded.

BUILDING LAND NEEDS



areas in hectares
scale 1:5000 DIAGRAM 35

OUTLINE SPECIFICATIONS

Alternatives Examined

Alternative building construction techniques using local materials were examined, each selected as being simple, economic, and in common use in Kenya. For purposes of cost comparison, classrooms, lecture rooms, and workshop buildings were used as they all need relatively large clear spans. A structural bay of 6.0 m was assumed for this exercise. For cost comparison purposes the same finishes were specified for each construction technique.

Construction Technique 1

Walls - Reinforced concrete columns at 6,000 cc supporting R.C. ring beam. Columns supported on R.C. pad foundations at depth to suit soil conditions. Non load-bearing infill walls of 200 mm thick concrete blocks on strip R.C. foundation, with glass louvre windows in S.W. subframe to underside of R.C. ring beam. Blockwork to be reinforced every other course with 25 x 16 B.W.G. hoop iron.

Floor - In situ mass concrete reinforced with fabric mesh on polyethylene sheet D.P.M. on sand blinding (base) on hardcore (gravel) treated with insecticide.

Finishes - Two coat plaster to walls with mist and two full coats vinyl emulsion paint. Sand-cement screed to floors with anti-dust and hardener additivies, painted finish. Cement skirtings with finish as floor.

Roof: Alternative A

"Super Seven" corrugated asbestos at 15° pitch on "Brollo" zed purlins at max 1,400 cc spacing on rectangular section hollow steel rafters at 6,000 cc bolted together at ridge and to ring beam. "Heraklith" woodwool slabs supported in inverted "T" sections as roof lining/insulation with ventilated void between asbestos and "Heraklith." Ridge capping in one-piece asbestos raised to provide ventilation. Paint finish to woodwool slabs.

ALTERNATIVE CONSTRUCTION TECHNIQUES
Structural Engineer's comments

Technique No.	Roof	Purlins/ Battens/ Joists	Rafters	Columns/ Foundations	Walls/ Beams	Ground Floor
1.A	Corrugated Asbestos @ 15°pitch. Wood wool slab ceiling on inverted T-Sections	Brollo ZS4 @ 1400 crs.	120x60x4 Brollo R.H.S. @6000 crs bolted to columns	600x200 R.C. @6000 crs 1500x1500x750 dp mass conc. fdts. Col. steel 4S32 M8-200.	400x200 R.C. Ring Beam on non-load bearing walls on 600x250 mass conc. strips. Beam steel 4S16 M6-200	150 solid slab with B.S. Fabric No. A142
1.B	2 layers corrugated asbestos @ 15° pitch. Gap between layers for ventilation	Brollo ZS6 @ 1400 crs	120x60x4 Brollo R.H.S bolted to columns	600x200 R.C. @ 1500x1500x750 dp mass conc. fdts Col. steel 4S32 M8-200	400x200 R.C Ring Beam non-load bearing walls on mass conc. strips. Beam steel 4S16 M6-200	150 solid with B.S. Fabric no. 142
1.C	Clay tiles on angle battens @ 340 crs. on steel sheet decking @ 15° pitch.	Brollo ZS9 @ 1400 crs	120x80x4 Brollo R.H.S @ 6000 crs. bolted to columns	600x200 R.C. @ 1500x1500x750 dp mass conc. fdts. Col. steel 4S32 2S16 M8-200	400x200 R.C. Ring Beam on non-load bearing walls on 600x250 mass conc. strips. Beam steel 4S16 M6-200	150 solid slab with B.S. Fabric No. A142
2.A	Corrugated asbestos @ 15°. Wood wool slab ceiling on inverted T-Sections.	Brollo ZS4 @ 1400 crs	120x80x4 Brollo R.H.S Portal Frames @6000 crs. 1000x1000x 750 dp mass on	120x80x4 Brollo R.H.S. Portal Frames @ 6000 crs	120x80x4 Brollo R.H.S. tie beams. Non-load bearing walls on 600x250 mass conc. strips	150 solid slab with B.S. Fabric No. A142

2.B	2 layers corrugated asbestos @ 15°.	Brollo ZS6 @ 1400 crs	- do -	- do -	- do -	-do -
2.C	Clay tiles on steel decking @ 15° and angle steel battens @ 340 crs.	Brollow ZS9 @ 1400 crs.	150x80x4 R.H.S. Portal Frames @6000 crs.1000x1000 x750 dp. mass conc. fdts.	150x80x4 Brollo R.H.S. Portal Frames @ 6000 crs	150x80x4 Brollo R.H.S. tie beams. Non-load bearing walls on 600x250 conc. strips.	- do -
3.A, 3.B, 3.C	Similar to corresponding ones in techniques 1A, 1B, and 1C but since the block piers cannot withstand flexural stresses caused by the horizontal force at the eaves level, a tie rod (20mm diameter) must be introduced at the ring beam level @ 6000 c/c (or at rafter points). Otherwise the method is not structurally feasible. If accepted, the walls will become normal load-bearing walls with 600x250 mass concrete foundations.					
3.D	Claymat planks covered with Roman (or other) tiles.	'Claymats' as such cannot be used economically for spans greater than 4.0 metres beyond which 'Maxspan' or in situ hollow-pot slab would be ideal. In this case spans are 6000 and the minimum slab depth is 200mm. Reinforced concrete column - beam - slab construction method may prove a better alternative to the proposed technique.				
4.A 4.B, 4.C	Similar to the corresponding ones in techniques 1A, 1B and 1C in roof structures and the ring beams. The minimum size of hollow block piers is 400x400 infilled with rich concrete and heavily reinforced with 2/4S32 main steel and M8 stirrups at every course. The only advantage this method has is exclusion of formwork. In concrete terms compared with technique 1 columns, this method gives a saving of 25% of volume of concrete. This, however, is obliterated by 100% increase in reinforcing steel weight and, hence, has no advantage.					
5.E	Mangalore Tiles on timber battens @ 340 crs on timber joists @ 6000m on purlins @ 1400 crs. across load bearing walls. Roof pitch 22½%	25x25 battens 100x25 joists (i) 225x100 purlins-laminated in living rooms.	None	None	400x200 R.C. ring beam on load-bearing walls on 600x250 mass concrete strips. Beam steel 4S16 M6-200	150 solid with B.S. Fabric No. A142.

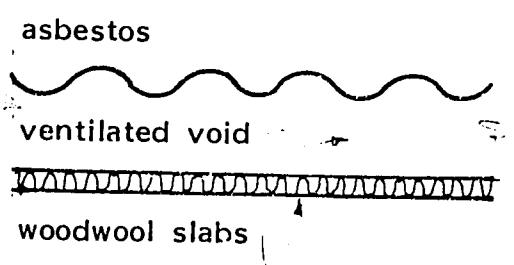
Roof: Alternative B

Two layers of "Super Seven" corrugated asbestos with ventilated void between at 15° pitch on "Brollo" zed purlins at 1400 cc max on rectangular hollow section steel rafters at 6000 cc fixed as before. One-piece asbestos ridge capping raised to provide ventilation. Paint finish to exposed asbestos internally.

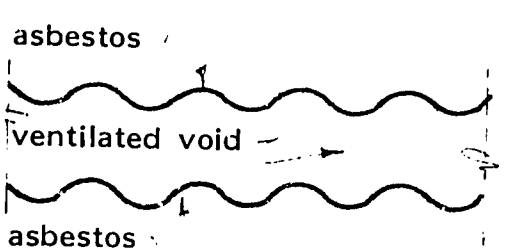
Roof: Alternative C

Clay tile slips laid on 24 gauge galvanzed corrugated steel sheeting type IT4 at 15° pitch on "Brollo" zed purlins on rectangular hollow section main rafters at 6000 cc fixed as before. Painted finish to underside of exposed steel sheeting.

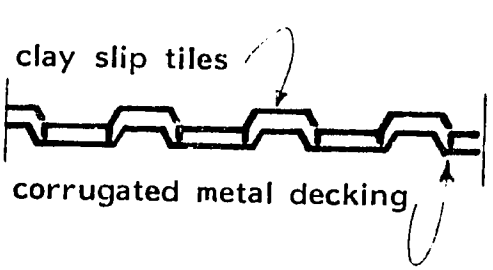
NOTE Clear internal span 8,000.



ROOF TYPE A



ROOF TYPE B



ROOF TYPE C

Construction Technique 2

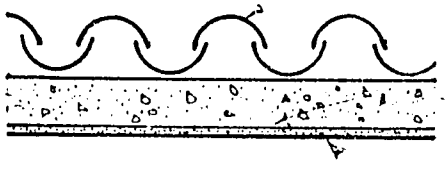
Walls - Rectangular hollow section steel columns at 6000 cc on base plates bolted to R.C. pad foundations. R.H.S. steel ring beam. Non-load-bearing infill walls of 200 mm concrete blocks on strip R.C. foundation with glass louvre windows in S.W. subframe to underside of ring beam.
Floor & Finishes - As in Construction Technique 1.
Roof - Alternatives A, B, & C as in Construction Technique 1.

Construction Technique 3

Walls - Load-bearing 200 mm concrete blockwalls on reinforced concrete strip foundations with integral blockwork piers at 6000 cc supporting in site R.C. ring beam. Walls reinforced every other course with 25 x 16 B.W.G. hoop iron.
Floors - All as in Construction Technique 1.
Finishes - All as in Construction Technique 1.
Roof - Alternatives A, B, & C - All as in Construction Technique 1.

Roof: Alternative D

"Roman" clay tiles laid dry on screen on "claymat" planks. Eaves and verge tiles bedded in mortar. Underside of "claymat" planks two-coat plaster and paint finish. This alternative relies on 150 mm minimum concrete block cross walls on strip foundations. Maximum span of roof planks and corresponding plank thickness to be confirmed by Structural Engineer.



Roman clay tiles

ROOF TYPE D

"Claymat" plank

plaster & paint

Construction Technique 4

Walls - Reinforced hollow concrete block piers at 6000 cc on R.C. pad foundations supporting in situ R.C. ring beam. Non-load-bearing 200 mm

concrete block infill wall on R.C. strip foundation wall reinforced every other course with 25 x 16 B.W.G. hoop iron. Glass louvre windows in S.W. subframe to underside of ring beam.

Floors - All as in Construction Technique 1.

Finishes - All as in Construction Technique 1.

Roof - Alternatives A, B, & C - All as in Construction Technique 1.

Note that for all construction techniques precast concrete louvre blocks 400 x 200 x 200 could be used as panel infill above floor level. Standard asbestos zed louvre blades could be used as panel infill at high level, say 1600 and above (to avoid damage at lower level). For comparison purposes, clear span for each type is assumed to be 8,000 clear. Basic finishes have been assumed for cost comparison purposes only. For actual finishes proposed, see "Finish Specifications" (next page).

Construction Technique 5

Walls - Load-bearing concrete block crosswalls 150 mm thick internally, 200 mm externally, on R.C. strip foundations; walls reinforced every other course with 25 x 16 B.W.G. hoop iron. External walls of 200 mm blockwork as above, but non-load-bearing on R.C. strip foundations. Glass louvre windows in S.W. subframe or patio sliding doors of 6 mm polished plate glass in H.W. frames and linings. All infill panels of concrete ventilating blocks.

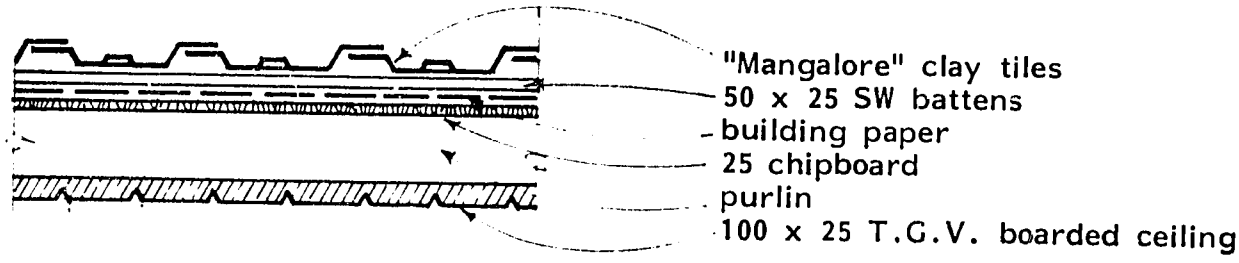
Floors & Finishes - As in Construction Technique 1.

Roof: Alternative E

"Mangalore" clay interlocking tiles at 22½° pitch on S.W. battens on building paper on 25 mm thick chipboard decking on S.W. purlins spanning onto crosswalls with ex 100 x 25 T.G.V. ceiling treated with two coats "Ronseal" preservative sealer.

This technique intended as suitable for house types B, C, & D where laminated timber purlin or trussed purlin used for span over living-dining room.

ROOF TYPE E



Specifications Selected

The steel frame with concrete block infill wall construction technique was selected as being the most appropriate for Institute buildings. Three alternative roofing specifications are within the same cost bracket, and any one of the three would be suitable. For estimating purposes the sum of Kshs.550/= per sq. m of building area was included for roof construction and finishes. The steel frame solution is most economical, is locally available (from Mombasa), flexible for future change, and can be rapidly erected. If properly shop treated, and field painted, corrosion problems should be no worse than with concrete.

One construction technique is not necessarily ideal for all buildings on the campus and it is recommended that the student Halls of Residence and staff houses be constructed of load-bearing concrete blockwork with reinforced concrete ring beams, steel zed section purlins and roof finish to match other buildings. The Halls of Residence and staff houses are essentially multi-cellular buildings where internal walls are required for separating activities, providing resistance to the spread of fire, sound insulation and security. The minimum recommended thickness of a non-load-bearing internal partition wall is 100 mm. By increasing it to 150 mm it can become a load-bearing wall. These buildings have, therefore, been designed to be cross-wall construction with purlins running parallel to the window wall and bearing on the cross-walls.

Finish Specifications

The following finishes are suggested as being suitable for the various buildings indicated below:

Walls - Two-coat plaster on concrete blockwork with mist coat and two coats vinyl emulsion paint (inside surface only). All buildings except Farm and Crop Production buildings where blockwork walls to be fairface.

Floors

1. Sand/Cement screed with hardener and polished finish, sand/cement skirting	Workshops Estates Central Stores Teaching area in Farm Plant Rooms
2. Rough-tamped concrete with anti-dust additive	Farm and Crop Production buildings Vehicles Shed
3. P.V.C. tiles on sand/cement screed. Sealed hardwood skirting	Classrooms Homec & Extension labs Clinic, Administration Staff housing. Library Halls of Residence
4. Epoxy resin with sand additive to provide non-slip finish, integral skirting	Biology & Chemistry labs
5. Hardwood parquet with sealed finish and hardwood skirting	Staff houses, living rooms only
6. Granolithic with integral skirting	Conference room Bathrooms, kitchens showers

Windows - Louvre windows generally with security bars. Obscure (sand-blasted finish glass to student housing and bathrooms). All buildings.

Ceiling - Subject to further research anticipated to be vinyl emulsion paint finish direct to insulation immediately beneath roof finish. All buildings.

Built-in furniture fixtures & fittings - Worktops, with cupboards under, for Classrooms, Laboratories, Workshops, Estates, Staff house kitchens. Writing table with shelf over Fume cupboards for Study bedrooms, Prep. Labs; Wardrobes for Study bedrooms and Staff house bedrooms.

Mechanical & Electrical Fixtures & Fittings - Plumbing and Electrical and fittings should be provided to an appropriate standard. For example:

House Type B, C, & D

Kitchen:	Stainless steel sink
Bathroom:	Western - type W.C., wash basin, shower tray as integral part of granolithic floor finish
Externally:	Splash (cold water tap, concrete tray with gully and rendered wall)

House Type E

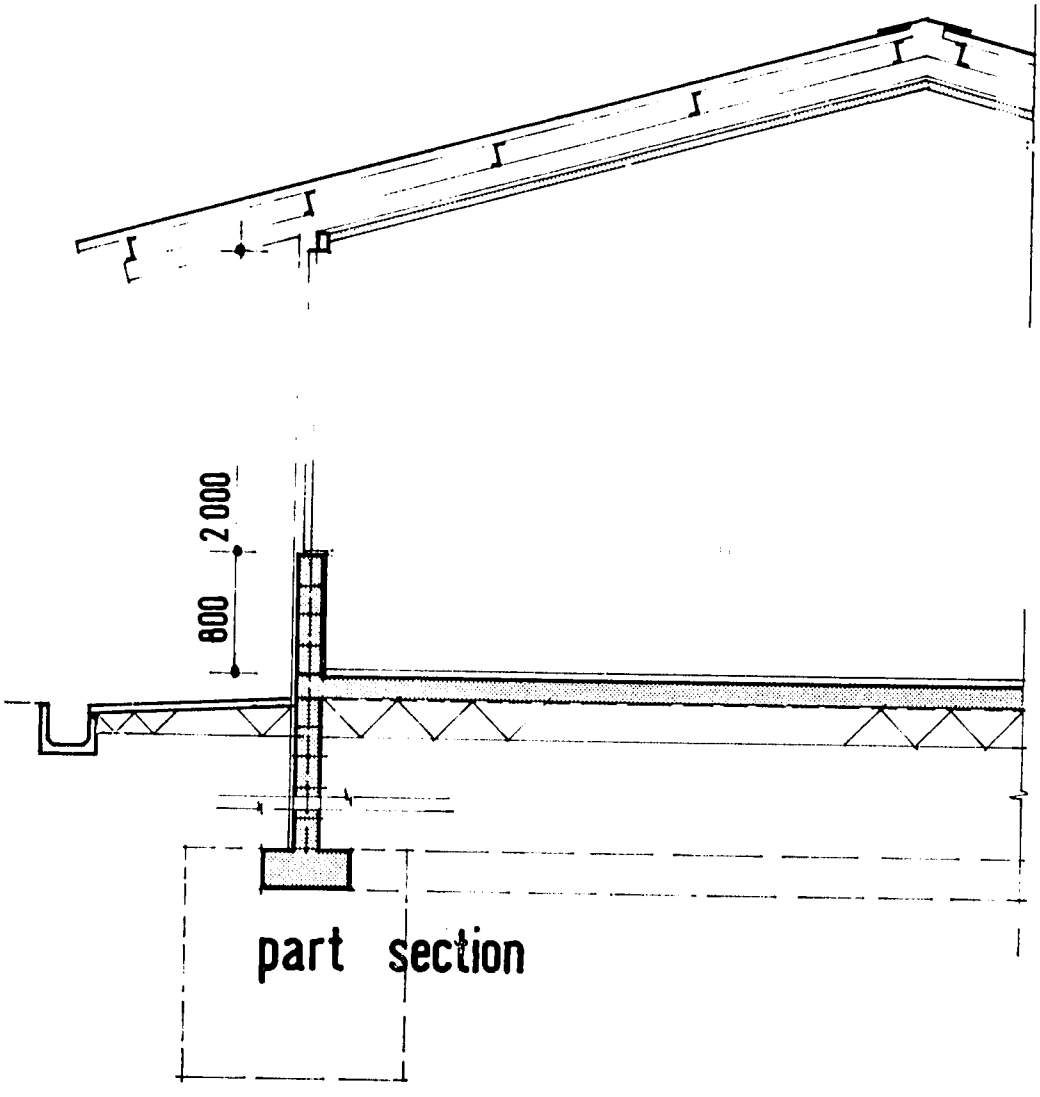
Kitchen:	Granolithic sink integral with worktop, cooking hood and fire
Toilet area:	Eastern-type W.C. Granolithic shower tray, splash

House Type F As Type E but without kitchen sink.

Typical Student Housing Unit -

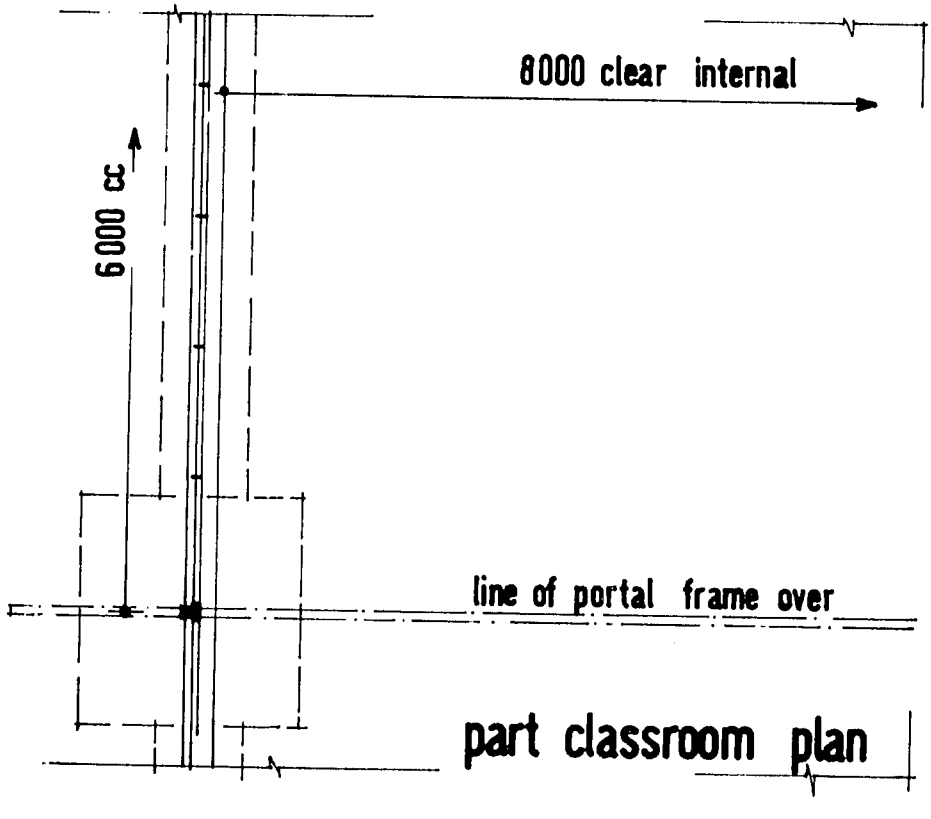
Washrooms:	4 Eastern type W.C.'s (6 W.C.'s required for women's hall) 2 Urinals 6 Granolithic showers 8 Wash basins Stainless steel trough type wash basins would reduce risk of damage
Laundry room:	3 stainless steel sinks and integral worktop
Typical Lab:	8 small sinks 8 twin gas outlets 12 twin electricity sockets
Prep Lab:	2 small sinks 2 twin gas outlets 4 twin electricity sockets

CONSTRUCTION TYPE 1



roof - super seven corrugated asbestos on steel 'zed' purlins on steel portal frame of rhs 120 x 80 with similar ring beam
ceiling - 50 mm woodwool slabs hung in inverted 'T' sections, all painted.
louvre windows
fairface 200 mm concrete block walls plastered internally
pvc tiles on 40 mm screed on 150 mm mesh-reinforced conc. floor on polythene sheet d.p.m on blinding on 250 hardcore

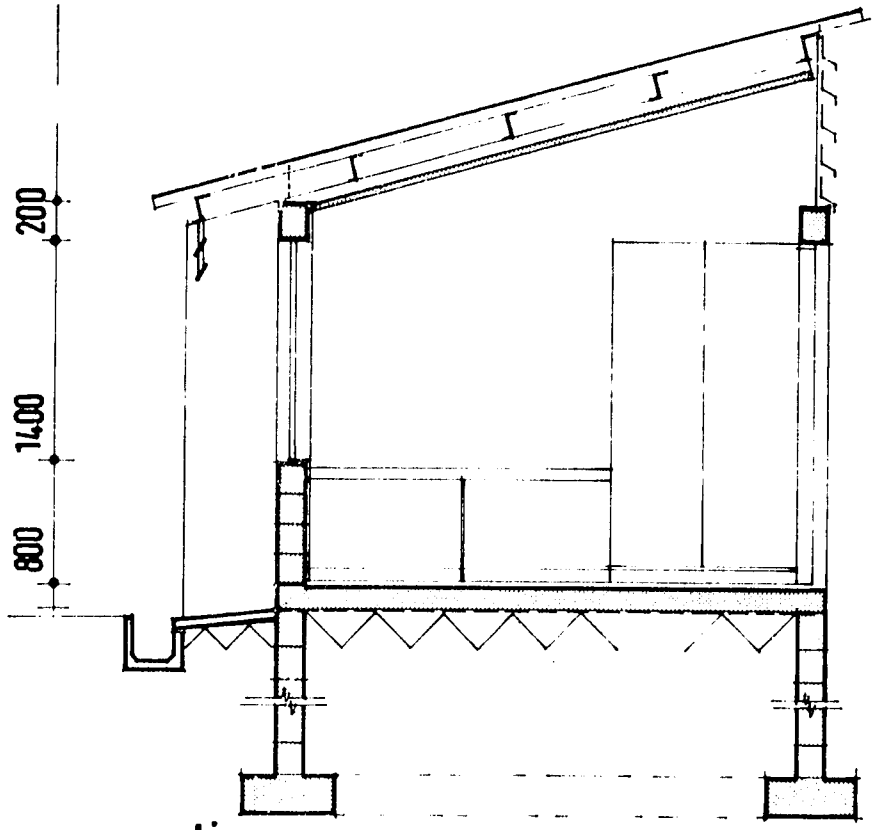
600 x 250 r.c. strip foundations to wall
pad foundations to columns



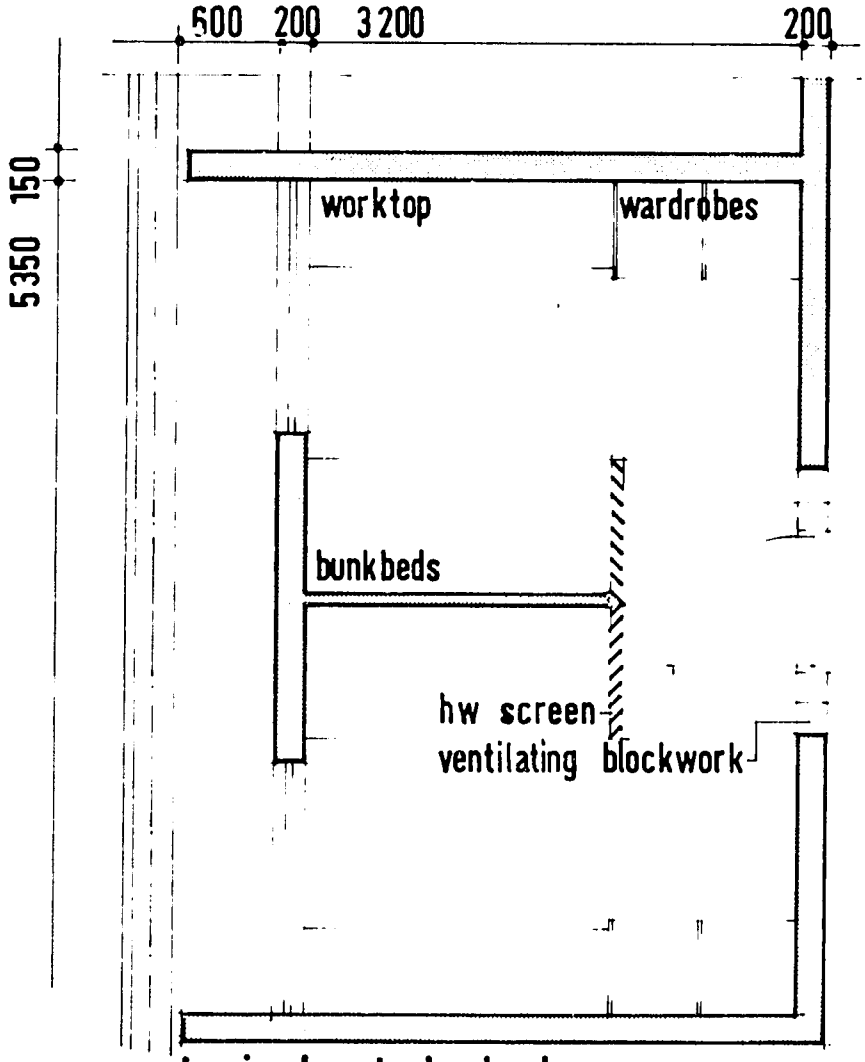
scale 1:50
DIAGRAM 36

CONSTRUCTION TYPE 5

roof - super seven corrugated asbestos on steel 'zed' purlins bolted to in situ r.c. ring beam on 150 mm thick blockwork crosswall.
ceiling - 50mm woodwool slabs hung in inverted 'T' sections, all painted
louvre windows
light metal sunbreakers
asbestos louvres
pvc tiles on 40mm screed on 125mm concrete with mesh reinforcement on polythene sheet d.p.m. on blinding on 250mm hardcore
precast concrete storm water drain with insitu concrete paving to fall
reinforced concrete foundations



section



scale 1:50

typical study bedroom

DIAGRAM 37

EQUIPMENT

Selection

Equipment requirements for the Coast Agricultural Institute were obtained after detailed study of the curriculum. Equipment listed was projected on the basis of numbers of students and maximum hands-on use, rather than specification of more limited quantities of expensive, complex equipment that can be used by only a few students at a time. This approach is considered to be in keeping with the nature of the program offered and the eventual work that will be done by the graduates, serving mainly farmers with small land holdings using simple implements.

Preliminary equipment lists were validated by instructors at Embu Institute of Agriculture and were reviewed by officials of the Ministry of Agriculture prior to being presented in this report. Particular attention was paid to the preferred types and frequency of use of equipment as well as to problems experienced in its maintenance.

Equipment specified for use at the Coast Agricultural Institute must take into account the hostile climate zone in which the Institute will be located. Certain equipment indicated will require a controlled environment to operate effectively. Other equipment will require dry storage.

Procurement

Items of equipment which must be available when classes begin, or for which there are likely to be high rates of inflation, should be indicated in order to facilitate preparation of a tender document for early procurement. Funds should be reserved for a second tender after the Institute is operating to enable the staff to take account of any items not previously provided.

Equipment cost estimates are based on international prices prevailing during 1980. It is expected that tenders will be let in Kenya. Where locally manufactured goods, particularly furniture, are available, a cost preference will be applied. Estimates for shipping and insurance have been included; however, cost of clearance and customs duties, if any, were assumed to be the responsibility of the Kenyan Government.

Clearance will be facilitated by the fact that the Institute is near Mombasa which has port facilities and an international airport.

Maintenance

Routine equipment maintenance would be carried out at the Institute, but facilities for major overhaul or repair work have not been provided. The proximity of the Institute to Mombasa will enable most specialized maintenance work to be done on site or by transporting the items into Mombasa where repair can be effected. Staff would be provided to do routine maintenance and servicing of plant equipment and vehicles. Maintenance equipment has been provided to enable this work to be done. Essential spare parts have been included, where it was considered necessary to avoid long delays and service outages due to unavailability of spare parts. Models of equipment recommended must take into account the availability of repair service in Kenya.

Schedule of Equipment and Furnishings

Classrooms - Each classroom should be equipped with a teacher's table, lectern, overhead projector, clock, miscellaneous chalkboard equipment, and chairs. Two classrooms of capacity 80 to have built-in chairs for students.

Chemistry laboratories - Each chemistry laboratory should be equipped with 10 lab positions. Each position should have a sink, gas and water outlets, drainage and an electrical outlet built in. Basic lab equipment and glassware would be provided to enable 20 students to perform the basic experiments. Main items of lab equipment should include: Barometer, bunsen burners, centrifuge, safety equipment, electric drying oven, basic lab glassware, stands and start-up supplies, soil dispersion cup and mechanical stirrer, 200 liter refrigerator and an auto clave. Chairs would be provided for 20 students; a fume cupboard should be built in.

Biology laboratory - Each biology laboratory should be equipped with 10 student lab positions. Equipment should be provided to enable 20 students to perform all the required experiments. Each lab position should have built-in sink, water, gas, and electricity. A refrigerator should also be provided. Basic lab equipment would consist of: Lab balances, 20 microscopes (monocular), 20 stereo dissecting microscopes, 25 oil immersion lenses, 35 mm camera, and dissecting equipment, culture dishes, safety equipment, cages, aquarium, aerators and miscellaneous biological charts and items.

Metal and Machines workshop - This workshop would provide a variety of practical exercises in layout, benchwork, elementary fitting, welding,

small engines, and some plumbing. Due to the limited number of hours of practical work, highly specialized equipment would not be required.

The following items of equipment recommended: Metal lathe, air compressor, 5 electric welders, 3 gas welding setups, metal shears portable crane, bench vises, portable petrol engines for demonstration, layout equipment, benches, bench grinder, drill press and handtools. Simple plumbing equipment for cutting and threading pipe. Work benches and stools.

Farm Structures and Wood Workshop - This workshop would enable 20 students to undertake practical exercises in woodwork and farm buildings.

The following items of equipment are recommended: Thickness planer, bandsaw, circular saw, bench vises, drill press, bench grinder, and handtools. Surveying equipment to include: a theodolite, clinometer, alidade tables, drawing table and instruments. Various types of illustrative charts and models should be provided along with benches and stools for students.

Home Economics labs - Two home economics laboratories would be required to enable students to conduct the practical exercises. A cookery lab should be provided for 20 students and an all-purpose lab for clothing construction and textiles should be provided for a similar number. A demonstration house should also be equipped to enable various new and improved house improvements to be demonstrated.

Cookery lab - The cookery laboratory should be equipped with the following: Two refrigerators, 4 electric, 4 gas, and 4 charcoal cookers, kettles, pressure cookers, mincers and various items for food preparation. Worktables and chairs would be required for groups of 4 students at one lab position. A teacher's demonstration table should also be required. Eight sinks should be installed and a gas manifold system would be required.

All-purpose laboratory - The all-purpose laboratory should be provided to enable students to do practical exercises in clothing construction, house care and various handicrafts.

The lab should be equipped with the following: Tables and chairs for 20 students and the teacher, 20 electric and 20 manual sewing machines, irons and ironing boards, handicraft equipment for weaving, knitting, basket construction. Miscellaneous items such as scissors, tapes and knitting needles would also be necessary.

Model Rural House - A model rural house to sleep 4 students should be provided, togehter with household items for normal household upkeep and operation.

Extension Room - This facility should be provided so that students can undertake practical exercises to gain experience in the preparation of extension materials, charts, posters and other items they will be required to produce as extension agents. It should be a workroom capable of handling 20 students, fitted with chairs, worktables, projector trolleys, and other visual equipment. Other items of equipment would include: a 16 mm projector, 35 mm slide projector, screens, flipchart stands, audio cassette units, and various handtools.

Library - The library should accommodate 100 students and would be stocked with 6,000 books and other instructional items. Major items of equipment and furnishings would include: 12 library tables for 8, student chairs for 100, library shelving for 6,000 books, 4 office desks and chairs, lockable file cabinet, 35mm slide projector, 16mm film projector, projection screen, stand, card catalogue, duplicator, paper cutter, display racks, book trucks, typewriters and miscellaneous items for book repair.

Clinic - The clinic should be equipped for 5 patients. Major items of equipment should include: Five beds, refrigerator, typewriter, desk, filing cabinet, 8 chairs, hot plate, kettle, sterilizer, stretcher, safety equipment and miscellaneous medical instruments.

Student Housing - Major items of equipment and furnishings should be provided for 8 dormitories, 6 for male and 2 for female students.

The furnishings should include: Beds and chairs for 640 students. Study tables and wardrobe closet to be built in, study lamps, linens and curtains to be provided.

Laundry - The main items of equipment to include: two washing machines, 1 extractor, 2 ironing machines, and 1 dryer, 4 trolleys, tables and chairs.

Dining Hall - A dining hall to cater for two shifts of 320 students per shift would be provided. The main items of equipment and furnishings should include: Dining tables to sit 10 persons (32 tables), 330 chairs, place settings for 330.

Kitchen - The major items of equipment and furniture to be built in include: Boiling pans, cookers (8 burner gas type), electric cookers, stock pots, potato peeler and mincer, mixing machines, fryers, ovens, charcoal stove (emergency use), food preparation tables. Cooking utensils knives, ladles, spoons and mixing bowls to be provided as loose equipment. A cold room should also be included.

Servery - To serve 320 students at a sitting. Two serving lines to be built in with hot service trays.

Media Room - The print media room should be designed to serve the needs of both instructional staff and administrative staff. The major items of equipment and furnishings to include: offset duplicator, 16mm film projector, 35mm camera and lens attachments, transparency maker, overhead projector, photocopy machine, worktable and chairs, drafting table, paper cutter, and filing cabinets. Typewriters, staplers, scissors and miscellaneous materials for preparing charts and posters should also be provided.

Dark Room - A dark room with built-in sinks should be provided near the media room for joint use by staff and students. The dark room should be equipped with: A refrigerator, an enlarger, timer, safe light, developing trays, measuring jars, and other miscellaneous items.

Single Staff Offices - Single staff offices for the principal, vice principal, registrar, executive officer, bursar and department heads should contain: Bookshelves, a desk and chair, file cabinet, coffee table and side chairs. Small conference tables and chairs should be provided for the principal and vice principal's offices (16 offices).

Shared Staff Offices - Shared staff offices for lecturers and demonstrators (17 offices) should contain 2 desks with chairs, 2 side chairs, 2 file cabinets, and 2 bookshelves.

General Office - General office accommodation for secretaries, copy typists, accounts clerks and messengers should be equipped with 8 desks, 8 typists' chairs, 10 side chairs, 6 file cabinets, 3 tables, built-in counter shelves under; reading table, waste paper baskets, duplicator, and paper store.

Student Common Room - The Student Common Room should be equipped and furnished to meet the needs of a recommended capacity of 200. An associated kiosk to sell student sundries should be located near the Common Room. Furniture required include 100 chairs, 30 settees, and 40 low tables, and a refrigerator and cooker.

Tea Room - One tea room should be provided near the administration and one near the staff meeting room. Each should be equipped with a refrigerator, 2 element hot plate, kettle and serving cups, and spoons.

Telephone Exchange - Space for a telephone operator should be provided with a chair and table, beside the telephone switchboard.

Cleaners Room and Store - A cleaners room should be equipped with: Shelving, 5 chairs, supplies cupboard, ladder, trolleys, mops, brooms, and pails.

Staff Meeting Room - A staff meeting room should be equipped with: 30 chairs, 4 settees, 2 large tables, 5 low tables, display board, and clock.

Staff Housing - Home furnishings should be provided for the various grades of staff housing. The furniture would be of Ministry of Works standard and would include: Chairs, tables, settees, cooker, refrigerator, beds and miscellaneous household items. The estimated budget by grade would be:

Type B	1 @ US$	3,300
Type C	11 @ "	3,000
Type D	26 @ "	2,500
Type E	24 @ "	1,200
Type F	25 @ "	800

Feed Store - Equipment should include: Chairs, table, filing cabinet, scale, pails, metal shelving, trolley and miscellaneous items such as overalls and cleaning equipment.

Dairy Building - A dairy building should have four stalls with equipment to include: Stainless steel pails, milking stools, strainers, churn, weigh scale, built-in sink, clean-up equipment, and other miscellaneous items.

Poultry House - Equipment should include: Incubator, fumigation box, brooders, feed hoppers, waterers, buckets, egg graders, thermometer, scale, debeaker, wing band applicator, models and charts, and cleanup items.

Piggery - Equipment should include: Ear notchers, pliers, knives, weigh scale, nose ring, shovels, wheelbarrow; forks, brooms, buckets, food and water troughs and other miscellaneous items.

Calf Pens - Equipment should include: pails, wheelbarrow, shovels, cattle scale, branding frame, branding iron set and other items required to care for Calves.

Goat and Sheep Pens - Equipment should include: Sheep tattoo, ear tag, pliers, ear notchers, elastrator, hand shears, portable scale, hoof shear, hoof knife, ewe marking harness, sheep crook, goat dehorner, milk bucket, strainers, filters, nursing bottle, charts and models.

Hay Storage - Equipment should include hay forks, hay wagon and miscellaneous items.

Cattle Dip, Cattle Squeeze or Crush, and Sheep Dip- should all be locally constructed.

Beekeeping - Beekeeping equipment and hives should include: Hives, cages, protection clothing, gloves and mask, smoke cartridge, hive tools, trays, knives, and honey ripening tank.

Horticultural Store - Equipment should include: shelving, hand sprayers, irrigation equipment, weigh scale, hand-tools, wheelbarrow, shovels, cleaning tools, jembes, water buckets, axes, pruning saws, secatues, forked jembes, pangas, sprayers, motor-blown sprayers, shovels, grass slashers, sledge hammers, fence auger, file cabinet, and other miscellaneous items.

Horticultural Products Supermarket - Equipment should include: Scales, cash register, pails, and cleaning equipment.

Seed Treatment Demonstration Shed - Equipment should include: scales, pails, measuring cups, shelving, shovels, wheelbarrow and other miscellaneous items.

Green House - A green house located near the biology laboratory should be equipped with: shovels, garden hand tools, pails, watering cans, hose, wooden flats, and other miscellaneous items.

Farm Machinery - Farm machinery should include: 4 tractors, tractor models, ploughs, mould board plough, disc harrow, cultivator, trailer, harvester, seeder, rakes and essential spares for maintenance.

Vehicles - Vehicles should be provided as follows: 1 landrover, 2 pickups, 2 staff cars, 3 buses (56 capacity), and 1 mini-bus.

Vehicle Maintenance and Estates - A twelve bay combination machine shed for storage and maintenance of farm machinery and vehicles should be equipped with: hand tools, oil cans, grease guns, air compressor, hydraulic jack, tire repair equipment, safety and grounds maintenance equipment.

Sports Equipment - A variety of sports equipment for football, volleyball, field hockey, tennis, and other miscellaneous items should be provided.

Central Stores - Equipment should include: wooden pallets, shelving, pallet lifters, weigh scale, office desk, chair and filing cupboard.

INFRASTRUCTURE

INFRASTRUCTURE
(Refer to separate opinions of engineering consultants in Report Summary)

Definition

A campus comprises an integrated network of systems, which are hierarchical. The building system and open space system are most apparent. Supporting and serving the buildings are the utility systems, referred to here as campus infrastructure.

Elements

This section describes existing conditions affecting the Project infrastructure, and the extent and characteristics of the respective elements required for the efficient technical functioning of the Coast Institute. The elements comprise:

Road Network
Walkway Network
Sewage Treatment
Potable Water
Electric Power
Telephone System
Refuse disposal
Irrigation potential
Solar Water Heating

Descriptions of salient features are included, and cost estimates have been prepared to feasibility determination levels (see Diagram 38).

Road Network

The several road components that would be required for the Project are:

1. Main access road (including parking area) and campus roads.
2. Extension of the Sokoke Road (from the point where it begins its southeast traverse through the Project area) along the northern boundary of the Project area to its intersection with the Kilifi-Malindi Road (see Diagram 38). This is needed to bypass Sokoke Road traffic from the center of the Project area to the perimeter boundary.
3. Farm roads.

The main access road would be 5.0 m wide with curbing and bituminized surface. The campus roads would be 3.0 m wide with a bituminized surface. Parking areas contiguous to campus roads would be bituminized. If phased development of the Institute is preferred, the paving of campus roads could be postponed to the second stage. The cost estimate has been prepared to reflect both conditions.

The Sokoke Road extension would be included in the national category of roads and would have a 7.0 m gravelled carriage-way with earth-side drains.

The farm roads would be shaped earth-surface roads suitable for communication to all cultivated areas within Project; with a 3.0 m width suitable for the passage of farm machinery.

All roads would have simple machine-shaped earth ditches and drains, with culverts beneath the road surface where necessary to protect the subsoil from erosion and unnecessary saturation from sheet runoff.

Walkways

The extent of the proposed walkway network, which totals about 4 km, is illustrated in Diagram 15. Walkways would average 2.0 m in width, extending out from the central paved plaza.

Sewage Treatment

In the review of various sewage treatment systems that could be adapted to the Project, those which required considerable experience or training for their operation, had complicated maintenance procedures, or involved substantial monetary outlays for materials and equipment, were eliminated. The two systems that were finally selected for possible incorporation in the Project are:

1. septic tanks, and
2. waste stabilization ponds

The former are used at the Kilifi Hospital and at the Cashew Nut Factory just north of the Project. The latter have been incorporated in the amended Master Plan for Egerton College. Both are simple to construct and operate, and periodic maintenance is not complicated. The degree of sewage treatment achieved, however, is distinctly different, as well as the possible recycling of treated effluent.

Septic tanks are basically one-storey sedimentation tanks with masonry or reinforced concrete walls. Sewage flows through the tank at a low velocity to permit suspended matter to settle to the bottom where it is retained while anaerobic decomposition takes place.

Although the digestion process of the settled solids is reasonably efficient, some sludge accummulates. It is common practice in Kenya to desludge the tanks every 1 to 5 years.

Septic tanks are commonly used to treat sewage from individual households but can also be designed to treat wastes from a communal facility. However, the code of practice applicable in Kenya is to limit communal septic tank treatment to populations not exceeding 300 contributors. For the proposed Institute, this effectively restricts consideration of septic tanks to separate households and to institutional buildings.

The standard designs for septic tanks provided by the Ministry of Works were used for this analysis.

Effluent from septic tanks is usually discharged into French drains (field trenches backfilled with stone). This procedure would be followed if individual septic tanks were chosen for treatment, unless impermeable subsurface conditions were encountered, in which case more costly leaching fields or upflow filters would be required. Such adverse conditions, however, have not been evaluated because they have been considered:

a) unlikely, in view of known soil conditions over the campus site; and
b) academic, considering the significant economic and potential agricultural benefits of aerobic waste stabilization ponds over septic tank treatments through the use of treated effluent for controlled irrigation.

Considering the technical limitations of septic tanks vis-à-vis waste stabilization ponds, plus their higher cost, it was decided to restrict investigation into the apparent optimum sewage treatment method for this Project, which is waste stabilization ponds.

Waste Stabilization Ponds - The treatment of sewage by this method is effected by first screening raw sewage to remove large solid matter and then to introduce the sewage to artificial ponds or lagoons. Through photosynthesis, algae produce oxygen which is used by bacteria to decompose or digest the organic matter in the sewage. Such ponds are described in detail in the WHO Study Report No. 9, "Selection and Design Criteria for Sewerage Projects."

For this Project, consideration has been given to the treatment of sewage in two stages, requiring two facultative lagoons. A third lagoon would be provided for use during periodic cleaning of either of the other lagoons. The system would provide an effluent whose characteristics would comply with the standards of the Ministry of Water Development for the discharge of treated sewage into lakes and rivers. These standards require that the BOD not exceed 20 mg/1, and that the E. coli count be equal or less than 5000/1.

The site recommended for the lagoons for either plan alternative is about 200 m west of the campus plan prepared for Alternative A, and occupies a relatively low-lying area. It was chosen because it would be:

1. Close to the Institute complex (if Alternative A);
2. At a lower elevation than any campus building, thus permitting sewage to flow to the ponds by gravity;
3. Located downwind to preclude noxious odors from reaching and affecting the complex; and
4. Not too far from those areas that might benefit from controlled irrigation practices should the treated effluent be used for such purposes.

The sizing of each of the two-stage facultative lagoons followed the formulae and empirical values given in the aforementioned WHO Report No. 9. The characteristics of the ponds are given in the following table.

Elements	Lagoons	
	Primary	Secondary
Treatment		
Daily inflow, cu m (population 2000) per cap. flow: 120 l equivalent to 150 litres/day water supply per capita; ratio of liquid sewage to water supply = 0.8	240	240
BOD contributions		
Per capita, grams	55	-
Total daily, mg/l	458.3	-
Ultimate inflow (1.6 x total daily), mg/l	733.0	-
1st stage outflow(=2nd stage inflow) mg/l	72.6	72.6
2nd stage outflow, mg/l	-	20.0
Pond depth, m	1.5	1.5
Retention time, days	22.0	7.0
Required surface area, hectares	0.35	0.11

Note: Supporting calculations are given in the Appendix.

Each lagoon would have an earthen base and side slopes. Impermeability would be provided by means of a polyethylene membrane extending over the base and up the side slopes. The membrane would be protected by earth backfill. Side slopes would also be protected against wave action by a thin layer of dumped crushed coral or other stone.

Bar screens with a detritus chamber would be included in the inlet works to the larger lagoons, and both inlet and outlet works would be provided with necessary valving.

Sewer reticulation network for "Campus Plan Alternative A" would comprise 150 mm and 225 mm diameter pipes of PVC and precast concrete respectively. Manholes would be of concrete and spaced at intervals not exceeding 60 m.

The topography for the Alternative A campus site would involve some relatively deep trench excavation (4 m) over a part of the western leg of the southernmost sewage collector. It was assumed that this excavation would

be in earth; although no subsurface boring data are available. Certainly elevations in the nearby draw to the west are deeper and no rock outcrop was noted there. However, the per capita cost of waste stabilization ponds would still be below that for septic tanks even if rock were encountered.

Optional Use of treated effluent - The effluent from the proposed secondary lagoon would be satisfactory for use in controlled irrigation of forested areas or fodder crops. Further "polishing" of this effluent would be required to enable it to be used for unrestricted irrigation. In such an event, the E. coli count should be less than 100 per 1. This could be effected by constructing two small maturation ponds in series, sized to provide 4-day retention periods each. Costs for these ponds and a possible pumping plant are shown as an optional development at the end of this section.

Comparative Costs - The provision for individual septic tanks was estimated as adding Kshs.20,000 per housing unit. Assuming a family size of 7, this is equivalent to about Kshs.3,000 per capita.

Whereas, the facultative lagoon system would require a reticulation network, two large lagoons covering 0.35 ha each, and a secondary lagoon covering 0.11 ha. The total cost is estimated to be about Ksh.1450 per capita.

Potable Water

Consumers in and contiguous to the Project area, and the population of Kilifi Town, are currently supplied with potable water through the 100 mm Mzima Pipeline. It passes through the Project area (see Diagram 10) and also supplies through 75 mm lines, the following:

Primary and secondary schools within the Project boundaries,
Cashew Nut Factory,
Sea Horse Hotel,
Kilifi Cooperative Union premises,
Miscellaneous other consumers

The Mizma Pipeline ends at three Water Development Division storage tanks having a total capacity of 356 cu m, which serve Kilifi Town. The Town's daily demand of 270 cu m added to other consumers' requirements cannot be met by the present system, which has been severely overtaxed to the point where mandatory rationing has been instituted. A chemical analysis of this water is included in the Appendix.

Experiments carried out in the Kilifi area to obtain potable water from deep fissures by drilling have proved unsuccessful, as the yields from these strata are brackish to saline. Water from some shallow wells in the area might be suitable for some salt-tolerant crops, but the irrigation potential would have to be determined on a case-by-case basis. Chemical analyses for two such wells, one at Kilifi the other at Mtondia, are given in the Appendix.

Construction of a new water supply for the Kilifi area is nearing completion. Flow from Sabaki Reservoir is treated at the Baricho Treatment Works, about 40 miles west of Malindi. From there it is conveyed through a 250 mm pipe along an alignment which also runs through the Project area (see Diagrams 10 and 38) to its terminus, a 3640 cu m storage tank above Kilifi Town. The Ministry has indicated that the Institute's water requirements could be furnished from this main provided that supervision of the connection is done by the Ministry.

This availability is limited to human and animal water requirements, and does not include irrigation usage.

The principal demand source for water would originate from and be practically confined to the student and staff housing population. Livestock and ancillary Institute requirements have been considered as contributing only a small fraction of the total water demand originating from the housed population. The water consumption rate to be applied to average housing developments for Kenya has been proposed in a WHO Study Report No. 4. This rate of 150 litres (34 gallons) per capita per day has been adopted for this analysis (and as the basis for determining sewage loads). The total domestic demand

is hence 300 cu m per day (80,000 gallons) excluding fire-fighting requirements.

The water supply reticulation network would comprise 80 mm and 100 mm PVC pipes in two ring mains generally following the major campus roads and walkways. Distribution to buildings would feed from the 80 mm main (see differing opinion in Summary).

To minimize interruptions to individual households, each house would be provided with an overhead roof tank having a capacity of 100 gallons.

Community water storage - An elevated storage tank would be provided for the Institute to:

1. Minimize supply interruptions caused by repairs to mains;
2. Decrease the maximum demand rates on the supply main from Sabaki Reservoir;
3. Limit and equalize pressure on distribution main; and
4. Provide a reserve supply for fire-fighting purposes.

This tank would have a capacity equal to a two-day requirement for the complex (600 cu m) plus 50 cu m for a fire-fighting reserve. The base of the tank would be 6.0 m above ground level to produce a tap pressure at least 8 psi. The domestic draw-off point would be located above the 50 cu m storage level; the fire-fighting reserve would be drawn from the lowest point of the tank.

Fire mains and hydrants - The fire-fighting supply from the elevated tank would be converted to two electrically operated centrifugal pumps, one of which would be a standby unit able to be connected to the emergency power system. The pumps would each have a capability of producing a pressure of 2.8 bar (41 psi) throughout the fire-fighting main. The fire-fighting supply system would comprise a ring main or 100 mm PVC pipe approximately paralleling the domestic main, and would terminate in hydrants located conveniently throughout the complex and readily accessible from roads.

Building fire protection - Within reasonable distance of each hydrant, fire boxes should be installed at easily accessible locations. These fire boxes, of steel construction and painted red, would have a wired glass front, inside would be fire hose having a hydrant connection fitting, and with sufficient hose length to reach all structures to be protected from the respective hydrant.

Fire extinguishers - Gas-pressure type fire extinguishers of 9 litre capacity would be provided for every 210 sq. m of building floor area. In the main Institute kitchen, two asbestos blankets of 5 sq. m area would be furnished in addition to the aforementioned extinguishers.

Electric Power

The two 33 kv overhead transmission lines to Baricho and Jaribuni, and the 11 kv distribution line to Kilifi Town, all cross the proposed Institute site. These lines, as well as the new power substantion contiguous to the southeast corner of the site, are shown on Diagrams 10 and 38. There are no underground cables passing through any part of the Project site.

All power lines crossing the site do so through a Wayleave Agreement signed between the power company (East African Power and Lighting Co. Ltd.) and the owners of the land. The Government Power Act stipulates that should the ownership of the land change, the Wayleave Agreement shall be binding upon the new owner without any changes. The Ministry of Agriculture should accordingly obtain the Wayleave Agreement from the previous owners of the plots and be conversant with the clauses contained therein.

In the aforementioned drawing the width of the easement of 30 m along the power lines is also shown. The owner of the land through which the power line passes is authorized by Wayleave Agreement to plough and plant any crops within the easement area whose mature height does not exceed 12 ft. above ground level.

The newly completed substation occupies a plot 100.3 m x 122 m and has a capacity of 15Mva. The two transmission lines and the distribution line

mentioned above all originate from this substation. The substation is scheduled to be commissioned before the end of 1980.

There are single-phase 240-v overhead supplies to Kilifi Secondary School, Kilifi School for the Blind, and Kilifi Primary School, and all derive their supplies from the existing Cashew Nut Factory substation.

These services could be retained without any alteration unless such change should be necessitated by future planning within the site.

Power supply to the Institute buildings would be derived from the new 15 Mva substation by an 11 kv, 3-phase overhead line to an 11 kv/415 v ground or pole-mounted transformer located at the load centre within the Institute campus. The maximum load demand for the Institute is estimated to be about 100 kva. Representatives of the power company have stated they would have sufficient reserve capacity to serve this load.

The electrical distribution from the central metering point to the individual buildings should be carried out using underground cable installations.

The electrical distribution to staff houses would be kept separate from the electrical distribution within the Institute to avoid any possiblity of an electrical fault within one part interrupting supply to the other. Supply would be from a pole-mounted 11 kv/415 v transformer located next to the housing area. If all categories of staff members are to have independently metered supply, the power company would carry out underground electrical distribution within the site up to the metering points at every house. (Although overhead distribution is cheaper, it is not recommended because playing children could easily interfere with the cables.)

In general, internal electrical installations would be carried out in accordance with the latest edition of I.E.E. Regulations, with Kenya Government amendments and in accordance with the Government Code of Practice.

It is recommended that electrical wiring within the buildings be carried in PVC conduit concealed in the walls and floors. All accessories and distribution boards would be of flush fixing pattern. All distribution boards would be equipped with miniature circuit breakers instead of rewireable fuses for ease of maintenance.

Luminaires wherever possible would be a simple fluorescent type using tubes of high efficiency. In rooms where glare index permits, bare batten luminires would be used; elsewhere metal-louvred attachments would be employed on the battens to reduce glare. British Standard illumination levels would be met, but modified with appropriate daylight factors, particularly in those areas not normally required to be used during night hours.

Socket outlet installations would be in accordance with the standard code of practice. Switched sockets of 13 amp capacity would be used throughout except in areas where special types might be required.

Installations for housing would generally conform to the specifications for the Institute buildings. However, the use of fluorescent luminaires would be limited to kitchen and laundry areas. All other living rooms would be equipped with incandescent luminaires to create a more desirable warm effect.

Power reticulation external to Institute buildings and student housing would consist of an underground radial network of 415 v three-phase, and 240 v single-phase cables originating at the medium-voltage central metering switchboard and running along appropriate directions to serve various buildings.

Power reticulation among the staff houses would be the responsibility of the power company to plan and install but would make use of underground installed cables.

Overhead reticulation would be cheaper than underground cables. However, being exposed to abuse by the students, this could be dangerous, especially during the rainy season, and is therefore not recommended. Additionally,

as all the buildings on the site would be single storey, the overhead wires would be the highest objects on the site exposed to lightning strikes. Underground cable distribution, although more expensive, is almost maintenance-free and hidden away from abuse by students and children, as well as being esthetically more pleasing.

Street lighting fittings would be installed along all the streets within the Institute including students' and staff houses.

The street lighting fittings would consist of either fluorescent or high-pressure mercury discharge lamps mounted on 5 m poles and spaced approximately 30 m apart. Power would originate from any of the nearest Institute meters and would be distributed to the lamps through underground cable installations.

Street lighting would be actuated and controlled through time switches.

A limited amount of security lighting would be supplied around livestock areas; these would also be time-switch controlled.

A diesel generator standby plant would provide emergency power only for cold storage facilities in the kitchen and limited Institute street lighting. It would be 3-phase 415 v with a capacity of 15 kva. The plant would have automatic changeover facilities and would be designed to meet emergency requirements during any power failure.

As all the proposed buildings are single-storey, well spaced out, and to be constructed of materials which are not highly combustible, there is no high fire risk that would warrant an expensive central fire alarm system. Minimal individual systems for the administration block, kitchen, laundry, library, and the laboratories are proposed. The systems would comprise alarm call points at the exits with an alarm bell loud enough to alert people within the complex.

Telephone Service

Existing overhead telephone lines crossing the site are confined to the Sokoke Road right-of-way and are shown on Diagram 38. There are no underground cables crossing through any part of the site.

Two existing public exchanges at Kilifi Post Office have a maximum capacity of 200 lines. These exchanges are wired for a maximum of 160 subscribers. There are 136 subscribers currently connected.

The Kilifi exchange is planned to be increased to a capacity of 300 lines by the end of the year 1981.

The existing exchange is manual. An investigation failed to establish when any automatic public exchange would be installed at Kilifi.

There are telephone services to Kilifi Secondary School, Kilifi Primary School, and Ministry of Agriculture installations on the Kibarani Farm. These existing services could be left undisturbed unless necessitated by future planning.

About 10 exchange lines would adequately handle incoming and outgoing traffic to the Institute without congestion. For communication within the Institute, extensions are proposed to all Type C and D houses, library, kitchen, laundry, workshop, and all laboratories and classrooms. About 15 extensions would be reserved for the Administration block. The total number of extensions would be about 72.

The switchboard that would meet these requirements is Type (20 + 100) which is capable of a maximum of 20 exchange lines and 100 extensions.

The manual switchboard would be manned by an operator for normal internal and external communications. In the operator's absence, communications could be provided for selected extensions through pre-arrangement with the Post Office exchange so that these extensions could receive and make external calls.

The telephone installations both internal and external would be installed by Kenya Posts and Telecommunications. Installation costs within this site would be based on their standard rates; the aforementioned cost of Kshs.25,800 would include both overhead and underground networks.

Three telephone booths are recommended to be installed within the student housing area.

Solid Waste Disposal

Waste Classification - The solid waste from various sources within the Institute complex may be classified as follows:

Class 1. Refuse from student and staff quarters, classrooms and administration block; includes paper, plastic, metal and glass.

Class 2. Kitchen waste both organic and inorganic, waste food, peels, fats and greases.

Class 3. Animal carcasses and organs.

Class 4. Livestock excreta.

Segregation of waste

Class 1. The weekly quantity of this class of refuse from the campus area is estimated to be about 4 tons. It should be segregated into three categories:

a. combustible;
b. non-combustible; and
c. compostable.

Class 2. Kitchen waste would be sorted into: supplemental animal feed; compostable; bones; and other non-combustible.

Collection of Waste - Central collection points would be designated within the campus for the collection of Class 1 waste. Class 2 waste would be gathered at a point outside and adjacent to the main kitchen. Classes 3 and 4 wastes would be removed from collection points adjacent to livestock pens, paddocks, and poultry houses.

Non-combustible waste could be collected by the Kilifi Town refuse collection department. Other waste originating within the Institute would be transported

from central collection points to disposal sites by handcarts or donkey-drawn carts, which are both economical and in common use at the Coast.

Methods of disposal - Non-combustible waste collected by the Kilifi Town refuse collection department would be disposed of at the Town dumping ground. Combustible material would be burned in the Institute incinerator. Compostable material would be placed in compost bins or pits for the production of compost for agricultural use. Bones would be crushed and sold for bone-meal. Animal carcasses and organs would be incinerated.

Final design studies should include investigations into the latest research available on bio-gas (methane) generators. It is recommended that animal excreta be used in such a generator to produce gas for fueling the incinerator, heating hot water, or other applications where heat energy would be required.

Incinerator - An oil-fired, three-burner incinerator should be provided for the Institute for burning combustible refuse. It should have the capacity to burn up to one cow carcass at a time. It should be convertible, with little adjustment, to burn methane gas from a bio-gas generator as previously described. Waste heat from the incinerator could also be utilized for heating the bio-gas generator, grain drying, and heating hot water.

Oil consumption for the incinerator is estimated at Kshs.25/= per hour.

Irrigation Potential

Sources - It has been assumed that consideration should be given to a certain amount of irrigated agriculture at the Institute, if only for demonstration plots or the irrigation of forested areas. The latter would be particularly advantageous for Kenya areas according to WHO Study Report No. 9.

Three possible sources of irrigation water were investigated: well water, compound runoff, and treated effluent from oxidation ponds. Each source is discussed in the following paragraphs:

Well water could be encountered in relatively shallow wells. There is insufficient evidence on groundwater conditions at the site to ascertain with certainty the depths at which such elevated aquifers would be found, or the quantity of water which would be available. It is likely that the water would be at least brackish; therefore, careful chemical analysis would be required to determine the degree of salinity. The salt-tolerant crops that could benefit from irrigation by such saline water, and the extent to which repeated inundation by such salt-laden water could be withstood by the soil itself, should be investigated.

Impounded runoff appears to be a possible source of irrigation water, considering the number of natural surface depressions encountered over the Project However, given the calcareous coral formations underlying the soil mantle, there is at least a possibility that solution channels through the coral are causing underground seepage and contributing to the formation of sinkholes.

To utilize these depressions, the proposed impoundment area must be rendered impermeable, probably through the placement of a clay blanket. Further drawbacks to such impoundment are the relatively small catchment areas involved, which severely limit the volume of runoff that could be stored; the significant losses that such storage could have to sustain from high evapotranspiration rates (about 2100 mm annually); and the potential crop loss from arable land consigned to a storage function. The present study indicated that this source of irrigation water was marginal.

Treated effluent from oxidation ponds could be used for controlled irrigation of non-food crops. The two oxidation lagoons would reduce the BOD characteristic of the effluent to below the 20 mg per 1 standard of the Ministry of Water Development, which would permit the effluent to be discharged into fresh water rivers. Although over 90 to 98% of the E. coli count would also have been removed, the amount remaining in this effluent would still be significant. This effluent could be further "polished" by passing it through two maturation ponds which would each retain the effluent for 4 days. By the end of these 8 days, calculations indicate that the E. coli count would be less than 25 per litre.

There could be cultural or esthetic objections for using the effluent for the cultivation of food crops. Evaluation of such consideration is beyond the purview of this Report. Accordingly, the options have been identified and cost estimates shown for irrigation of fodder and forest by treated effluent.

Solar Water Heating

During the course of the study a visit to the Bamburi Technical Institute revealed that a major part of the hot-water heating load was provided through the use of solar heating panels. Such systems, properly installed, can provide hot water up to 57°C. Examination of a summary of radiation and sunshine records for meteorological stations at Malindi and Mombasa indicated that solar energy experienced in the one selected year, 1974, was both abundant and reasonably steady during daylight hours.

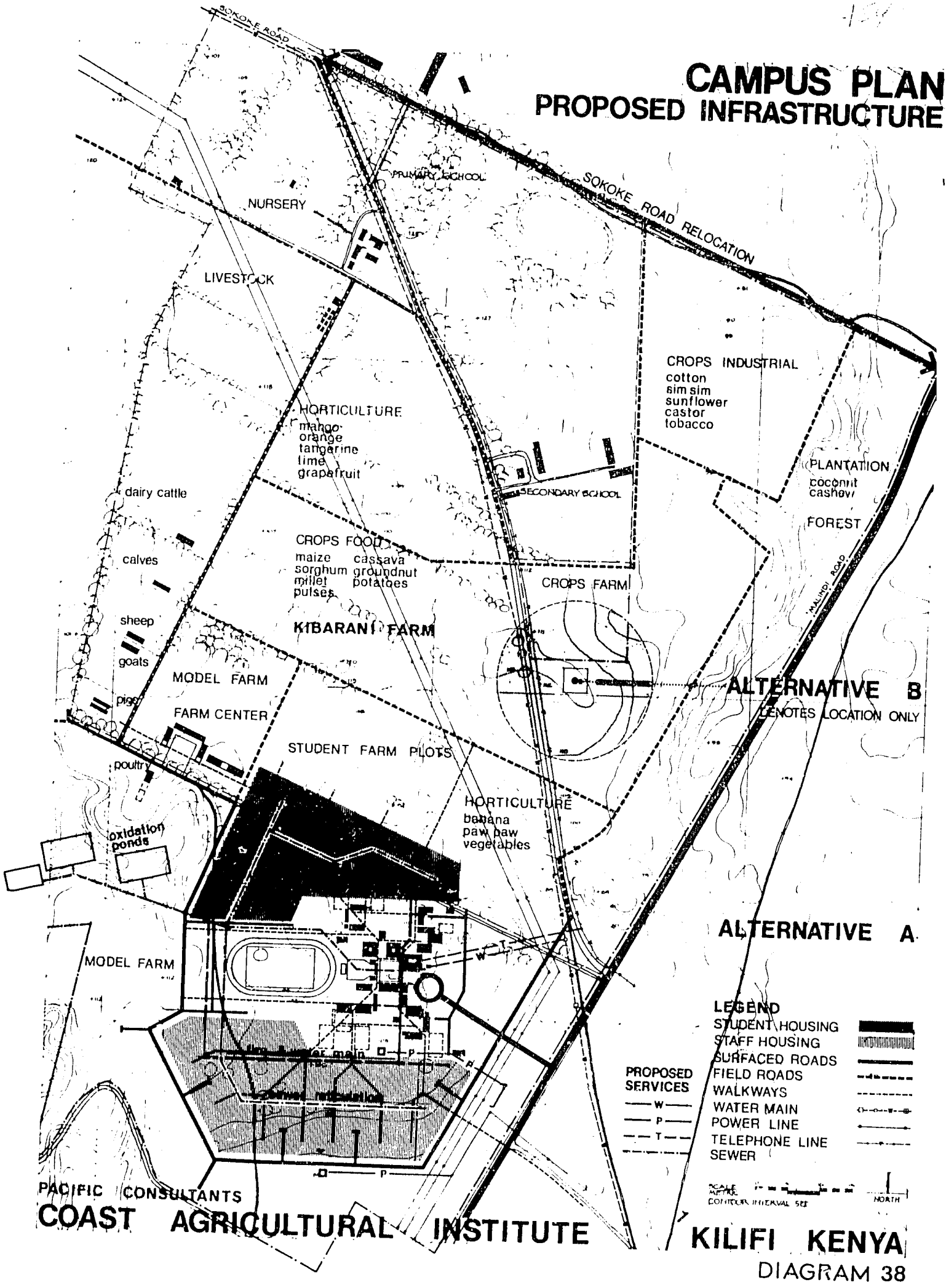
Costs for solar energy hot water installations are approximately three to four times those for equivalent electrical or oil-fired systems. However, annual savings on fuel costs, and other operations and maintenance costs usually permit amortization of the initial investment within a reasonable length of time, particularly during present conditions of escalating petroleum prices.

Final design studies should accordingly investigate the latest research on solar energy developments with a view towards incorporating solar hot-water equipment in the Project.

Cost Comparison, Alternatives A & B

Overall infrastructure costs for Campus Plan Alternative B would be greater than for Alternative A. Additional costs would be required for sewage disposal in the form of a main collector from the campus site to connect with the previous (Alternative A) main collector leading to the oxidation lagoons. The access road to the Alternative B site would be double that estimated for Alternative A. An increased length of 11 Kv distribution line would be required from the substation. Telephone installations costs would be essentially the same as would all internal infrastructure costs.

CAMPUS PLAN
PROPOSED INFRASTRUCTURE



PACIFIC CONSULTANTS

COAST AGRICULTURAL INSTITUTE KILIFI KENYA

DIAGRAM 38

CODE ANALYSIS

Legal Constraints

BUILDING CODE 1968 - The Republic of Kenya Building Code sets out the minimum building standards in Kenya. It specifies requirements for siting and space around buildings, building materials, elements of construction, fire escape and fire resistance, refuse disposal, lighting, ventilation, and services. As a Government building, the Coast Agricultural Institute is exempt from compliance with the Code; but it is strongly recommended that the buildings are designed to comply with the Code.

THE EDUCATION (HEALTH AND SAFETY) REGULATIONS 1958 - This document sets out the minimum requirements for the design of educational buildings and includes classroom sizing, natural light and ventilation, provision of toilet facilities and fire escape. For example, the standard minimum classroom size for 40 students is 55 sq. m., and dormitories must not be smaller than 3.7 sq. m. per person. Corridors, staircase or other means of escape must not be narrower than 1.2 m. Minimum room height at eaves is 2.6 m.

CODE FOR THE DESIGN AND CONSTRUCTION OF BUILDINGS IN RELATION TO EARTHQUAKES - 1973

This Code of Practice classifies buildings into five categories, and sets out recommendations for the design of framed structures and load-bearing walls in the four seismic zones of Kenya. The Institute falls within Category A and Zone VI seismic area (Refer to Code).

BRITISH STANDARD SPECIFICATIONS, CODES OF PRACTICE INSTITUTE OF ELECTRICAL ENGINEERS, INSTITUTE OF MECHANICAL, VENTILATION, AND HEATING ENGINEERS

Generally, all building materials, mechanical and electrical installations, and structural designs should comply with the relevant standards, Codes of Practice or recommendations issued by the professional institutions. In the absence of Kenyan standards, the British documents should be adopted.

Government Standards

RENTAL CLASSIFICATION OF GOVERNMENT QUARTERS - This document sets out the minimum and maximum design areas of living space for seven categories of government houses. See following table:

House Category	Government Net Areas of Living Rooms* sq. m	Design Proposal sq. m	Officers Job Group	Monthly Rent Kshs.
A	More than 120	-	M & above	304
B	84 - 120	-	K & L	266
C	58 - 83	62.7	H & J	176
D	40 - 57	46.9	G	106
E	28 - 39	32.9	E & F	83
F	16 - 27	26.6	D & below	38
G	Less than 16	-	Servants	26

*Living rooms and bedrooms, net total.

Major policy decisions concerning the location, type and allocation of domestic workers' housing, and the selection of land for the proposed Institute housing program would affect the design of individual dwelling units. Diagrammatic design proposals in the previous section "BUILDING DESIGN" indicate possible organization of the internal spaces. Objectives of the preliminary approach to the problem of housing are as follows:

a. The difference in total areas between the upper and lower house categories would be evened out. Type C, for example, is at the lower end of the range, while Type F is at the upper limit. It is proposed that the cost differential may be increased by a progressive reduction of standards for finishes and fittings, particularly for Types E and F.

b. A similar construction technique for all types would be provided so that a conspicuously different image for each type is avoided. This would allow for a more socially integrated approach to layout planning.

c. Recommendations for low cost housing, from the Nariobi University Housing Research Development Unit should influence design decisions.

ACCOMMODATION STANDARDS FOR GOVERNMENT OFFICES, MUGURO 1968

Space standards for government offices are set out in this memorandum. Standards in Mombasa are 15% higher than Nairobi to allow for the climatic conditions. The minimum office size for an individual is 10 sq. m and the maximum 16 sq. m except for senior staff where the maximum size is 26 sq. m. Offices for those sharing should not be less than 7.5 sq. m per person.

EDUCATION: STANDARD BUILDINGS, MINISTRY OF WORKS, KENYA - 1974

This document consists of a number of type plans for various secondary school buildings and was a helpful reference while preparing the schedule of accommodation.

TOWN PLANNING BYLAWS - This document sets out the Town Planning requirements for Kenya. It has been out of print for many years and is not due to be printed until it has been reviewed and up-dated.

PROCEDURES

Professional Services

Basically, the British contracting system is used in Kenya, adapted slightly to suit local conditions. Architects and other professional consultants are required to have qualifications approved by the Government before being allowed to practice. Standard fee scales are used by all consultants. Charges depend upon project type and cost, and close estimates can be made of total fee content at an early stage in the planning process.

The Architect is appointed by the Client (Employer) and is the main consultant. As such, his duties encompass those of a Project Manager and he is responsible for the co-ordination and design of the whole project and its supervision on site through to completion. If necessary, he will recommend that the client should also appoint consulting engineers and other specialists as required. Working closely with and under the direction of the Architect, these additional consultants become responsible for the design and supervision of the structural, mechanical, electrical and other systems within the Architect's overall design.

On major projects, the Architect will also recommend that a Quantity Surveyor (Q.S.) is necessary. This consultant is responsible for pre- and post-contract cost control, advice and recommendations on contractual and legal matters, and for obtaining bids, or tenders. Pre-contract cost control includes feasibility studies, cost reports, studies of alternative methods of construction, projected cash flows, checking and reporting on tenders, etc., as required during the design process. Post-contract cost control includes preparation of monthly valuations of work executed and materials on site for payment to the Contractor, measurement and agreement of adjustments to the contract price for post-contract variations, and settlement of all the final accounts of payment.

Tenders are checked and reported on by the Q.S. and Architect, and a recommendation is made as to which the client should accept.

Contract Documentation

The contract signed with the successful tenderer is a comprehensive printed document standard to all building projects, minor insertions only being necessary to suit particular circumstances. The tender figure with its basis of detailed quantities and prices contained in the B.Q. is incorporated in the contract. Quantities of labour and materials scheduled in the B.Q. are only adjusted if the design is varied. The contract closely defines the causes for which the Contract Sum or Contract Period are allowed to be varied and the methods by which financial adjustments are calculated.

Major contracts incorporate standard clauses, allowing specified fluctuations in prices of labour and certain basic materials, i.e., cement, steel, timber. Current price lists are issued regularly by the authorized Joint Building Council of Kenya, and various formulae are used for the adjustment of the Contract Sum so that the risk of inflation is reduced for contractors preparing new tenders. As with all other financial matters, the Q.S. administers the fluctuation clauses using B.Q. quantities and rates. It is normal for the Contract Sum to incorporate an allowance for the cost of fluctuations anticipated during construction.

Rules as to payment are also incorporated in the Contract as standard clauses. Mobilization or advance payments are not normal in the building industry.

Following the signing of a Building Contract, the Quantity Surveyor's role changes slightly and, although employed and paid by the Employer, the Q.S. has a duty to act impartially to protect the interest of both Employer and contractors.

Tender (Bid) Procedure Selection of Contractor

Tenders are obtained by the use of Bills of Quantities (B.Q.). The Architect and other consultants complete their detail designs and from their drawings the Q.S. measures accurately the labour and material content of the project. These items are scheduled in the B.Q. which also contains

specifications of workmanship and materials, notes on the conditions of contract, site requirements, etc. The successful tenderer (bidder) becomes the main contractor, responsible for administering the whole project, including specialist sub-contracts and supply items. These are allowed for in the B.Q. by means of "Prime Cost Sums" inserted by the Q.S. Tenders for these items are called separately by the appropriate consultants and the main contractor is instructed to enter into sub-contract or supply agreements with the selected firms. Actual sums expended are paid through the main contractor and offset against the Prime Cost Sums when the Final Account is settled. The client's only contractual relationship is with the main contractor.

The completed B.Q. is issued to all the contractors tendering, pre-selected by the Architect and client. All items in the document are priced in detail and totalled by each contractor and the final total becomes his tender. The contract Period may be specified in the tender documents as a fixed period of time or it may be left for individual tenderers to insert, in which case their time required becomes part of their tender and is considered along with the tender amount.

Interim certificates are issued at monthly intervals based upon valuations by the Q.S. of total work executed and materials on site, less previous payments. Retention of 10% is normally withheld, reducing to 5% on practical completion and released in full 6 months thereafter. All payments are made through the main contractor who is instructed as to how much must be paid to specialist sub-contractors and suppliers.

Insurances are required to be provided by the main contractor as specified in detail in the contract. All risks are covered, including those required by labour legislation and statutory authorities.

Tender (bid) bonds are not normally called for in the building industry but Performance bonds are required. These generally amount to 10 or 7½% of the Contract Sum for private sector or government contracts, respectively.

Alternate Phased Development Program

The Academic and Technical Teams examined a reduction in the size of the initial building program to suit an initial student population of 320 students. The alternate development shcedule would be based on the following student intake program:

June 1983	- 160 students	Year 1
June 1984	- 160 students	Year 1
	- 160 students	Year 2
June 1985	- 160 students	Year 1
	- 160 students	Year 2
June 1986	- 320 students	Year 1
	- 160 students	Year 2
June 1987	- 320 students	Year 1
	- 320 students	Year 2

The reduced volume of buildings required for June 1983 permits a reduction in the building contract period, although the Architect's contract must still commence September 1, 1980. (See Development Schedule, next page.)

PHASES

A	September 1, 1981	- May 31, 1983
B	June 1, 1985	- May 31, 1986
C	June 1, 1986	- May 31, 1987

For the purposes of costing, the following time schedules have been assumed:

i) Full Project Development, tenders called in August 1981, two years construction period, completion in August 1983.

ii) Phased Two Part Development, tenders called in August 1981 and May 1985, respectively, two years and one year construction periods and completion in June 1983 and June 1986 and June 1987, respectively.

DEVELOPMENT SCHEDULE

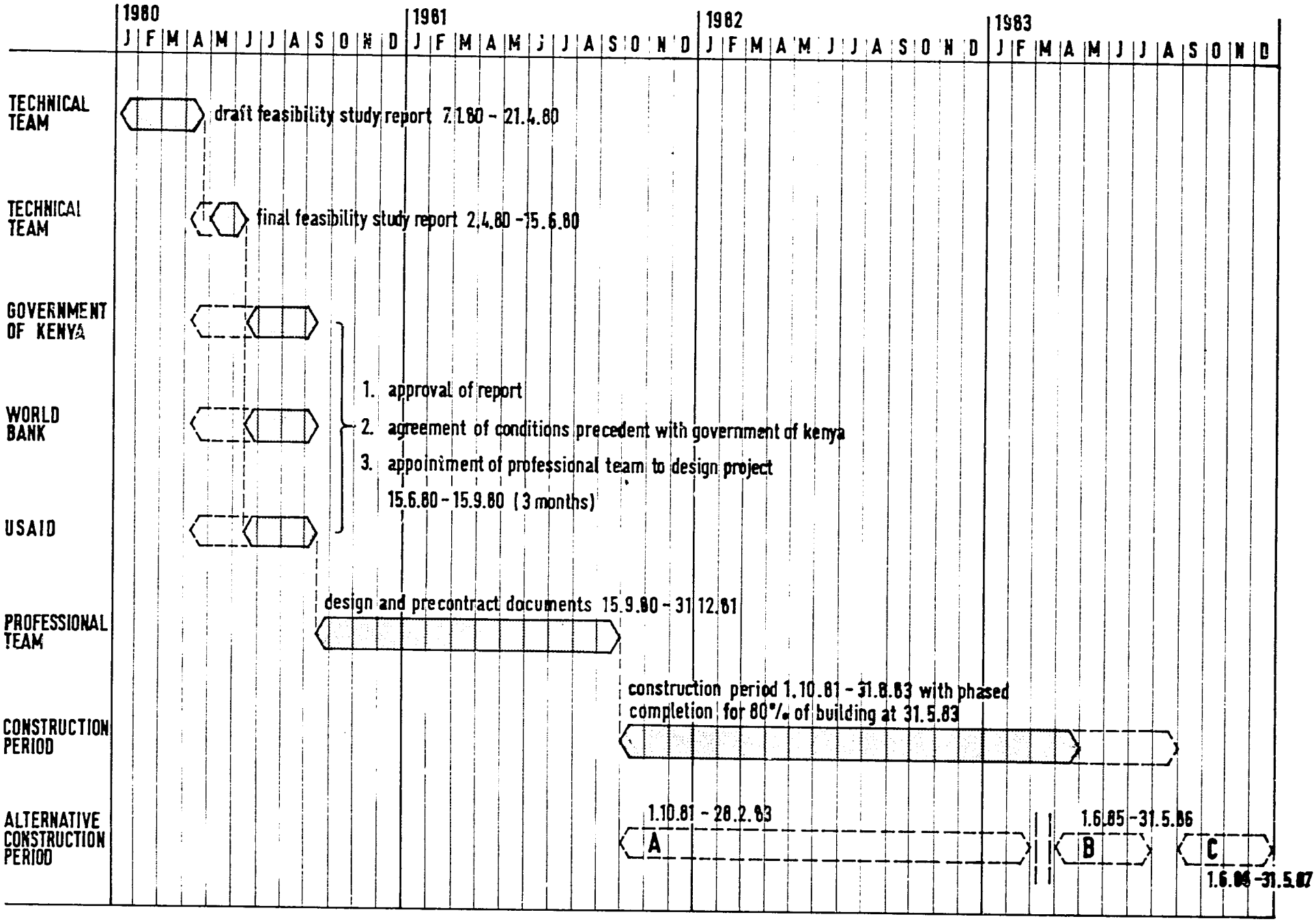


DIAGRAM 39

COST ANALYSIS

Estimated costs for the physical development of this project are based upon March 1980 tender prices, taking account of the proposed location. Projections for tender level inflation to the proposed tender date and for cost inflation to assess contractually incurred fluctuations are included, as are all allowances for professional fees and disbursements.

Explanations for these projections are included in the Appendices.

General Cost Allowances

Allowances of 7½% and 1½%, respectively, have been included in each cost total for Preliminaries and Contract Contingencies. The first allows for the prices inserted by tenderers to cover specific requirements of the contract, i.e., insurances, performance bond, storage, water, power, etc. The second allows for the Provisional Sum to be included in tenders to cover the cost of variations during construction.

An additional overall allowance of 10% for design and other contingencies is included to allow for events and changes which occur between the feasibility study and the tender date.

Foreign Exchange Content

Foreign exchange costs have been calculated on the following basis:

a) Directly imported materials assumed to have 95% foreign exchange content.
b) Imported goods procured locally assumed to have 70% foreign exchange content.
c) Locally manufactured goods assumed to have 5% foreign exchange content.

Materials have been taken to account for 60% of the cost of all building elements.

Almost all imported goods will be procured locally through agents or stockists who obtain foreign exchange allocations and import licences as required. All payments to local suppliers are in Kenya shillings. Direct contracts with overseas suppliers will not be necessary.

All costs are estimated in Kenya Shillings with a final single conversion to United States Dollars for evaluation purposes. The recent average exchange rate of K.sh.7.60 to U.S.$1 has been used for this conversion.

Elemental Costs

The Appendices contain the comparative costs analysis of the various structural and roofing systems prepared. Two typical buildings were examined for each of four structural designs and a total of six roof designs were analyzed.

The selected specifications are incorporated in the detailed elemental cost estimates, which are based upon approximate measurement of quantitites. The resulting costs per unit area are extrapolated as necessary to give accurate cost estimates of those buildings which have not been measured in detail. In accordance with local practice all area measurements for cost purposes are taken to the external face of enclosing walls. The basis for typical building cost calculation is detailed in the Appendices.

Specialist internal mechanical and electrical installations are included in each building cost total, but loose equipment and furnishings are shown separately. External services and reticulations are shown separately.

Equipment and Furnishing Costs

Equipment and Furnishing Costs are all estimated in local currency. These items will probably not be supplied through the main contract and estimates include an allowance for variation contingencies.

As a result, the percentage allowance for Preliminaries and Contract Contingencies referred to in above is not necessary. However, the 10% overall allowance for design and other contingencies has been included. Duty and Sales Taxes are allowed for in the estimates.

Equipment and Furnishings Cost Estimate Summary (U.S. dollars)

Accommodation Unit	Number	Unit Cost	Total Cost U.S.$
1. Classrooms	12	3,500	42,000
2. Chemistry Labs	2	28,000	56,000
3. Biology Labs	2	26,000	52,000
4. Metal workshop	1	26,000	26,000
5. Farm structures workshop	1	25,000	25,000
6. Home Economics Labs	2	17,000/9,500	26,500
7. Model Rural House	1	1,500	1,500
8. Extension Room	1	12,000	12,000
9. Library	1	130,000	130,000
10. Clinic	1	9,500	9,500
11. Laundry	1	14,000	14,000
12. Dining Hall(s)	1	34,000	34,000
13. Kitchen	1	48,000	48,000
14. Servery	1	18,000	18,000
15. Media Room	1	29,000	29,000
16. Dark Room	1	5,000	5,000
17. Single staff offices	16	2,000	32,000
18. Shared staff offices	17	2,000	34,000
19. General office	1	28,000	28,000
20. Student Common Room	1	18,500	18,500
21. Tea Rooms	2	1,800	3,600
22. Telephone Exch. Room	1	200	200
23. Cleaners Room	1	2,800	2,800
24. Staff Room	1	4,000	4,000
25. Student Housing	8	16,000	128,000
26. Staff Housing	87	-	150,200
27. Farm Buildings (summary)	-	-	43,400
28. Farm Machinery	-	-	80,000
29. Vehicles	-	-	292,000
30. Vehicles Maintenance/ Estates	1	22,000	22,000
31. Sports Equipment	-	3,000	3,000
32. Central Stores	1	12,000	12,000
Sub Total		US$	1,382,200
Contingency 10%		$	138,200
Sub Total		US$	1,520,400
Shipping and Insurance 22%		$	334,600
TOTAL		US$	1,855,000

Maintenance Costs

"Life cycle cost analysis" has not yet been undertaken, as relatively few design options exist and as the quality and extent of maintenance can vary widely. The choice of materials and specifications has been strongly influenced by the need to reduce maintenance requirements and costs to the minimum.

The annual maintenance cost for each building has been established on the simple basis of making good wear and tear to finishes, roofs and services and of regular re-decoration. No structural or other replacement costs have been allowed for.

Building and Site Development Cost Analysis

The following tables set out estimated costs of individual buildings, including costs of equipment and furnishings. The costs shown also include costs of site development (infrastructure) and farm development at current March 1980 prices.

Cost Full Development (Alternative A)

Building Type	No. Units	Total Cost incl. Equip. & Furn.	Foreign Exchange Content	Annual Maintenance Cost
ACADEMIC BUILDINGS				
Classroom Blocks with two classrooms of 40 students each	5	2,522,900	320,800	48,500
Lecture Room Block with two Lecture rms. of 80 students each	1	820,500	114,800	16,250
Laboratory Blocks with two teaching rms. (Biol. & Chem.) of 20 students each	2	2,634,200	1,270,800	42,500
Laboratory with two teaching rooms (Home Economics) for 40 students	1	1,002,200	295,400	17,250

Building Type	No. Units	Total Cost incl. Equip. & Furn.	Foreign Exchange Content	Annual Maintenance Cost
Extension Laboratory for 20 students	1	534,500	181,400	8,750
Workshops (Metal, Wood) for 20 students each	2	1,524,600	507,000	23,500
Library	1	2,669,700	1,427,800	29,000
Dining Halls for 160 students	2	2,043,000	316,500	40,000
Junior Common Room	1	1,096,500	151,800	23,000
Kitchen and Servery	1	2,800,000	600,000	46,000
Laundry	1	1,100,000	300,000	16,000
Administration Complex	1	2,945,000	815,800	48,000
STUDENT HOUSING				
Halls of Residence for 40 students each	16	14,272,800	3,050,000	292,800
MISCELLANEOUS				
Workshop, Estates (Bldg. and Vehicle Maintenance) 20 persons each	2	1,218,700	313,900	17,500
Central Stores	1	586,000	127,000	8,250
Vehicle Shed and Vehicles	1	4,399,300	3,090,900	202,500
Clinic	1	379,000	131,000	7,800
Sports	1	187,000	43,900	4,750
Guest House	1	384,200	64,000	7,680

Building Type	No. Units	Total Cost incl. Equip. & Furn.	Foreign Exchange Content	Annual Maintenance Cost
FARM				
Feed and Hay Store	1	319,000	51,500	6,200
Calf, Sheep & Goat Shed	3	253,000	41,400	3,800
Dairy	1	231,300	36,600	3,300
Piggery	2	180,000	27,100	2,900
Teaching Area	1	89,100	9,000	1,500
Horticulture Shop and Demonstration	1	220,600	48,500	3,600
Screen House	1	35,700	6,700	400
Poultry	1	119,000	26,900	1,900
Model Rural House	1	274,000	35,300	6,900
Dips and Bee-Keeping	2+1	129,500	45,200	4,000
STAFF HOUSING				
Type B	1	394,200	54,600	6,500
Type C	11	3,844,700	535,600	68,000
Type D	26	7,357,800	1,121,400	184,600
Type E	24	3,585,000	530,000	86,400
Type F	25	2,991,500	448,700	89,400
SUNDRIES				
Site Fencing and paddock/ compound fencing		265,000	5,000	10,000
Additional Accommodation for Servants Quarters & Ablutions, ets.		1,290,000	129,000	30,000
Sports Field, est.		100,000	3,000	2,000
Outdoor Assembly and Centrum Pavings, est.		200,000	6,000	3,000
Additional Links and Footpaths, est.		532,500	15,975	10,400
Gas and Solar Heating Equipment		826,000	580,000	25,000
Landscaping		600,000	150,000	25,000

Building Type	No. Units	Total Cost incl. Equip. & Furn.	Foreign Exchange Content	Annual Maintenance Cost
INFRASTRUCTURE (Site Services & Reticulation)				
Road Network, surfaced and unsurfaced (incl. parking)		971,350		
Foul and Surface water drains and Oxidation ponds		2,156,500		
Potable Water system		2,571,000		
Electric Power system (incl. street lighting)		960,000		
Telephone system (without PAX)		25,800		
Incinerator		215,350		
Total Infrastructure		6,900,000	2,400,000	200,000

Cost Phased Two-Part Development

PHASE 1

Building Type	No. Units	Total Cost incl. Equip. & Furn.	Foreign Exchange Content	Annual Maintenance Cost
ACADEMIC BUILDINGS				
Classrooms	3	1,513,700	192,500	29,100
Lecture Room	1	410,250	57,400	8,100
Laboratory (Biology)	1	1,317,100	635,400	21,250
Laboratory (Home Economics)	1	1,002,200	295,400	17,250
Extension Laboratory	1	534,500	181,400	8,750
Workshops	2	1,524,600	507,000	23,500
Library	1	2,669,700	1,427,800	29,000
Dining Hall	1	1,021,600	158,200	20,000
Junior Common Room	1	1,096,500	151,800	23,000
Kitchen and Servery	1	2,000,000	400,000	46,000
Laundry	1	850,000	300,000	16,000
Administration Complex	1	2,945,000	815,800	48,000
STUDENT HOUSING				
Halls of Residence	8	7,136,400	1,525,000	146,400
MISCELLANEOUS				
Workshops (Maintenance)	2	1,218,700	313,900	17,500
Workshop (Stores)	1	586,000	127,000	8,250
Vehicle Shed	1	2,399,300	2,090,900	102,000
Clinic	1	379,000	131,000	7,800
Sports	1	187,000	43,900	4,750
FARM				
All as full development		1,851,300	328,200	34,500
STAFF HOUSING				
Type B	1	394,200	54,600	6,500
Type C	10	3,495,200	486,900	62,000
Type D	10	2,829,900	431,300	71,000
Type E	14	2,091,300	530,000	50,400
Type F	15	1,795,000	269,200	53,600
SUNDRIES				
All as full development, less part additional accommodation, sports field & part additional links, & part solar heating (est.)		2,500,000	800,000	80,000
SITE SERVICES AND RETICULATION				
All as full development		6,900,000	2,400,000	200,000

PHASE 2

Building Type	No. Units	Total Cost incl. Equip. & Furn.	Foreign Exchange Content	Annual Maintenance Cost
ACADEMIC BUILDINGS				
Classrooms	2	1,009,200	128,300	19,400
Lecture Room only	1	410,250	57,400	8,125
Laboratory (Chemistry)	1	1,317,100	635,400	21,250
Dining Hall	1	1,021,600	158,200	20,000
STUDENT HOUSING				
Halls of Residence	8	7,136,400	1,525,000	146,400
MISCELLANEOUS				
Vehicles		2,000,000	1,000,000	100,000
Guest House	1	384,200	64,000	7,680
FARM				
(Assumed complete in Phase 1)				
STAFF HOUSING				
Type C	1	349,500	48,700	6,180
Type D	16	4,527,900	690,000	113,600
Type E	10	1,493,800	220,800	36,000
Type F	10	1,196,600	179,500	35,750
SUNDRIES				
Balance of full development less Phase 1		1,313,500	250,000	26,000
SITE SERVICES AND RETICULATION				
(Assumed virtually complete in Phase 1)				

Cost Analysis Summary

● FULL DEVELOPMENT (Alternative A)

Buildings and Other Elements	Local Cost (Mar. 1980) incl. Equip. & Furn.	Foreign Exchange Cost Ksh.	Total Ksh.
Academic Buildings	14,331,500	6,000,900	20,332,400
Student Housing	11,222,600	3,050,200	14,272,800
Other Buildings	3,383,500	3,770,800	7,154,300
Farm Facilities	1,523,300	328,000	1,851,300
Staff Housing	15,483,100	2,690,300	18,173,400
Sundries	2,924,500	889,000	3,813,500
Infrastructure	4,500,000	2,400,000	6,900,000
	53,368,500	19,129,200	72,497,700
Design Contingencies 10%	5,336,800	1,912,900	7,249,800
TOTALS	58,705,300	21,042,100	79,747,500

Annual Maintenance Costs — Ksh. 1,674,800

Cost Projections

Total Estimated Project Cost March 1980 prices	79,747,500
Add for inflation to tender date June 1981, 20%	15,949,500
Total tender cost at June 1981	95,697,000
Add for fluctuations during construction, 10%	9,569,700
Estimated final cost June 1983	105,266,700
Add for Professional Fees & Disbursements, 10%	10,526,700
TOTAL FINAL COST ESTIMATE	Ksh. 115,793,400
EQUIVALENT to US$ (Ksh. 7.60 to US$1	$ 15,236,000

PHASED TWO-PART DEVELOPMENT

PHASE 1

Buildings and Other Elements	Local Cost (Mar. 1980) inc. Equip. & Furn.	Foreign Exchange Cost Ksh.	Total Ksh.
Academic Buildings	11,552,800	5,021,600	16,574,400
Student Housing	5,611,300	1,525,000	7,136,300
Other Buildings	2,938,400	2,706,900	5,645,300
Farm Facilities	1,523,300	328,000	1,851,300
Staff Housing	9,054,400	1,551,200	10,605,600
Sundries	1,700,000	800,000	2,500,000
Infrastructure	4,500,000	2,400,000	6,900,000
	36,880,200	14,332,700	51,212,900
Design Contingencies 10%	3,688,000	1,433,300	5,121,300
TOTALS	40,568,200	15,766,000	56,334,200

PHASE 2

Academic Buildings	2,778,700	979,300	3,758,000
Student Housing	5,611,300	1,525,100	7,136,400
Other Buildings	455,100	1,063,900	1,509,000
Farm Facilities	(assumed complete Phase 1)		
Staff Housing	6,428,700	1,139,100	7,567,800
Sundries	1,063,500	250,000	1,313,500
Infrastructure	(assumed complete Phase 1)		
	16,327,300	4,957,400	21,284,700
Design Contingencies 10%	1,632,700	495,700	2,128,400
TOTALS	17,960,000	5,453,100	23,413,100

Cost Projections		PHASE 1	PHASE 2
TOTAL Estimated Costs March 1980		56,334,200	23,413,100
Add for inflation to tender dates:			
PHASE 1 June 1981 (20%)		11,266,800	
PHASE 2 June 1985 (60%)			14,047,900
TOTAL Tender Costs	Ksh.	67,601,000	37,461,000
Add for fluctuations during construction			
PHASE 1-24 months (10%)		6,760,100	
PHASE 2-12 months (5%)			1,873,000
Estimated Final Cost	Ksh.	74,361,100	39,334,000
Professional Fees 10%		7,436,100	3,933,400
TOTAL FINAL COST ESTIMATES		81,797,200	43,267,400
PHASE 1 and PHASE 2 TOTAL	Ksh.	125,064,600	
EQUIVALENT to US$		$16,455,900	

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INTERVIEWS

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Mr. Wainaina	Animal Husbandry Officer
Mr. M. J. Voestermans	Irrigation Engineer

Provincial Office of Education

Mrs. N. N. Zari	Basic Education

Provincial Physical Planning Office

Mr. Levis Karani	Physical Planning Officer

Ministry of Water Development

Mr. Dugdale	Director of Maintenance

Ministry of Roads and Transport

Mr. Okumu	Provincial Engineer

KILIFI

District Offices

Mr. B. A. Omuse	District Commissioner
Mr. Abudi Kobai	Acting District Commissioner
Mr. Benson Mbogoh	District Development Officer
Mr. W. M. G. Kitti	Farm Manager, Kibarani Farm

Other

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Mr. Svoboda	Settlement Officer, Settlement Schemes, Ministry of Lands and Settlement
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Mr. Dennis Wilson	Manager, Kilifi Plantations

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