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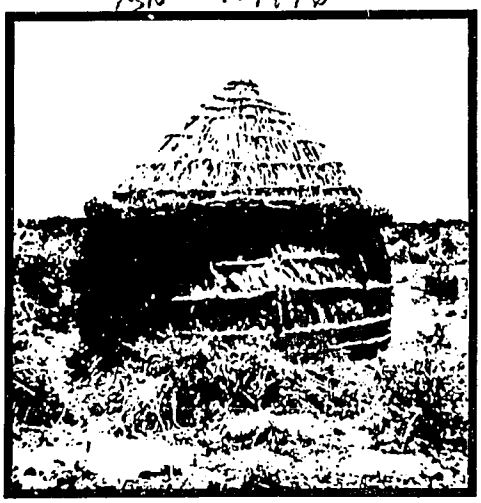

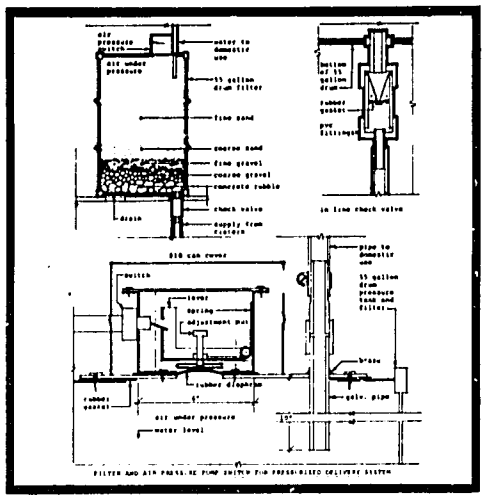

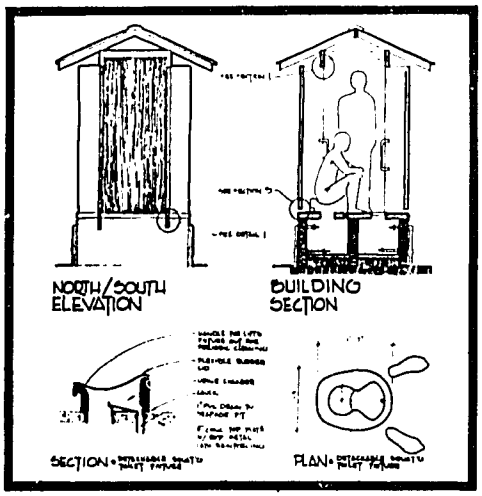

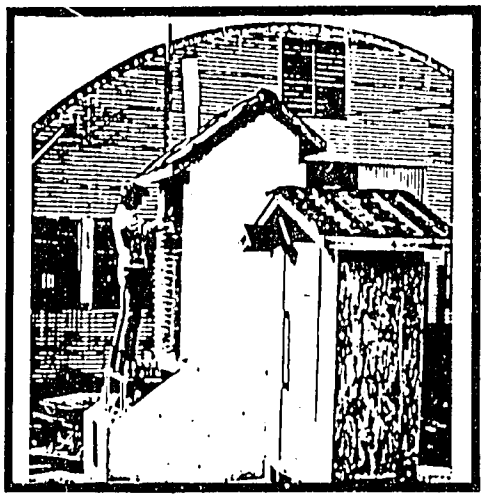

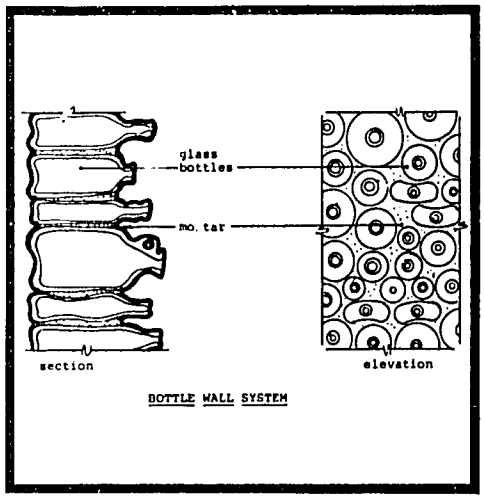

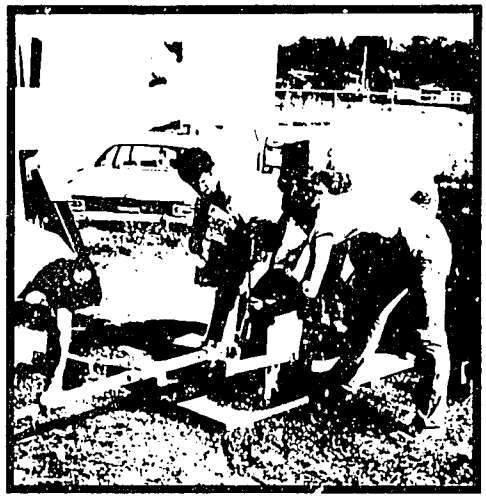

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT

FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307

SCHOOL OF ARCHITECTURE

This report was prepared as a result of the Construction Training Program for the Pilot Housing Project in Kurtunwaare, Somalia, conducted by a team from the Experimental Low Cost Construction Unit, School of Architecture, Florida A&M University, from June to December of 1980.

TEAM MEMBERS:

School Superintendent . . . . . James Blakeley Bruce

Instructor of Masonry . . . . . Millard M. Wright

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TEXT AND ILLUSTRATIONS . . . . . David Tod Hollister

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& Juanita V. Smith

DESIGN OF ALTERNATIVE HOUSING UNITS
FOR THE KURTUNWAARE PILOT HOUSING PROJECT

Publication #6 June, 1981

FUNDING AGENCIES:

240 USAID, East African Mission
Washington, DC, USA

Government of Somalia
Magadishu, Somalia, East Africa

SUB-CONTRACTOR

Florida A&M University, School of Architecture
Experimental Low Cost Construction Unit
P. O. Box 597, Tallahassee, Florida, USA

Work performed in support of the Low Cost Housing Project for Kurtunwaare, Somalia. Prime Contractor: Louis Berger
241 International Inc., 100 Halsted Street, East Orange, New Jersey, USA

Other documents available from the Experimental Low Cost Construction Unit include:

Publication #1: Energy Efficient Technologies and Methodologies for Low Income Rural Housing, 1978

Publication #2: Training Program in Low Cost Energy Efficient Technology, 1979

Publication #3: Contruction Training Program for the Kurtunwaare Pilot Housing Project, Kurtunwaare, Somalia, 1981

Publication #4: Contruction Training Manual for the Pilot Housing Project, Kutunwaare, Somalia, 1981

Publication #5 Investigation of Alternative Roofing Systems Available for Use in the Kurtunwaare Pilot Housing Project, 1981

2

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Project Summary

PROJECT SUMMARY

CONSTRUCTION TRAINING PROGRAM

FOR THE KURTUNWAARE PILOT HOUSING PROJECT

KURTUNWAARE, SOMALIA

PROJECT TEAM	All team members were provided by the School of Architecture, Experimental Low Cost Construction Unit, Florida A&M University.
TRAINING PROGRAM BUDGET	$99,183.00
APPROXIMATE PROJECT BUDGET	$4,000,000.00

PROJECT SUMMARY

Background - Somalia was one of the many African nations affected by the 1973-1975 drought. In response to the thousands of refugee nomads produced by the drought, the Somali government set up 21 temporary relief camps in the drought-stricken areas, most of which are still in use today.

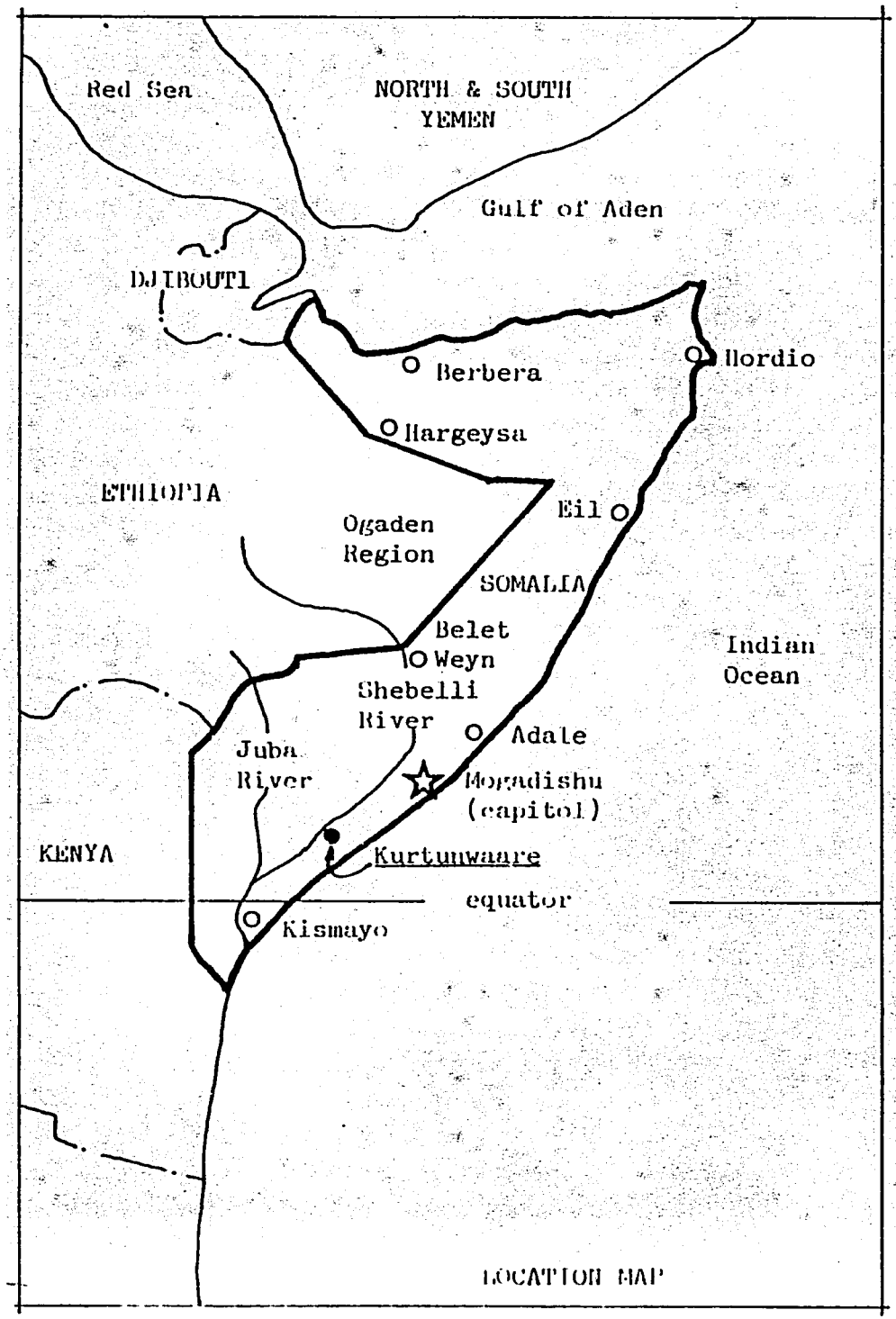
In an effort to provide the nomads with an opportunity to rebuild their lives based on an alternative life style, the government's Settlement Development Agency (SDA) set up six permanent villages that were to have an economic base in agriculture or fishing. One of those villages, Kurtunwaare, located on the Sheblli River, was established as an agricultural village.

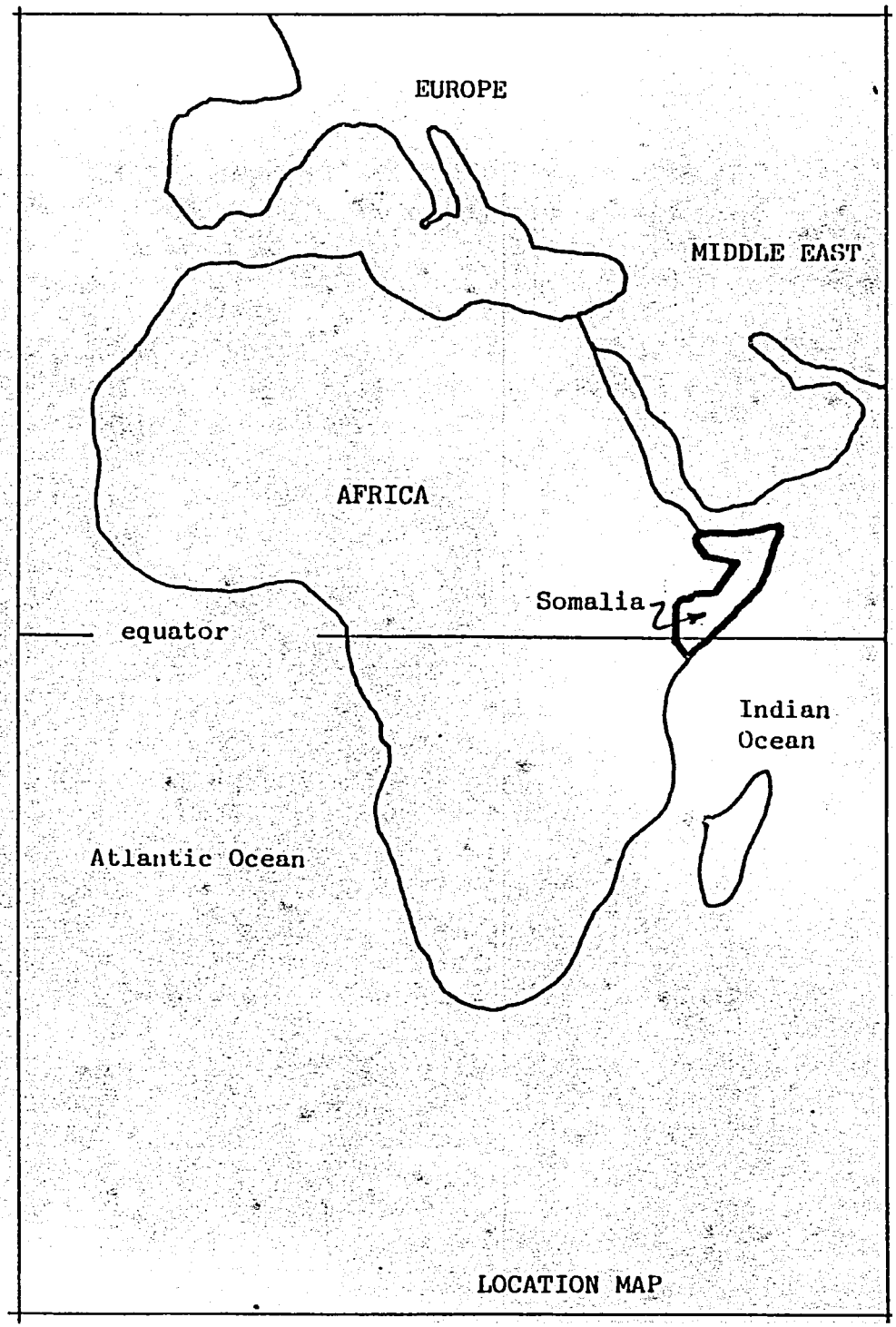
Kurtunwaare - The village of Kurtunwaare was founded in 1975 with 4,000 nomad families. The primary crops produced by the village are rice and corn. In exchange for labor in the fields or village, settlers are provided with a food ration, clothing, education, health care, 2 shillings (13¢) a day, and housing.

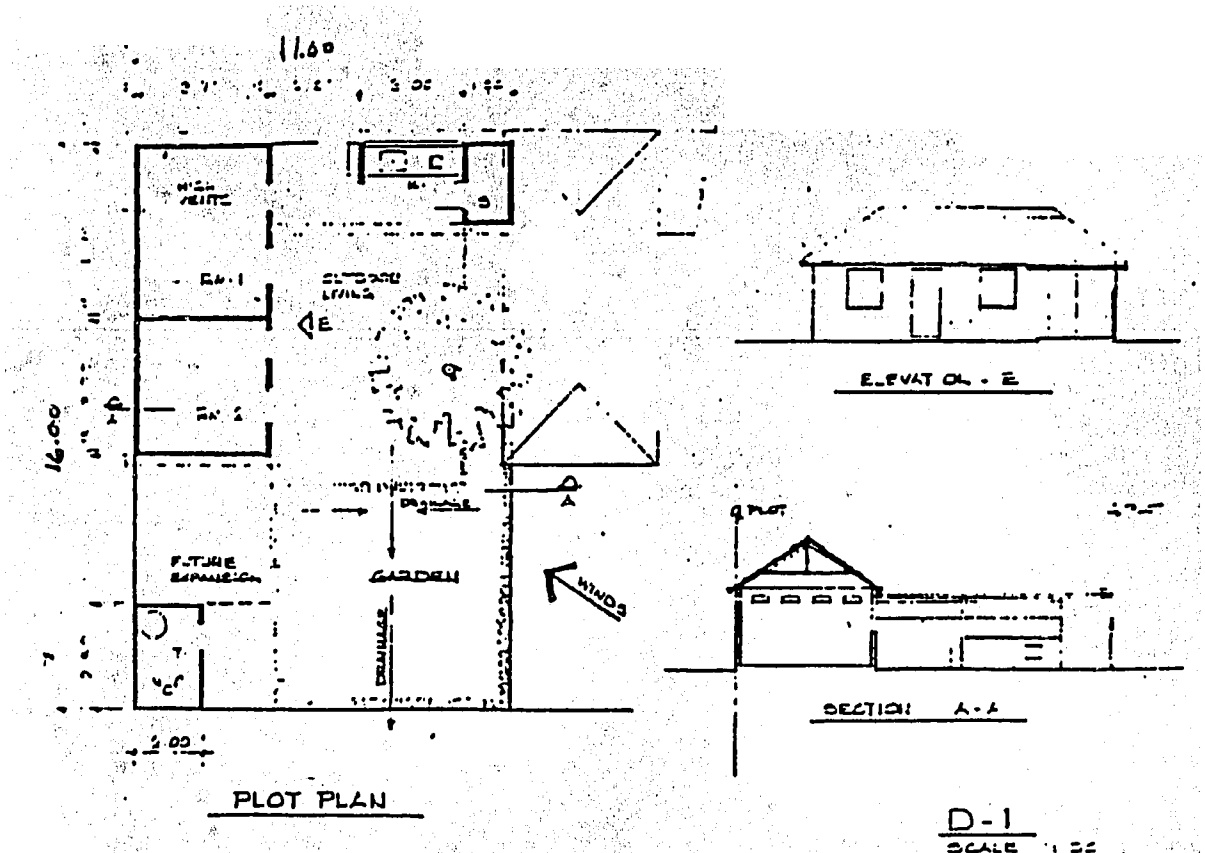
Most of the village development effort, until recently, has been aimed at the village's economic base, farming and its infrastructure. There was little opportunity to upgrade the temporary housing and infrastructure, which were all quickly set up when the village was established. The housing built consisted of mud and wattle agals or munduuls with open pit-type latrines and with little attention paid to site drainage.

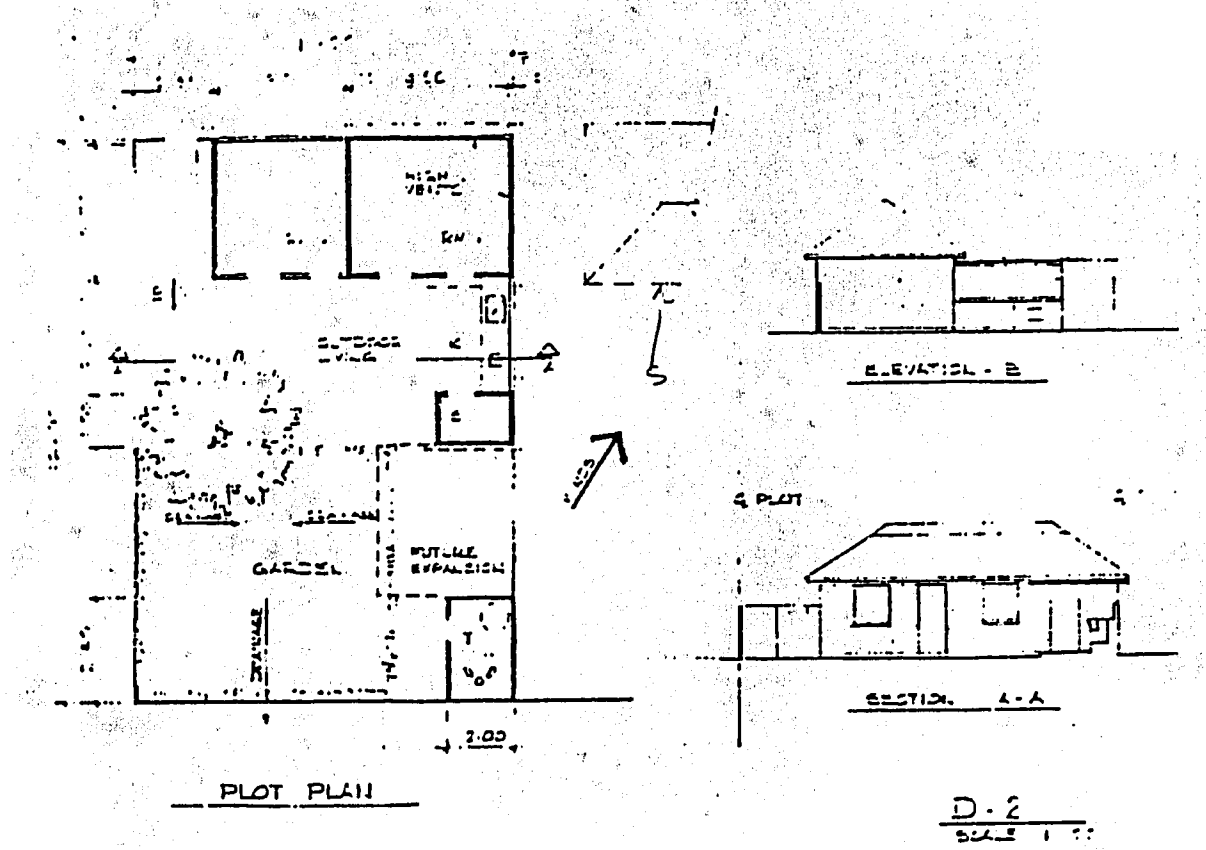
Project Description - Because of these problems, the SDA, aided by the local USAID mission designed a prototype housing unit and developed a site plan that calls for 4,000 new houses with appropriate site infrastructure which includes a water standpipe and cistern for every 20 houses, a composting toilet for each house, and adequate site drainage. The first phase of the project was the construction of a portion (400 houses) of the complete project. The houses were constructed using the following systems:

5

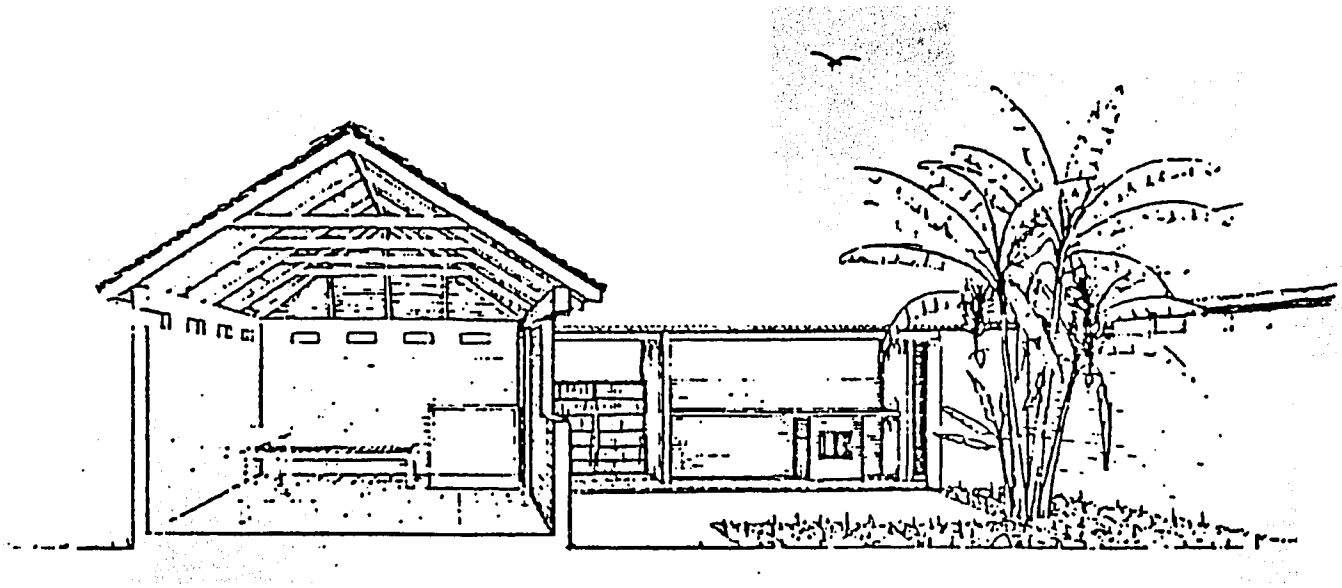

Red Sea
NORTH & SOUTH YEMEN
Gulf of Aden
DJIBOUTI
Berbera
Hordio
Hargeysa
ETHIOPIA
Ogaden Region
Eil
SOMALIA
Belet Weyn
Indian Ocean
Shebelli River
Adale
Juba River
Mogadishu (capitol)
KENYA
Kurtunwaare
equator
Kismayo
LOCATION MAP

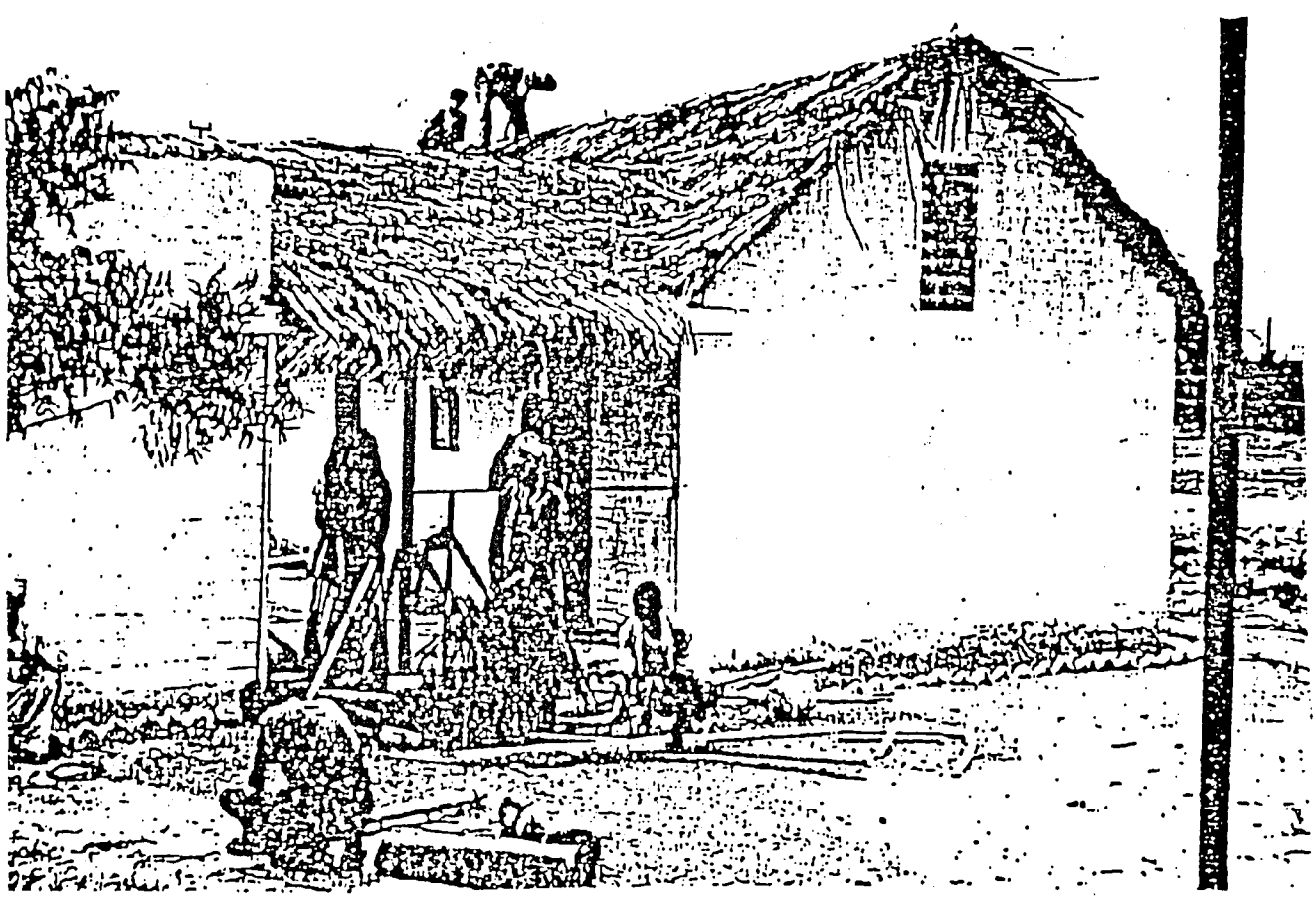

EUROPE
MIDDLE EAST
AFRICA
Somalia
equator
Indian Ocean
Atlantic Ocean
LOCATION MAP





Original U.S.A.I.D. House Prototype Drawings From the Kurtunwaare Settlement Project, Project Paper





Original U.S.A.I.D. House Prototype Illustration and Photograph
From the Kurtunwaare Settlement Project, Project Paper

Concrete grade beam foundations
Masonry walls of hand-made cinva-ram brick and cement mortar.
Conventional wood frame roof structures.
Coconut palm leaf thatched roof mumbrane improved with tar paper.

CRAFTS TRAINING PROGRAM SUMMARY

Crafts Training Program - The work force that was to build the project was to consist of Kurtunwaare settlers. This required that a crafts training program be set up for their training. The primary objective of the training program was to train the approximately 100 skilled laborers that it was estimated would be required for the project. In addition, leadership training was provided to produce the necessary crew chiefs and foremen.

The Florida A&M Team's primary contractual responsibility was to organize and set into motion the Crafts Training Program and the training of the School Staff of Somalis to whom the day-to-day management would be gradually turned over. This was done by the Team between June and December 1980.

Organization of the Crafts Training Program - The program was divided into the following instructional divisions:

Unskilled Labor Experience
Crafts Training Components
- Foundations
- Masonry
- Carpentry

Leadership

The Crafts Training Components -- Foundations, Masonry, and Carpentry, represented the backbone of the program by producing the skilled labor crew. The unskilled labor experience provided each trainee with a minimum one month weeding out, introductory period that led to promotion to the Training Program. The Leadership Training was provided for likely candidates that had completed the Crafts Training Program and at least two months of experience with the production crews.

Training Method - The method of training was based on providing the trainee with highly supervised, on-the-job construction experience by constructing houses from the ground up that were identical to houses being built by the production crews. This method avoided wasting time and materials on practice structures and provided the trainees with the most realistic experience possible. This basic training concept was applied not only to crafts trainees but also to leadership trainees. They were trained by assigning them a crew of trainees, a plot to build on, and by giving them decision-making responsibility.

School Site - The training was conducted at the school site which consisted of one of the sites of 10 houses (called a Xubin). The Florida A&M Team established the site which included the training houses, an administrative

office, storage for materials, and a large equipment operation and storage area. Once all the plots were used, the program was to be relocated on the next Xubin.

RESULTS

By the time the Florida A&M Team left Kurtunwaare in December 1980, the following results had been achieved:

School Staff - A staff consisting of a School Superintendent, Instructors of Foundations, Masonry, and Carpentry, a general Labor Foreman, and assistants for each (10 personnel) had been trained to operate the program. This was the most important task because it insured the continuation of the program.

Training Program Curriculum - A curriculum was developed and documented in a manual for use by the school staff.

Sixty Apprentice Craftsmen Trained - These apprentice craftsmen (including about 20% women) were trained and promoted to the production crews. Additionally, about 40 trainees were still in the program to be replaced by new trainees once they were promoted.

Construction of 13 Houses - Twenty-five percent, or 13 of the total of 50 houses started by December 1980 had been started by crafts trainees in the training program. Of the 13, 7 were completed.

Establishment of a School Site with Facilities and Equipment - In December, the second school site was established with the layout of its first foundation.

ADDITIONAL SERVICES

Construction Supervision - Each team member provided general construction supervision to aid in project mobilization.

Set Up and Daily Operation of Cinva-ram Block Plant

Roofing System Investigation - Investigation and limited testing of alternative roofing systems was carried out.

House Unit Design - Eleven alternative housing units were designed and built.

This report and accompanying drawings document the alternative housing unit designs developed and built by the project team during their stay in Kurtunwaare.

INTRODUCTION

At the time the Kurtunwaare Pilot Housing Project was mobilized, the Settlement Development Agency (SDA) had not decided upon a final design for the project housing unit. What had been decided on, was a construction system that consisted of a concrete grade beam and piers, cinva-ram block masonry walls, a dirt floor, and a makuti (thatch) roof on light truss framing. There was and still is considerable resistance to the use of a makuti roof on the part of the SDA.[1]

It was agreed upon that the first house to be built in Kurtunwaare was to be based on the design of a house developed for the Sablaale Housing Project, a sister project to Kurtunwaare funded by the Dutch Government and located about 150 km south of Kurtunwaare. The house consisted of 42 square meters of enclosed space with three rooms and an additional 8 square meters of covered outdoor space. A copy of the original plan for this house is in the Appendix. It was built on the 10 plots of Xubin[2] A-1 with two variations in plan and three variations in the construction of its roof. See Schematic Site Plan page 10 for location of Xubin A-1.

In addition to the Housing unit described above, other units were to be designed and built so that the SDA and representatives from Kurtunwaare could select the house design that seemed to be the most appropriate solution. This was to be done during the construction of the first 50 houses of the pilot project.

The Florida A&M University Technical Assistance Team was asked to design a portion of these houses. The team designed the houses located on Xubins A-2, A-3, and B-2. The house type on Xubin A-3 was designed first followed by those on Xubin A-2. The house types located in Xubin A-2 and Xubin B-2 were also used as the Construction Crafts Training School Sites.

---

1 Another report has been prepared by the Experimental Low-Cost Construction Unit that presents alternative roof systems that might be used in Kurtunwaare.

2 An Xubin consists of 10 house plots. Five Xubins make up an Udud and eight Udud's make up a beel. These site divisions are based on the socio-political hierarchy that is used to organize the present village.

The design was to utilize the existing site plan, the construction system previously described, and as a design program, the Kurtunwaare Settlement Program Architecture and Planning Analysis found in Annex 7 of the USAID Project Paper. Portions of that analysis are included in the appendix. The remaining design variables consisted primarily of the following:

Location and orientation of the house on the plot

Plan configuration

Elevation configuration

Minor modifications to the construction system while still using the same materials

The team was asked to adhere to a floor area of approximately 40 square meters. In most cases this request was complied with except in the design of about half of the housing units on the Training School Site, Xubin A-2. Houses on this site represent variations of smaller houses that could be built ranging from 26 square meters, with one to three enclosed rooms, up to 43 square meters.

Eleven different houses were designed. From these emerge five basically different design concepts. They are denoted arbitrarily as Types I through 5 and are identified in plan and site location on the site plans on pages 10 through 12.

In general, it was the intent of the Florida A&M Team to simplify the design and construction of the houses they developed and to minimize the total amount of materials required to build each house. This was attempted through the application of the following principles:

House dimensioning based on a 30.5 cm (12") cinva-ram block module.

Simple square or rectangular plan.

Minimum roof span limited in most cases to 3.66m (12'-0").

Simple roof trusses with a lower 33.7^{o} slope (8 in 12 pitch).

Masonry gable ends used instead of hipped roof ends.

Use of lowest possible wall height.

Door and window opening size minimized.

Dimensioning based on the block module resulted in a simplified first course layout that required a minimum of block cutting. This also led to a savings of material because most blocks cut were cut in half.

Almost all of the plans were squares or rectangles simply divided into rooms. This minimized the complexity of all aspects of their construction. Complicated foundation formwork was not needed, unnecessary hips and valleys in the roof that would be required in an "L" shaped plan were avoided, and the general plan was more easily perceived by the settlers building the houses.

The shorter roof span simplified and reduced the size of the truss. This combined with a lowered roof slope not only reduced the actual roof area, but also made construction easier. Earlier roofs had been built at a 45° slope making them more difficult to work on. The reduced slope also reduced the area to be covered by the roof membrane, by decreasing the length of the top chord of the trusses.

In earlier houses, hip roofs had been used. Gable ends of cinvaram masonry were more simply constructed, not only reducing the construction complexity, but it also avoiding unnecessary construction of hips which in a makuti roof are the most apt to begin leaking.

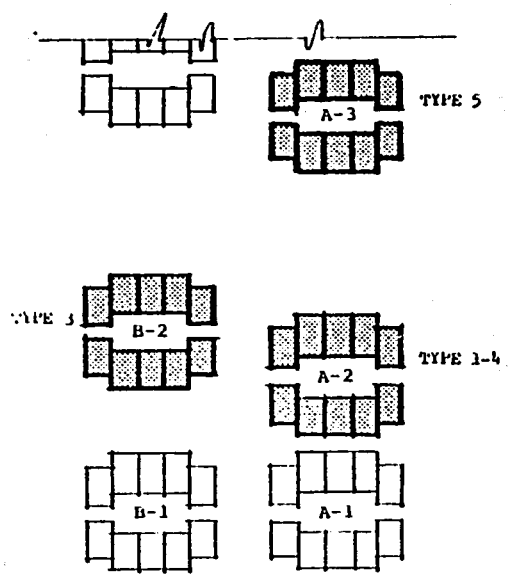
In an attempt to reduce the use of unnecessary material, the walls were built as low as possible. In previous houses, the wall height had been set at 2.4 m (8'-0"). This required 24 courses of cinvaram blocks. This resulted in a material savings of up to 17% of that required for the 24 course wall.

Door and window sizes were reduced to a smaller size so that the materials required to cover them would be reduced. It was assumed that wood would be used to cover the door openings and possibly the window openings. This would require the use of local or imported lumber which are both expensive items.

Except for the Type 4 house located in Xubin A-2, Plot #10, houses were not located on the site based on consideration of proper orientation to breezes and the sun since, in most cases, this was impossible due to the orientation of the plots in each Xubin. Plots should have been rotated 90° to allow houses to be oriented for proper ventilation and reduced heat gain from the sun on the east and west sides. Should any of these houses be considered for use in the future, this important aspect must be carefully studied along with window location in the house to insure the selection of the optimum solution.

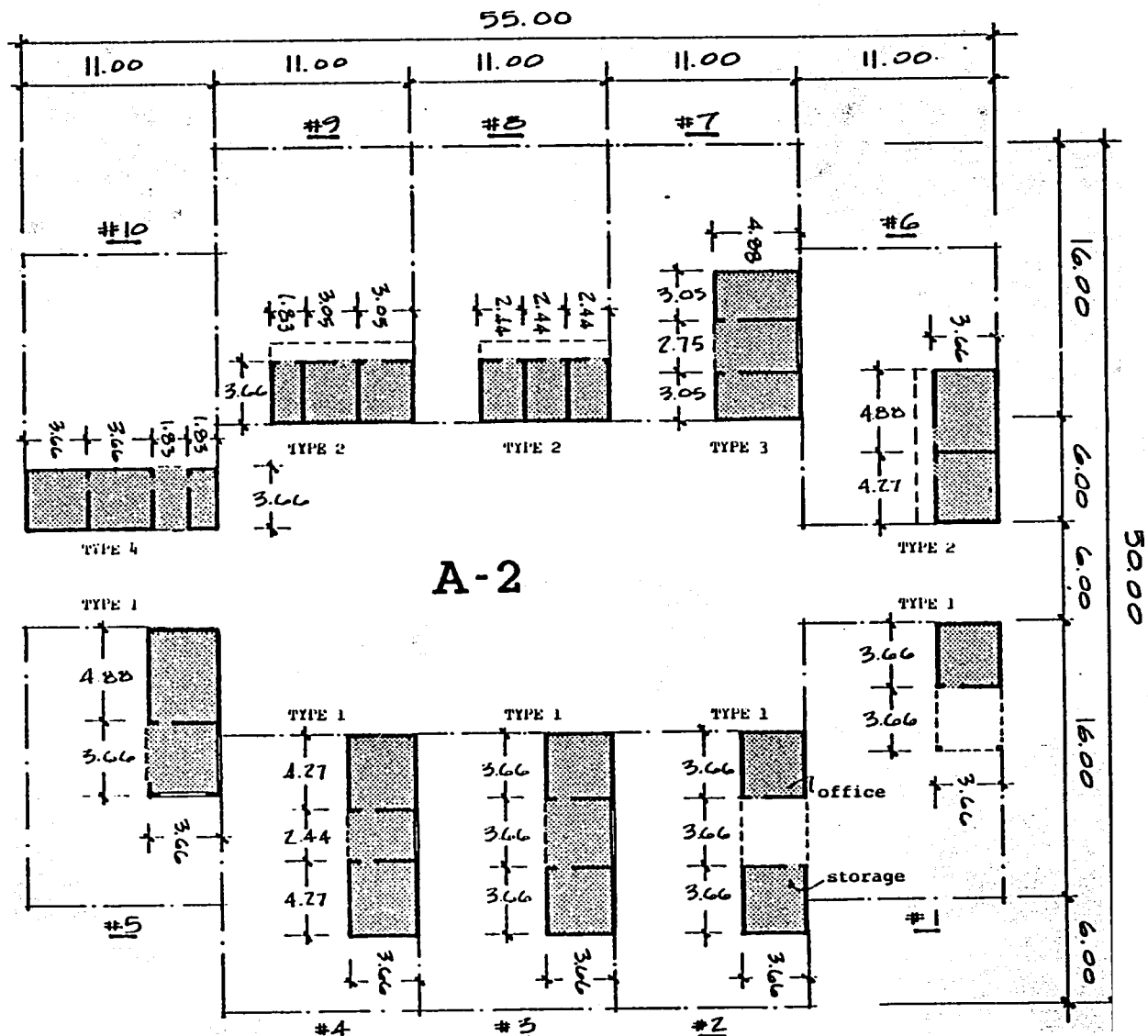
Site Plans, Housing Unit Building Sections, Details, and Photographs

14



SCHEMATIC SITE PLAN

NO SCALE (PARTIAL PLAN)



XUBIN A-2 SITE PLAN

1:250

NORTH

SITE PLAN

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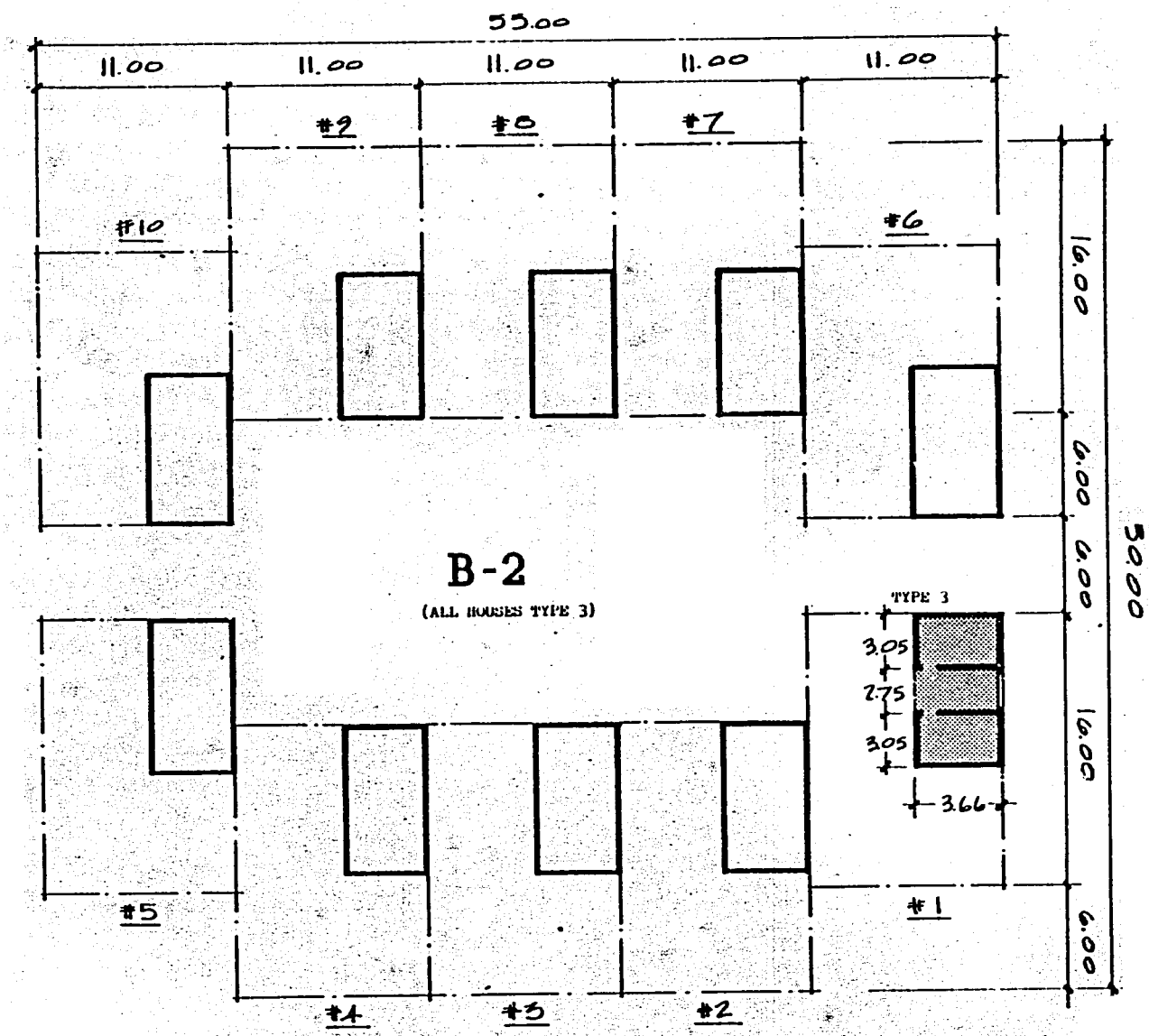
SCHOOL OF ARCHITECTURE



XUBIN B-2 SITE PLAN

1:250

16

SITE PLAN

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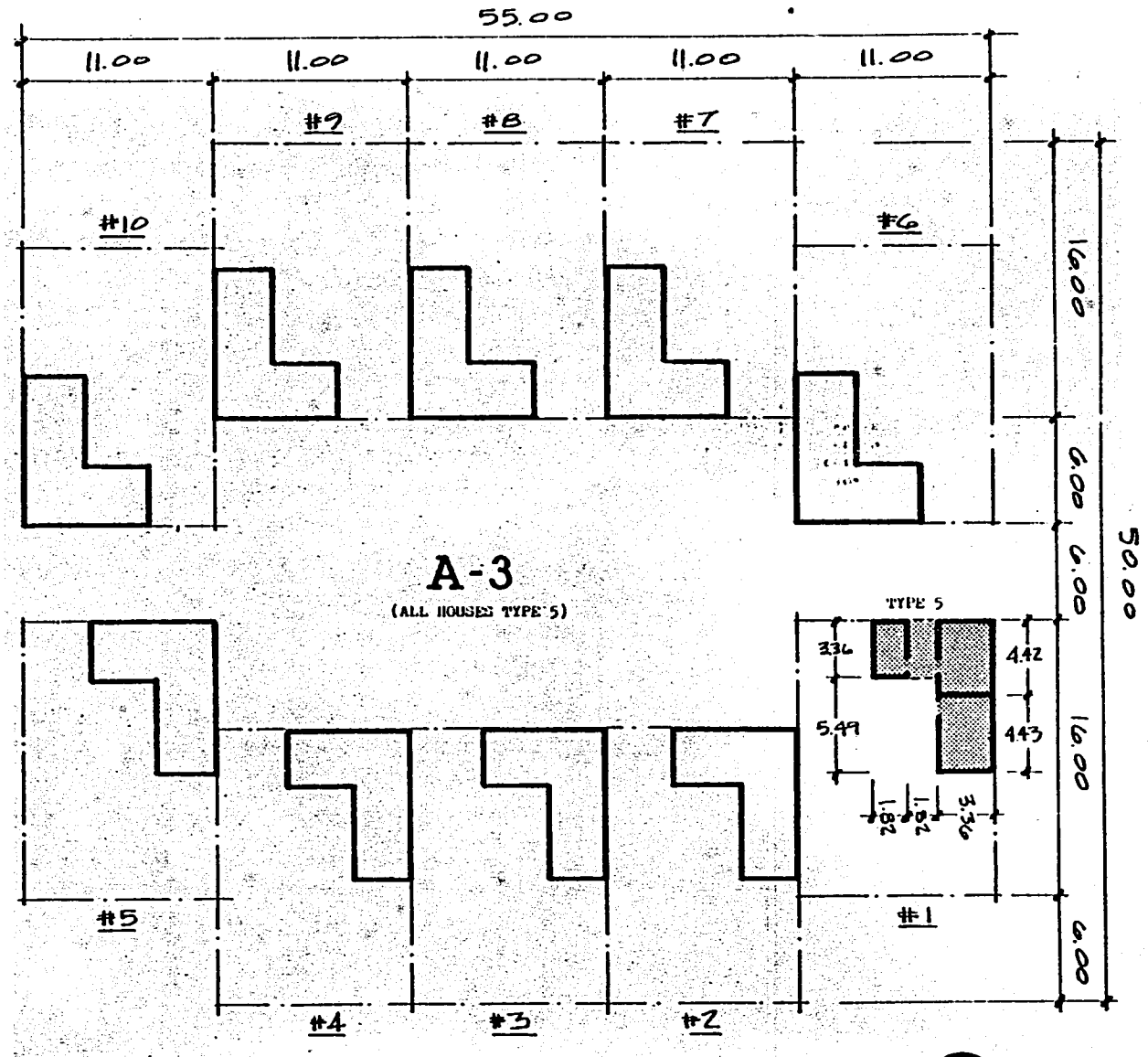
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307

SCHOOL OF ARCHITECTURE



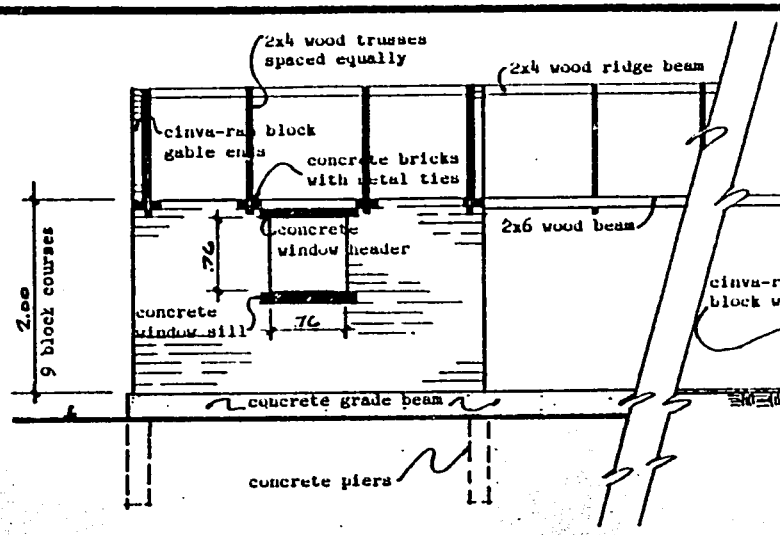
XUBIN A-3 SITE PLAN 1:250

NORTH

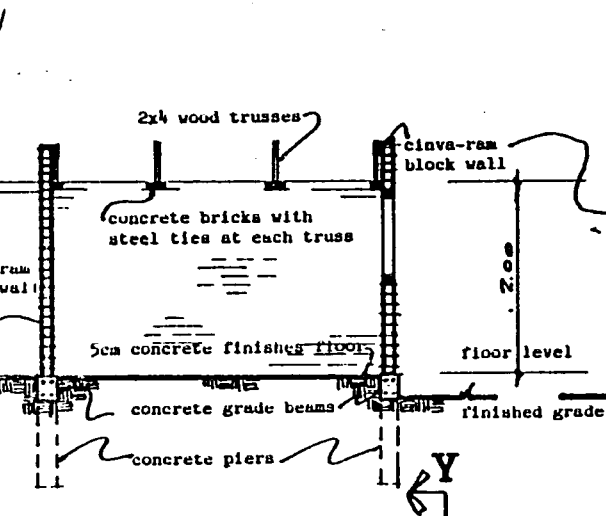
SITE PLAN

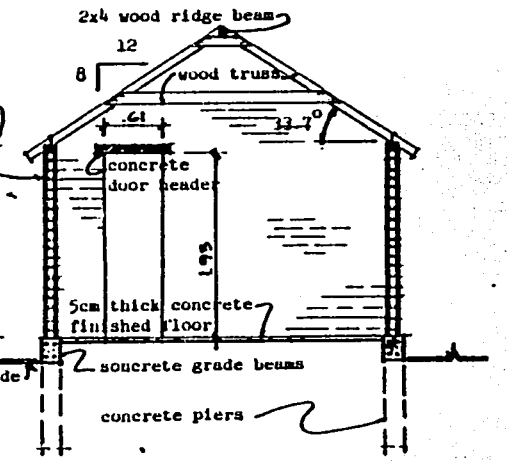
EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307

SCHOOL OF
ARCHITECTURE

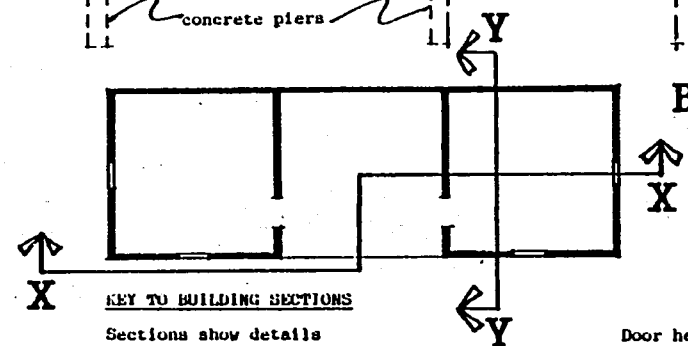


BUILDING SECTION X-X



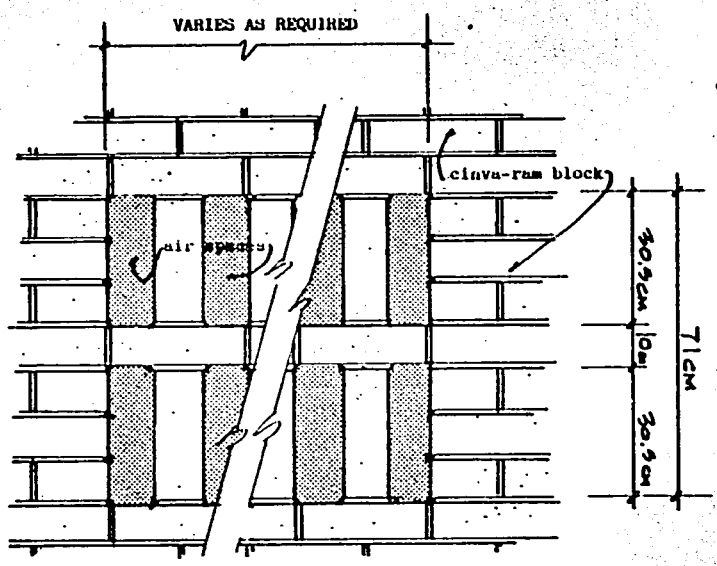


BUILDING SECTION Y-Y



KEY TO BUILDING SECTIONS

Sections show details typical of all house unit alternatives.

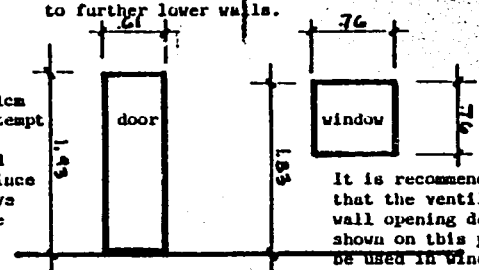


TYPICAL DETAIL OF VENTILATED WALL OPENINGS

DETAIL

Door heights were established at 193cm (6'-4") in an attempt to lower the wall heights. Doors were located in gable end walls to further lower walls.

Door widths were established at 61cm (2'-0") in an attempt to minimize the material required to make a door since wood, an expensive material, might be used.



It is recommended that the ventilated wall opening detail shown on this page be used in windows to provide security.

TYPICAL DOOR AND WINDOW OPENING DETAILS

DETAIL

BUILDING SECTIONS AND DETAILS

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
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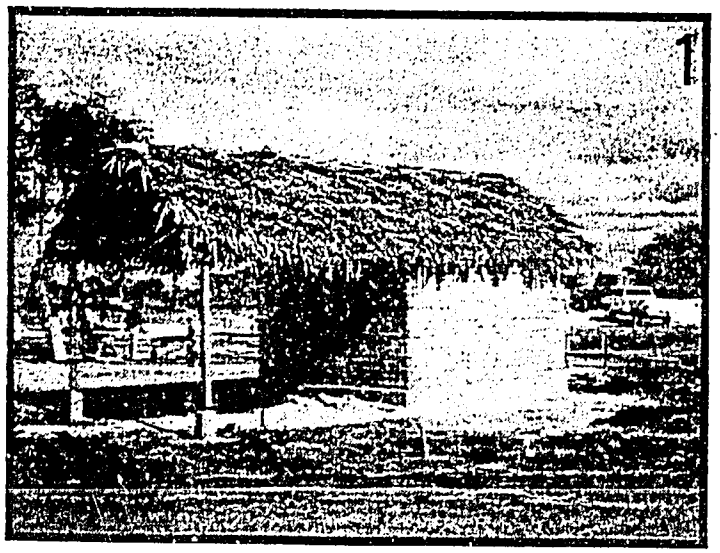
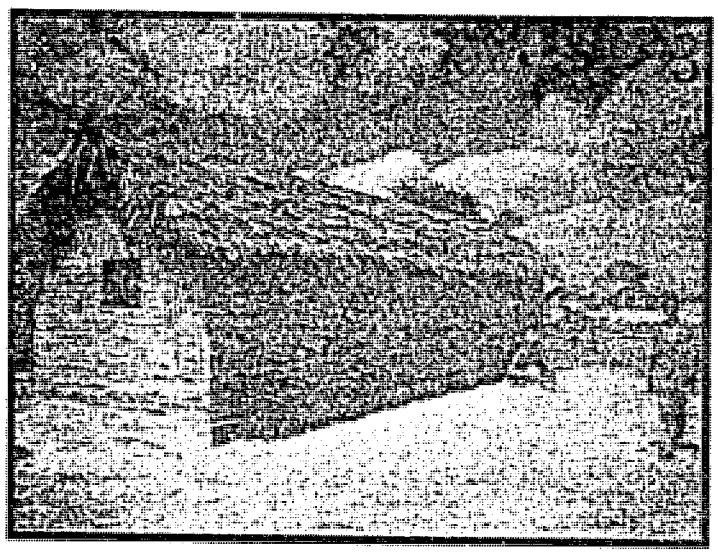
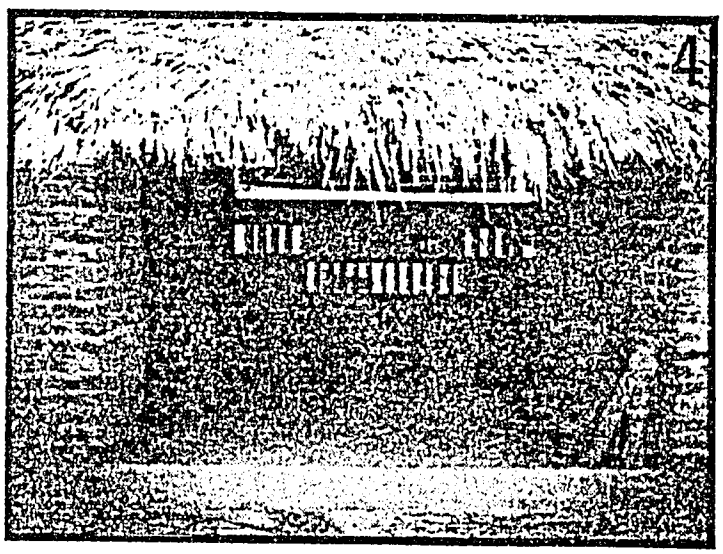
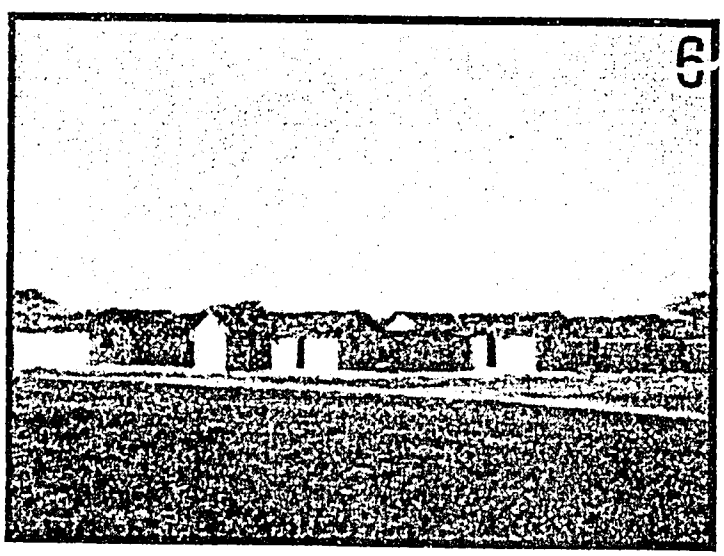
SCHOOL OF ARCHITECTURE









1 Simple core house with outdoor covered cooking area, 27 square meters, Training School Site A-2, Plot #1 **2** Two room core house with outdoor covered cooking area, 40 square meters, Training School Site A-2, Plot #2 **3** Two room core house with ventilated privacy wall for cooking area on zero lot line side, Training School Site A-2, Plot #3 **4** Covered cooking area with ventilated privac wall **5** "L" shaped house with two rooms and a storage/cooking room connecte by a small covered entrance space, 42 square meters, Site A-3, Plots 1-10 **6** Site A-3 completed

HOUSING UNIT ALTERNATIVES

There are five conceptually different types of houses. They have been identified as Types 1 through 5. In addition to this identification the houses have also been identified by their location on the site. The following chart identifies this relationship.

TYPE	LOCATION
1-a	Xubin A-2, Plot #1
1-b	Xubin A-2, Plot #2
1-c	Xubin A-2, Plot #3
1-d	Xubin A-2, Plot #4
1-e	Xubin A-2, Plot #5
2-a	Xubin A-2, Plot #6
2-b	Xubin A-2, Plot #8
2-c	Xubin A-2, Plot #9
3	Xubin A-2, Plot #7 Xubin B-2, Plot #1 - 10
4	Xubin A-2, Plot #10
5	Xubin A-3, Plot #1 - 10

Each house type is shown on the site plans and then a drawing page is devoted to it which includes its plan, elevations, and basic data. The plan shows the basic layout, first course block layout, door and window locations, dimensions, its existing relationship to the plot, and other necessary notes. The elevations include each house's four major elevations. Windows, ventilated walls, and doors are indicated with a shaded area of coarsely spaced dots. Covered areas are indicated by a shaded area made up of finely spaced dots. Other materials or building elements are indicated with notes. The data shown on each page includes the house's floor area, wall surface area, roof surface area, and foundation information. Floor area is differentiated by the terms enclosed and covered. Enclosed floor area refers to parts of the house that are securable and have a roof and walls that totally enclose that area. Covered floor area refers to areas that are protected by a roof, one to three walls, and are not securable. Wall area is differentiated by whether the surface areas are exterior walls

that completely enclose and secure a space or partition walls that divide a secured space into separate rooms. The roof surface area is self explanatory. All of the above areas are measured in square meters (SM). Under the heading of foundations, will be listed the length in lineal meters (LM) of the grade beam required for that house, and the number of piers used to support the grade beam. From this information rough cost comparisions could be made for each house. The chart on the following page summarizes the data presented for each house.

COMPARATIVE HOUSE DATA CHART

HOUSE TYPE	FLOOR AREA (GROSS)			WALL AREA			ROOF AREA	FOUNDATIONS	
	Encl.	Cov.	Total	Exterior	Part.	Total	Total	Gr. Bm.	Piers
1-a	13.4	13.4	26.8	33.4	0.0	33.4	37.7	14.0	6
1-b	26.8	12.4	39.2	66.4	0.0	66.6	54.2	28.0	8
1-c	26.8	12.4	39.2	72.6	0.0	72.6	54.2	34.8	8
1-d	31.3	7.9	39.2	75.2	0.0	75.2	54.2	34.8	8
1-e	17.8	13.4	29.0	52.7	0.0	52.7	43.6	26.9	6
2-a	33.5	0.0	33.5	55.7	6.8	62.5	46.6	28.4	6
2-b	26.8	0.0	26.8	46.0	13.5	59.5	37.7	28.0	6
2-c	29.0	0.0	29.0	50.7	13.5	64.2	40.7	29.3	6
3	29.8	13.4	43.2	78.1	0.0	78.1	56.4	36.0	8
4	33.5	6.7	40.2	48.4	6.8	55.2	55.5	38.8	6
5	36.9	6.1	43.0	84.8	3.1	87.9	69.5	44.2	8

Drawings and Descriptions

TYPE 1 DRAWINGS & DESCRIPTIONS

Five different examples of the Type 1 house were built. They are all located on the original Training School site, Xubin A-2. They are as follows:

TYPE	LOCATION
1-a	Xubin A-2, Plot #1
1-b	Xubin A-2, Plot #2
1-c	Xubin A-2, Plot #3
1-d	Xubin A-2, Plot #4
1-e	Xubin A-2, Plot #5

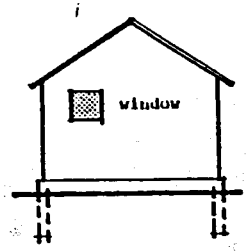
The concept behind the design of the Type 1 houses is based on the use of one very simple core unit that would be built by itself, with a roof extension that provides additional covered area, or in combination with another core unit connected to it with a roof that provides a third covered space. The simplest example built is Type 1-a located on plot #1. In this case, the core and a covered area were built providing the dweller with a secured sleeping room of a size approximately equivalent to existing houses in Kurtunwaare and providing a covered area for cooking and other semi-private activities that might take place outside. It is assumed that once the dweller is ready for more space, the covered area could easily be walled in with a similar construction system of cinva-ram block, locally manufactured clay brick, or mud and wattle.

Another option might be the construction of an additional room on one of the three sides of the covered area such as in the case of the Type 1-b house located on plot #2. Again the materials that might be used are seen as optional to the builder based on the economic realities of available materials at that time. In this case, the additional core was constructed from the cinva-ram and makuti construction system.

One of the problems with the unit on plot #2 was that the covered area did not seem private at all. The solution to this of course would be the construction of a wattle fence on the side of the plot boundary. This would provide privacy and good ventilation. A version of this was built on plot #3 (Type 1-c). This house is identical to the previous one except that it has a floor and ventilated wall between the two core units.

24

The house on plot #4 (Type 1-d) is similar to the one on plot #3 except that the core units are larger. The core unit on plot #5 is larger still. These variations were built so that a comparision of different size spaces could be made by those responsible for the selection of the housing unit. The covered space on plot #4 (Type 1-d) is the smallest useful living or cooking space that was built. The covered area on plot #5 (Type 1-e) is an example of a partially closed covered area added to a single core unit.



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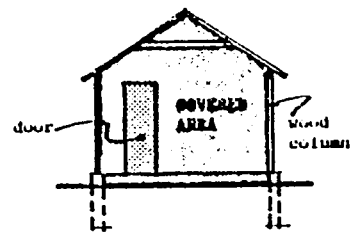

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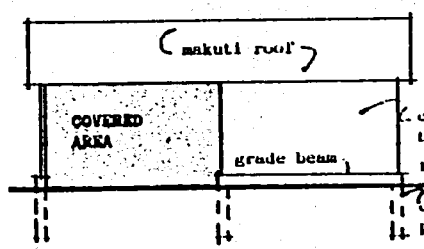

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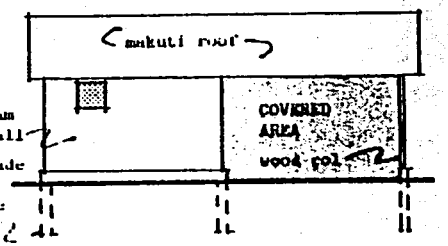


WEST

ELEVATIONS

1:100

DATA

ROOF AREA

Total	37.7 SM

FOUNDATIONS

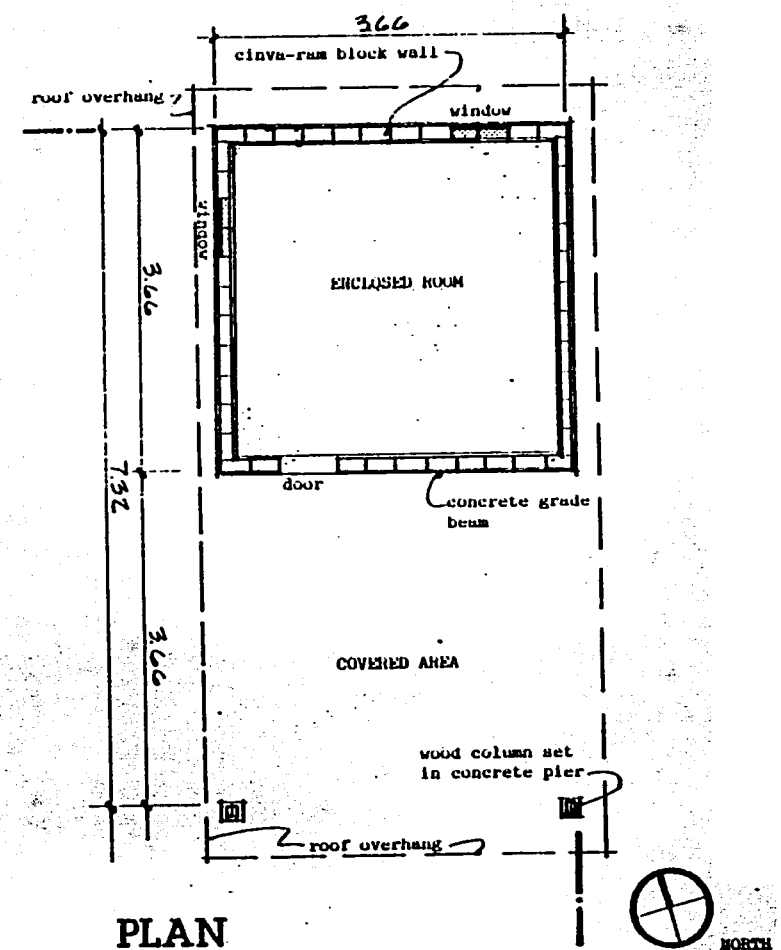
Grade Beam	14.0 LM
Piers	6

FLOOR AREA (GROSS)

Enclosed	13.4 SM
Covered	13.4 SM
Total	26.8 SM

WALL AREA

Exterior	33.4 SM
Partition	0.0 SM
Total	33.4 SM



PLAN

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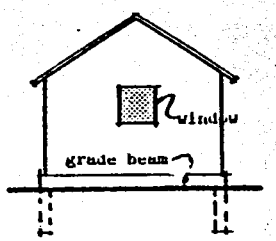
HOUSE UNIT ALTERNATIVES
TYPE 1 LOCATION A-2, #1

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307
SCHOOL OF ARCHITECTURE



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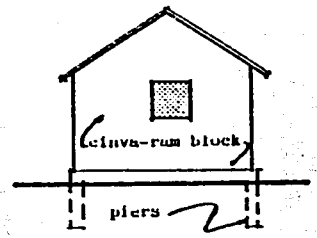

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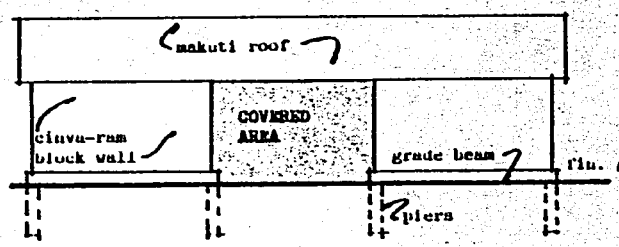

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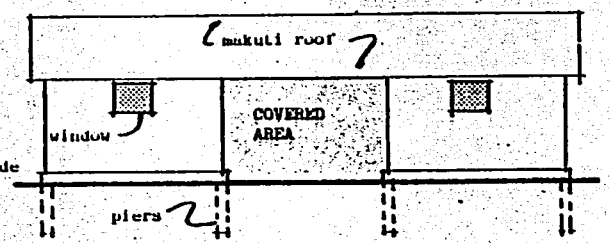

WEST

ELEVATIONS

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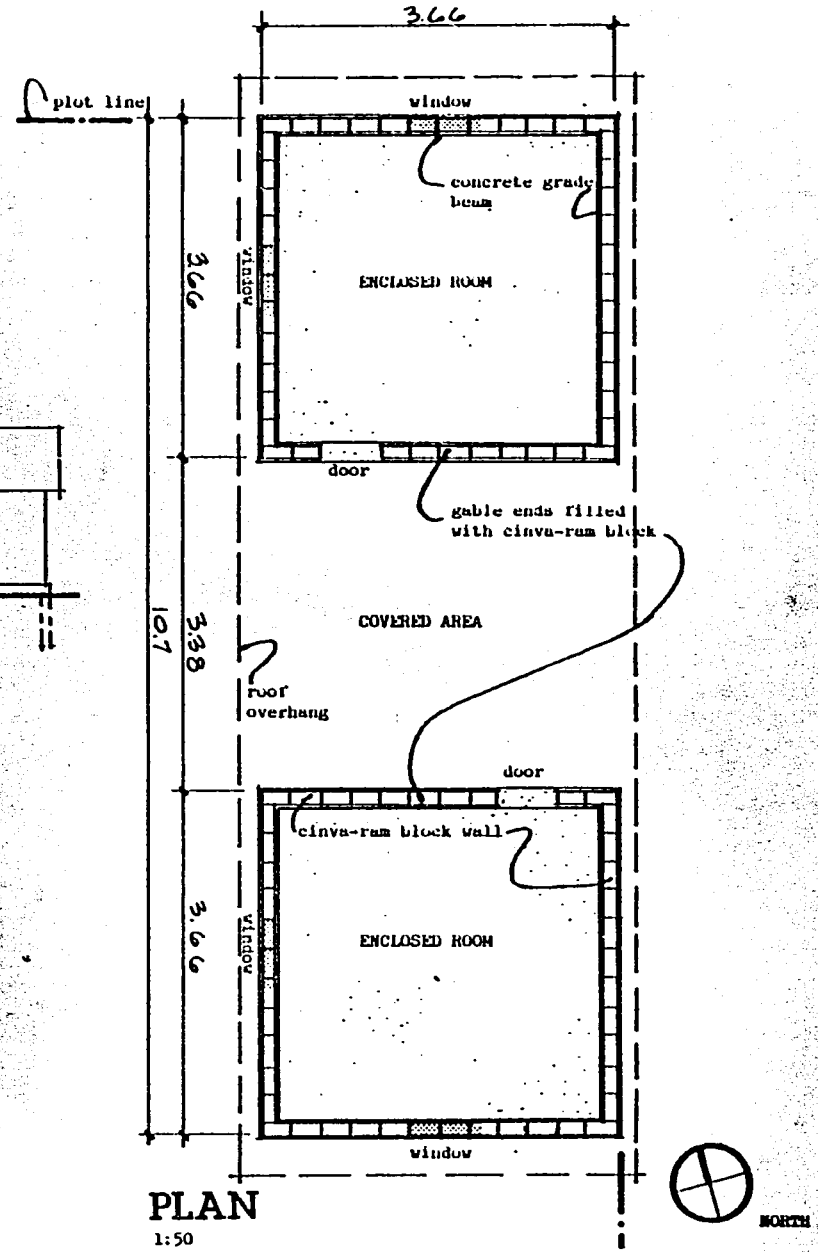

PLAN

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DATA

ROOF AREA

Total	54.2 SM

FOUNDATIONS

Grade Beam	28 LF
Piers	8

FLOOR AREA (GROSS)

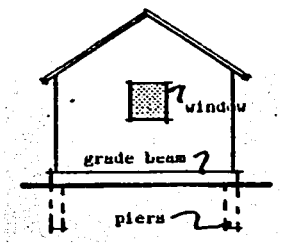
Enclosed	26.8 SM
Covered	12.4 SM
Total	39.2 SM

WALL AREA

Exterior	66.4 SM
Partition	0.0 SM
Total	66.4 SM

HOUSE UNIT ALTERNATIVES
TYPE 1 LOCATION A-2, #2

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307
SCHOOL OF ARCHITECTURE



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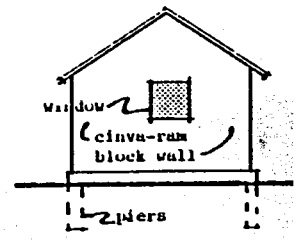

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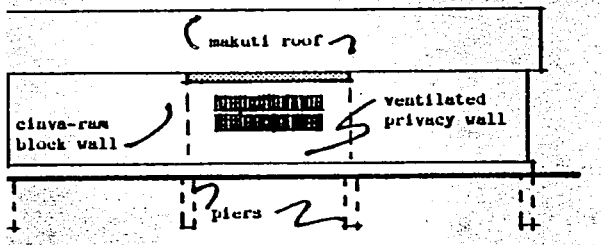

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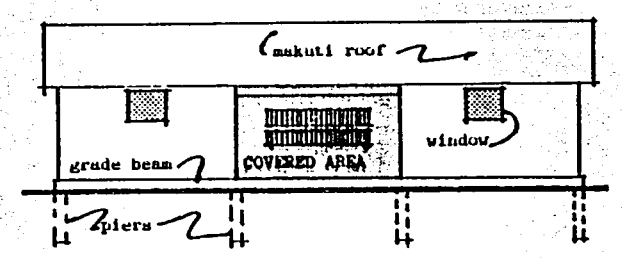

WEST

ELEVATIONS

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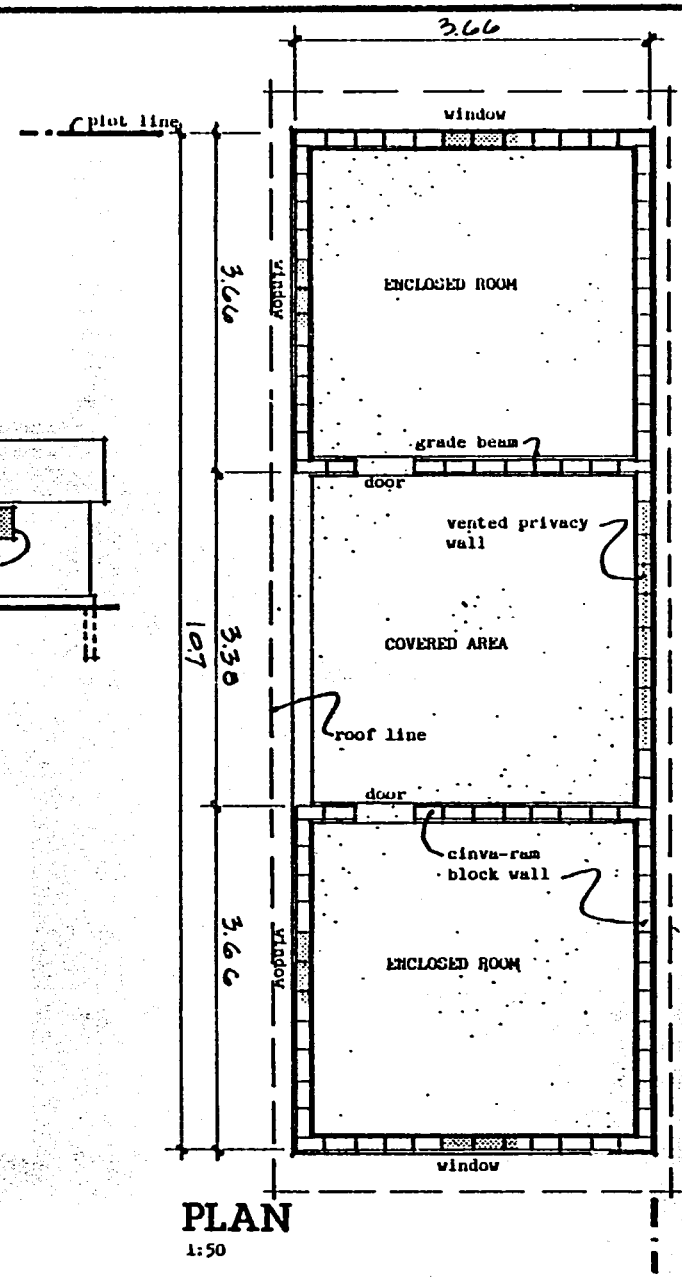

PLAN

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DATA

ROOF AREA

Total	54.2 SM

FOUNDATIONS

Grade Beam	34.8 LM
Piers	8

FLOOR AREA (GROSS)

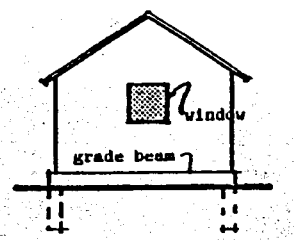
Enclosed	26.8 SM
Covered	12.4 SM
Total	39.2 SM

WALL AREA

Exterior	72.6 SM
Partition	0.0 SM
Total	72.6 SM

HOUSE UNIT ALTERNATIVES
TYPE 1 LOCATION A-2, #3

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307
SCHOOL OF ARCHITECTURE



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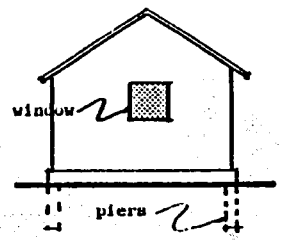

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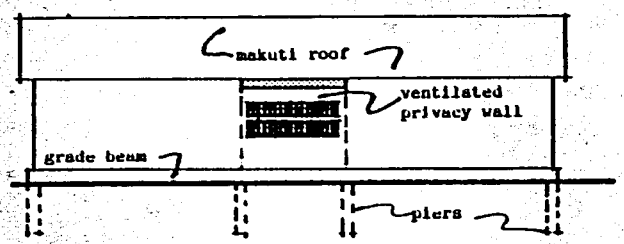

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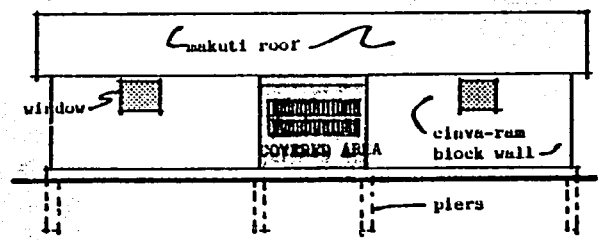

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ELEVATIONS

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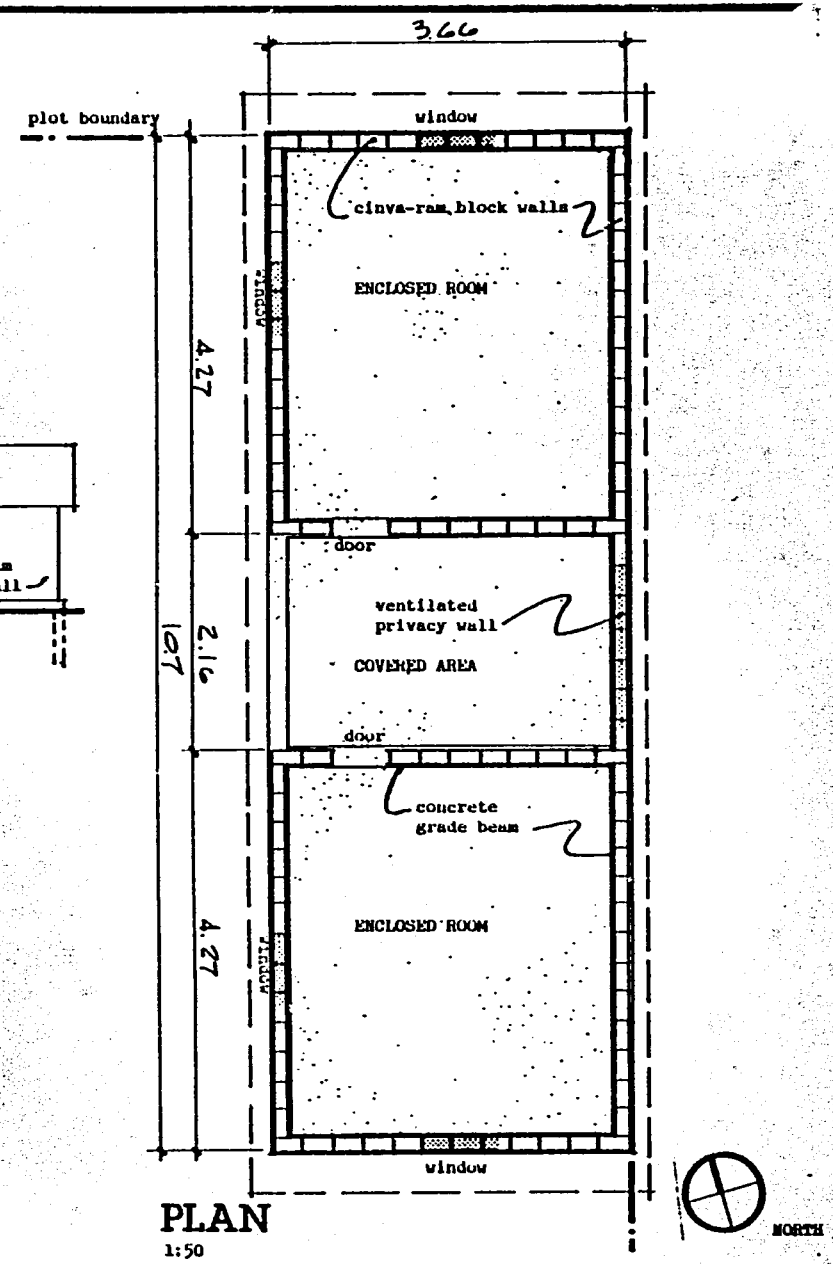

PLAN

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DATA

ROOF AREA

Total	54.2 SM

FOUNDATIONS

Grade Beam	34.8 LM
Piers	8

FLOOR AREA (GROSS)

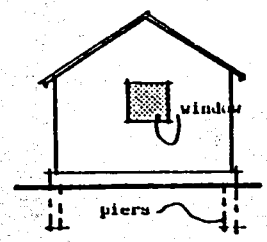
Enclosed	31.3 SM
Covered	7.9 SM
Total	39.2 SM

WALL AREA

Exterior	75.2 SM
Partition	0.0 SM
Total	75.2 SM

HOUSE UNIT ALTERNATIVES
TYPE 1 LOCATION A-2, #4

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307
SCHOOL OF ARCHITECTURE



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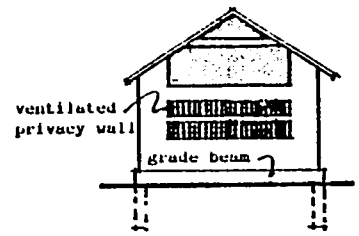

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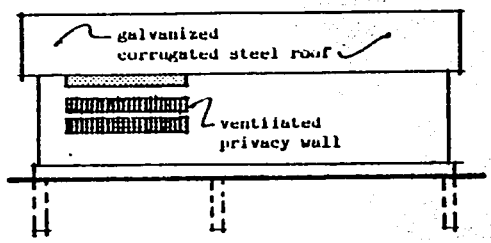

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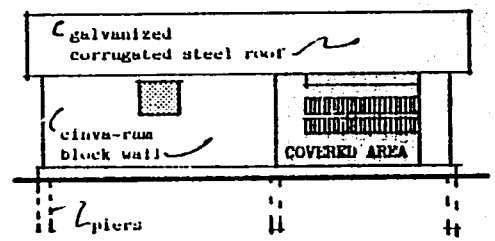

WEST

ELEVATIONS

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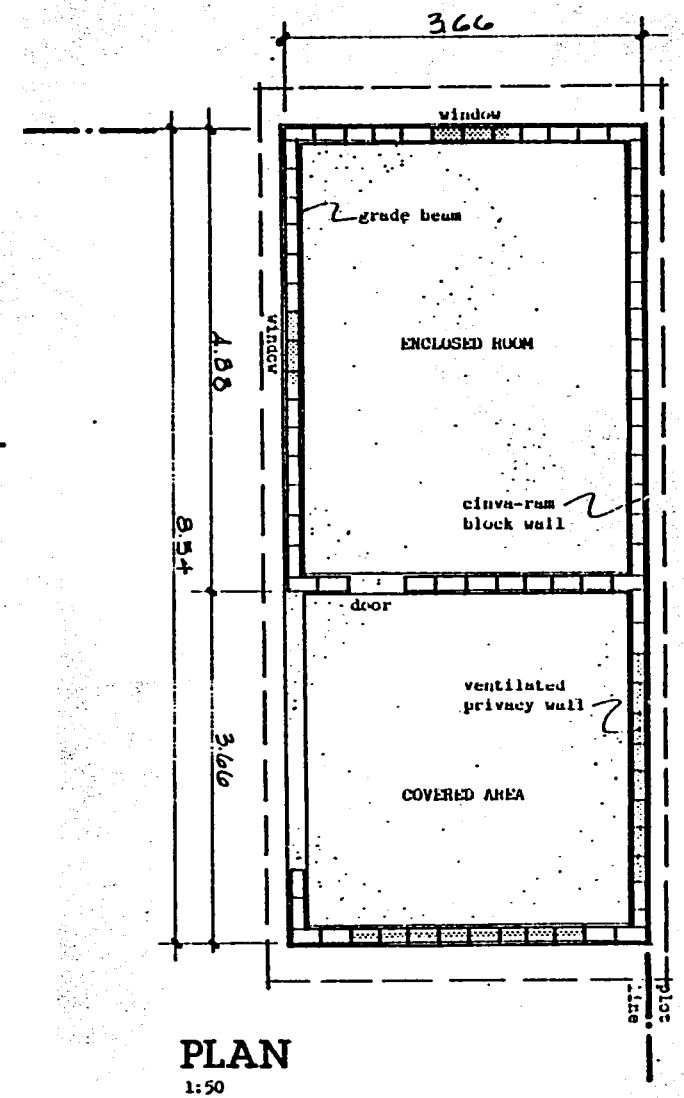

PLAN

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NORTH

DATA

ROOF AREA

Total	43.6 SM

FOUNDATIONS

Grade Beam	26.9 LM
Piers	6

FLOOR AREA (GROSS)

Enclosed	17.8 SM
Covered	13.4 SM
Total	29.0 SM

WALL AREA

Exterior	52.7 SM
Partition	0.0 SM
Total	52.7 SM

HOUSE UNIT ALTERNATIVES
TYPE 1 LOCATION A-2, #5

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307
SCHOOL OF ARCHITECTURE

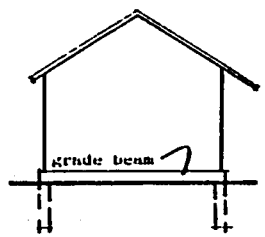
TYPE 2 DRAWINGS & DESCEIPTIONS

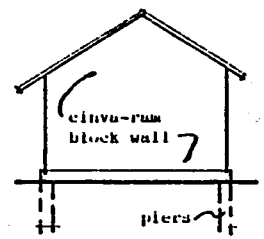
Three different examples of the Type 2 house were built. They are also located on the Training School site, Xubin A-2 They are as follows:

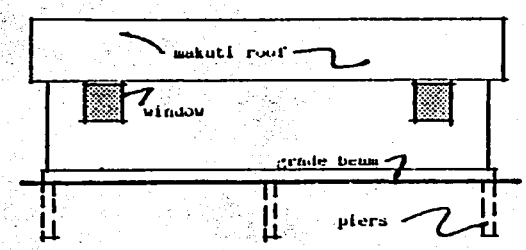
TYPE	LOCATION
2-a	Xubin A-2, Plot #6
2-b	Xubin A-2, Plot #8
2-c	Xubin A-2, Plot #9

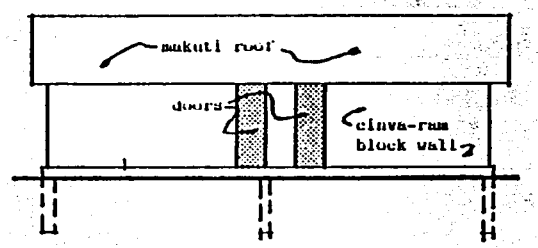
Type 2 houses are similar to the housing unit proposed in the original project paper, except that no kitchen is provided. It is assumed that cooking would take place outside the house, or that later, a covered cooking area would be built as desired by the dweller. A room intended for use as a storage room was included in the house on plot #9 (Type 2-c) but it is felt that rooms like this would eventually be used for habitation, depending on the circumstances of the family occupying the house. An extended overhang was added to the side of the house to provide a covered area that would connect the rooms. This provides a sense of entry to each room that avoids the starkness that no overhang would produce. These houses provide examples of the smallest rooms built. They are 2.44 m by 3.66 m (8' x 12') or approximately 8 square meters of net area.

The location of these houses on the site is slightly different from the location of other houses on the site in that their long side is located along the plot boundary that faces the communal space of the Xubin. This arrangement provides a good sense of entrance from the communal space between the houses. The back end of the plot, however, provides little privacy. This could be remedied by each family by the construction of a wattle fence on the boundary lines of the plot.









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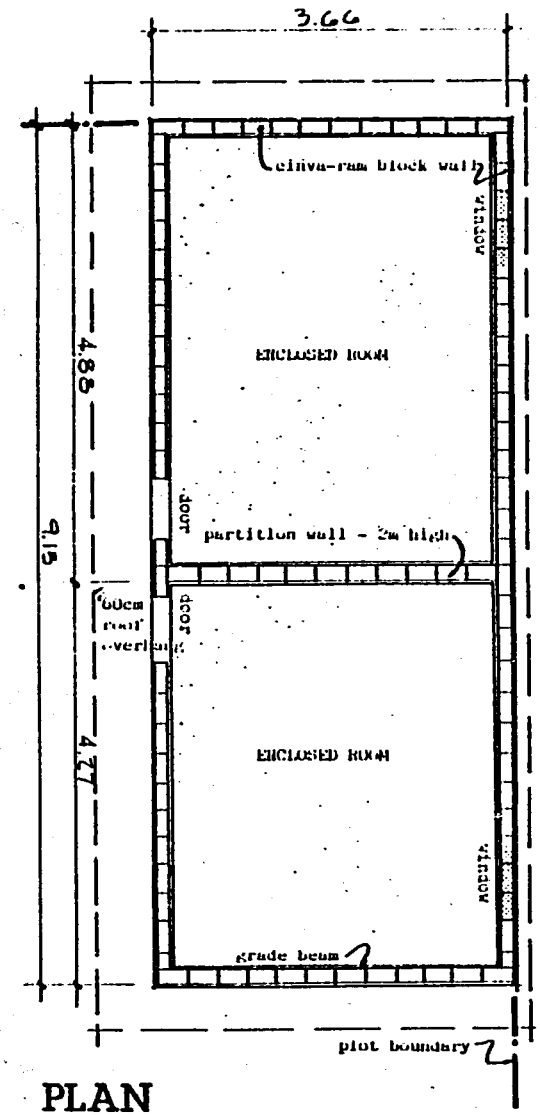

PLAN

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DATA

ROOF AREA

Total	46.6 SM

FOUNDATION

Grade beam	28.4 LM
Piers	6

FLOOR AREA (GROSS)

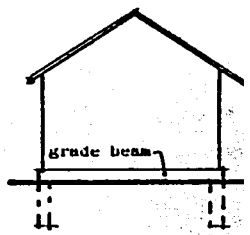
Enclosed	33.5 SM
Covered	0.0 SM
Total	33.5 SM

WALL AREA

Exterior	55.7 SM
Partition	6.8 SM
Total	62.5 SM

HOUSE UNIT ALTERNATIVES
TYPE 2 LOCATION A-2, #6

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307
SCHOOL OF ARCHITECTURE



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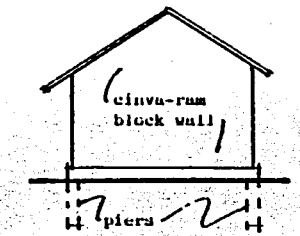

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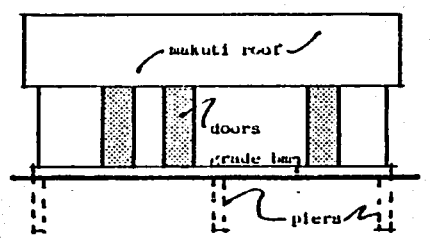

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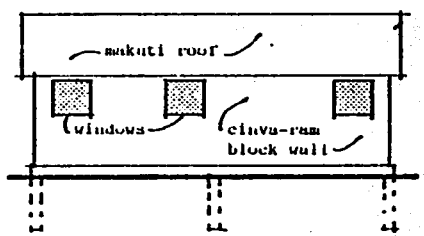
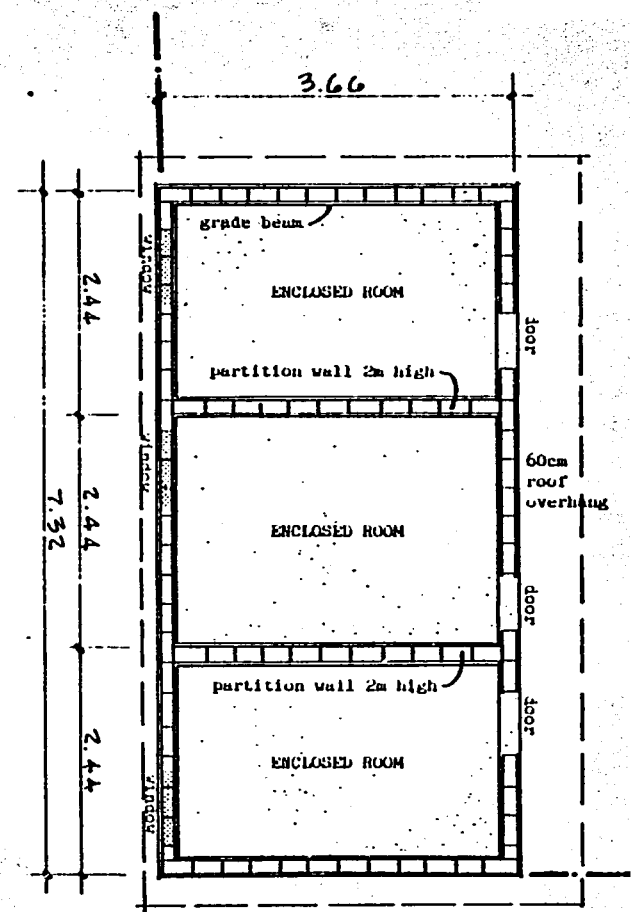


SOUTH

ELEVATIONS

1:100



PLAN

1:50

DATA

ROOF AREA

Total	37.7 SM

FOUNDATION

Grade Beam	28.0 LM
Piers	6

FLOOR AREA (GROSS)

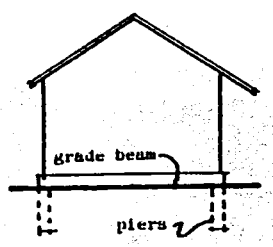
Enclosed	26.8 SM
Covered	0.0 SM
Total	26.8 SM

WALL AREA

Exterior	46.0 SM
Partition	13.5 SM
Total	59.5 SM

HOUSE UNIT ALTERNATIVES
TYPE 2 LOCATION A-2, #8

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307
SCHOOL OF ARCHITECTURE



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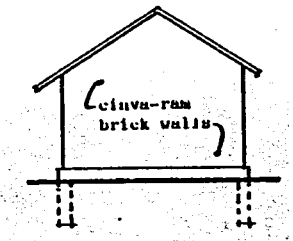

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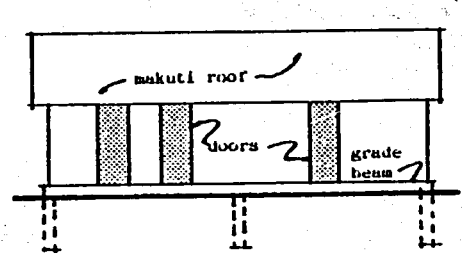

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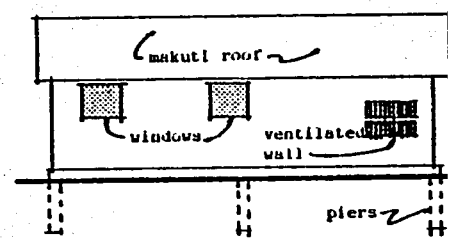


SOUTH

ELEVATIONS

1:100

DATA

ROOF AREA

Total	40.7 SM

FOUNDATION

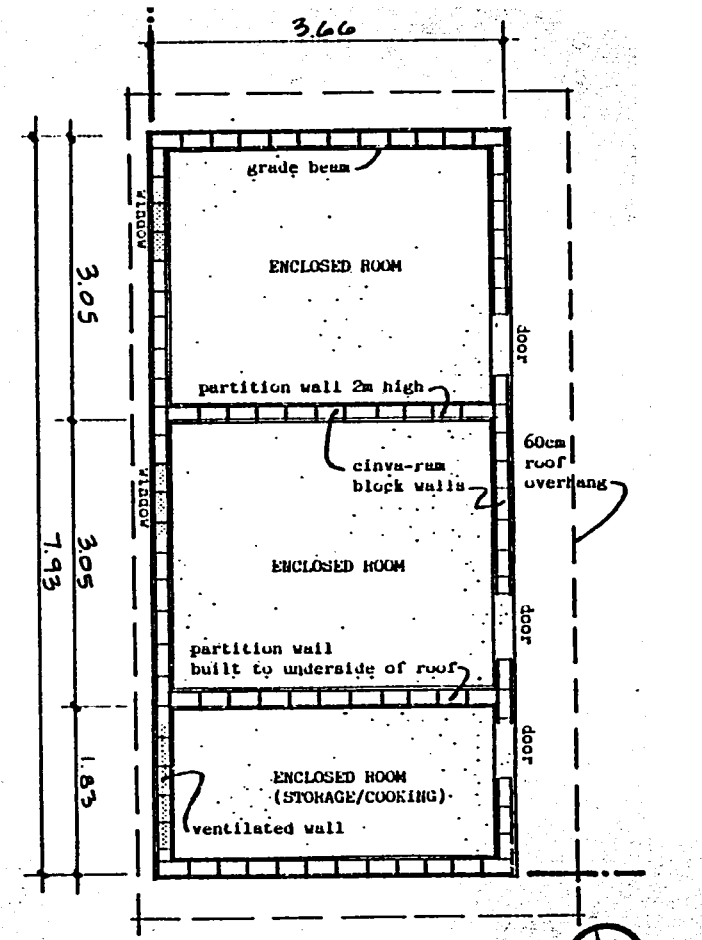
Grade Beam	29.3 LM
Piers	6

FLOOR AREA (

Enclosed	29.0 SM
Covered	0.0 SM
Total	29.0 SM

WALL AREA

Exterior	50.7 SM
Partition	13.5 SM
Total	64.2 SM



PLAN

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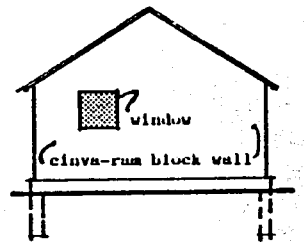
HOUSE UNIT ALTERNATIVES
TYPE 2 LOCATION A-2, #9

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307
SCHOOL OF
ARCHITECTURE

TYPE 3 DRAWINGS & DESCRIPTIONS

The Type 3 house is a modification of the floor plan selected by the SDA. This house is located on Xubin A-2, Plot #7 and Xubin B-2, Plots #1 thru 10. In the original plan, there were three sleeping rooms connected room to room, a storage room, and a porch, for a total of five rooms. This plan requires a great deal of materials and is quite complicated to construct. The Type 3 house was designed in an attempt to offer an alternative to this that used the same outside dimensions. It is based conceptually on the core concept of Type 1 houses. It consists of three spaces-the that are fully enclosed, and one that has two solid walls, a ventilated wall, and one open side. An additional difference between this and the original design is that the walls are only 2 meters high resulting in a materials savings of 17% in the perimeter walls. The reduction of interior walls results in an additional materials savings.



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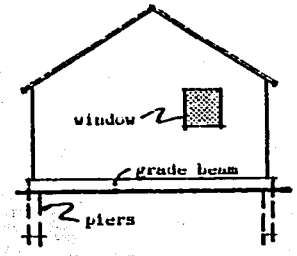

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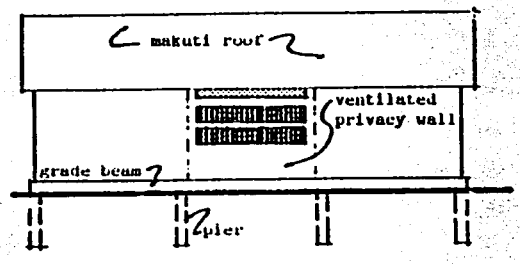

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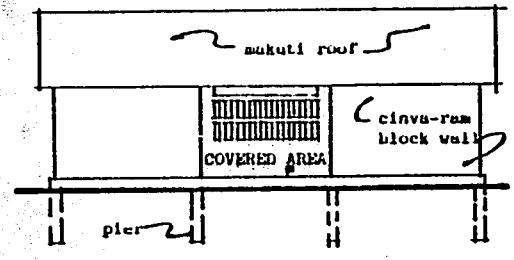

WEST

ELEVATIONS

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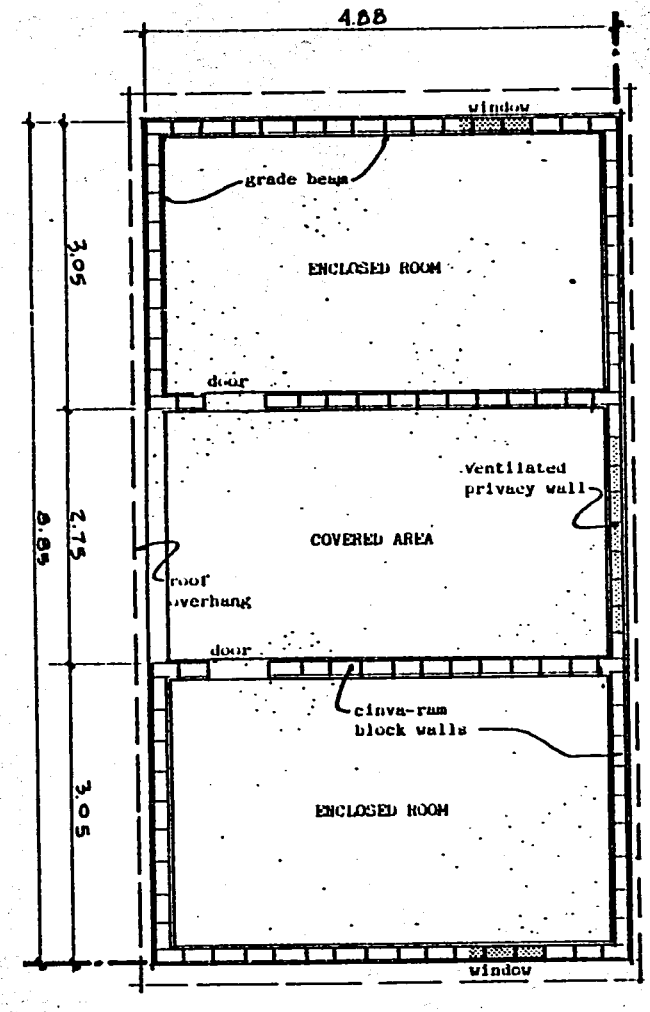


PLAN

1:50

NORTH

DATA

ROOF AREA

Total	56.4 SM

FOUNDATION

Grade Beam	36.0 LM
Piers	8

FLOOR AREA (GROSS)

Enclosed	29.8 SM
Covered	13.4 SM
Total	43.2 SM

WALL AREA

Exterior	76.1 SM
Partition	0.0 SM
Total	78.1 SM

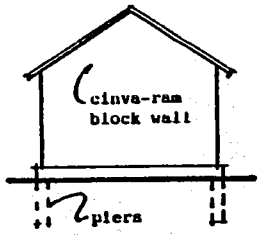
HOUSE UNIT ALTERNATIVES

TYPE 3 LOCATION A-2, #7 & B-2 #1-10

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307
SCHOOL OF ARCHITECTURE

TYPE 4 DRAWINGS & DESCRIPTIONS

The Type 4 house, located on Xubin A-2, Plot #10, consists of two rooms equal in size connected with a door between them. These two rooms are then connected to a small storage room by an entrance/ breezeway. Again, cooking is to be done outside near the storage room. An alternative to this that was considered but not built, included an extended overhang on one side with doors opening to that side similar to the Type 2 houses. The breezeway was seen as the key feature that set this house apart from the others. The breezeway is to serve as an entrance and semi-private sitting area where one might receive quests. It is of a minimum size for this purpose but still adequate.



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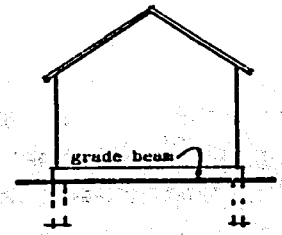

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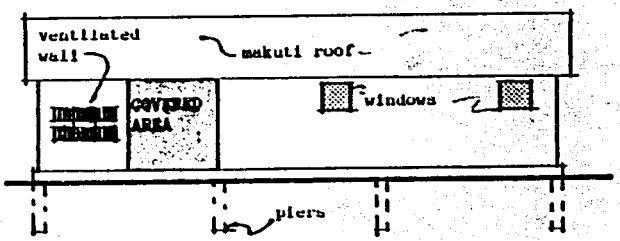

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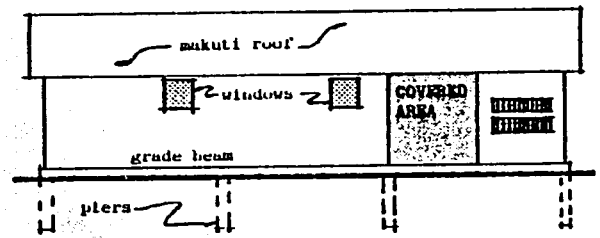

SOUTH

ELEVATIONS

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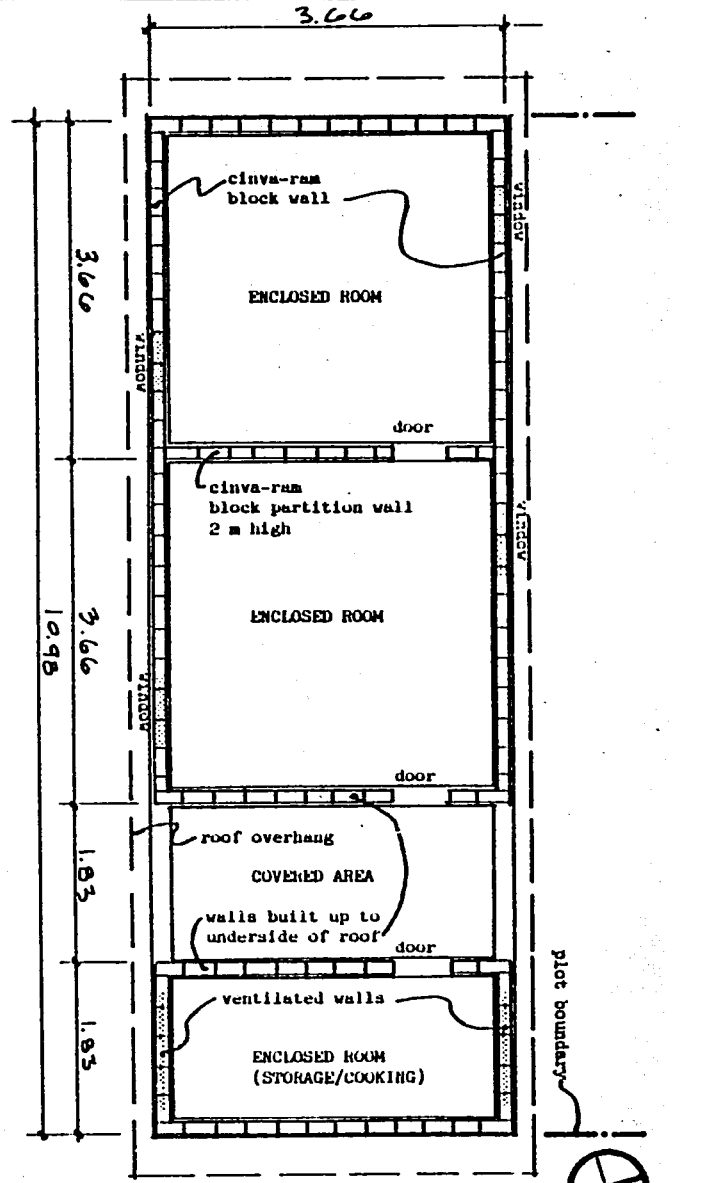


PLAN

1:50

NORTH

DATA

ROOF AREA

Total	55.5 SM

FOUNDATION

Grade Beam	38.8 LM
Piers	6

FLOOR AREA (GROSS)

Enclosed	33.5 SM
Covered	6.7 SM
Total	40.2 SM

WALL AREA

Exterior	48.4 SM
Partition	6.8 SM
Total	55.2 SM

HOUSE UNIT ALTERNATIVES
TYPE 4 LOCATION A-2, #10

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307
SCHOOL OF
ARCHITECTURE

TYPE 5 DRAWINGS & DESCRIPTIONS

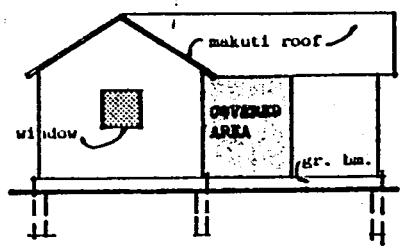
The Type 5 house, located on Xubin A-3, Plots #1 thru 10, was designed first. Its design was based on the following requirements:

Eight foot high walls

A configuration other than a rectangle

Three rooms

It is similar to the Type 4 house in that it has three rooms connected by a small breezeway. In the original design it was to have an overhang the width of the breezeway that extended back to the door of the second sleeping room. This feature was left off due to complications in its construction.



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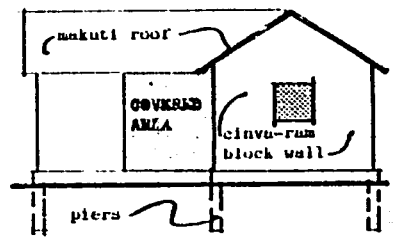

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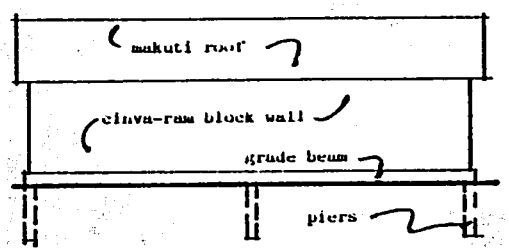

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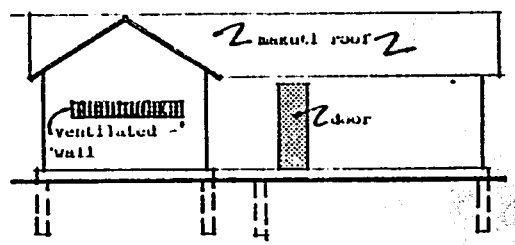

WEST

ELEVATIONS

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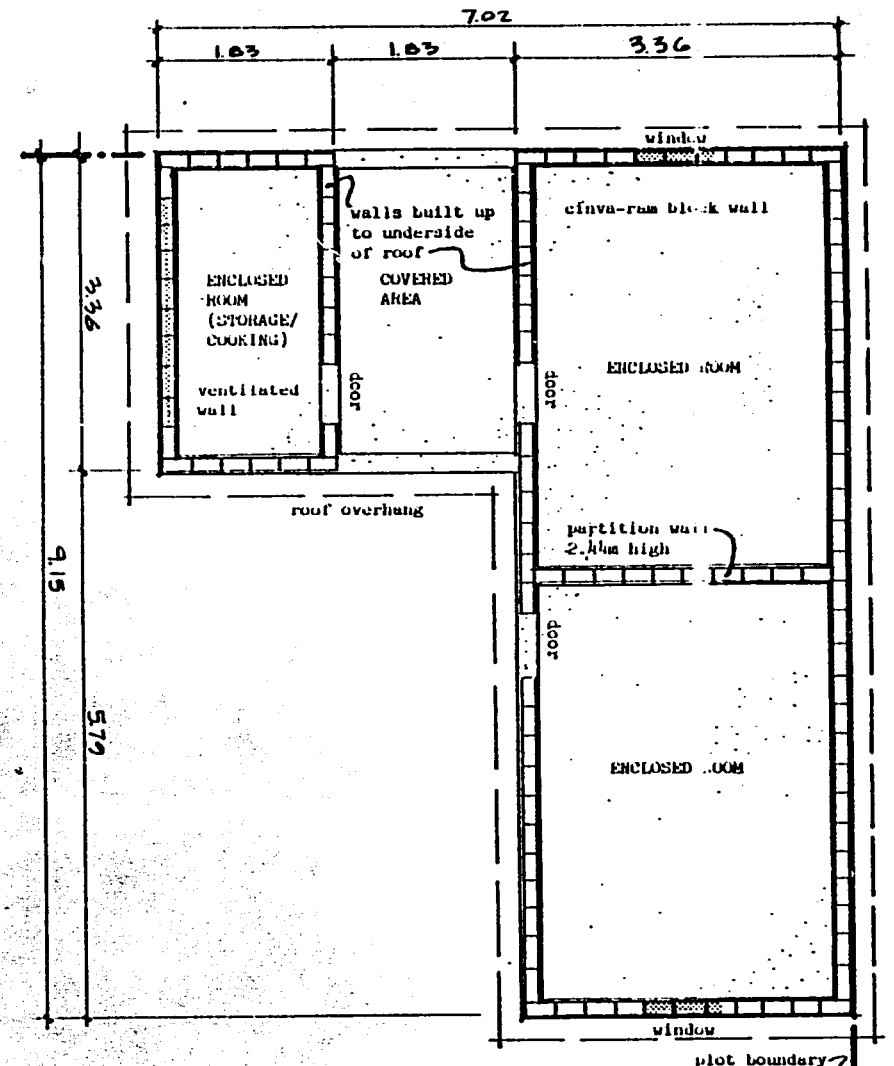

PLAN

1:50

DATA

ROOF AREA

Total	69.5 SM

FOUNDATION

Grade Beam	44.2 SM
Piers	8

FLOOR AREA (GROSS)

Enclosed	36.9 SM
Covered	6.1 SM
Total	43.0 SM

WALL AREA

Exterior	84.8 SM
Partition	3.1 SM
Total	87.9 SM

HOUSE UNIT ALTERNATIVES
TYPE 5 LOCATION A-3, #10

EXPERIMENTAL LOW-COST CONSTRUCTION UNIT
FLORIDA A&M UNIVERSITY
P.O. BOX 597, TALLAHASSEE, FL 32307
SCHOOL OF ARCHITECTURE

Conclusion and Recomendations

CONCLUSIONS AND RECOMMENDATIONS

The following recommendations are offered to guide the development of future housing prototypes for Kurtunwaare or indeed other similiar areas of Somalia. The recommendations are based on the experience of the Florida A&M University technical assistance team gained in the design of the prototypes illustrated in this report. These recommendations are aimed at reducing the cost or increasing the quality of the unit.

Reduce size of housing unit.

Evaluation of plan types should be done by the occupants.

Study foundation system in attempt to minimize its size.

Reconsider cyclopean foundation system.

Use a sand and clay floor rather than concrete.

Reduce the height of the walls to at least 2 meters.

Use slope of roof in combination with low walls to provide necessary head room.

Reduce cement content of the cinva-ram blocks.

Investigate the use of lime mortar rather than cement martar

Orient the site and/or house so that the long axis points North and South.

Investigate use of larger roof overhangs to shade walls.

Avoid use of a roof system that includes hips and valleys especially if a makuti roof system is used.

Investigate the development of a simplified way of anchoring the roof to the walls.

Reduce size of doors to minimize the cost of door materials.

Provide door and window materials so that these openings can be closed providing security.

Investigate the use of louvered window types that are made from masonry units that provide security and a way of closing them off from biting bugs.

The above recommendations are made on the assumption that the basic construction system is considered appropriate for this project. Other construction systems that might be considered are not included in this evaluation.

House Size Reduction

A reduction in the size of the house is recommended as a method of reducing the cost of the houses while maintaining the same construction system. This approach to cost reduction might be illustrated by comparing the size of the house selected by the SDA (43 square meters of floor area) to houses that are presently available in Kurtunwaare. Based on a visual inspection of the village, it was observed that most of the houses range in size from 10 to 15 square meters. That is to say they are approximately 25 to 30% of the size of the proposed house. If it is assumed that a house this size or slightly larger accomodates the life style of the inhabitants then it is perhaps possible to reduce the house size without causing serious difficulty. Should a smaller house be considered, then house Type 1 or 2, or something similar would be recommended.

Evaluation of House and Site Plans

Before any house type or site layout can be confidently recommended, a thorough evaluation of it should be made. It is recommended that any housing unit presented in this report be evaluated through a program similar to that proposed in the original project proposal in which settlers are allowed to move into the houses so that they may be observed, questioned, and given the opportunity to judge the appropriateness of a given solution for themselves. Evaluation of this nature would prove to be very beneficial in the development and selection of the most appropriate solution.

Foundations

It is recommended that the foundations system be re-evaluated in an attempt to reduce its size. It is felt that this might be possible by using a reinforced concrete footing, thereby eliminating the piers, or by using the cyclopean foundation originally proposed. Either approach, if proven practical, would result in construction cost reductions. The first would reduce costs simply by reducing materials and labor required for the construction of the foundations, and the second by eliminating or drastically reducing the need for imported cement. The cyclopean footing should be reconsidered due to the recent, successful construction of the village hospital building which uses this type of foundation. Although its success has not yet been fully proven due to its short duration (approximately nine months at this time) it is recommended that the performance of the foundation of this building be closely watched.

Floors

Pilot project houses were provided with floors that consisted of a thin layer (approximately 4 to 6 centimeters thick) of unreinforced concrete over sand and gravel fill. In order to reduce the cost of the floors, it is recommended that use of a sand and clay floor be considered for use in future houses. This would provide a hardened earth floor for each house similar to the floors presently available in the village. The settlers are accustomed to this type of floor and in addition to costing less, it is almost as hard and equally easy to keep clean as concrete. In the future, floors may still be upgraded with brick concrete etc., if the resources are available.

Walls

It is recommended that walls be built as low as possible in order to reduce the amount of materials required for their construction. Even a height lower than 2 meters might be considered (but not lower than 1.5 meters) for future houses. The roof slope will provide head room required inside the house. Another recommendation that should be made pertains to the strength of the materials used in the walls. During the pilot project, cinva-ram blocks were manufactured with a cement content of between 15 and 25 percent. This was done in the initial stages of the project in order to expedite the construction process by reducing the required curing time of the blocks. The high cement content allowed the blocks to be used with only a few days of curing instead of the minimum two week curing time required for cinva-ram blocks. Assuming that the block plant will be operating more efficiently than it did during its first months of operation during which the kinks in the production process were being worked out, the following recommendation can be made. Future cinva-ram blocks should be made with the normal lower cement content as recommended by the developers of cinva-ram technology. Blocks can be made that have a cement content of around 5 to 6 percent. This will significantly reduce their cost and still produce blocks with the required strength.

In conjunction with a reduction of the cement content of the blocks, the strength of the mortar should also be re-evaluated. This is because the strength of a masonry unit and the mortar used to set it in a wall should be equivalent. This will result in a wall of even strength and thereby reduce cracking due to a differences in the strength of materials used. One way to reduce the strength of the mortar is to reduce its cement content. This however, produces a mortar that is very difficult to work with and would not be recommended since use of a mortar such as this would require very skilled and experienced masons. Another way to make a mortar of lower strength is by reducing or eliminating the cement and replacing it with lime. This results in a sufficiently strong mortar that is also easily worked with. Another advantage of a mortar of this type is the fact that lime is manufactured locally. Because of this, no imported materials would have to be used in the mortar.

The walls of a masonry house when exposed to sunlight absorb a great deal of heat that is later radiated to the inside of the house causing discomfort to its occupants. This effect can be reduced by orienting the houses in such a way that the smallest face east or west. Walls facing east or west in Somalia will absorb the greatest amount of heat while walls facing north or south will absorb the least amount since they can easily be shaded for most of the day with the roof overhang. Therefore, it is recommended that the houses and/or the site be oriented is such a way that the longest axis of the house will point north and south.

Roofs

As mentioned above, overhangs are important in that they provide shade for the walls. In addition to this, an adequate overhang can increase the life of the walls by providing protection from erosive driving rain and by shedding roof water away from the walls. It is recommended that overhangs be built to provide this protection. A minimum of 30 centimeters is required to do this.

Roofs with hips or valleys are more difficult to make waterproof than a simpler roof with only a top ridge. This is especially important to consider if makuti (thatch) is used for the roof membrane. In addition, a roof with hips and valleys is more expensive to build because of its greater complexity. It is therefore recommended that simple gable end roofs be built that avoid the use of hips and valleys.

A problem that was encountered in the construction of the roofs, was the method of attaching the roof to the wall. A simple concrete brick was finally made that contained a steel bar that extended out of its side about 60 cm. This concrete brick was then placed in the wall about three courses below the top. Another concrete brick was placed in the top of the wall upon which the trusses were set. The steel bar was then extended up and bent over the truss and nailed to it. This was an adequate method, but it would be recommended that a simpler method be developed to tie down the trusses.

Door and Windows

The size of the windows and doors built in the houses presented in this report was reduced. This was in order to reduced the quantity of material required to cover the windows and doors. During the pilot project phase, no windows or doors were installed. If only from a security standpoint however, windows and doors must be provided. It is recommended that doors be limited in size to .6m wide by 1.9m high. (2' by 6' - 4"). The height could possibly be reduced as much as 30 cm (1') if it is determined that this would be acceptable to the villagers, most of whom presently live in houses with doors as low as 1.4 meters.

Besides security, an important consideration when designing windows for the houses is health. A method of keeping mosquitoes and other biting bugs out of the houses must be possible. This could be done with screening, however, this is fairly expensive. It is recommended that windows be designed that can be easily closed off. One way this might be done would be by building windows in the form of the ventilated wall shown on the building sections and details page of the drawings. A window built this way could be closed off by filling the holes with cloth or vegetation. This might be done seasonally depending on the occupants desires, temperature, wind direction, or whether or not mosquitoes and biting bugs were "in season". This would also be compatable with other ventilated walls found throughout Somalia in most major buildings.

Appendix

KURTUNWAARE SETTLEMENT PROGRAM

ARCHITECTURE AND PLANNING ANALYSIS

INTRODUCTION

The data gathered for this Architecture and Planning Analysis represents the collective results of research gathering and interviews held between the A.I.D. Design Team and the Somali Government, the private sector and the inhabitants of the Kurtunwaare Settlement. The contributing government agencies include the Settlement Development Agency, Ministry of Public Works and Ministry of Agriculture. The private sector contacts include local architects, engineering consultants and building contracting agencies. The interviews with the Kurtunwaare inhabitants include individual household occupants, community leaders and representatives of the local women's association. As a result of these initial investigations and field observations a series of design considerations and constraints were identified.

PART I - DESIGN CONSIDERATIONS AND CONSTRAINTS

A. FUTURE DEVELOPMENT PLANS

An important consideration relating to project design is the extent of the Somali Government's commitment in resources, personnel and established agricultural development plans. The total area of planned agricultural development is vast and would require traveling distances from the principal village to remote fields of more than 12 km. Plans call for a decentralization development of 3 to 4 new satellite villages of 1000-1200 families each, and reducing the current principal village nucleus in size. Each satellite village would have the necessary community services but would still be reliant upon the principal village for major services and administration. Such a development will bring the families closer to the fields in which they are working and will relieve the present congestion of the principal village.

Since agricultural development plans would have these satellite villages located equidistant from the planned irrigated lands and rainfed lands, some of the land most suitable for agricultural development will be used for the purposes of housing. Such housing development plans must, therefore, be land conservative in nature. It is envisaged by the SDA that individual plots will be relatively small, sized sufficiently to support the family's indoor and outdoor living requirements, and to include small private vegetable gardens. No animals (goats or sheep) will be permitted within the housing compounds other than domestic pets and poultry.

Ideally, the existing principal village should act as a nucleus around which the satellite villages would be located. Current agricultural plans have dictated that all future development will be downstream only, thus placing the principal village at the extreme upstream end of the settlement area. There are, presently, no immediate plans for developing the north bank of the river, however long term plans may include this section also.

B. SOCIO-POLITICAL ORGANIZATION

Kurtunwaare's highly organized hierarchial system of leaders and sub-leaders in the settlement has been reviewed in the Social Analysis and by Lewis (1978). Since it is the desire of the SDA to have this system reflected in the village master plan we shall briefly outline the village organizational structural constraints.

The smallest organizational unit is the "Xubin", or group of 10 families who are responsible for monitoring their own security, education, health, finances, construction and agricultural production. Five such groups form an "Udud" of 50 families which are currently responsible for farming 12 hectares. Similarly, two such groups make up a unit of 100 families called a "Birjeex" and two groups of these form the 200 family group called a "Bulsho". Ultimately two such groups form to make a unit of 400 families, constituting a village, or "Beel", with the responsibility of managing a large cultivated area (currently about 100 hectares) and constituting the major political unit. Meetings of each group, from 10 families to the village of 400, take place every 48 hours. These are

presided by chairmen at each level, submitting written reports to three senior village officers, representing the Party, police and security. The resulting tight social, political and economic structure is not unlike the model of an Israeli Kubutz.

C. SOCIAL AND CULTURAL

In order to determine a suitable approach to dwelling design and settlement planning which shall be socially and culturally compatible with the Kurtunwaare inhabitants we must first have a look at the local building and settlement traditions. An investigation of the traditional Somali house types illustrates the selection of locally available building materials and the general level of building skills of the people. The basic Somali house types are the Agal, the Mundul and its urban derivative, the Arish. Each type has its own characteristic structure inspired by the life style of the people in different parts of Somalia and, generally speaking, are all suited for the tropical climate.

The Agal, used nearly exclusively by the nomads, is in practical terms a portable hut constructed of curved sticks covered either by leather, grass mats or cloth. Three to four agals are usually grouped together to form a loose compound for the extended family. Cooking and eating are done in the yard, which is enclosed by a fence, constructed primarily for the purpose of retaining animals at night. Meetings between different compounds are organized under a large tree, where problems of mutual interest are discussed. This tree is the focal point of the nomadic campsite

The Mundul is the traditional dwelling of the farming villages along the Juba and Shebelli rivers. It is a cylindrical, one room, wattle structure with a grass roof. The building materials are all of local origin and, if well constructed, the Mundul can be a reasonably durable structure, however the wattle is quite vulnerable to termite attack.

The Arish is the urban version of the Mundul and is constructed of the same materials but is rectangular in layout. The grass roofing is frequently substituted by "Makuti" which is produced from palm fronds and is considerably more durable than grass. The design consists of 3 to 4 rooms facing a common courtyard to which the kitchen and toilet is established. It is, in many respects, a very functional house type; the open courtyard reflecting the Somali desire for privacy and security and providing an outdoor living area which is an extension of the house. The Arish arrangement has evolved as the most widely accepted dwelling layout found in most Somali houses.

During the social and cultural data gathering period of the project design phase specific considerations have been identified, many of which form a basis for various design concepts in the master planning and dwelling design stages. These considerations have resulted from direct consultation with the village inhabitants, community leaders, and representatives of the women's organization. As reviewed briefly by Lewis (1978), "the available educational opportunities of the settlement are highly valued by the nomads" and this was in fact confirmed by the people interviewed.

Part of the "settled" nomad's commitment to Kurtunwaare appears to depend upon its provision of schooling for his children. With over half of the Kurtunwaare population being of school age or pre-school age it is not surprising that this is a high priority in the eyes of the people. Religious preferences have suggested that the neighborhood mosque and Koranic school should also prove an important unifying element to the community.

A strong preference was indicated for spaces of social gathering, relating to one's neighborhood, yet preserving the identity of the individual family. Spaces with a clearly defined sense of passage were preferred to the "contained" cul-de-sac method of grouping plots. The reaction against this type of arrangement was frequently described as "too confining" or "like a prison" -- a somewhat predictable reaction coming from a group of ex-nomads. Rectangular grouping was preferred to a circular arrangement. Reaction of both men and women alike was rather strongly opposed to the concept of communal bathing and toilet facilities. This reaction seemed mostly due to personal and cultural reasons and the Somali's strong desire for personal privacy. Concern was also expressed regarding the maintenance of such communal facilities.

The discussions concerning dwelling design and functional layout generated a more specific set of responses and problem areas. Traditional living and sleeping patterns would have a separation of the younger and older children with a separate room for the parents. The villagers felt if

the government could provide them with no more than two rooms, that provision be made for the addition of a future third room. The women indicated a preference of separate and not connecting rooms. The entire group seemed unanimous regarding room shape -- rectangular over circular. The Somali conception of a house appears to be that of the entire indoor and outdoor living areas and not necessarily confined to the enclosed structure. The entry should be clearly defined and into the outdoor courtyard, not into the house directly. This concept would preclude any use of a rowhouse layout. All agreed that small private garden plots should be provided within the family compound. There has been a good deal of discussion regarding the walled compound and its primary function. However, the group surveyed determined that the function was primarily for security purposes (children, animals and vegetable garden) rather than privacy. When questioned how high they would build a wall the answer was usually about 1.5 meters high. They want to be able to see out (who is coming and going) and also feel that a high wall blocks the badly needed flow of ventilation through the open court. Aside from the durability of their present temporary dwellings the villagers see insects and vermin, ventilation, and waste disposal as the greatest housing problems now confronting them. Functional layout preferences were for a kitchen separate from the house but within easy access and the toilet to be private and away from the house and kitchen.

D. PHYSICAL CONSIDERATIONS

This section is a review and analysis of the physical factors which are viewed to have significant impact upon the design and implementation of the shelter program at Kurtunwaare. Although scant specific data exists regarding the Kurtunwaare area, observations and testing at the project site by the A.I.D. team and response from local inhabitants have confirmed several physically correlated patterns and conditions which prevail at the regional level. These observations and testing, combined with a process of judicious extrapolation from known nearby phenomena, have provided the basis for the relevant physical conditions which affect the project design:

1. Geographical Location - Kurtunwaare is located along the Shebelli river at approximately 1° 40' N. latitude and 44° 15' E. longitude. It lies about 150 km. west/southwest of Mogadishu and the Indian Ocean is about 25 km. to the southeast. There is minimal relief between the Shebelli river and the settlement area and measurements provided through the irrigation survey and the topographic survey indicate an elevation of 59.5 meters above mean sea level near the river, and an elevation of 60.22 meters at the entrance to the existing village. The entire area of planned development does not vary more than 4 meters in elevation.

2. Climate - Climatic fatigue has been suggested as one of the main causes for the slow progress of technological and economic development

among some of the nations of the tropics and extreme north. Work under conditions of extreme heat or cold is easier when the worker has the prospect of returning to the haven of a house with a good climate where rest and recovery are possible.

Kurtunwaare has a semi-arid, monsoon climate with a seasonal rainfall pattern. The monsoon winds from the southwest, the "Gu" season (mid-March to mid-May), bring the heavier rains; monsoon winds from the northeast, the "Der" season (October to mid-December), bring lighter rains. Average annual precipitation is 460 mm or approximately 18 inches of rain. Rainfall is unreliable and comes in the form of intermittent and sometimes heavy localised showers. Also experienced were an occasional extended rain of 3 to 4 hours duration.

Temperature is tropical with a range of mean monthly maximums from 34.0°C (March) to 28.4°C (July) and a range of mean monthly minimums from 23.6°C (April) to 21.5°C (July and August). Relative humidity is high, remaining in the 70-75 percent range during most of the year and dipping below 70 percent during the driest months (December through March).

Although no local recorded wind data exists for the Kurtunwaare area, site observations and the local inhabitants have confirmed the prevailing wind pattern along a general axis southwest/northeast. These winds can be quite brisk and constant, providing a refreshing cooling

effect during the more humid months. During the dry months, however, the problems of wind-borne dust presents a significant design problem.

Analysing the aforementioned climatic considerations which affect housing design, we have used a method which does not require assumptions. Various known climatic data have been assembled and entered into simple tables known as Mahoney Tables. The comparison of these tables with a theoretical ideal for the region in question, known as the "comfort" zone, makes it possible to identify at a glance groups of dominant climatic problems. The identification of these groups provides indicators for the recommendations that follow in the design stage. It is a method of forward - not of backward - analysis. The results of these tables are contained in Annex 1.

3. Hydrology - The problems of water quality and supply are discussed in the IEE. Of particular concern affecting the project design is the problem of standing water and protection of the groundwaters from contamination. Suitable drainage designs for the control of flooding and runoff will prove a most critical issue facing the project design.

4. Geology and Soils - The probability of earthquake potential in the area is very low and no visible or historic record of seismic activity exists. The problem of black cotton (expansive) soils throughout the project area dictates special considerations regarding the foundation system for all permanent buildings. The extent of this problem

and foundation design recommendations are covered in the materials design section of the technical analysis. The other critical soils problem influencing the project design is the impermeability of these soils which has considerable impact upon the design of surface drainage and waste disposal systems. Test borings have been taken and soils samples laboratory tested to determine the physical properties of the soils and their recommended stabilization techniques. The results of these soil tests are contained in Annex 2.

E. HEALTH AND ENVIRONMENTAL

This section has been dealt with in the IEE, however it is worthwhile to mention here those specific areas which can be improved upon through sound physical planning and dwelling design. These areas include the high concentration of vermin, flies and mosquitos which are prevalent and the design measures necessary to insure adequate protection against them. The design of the toilets and waste disposal system will have to incorporate ease of operation and maintenance in consideration of the nomad's unfamiliarity with waste disposal concepts. The apparent percolation rates of the soils within the area would preclude the use of most water intensive sewerage systems. In addition, the seasonal high groundwater tables encoutered in the area would only tend to exacerbate the problems. Design recommendations which can reduce the effect of wind-borne dust and its related diseases will also prove beneficial.

ANNEX NO. 1

KURTUNWAARE, SOMALIA

LONG. 44° 15' E.
LAT. 01° 40' N.
ALTITUDE 60 METERS

Annex V

MAHONEY TABLES 1 TO 6

TABLE 1. AIR TEMPERATURE (°C)

	J	F	M	A	M	J	J	A	S	O	N	D	Highest	AMT
Monthly mean max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Monthly mean min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Monthly mean range	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Lowest	AMR

TABLE 2. HUMIDITY, RAIN AND WIND

RH (percentage)	J	F	M	A	M	J	J	A	S	O	N	D	
Monthly mean max. a.m.													N/A
Monthly mean min. p.m.													N/A
Average	65	66	66	64	73	75	74	72	67	63	60	66	
Humidity group	3	3	3	3	4	4	4	4	3	3	3	3	
Rainfall (mm)	5	–	10	90	75	60	60	20	10	20	70	40	Total [illegible]
Wind: Prevailing													
Secondary													

TABLE 3. DIAGNOSIS

	J	F	M	A	M	J	J	A	S	O	N	D
Humidity group	3	3	3	3	4	4	4	4	3	3	3	3
Temperature (° C)												
Monthly mean max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Day comfort: Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Monthly mean min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Night comfort: Max.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Thermal stress												
Day	H	H	H	H	H	H	H	H	H	H	H	H
Night	—	—	—	H	H	H	H	H	—	—	—	—

TABLE 4. INDICATORS

	J	F	M	A	M	J	J	A	S	O	N	D	Totals
Humid													
H1 Air movement (essential)					✓	✓	✓	✓	✓	✓	✓		6
H2 Air movement (desirable)													
H3 Rain protection	✓	✓	✓	✓									
Arid	✓	✓	✓	✓								✓	
A1 Thermal storage	✓	✓	✓	✓							✓	✓	5
A2 Outdoor sleeping													
A3 Cold-season problems													

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TABLE 5. SKETCH DESIGN RECOMMENDATIONS

Indicator totals from table 4						Recommendations
Humid			Arid			
H1	H2	H3	A1	A2	A3	
6+			5+			
						Layout
			2-10			1. Buildings orientated on east-west axis to reduce exposure to sun
			11 or 12		5-12	
					0-4	2. Compact courtyard planning
						Spacing
11 or 12						3. Open spacing for breeze penetration
2-10						4. As 3, but protect from cold/hot wind
0 or 1						5. Compact planning
						Air movement
3-12						6. Rooms single banked. Permanent provision for air movement
1 or 2			0-5			
			6-12			7. Double-banked rooms with temporary provision for air movement
0	2-12					
	0 or 1					8. No air movement requirement
						Openings
			0 or 1		0	9. Large openings, 40-80% of N and S walls
			11 or 12		0 or 1	10. Very small openings, 10-20%
		Any other conditions				11. Medium openings, 20-40%
						Walls
			0-2			12. Light walls: short time lag
			3-12			13. Heavy external and internal walls *
						Roofs
			0-5			14. Light insulated roofs *
			6-12			15. Heavy roofs: over 3 hours' time lag
						Outdoor sleeping
				2-12		X 16. Space for outdoor sleeping required
						Rain protection
		3-12				X 17. Protection from heavy rain needed

* SOILS PROBLEM LOW BEARING CAPACITY

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TABLE 6. ELEMENT DESIGN RECOMMENDATIONS

Indicator totals from table 4						Recommendations
Humid			Arid			
H1	H2	H3	A1	A2	A3	
6+			5+			
						Size of openings
			0 or 1		0	1. Large, 40-80% of N and S walls
					1-12	2. Medium, 25-40% of wall area
			2-5			
			6-10			3. Composite, 20-35% of wall area
			11 or 12		0-3	4. Small, 15-25% of wall area
					4-12	5. Medium, 25-40% of wall area
						Position of openings
3-12						
1-2			0-5			6. Openings in N and S walls at body height on the windward side
			6-12			
0	2-12					7. As above, but including openings in internal walls
						Protection for openings
					0-2	8. Exclude direct sunlight
		2-12				9. Provide protection from rain
						Walls and floors
			0-2			10. Light: low heat capacity
			3-12			11. Heavy: over 3 hours' time lag *
						Roofs
10-12			0-2			12. Light: reflective surface and cavity
			3-12			13. Light and well insulated
0-9			0-5			
			6-12			14. Heavy: over 3 hours' time lag
						External surface treatments
				1-12		15. Space for outdoor sleeping
		1-12				16. Adequate drainage for rainwater

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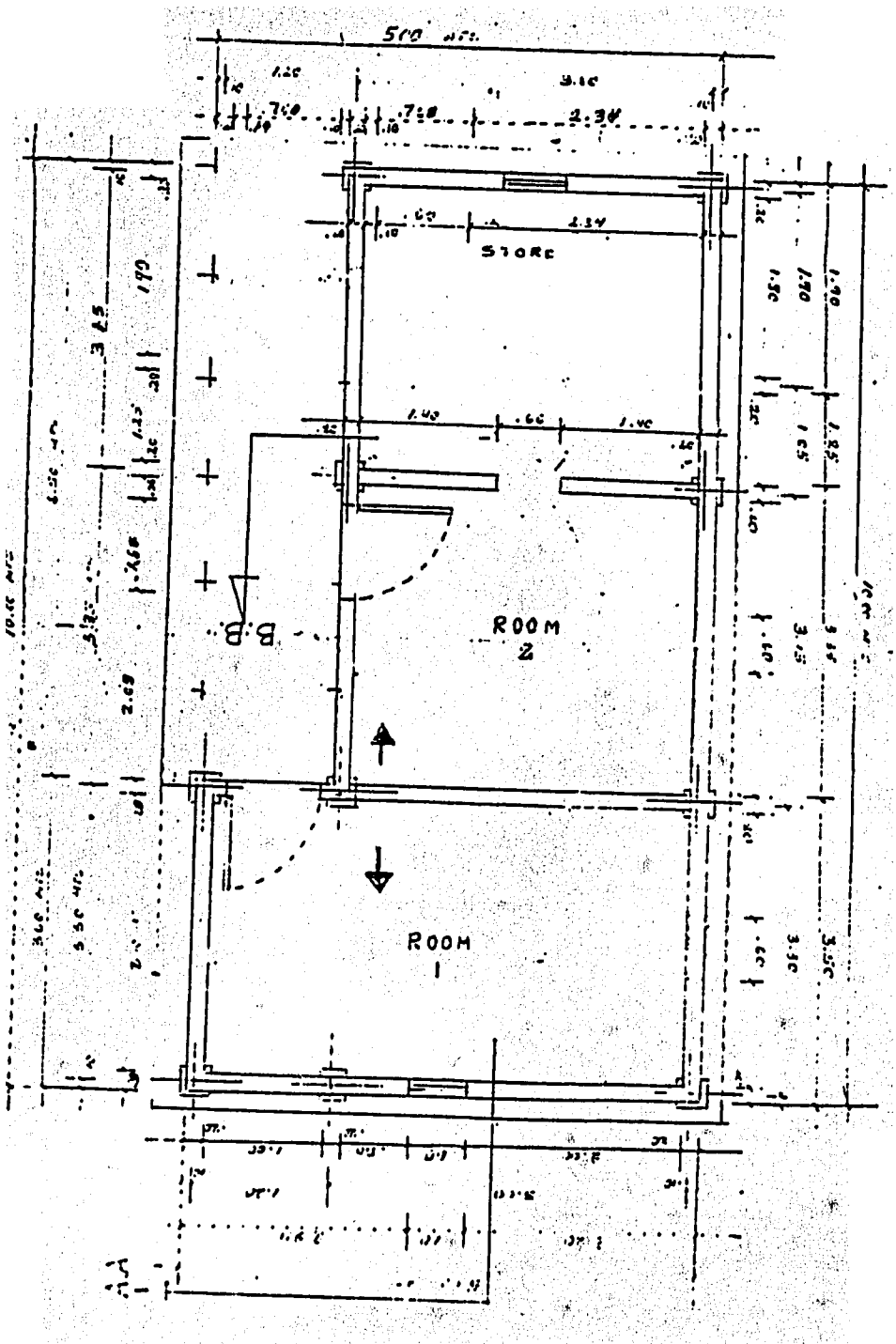

Plan - First house built on Xubin A-1, sites 1 thru 10

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