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The Democratic Republic of Sudan
Ministry of Agriculture, Food, & Natural Resources

WESTERN SUDAN AGRICULTURAL RESEARCH PROJECT STATIONS

Development Study

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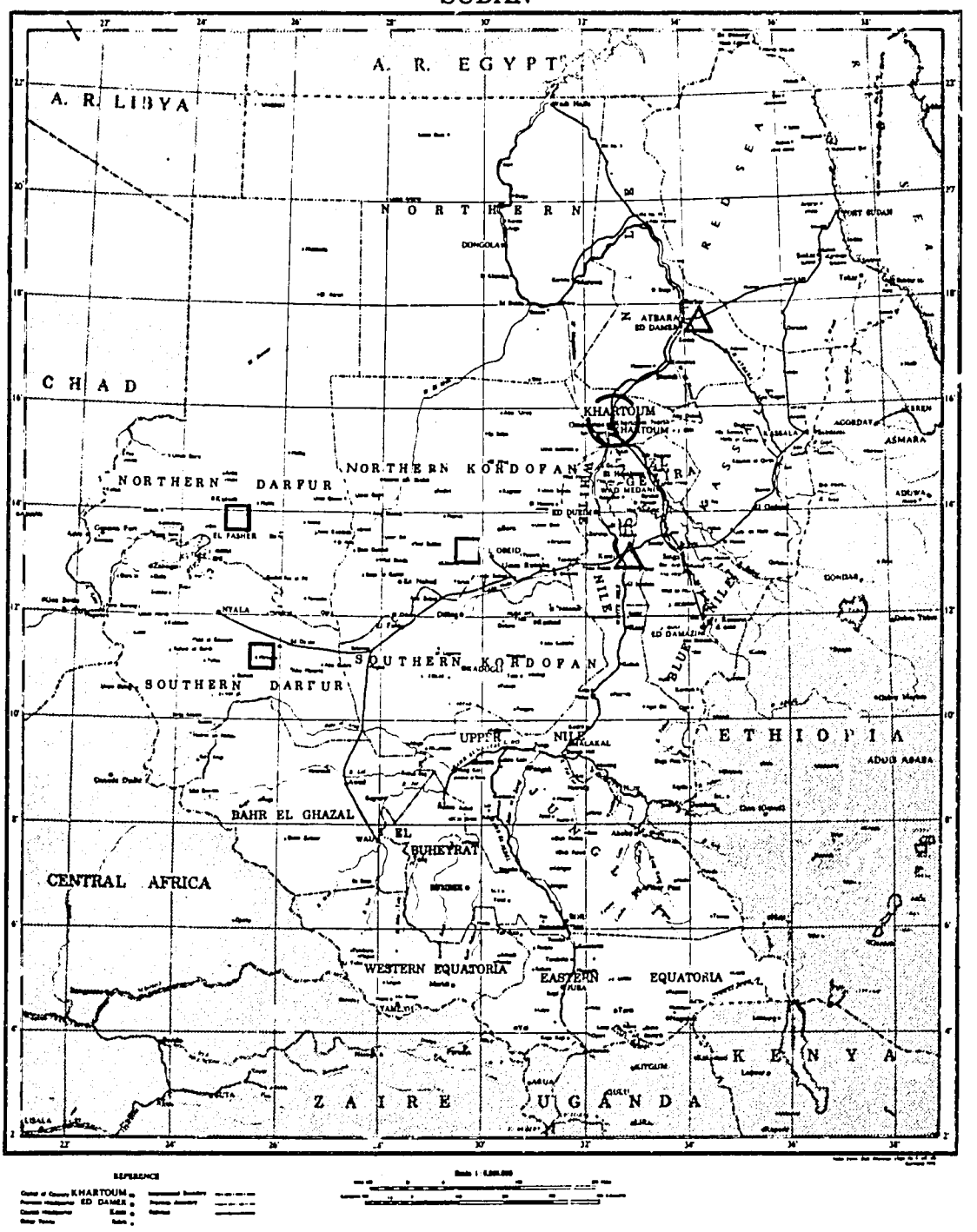

LEGEND

- ○ Project Headquarters
- □ Research Station
- △ Cement Plant

II. INTRODUCTION

1. This development study has the purpose of establishing schedules of facilities with budget projections and to identify criteria influencing the design and construction implementation for the Western Sudan Agricultural Research Stations in El Obeid, El Fasher, Ghazala Gawazet and for the ARC Headquarters in Khartoum.

   The schedule of facilities is based on programming information developed in cooperation with the Agricultural Research Corporation, the project support unit I.D.A. and U.S.A.I.D., and reflects essential requirements for a successful operation of the stations.

2. Various limitations affecting building construction in the Western Sudan have been analyzed and considered in the budget projections. Cost information was obtained during interviews with representatives of government agencies, private contractors, and by review of the Kadugli construction tender result.

3. Local conditions, climate, transportation difficulties, material and skilled labor restrictions have also influenced building systems recommendations and proposed time schedules. Emphasis was given to the study of potential logistical problems and their effect on construction methods and cost. The investigation into conventional construction systems versus prefabricated systems, as outlined in this report, will have to be continued during the design phase.

4. During visits to the project locations, meetings were held with representatives of the Ministry of Construction & Public Works, the Water and Electricity Corporations, Survey and Planning Departments. The proposed sites were investigated and preliminary soils evaluations conducted. Site boundary and contour surveys were initiated and the availability of water and power in required quantities verified. Site organization diagrams of facilities and utilities were prepared to assure workable site conditions.

5. The project team made a careful evaluation of the existing buildings in Ghazala Gawazet. Each structure was analyzed as to the condition of its building components; floor plans were drawn and photographic surveys established.

6. The project team would like to express its appreciation for the close cooperation and valuable assistance received from the Agricultural Research Corporation, the Western Sudan Agricultural Research Project and other Sudan Government Agencies, especially the Ministry of Construction & Public Works in Khartoum and its regional representatives, The District Commissioners and their staff and from P.S.U., U.S.A.I.D. and I.D.A.

III. SCHEDULE OF FACILITIES & CONSTRUCTION BUDGET

The schedule of facilities is based on numbers of expatriate Sudanese staff members for the individual stations and on the resulting area requirements of different building types. The program was developed as a result of a screening process to arrive at the essential facilities needed to operate the stations.

1. CONSTRUCTION COST INDEXES

As a method of arriving at a realistic construction cost, the Kadugli tender results of January, 1980, have been adjusted by one additional year's inflation index and by a transportation and general difficulties index. Corresponding construction cost have also been developed for enclosed, wall and circulation areas.

2. LOCAL & FOREIGN CURRENCY REQUIREMENTS

The distribution of LS construction cost into foreign and local currency components is approximately 60% for foreign and 40% for local funds required. At the time of completion of this study, contractors are requesting in their tenders an exchange rate of U.S. $2.00 for LS 1.000 as compared with the official "parallel" rate of U.S. $1.25 for LS 1.000. In budgeting for currency requirements, this possibly changing situation should be taken into account.

3. SUMMARY OF CONSTRUCTION BUDGET

The summary presents building types of different stations by total areas, unit construction cost and total construction cost indexed for a construction contract in March 1981 and a construction period of 18 months. Detailed information on building types related to enclosed, wall and circulation areas and corresponding unit costs, as well as site work items are included in the schedule of facilities and construction budget following the summary and construction cost analysis.

1. Summary

	Area M^2	Unit Cost LS/M^2	Total LS
a. EL OBEID			
Offices, labs	2,563	437	1,119,610
Farm Buildings	833	218	181,890
Senior houses (21)	(224 ea.)		(103,534 ea.)
	4,704	462	2,174,230
Middle houses (22)	(187 ea.)		(83,245 ea.)
	4,112	445	1,831,380
Junior houses (12)	(105 ea.)		(34,895 ea.)
	1,263	332	418,740
Guest Houses (2)	490	404	197,970
Other buildings	261	448	116,960
Site work			1,149,900
		LS	7,190,680
b. EL FASHER			
Offices, labs	869	489	425,430
Farm buildings	518	235	121,660
Senior houses (5)	(224 ea.)		(112,364 ea.)
	1,122	501	561,820
Middle houses (8)	(187 ea.)		(90,275 ea.)
	1,495	483	722,200
Junior houses (4)	(105 ea.)		(37,432 ea.)
	421	356	149,730
Guest houses (2)	490	436	213,870
Other buildings	217	490	106,300
Site work			537,300
		LS	2,838,310

	Area M^2	Unit Cost LS/M^2	Total LS
c. GHAZALA GAWAZET			
Offices, labs	1,062	487	517,590
Farm buildings	173	232	40,050
Senior houses (8)	(224 ea.)		(110,918 ea.)
	1,794	495	887,340
Middle houses (6)	(187 ea.)		(89,177 ea.)
	1,122	477	535,060
Junior houses (6)	(105 ea.)		(36,708 ea.)
	632	348	220,250
Guest house	272	497	135,130
Other buildings	193	482	93,050
Site work			410,450
		LS	2,838,920
d. ARC HEADQUARTERS			
Offices	812	445	361,500
Warehouse	270	197	53,400
Site work			80,340
		LS	495,240
Sub-Total			LS 13,363,150
Contingencies @ 15%			2,004,480
TOTAL			LS 15,367,630

4. CONSTRUCTION COST ANALYSIS

As indicated in the following tables, construction unit costs per m2/area of different building types do reflect the latest information of the January, 1980 Kadugli tender results.

The Kadugli unit construction costs have been selected as a basis for the construction cost analysis of the Western Sudan Agricultural Research Stations project because of the following:

1. Six of the contractors interested in this project participated in the Kadugli tender.

2. The tender amounts did not differ substantially.

3. The square meter unit cost for different building types correspond with information received from other contractor sources.

4. Transportation difficulties, although over a shorter distance, are indicative of the El Fasher and Ghazala Gawazet projects.

5. By timing and project type, this tender provides the most relevant available example for comparison.

Figures have been adjusted for the construction inflation index increase between January , 1980 and March, 1981 and for a transportation and logistics difficulty index increase relative to the Kadugli project.

5. CONSTRUCTION INFLATION & TRANSPORTATION/LOGISTICS DIFFICULTY INDEX INCREASE RELATIVE TO KADUGLI

	El Obeid	El Fasher	Ghazala G.
Construction Inflation, 80/81	42%	42%	42%
Transportation/Logistics Index	-2%	11%	9%
Total Index Increase Over Kadugli Prices	40%	53%	51%

6. ANALYSIS OF UNIT PRICES RELATED TO KADUGLI TENDER

	Kadugli Tender Jan. 80 Ls/m2	El Obeid Tender Mar. 81 + 40% Ls/m2	El Fasher Tender Mar. 81 + 53% Ls/m2	Ghazala G. Tender Mar. 81 + 51% Ls/m2
Senior House	403 (enclosed) 134 (circul.) + overhangs	564 180	617 180	609 180
Middle House	403 134	525 180	574 180	566 180
Junior House	315 104	400 180	435 180	425 180
Laboratories	524 173	734 180	802 180	791 180
Offices		550 180	601 180	594 180
Warehouse Maintenance	163 54	228 180	249 180	246 180
Average Cost Ls/m2		424	448	436

III. SCHEDULE OF FACILITIES AND CONSTRUCTION BUDGET: EL OBEID

El Obeid	Enclosed Space							Exterior Circulation/ Overhang/Apron			Total Cost Ls
Schedule of Facilities	#	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Area (55%) M^2	Unit Cost Ls/M^2	Total Cost Ls	
1. Administration											
Reception	1	21	21								
Secretarial	1	21	21								
Proj. Director Office	1	25	25								
Dep. Proj. Dir. Off.	1	16	16								
Meeting/Seminar	1	25	25								
Work/Storage/File	1	14	14								
Accountant	1	14	14								
Communications	1	10	10								
Executive Officer	1	14	14								
Tea Kitchen	1	10	10								
Stores	1	21	21								
Cashier	1	14	14								
Driver's Waiting Room	1	6	6								
Toilets	1	16	16								
Janitor	1	4	4								
Mechanical Room	1	4	4								
Sub-Total			235								
Internal Circulation @ 15%			35								
Total			270	68	338	550	185,800	186	130	33,450	219,250

El Obeid	Enclosed Space							Exterior Circulation/ Overhang/Apron			Total Cost Ls
Schedule of Facilities	#	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Area (55%) M^2	Unit Cost Ls/M^2	Total Cost Ls	
2. Training Unit											
Office	1	12	12								
Work Space	1	16	16								
Lecture/Conf./Training	1	132	132								
Furniture Storage	1	10	10								
Equip. Storage	1	10	10								
Sub-Total			180								
Internal Circulation 15%			27								
Total			207	52	259	550	142,310	142	180	25,650	167,950
3. Research Support Services											
Team Leader Office	1	16	16								
Senior Scientist Office	2	14	28								
Work Room	1	21	21								
Storage	1	12	12								
Sub-Total			77								
Internal Circulation 15%			12								
Total			89	22	111	550	60,880	61	180	10,990	71,870

El Obeid	Enclosed Space							Exterior Circulation/ Overhang/Apron			Total Cost Ls
Schedule of Facilities	#	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Area (55%) M^2	Unit Cost Ls/M^2	Total Cost Ls	
4. Integrated Crop/Livestock on non-cracking clays											
Scientist Office	4	14	56								
Asst. Scientist Office	4	14	56								
Technicians' Space	2	21	42								
Tea Kitchen	1	10	10								
Sub-Total			164								
Internal Circulation 15%			25								
Total			189	47	236	550	129,670	130	180	23,360	
Laboratory	2	41	82								
Equipment	1	21	21								
Sub-Total			103								
Internal Circulation 15%			15								
Total			118	30	148	734	108,680	81	180	14,650	
Total											276,360

El Obeid

Schedule of Facilities	Enclosed Space #	Net Unit Area M2	Net Total Area M2	Wall Area (25%) M2	Gross Total Area M2	Unit Cost Ls/M2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area (55 %) M2	Unit Cost Ls/M2	Total Cost Ls	Total Cost Ls
5. Library											
Reading Room/Periodicals	1	21	21								
Check-out Area	1	10	10								
Office	1	10	10								
Work Room	1	25	25								
Storage	1	10	10								
Map/Illustrations	1	10	10								
Stacks	1	60	60								
Darkroom	1	10	10								
Sub-Total			156								
Internal Circulation 15%			23								
Total			179	45	224	590	132,310	123	180	22,200	154,510

El Obeid Schedule of Facilities	Enclosed Space #	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area (55%) M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Cost Ls
6. Water/Land Use Management											
Program Leader Offices	1	16	16								
Sr. Scientist Office	1	14	14								
Jr. Scientist Office	1	14	14								
Technical Space	1	21	21								
Stores	1	10	10								
Toilets	1	16	16								
Janitor	1	4	4								
Mechanical Room	1	4	4								
Sub-Total			99								
Internal Circulation 15%			15								
Total			114	29	143	550	78,650	79	180	14,160	
Laboratories (2) & Equipment Room	1	100	100								
Internal Circulation 15%			15								
Total			115	29	144	734	105,510	79	180	14,250	
Total											212,580
7. General Office/Lab Stores	1	50	50	13	63	228	14,250	(25%) 16	180	2,840	17,090

El Obeid

Schedule of Facilities	Enclosed Space #	Net Unit Area M2	Net Total Area M2	Wall Area (25%) M2	Gross Total Area M2	Unit Cost Ls/M2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area (25%) M2	Unit Cost Ls/M2	Total Cost Ls	Total Cost Ls
8. Maintenance/Operations											
Vehicle Shop/Stores/Tools	1	60	60								
Carpentry/Plumbing Shop	1	20	20								
Generator House/Tools	1	75	75								
Water Pump House	3	10	30								
Total			185	46	231	228	52,730	58	180	10,400	63,130
9. Farm Buildings											
Tool Shed/Storage	2	10	20								
Fertilizer/Insecticide Storage	1	20	20								
Warehouse	1	140	140								
Seed House	1	20	20								
Threshing Floor	1	20	20								
Implement Shed	1	60	60								
Farm Shop	1	20	20								
Toilets & Showers	1	20	20								
Farm Manager Office	1	14	14								
Assist. Technician	1	14	14								
Total			348	87	435	228	99,180	109	180	19,580	118,760
10. Gate House	1	10	10	3	13	228	2,964	4	180	720	3,680

El Obeid	Enclosed Space							Exterior Circulation/ Overhang/Apron			Total Cost Ls
Schedule of Facilities	#	Net Unit Area M2	Net Total Area M2	Wall Area (25%) M2	Gross Total Area M2	Unit Cost Ls/M2	Total Cost Ls	Total Area (30%) M2	Unit Cost Ls/M2	Total Cost Ls	
11. Housing											
Senior Houses	21										
Living Room (8.0 x 4.0)		32									
Bedroom 1 (4.5 x 4.0)		18									
Bedroom 2 (4.5 x 4.0)		18									
Veranda (3.0 x 10.0)		30									
Kitchen/Storage (4.5 x 4.0)		18									
Bathroom (3.5 x 2.0)		7									
Total		123	2,583	646	3,229	564	1,821,020	969	180	174,370	1,995,390
Servant Quarters	21	15	315	79	394	400	157,600	118	180	21,240	178,840
Total Encl. + Circ. Each					(224m2 @ 462 LS/m2 = 103,488 LS each)						
Middle Houses	22										
Living Room (7.0 x 4.0)		28									
Bedroom 1 (4.5 x 4.0)		18									
Bedroom 2 (4.5 x 4.0)		18									
Veranda (10.0 x 3.0)		30									
Kitchen/Storage (3.5 x 4.0)		14									
Bathroom (3.5 x 2.0)		7									
Total		115	2,530	633	3,163	525	1,660,580	949	180	170,800	1,831,380
Total Encl. + Circl. Each					(187m2 @ 445 LS/m2 = 83,245 LS each)						

El Obeid	Enclosed Space							Exterior Circulation/ Overhang/Apron			Total Cost Ls
Schedule of Facilities	#	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Area (30 %) M^2	Unit Cost Ls/M^2	Total Cost Ls	
Junior Houses	12										
Hall (4.0 x 4.0)		16									
Bedroom 1 (4.0 x 4.0)		16									
Bedroom 2 (4.0 x 4.0)		16									
Kitchen (3.0 x 2.5)		7.5									
Toilet (2.5 x 1.0)		2.5									
Total		58	696	174	870	400	348,000	261	180	46,980	
Covered Veranda								132	180	23,760	
Total											418,740
Total Encl. + Circ. Each					($105m^2$ @ 332 LS/m^2 = 34,895 LS each)						
Junior Guest House (Bachelors)											
Hall (4.0 x 4.0)		16									
Bedroom 1 (4.0 x 4.0)		16									
Bedroom 2 (4.0 x 4.0)		16									
Bedroom 3 (4.0 x 4.0)		16									
Bedroom 4 (4.0 x 4.0)		16									
Bedroom 5 (4.0 x 4.0)		16									
Kitchen (3.0 x 2.5)		8									
Bath (3.0 x 2.0)		6									
Servants Quarters (3.0 x 3.0)		9									
		119	119	30	149	400	59,500	45	180	8,050	
Covered Veranda								24	180	4,320	
Total											71,870

El Obeid

Schedule of Facilities	Enclosed Space #	Net Unit Area M2	Net Total Area M2	Wall Area (25%) M2	Gross Total Area M2	Unit Cost Ls/M2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area (30%) M2	Unit Cost Ls/M2	Total Cost Ls	Total Cost Ls
Senior Guest House	1										
Saloon (5.0 x 4.0)		20									
Bedroom 1 (4.0 x 4.0)		16									
Bedroom 2 (4.0 x 4.0)		16									
Bathroom 1 (3.0 x 2.0)		6									
Veranda 1 (10.0 x 3.0)		30									
Bedroom 3 (4.0 x 4.0)		16									
Bathroom 2 (3.0 x 2.0)		6									
Veranda 2 (8.0 x 3.0)		24									
Kitchen/Store (4.5 x 4.0)		18									
Total		152	152	38	190	564	107,160	57	180	10,260	117,420
Servant's Quarters		15	15	4	19	400	7,600	6	180	1,080	8,680
12. Conference/Meeting Hall	1	150	150	38	188	550	103,130	56	180	10,150	113,280

El Obeid Site Work

ITEM	QUANTITY/UNIT COST	TOTAL COSTS
Petrol Station		35,000 Ls
Power System		
Generators	3 @ 60,000 =	180,000
Service Lines	1,460 ML 3-phase @ 21.3) 800 ML sgl. phase @ 15.6) =	43,600
Utility Poles	45 @ 210	10,000
Fuel Storage	5 tanks, piping, venting, pumps, controls	50,000
Street Lights	25 fixtures @ 100	2,500
Water System		
Reservoir/Booster Pump		40,000
Tank/Tower		50,000
Domestic Piping		71,500
Borehole + Pump		30,000
Irrigation Piping		60,000
Sewer System		
Maturation Ponds		3,500
Clay Surfacing		3,400
Irrigation Chamber		2,800
Irrigation Pump		5,600
Main 6" Ø Lines	2,000 ML @ 28	56,000
Other Works		120,000
Outdoor Works		
Brick Compound Walls	2,550 ML @ 75	192,000
Perimeter Fencing	2,300 ML @ 10	23,000
Main Gate	Allowance	2,300
Internal Roads	4,620 M^2 @ 15	69,300
Tennis Courts	4 @ 7,350	29,400
Grading/Landscaping	Allowance	70,000
Total Site Work		1,149,900 Ls

EL OBEID, COST SUMMARY

Schedule of Facilities	Enclosed Space #	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Cost Ls
1. Administration			270	68	338	550	185,800	186	180	33,450	219,250
2. Training Unit			207	52	259	550	142,310	142	180	25,650	167,950
3. Research Support Services			89	22	111	550	60,880	61	180	10,990	71,870
4. Integrated Crop/Livestock			307	77	384	Var.	238,350	211	180	38,010	276,360
5. Library			179	45	224	590	132,310	123	180	22,200	154,510
6. Water/Land Use Management			229	58	287	Var.	184,160	158	180	28,410	212,580
7. General Office/Lab Stores			50	13	63	228	14,250	16	180	2,840	17,090
8. Maintenance, Operations			185	46	231	228	52,730	58	180	10,400	63,130
9. Farm Buildings			348	87	435	228	99,180	109	180	19,580	118,760
10. Gate House			10	3	13	228	2,964	4	180	720	3,680
11. Housing											
Senior Houses	21	138	2,898	725	3,623	Var.	1,978,620	1,087	180	195,610	2,174,230
Middle Houses	22	115	2,530	633	3,163	525	1,660,580	949	180	170,800	1,831,380
Junior Houses	12	58	696	174	870	400	348,000	393	180	70,740	418,740
Junior Guest House	1	119	119	30	149	400	59,500	69	180	12,370	71,870
Senior Guest House	1	167	167	42	209	Var.	114,760	63	180	11,340	126,100
12. Conference/Meeting Hall	1	150	150	38	188	550	103,130	56	180	10,150	113,280
Total Buildings:			8,434	2,113	10,547	510	5,377,524	3,685	180	663,260	6,040,780
Enclosed & Circulation Space:						424					
Site Work:											1,149,900
Total Buildings & Site Work											7,190,680

8. SCHEDULE OF FACILITIES AND CONSTRUCTION BUDGET: EL FASHER

El Fasher

Schedule of Facilities	Enclosed Space #	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area (55 %) M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Cost Ls
1. Administration											
Reception/Secretarial	1	16	16								
Director's Office	1	16	16								
Library/Seminar	1	25	25								
Work Room	1	14	14								
Accountant	1	14	14								
Cashier	1	14	14								
Administrative Officer	1	14	14								
Tea Kitchen	1	10	10								
Stores	1	10	10								
Communications	1	10	10								
Driver's Waiting Room	1	6	6								
Toilets	1	16	16								
Janitor	1	4	4								
Mechanical Room	1	4	4								
Sub-Total			173								
Internal Circulation 15%			26								
Total			199	50	249	601	149,460	137	180	24,650	174,110

El Fasher

Schedule of Facilities	Enclosed Space #	Net Unit Area M2	Net Total Area M2	Wall Area (25%) M2	Gross Total Area M2	Unit Cost Ls/M2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area (55 %) M2	Unit Cost Ls/M2	Total Cost Ls	Total Cost Ls
2. Research Spaces											
Laboratories	2	40	80								
Equipment Room	1	21	21								
Scientific Stores	1	16	16								
Sub-Total (labs only)			117								
Internal Circulation 15%			18								
Sub-Total			135	34	169	802	134,890	92	180	16,630	
Scientific Offices	5	14	70								
Technician's Space	1	21	21								
Janitor	1	4	4								
Mechanical Room	1	4	4								
Sub-Total			99								
Internal Circulation 15%			15								
Sub-Total			114	29	143	601	85,640	79	180	14,160	
Total											251,320

El Fasher

Schedule of Facilities	Enclosed Space #	Net Unit Area M2	Net Total Area M2	Wall Area (25%) M2	Gross Total Area M2	Unit Cost Ls/M2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area (25%) M2	Unit Cost Ls/M2	Total Cost Ls	Total Cost Ls
3. Livestock Facilities											
Shed	1	40	40	10	50	249	12,450	13	180	2,250	14,700
4. Maintenance/Offices											
Vehicle Maintenance	1	25	25								
Tool Room	1	10	10								
Spares Store	1	10	10								
Shop	1	20	20								
Office/Records	1	10	10								
Generator House	1	50	50								
Toilets	1	16	16								
Total			141	35	176	249	43,890	44	180	7,920	51,810
5. Farm Buildings											
Warehouse	1	136	136								
Office (space) for Mgr.	1	14	14								
Total			150	38	188	249	46,690	47	180	8,460	55,150
6. Gate House	1	10	10	3	13	249	3,240	4	180	720	3,960

El Fasher

Schedule of Facilities	#	Enclosed Space: Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Exterior Circulation/ Overhang/Apron: Total Area (80 %) M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Cost Ls
Housing											
Senior Houses	5										
Living Room (8.0 x 4.0)		32									
Bedroom 1 (4.5 x 4.0)		18									
Bedroom 2 (4.5 x 4.0)		18									
Veranda (3.0 x 10.0)		30									
Kitchen/Storage (4.5 x 4.0)		18									
Bathroom (3.5 x 2.0)		7									
Total		123	615	154	769	617	474,320	231	180	41,580	515,850
Servants Quarters	5	15	75	19	94	435	40,890	28	180	5,080	45,970
Total Encl. + Circ. Each					(224m^2 @ 502 LS/m^2 = 112,364 LS each)						
Middle Houses	8										
Living Room (7.0 x 4.0)		28									
Bedroom 1 (4.5 x 4.0)		18									
Bedroom 2 (4.5 x 4.0)		18									
Veranda (10.0 x 3.0)		30									
Kitchen/Storage (3.5 x 4.0)		14									
Bathroom (3.5 x 2.0)		7									
Total		115	920	230	1,150	574	660,100	345	180	62,100	722,200
Total Encl. + Circ. Each					(187m^2 @ 483 LS/m^2 = 90,275 LS each)						

El Fasher		Enclosed Space							Exterior Circulation/ Overhang/Apron			Total Cost Ls
Schedule of Facilities		#	Net Unit Area M2	Net Total Area M2	Wall Area (25%) M2	Gross Total Area M2	Unit Cost Ls/M2	Total Cost Ls	Total Area (30 %) M2	Unit Cost Ls/M2	Total Cost Ls	
Junior Houses		4										
Hall	(4.0 x 4.0)		16									
Bedroom 1	(4.0 x 4.0)		16									
Bedroom 2	(4.0 x 4.0)		16									
Kitchen	(3.0 x 2.5)		7.5									
Toilet	(2.5 x 1.0)		2.5									
Total			58	232	58	290	435	126,150	87	180	15,660	
Covered Veranda									44	180	7,920	
Total												149,730
Total Encl. + Circ. Each						(105m2 @ 357 LS/m2 = 37,432 LS each)						
Junior Guest House (Bachelors)		1										
Hall	(4.0 x 4.0)		16									
Bedroom 1	(4.0 x 4.0)		16									
Bedroom 2	(4.0 x 4.0)		16									
Bedroom 3	(4.0 x 4.0)		16									
Bedroom 4	(4.0 x 4.0)		16									
Bedroom 5	(4.0 x 4.0)		16									
Kitchen	(3.0 x 2.5)		8									
Bath	(3.0 x 2.0)		6									
Servants Quarters	(3.0 x 3.0)		9									
			119	119	30	149	435	64,710	45	180	8,050	
Covered Veranda									24	180	4,320	
Total												77,080

El Fasher	Enclosed Space							Exterior Circulation/ Overhang/Apron			Total Cost Ls
Schedule of Facilities	#	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Area (30 %) M^2	Unit Cost Ls/M^2	Total Cost Ls	
Senior Guest House	1										
Saloon (5.0 x 4.0)		20									
Bedroom 1 (4.0 x 4.0)		16									
Bedroom 2 (4.0 x 4.0)		16									
Bathroom 1 (3.0 x 2.0)		6									
Veranda 1 (10.0 x 3.0)		30									
Bedroom 3 (4.0 x 4.0)		16									
Bathroom 2 (3.0 x 2.0		6									
Veranda 2 (8.0 x 3.0)		24									
Kitchen/Store (4.5 x 4.0)		18									
Total		152	152	38	190	617	117,230	57	180	10,260	127,490
Servant's Quarters		15	15	4	19	435	8,270	6	180	1,030	9,300
8. Conference Hall	1	125	125	31	156	601	93,910	47	180	8,430	102,340

El Fasher Site Work

ITEM	QUANTITY/UNIT COST	TOTAL COSTS
Petrol Station		27,000 Ls
Power System		
Generators	2 @ 50,000	100,000
Service Lines	800 ML - 3 phase @ 23) =	23,500
Service Lines	300 ML - 1 phase @ 17)	
Utility Poles	20 @ 230	4,600
Fuel Storage	2 tanks, pumping, piping, venting, controls	25,000
Street Lighting	12 fixtures @ 115	1,400
Water System		
Tank/Tower		35,000
Domestic Piping		32,500
Bore Hole/Pump		30,900
Irrigation Piping		25,000
Sewer System		
Septic Tanks	11 @ 1,680	18,500
Seepage Pits	22 @ 2,300	50,600
4" Pipelines	660 ML @ 30	19,800
Outdoor Works		
Br. Compound Walls	530 ML @ 82	43,300
Perimeter Fencing	2,000 ML @ 11	22,000
Main Gate	Allowance	2,500
Internal Roads	2,310 M^2 @ 15	34,700
Tennis Courts	2 @ 8,000	16,000
Grading/Landscaping	Allowance	25,000
Total Site Work		537,300 Ls

EL FASHER, COST SUMMARY

Schedule of Facilities	Enclosed Space #	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Cost Ls
1. Administration			199	50	249	601	149,460	137	180	24,650	174,110
2. Research Spaces			249	63	312	Var.	220,530	171	180	30,790	251,320
3. Livestock Facilities			40	10	50	249	12,450	13	180	2,250	14,700
4. Maintenance/Offices			141	35	176	249	43,890	44	180	7,920	51,810
5. Farm Buildings			150	38	188	249	46,690	47	180	8,460	55,150
6. Gate House	1	10	10	3	13	249	3,240	4	180	720	3,960
7. Housing											
Senior Houses	5	138	690	173	863	Var.	515,210	259	180	46,610	561,820
Middle Houses	8	115	920	230	1,150	574	660,100	345	180	62,100	722,200
Junior Houses	4	58	232	58	290	435	126,150	131	180	23,580	149,730
Junior Guest House	1	119	119	30	149	435	64,710	69	180	12,370	77,080
Guest House	1	167	167	42	209	Var.	125,500	63	180	11,290	136,790
8. Conference Hall	1	125	125	31	156	601	93,910	47	180	8,430	102,340
Total Buildings			3,042	763	3,805	542	2,061,840	1,330	180	239,170	2,301,010
Total Enclosed Space & Circulation						448					
Site Work											537,300
Total Buildings & Site Work											2,838,310

9. SCHEDULE OF FACILITIES AND CONSTRUCTION BUDGET: GHAZALA GAWAZET

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Ghazala Gawazet	Enclosed Space							Exterior Circulation/ Overhang/Apron			Total Cost Ls
Schedule of Facilities	#	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Area (55%) M^2	Unit Cost Ls/M^2	Total Cost Ls	
1. Administrative											
Station Superintendent	1	16	16								
Executive Officer	1	14	14								
Accountant	1	14	14								
Cashier	1	14	14								
Reception/Secretarial	1	20	20								
Work/Storage/Files	1	10	10								
Stores	1	10	10								
Tea Kitchen	1	10	10								
Seminar & Reading Room	1	25	25								
Communications	1	10	10								
Driver's Waiting Room	1	6	6								
Toilets	1	16	16								
Janitor	1	4	4								
Mechanical Room	1	4	4								
Sub-Total			172								
Internal Circulation 15%			26								
Total			199	50	249	594	147,720	137	180	24,650	172,370

Ghazala Gawazet	Enclosed Space							Exterior Circulation/ Overhang/Apron			Total Cost Ls
Schedule of Facilities	#	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Area (55%) M^2	Unit Cost Ls/M^2	Total Cost Ls	
2. Research Facilities											
Laboratories	2	40	80								
Equipment Room	1	21	21								
Technician's Space	2	21	42								
Scientific Stores	1	10	10								
Sub-Total (Labs)			153								
Internal Circulation 15%			23								
Sub-Total			176	44	220	791	173,970	121	180	21,780	
Sr. Scientist Offices	9	14	126								
Toilets	1	16	16								
Janitor	1	4	4								
Mechanical Room	1	4	4								
Sub-Total			150								
Internal Circulation 15%			23								
Sub-Total (Other)			173	43	216	594	128,080	119	180	21,390	
Total Research Fac.											345,220
3. Gate House	1	10	10	3	13	246	3,200	4	180	720	3,920

Ghazala Gawazet	Enclosed Space							Exterior Circulation/ Overhang/Apron			Total Cost Ls
Schedule of Facilities	#	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Area (25%) M^2	Unit Cost Ls/M^2	Total Cost Ls	
4. Operations & Farm Building											
Warehouse w/1 office	1	100	100								
Farm/Livestock-Tool Shed	1	10	10								
Sub-Total			110	28	138	246	33,840	35	180	6,210	40,050
5. Housing											
Senior Houses	8										
Living Room (8.0 x 4.0)		32									
Bedroom 1 (4.5 x 4.0)		18									
Bedroom 2 (4.5 x 4.0)		18									
Veranda (3.0 x 10.0)		30									
Kitchen/Storage (4.5 x 4.0)		18									
Bathroom (3.5 x 2.0)		7						(30%)			
Total		123	984	246	1,230	609	749,080	369	180	66,420	815,490
Servant's Quarters	8	15	120	30	150	425	63,750	45	180	8,100	71,850
Total Encl. & Circ. each				(224 M^2 @ 495 LS/M^2 = 110,918 LS each)							

Ghazala Gawazet		Enclosed Space							Exterior Circulation/ Overhang/Apron			Total Cost Ls
Schedule of Facilities		#	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Area (30 %) M^2	Unit Cost Ls/M^2	Total Cost Ls	
Middle Houses		6										
Living Room	(7.0 x 4.0)		28									
Bedroom 1	(4.5 x 4.0)		18									
Bedroom 2	(4.5 x 4.0)		18									
Veranda	(10.0 x 3.0)		30									
Kitchen/Storage	(4.0 x 3.5)		14									
Bathroom	(3.5 x 2.0)		7									
Total			115	690	173	863	566	488,460	259	180	46,602	535,060
Total Encl. + Circ. Each						(187m^2 @ 477 LS/m^2 = 89,176 LS each)						
Junior Houses		6										
Hall	(4.0 x 4.0)		16									
Bedroom 1	(4.0 x 4.0)		16									
Bedroom 2	(4.0 x 4.0)		16									
Kitchen	(3.0 x 2.5)		7.5									
Toilet	(2.5 x 1.0)		2.5									
Total			58	348	87	435	425	184,880	131	180	23,490	
Covered Veranda									66	180	11,880	
Total												220,250
Total Encl. + Circ. Each						(105m^2 @ 350 LS/m^2 = 36,708 LS each)						

Ghazala Gawazet		Enclosed Space							Exterior Circulation/ Overhang/Apron			Total Cost Ls
Schedule of Facilities		#	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Area (30%) M^2	Unit Cost Ls/M^2	Total Cost Ls	
Senior Guest House		1										
Saloon	(5.0 x 4.0)		20									
Bedroom 1	(4.0 x 4.0)		16									
Bedroom 2	(4.0 x 4.0)		16									
Bathroom 1	(3.0 x 2.0)		6									
Veranda 1	(10.0 x 3.0)		30									
Bedroom 3	(4.0 x 4.0)		16									
Bathroom 2	(3.0 x 2.0)		6									
Veranda 2	(8.0 x 3.0)		24									
Kitchen/Store	(4.5 x 4.0)		18									
Total			152	152	38	190	609	115,710	57	180	10,260	125,970
Servant's Quarters		1	15	15	4	19	425	8,080	6	180	1,080	9,160
6. Conference/Meeting Hall		1	110	110	28	138	594	81,680	41	180	7,450	89,130

Ghazala Gawazet Site Work

ITEM	QUANTITY/UNIT COST	TOTAL COSTS
Petrol Station		27,000 Ls
Power System		
Service Lines	1,000 3-phase lines @ 23) =	29,800
Services Lines	400 single phase lines @ 17)	
Utility Poles	30 @ 230	6,900
Fuel Storage	3 tanks, pumping, piping, venting, controls	35,000
Street Lighting	15 fixtures @ 114	1,700
Water System		
Piping (domestic & irrigation)		37,750
Sewer System		
Septic Tanks	10 @ 1,650	16,500
Seepage Pits	20 @ 2,250	45,000
4" Pipelines	600 ML @ 30	18,000
Outdoor Works		
Brick Compound Walls	800 ML @ 81	65,000
Perimeter Fencing	2,400 ML @ 11	26,400
Main Gate		2,500
Internal Roads	4,200 @ M^2 @ 15	63,000
Tennis Courts	2 @ 7,930	15,900
Grading/Landscaping	Allowance	20,000
Total Site Work		410,450 Ls

Railroad-Siding -
Warehouse -

GHAZALA GAWAZET COST SUMMARY

Schedule of Facilities	Enclosed Space #	Net Unit Area M2	Net Total Area M2	Wall Area (25%) M2	Gross Total Area M2	Unit Cost Ls/M2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area M2	Unit Cost Ls/M2	Total Cost Ls	Total Cost Ls
1. Administrative			199	50	249	594	147,720	137	180	24,650	172,370
2. Research Facilities			349	87	436	Var.	302,050	240	180	43,170	345,220
3. Gate House	1	10	10	3	13	246	3,200	4	180	720	3,920
4. Operations & Farm Buildings			110	28	138	246	33,840	35	180	6,210	40,050
5. Housing											
Senior Houses	8	137	1,104	276	1,380	Var.	812,820	414	180	74,520	887,340
Middle Houses	6	115	690	173	863	566	488,460	259	180	46,600	535,060
Junior Houses	6	58	348	87	435	425	184,880	197	180	35,370	220,250
Senior Guest House	1	167	167	42	209	Var.	123,790	63	180	11,340	135,130
6. Conference/Meeting Hall	1	110	110	28	138	594	81,680	41	180	7,450	89,130
Total Buildings			3,087	774	3,861	564	2,178,440	1,390	180	250,030	2,428,470
Total Enclosed & Circulation Area						436					
Site Work											410,450
Total Buildings & Site Work											2,838,920

10. SCHEDULE OF FACILITIES AND CONSTRUCTION BUDGET: A.R.C. HEADQUARTERS, KHARTOUM

A.R.C. Headquarters, Khartoum

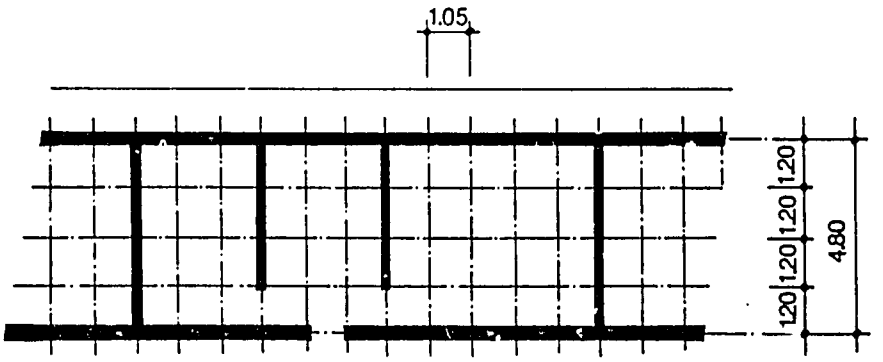
Schedule of Facilities	Enclosed Space #	Net Unit Area M2	Net Total Area M2	Wall Area (25%) M2	Gross Total Area M2	Unit Cost Ls/M2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area (20%) M2	Unit Cost Ls/M2	Total Cost Ls	Total Cost Ls
ARC OFFICES											
Director	1	25	25								
Associate Director Office	2	21	42								
Advisor Office	1	21	21								
Accountant	1	14	14								
Secretaries/Reception	1	21	21								
Offices	2	14	28								
Seminar/Library	1	21	21								
Tea Kitchen	1	10	10								
Stores	1	14	14								
File/Work Room	1	21	21								
Toilets	1	16	16								
Janitor	1	4	4								
Mechanical Room	1	4	4								
Sub Total			241								
Internal Circulation 25%			60								
Total			301	75	376	500	188,000	75	170	12,800	200,800

A.R.C. Headquarters, Khartoum

Schedule of Facilities	Enclosed Space #	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area (20%) M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Cost Ls
PROJECT FACILITIES											
Director Office	1	21	21								
Offices	4	14	56								
Support Staff	2	10	20								
Communication Offices	1	14	14								
Stores	1	16	16								
Secretary/Work/Files	1	21	21								
Secretary/Reception	1	21	21								
Toilet	1	16	16								
Janitor	1	4	4								
Mechanical Space	1	4	4								
Sub Total			193								
Internal Circulation 25%			48								
Sub Total			241	60	301	500	150,500	60	170	10,200	160,700
Total Building			541	135	677	500	338,500	135	170	23,000	361,500
Cost Per m^2						445					
Warehouse/Storage	1	200	200	50	250	200	50,000	20	170	3,400	53,400
Total Buildings											414,900
Site Work											80,340
Total Building & Site Work											495,240

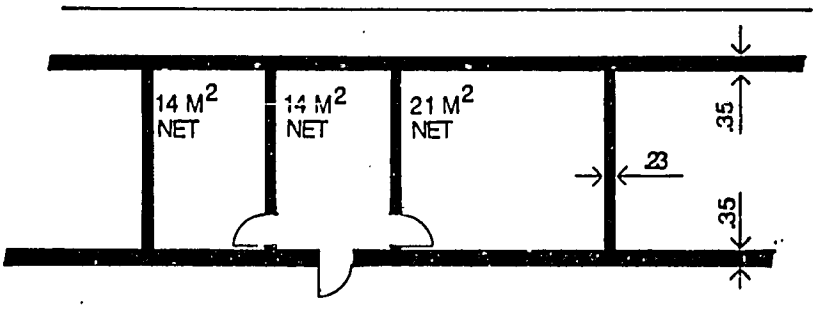
COST SUMMARY

Schedule of Facilities	Enclosed Space #	Net Unit Area M^2	Net Total Area M^2	Wall Area (25%) M^2	Gross Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Exterior Circulation/ Overhang/Apron Total Area M^2	Unit Cost Ls/M^2	Total Cost Ls	Total Cost Ls
El Obeid											7,190,680
El Fasher											2,838,310
Ghazala Gawazet											2,838,920
ARC Headquarters, Khartoum											495,240
Sub Total											13,363,150
5% Estimating Contingency											668,160
10% Construction Contingency											1,336,320
Total											15,367,630



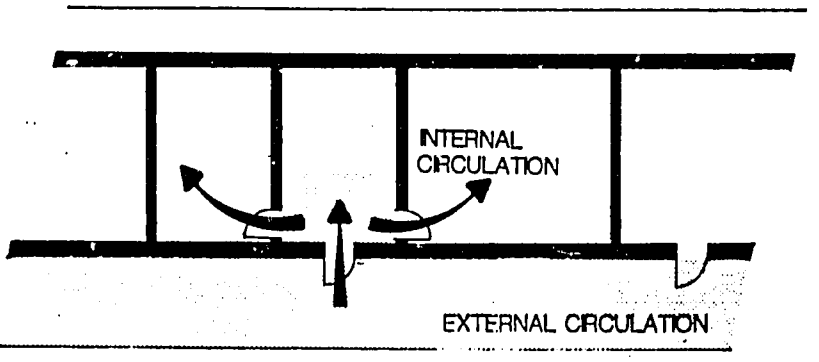
PLANNING MODULE

The Schedule of Facilities is based on a planning module of 4.80m building depth which subdivides into 1.20m segments and could accommodate offices, laboratories, secretarial and meeting rooms. A 4.20m module running the length of the building subdivides into 1.05m segments for window, ceiling, and partition systems.



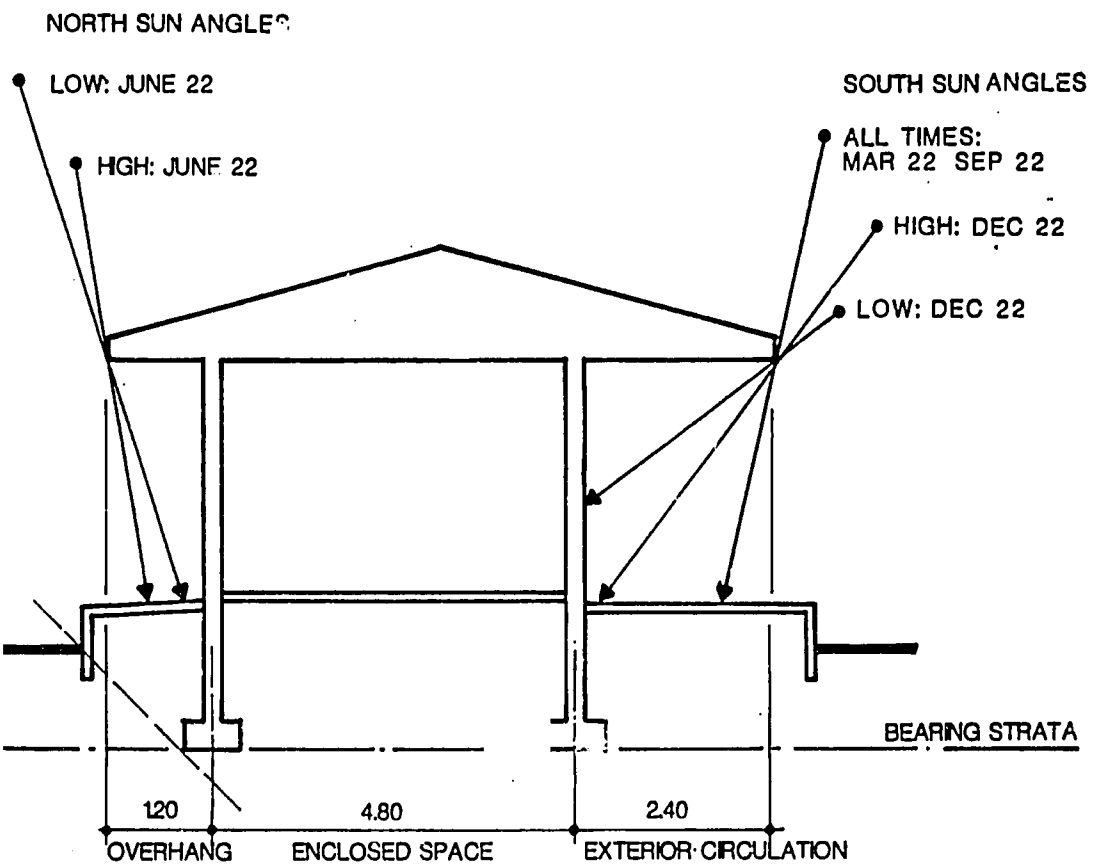
WALL AREAS 12.5 M^2 WALLS ÷ 49 M^2 NET ENCLOSED = 25%

Gross square meter areas include a wall area of 25% of the net areas. This percentage relates to 0.35m exterior walls and 0.23m interior partitions.



CIRCULATION SPACES

The Schedule of Facilities lists varying percentages of exterior circulation in combination with overhangs. Interior circulation is shown as an average percentage of 15%.



EXTERIOR CIRCULATION / OVERHANG / APRON

Overhangs have the function of shading south and north walls from sun radiation, providing cover for exterior circulation and in conjunction with aprons, protecting foundations from rain water reaching bearing soil.

IV. FACTORS INFLUENCING CONSTRUCTION COST & SCHEDULE

1. SUMMARY AND CONCLUSIONS:

Imported building materials which includes virtually all manufactured building products are not readily available from local suppliers. It must be assumed that these materials and products will be imported directly for this project.

Prefabricated building systems offer promise of lower cost, quicker erection, and better quality. However, the limited experience thus far in the Sudan indicated potential problems with transport, erection, available skilled labor and resulting high costs. Additional research is required.

Local materials, primarily cement and brick also present supply problems. The government cement is attractively priced but difficult to get. Free market cement is generally available, but at twice the cost. Every effort should be made to secure as much government cement as possible. Bricks are generally available with sufficient advance notice.

A separate material supply tender has been investigated. It offers potentially lower cost through reduced uncertainties for construction contractors and an improved schedule. Potential problems include over supply, management of divided contract responsibilities, and considerable resistance rom construction contractors. It is not recommended. However, a limited prepurchase of cement and reinforcing steel would allow an early start on foundations saving several months and considerable cost at minimum risk.

Transportation is a continuous problem due to an overloaded rail system, high cost, albeit more reliable truck transport, poor roads (unuseable during rainy season), and potentially high freight damage. The higher cost truck transport is most likely requiring, however, careful scheduling around the rainy season.

Inflation is a major contribution to the rapid increase in construction costs. Research indicates that an index of 34% annually should be used rather than the more commonly assumed index of 25%, particularly for construction in the Western Sudan.

Contractor capacity should pose no particular problems. There are several qualified major Sudanese contractors as well as international contractors with experience in the Sudan. Considerable interest has been expressed.

Several contracting alternatives have been investigated offering various advantages. Due to sponsor regulations, ARC preferences, and local experience, a conventional open tender is recommended. A single contract for all sites is recommended.

2. AVAILABILITY OF MATERIALS:

a. Imported Materials:

Materials such as construction steel, reinforcement steel, any steel and aluminum products such as windows, doors and frames, hardware and roofing material, all electrical installation components, plumbing fixtures, piping and mechanical equipment, are imported from abroad. Some of these materials are available in Khartoum at limited quantities on an irregular supply basis. Construction steel is theoretically obtainable at a government-controlled price of LS 600/ton, but most of the time not available unless purchased in the free market at LS 1,000/ton.

The local supply situation for imported materials is so restricted that it must be assumed that any of the materials described will have to be imported directly for the project.

b. Prefab Building Systems:

The use of prefabricated building systems offers potentially:

- lower costs
- quicker erection
- better quality control
- lower maintenance

However, there are also potential problems with such systems in the Sudan. Experience thus far, which is limited, has indicated problems with:

- transportation delays, high cost and damage
- repair and/or replacement of damaged components
- higher percentage of imported materials and therefore, foreign currency requirements
- shortage of local skilled labor and therefore, higher costs for expatriate crews
- coordination and tolerances of locally built pads, utilities, and connection points
- adaptability to local climate, customs, and life styles

Preliminary research (see page) indicates that there may be several suitable systems, particularly the flexible panel or component systems which can be adapted to a variety of uses, site or climate conditions.

Transport problems could be solved by using air freight from Port Sudan albeit at higher costs.

Cost data from manufacturers are factory or Port Sudan prices. Experience in the Sudan is limited, therefore, cost data on transportation and erection is limited. However, they have been known to double preliminary quotations for a prefab house. A fully developed tender is the only reliable method to arrive at true costs.

Research and investigation into such systems should continue through the design phase. A parallel tender inviting proposals from system manufacturers based upon well-developed design and performance criteria suggests itself as the only way to arrive at truly comparative costs.

c. Local Materials:

The demand for cement is considerably larger than the current rate of production in the government-adminstered Atbara and Kosti plants. The cement allocation is organized by means of a quota system for government districts, high priority central government projects, and for the private sector at a base price of approximately LS 65/ton. Because of insufficient supply, projects have to be delayed, waiting lists get longer, and no dependable time schedules for current and future allocation can be established. The resulting free market is flourishing and can supply any quantities ranging from LS 160/ton in Khartoum to LS 240/ton in Nyala.

Cement Cost Index

	El Obeid	El Fasher	Ghazala G.
Official	LS 80-110	LS 95-140	LS 100-140
Free Market	LS 160-180	LS 200-240	LS 220-240

The most critical materials involve cement and bricks. The difference in cost between local manufactured cement at offical rates and local free market or imported cement is substantial enough to explore any means of obtaining government allocated supplies to be purchased prior and during the construction tender. Negotiations, as to the quantities obtainable at offical prices, should start during the design phase as soon as appropriate quantities can be established.

Bricks of reasonable quality and quantity are available near all three locations. While all brick works have a waiting list of projects to be supplied, assurances were given that material can be obtained in sufficient quantities if ordered ahead of the construction schedule.

3. MATERIAL SUPPLY TENDER:

A separate tender has been studied for the supply of all critical and imported materials delivered to each site prior to the construction tender. This concept has been used in the Sudan and elsewhere.

a. Advantages:

Assures adequate supply of all essential construction materials on site at the start of construction.

It thereby allows a shorter overall project schedule.

It reduces uncertainties and transport problems for the general contractor.

Assured material supply, shorter schedule and reduced uncertainties and problems should yield lower construction costs.

Prepurchase limited to sufficient cement and reinforcing steel to allow an early start on construction of foundations during the rainy season could save several months (and resulting costs) on the project construction schedule.

b. Disadvantages:

Prior experience by the Ministry of Construction and Public Works with this or similar concepts indicates that the ARC would require a substantial staff of very skilled and experienced people to become its own purchasing agent. Only a single source-to-site contract should be considered.

Even a single source-to-site contract will require additional administration and coordination by the ARC.

Pre-purchase of materials poses problems of over supply if high construction tenders force changes in project scope.

Large international general contractors are opposed to a separate supply tender. Their major profit source is mark-up on materials. They probably would not tender for local materials and labor only.

If they did tender for local materials and labor only, they would almost certainly apply an additional profit mark-up to the labor which could duplicate material profit mark-ups.

Split responsibilities between supply and construction contractors could make assignment of responsibility difficult in the event of delays, problems, etc.

c. Conclusion:

It is recommended that pre-purchase of materials be limited to cement and concrete reinforcing steel. Government officials have indicated that 40% to 50% of the required cement may be available from government plants at official prices. As much as half of this amount could be available initially and the balance delivered as monthly allocations during the course of the project.

This cement, plus sufficient reinforcing steel delivered to the sites prior to mid-May, 1981, would allow an early start on construction of building foundations during the 1981 rainy season.

Risk is minimal since these materials could be easily assigned or sold to other projects if necessary.

The resulting time savings (up to six months) could save as much as 15 to 20% in escalating construction costs.

4. TRANSPORTATION CONSIDERATIONS:

a. Railroad:

El Obeid and Ghazala Gawazet (via Nyala or Ed Da'ein) have direct access to the railroad. All land transportation to El Fasher is by truck. The railroad system is overloaded. Requests for rail car allocation even six months in advance do not guarantee available space.

Although railroad transportation costs are attractive (Port Sudan - El Obeid, LS 31/ton), contractors prefer to use trucks in order to control the time element; thereby tripling the transportation cost (Port Sudan - El Obeid LS 90/ton). All possible avenues of obtaining timely rail transport should be explored.

b. Trucks:

Trucking is by far the more reliable means of material transport but at three or four times cost. Transportation costs for trucks are also increasing with the rising cost of fuel, frequent fuel shortages, and the difficulties in obtaining spare parts. However, these rising costs could be offset in the next 2 to 3 years by a substantial increase in competition.

Roads between Khartoum/Kosti and the three project locations are unimproved and become extremely difficult during the rainy season. This seriously impacts construction scheduling.

c. Truck/Rail:

A combination of truck and rail could be successful as follows:

- trucks from Port Sudan to Khartoum, Kosti, or the rail head at El Rahad. The roads are comparatively good and rail service is overloaded.

- rail from Khartoum or Kosti to the west where roads are poor (impassable during rainy season) and railroad cars are more readily available.

d. Transportation Cost Index:

Transportation From Port Sudan Per Ton	To El Obeid	To El Fasher	To Ghazala G.
Rail: Cement	LS 31,000	-	LS 57,000
Truck	LS 90,000	LS 200,000	LS 180,000

e. Availability:

Available transportation means for material supply to the sites will be critical to the time schedule of the project. Negotiations with transportation carriers should be started as early as possible so transportation options can be included in tender. Even a tightly organized transport network will need government support in case of fuel shortages or with vehicle and spare parts import licenses.

One contractor interviewed suggests having trucks, drivers, and fuel supplied by project and leased to contractor during construction to reduce uncertainties of transport. Project to retain or dispose of trucks upon completion. The suggestion has merit and should be considered.

f. Truck Capacities:

Trucks in most common use are standard Fiat of 10 to 12 ton capacity plus a 15 ton trailer. Trailers cannot be used beyond Khartoum because of road conditions and some shippers charge for trailers whether used or not. Trucks are either owned by shippers or hired from independent truckers or contractors. Larger capacity (French or German) trucks are occasionally available. Very large capacity trucks - 80 tons Port Sudan to Khartoum, 40 tons beyond - may soon be operating.

g. Packaging and Handling:

Standard cargo containers require 5.5m x 2.5m truck bed with maximum load of 9.5 tons including weight of container. Conventional highway packing in containers is not adequate for road conditions in Sudan. Packing for vertical as well as horizontal movement is required as well as special attachment of container to truck.

The consensus of shippers and contractors is that cement is best shipped in bags, palletized and strapped. Extra bags should be included for re-packing damaged bags. Drums, as used by WSDC, require special handling and are easily damaged.

h. Air Transport:

Air transportation could be advantageous for prefab components or other manufactured building products susceptible to freight damage. Preliminary investigation suggests that costs would be considerably higher more than perhaps could be offset by potential savings. This should be investigated further.

i. Conclusions:

Truck transport is the most dependable and the most expensive. Rail transport or a combination of rail/truck could realize considerable savings to the project.

5. INFLATION:

As a major contributor to the rapid increase in construction cost, inflation indexes information for the construction industry are difficult to obtain. The index of around 25% per year quoted by Government sources in Khartoum does not match with data given by representatives of private and local government sources in El Obeid, El Fasher, and Nyala. The following schedule represents an analysis of inflation indexes related to specific components of construction cost from information obtained by government and independent contractor sources.

Inflation Index Analysis

Construction Cost Component	% of Total Const. Cost	Inflation Index 1 Year	Index Related To % of Total Cost
Labor	6%	32%	1.9%
Overhead	10%	30%	3.0%
Imported Materials	30%	31%	9.3%
Customs Duties	15%	31%	4.7%
Local Materials	9%	40%	3.6%
Transportation	10%	50%	5.0%
Materials Mark-Up	10%	35%	3.5%
Profit	10%	30%	3.0%
Inflation Index			34.0%

For budgeting purposes the construction inflation index of 34% for 1980 has been applied reflecting a monthly increase in construction cost of 2.8%. The resulting index increase for the time difference between the Kadugli tender in January, 1980, and the tender of this project in March, 1981, would be 13 months times 2.8% = 42%.

6. CONTRACTOR CAPACITY:

The three projects differ considerably in scope, remoteness of location, access and local labor market. Construction contracting options are more flexible in El Obeid as compared with El Fasher and Ghazala Gawazet.

Local contractors in Khartoum, El Obeid, and Nyala have different opinions on the subject of a package tender for all three projects, as compared with options for individual project tenders. The large international or Sudanese contractors in Khartoum are very interested in the El Obeid project where problems of logistics are more manageable and where the scope of construction justifies utilization of more sophisticated construction equipment.

a. El Obeid:

The project will be of interest to international contractors operating in the Sudan, to the larger Sudanese contractor with home base in Khartoum and to the local contractor in El Obeid with approximately three qualified firms. There are also a number of qualified sub-contractors in El Obeid.

It is by the means of equipment, skilled manpower resources, and volume that contemporary modular construction systems could prove very economical. Khartoum contractors are familiar with systems construction and understand the inherent economic advantages. These contractors are not interested in the El Fasher and Ghazala Gawazet projects and would prefer to be able to tender for a single project. In a tender package situation, they may either refrain from bidding or add a substantial cost penalty to their offer.

b. El Fasher:

There are two independent local contractors operating in El Fasher with construction capacity for limited projects. The most viable contracting capacity is the building unit of the Ministry of Construction and Public Works, which is currently executing the convention hall of the Socialist Union and a girls' secondary school.

With few local contractors available, the El Fasher project could be performed either by international or Khartoum-based Sudanese contractors and outside local contractors from El Obeid or Nyala who are familiar with, and have the capability to construct in traditional methods, or by the construction unit of the Ministry of Public Works in El Fasher. Any more contemporary construction approach as a modular concrete ceiling system prefabricated on site would not be feasible and would be more expensive.

c. Ghazala Gawazet (Nyala):

A number of small contractors with limited construction capacities in skilled manpower and equipment operate in Nyala and Ed Da'ein. The most qualified contracting entity is the building unit of the Ministry of Construction and Public Works in Nyala which is currently involved in school projects of the IDA Educational Program in the Sudan.

The situation is similar to El Fasher: small independent contracting firms do exist in the area, however, the quality of construction is marginal. The building unit of the Ministry of Construction and Public Works has the best construction capacity in the area, and would be interested in the project.

7. CONTRACTING ALTERNATIVES:

Several alternative forms of construction contracts have been investigated with contractors, agents, and government officials.

a. Conventional open tender for supply/build. Preferred by contractors and procedure required by sponsor.

b. Separate tenders for supply and for construction. Favorable interest expressed by purchasing agents/forwarders with no construction involvement. Suggested splitting supply and transport into separate contracts.

c. Negotiated fee, construction management with open tender for supply and all major subcontracts. Though widely used in U.S. there has been no apparent experience with this system in Sudan. Response unfavorable. Potential difficulties with sponsor regulations.

d. Conventional supply/build with open tender for World Bank portion, U. S. tender for USAID portion.

More cumbersome for contractor, consultants, and ARC. Viable only as a last resort to comply with sponsor regulations.

It is recommended that a conventional open tender be used with possible pre-purchase limited to cement and steel, as previously discussed. Split tender only if absolutely essential for compliance to sponsor regulations.

8. CONTRACTOR PAYMENT SCHEDULES:

Independent contractors and construction units of the Ministry of Construction and Public Works performing on government projects frequently fall behind schedule because of long delays in payments due by the government. Under these circumstances, contractors include special interest allowances in their tender prices. This affects purchases of materials from abroad and from local sources. Financial strength of the contractor is critical for this reason and for his capacity to sustain his labor force during extended payment delays, rather than interrupting work, as is common practice.

The difficulty of obtaining payments for local or foreign currency expenditures within agreed time limits is caused by the irregular cash flow in the Bank of Sudan and the resulting need to improvise on payment schedules. Since the foreign currency component of construction funds for this project is provided through the World Bank and USAID, the establishment of an independent project account presents no problem. Such an account, under direct project control with pre-deposited funds, should also be established for the local currency component, with an acknowledgement of this fact in the tender documents.

9. IMPORT PROCEDURES:

The project will need separate general import licenses for sea and air freight which should be obtained well in advance of any shipments. (1)

Port regulations require that containerized cargo and cement shipments be pre-cleared before ship docks and off-loaded direct to transport. General cargo is off-loaded to various areas of the dock and cannot be cleared until the shipment is re-assembled which can take anywhere from 2 weeks to 2 months. (3) All cargo except cement should therefore be containerized, if possible.

Final customs inspection and clearance can be arranged at destination so containers need be opened only once at point of use. (1)

The procedures for determining values of customs duties on imported materials, establishing customs credit in Port Sudan, and a project customs account with the Customs Department of the Ministry of Works are time consuming and require careful co-ordination. Project account should be independent of Bank of Sudan and agent should have funds and authorization for expeditious clearance of cargo.

Current charges quoted for general cargo (1) (cement pallets) are:

Clearing:	½% of value.
Handling:	6 Ls per freight ton or m^3 plus fee of 3.5 Ls per freight ton.
Transport:	Actual cost plus 10%.

Charges for containerized cargo were not quoted.

Current import duties quoted: (1)

Cement:	20%
Steel:	25%
Doors, windows, etc.:	70%

Conclusion:

Delays with import procedures result in project delays. The ARC must have all procedures worked out well in advance to assure a smooth flow of material through Port Sudan.

10. CONSTRUCTION COST INTERPRETATION:

In El Obeid, El Fasher, and Nyala, a major volume of construction of public projects is performed by the building units of the local branches of the Ministry of Construction and Public Works. Supported by their Civil Service engineering staff, these units operate their own construction equipment using direct labor for the execution of work. They have priority in the supply of building materials, especially of cement at official market rates out of the monthly district allocations. The quality of construction in El Fasher and Nyala is far superior to that of private contractors.

Because of the fact that engineering staff, drivers, and sometimes foremen are on government payroll and the equipment park is serviced by government maintenance, and has priority in fuel allocation, the general overhead and various labor expenses are considerably lower than those of private contractors. Salaries in the private sector have risen faster than in the Civil Service, and Ministry of Construction and Public Works building units operate out of government premises for offices, warehouses, and vehicle shelters.

These are the reasons for the difference in construction cost quotations by government and private sector contractor sources. Another reason for this difference, which is frequently more than 100%, is the fact that official quotations do not always reflect up-to-date information on inflation indexes.

As analyzed in other parts of this report, the general quality of construction for public buildings is suffering from restricted budgets, material shortages, and limited labor skills. The resulting buildings require substantial maintenance attention. These are the buildings referred to when cost information is provided. In all three locations, there is no precedent for recent structures of satisfactory design and execution to serve as facilities for the project stations. After discussing construction cost, based on an outline of proposed standards, with representatives of the Ministry of Construction & Public Works, and with private contractors in the three locations, it was concluded that the Kadugli project was the most current example of anticipated standards.

V. TIME & TASK SCHEDULE:

Coordination of tasks to be accomplished by Sudan central and local government agencies, WSARP, PSU, IDA, AID and the A/E firm will be of utmost importance to the implementation of the project within the desired budget and time frames.

The time and task schedule shown in this chapter attempts to outline the various simultaneous steps to be undertaken by the relevant parties involved. The formation of a management team comprised of representatives of the key agencies and the A/E firm should be considered.

This team would be in a position to initiate steps, seek consensus for decisions, alert to potential problems, delegate responsibilities and follow up on results.

In order to meet the proposed time schedule, several procedures should be coordinated simultaneously.

REVIEWS & APPROVALS:

Because of the relatively short time periods for completion of the A/E design and construction document phases, reviews and approvals by all government and sponsor agencies should be accomplished expeditiously. Scheduled meetings in Khartoum of all representatives involved would be required. This is especially urgent at the conclusion of the construction document phase when reviews, finalizing of drawings, specifications, and Bills of Quantities have to be achieved while advertising for tenders and prequalification of contractors are conducted.

A/E SERVICES & TENDER PHASE:

The timing for A/E services, construction tender and tender review has been arranged to leave 1.5 to 2 months mobilization and local materials purchase period prior to the beginning of the rainy season in 1981.

CONSTRUCTION TIME:

The estimated construction time assumes that the contractor will proceed with construction on all sites simultaneously.

TIME & TASK SCHEDULE

	JUNE 1980	JULY	AUGUST	SEPTEMBER	OCTOB
A.R.C. / W.S.A.R.P.	REQUEST SITE UTILITIES & FOLLOW UP			APPROVE DESIGN; ARRANGE FOR CUSTOMS DUTY; LIMITED SUPPLY TENDER	
P.S.U	ESTABLISH PROCEDURE FOR PROJECT ACCOUNT; ASSIST IN REQUEST FOR SITE UTILITIES			APPROVE DESIGN; ARRANGE FOR CUSTOMS DUTY	
AID	IDENTIFY CONSTRUCTION FUNDS			APPROVE DESIGN	
IDA	IDENTIFY CONSTRUCTION FUNDS			APPROVE DESIGN	
MINISTRY OF CONSTRUCTION & PUBLIC WORKS KHARTOUM				APPROVE DESIGN	
EL OBEID	ARRANGE & PROVIDE POWER & WATER TO SITE				
EL FASHER	ARRANGE & PROVIDE POWER & WATER TO SITE				
GHAZALA GAWAZET					
MINISTRY OF FINANCE				APPROVE DESIGN	
CID.					
A/E FIRM	DESIGN & DESIGN	DEVELOPMENT		APPROVAL PERIOD	
			CONSTRUCTION DOCUMENTS		

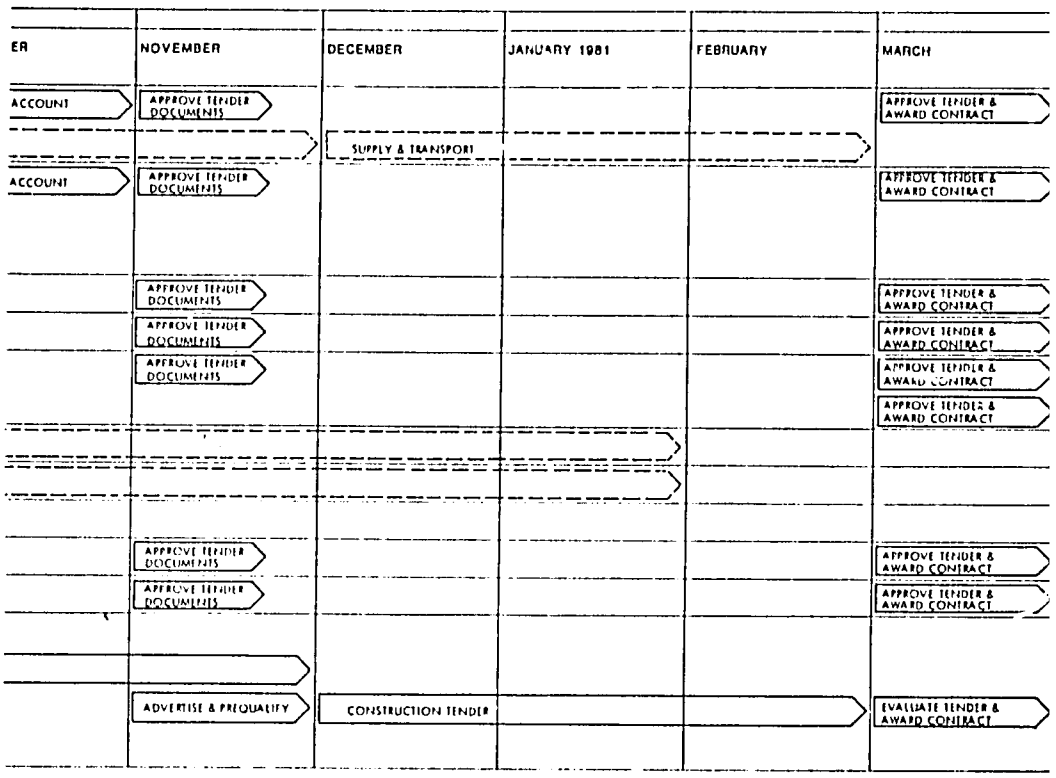
Criteria for Prequalif.

start Aug w/ prequal. criteria.

~~[illegible]~~

IMPLEMENTATION SCHEDULE

	APRIL 1981	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMB
				RAINY SEASON					
A.R.C / W.S.A.R.P.	REVIEW, APPROVE, PROCESS BILLINGS			MONTHLY BASIS LIAISON, ON GOING BASIS					
P.S.U.	LIAISON, CO ORDINATION ON GOING BASIS								
A.I.D.	PROVIDE FUNDING, REVIEW ACCOUNTING								
I.D.A	PROVIDE FUNDING, REVIEW ACCOUNTING								
MINISTRY OF CONSTRUCTION & PUBLIC WORKS	REVIEW, APPROVE, PROCESS BILLINGS			MONTHLY BASIS					
KHARTOUM	PROJECT ENGINEER ON SITE SUPERVISION, QUALITY CONTROL ON GOING BASIS CLERK OF WORKS VERIFY QUANTITIES, MAINTAIN RECORDS DAILY BASIS								
EL OBEID	PROJECT ENGINEER ON SITE SUPERVISION, QUALITY CONTROL ON GOING BASIS CLERK OF WORKS VERIFY QUANTITIES, MAINTAIN RECORDS DAILY BASIS								
GHAZALA GAWAZET	PROJECT ENGINEER ON SITE SUPERVISION, QUALITY CONTROL ON GOING BASIS CLERK OF WORKS VERIFY QUANTITIES, MAINTAIN RECORDS DAILY BASIS								
EL FASHER	PROJECT ENGINEER ON SITE SUPERVISION, QUALITY CONTROL ON GOING BASIS CLERK OF WORKS VERIFY QUANTITIES, MAINTAIN RECORDS DAILY BASIS								
MINISTRY OF FINANCE	REVIEW, PROCESS BILLINGS, DISBURSE FUNDS PROJECT ACCOUNTING MONTHLY BASIS								
BUILDING CONTRACTOR									
KHARTOUM	MOBILIZE	SITE UTILITIES FOUNDATIONS	FOUNDATION WALLS	WALLS & PARTITIONS		WALLS ROUGH PLBG	WALLS, ROOFS ROUGH PLBG & ELECT.		ROOFING WIND, DO
EL OBEID	MOBILIZE	TEMP. SITE UTILITIES FOUNDATIONS	FOUND. WALLS		FOUND WALLS	WALLS & PARTITIONS			ROOFS, F FLOOR S
GHAZALA GAWAZET	MOBILIZE	TEMP. SITE UTILITIES FOUNDATIONS		FOUNDATION WALLS WALLS & PARTITIONS			ROOFS ROUGH PLUMBING		WINDOWS ROUGH
EL FASHER	MOBILIZE	TEMP. SITE UTILITIES FOUNDATIONS		FOUNDATION WALLS WALLS & PARTITIONS			ROOFS ROUGH PLUMBING		WINDOWS ROUGH
A/E FIRM — A/E STAFF	PROJECT ADMINISTRATION, PERIODIC SITE VISITS								
PROJECT ARCHITECT	ON SITE OBSERVATION, QUALITY CONTROL ALL SITES ON GOING BASIS CO ORDINATE WITH AGENCIES, EXPEDITE ON-GOING BASIS REVIEW QUANTITIES & BILLINGS, CERTIFY; MONTHLY BASIS								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ACCOUNT
APPROVE TENDER DOCUMENTS
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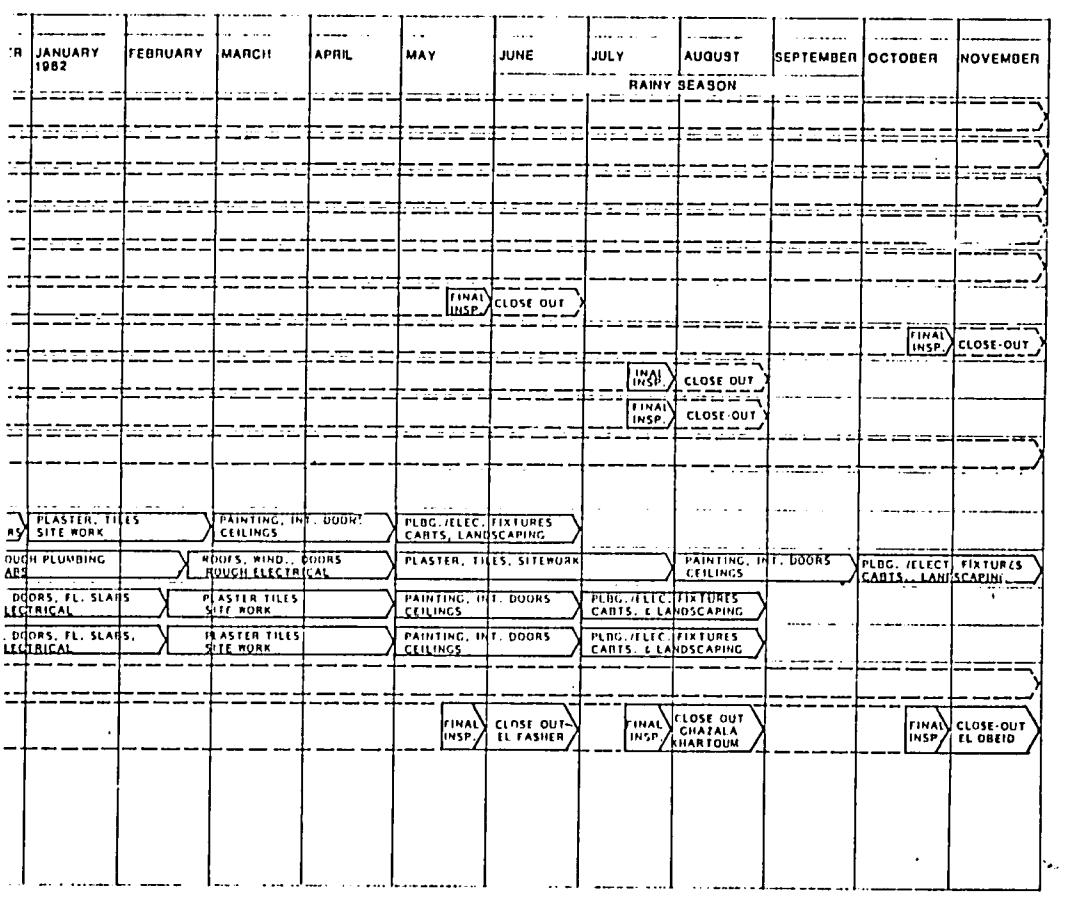
ADVERTISE & PREQUALIFY
CONSTRUCTION TENDER
EVALUATE TENDER & AWARD CONTRACT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RAINY SEASON
FINAL INSP.
CLOSE OUT
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CLOSE OUT
FINAL INSP.
CLOSE-OUT
PLASTER, TILES SITE WORK
PAINTING, INT. DOORS CEILINGS
PLBG./ELEC. FIXTURES CABTS, LANDSCAPING
ROUGH PLUMBING
DOORS, WIND., DOORS ROUGH ELECTRICAL
PLASTER, TILES, SITEWORK
PAINTING, INT. DOORS CEILINGS
PLBG./ELECT. FIXTURES CABTS., LANDSCAPING
DOORS, FL. SLABS ELECTRICAL
PLASTER TILES SITE WORK
PAINTING, INT. DOORS CEILINGS
PLBG./ELEC. FIXTURES CABTS. & LANDSCAPING
DOORS, FL. SLABS, ELECTRICAL
PLASTER TILES SITE WORK
PAINTING, INT. DOORS CEILINGS
PLBG./ELEC. FIXTURES CABTS. & LANDSCAPING
FINAL INSP.
CLOSE OUT-EL FASHER
FINAL INSP.
CLOSE OUT GHAZALA KHARTOUM
FINAL INSP.
CLOSE-OUT EL OBEID

VI. SITE DATA, CRITERIA AND DIAGRAMS

The three sites vary considerably in scope, size, relationships to existing communities' adjoining uses, available utilities, and possibly their soil conditions. However, it is recommended that certain general criteria be applied to the development of all sites, yet which are flexible enough to recognize the wide variation in sites.

1. GENERAL SITE PLANNING CRITERIA:

a. The developments should be compact and closely clustered to provide efficient utility systems, roads, landscaping, thereby minimizing construction and operating/maintenance costs.

b. Facilities on site should be located in relation to similar surrounding uses where possible, e.g., housing next to housing, farm buildings next to warehousing, etc.

c. Buffer space, with landscaping where appropriate, should be provided adjacent to surrounding uses, roads, and areas of unknown future uses to minimize noise, dust, or other conflicts. There should also be buffer space between the various functions or types of facilities on site.

d. General landscaping should be limited to rows or clusters of trees in order to minimize irrigation and maintenance. They should be used as buffers, shaded walkways, and for recreational functions. Special landscaping should be developed as water availability permits as part of the housing compounds, guest houses, and office areas.

e. Exterior walkways should be shaded by building overhangs or trees wherever possible.

f. All facilities should be oriented for optimum natural (north/south) ventilation.

g. Office/lab buildings should be located near the site entrance and close to the farm buildings for control and convenience.

h. Farm buildings should be located next to access to the agricultural areas to minimize vehicle traffic through the sites.

i. Junior housing should be farthest away from major activities and surrounding uses to minimize traffic through site and to allow space for temporary housing nearby.

j. Senior and middle housing should have comparable privacy, if possible, and be conveniently located to all other buildings.

k. Guest house/conference buildings and related recreational facilities should be close to the entrance to the project within convenient walking distance of the office/lab complex.

l. The sites should be organized to encourage a sense of community for each station.

2. EL OBEID: EXISTING CONDITIONS:

The site for the El Obeid Research Station is undeveloped, roughly triangular in shape with an area of approximately 700 Feddans. It was formerly designated as forest preserve. It is located on the north outskirts of the city, about 2 kilometers from the city center with easy access by dedicated unimproved roads. The site is within 2 kilometers of the El Obeid rail terminus and commercial air service is available.

The portion designated for building construction lies at the southeast corner of the site with its long dimension parallel to the base of the triangular site. The area available for construction is 870m x 285m. It is bounded on the south and east by unimproved streets, with provision at the west for a 30m right-of-way for future access. Immediately adjacent to the west is an area currently under development as warehousing and a site proposed for a bakery. To the south and east, current use is residential.

A proposed cattle market could occur at the southwest corner of the site along the western boundary, Bara Road. Such a development should be consistent with the purposes of the station. A portion of the station site would have to be set aside for this purpose.

a. Topography & Soils:

The building site slopes slightly to the west and north with only minor vegetation. Boundary and topographic surveys are in preparation by the Government of the Sudan. At one time, the entire site appears to have been fenced. Currently fencing is all but destroyed, and will have to be repaired/replaced.

Test pits have been dug to 2.0m depth for verification of soil profile and bearing capacity. Soil is sand to 1.5m depth overlying compact silt/sand with high percentage of silt. Recommended foundation depth 1.5m minimum or below root zone. Bearing value 1.5 tons per sq.ft. (7,328 kg/m^2).

A site survey is currently being prepared by the Government of Sudan for this property.

b. Access & Circulation:

Roads and streets adjacent the site are unimproved. No internal roads currently exist on the site and will be developed as required.

c. Domestic Water Supply:

Water sufficient for human consumption can be supplied from the municipal system according to local officials. Formal application is currently being made by the A.R.C. This should be confirmed. A municipal storage tank assures adequate pressures most of the time, and it is claimed that few serious outages occur. However, it is recommended by local officials that a tank sufficient for storage of one week's supply be erected at the station.

d. Agricultural Water Supply:

The municipal system cannot supply water in sufficient quantities for agricultural purposes or landscape irrigation.

e. Electrical Service:

Power can be supplied to the site from the municipal power plant which is within 1 kilometer of the building area. Service would be overhead to the site. Standby generating facilities are mandatory in view of frequent outages.

f. Sanitary:

Local practice for sewage disposal is to use individual septic tanks with soakaway wells. Wells are customarily 3m diameter and 5m deep filled with broken brick, with 2 wells being used alternately at approximately 5 year intervals.

Because of the population density proposed at the El Obeid station, and the rapid rate at which septic tank/wells use up space on the site, a lagoon system such as designed for the Kadugli station offers advantages over the local practice. This is being confirmed.

3. EL OBEID: PLANNING CONCEPT:

The area designated for building is more than adequate in size and allows an efficient, compact layout. The suggested plan provides a single east/west road through the site. It connects to a north/south entrance road at the west end of the site. Parking is indicated at strategic locations along the road and next to the office/labs.

The office/labs are located close to the site entrance and near the farm buildings along the entrance road for optimum control. The farm buildings are adjacent to the agricultural access road and nearby warehousing. This location would minimize through traffic. The guest houses and conference hall complex are located near the office/lab complex for accessibility.

Three distinct, compact clusters of housing are suggested along the center road. Senior houses are given priority for proximity to the office/lab complex. Junior houses are the most remote, since they will need adjacent space to accommodate temporary housing nearby.

a. Landscaping:

General landscaping is limited to rows of trees along the road for sheltered walkways and as buffers between functions and the surrounding areas. Special landscaping is suggested for the areas around the office/lab area, the residential compounds, and the guest house complex.

A large area, 185m x 285m, at the east end of the site is available for expansion and as a buffer. It could be developed as a football field for station residents and neighbors.

A major utility corridor is indicated parallel to the single east/west road through the site.

Municipal water should enter the site near the southwest corner. An elevated storage and pressure tank is proposed at the east end which is the higher part of the site. It is also close to the housing clusters which will use most water.

Water Requirements:	4,650 gallons per day ($20m^3$)
	180 gallons per minute peak flow
	39,600 gallons storage capacity ($150m^3$)

Proposed for the project is a 100m3 reservoir with a booster pump to a $50m^3$ raised storage tank, capable of providing a one-week's supply to the project.

c. Agricultural Water:

A dependable source of water for agricultural purposes is essential to the operation of the research program. Since this cannot be supplied by the municipal system, a separate source must be developed consisting of an 8" diameter cased borehole well and pump located about 2 km west of the station, a pipeline to storage tanks, a booster pump on the site, and an on-site distribution system to points of use on the station. Auxiliary distribution piping to supply limited landscape irrigation water will be served from the agricultural water system. Agricultural needs would have priority of use during periods of short supply. The well and on-site landscape irrigation piping costs will be borne by this project.

d. Sewer System:

A sewer system is proposed which would collect sewage and carry it to an anaerobic lagoon in the far southwest corner of the station. This is similar to the facility under construction at the Kadugli station.

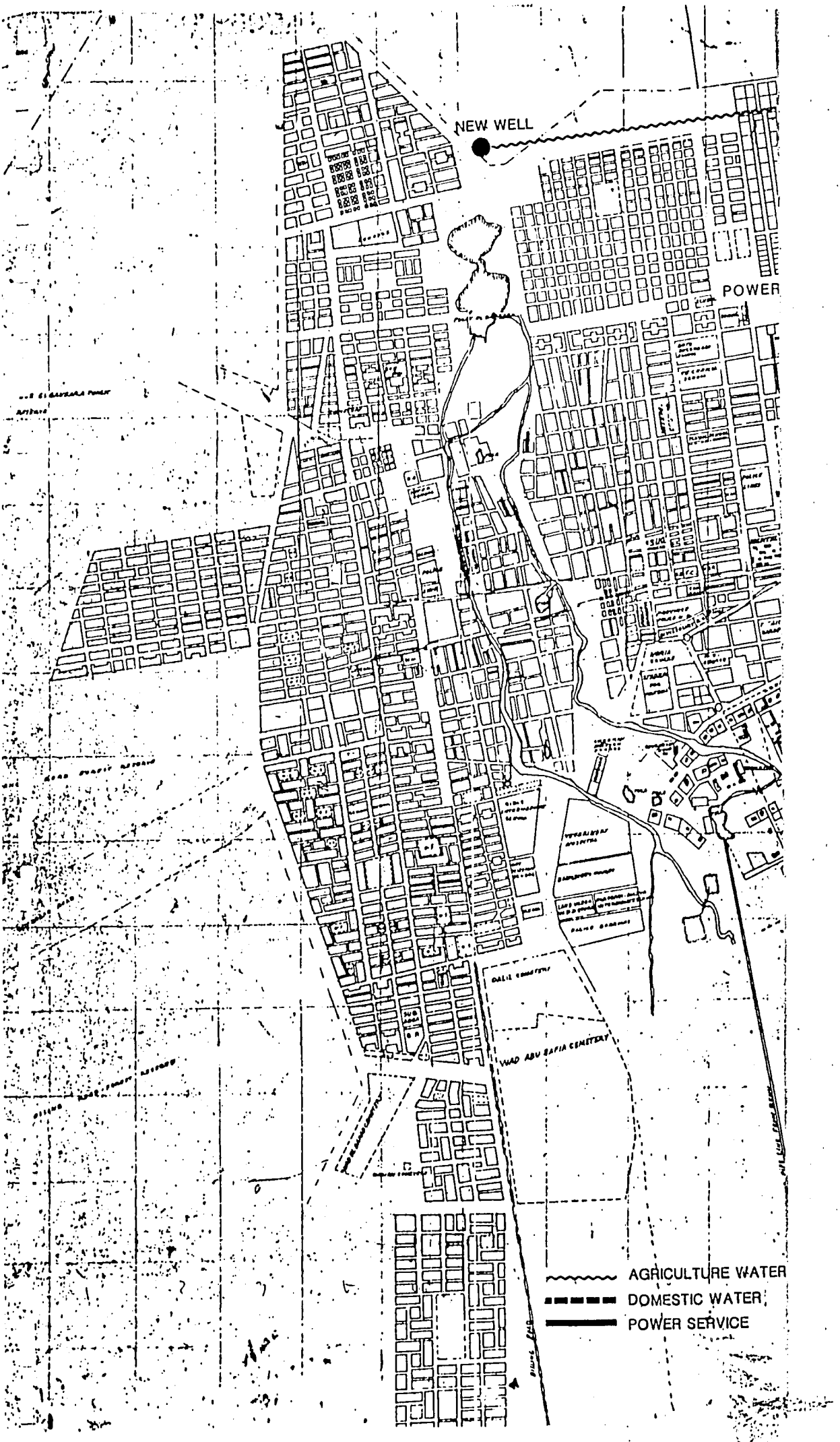
e. Power System:

Power should also enter the site at the southwest corner and be carried overhead along the road. The system would be interconnected with an on-site standby generator. It is recommended that electrical service be overhead within the housing clusters with individual metering provisions.

f. Townhouse Concept:

An alternative housing concept has been studied as it might apply to the El Obeid site. It would provide one and two-story townhouses with courtyards in addition to the conventional free-standing houses and compounds. Each townhouse would use approximately 40% less land area and thereby allow for more compact and efficient layout with resulting cost savings.

It is recommended that townhouses can provide an effective alternative to conventional housing concepts while retaining the more important residential values including privacy, security, natural ventilation, and required separations. This concept should be studied further.


NEW WELL
POWER
WAD ABU RAFIA CEMETERY
AGRICULTURE WATER
DOMESTIC WATER
POWER SERVICE

RESEARCH STATION
MARKET
BUILDING SITE
WAREHOUSING
BAKERY
OWER PLANT
WATER
ER
VICINITY MAP
EL OBEID
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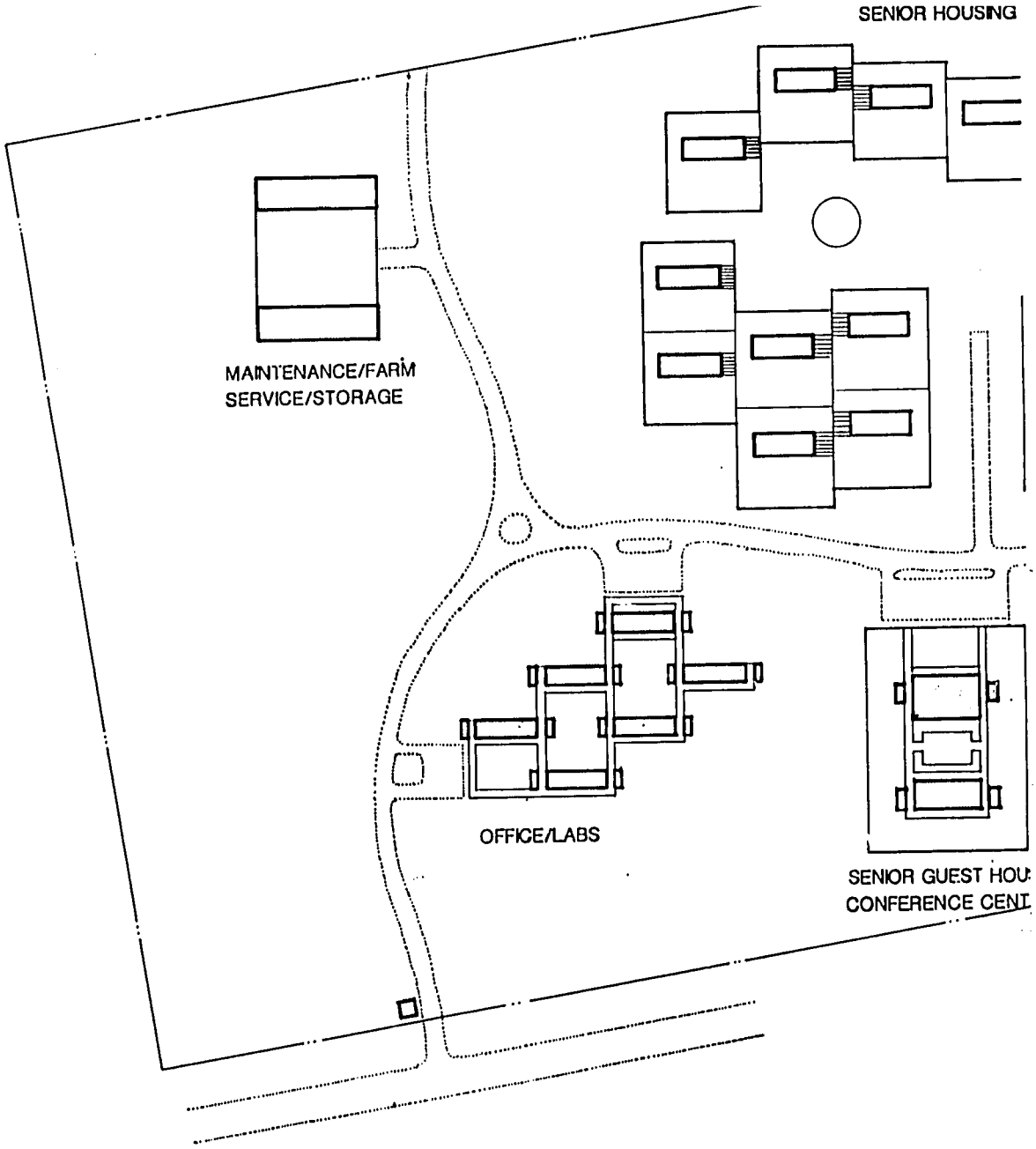
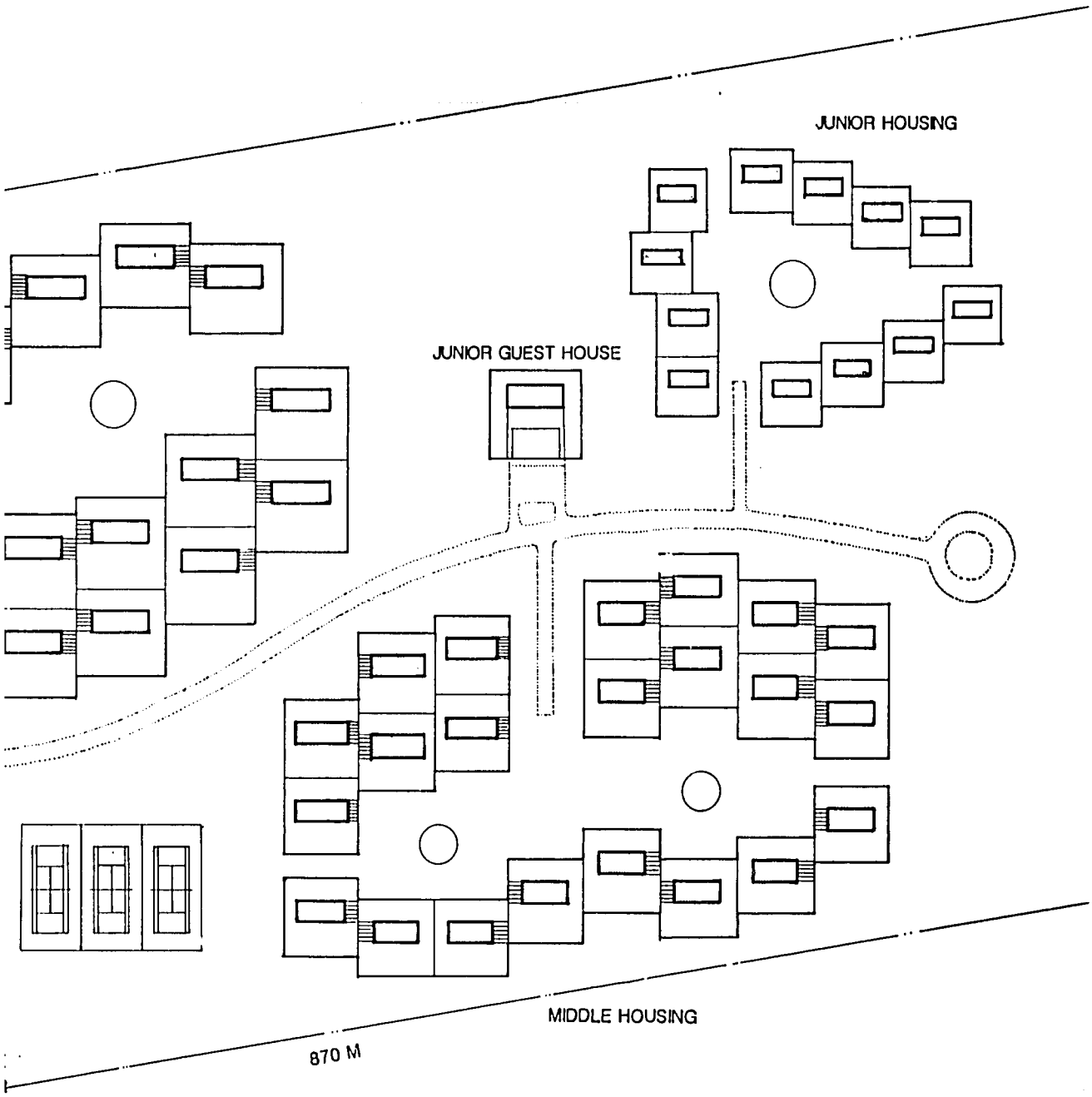
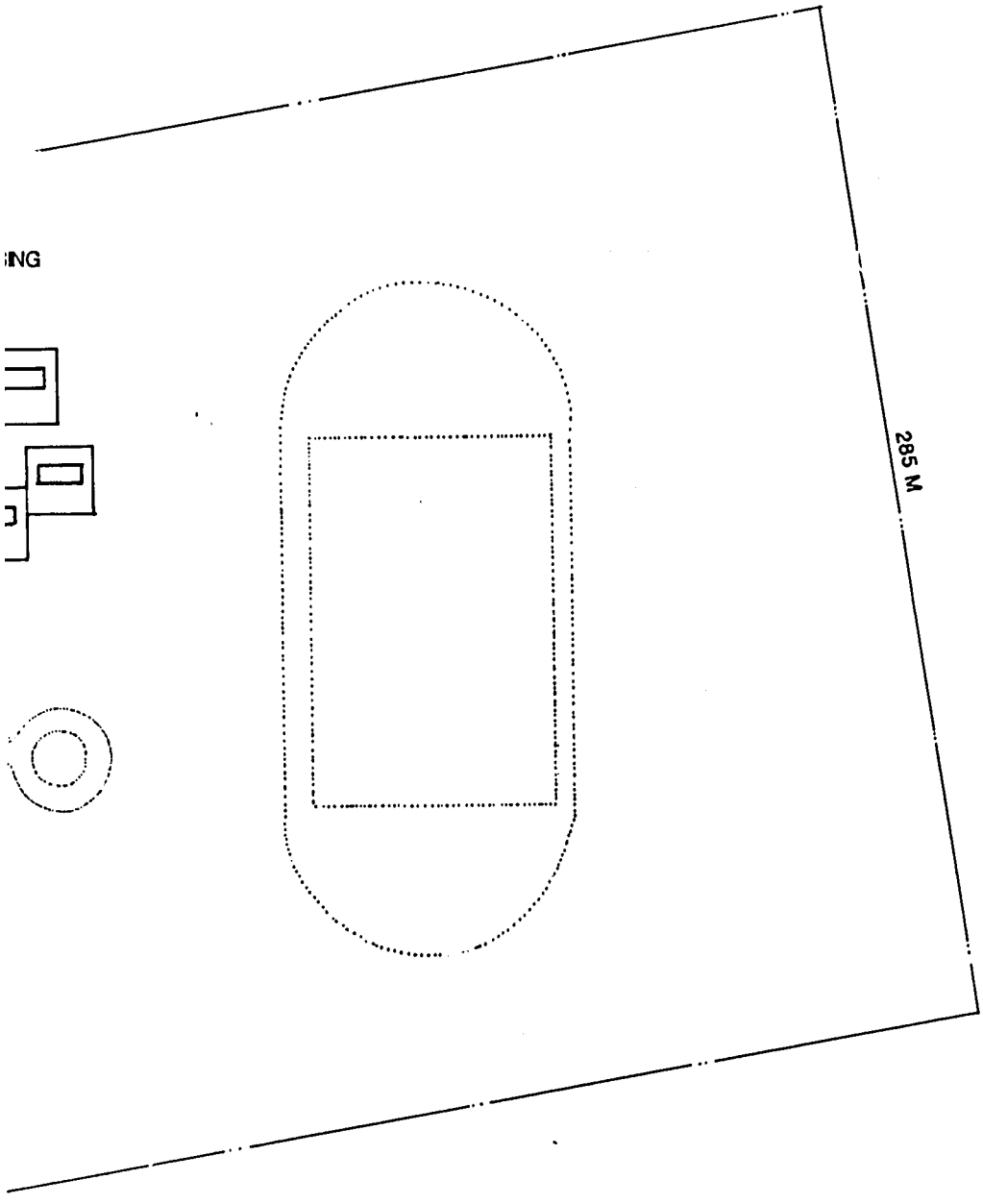
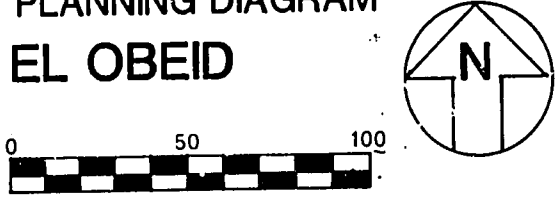

SENIOR HOUSING
MAINTENANCE/FARM
SERVICE/STORAGE
OFFICE/LABS
SENIOR GUEST HOU
CONFERENCE CENT

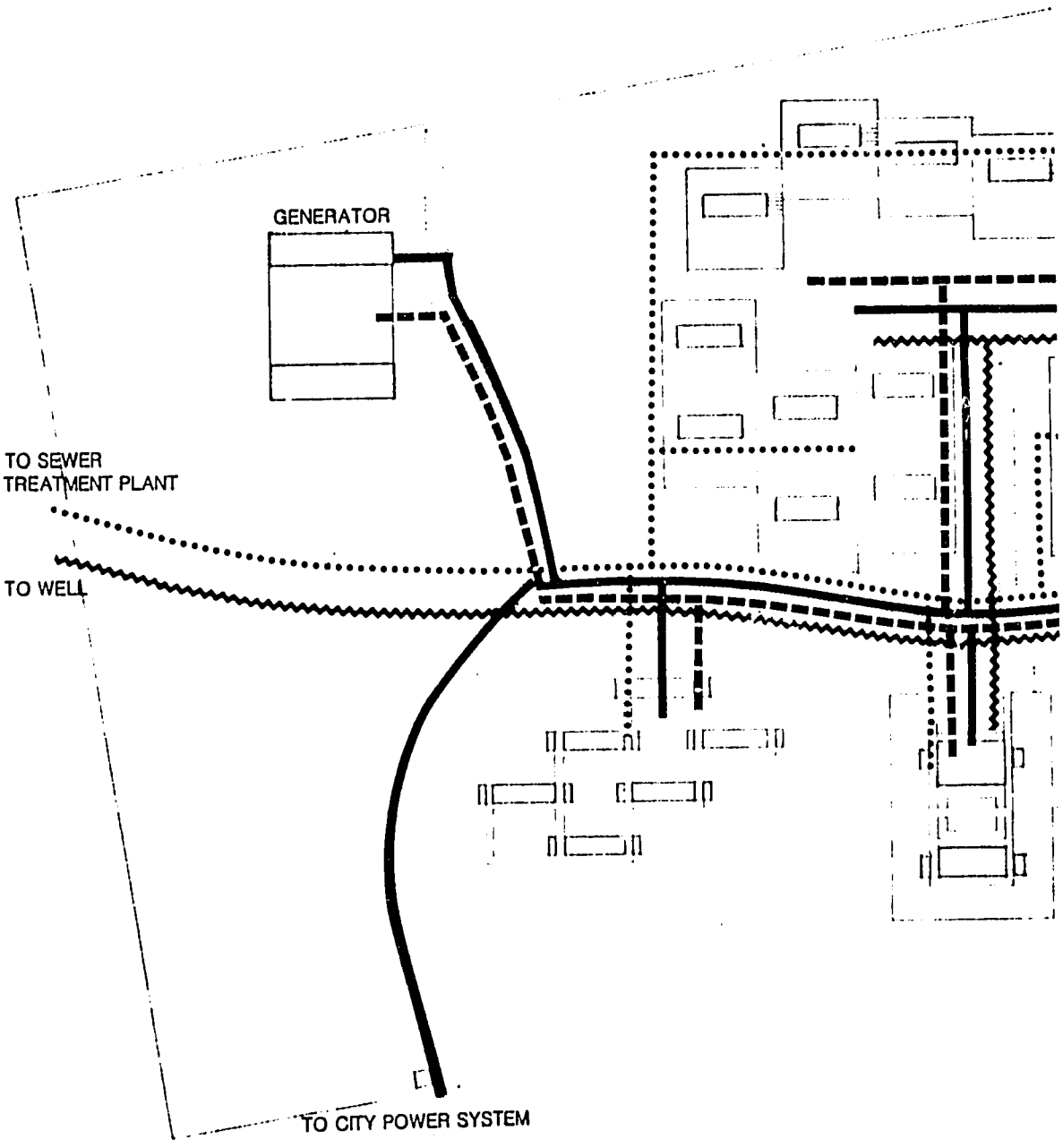

JUNIOR HOUSING
JUNIOR GUEST HOUSE
MIDDLE HOUSING
870 M

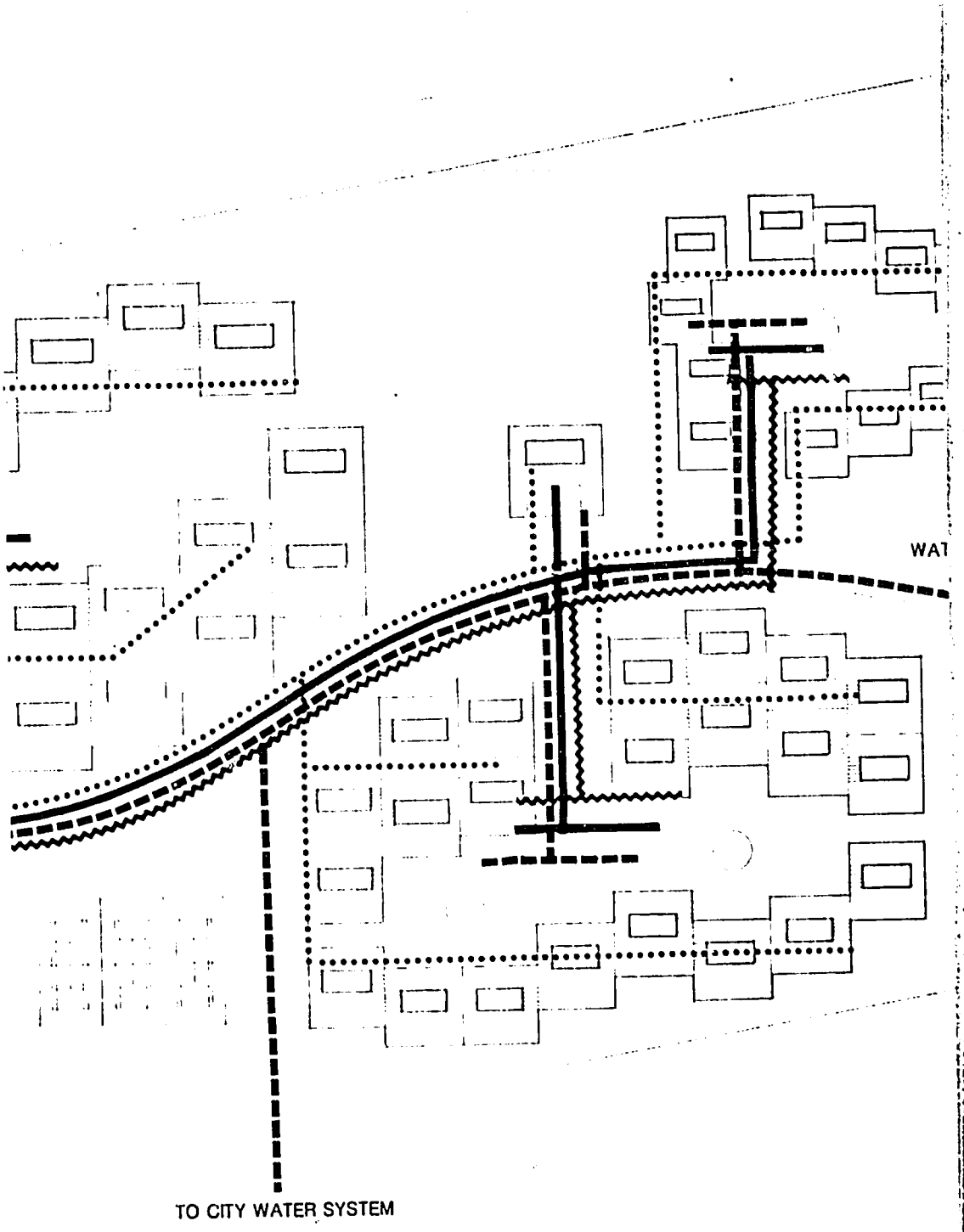


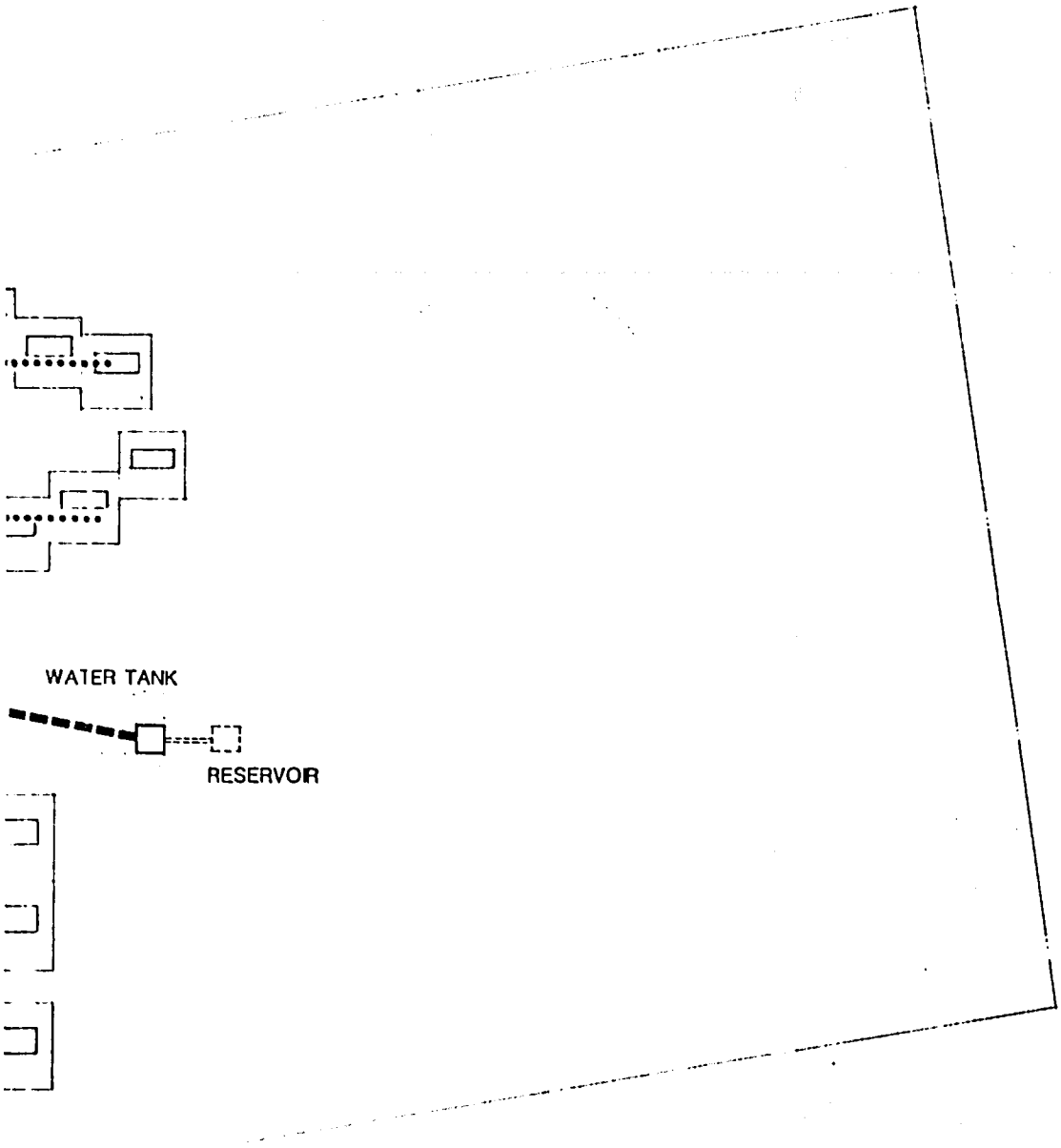
PLANNING DIAGRAM

EL OBEID



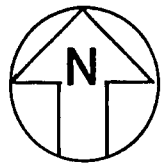

GENERATOR
TO SEWER
TREATMENT PLANT
TO WELL
TO CITY POWER SYSTEM

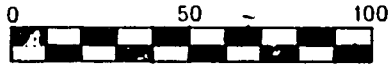

WAT
TO CITY WATER SYSTEM



DOMESTIC WATER
IRRIGATION WATER
SEWER SYSTEM
POWER LINES

UTILITIES DIAGRAM
EL OBEID





4. EL FASHER: EXISTING CONDITIONS:

The El Fasher station will be on an undeveloped site on the west outskirts of town immediately to the north of the Teacher Training College. It is accessible from the south by unimproved streets. Vegetation is very sparse with no trees. The building site is a square, 500m x 500m located at the southeast corner of the 1km x 2km station site. Boundary and topographic surveys have been furnished by the Government of Sudan. No buildings, services, fencing, or roads exist on the site.

a. Topography & Soils:

The land slopes uniformly to the south with a low sand ridge angling through the site in a north-south direction.

Test pit dug to 2m depth for verification of soil profile and bearing capacity. Soil is compact sand with small amount of silt. Recommended foundation depth 1.5m minimum or below root zone. Bearing value 1.5 tons per sq.ft. (7,328 kg/m^2).

A site survey has been prepared by the Government of Sudan of this property.

b. Access & Circulation:

Site will be served from the south by dedicated unimproved public streets. Internal roadways will have to be developed. El Fasher has commercial air service but no rail service.

c. Water Supply:

Domestic water will be supplied to the site from a 4" main, 500 meters away, by the municipal system. The local system, because of its limited capacity, is divided into three separate districts, which are supplied alternately every three days. Therefore, two days' supply must be stored on site. Because of such a limited supply, municipal water will be used only for domestic water. Agricultural water must come from a separate source.

d. Electrical Service:

Power can be supplied by the municipal system with overhead service from the south to the site connection point. It is reported that there are few outages. Standby generating capacity of 100 KVA is recommended locally.

e. Sanitary:

Local sewage disposal practice is to employ septic tanks and soakaway wells. The proposed station can most probably be well served in this manner due to its small size.

5. EL FASHER: PLANNING CONCEPT:

This site is much smaller than the El Obeid site, but more than adequate to accommodate the smaller program. The suggested plan is similar in concept to that suggested for El Obeid with a central east/west road connecting to a north/south entrance road. Office/labs are close to the entrance, as well as the farm buildings for optimum control and convenience. The farm buildings are in turn close to the agricultural area access. Small clusters of senior, middle, and junior housing are located along the north/south road. Near the office/lab complex are the guesthouses and conference hall complex. It is located convenient to both the entrance and the office/lab buildings.

a. Landscaping:

General landscaping is limited to rows of trees along the road for sheltered walkways and as buffers between functions and the surrounding areas. Special landscaping is suggested for the areas around the office/lab area, the residential compounds, and the guest house complex. Extension of the agricultural water system is proposed for limited landscape irrigation.

b. Domestic Water:

Water from the municipal system should enter the site near the southeast corner to be distributed parallel to the on-site road system. An elevated storage and pressure tank of 30 m^3 is proposed in the northeast corner which is the higher part of the site and close to the housing clusters which will use most water.

Water Requirements:	3,300 gallons per day ($15m^3$)
	140 gallons per minute peak flow
	6,600 gallons storage capacity ($30m^3$)

c. Agricultural Water:

A dependable source of agricultural water separate from the municipal system must be developed. Such a well need not be on the station site and geophysical investigation is recommended for determining best possible location. An 8" dia. cased bore hole and pump, pipeline to storage tanks and booster pump on site, and distribution piping to points of use on the station are required. Water table in area is approximately at 30m depth and saturated layer is relatively shallow. Estimated depth of well is 45 to 60m.

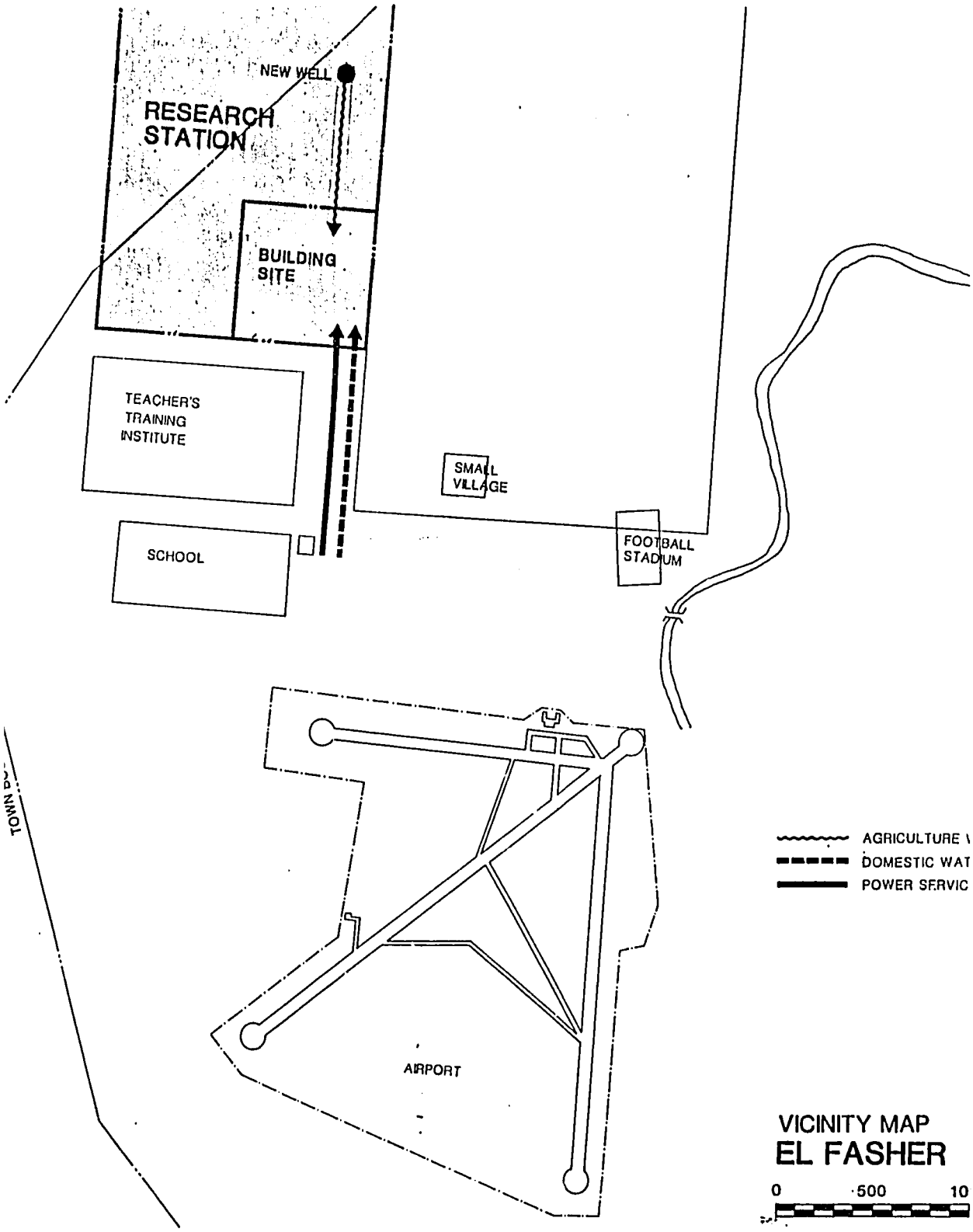
Auxiliary distribution piping to supply limited landscaping irrigation water will be served from agricultural water system with agricultural needs having priority. The well and on-site landscape irrigation piping costs will be borne by this project.

d. Sewage:

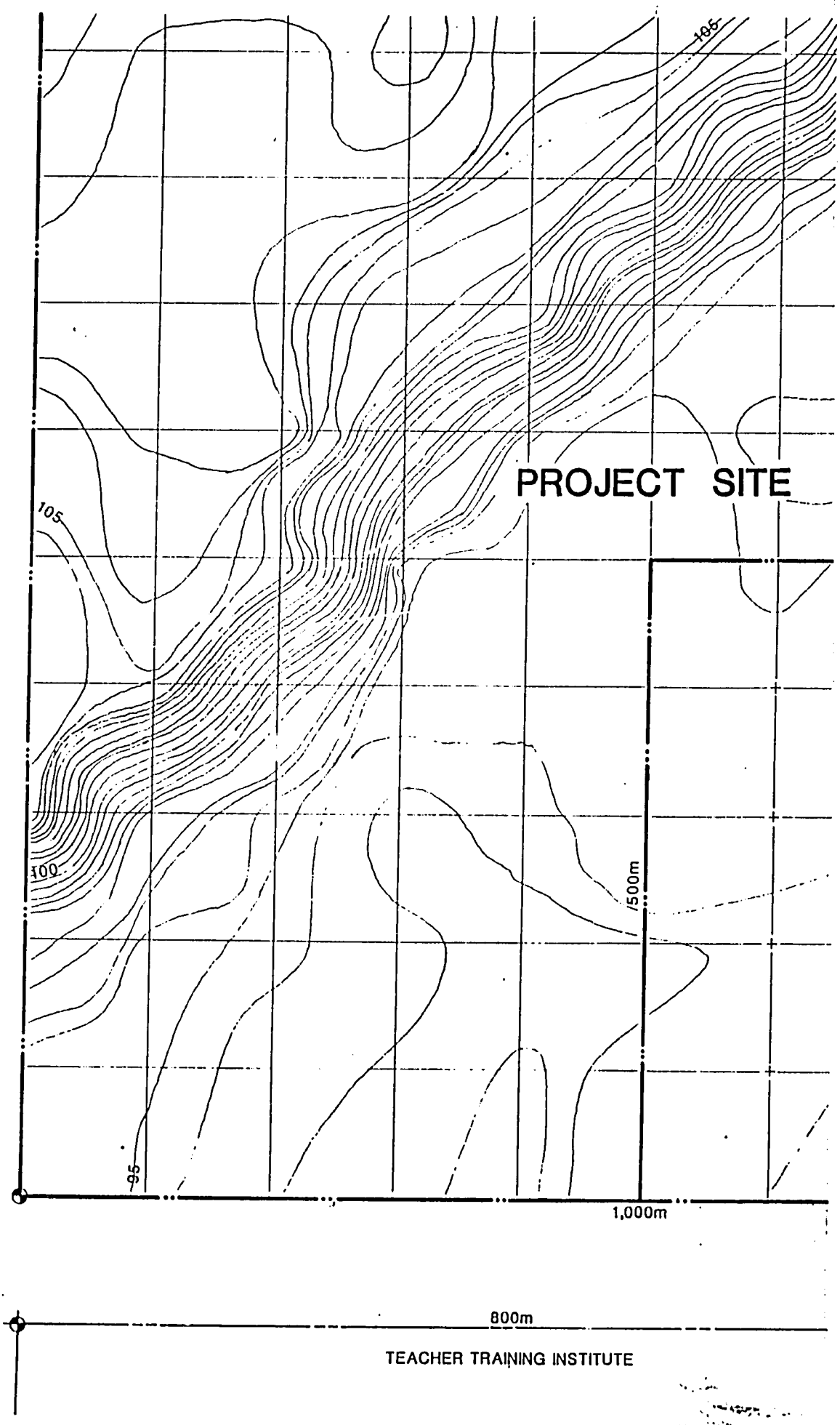
A system of septic tanks and soakaway wells, similar to local practice, is recommended for sewage disposal.

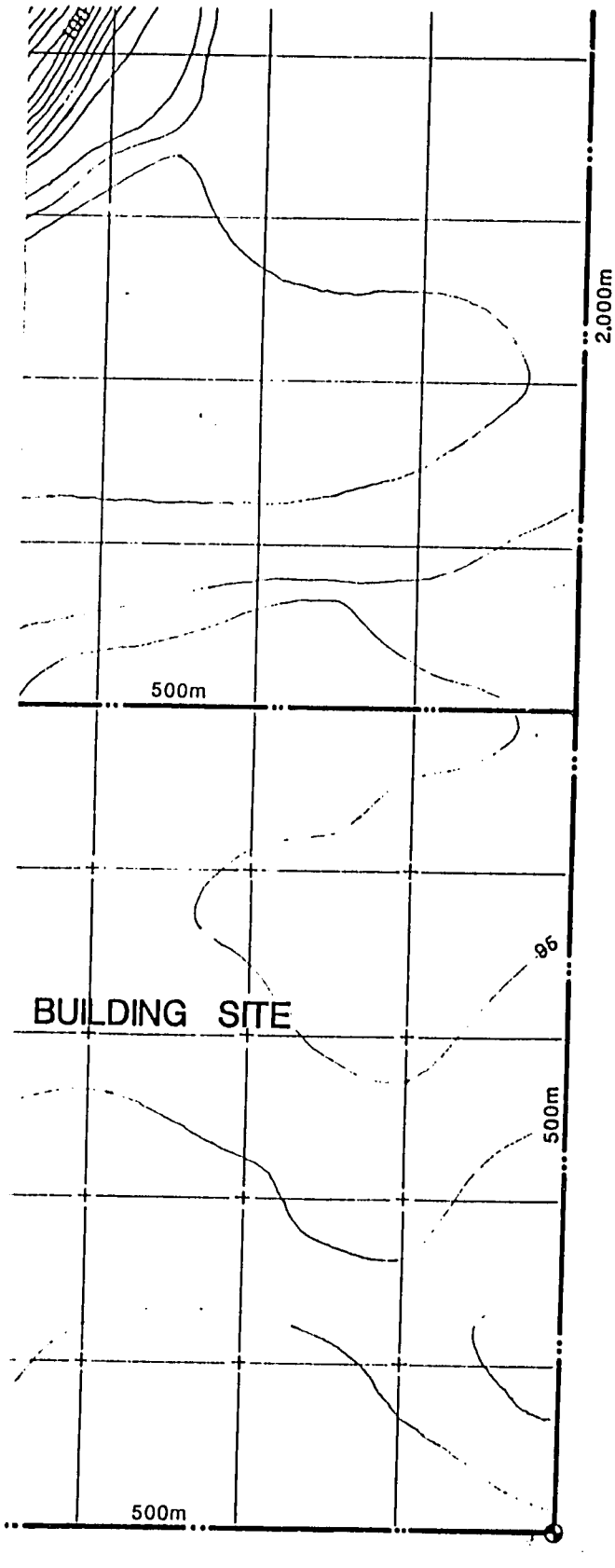
e. Electrical:

Power should also enter the site at the southeast corner and be carried overhead along the road. The system should be interconnected with an on-site standby generator. It is recommended that electrical service be overhead(to save costs) with individual metering provisions.



VICINITY MAP
EL FASHER


PROJECT SITE
105
100
95
1,500m
1,000m
800m
TEACHER TRAINING INSTITUTE



SITE SURVEY
EL FASHER

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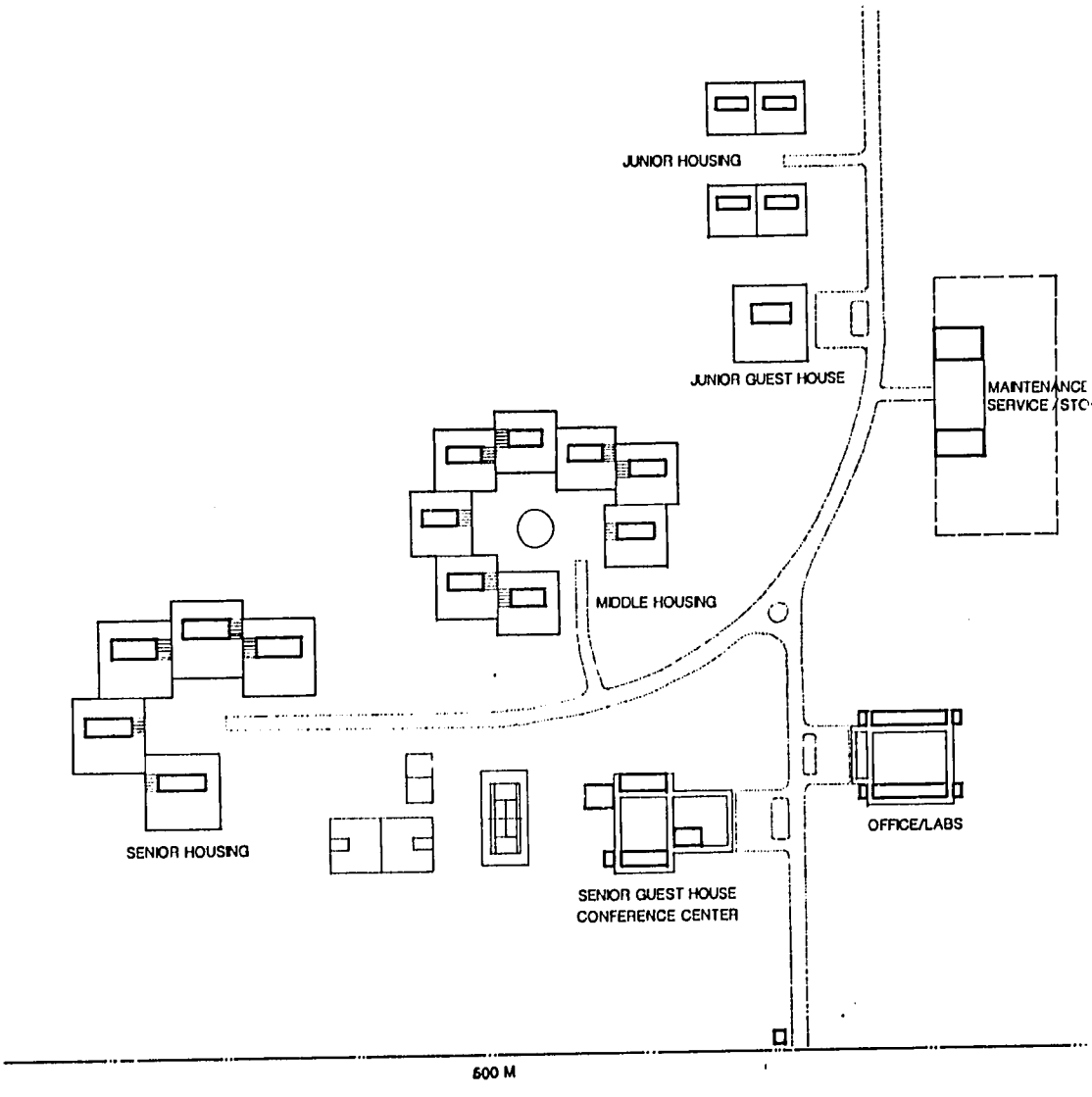
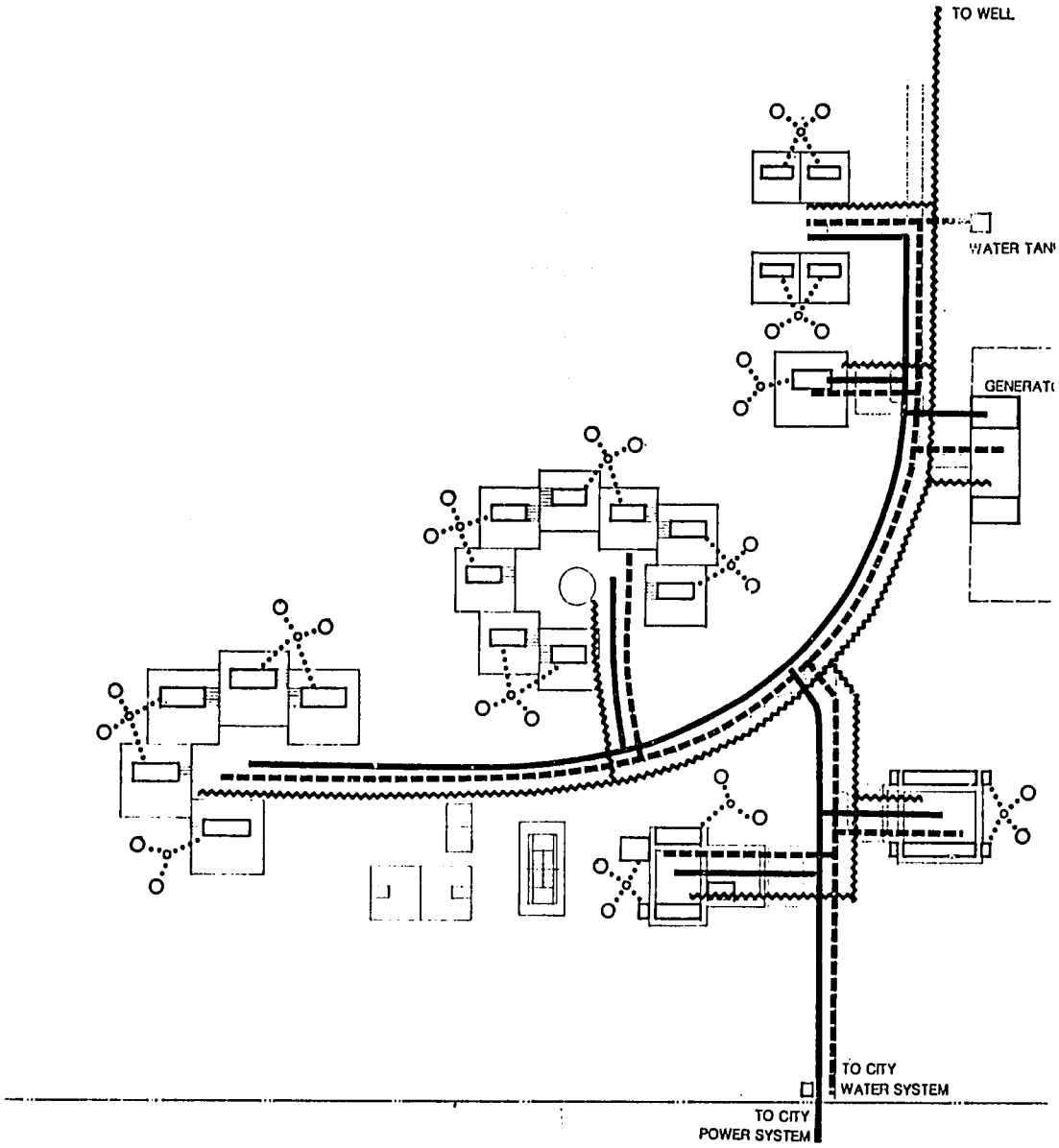
N

67A



PLANNING DIAGRAM
EL FASHER

68



DOMESTIC WATER
IRRIGATION WATER
SEPTIC TANK
POWER LINES

UTILITIES DIAGRAM
EL FASHER

0 50 100

6. GHAZALA GAWAZET: EXISTING CONDITIONS:

Ghazala Gawazet is an existing research station which will be expanded to accommodate the proposed augmented research program. The site is approximately 125 kilometers East and South of Nyala and about 30 kilometers West of Ed Da'ein. The railroad between these two points crosses the station a short distance south of the existing development at the site.

Though there is no sizeable community nearer than Ed Da'ein, there are numerous small settlements nearby, populous enough to support an elementary school of 300 students which is situated on the station to the south.

a. Topography & Soils:

The station is open-range land typical of the locale. Boundary and topographic surveys are in preparation by the Government of Sudan. The most logical area for expansion, that adjacent to the existing development, is essentially open and flat with a slight uniform slope to the south. There is sufficient space between existing elements to allow for the proposed expansion and any foreseeable future development. Such siting should result in a more compact development with consequent savings in the required site utility runs. A site survey is being prepared currently.

Test pits dug to 2m depth for verification of soil profile and bearing capacity. Soil is .15m loose sand overlying .60m compact red sand overlying compact coarse sand/silt. Recommended foundation depth 1.3m minimum or below root zone. Bearing value 1.5 tons per sq.ft. (7,328 kg/m2).

b. Access & Circulation:

Access to the Ghazala Gawazet station is by unimproved road from Nyala or Ed Da'ein with consequent periods of inaccessibility during the rainy season, and by railroad which crosses the station. The nearest airstrip is at Ed Da'ein and is reported useable by smaller aircraft depending on the season and the judgement of the pilot. No commercial air service is available. The possibility exists for development of an air strip at the station itself.

A meteorological station exists at the site with offices and a fenced area for instruments. For purposes of this report, this facility is not considered part of the research program.

There are no improved roads on the site, but a central roadway exists angling from the main gate through the station and defined by mature trees planted on both sides. Other plantings define potential circulation routes and offer a framework for site planning. Aside from a few random tree plantings, the building site otherwise has no vegetation. Fencing flanking the main gate of the station is in such disrepair as to be useless.

c. Existing Improvements:

Buildings at the station were built in 1957. Major buildings are of typical construction as follows:

70'

Foundations	Stone or brick, cement mortar.
Walls & Partitions	Local brick, mud mortar. Cement mortar pointing or plastering on exterior. Plaster interior.
Floors	Usually topping concrete over brick substrate.
Roofs	Corrugated sheet metal over wood structure.
Doors, Windows, Millwork	Wood, mostly unscreened and unglazed. Some screened verandas.
Ceilings	Mostly stretched cloth over wire grid. Some masonite on wood frame.
Electrical	Surface wiring, mostly fluorescent lighting.
Plumbing	Minimal piping for domestic water. Eastern toilets.

d. Water Supply:

The station supply for both domestic and agricultural water comes from wells. Exact locations and distance from the building site will be confirmed on the survey. No reliable data on the distribution network. Water is being transported in containers from one of the wells for domestic use. Local residents not connected with the station are also using this water source.

e. Electrical Service:

Electrical power at the station is supplied by two existing 80 KVA generators which appear to be in good condition. An older generator is not operable and has been abandoned.

f. Sanitary:

Sewage disposal at the existing station is by means of traditional Eastern toilets with buckets. For new construction, it appears that septic tanks and soakaway wells will be the most appropriate solution.

g. Condition of Buildings:

The existing buildings are in poor condition. The cost for total rehabilitation will almost equal the cost for new construction. It is, therefore, recommended that they be provided moderate rehabilitation and maintenance commensurate with their remaining useful life. A rehabilitation and maintenance program is recommended which will provide on-going preventative maintenance for all buildings and the gradual rehabilitation of existing buildings.

Funds from this current project should be used for new construction only.

Foundations: Approximately 80% of the structures have experienced foundation settlement at the corners due primarily to soil erosion near the buildings, subsequent water penetration beneath the shallow foundations, and resulting consolidation of foundation soils. There is evidence that this occurs frequently, perhaps annually.

Walls: Foundation settlements have caused extensive vertical and diagonal cracks. Apparent efforts to repair these cracks are frustrated by re-occurring foundation movement. Most such cracks penetrate through the walls. The base of most exterior walls are deteriorated due to erosion of mud mortar joints. Interior surfaces of plaster are damaged where cracks have occurred, but are otherwise in reasonable condition. Exterior gable end parapets have been cracked in varying degrees due to thermal expansion of roof sheets.

Floors: Approximately 50% of the floors have crack damage due to foundation and soil settlement and general wear. The remaining 50% have moderate cracks and wear.

Ceilings: Fabric ceilings are generally deteriorated. Some relatively new fabric ceilings have been damaged by roof leaks. New composition panel ceilings have been badly damaged in six months by termites.

Baths: Attached baths on the junior houses have settled and separated from the main structures due primarily to undermining of foundations from poor drainage of bath water. Similar problems exist for the middle and senior houses.

Roofs: The corrugated sheets are generally in satisfactory condition. However, all roofs leak due to loose fastenings, absence of rubber washers, and insufficient overlaps between sheets, particularly at the ridge caps. This leakage has damaged the wood structures, ceilings, and other interior surfaces.

Wood: All wood has received varying degrees of termite damage although some treated wood structural members have held up remarkably well considering their age (23 years) and extent of the termite problem. There is evidence of termite runs on the outside of cement mortar walls and internal to mud mortar walls. The latter makes correction very difficult. The most extensively damaged are those wood members near the ground or in direct contact with masonry walls such as posts, window and door frames, veranda frames and supports, and many roof structural members.

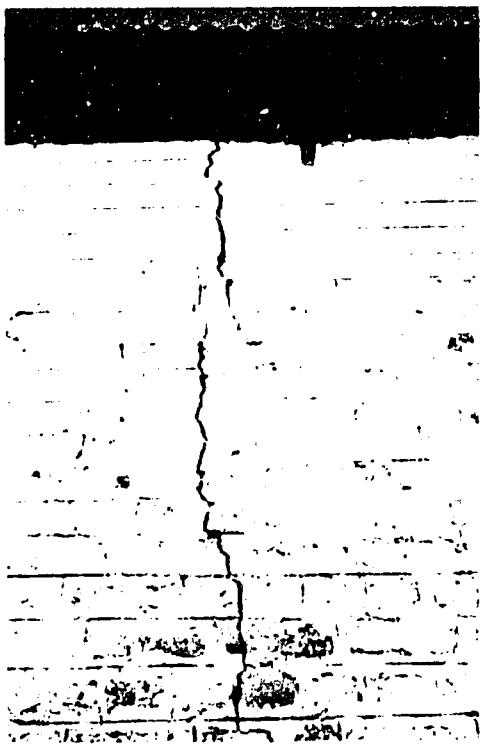
Minimal rehabilitation should consider the following fundamental corrections along with general repairs:

- regrading and concrete aprons around all buildings to protect foundations from further water penetration and settlement.
- cement mortar repair of walls.
- refastening of roof sheets with combination metal/rubber washers, and new ridge caps to eliminate leaks.
- selective replacement of termite-damaged wood members with new pressure-treated wood.
- settled and separated bath units should be removed and rebuilt with proper drainage to soakaway wells.

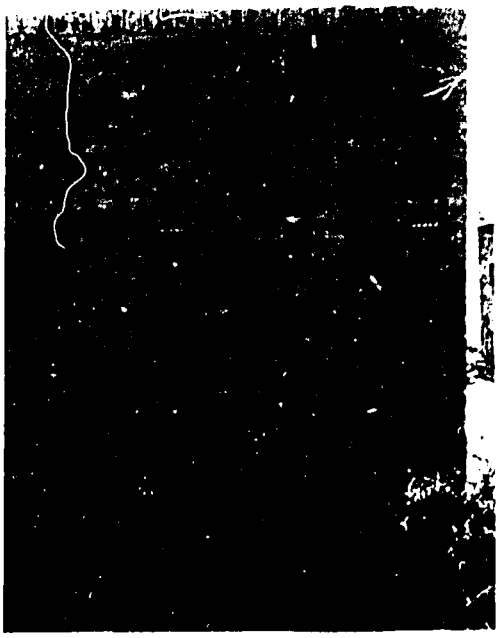
As part of a gradual rehabilitation and maintenance program, such improvements can be accomplished much more selectively and economically than as part of a new general construction contract.

Through-wall cracking at corner

Through-wall cracking at midwall



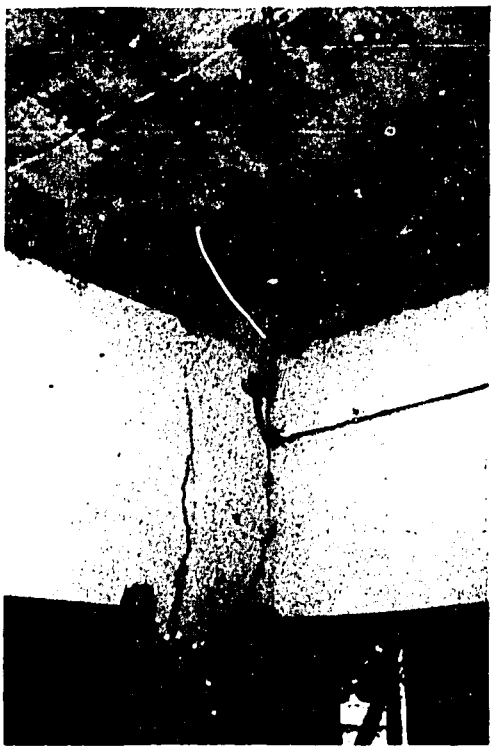
Through-wall cracking at midwall



Through-wall cracking at midwall

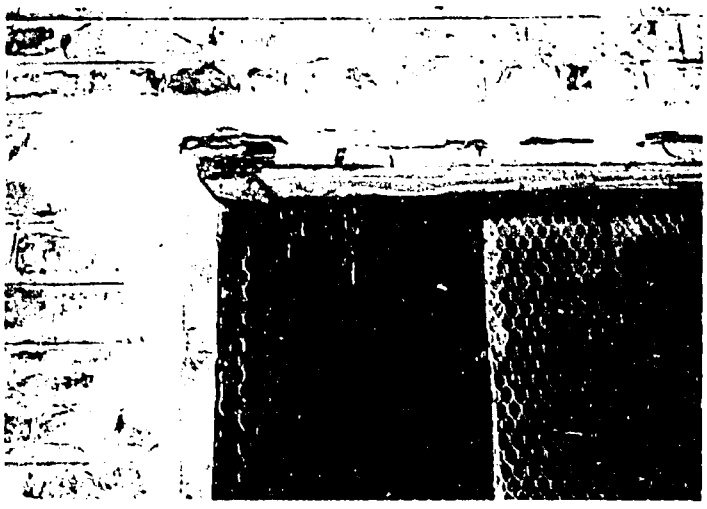
Masonry parapet separated by movement of metal roofing

Lower Roof Edge: Plaster seal broken by movement of metal roof

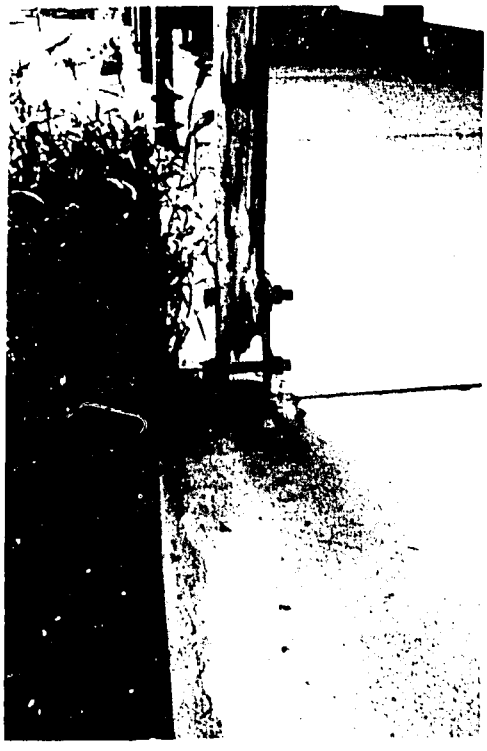


Cloth ceiling damaged by roof leakage/soiling

Grade washed away and subsequent foundation disintegration



Termite damage at wood window frame



Termite-damaged veranda support

Bath wing separation from settlement at house

7. GHAZALA GAWAZET: PLANNING CONCEPT

The suggested plan concept for this site derives primarily from the existing development and buildings which are to be reused as much as possible. The existing buildings are quite dispersed, making a compact layout very difficult. In spite of this, every effort should be made to achieve a more efficient and cost-effective site plan.

The central roadway should be improved as primary access. It can also serve as a utility corridor. An unimproved desert track serves the existing farm buildings. This should be maintained to minimize truck and equipment traffic through the site.

The existing office/lab complex is reasonably close to the existing stores complex. Since more storage is required for use within the building site and these structures are not suitable for office/lab functions, it is recommended that they be used for further storage. The new office/lab complex is proposed to the south of the existing complex.

The existing guest house, with regular maintenance, will be suitable for the junior guest house. A new senior guest house and conference center would be built nearby, creating a guest/recreation complex.

All housing will be suitable for re-use with routine maintenance. It is recommended that the existing one senior and two middle houses be built up with new middle houses to form a cluster. A new senior house cluster would be built to the south. The existing junior house cluster would be supplemented with new houses to create the required number.

The remainder of warehousing requirements would be accommodated in a new building, placed near the existing service buildings at the northwest corner of the site.

a. Landscaping:

General landscaping in the form of rows of trees along the central road and similar paths is substantially complete. It will require selected pruning or similar maintenance and additions to complete the patterns.

Special landscaping is suggested for the office/lab complex, the guest house conference hall area and as part of the housing compounds, water permitting.

b. Domestic Water Supply:

A new water distribution system is recommended parallel to the central road. It should be connected to one or more of the existing wells on site and supported by an elevated storage/pressure tank near the existing farm buildings.

Water Requirements:	1,650 gallons per day ($6m^3$)
	70 gallons per minute peak flow
	3,300 gallons storage capacity ($12m^3$)

c. Electrical Service:

The existing generators should not be supplemented with additional generators. The existing overhead distribution system will require upgrading for additional capacity.

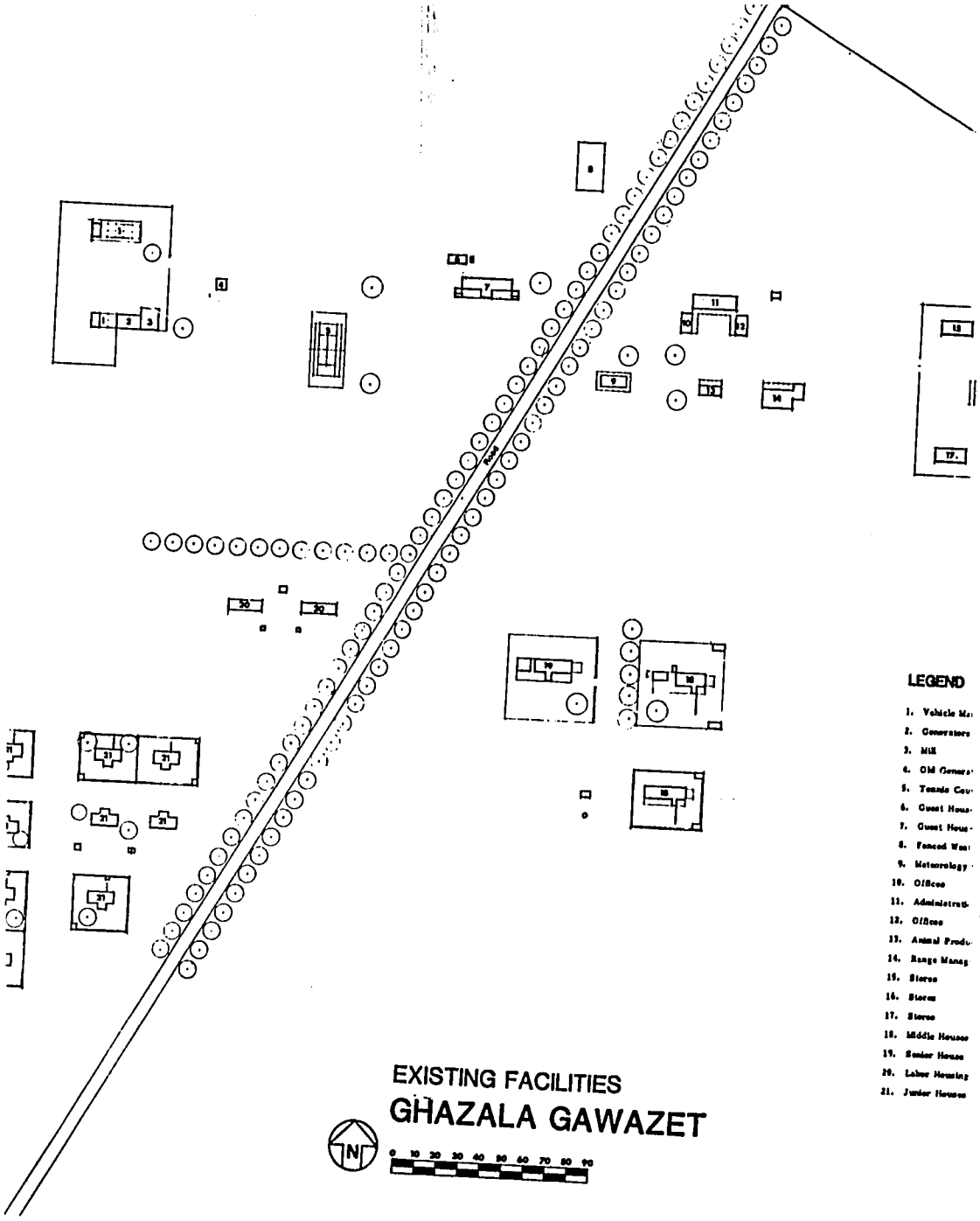
d. Sewage:

Septic tanks with soakaway wells are suggested as the most economically effective sewage disposal system, particularly with the generous amounts of land area between buildings at this site.

e. Rail Platform:

Construction of a rail siding and platform at the Ghazala Gawazet station is proposed as a logical step in assuring year-round supply capability. Because of the remoteness of the site, warehousing of needed supplies is also more critical than at the other stations.

77


LEGEND
1. Vehicle Ma
2. Generators
3. Mill
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5. Tennis Cou
6. Guest Hous
7. Guest Hous
8. Fenced Wat
9. Meteorology
10. Offices
11. Administrati
12. Offices
13. Animal Produ
14. Range Manag
15. Stores
16. Stores
17. Stores
18. Middle Houses
19. Senior House
20. Labor Housing
21. Junior Houses
EXISTING FACILITIES
GHAZALA GAWAZET
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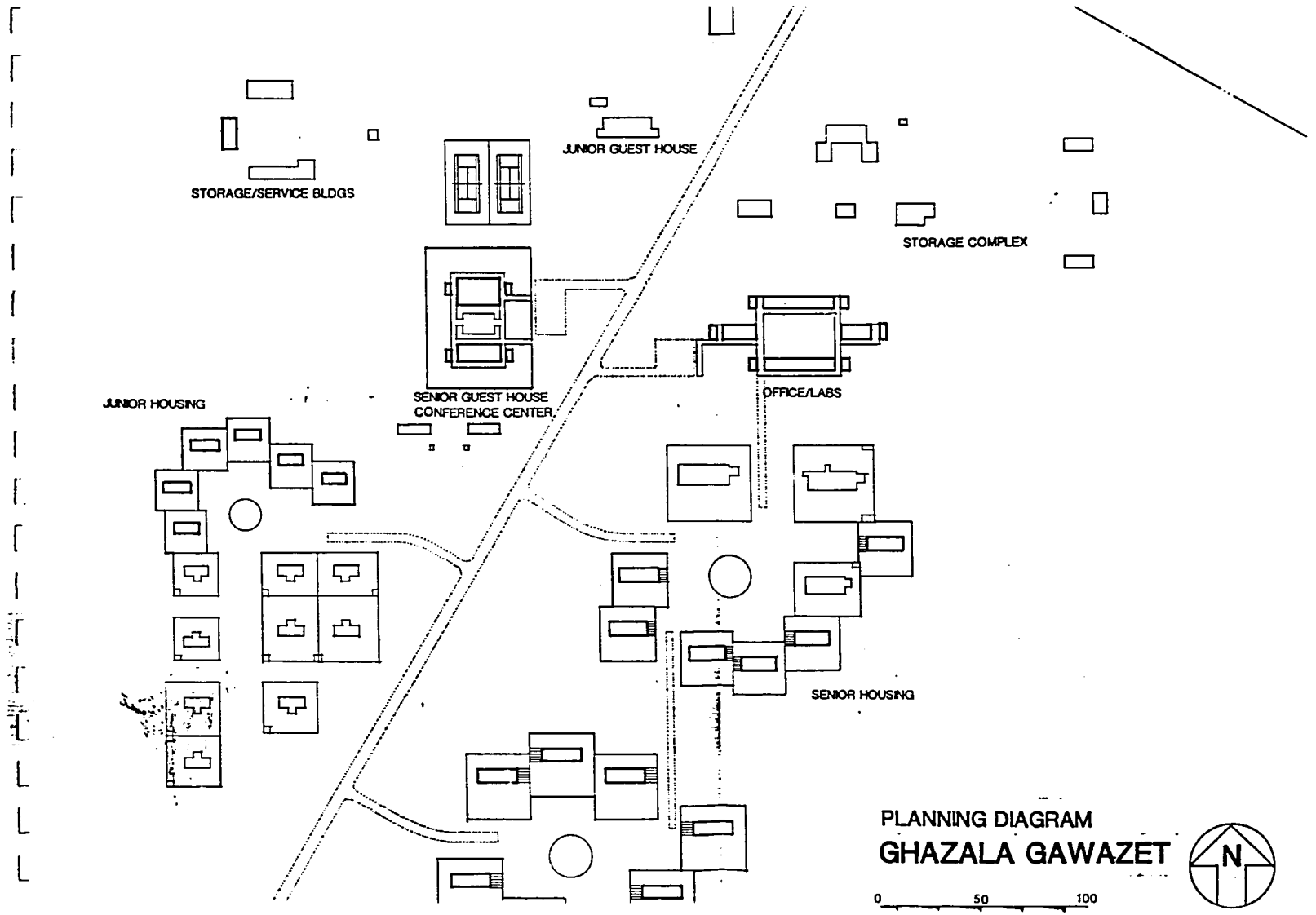
STORAGE/SERVICE BLDGS
JUNIOR GUEST HOUSE
STORAGE COMPLEX
SENIOR GUEST HOUSE
CONFERENCE CENTER
OFFICE/LABS
JUNIOR HOUSING
SENIOR HOUSING
PLANNING DIAGRAM
GHAZALA GAWAZET
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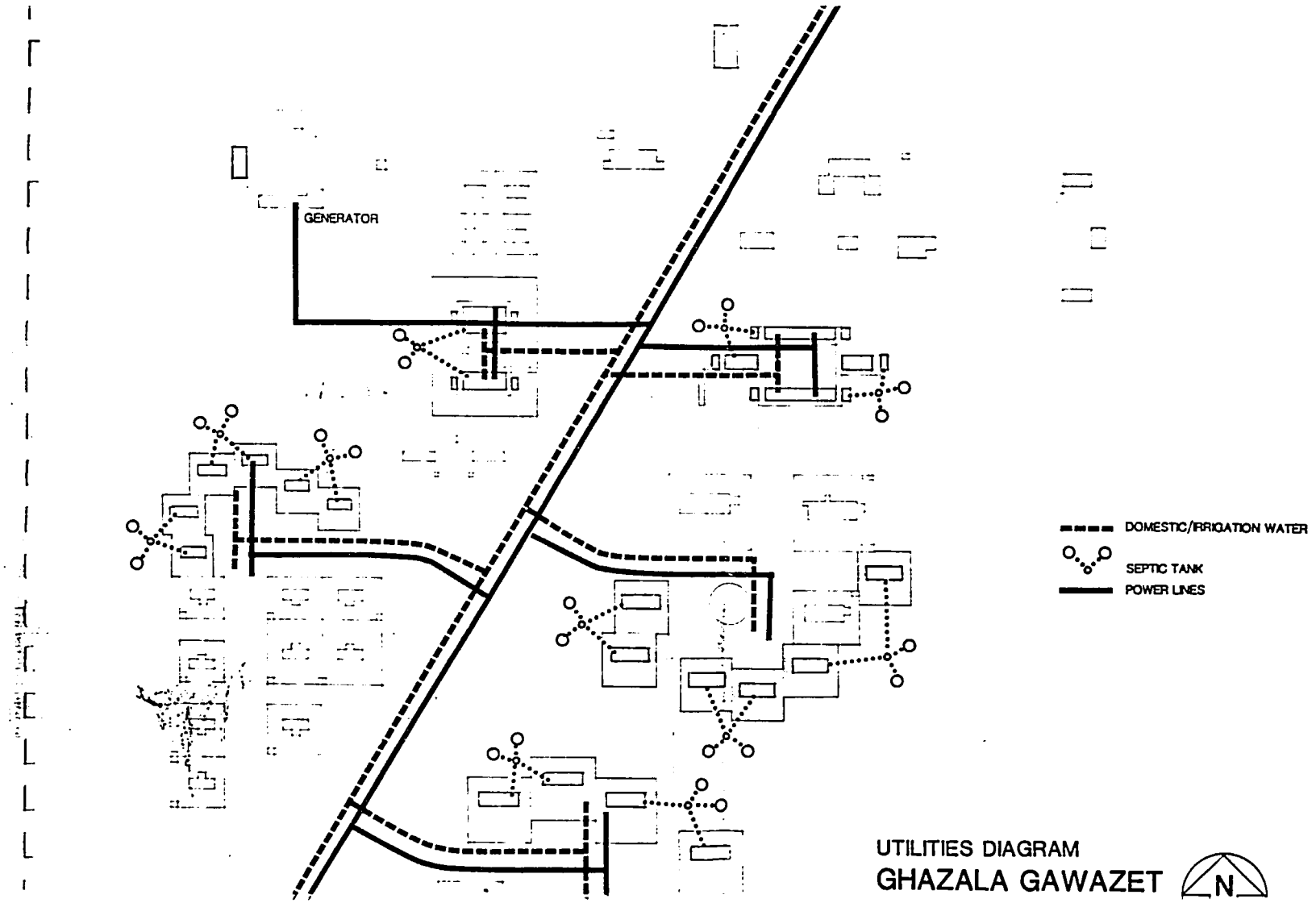

GENERATOR
DOMESTIC/IRRIGATION WATER
SEPTIC TANK
POWER LINES
UTILITIES DIAGRAM
GHAZALA GAWAZET
N

8. KHARTOUM: A.R.C. HEADQUARTERS SITE:

Several sites have been examined in the Shambat District of Khartoum North. The recommended site is an irregular-shaped area of approximately 11 fedans. This is more than adequate to accommodate the proposed A. R. C. Headquarters and future expansion. Parts of the site are now used by A. R. C. for agricultural experiments and has been for some time.

a. Topography & Soils: The land is very flat with the remains of several years of agricultural experimentation. There are no existing trees or other landscape features. There are trees bordering the site to the south and west. No information exists regarding subsurface soil conditions. However, nearby buildings do not indicate any extraordinary soil problems.

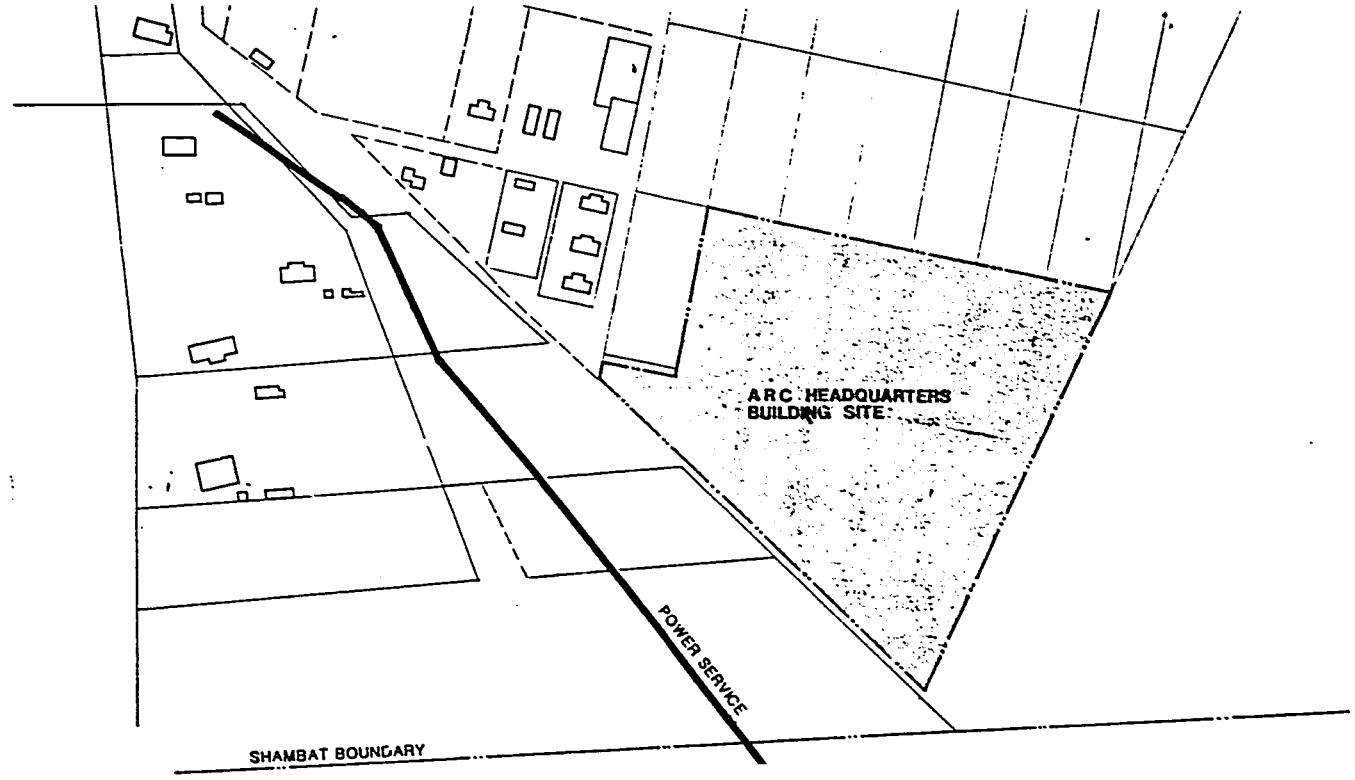
b. Access: The site is accessible from a major arterial street which borders the site along its southwest boundary. There are no roads on site.

c. Water Supply: Water supply is available from the municipal system. However, on-site storage for two days needs is recommended.

d. Electrical Service: Power is available from the municipal system. A major power line parallels the arterial street along the southwest boundary of the site. Standby generating capacity is also recommended, size to be determined.

Concepts of the use of the site have yet to be developed.

81



VICINITY MAP
KHARTOUM

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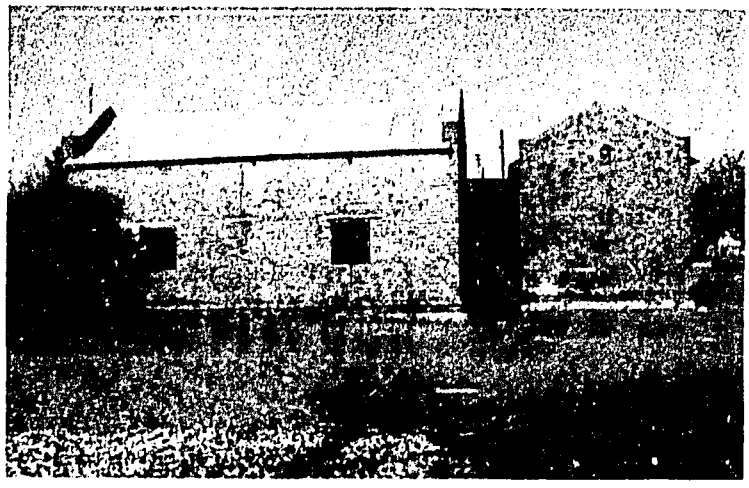
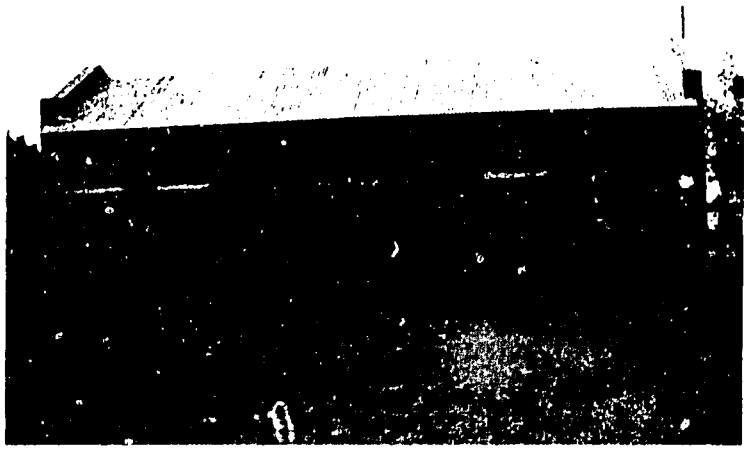
ADMINISTRATION BUILDING

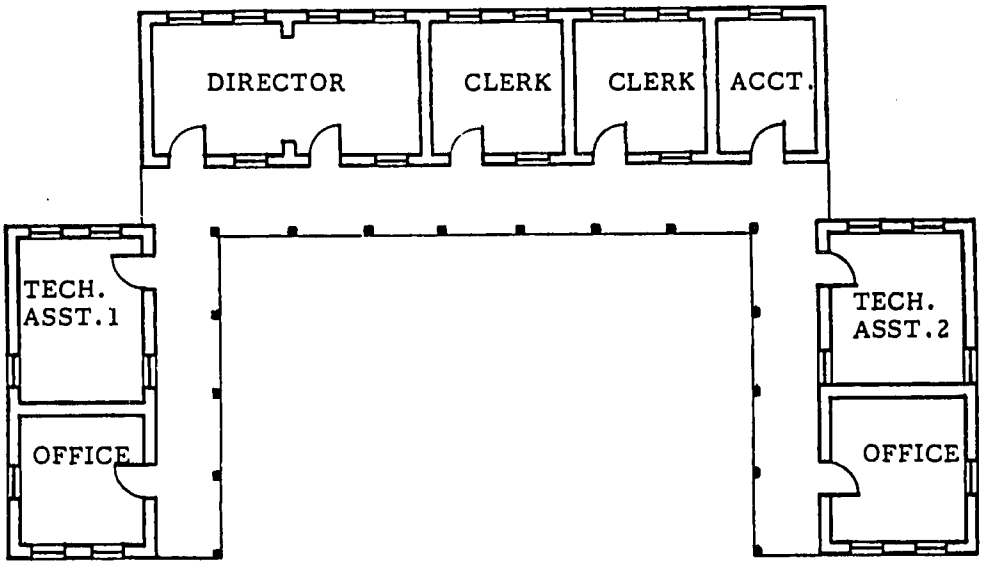


ADMINISTRATION BUILDING

LABOR HOUSING



LABOR HOUSING



ADMINISTRATION

ADMINISTRATION/ANIMAL PRODUCTION (1)

SPACES

Livestock Office 1		4.0 x 4.0 =	16.0	
Tech. Asst. 1		4.0 x 5.0 =	20.0	
Director		8.5 x 4.0 =	34.0	
Clerk	2 @	4.0 x 4.0 =	16.0	
Acct.		3.0 x 4.0 =	12.0	
Tech. Asst. 2		4.0 x 4.5 =	18.0	
Livestock 2		4.0 x 4.5 =	18.0	
			134.0	M^2
Covered Veranda		2.0 x 42.0=	84.0	
		7 =	218.0	M^2
Toilets			10.0	M^2

COMMENTS:

ADMINISTRATION BUILDING (#10, 11, 12) 1957

Foundations:

Backfill washed away at corners, exposing foundations.
Stone with cement mortar.
80 cm deep.
Water supply line exposed at grade at perimeter.

Floors:

Packed brick with concrete topping/multiple cracks and voids.
Slopes to corners caused by settlement.

Walls:

40 cm brick by mud mortar.
Cement pointed at exterior/plaster at interior.
Multiple cracks through wall from settlement of foundations.
Evidence of termite runs in mud mortar.
Mud mortar washed out at lower exterior walls at places.
Parapets cracked at roof line from movement of roofing.
Water damage at plaster where roof leaks occur.

Windows & Doors:

Wood frames with wood shutters + wood doors termite infested.
Four new windows with wood lintels.

Roof Structure:

Some trusses termite infested. Also purlins.
Corrugated roofing patched at ridge and some side laps.
No flashing at parapets.
Openings created where plaster cracked under roof sheets (bats and moisture enters).
Some corrugated metal side laps turned up/leaking.

Ceilings:

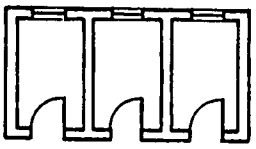
Cotton cloth supported by wire, 1m x 1m.
Some removed
Some replaced.
Most damaged by water and soiled severely.
Hardwood ceiling termite infested/destroyed in 6 months at director's office.

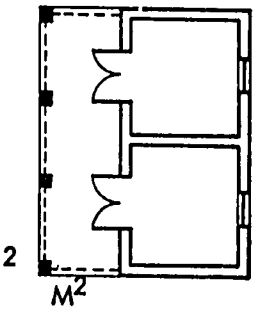
Verandas:

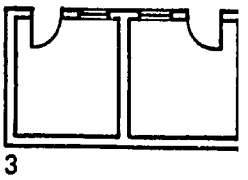
Corrugated metal on wood post and beam supports.
Settlement in veranda foundations.
Cracked veranda slabs.
Posts and beams termite infested.

Electrical System:

Surface wiring.
Bare and broken connections.
No fuses or breakers.



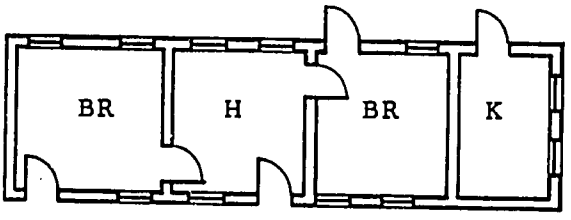




STORES

SPACES:

1	3 @	2.0 x 3.5	=	21.0
2	2 @	3.0 x 3.5	=	21.0
	Ver.	2.5 x 8.0	=	20.0
3	2 @	3.5 x 3.5	=	24.50



LABOR HOUSING (2)

SPACES:

Br.	2 @	4.0 x 4.5	=	18.0
Hall		4.0 x 4.5	=	18.0
Kitchen		3.0 x 4.5	=	10.5
				46.5 M^2
Toilet		1.0 x 2.0	=	2.0
				48.5 M^2

COMMENTS:

LABOR HOUSING BUILDINGS (#20) 1957

Foundations:

Probably stone with cement mortar - settled somewhat.
Adjacent grade washed away 1'-0" all around.

Floors:

Brick with cement topping.
Multiple cracking.

Walls:

Brick with mud mortar, pointed with cement.
Only minor cracking at mid-wall areas.
Major cracks separating bath wing from severe settling - beyond repair.
Parapets cracked from movement of roofing.

Windows/Doors:

Termite damage at wood windows.

Roof Structure:

Galvanized corrugated metal with curled side laps.
Leaks at side laps, fasteners, ridge.

Ceilings:

Cotton cloth supported by wires.
Severely damaged by water.
Soiled by droppings from bats, lizards.

STORES (#15, 16, 17) 1957

Foundations:

Stable - probably stone with cement mortar.
Some adjacent grade washed away.

Floors:

Concrete slabs in good condition.
Only minor cracking apparent.

Walls:

Brick with mud mortar and cement pointing on exterior.
Plastered exterior at Building #16 (cracking).
No major structural through-wall cracking.
All parapets cracked from roofing movement.

Windows & Doors:

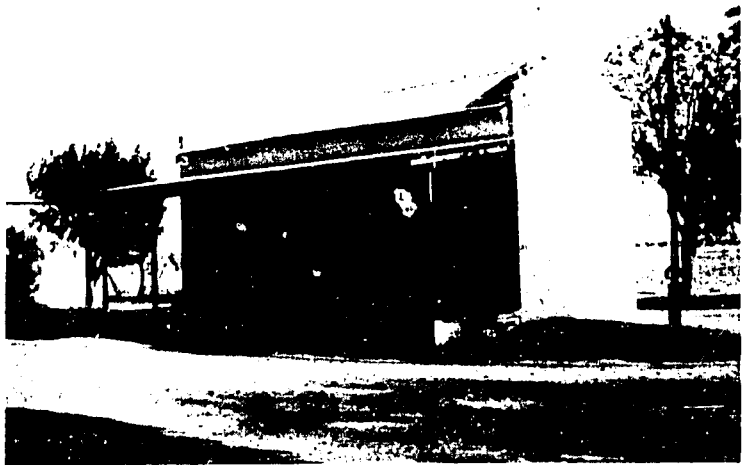
Wood doors and frames and window shutters and frames.
No visible termite damage.

Roof Structure:

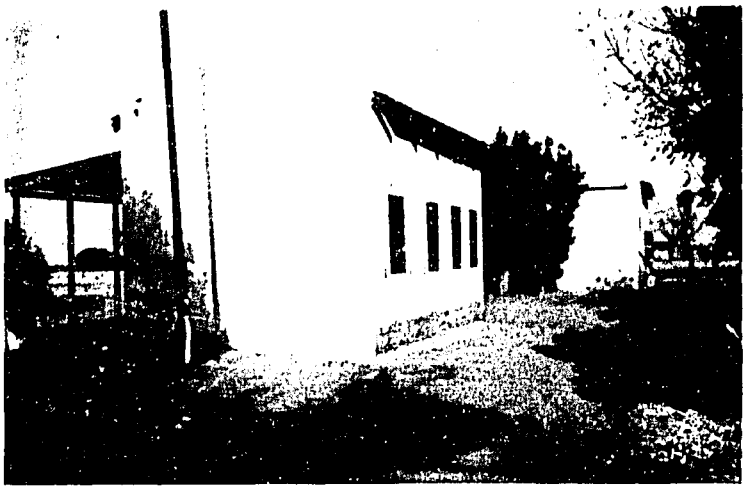
Galvanized metal roofing attached with J-hooks.
Steel angle roof trusses.
Leaks at connections.
No ceilings.

Electrical System:

Exposed surface wiring.



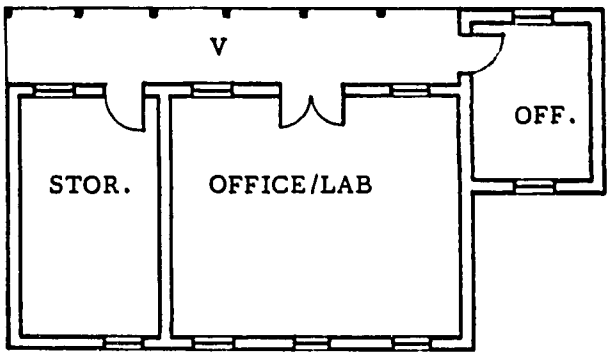
ANIMAL PROD. BLDG.



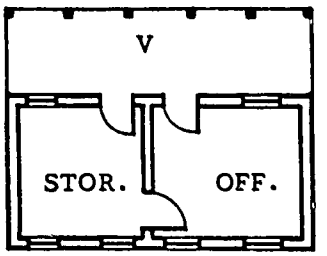
ANIMAL PROD. BLDG.

ANIMAL PROD. BLDG., RANGE MANAGEMENT

STORES



RANGE MANAGEMENT



ANIMAL PRODUCTION

RANGE MANAGEMENT BLDG. (1)

SPACES

Office	3.6 x 4.6 =	16.56	
Office	9.5 x 7.5 =	71.25	
Store	4.5 x 7.5 =	33.75	
		121.56	M^2
Veranda	2.5 x 19.0=	47.50	
		169.06	M^2

ANIMAL PRODUCTION BLDG. (1)

SPACES

Stores	4.0 x 4.0 =	16.0	
Office	4.5 x 4.0 =	18.0	
		34.0	
Veranda	9.5 x 2.5 =	23.75	
		57.75	M^2

COMMENTS:

ANIMAL PRODUCTION AND RANGE MANAGEMENT BUILDINGS (#13 & 14) 1964

Foundations:

Brick with cement mortar - 85 cm deep.
Apparently stable at present
Grade slightly washed away at corners.

Floors:

Concrete with multiple cracking along control joints only.
Cracks and pockets at animal production building.

Walls:

40 cm brick with cement plaster at interior and exterior.
Cement mortar.
No cracks at walls.
Cracking at parapets at roof line - continuous from movement of roofing.

Windows/Doors:

Wood frames termite infested.
Wood doors.
Wood windows with glass - some termite infested.
Wood shutters - destroyed by termites.

Roof Structure:

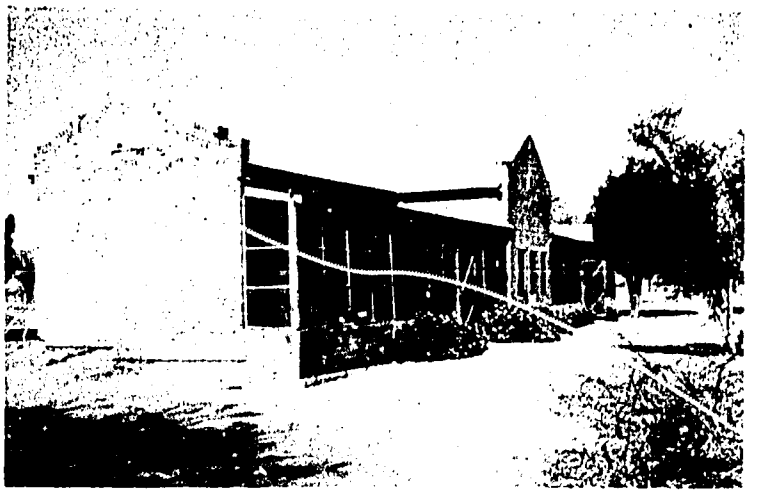
Wood beams and purlins.
Termite infested at walls.
Corrugated metal roof - slight leaks.

Ceilings:

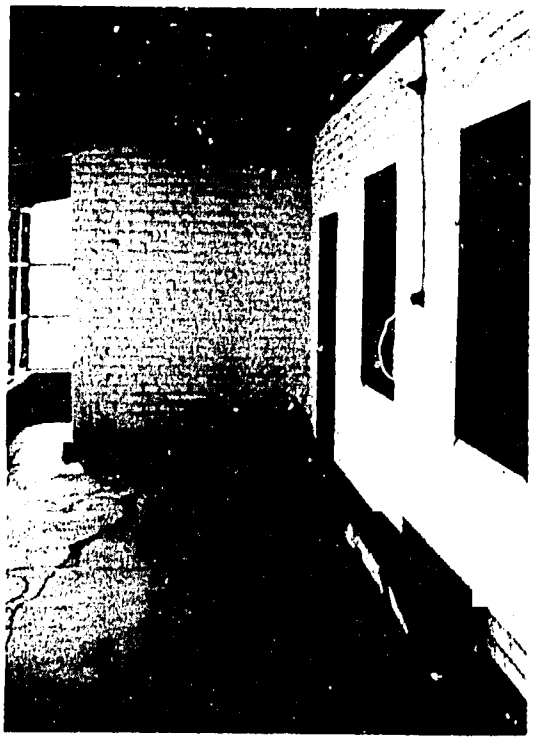
Particle board with wood battens with some termite runs.
Some water damage.

Verandas:

Wood post and beam termite infested.
Corrugated metal roof.
Concrete floor good condition at range management.
Concrete floor cracked and pocketed at animal production.



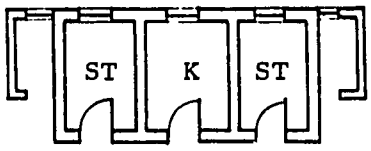
GUEST HOUSE

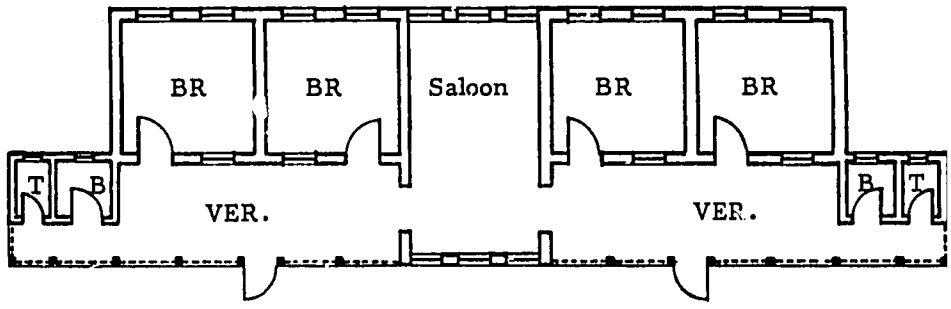


GUEST HOUSE VERANDA

GUEST HOUSE VERANDA

GHAZALA GAWAZET
GUEST HOUSE





GUEST HOUSE (1)

SPACES

Toilets	2 @ 1.0	x 1.75	=	1.75 x 2	=	3.5
Baths	2 @ 1.75	x 1.75	=	3.06 x 2	=	6.0
Bedroom	4 @ 4.0	x 4.0	=	16.00 x 4	=	64.0
Saloon	4.0	x 7.0	=	28.00	=	28.0
						101.50
Veranda						61.00
					T =	162.50 M^2

OUTBUILDING:

Store	2 @ 2	x 3.5	=	14.0
Kit	2.5	x 3.5	=	8.75
				22.75 M^2

COMMENTS:

-92

GUEST HOUSE (#7) 1957

Foundations:

Partly settled. Especially at south side/veranda.
Assume stone with cement mortar.

Floors:

Heavily cracked and pocketed at veranda.
Minor cracking throughout interior.
Some concentrations of cracking at windows. Probably from wind-blown rain.

Walls:

Brick with mud mortar + cement mortar pointing, exterior and plaster interior.
Cracks at parapet from movement of roofing.
Minor through-wall cracking at walls only.

Windows & Doors:

Wood windows, doors and shutters.
Badly infested by termites.

Roof Structure:

Corrugated metal on wood purlins.
Leaks at purlin connections and ridge.
No flashing at parapets.

Ceilings:

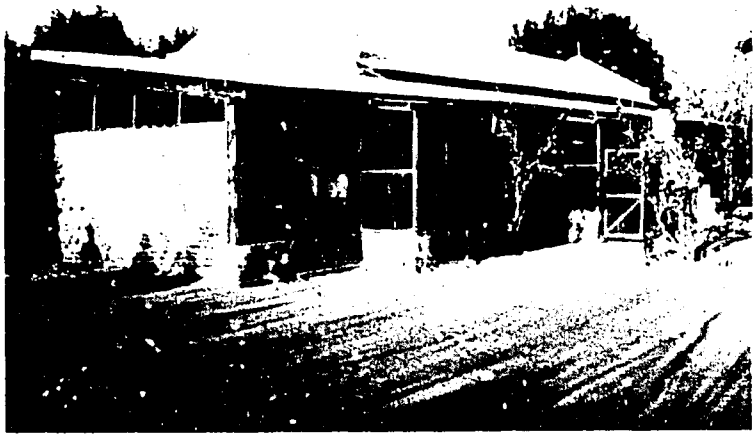
Cotton cloth supported by wire.
Badly stained, rotten and torn.

Veranda:

Wood infested and falling down.
Roof structure similar.

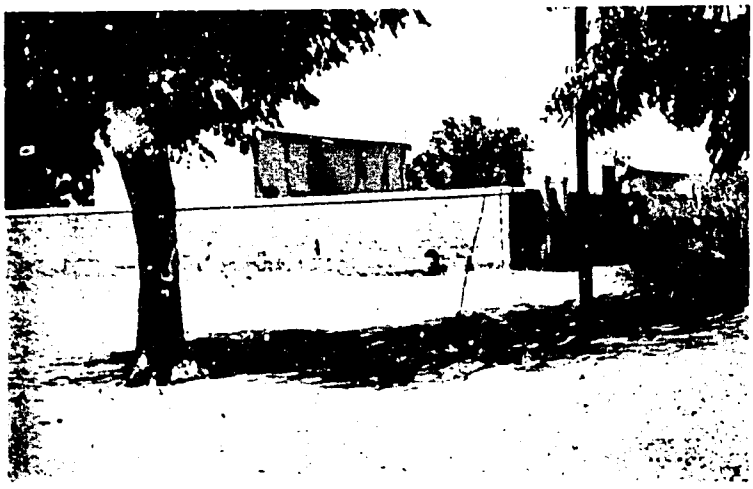
Electrical:

Exposed wiring.
Some broken connections.



SENIOR HOUSE

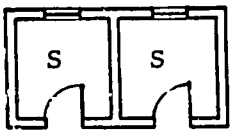
MIDDLE HOUSE

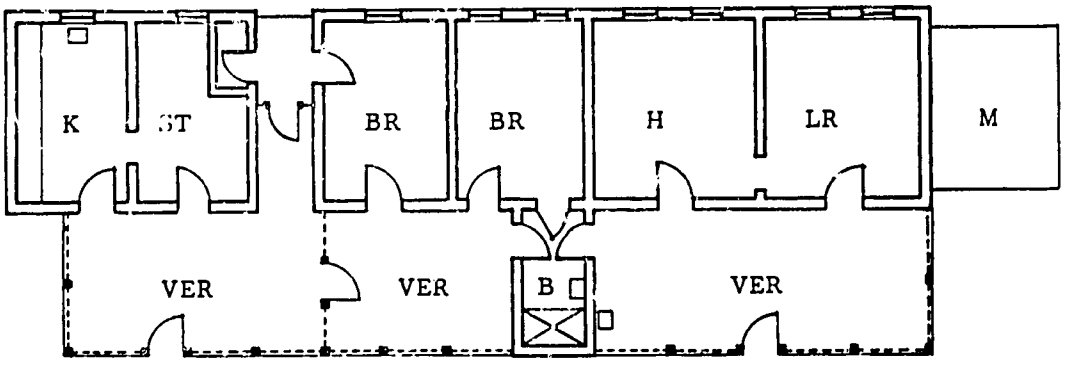


MIDDLE HOUSE

JUNIOR HOUSE

GHAZALA GAWAZET
SENIOR HOUSE (1)





SENIOR HOUSE (1)

SPACES

Kit.	3.0 x 5.5 =	16.5		
Stores	3.0 x 5.5 =	16.5		
Toilet	1.0 x 2.0 =	2.0		
Br. 2 @	4.0 x 5.5 =	44.0		
Bath	2.0 x 4.0 =	8.0		
LR	5.0 x 5.5 =	27.5		
Saloon	5.0 x 5.5 =	27.5		
		142.00 M^2		142
Verandas & Covered Passage	24.0 x 4.5 1.5 x 5.5 =	116.0		116
Mustaba	4.0 x 5.0 =	20.0		
		136.0 M^2		136
				278 M^2
Servants 2 @	3.0 x 3.0 =	18.0		18
			.7 =	296 M^2

COMMENTS:

SENIOR HOUSES (#19) 1957

Foundations:

Probably brick with cement mortar.
Protected at exterior by grade level.
Better maintained than most.
Fairly stable.

Floors:

Brick with concrete topping.
No settlement.
Only minor cracks.

Walls:

Pointed brick in good condition - few cracks at middle of walls at kitchen where separated from settled foundations.
Parapet cracked at roofline from movement of roofing.

Windows/Doors:

Wood doors, shutters.
Wood not noticeably termite infested.

Roof Structure:

Corrugated metal roofing on wood rafters.
Ridge/fastener leaks.

Ceilings:

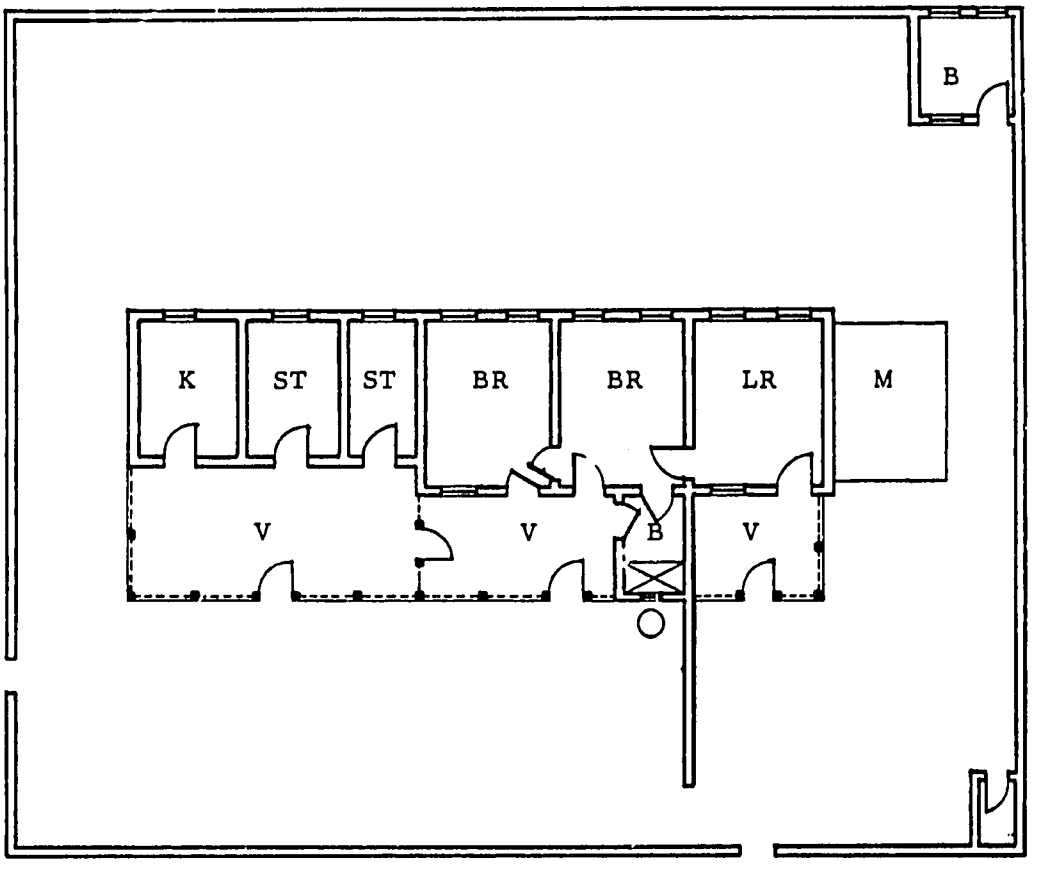
Cotton cloth on wire.
Damaged by roof leaks and bat and lizard droppings.

Veranda:

Floor cracked/pocketed.
Wood mullions termite infested.

Electrical/Plumbing:

Surface wiring.
No fuses or breakers.



MIDDLE HOUSES (2)

SPACES

Store		3.0 x 4.0 =	12.0	
Kitchen		3.0 x 4.0 =	12.0	
Store		2.0 x 4.0 =	8.0	
Br.	2 @	4.0 x 5.0 =	40.0	
Hall		4.0 x 5.0 =	20.0	
Bath		2.0 x 3.0 =	6.0	
			98.0 M^2	
Verandas		9.0 x 4.0 =	36.0	
		6.0 x 3.0 =	18.0	
		4.0 x 3.0 =	12.0	
			76.0 M^2	
Mustaba		3.5 x 4.5 =	17.75 M^2	
				191.75 M^2
Servants		3.0 x 3.0 =	9.0	
Toilet		1.0 x 2.0 =	2.0	

COMMENTS:

MIDDLE HOUSES (SOUTH) (#18) 1957

Foundations:

Probably brick with cement mortar.
Somewhat protected but apparently settled.

Floors:

Main houses o.k. - brick with concrete topping.
Veranda badly cracked and pocketed.

Walls:

Plastered brick - badly cracked through wall.
Parapet cracked at roofline from movement of roofing.

Windows/Doors:

Wood at openings at house not noticeably infested.
Veranda wood termite infested.

Roof:

Corrugated metal on wood rafters.
Leaks at fasteners.

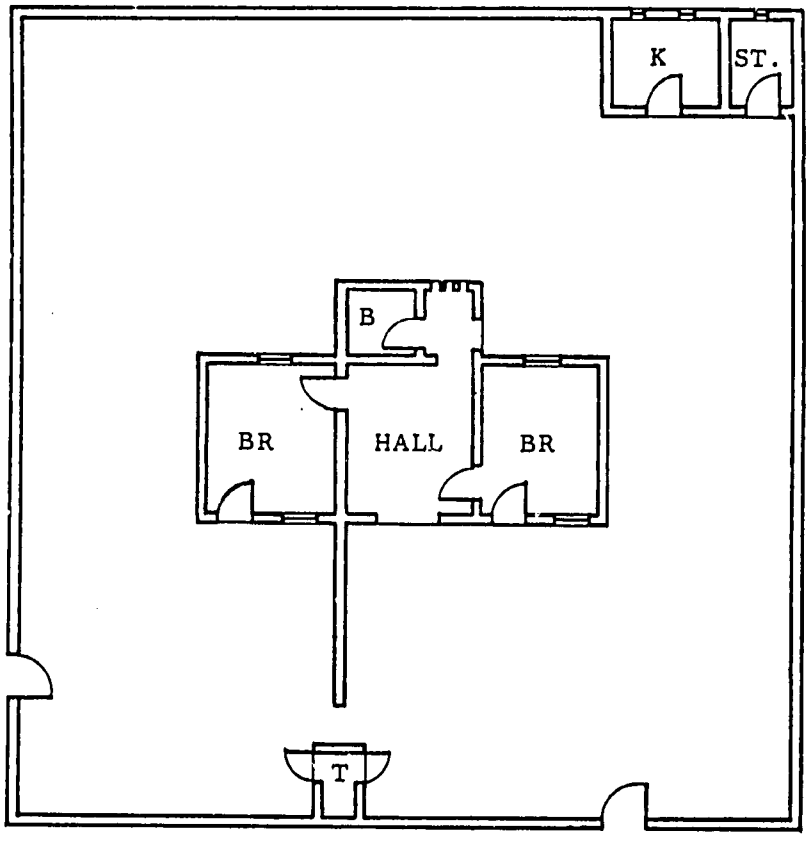
Ceiling:

Cotton cloth with wire supports.
Badly water damaged and stained.

Electrical:

Surface wiring.
No fuses or breakers.

GHAZALA GAWAZET
JUNIOR HOUSES (9)



JUNIOR HOUSES (9)

SPACES

Bedroom	2@	4.0 x 4.5 =	36.0
Hall		4.0 x 4.5 =	18.0
Bath & Vest.		4.0 x 2.0 =	8.0
			62.0 M^2
Kitchen		3.0 x 2.5 =	7.5
Stores		2.0 x 2.5 =	5.0
			12.5 M^2
Toilet		1.0 x 2.0 =	2.0
			76.5 M^2

COMMENTS:

99

JUNIOR HOUSE (TYP.) (#21) 1957

Foundations:

Probably stone with cement mortar.
Settled at corners where washed away near grade (water has penetrated and settled foundation bearing).

Floors:

Brick with concrete topping.
Badly cracked and pocketed.

Walls:

Brick with mud mortar severely cracked.
Some with cement plaster at exterior, some pointed.
Parapet walls at ends cracked at roof line.
Some compound walls concrete block with cement plaster (frequent cracks)
Bath wing of house separated from main part with major through-wall cracks - beyond repair.

Windows/Doors:

Wood doors, frames, window shutters.
Termite infestation throughout.

Roof Structure:

Wood rafters.
Galvanized corrugated sheets - in good condition.
Leaks at fasteners and ridge.

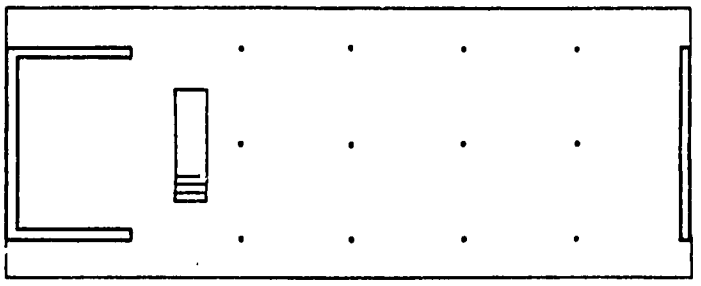
Ceilings:

Cotton with wire supports.
Damaged by leaks at roof.
Soiled by bat and lizard droppings.

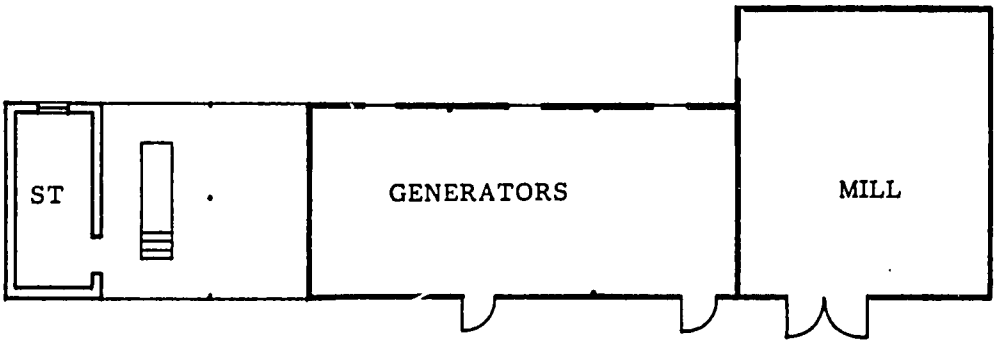
Electrical System:

Minimal with surface wiring.
Broken connections.
No fuses or breakers.

100



BUILDING 1



BUILDING 2

VEHICLE MAINTENANCE BLDG.

SPACES

BLDG. 1	Enclosed work sp.	5.5 x 3.5	=	19.25
	Open work area	17.5 x 8.0	=	140.00
		7	=	159.25 M^2
BLDG. 2	Stores	2.5 x 5.5	=	13.75
	Open work area	6.5 x 6.0	=	39.00
	Generators	13.5 x 6.0	=	81.00
	Mill	8.0 x 9.0	=	72.00
		7	=	205.75 M^2

COMMENTS:

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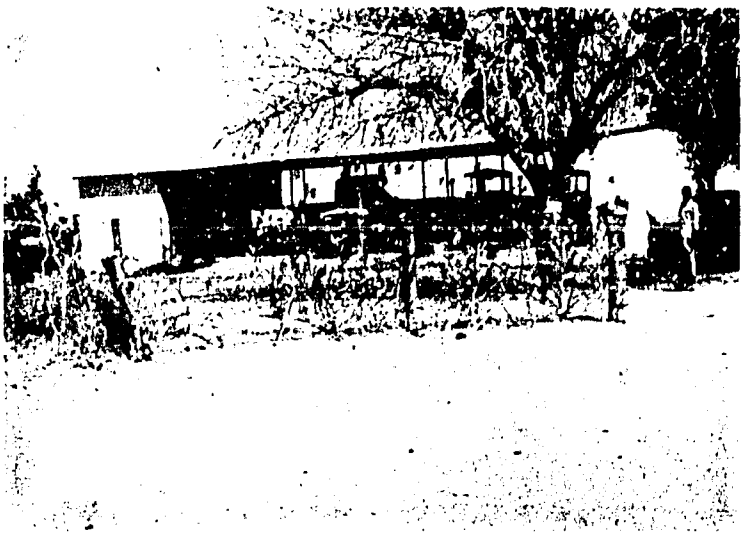

VEHICLE
MAINTENANCE

MAIN STREET

TENNIS COURT
JUNIOR HOUSING
SERVICE TRACK

VIII. GENERAL DESIGN CONSIDERATIONS

The following general design considerations and recommendations are based upon climate, function, and traditional or new practices. Climate is the most important of these, and should be second only to cost and available construction techniques in determining the architectural design for these new facilities.

CLIMATE:

The climate at all three sites is substantially the same. This is confirmed by the climate data further in this report. The only notable exception is the more severe dust conditions at El Obeid. The following recommendations are based upon

- sun control
- prevailing winds
- natural ventilation
- severe rains
- dust

All buildings should be designed with a long east/west axis to allow for optimum sun control and natural ventilation with prevailing north/south winds.

Roof overhangs or similar protection are recommended at least along the north and south walls for sun control, rain protection and covered walks where appropriate.

Solar-powered hot water systems should be considered.

Materials and construction details should provide delayed heat transfer into buildings.

Cooling by evaporative coolers or air conditioners is recommended for laboratories and selected offices and houses. All other spaces should have optimum cross ventilation.

All house verandas should be on the south side to capture prevailing south summer winds, as protection from the cooler north winter winds, and for optimum cross ventilation.

Major walkways between or near buildings should be sheltered by building overhangs, walkway covers or trees.

Heavy rains (including wind-driven rain) account for most of the deterioration and maintenance problems of existing structures with traditional construction. Attention to critical construction materials and details, roof edges, roof/wall connections, openings, etc. is essential.

It is recommended that all foundations be protected from moisture penetration and resulting movement by building aprons/walkways or equivalent means.

Dust conditions, particularly at El Obeid, require care with construction details where infiltration is possible, windows, doors, roof edges, etc. Some additional interior circulation may be required for selected activities.

TRADITIONAL AND NEW PRACTICES:

All senior and middle houses should be designed to accommodate changing patterns of Sudanese living. Traditional male/female segregation (particularly when guests are present) must be provided. However, future living patterns will likely include less segregation with more expatriate influence.

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It is recommended that one and two-story townhouses be seriously considered for part of the senior and middle houses, particularly at El Obeid. They should be much more economical than the free-standing houses and compounds, while preserving most traditional living habits and values.

Traditional compounds should be minimized in the interest of cost, but adequate to accommodate the essential functions, i.e., gardening, animals, auto parking, cooking, sleeping, and general privacy.

Most laboratories and offices can be accommodated in traditional space, one room deep with exterior circulation and natural ventilation. Selected labs, and special storage areas will require special design considerations such as dustproofing, air conditioning, humidity control, etc.

Service spaces such as stairs, toilets, general storage, etc. should be located at east and west ends in small separate structures, if possible. This will minimize interference with the primary work space. It can also buffer the east and west heat gain.

IX. LOCAL MATERIALS & CONSTRUCTION METHODS

The discussion in the following section of this report is confined to the building types which seem most appropriate to the task in hand even though other building types and methods were observed during our visit.

A site-by-site listing of local building materials and practices as observed and discussed follows, along with comments and recommendations.

EL OBEID:

Foundations:	Strip foundations to 1.5m depth, bearing on clay. Stone rubble, brick, or combination. Unreinforced. Mud mortar usual practice. Foundations protected by aprons in better condition.
Bearing Walls:	Local brick or stone, cement or mud mortar. Mud most usual with cement mortar pointing or plaster on exterior. Walls unreinforced. Concrete lintels at openings. No bond beams usually. Concrete block made locally but not waterproof.
Mortar:	Mud - 50:50 clay-sand. Cement - 1:6 Portland Cement - sand.
Plaster:	Interior walls and partitions. Minimum cement content.
Floors:	Concrete slab with cement tile over screed. Terrazzo tile available from Khartoum. Considerably more expensive.
Roof Structure:	Wood used for minimum framing use only. More expensive than steel. Steel framing from Khartoum or import. Corrugated sheet metal roofing.
Ceilings:	Hung Celotex on wood grid usual practice.
Windows:	Wood usual, steel preferred. Security grilles required.
Doors:	Flush timber, painted. Re-painting required at 2-year intervals.
Hardware:	Mostly British.

EL FASHER:

Foundations:	Strip foundations to 1.5m depth, bearing on clay. Stone rubble, brick, or combination. Unreinforced. Mud mortar usual practice. Foundation protected by aprons in better condition.
Bearing Walls:	Local brick or stone, cement or mud mortar. Mud mortar most usual with cement mortar pointing or plaster on exterior. Common practice is cement and brick dust plaster on exterior with false brick jointing tooled into surface. Walls unreinforced. Concrete lintels at openings. Some use of continuous concrete bond beams at lintel level.

	Some concrete block used. Machinery for block manufacture is available for local production if cement is obtainable, but block is not waterproof, generally. Two-year old unreinforced concrete block school buildings were observed which had been destroyed by windstorm; roofs torn off, walls collapsed.
Mortar:	Mud - 50:50 clay-sand. Cement - 1:6 Portland Cemend, sand, lime available locally in any quantity.
Plaster:	Interior walls and partitions. Minimum cement content.
Floors:	Concrete slab with cement tile over screed. Some use of trowel-finished concrete slab.
Roof Structure:	Mostly timber trusses. Rough timber from Jebel Mara, kiln-dried sawn timber from Khartoum. Green sawn timber from Central African Republic. Steel trusses fabricated locally. Corrugated sheet metal roofing.
Ceiling:	Masonite, hung on wood grid. Celotex preferred but no longer available. Cloth stretched over wire grid.
Windows:	Mostly wood millwork. Very little steel used. All windows screened. Security grilles desirable at offices; not necessary at houses.
Doors:	99% wood.
Hardware:	Mostly British. Replacement parts are a problem.

GHAZALA GAWAZET:

Foundations:	Strip foundations to 1.5m depth bearing on clay. Stone rubble or brick with brick most common. Unreinforced. Cement mortar usual practice. Lack of cement aprons to protect foundations.
Bearing Walls:	Local brick. Cement or mud mortar. Mud mortar most usual with cement mortar pointing or plaster on exterior. Walls unreinforced. Concrete lintels at openings. No bond beams usually.
Mortar:	Mud - 50:50 clay-sand. Cement - 1:6 Portland Cement - sand. Lime available from Nyala in any quantity.
Plaster:	Interior walls and partitions. Minimum cement content.
Floors:	Trowel finished concrete topping over brick substrate. Existing floors badly cracked.
Roof Structure:	Wood trusses and purlins. Corrugated sheet metal roofing.

Ceilings:	Masonite hung on wood grid. Cloth stretched over wire grid.
Windows:	Wood usual practice; metal preferable. No security grilles required. Screen all windows.
Doors:	Wood doors and frames usual practice.
Hardware:	Mostly British.

COMMENTS:

Foundations:

Unreinforced stone or brick foundations are susceptible to damage by rain water. Many buildings show vertical cracks in exterior masonry. Where protected by aprons around exterior walls, considerably less damage has resulted to foundations.

Bearing Walls:

Stone or brick walls laid in mud or lime/sand mortar are vulnerable to stresses caused by foundation movement, and by damage to the protective exterior plaster coat. Severe masonry cracks and separation was observed at gables, parapets, and general wall surfaces. Local brick with cement mortar produces durable and watertight walls, where foundations are stable.

Plaster:

Exterior plaster has to accommodate extreme temperature changes during day and night time. If exterior walls crack because of foundation movement, plaster separates or shows major cracks, plaster over exterior concrete on brick surfaces presents a constant maintenance problem.

Floors:

Frequent cracks in floors are caused by lack of reinforcement and by expanding clay soils, or settlement.

Roof Structure:

Roof leakage was evident in most buildings observed. The most frequent cause is the deterioration of gaskets at steel roof fastening or connection points because of constant movement under extreme temperature changes. Other causes are insufficient overlapping distance at joints and separations at brick work connection points, at bearing walls, gables and parapets. Inadequate closure of corrugations at eaves allows access of insects and bats to ceiling space resulting in staining of ceilings.

Ceilings:

Ceilings in all locations were affected by termites and roof leakage. Celotex suspended panels, cloth-wire or masonite hung ceilings were invariably in poor condition and need constant maintenance and frequent replacement.

Windows/Doors:

Steel windows are in good condition, repainting is a maintenance item. Wood doors or window frames, posts or veranda framing were badly damaged by termites in Ghazala Gawazet and to a lesser, but still substantial degree, in El Obeid and El Fasher.

General:

Local construction methods have developed from severe restrictions utilizing available materials and labor skills. The resulting buildings are of remarkable standards under these circumstances, but require a high degree of maintenance which is frequently not available.

X. BUILDING SYSTEMS RECOMMENDATIONS

1. GENERAL CONSIDERATIONS:

a. DURABILITY AND LOW MAINTENANCE:

In the absence of architectural traditions for permanent buildings, construction methods in the Western Provinces have been shaped more by restrictions of funds, materials, and manpower skills than by appropriate technical solutions to accommodate primarily extreme climate conditions in the area.

As funds and materials for repair are lacking, the lifespan of existing buildings is greatly reduced. Design for durability and low maintenance has to be a planning objective. Maintenance considerations such as service capabilities and availability of replacement parts in Khartoum should be observed in specifying materials and equipment.

b. USE OF LOCAL AND IMPORTED MATERIALS:

Because of high cost and transportation difficulties for non-local building components, it is important to emphasize the use of local materials, construction methods, and related labor skills. These are limited to brickworks and crude building systems installation of high maintenance character. Therefore, imported materials will have to be specified to complement local materials for long-term efficiency and low maintenance. This will be more costly at first, but more economical in the long run.

c. CONSTRUCTION METHODS:

Labor skills in connection with stone, brickworks, simple carpentry and site utilities are of acceptable standards in the three locations. Capacities for limited finishing work are available in El Obeid. Any specialized skills related to on-site prefab systems or the working with metal components, electrical and plumbing installations, would have to be provided by outside international or Khartoum-based contractors. In proposing building systems, it is important to consider local limitations of transportation means and available construction equipment.

2. BUILDING SYSTEMS:

a. FOUNDATIONS:

Because of shortages and the high cost of cement, most foundations are constructed in stone or brick with mud or lime/sand mortar. Problems occur during the rainy season when water penetrates to the bearing level causing it to expand or to settle and to partially dissolve mortar joints, resulting in multiple cracking of walls.

To assure stability of foundations, continuous reinforced concrete footings under foundations walls, continuous reinforced bond beams at the floor line, isolated reinforced concrete footings with short columns and grade beams, or reinforced concrete pilings with grade beams should be used. The danger of water disturbing the bearing soil would be reduced by constructing continuous aprons at all sides of the building.

RECOMMENDATIONS: FOUNDATIONS

Following a more detailed investigation of soil types, profiles, and test pits at each site, there appear to be five viable alternatives for foundation design. Any of the five would be appropriate on either site; final choice is to be determined by structural requirements and analysis of cost effectiveness after building designs have been established.

Option 1: Strip foundations; reinforced concrete footings with brick or stone foundation walls, reinforced concrete bond beam at floor level. Footings 1.5m deep. Cement mortar.

Option 2: Strip foundations; brick or preferably stone footings, brick foundation walls, reinforced concrete bond beam at floor level. Footings 1.5m deep. Cement mortar.

Option 3: Isolated reinforced concrete footings, reinforced concrete short columns, reinforced concrete continuous grade beam at floor level. Footings 1.5m deep.

Option 4: Drilled short pilings 8 to 12" diameter, bulbed at bottom, reinforced and poured concrete. Reinforced concrete continuous grade beam at floor level. Pilings to 2.5m depth, spaced as required by loads.

Option 5: Concrete frame for two-story building. Isolated reinforced concrete footings, reinforced concrete columns supporting continuous reinforced concrete beams at first and second floor levels. Brick in-fill walls. Footings to 1.5m depth. Cement mortar.

All exterior foundations to be protected by perimeter aprons equal in width to depth of footing.

2. WALL CONSTRUCTION/WALL FINISHES:

Bricks manufactured in El Obeid, El Fasher, and near Ghazala Gawazet (Ed Da'ein) are reasonably regular in size, structurally stable, although slightly soft. Stone is available in required quantities, but less economical because of larger amounts of mortar required in walls. Concrete blocks are available in El Obeid, and El Fasher, but do not produce a waterproof wall.

Brick has low heat transmission, is a low maintenance material, and local labor is skilled in masonry construction.

Common practice locally is to use mud mortar with a thin, colored cement plaster or lime plaster veneer on the outside. This approach requires frequent maintenance as the combination of heat and water impacts cause regular deterioration of the joints. Cement mortar would provide permanent joints with no need for exterior plasters or egular repointing. The extra costs of cement mortar would be repaid many times over in maintenance savings. Common local practice is to plaster interior wall surfaces with lime plaster, painted a logical finish.

RECOMMENDATIONS: WALL CONSTRUCTION/FINISHES

Option 1: Walls of locally-made brick.

a. Laid up with cement mortar.
b. Lime mortar w/cement mortar pointing.

Exterior bearing walls: 1½ bricks: .35m thick
Interior Walls: 1 brick: .23m thick
East + west end walls: 1½ brick + .05m air space + ½ brick = .52m thick
Reinforced site cast concrete lintels over windows and doors.
Bond beam of reinforced concrete at top of wall or at lintel line continuous all around building.
Walls untreated at exterior, plastered at interior with lime plaster, painted.

Option 2: Same as above, but using local stone where available.

3. ROOF SYSTEM/CEILING:

Roof surfaces are subject to extreme heat buildup causing movement and potential damage to surface edge conditions at gables and parapets and at material connection points. It is difficult to maintain a watertight roof under such conditions, even with the most advanced technology.

Galvanized corrugated sheet metal is the most common roof surface at all three locations, giving it the advantage of familiarity. It is capable of withstanding extreme heat, but requires careful detailing at edges and connections because of its tendency to move under thermal stresses. Prefinished enameled or plastic-coated metals should be considered for their long-term resistance to rusting. A suspended ceiling system must be used under the sheet metal to counter heat impact on spaces below. Ceiling spaces should be sealed to prevent entrance of insects, lizards, and bats.

Support for roofs needs to be steel or concrete in order to be durable. Wood roof structures in place at all three locales typically become infested with termites, regardless of treatment and maintenance.

Insulated metal sandwich panels should be considered for their insulating value and simplicity of erection, eliminating the need for a ceiling system.

Concrete, using cast-in-place or on-site precast systems should be considered as a suitable roof structure in conjunction with insulation panels and bituminous roofing, which has the ability to absorb extreme thermal differences. The great benefit of a concrete system is its inherent ability to delay heat transmission through its mass, and its relative thermal stability. The basic disadvantage is its need for cement in fairly large quantities. Past inadequacies in concrete forming must be addressed by employing reusable forms. Contractors estimate a cost penalty of around 15% for concrete roofs over conventional roof construction of corrugated sheets. Cast-in-place concrete is generally preferred due to erection problems with precast. Hoisting equipment is difficult to transport to Western sites. Also local labor is not experienced with precasting.

RECOMMENDATIONS: ROOF SYSTEM/CEILING

Option 1: Galvanized steel roofing sheets (sloped).
Steel trusses and purlins (fabricated on site).
Suspended ceiling (non-cellulose panels).

Option 2: Prefinished insulated metal sandwich panels (sloped). Bottom finished as ceiling (painted). Supported by steel framing and bearing walls.

Option 3: Bituminous roof surface, over Khafgi (lime compound) screed (slightly sloped), over insulation panels, over:

cast-in-place reinforced concrete slab (level) formed with reusable forms.

4. WINDOWS/DOORS/HARDWARE:

Steel, aluminum, and wood windows or doors all have to be imported. Steel and aluminum products are more expensive but durable. Wood products are subject to drying out, twisting, repainting and termite infestation. Hardware will have to be imported and should be of a brand for which spare parts are reasonably available.

RECOMMENDATION: WINDOWS/DOORS/HARDWARE:

Windows: Steel or aluminum sash and frame. Screens at all windows. Security grilles at non-residential windows at El Fasher and Ghazala Gawazet. Security grilles at all windows at El Obeid.

Doors: Flush wood or hollow metal doors in hollow metal frames.

Hardware: (Imported) Durable hardware for which spare parts available.

QUALITY CONTROL:

The Sudan is experiencing a serious manpower drain among skilled technicians and workmen who seek higher payscales outside the country. This is true of the building industry and results in a general lowering of the skill levels available, particularly away from the major cities. It is essential that this fact be recognized in the design and execution of the project.

Some critical requirements are:

a. Simple and effective way to evaluate and approve substitution submittals in advance of ordering.

b. Simple design and foolproof detailing. Tolerances as generous as possible consistent with good work.

c. Contractors superintendent at each site with requisite skills to maintain accurate layout, lines, and levels. English speaking.

Clerk of Works to check quantities and maintain records on day-to-day basis. English speaking.

d. Clear and enforceable specification provisions for workmanship. Standard specification references kept to absolute minimum with critical portions spelled out.

e. Simple means to assure accurate forming, placing, finishing, and curing of concrete.

f. Eliminate to fullest extent possible field fabrication of iron work. Shop cut and drill to template. Bolted connections. Avoid mortise locks, drill-in type preferred. Factory prepare doors and frames for hardware.

XI. PREFAB BUILDING SYSTEMS

The Trade Commissions in the United States for England, France, Italy, W. Germany, Sweden, and Switzerland have been contacted. Each has been asked to furnish a list of manufacturers of paneled or modular buildings which could be used in the Sahel Desert of Western Sudan. A total of 17 responses have been received to date.

The National Association of Home Manufacturers, U.S.A., Foreign Trade Council Members were contacted. From the list, 5 manufacturers have been telephoned. All use wood framing throughout which is judged unsuitable due to severe termite problems.

Light-gage metal framing manufacturers in the U. S. were contacted for names of fabricators who produce panelized buildings using light-gage framing. Of 10 fabricators contacted, none have yet provided information which shows the type of units they can manufacture. Most of these manufacturers could probably produce a quality product but only from complete contract documents.

As a basis of evaluating pre-fab systems, several criteria are assumed essential:

a. A flexible, modular system capable of producing the building designs developed for conventional construction with a minimum of modifications to either the designs or to the manufacturer's standard system of assembly.

b. Alternatively, predesigned standard units should be considered.

c. Tight roof systems with provision for heavy rain drainage.

d. Adequate thermal insulation.

e. Light-weight components of low maintenance: permanent, termite-proof.

f. Ease of assembly with semi-skilled crews and minimum special equipment.

Systems using wood as a major component have been ruled out preliminarily. Based upon recent experience, it is doubtful that treated wood will be termite-proof for the life of the building.

One system utilizing light-weight concrete panels is also deemed unsuitable because of cement shortages, transport and erection difficulties, and probable high cost.

Standard design plans submitted are more suied to western lifestyles than to the Sudanese and rely heavily on air conditioning for comfort control. Heavy electrical demands and lack of adequate parts and service make this undesirable.

Of those manufacturers quoting costs of standard units, all quoted dockside, Port Sudan. Sitework and construction of foundations would have to be by others. These costs plus cost of transport to the sites must be added to the unit costs to accurately assess overall costs. Trained expatriate erection crews were most often quoted as indeterminate extra cost.

Firms quoting terms of payment require 30 to 50% upon receipt of order with balance due upon shipment or arrival at Port Sudan. Under these conditions, there is very little leverage for correction of incomplete shipments, damage, or unacceptable workmanship in manufacture. Therefore, tenders should be source-to-site including erection.

At this point, four manufacturers have submitted data on products with potential for meeting the criteria. Sample data follows. Research is continuing and will be carried out through the project design phase.

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Graham Export

P.O. Box 70,
Windsor House,
Cornwall Road,
Harrogate HG1 2PA,
North Yorkshire,
United Kingdom.
Telephone: 0423-501641.
Telex: 57671-Graham.
Cables: Gramex Harrogate.

Your Ref.

Our Ref. GRF/FJT

Richard Burling, Esq.,
Campbell-Yost-Grube PC (Architects),
2040 SW Jefferson,
Portland,
Oregon 97201,
UNITED STATES OF AMERICA.

22nd April, 1980

Dear Mr. Burling,

We were interested to read of your World Bank/US Aid funded agricultural project in the Sudan.

As primary suppliers of building and construction materials based in the UK, we are already supplying a large scale project, "The South Darfur Rural Development" in the Sudan. We would be very interested to receive details of the contractors involved in supplying the prefabricated housing, etc. to this project, in order to contact them to offer our procurement services.

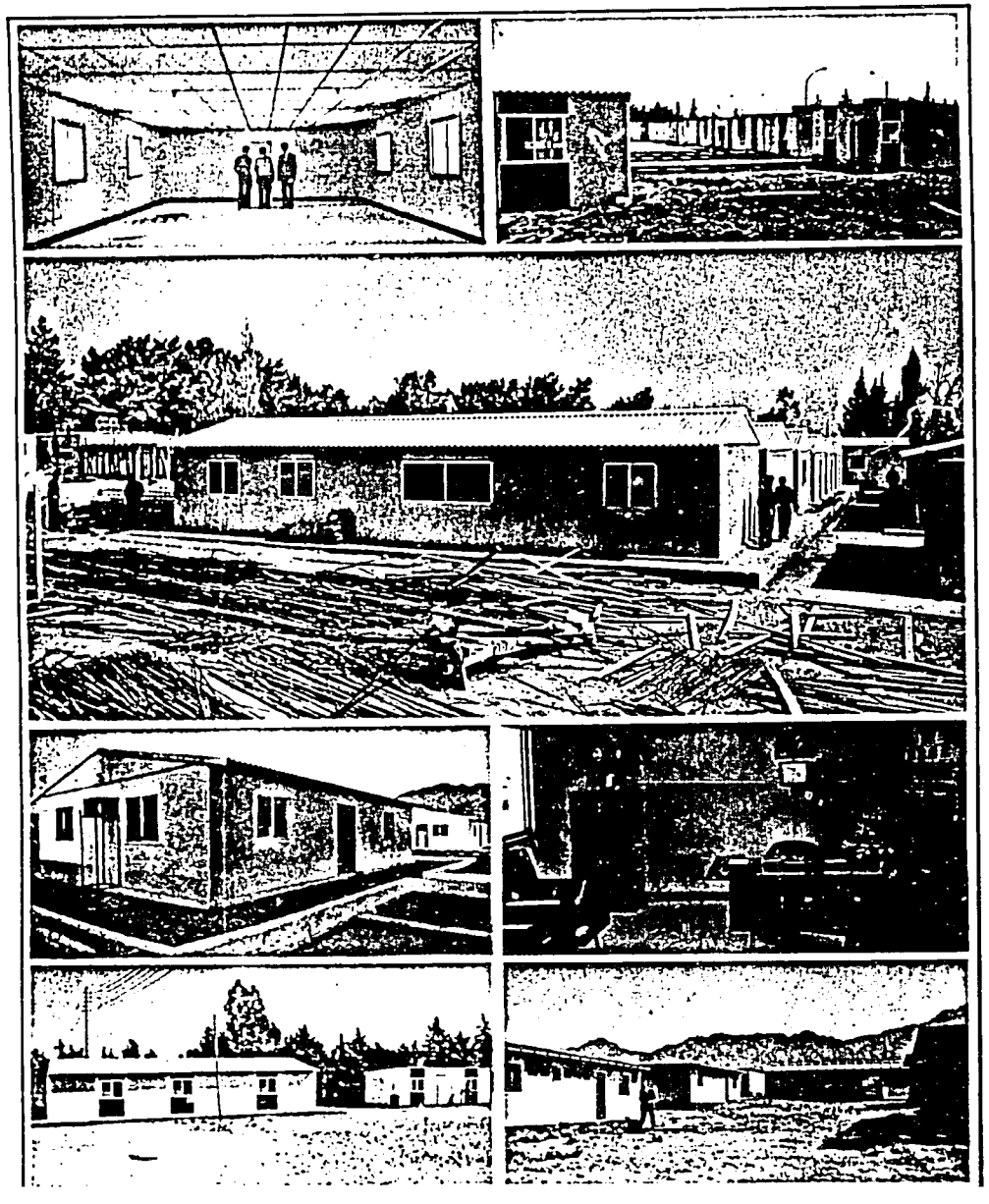
We are enclosing a brochure which describes the more general services we are able to offer for your information, and we look forward to hearing from you in due course.

Yours sincerely,

F. J. Thistlethwaite

pp G. R. Fowler
Managing Director

Enc.



Contractors and Military Camp Sites

Stocks

A quantity of all materials and equipment for site camps is kept in stock ready to move at a moments notice to any site.

Transport

400 square metres of building can be transported in one lorry. The buildings after use can be dismantled and re-erected on another site without loss of components.

Erection

We can provide Supervisors to direct local unskilled labour. Or provide erection teams to undertake the complete erection and provision of equipment and furniture for Canteens – Dormitories – Clinics and Offices.

The parts for all our buildings can be manhandled and no mechanical plant is required on the site.

Time

Eight workers can average the erection and finish of 150 square metres per week.

114

Introduction

This brochure gives you an impression of our prefabricated buildings.

The following pages give some idea of the large variety of work we have done, illustrated by photographs and typical layouts. These photographs alone cannot show the simplicity of design or how it can be adapted for any purpose; but our prices and low maintenance costs under the worst weather conditions, prove the prefabricated system is very economic.

●

Our experience has shown that occasions arise when accommodation is required and neither transport nor site labour is economically obtainable. These problems are overcome by the small size and compactness of the component parts. Every part can be manhandled and erected without any skilled labour or mechanical aid.

●

Our buildings are ideal for remote or developing areas. They are very competitive with other forms of prefabricated structures. The same basic parts can make a temporary and even a permanent building finished to the standard of traditional construction.

A simple concrete slab is all that is required for foundations. However, a prefabricated base with floor can be provided which requires no concrete.

We are at your disposal to discuss and prepare plans and suggestions to suit your special requirements.

We can supply all requirements quickly from our factory and warehouses. Erection teams are available to undertake all the work or supervise your own workforce at very short notice.

●

Quotations for a full turnkey operation with furniture, fixtures and fittings can be given.

●

A letter, telex or telephone call is all that is required to get our experience working for you.

Telephone: (01) 730 9105

Telex: 919645 CONPRT G

Conport Structures Ltd.,
11, Kings Road,
Sloane Square,
LONDON S.W.3

Specification

The building is assembled from standard components bolted together on a module of 1.23 m.

All parts can be manhandled and no cranes or special equipment needed for the erection.

Foundations
10 cm concrete slab. On soft or made up ground steel reinforcements and hardcore base will be necessary. Prefabricated foundations can be supplied.

Floor
(1) A cement screed on the concrete slab treated with a sealer, or with vinyl or mosaic tiles.

(2) Or floor grade chipboard with a sealer.

Walls
Insulated sandwich panels of any suitable material such as metal sheet, hardboard, plywood or plastic giving a U value not more than 0.5 W per m^2 (0.13 BTU/ft^2/°F). The panels are simply fixed into load bearing sections and anchored to the base through a perimeter angle.

Partitions
Similar to external walls, or wall board on timber or metal studding.

Roof
20 to 22 gauge (0.9 – 0.7 mm) steel trough section sheets galvanised or plastic coated.

Ceiling
Suspended on a standard grid system with ceiling tiles of suitable materials. Glass wool in the roof cavity will provide extra insulation.

Windows
Standard or purpose made windows of any size within the module. Shutters, bars and blinds can be fitted.

Doors
Standard, aluminium, timber or steel, double or single.

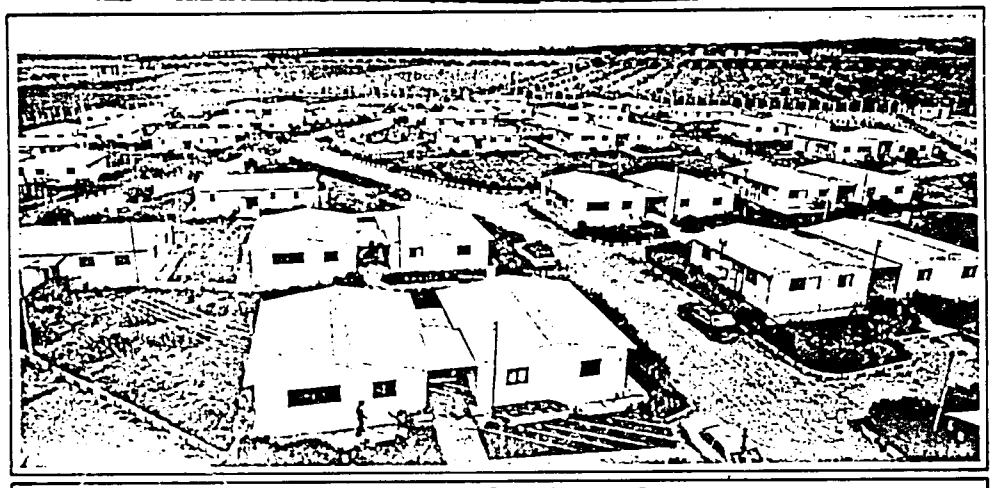
Electrics
Prefabricated wiring to customers requirements is provided in the roof cavity and wall panels ready for connection to mains.

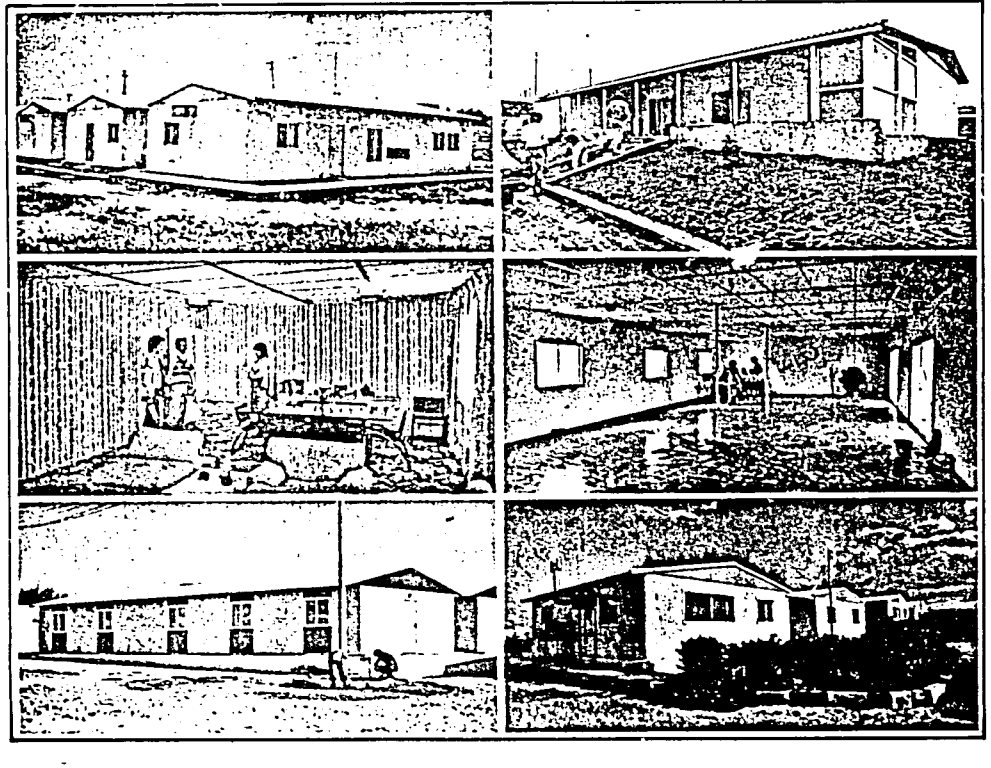
Paint
The external walls are sealed with an elastic plastic paint suitable for the appropriate climatic conditions.

Internal decoration with emulsion paint or as required.

Plumbing
Prefabricated plumbing to customers requirements for connections to mains or complete with prefabricated septic tank.

Sundries
Air conditioners for each room cooling or cooling and heating. Underfloor heating or any other form of heating specified.





Housing, Schools and Offices

The unit construction allows a great variety of plans and sizes from a small variety of parts.

As all parts can be manhandled, no mechanical equipment is required for erection.

External finish and internal decoration can be carried out to the clients requirements to give a most attractive appearance to harmonize with the local conditions and surroundings.

We can supply complete buildings erected on site and fully equipped.

MULTIPURPOSE U.K. LTD
REGISTERED TRADE MARK

DEMOUNTABLE STEEL MILITARY/SECURITY BUILDINGS EMERGENCY HOUSING
Reg: Office RYE HARBOUR ROAD. RYE, EAST SUSSEX TN31 7TE
Telephone: (07973) 3307/3495 Telex: 95242 MULTIB

MRM/SM/80402

3 April 1980

Campbell-Yost-Grube PC
Architects
2040 SW Jefferson
PORTLAND OREGON USA

For the attention of Mr Richard Burling

Dear Sirs

PREFABRICATED HOUSES - SUDAN

We understand from our Department of Trade, London, that you would like to hear from firms such as ourselves in connection with housing to remote sites. Accordingly, we have pleasure in forwarding enclosures.

We have supplied our building system to Australia, West Africa, Middle East and Yemen Arab Republic, and have wide experience in the type of housing that you have specified.

The enclosures are intended for introduction and we shall be pleased to answer any questions arising thereto.

Meantime, we would like to be included in the tender list and look forward to hearing from you in due course.

Yours faithfully
MULTIPURPOSE UK LTD

M R Musselt
Director

ENCS

SOLE MANUFACTURERS & SUPPLIERS

multipurpose buildings limited

Reg Office:
RYE HARBOUR ROAD
Telephone: (07973) 3307/3495

RYE
Cables: MULTICLAD, RYE

Reg No. 534880 (Eng)
EAST SUSSEX ENGLAND
Telex: 95242 MULTIB

M B
REGISTERED TRADE MARK

DESIGNED FOR THE MIDDLE EAST

LIVING OR WORKING ACCOMMODATION:

FOR LABOUR CAMPS

DEVELOPMENT SITES

MILITARY PERSONNEL

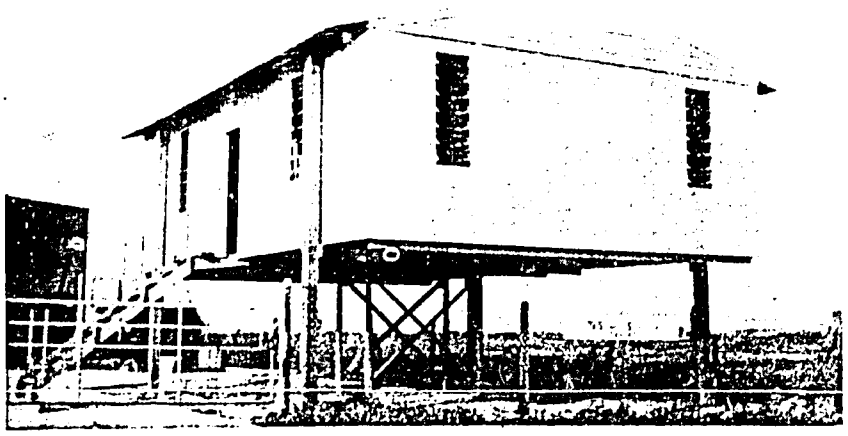
SITED ABOVE GROUND

or

AT GROUND LEVEL

70 m² plus FLOOR AREA

CAN BE ERECTED BY UNSKILLED LABOUR UNDER SUPERVISION, IN LESS THAN 8 MAN HOURS PER m²

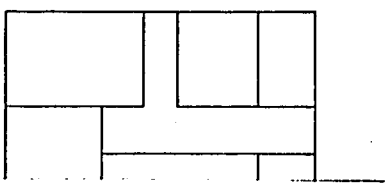


UNIT ABOVE GROUND GIVES SHADED PARKING FOR VEHICLES

(OR CAN BE ENCLOSED TO MAKE TWO STOREY BUILDING)

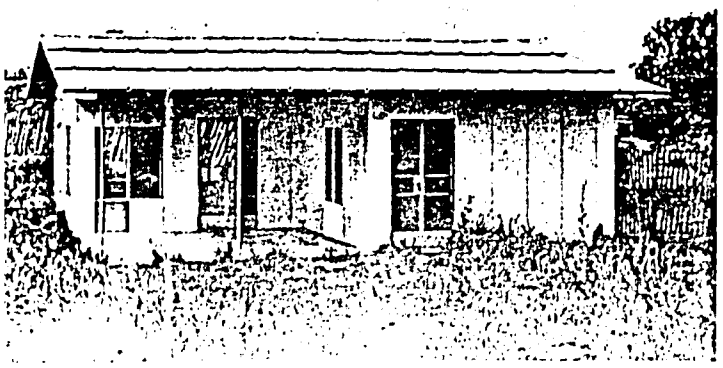
SHIPPED IN ONE x 40ft CONTAINER

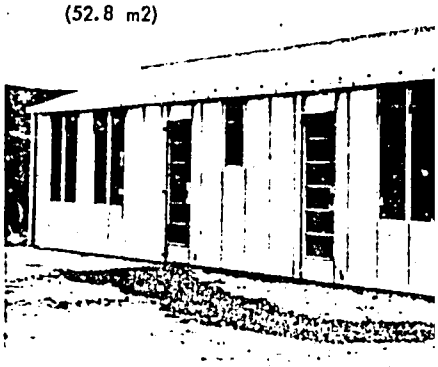
TYPE A
Living room, 3 bedrooms,
kitchen and bathroom.
Verandah at each end.



MULTIPURPOSE BUILDING

12 m x 4.4 m x 2.4 m to eaves
(52.8 m2)





MULTIPURPOSE HOUSING UNITS

PREFABRICATED IN STEEL or ALUMINIUM

• • •

COLOUR-COATED THROUGHOUT

• • •

SHELL (1)

The Multipurpose Building System consists of completely weather-tight outer skin of 300 mm or 500 mm wide Multiclad sheets, connected to skeleton framework by means of steel tierods running the entire length of sheeting.

For spans up to 6 metres, no trusses or purlins are required, therefore it is cheaper to produce and faster to erect. No special foundations are necessary - the site must be level and firm with either spot concrete bases or concrete slabs.

Including wh' ·eiling tiles, with insulation pads, and concealed grid system.

(Partitions, doors, wall insulation, and internal lining, from local resources).

OPTIONAL

(2) Supplied complete with Euroclad liner and insulation, partitions and doors, electrical wiring harness and fittings.

(3) Supplied with bathroom and kitchen equipment, air conditioning.

(4) Above Ground Units with staircase. Recommended for sites near coast or rivers liable to flood.

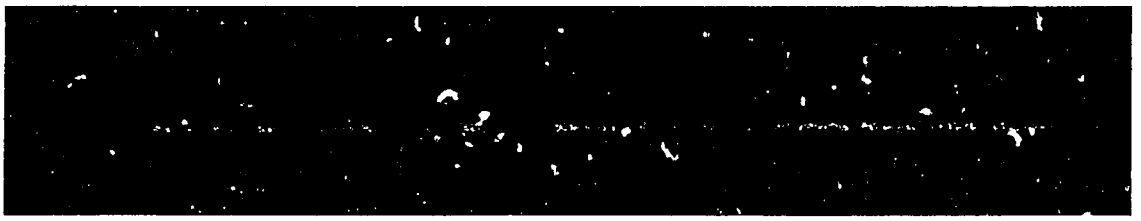
• • •

DESIGNED FOR THE MIDDLE EAST - GENERAL SPECIFICATION

Approximate dimensions:	10 x 7 x 5 metres to eaves
Construction:	Multipurpose Building System - mounted on four stanchions for above ground unit
Framework:	Steel sections bolted together on site
Roof:	MULTICLAD sheeting in 0.7 mm colour coated galvanised steel
External Walls:	MULTICLAD insulated double skin - 75 mm insulation - tierod fixing. Surface finishes in different colours
Windows or Louvres:	9 no. size 1m x 1m approximately
Ceiling:	Metal ceiling tiles on steel grid system, with insulation pads
Floor:	MULTICLAD galvanised decking; insulated chipboard panels
Partitions:	EUROCLAD insulated double skin on timber grid
Internal doors:	6 no. Sapele finish flush doors 1981 x 762 complete with locks and hardware
Bathroom equipment:	Shower / Hand basin / Heater. Toilet and low level cistern
Kitchen equipment:	To order
Electrics:	Lighting, heating, and power points, complete with switchgear
Air Conditioning:	To order
Water supply:	Special pump provided to serve bathroom and kitchen requirements
Foundations: ***	Four spot concrete bases for stanchions: approx. 762 x 762 1500 depth * * according to site conditions Each stanchion is set on four holding down bolts. Concrete slab for ground level unit
***by others	
Standard colours:	Green / Sand / White / Grey (other colours to order- refer BSC colour cards)

NOTE: BSC Silicon Polyester colours for exterior (or interior)
BSC Colourcoat Leather Grain for interior only

120



Evolution du procédé Tramacier homologué le 28.7.75 par le Ministère de l'Education.

Utilisations :
Classes d'enseignement général.
Bureaux tous standings ; locaux scolaires, sociaux et d'accueil ; banques ; services sanitaires, hôpitaux... Restaurants, réfectoires, cuisines... Dortoirs...
Tous logements évolutifs, sociaux et de standing.

Caractères originaux :
Technique de panneaux porteurs + éléments porteurs incorporés aux panneaux.
Conception mixte, panneaux porteurs et intermédiaires de remplissage alternés.
Toutes dispositions architecturales envisageables.

Modulation :
Façades et pignons : 1,50 m avec panneaux porteurs de 0,50 m et intermédiaires de 1 m.

Portées :
4,50 - 6,00 - 7,50 - 9,00 - 10,50 m.
Toutes dimensions par accolement avec interposition de portiques.

Structures :
● Haute
Poutres Galvapoutre, brevetées, profilées à froid et galvanisées, supportant des pannes de hauteurs différentes qui déterminent la pente de la couverture.
Poutre au vent, horizontale, entre pannes centrales.
Chaînages de façades réalisés par les chéneaux.
● Verticale
Panneaux porteurs.
● Basse
L acier galvanisé périmétrique scellée dans les fondations.

Couverture :
Bi-pente, faible, 1,2 à 2 %, sans faîtière.
Bacs autoportants acier galvanisé B, épaisseur 63/100°, type UNINERVA avec larmiers en bas de pentes et solins en pignons.
Ventilation par les ondes des bacs de couverture renforcée sous bandeaux par ouverture permanente.
Chéneaux sur façades, acier galvanisé, épaisseur 15/10°.
Descentes EP, extérieures, rectangulaires 90 x 70 en PVC.

Parois extérieures :
Panneaux sandwich, épaisseur totale 40/41 mm avec :
● Ame isolante, mousse polyuréthane, expansée, in situ.
● Parements extérieur et intérieur, tôle galvanisée, revêtement Organosol strié. Coeff. k ≤ 0,53.

Development of Tramacier design officially-approved by the ministry of Education on July 28th 1975.

Uses:
Classes for general teaching.
Offices of all standings: buildings for schools, social uses, reception; banks; sanitary facilities, hospitals... Restaurants, dining-halls, kitchens... Dormitories...
All kinds of lodgings: evolutive, social and luxury buildings.

Special features:
Engineering: bearing panels and bearing parts incorporated in panels.
Mixed type design, bearing panels and intermediate fill panels alternately.
All kinds of architectural designs are possible.

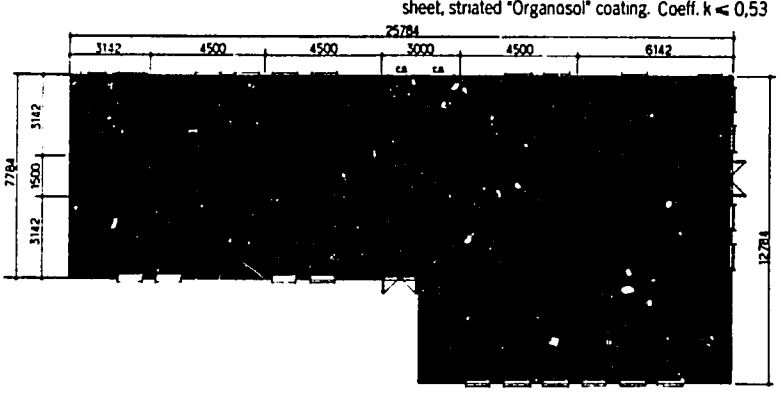
Framing:
Front walls and gable ends: 1,50 m, with 0,50 m wide bearing panels and 1 m wide intermediate panels.

Bearing:
4,50 - 6,00 - 7,50 - 9,00 - 10,50 m.
Other dimensions by coupling and use of intermediate crossbeams.

Structure:
● High
"Galvapoutre" (patented) type beams, cold rolled and galvanized, bearing trusses of different heights which determine the slope.
Attic beams running perpendicular to central purlins.
On front walls: gutters forming top bond beams.
● Vertical
Bearing panels.
● Low
Galvanized steel-shaped bond beam fixed in foundations.

Roofing:
Double-slope, gentle, 1,2 to 2%; no ridge.
Self-supporting galvanized steel gutter throughs, class B, 63/100 thick, "Uninerva" type; with turn-up into lower part of slope and flashings at gable ends.
Ventilation through trough corrugations and permanent opening under cornice strip.
Gutters on each front wall: galvanized steel, thickness: 15/10.
Rainwater collection: external, rectangular PVC, 90 x 70.

External walls:
"Sandwich" type panels; overall thickness: 40/41 mm, with:
● Insulating core: expanded polyurethane foam, in situ.
● External and internal cladding: galvanized steel sheet, striated "Organosol" coating. Coeff. k ≤ 0,53



Bandeau :
Périmétrique en aluminium strié ou en acier galvanisé revêtu d'Organosol strié.

Menuiseries extérieures :
● Châssis
ALU, suivant normes AFNOR et DTU, sans oxydation anodique (en option).
Dimensions : H = 1,50 m et 0,50 m, l = 1 m
soit fixe, soit ouvrant, coulissants, à la française, à l'italienne.

Cornice strip:
Peripheral; striated aluminium or galvanized steel with striated Organosol coating.

Frames:
● Types
Aluminium, meeting AFNOR and DTU regulations, anode oxidation if requested only.
Dimensions: H = 1,50 m and 0,50 m, w = 1 m.
Either fixed or opening, sliding, opening inwards or push-out type. Latch.

Fermeture par [illegible]
Pose par emboîtement [illegible] : [illegible]eaux porteurs latéraux, avec allège [illegible]
En option : volet [illegible] et extérieur, stores, toile avec ou sans [illegible] [illegible]chaînettes.

● Vitrage
Suivant normes, [illegible] (en option)
Pose sur joints [illegible] et [illegible]loses ALU

● Portes
Tout ALU, suivant [illegible], sans oxydation anodique (en option)
1 et 2 vantaux : 1 m et 1,60 m sur [illegible] = 2,40 m, ouvrants extérieur et intérieur, [illegible] par des panneaux identiques à ceux de façade avec finition des chants verticaux en ALU (acier en option)

Plafond:
Sous poutres ; H sous = 2,50 m
Ossature du plafond apparente ou non
Matériaux utilisés
- laine de verre, face apparente PVC (Spanglass),
- fibre minérale, face apparente PVC ou peinte (Owacoustic ou similaire),
- placoplâtre, face apparente PVC,
- plâtre moulé armé ou non avec incorporation de l'isolation en mousse de polyuréthane.

Isolation Calorouate 96 PAF, coeff. k ≤ 0,8.

Plancher bois :
Parquet lames à fanglaise 22/24 mm, pin maritime, classe B, normes NF B 54003, label CTB ou platelage aggloméré, 24 mm, montage par languettes ; solivage sapin 110 x 75 à 0,50 m – traitement insecticide et fongicide Surcharge : 250 kg/m².
Repos sur chaînage bas et retends - V.S. : 0,165 m avec ventilation. Isolation Calorouate 96 PAF avec polyane en sous face ; coeff. k ≤ 0,8

Cloisons :
Sobalac, Clips, Leroy ou similaire
Epaisseur 50 mm
Revêtement PVC borde ou non, 2 faces.
Implantations bois ou PVC : lisses hautes et liaisons sur façades ALU. Languettes plastiques (H. ALU en option)
Plinthes bois (ALU en option avec ou sans porte fils).
Affaiblissement phonique : 29 db

Menuiseries intérieures :
Portes type isoplane, à feuillures, âme alvéolaire, laquées 2 faces, équipées en usines.
Huisserie plastique à aiguille avec linteau incorporé de même qualité que les portes ;
Dimensions : 0,63 - 0,73 - 0,83 m sur 2,04 m de hauteur.

Montage :
Aisé : outillage spécialisé ni engin de levage.
Au[illegible]ece de plus de 50 kg. Récupération à 100

Fondations :
● Dalle béton, avec réservation périphérique
● Plancher bois, sur muret périphérique et refends en parpaings - semelle béton.

Peinture :
Néant. Tous traitements exécutés en usines.

Electricité
Chauffage
Conditionnement d'air
Plomberie
Sanitaires
Revêtements de sols
] Tous travaux exécutés à la demande.

En vente uniquement.

Bonding with lateral bearing panels, basements and lintels.
Optional: Aluminum external rolling shutters, cloth blinds, mosquito nets.

● Glazing
According to regulations, ordinary or double glazing ("Thverre" type) if requested.
Fixed by means of Neoprene seal and aluminum bead

● Doors
Aluminum exclusively, meeting regulations and DTU specifications, anode oxidation if requested only
1 and 2 leaves : 1 m and 1,60 m, H = 2,40 m
Opening, inwards or outwards
Leaves made of panels similar to front panels with aluminum finishing on edges (steel if requested).

Ceiling:
Under beams. Height under beams : 2,50 m
Metallic frame, visible or not
Materials used
- fibre glass, visible face : Spanglass type PVC,
- mineral fibre, visible face : painted, or PVC, Owacoustic type or similar,
- Placoplâtre, visible face : PVC, etc.,
- moulded plaster, reinforced or not, with insulating Polyurethane foam.

Insulation by "Calorouate" wadding, 96 PAF type. Coeff. K ≤ 0,8.

Parquet flooring:
Pinewood strips laid in conventional British manner (maritime pine), thickness : 22/24 mm, class B, C.T.B. Label, French standard: NF B 54003, or fibreboar 1-24 mm thick- tonging and grooving; fir joisting: 110 x 75, spaced 0,50 m. Insecticide und fungicide treatment. Live weight: 250 kg/sq.meter.
Laid on bottom peripheral bond beam and cross beams. 0,165 m clearance for venting.
Insulation by Calorouate wadding, 96 PAF type, with Polyane sheet on under face. Coeff. K ≤ 0,8.

Partitions:
SOBALAC, CLIPS, LEROY or similar types 50 mm thick.
On both faces, PVC coating covering edges or not.
Mounted on wood or PVC. Top bonding and bonding on front walls in aluminum. Plastic tongues (H shaped aluminum if requested)
Wooden skirting (aluminum if requested, with or without passage for wires)
Sound damping: 29 db

Interna doors:
("Isoplane" type) flush panels, cavity core, enamelled on both faces, factory equipped.
Reinforced plastic frame incorporating lintel of same material as the doors themselves.
Dimensions : 0,63 - 0,73 - 0,83 m, H : 2,04 m.

Erection:
Easy : no special tool, no lifting device required
No part weighing more than 50 kg. 100% re use.

Foundations:
● Concrete slab, with peripheral pocket.
● Parquet flooring: on hollow block boundary and cross walls – concrete ground plate.

Painting:
No painting; all coatings made at works.

Electricity
Heating
Air-Conditioning
Plumbing
Sanitary installations
Floor covering
] On request.

For sale only.

algeco

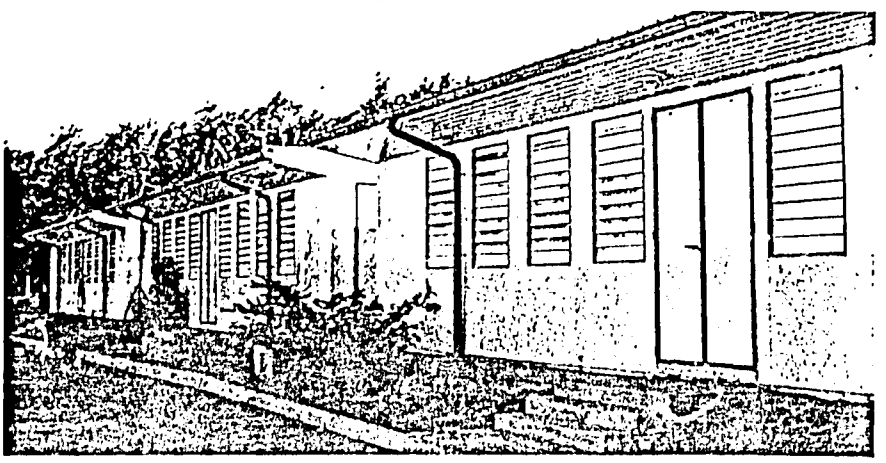
Vente et location de toutes constructions mobiles et industrialisées. En France : 5 agences, 26 dépôts. La Société Algeco se réserve le droit de modifier à tout moment et sans préavis ses modèles pour les améliorer ou pour leur conférer un ordre commercial et conditionnel.

Algeco [illegible] 30 Paris Cedex 01 - Tél. [illegible] - Tx [illegible]

algeco

Sale and hire of all mobile and industrialized units. In France : 5 branches, 26 depots.
Algeco hold the right to modify their models at any time and without notice to improve them or meet any commercial and conditional requirement.

C.C.R.P. Paris R.C. Mâcon B 685 550 559 - Printed in France.



Geoffrey Purves and Partners
chartered architects

8 North Terrace
Newcastle upon Tyne
NE2 4AD
telephone 0532 20424
telex 53440 CHAMCO G GPP

GP/JH

16th April 1980

Mr. Richard Burling,
Campbell-Yost-Grube PC,
Architects,
2040 SW Jefferson,
Portland,
Oregon 97201,
U. S. A.

Dear Mr. Burling,

Low Cost Prefabricated Units For Sudan

I was pleased to speak to you on Tuesday afternoon in connection with your firm's search for a suitable prefabricated housing and agricultural laboratories system for your project in the Sudan.

We act as consultants to the Hungerford-Schroeder Organisation and a copy of their brochure describing a system I believe will be suitable for your requirements is enclosed.

I am leaving the U.K. for a trip to Eygpt and Saudi Arabia tomorrow which will last approximately 7/8 days and look forward to hearing from you on my return. Perhaps I should add that through the University of Newcastle upon Tyne School of Architecture, where I am a part-time lecturer, we have a highly specialised post graduate course in housing for developing countries. Our connections with Khartoum University and the Sudan in general are excellent, and we would be pleased to assist you if at all possible.

Yours sincerely,

Geoffrey Purves

A. G. Purves

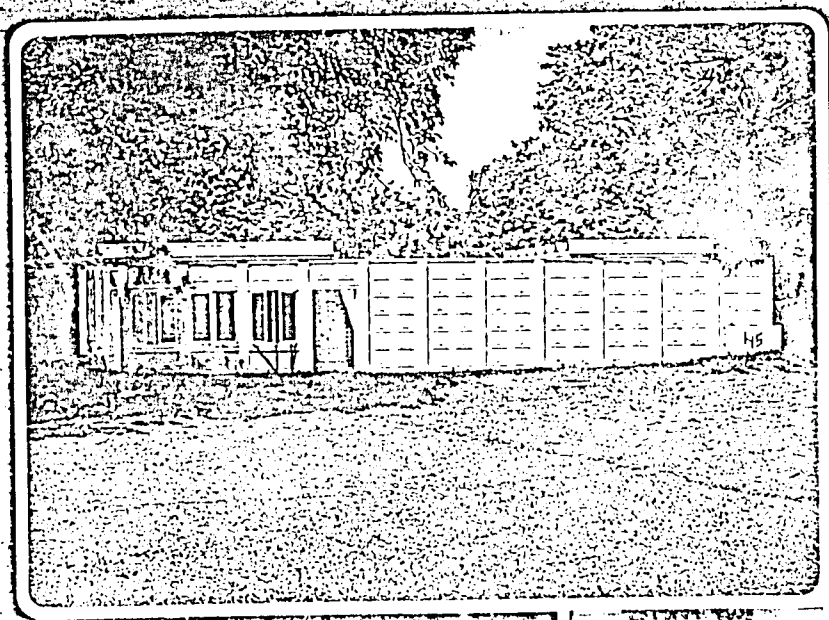
Enc.

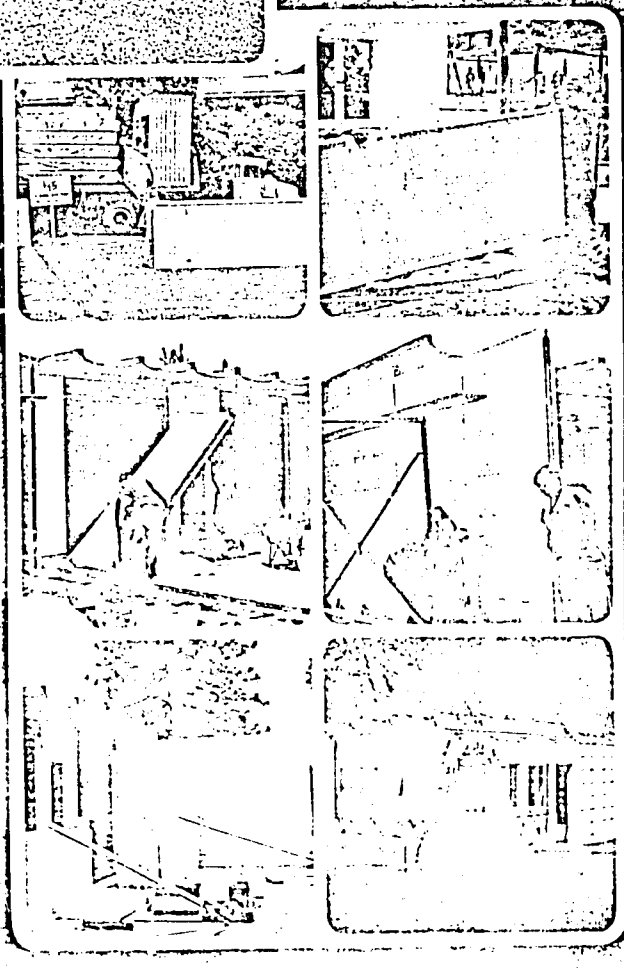
cc: Mr. D. Schroeder

A Geoffrey Purves BA BArch RIBA ARIAS
Nicholas A McPherson BA BArch RIBA
Peter L Horneycroft BA BArch RIBA

in association with
Household Purves and McPherson
London and Maseru

the HS modular building system





a new approach to single level building construction using standard components

The System

THE H.S. BUILDING SYSTEM IS A RADICALLY NEW PATENTED APPROACH TO BUILDING CONSTRUCTION, FACILITATING THE EXTREMELY RAPID ERECTION OF LONG LIFE, MAINTENANCE FREE, ARCHITECTURALLY SATISFYING STRUCTURES.

THE CRITERIA OF THE SYSTEM INCLUDES:

- Relatively few (basically three) standardised, lightweight, factory finished components comprising wall panels which in the case of window and door panels, are factory glazed and fitted with doors, column joints and roof/ceiling units.
- Readily transportable without special packing.
- Non-critical foundation requirements.
- Rapid construction requiring only spanner, spade and hammer for tools.
- Permanent quality of construction yet permitting recovery of components and re-use.
- Modular design permitting completely unrestricted flexibility of architectural arrangement of the building plan on the basis of a 1,2 metre grid module.
- Structures ready for occupation immediately after erection and floor laying, no finishing work required.

CONSTRUCTION PROCEDURE

- Site levelling (cut and compacted fill).
- Setting out of a 1,2 metre grid using roof units as position marker for steel reinforcement spikes placed at positions of wall joint columns.
- Digging of wall joint columns plinth holes measuring approximately 0,3 metres square to a depth suitable for soil conditions.
- Filling of plinth holes with concrete.
- Assembly of wall panels bolted top and bottom with column joints clipped into place.
- Levelling of panels with wedges simply by sighting one panel against another.
- Placing and bolting of roof units on top of the panels together with the simultaneous filling of columns with masonry/concrete grout.
- Pouring of concrete floor slab and outer wall surrounds to levels established by moulded in screed lines on panels.
- Electric wiring of building as required using conduit paths moulded into panels.
- Installation of sanitary fittings and modular plumbing piping.
- Finally cleaning of building using scouring soap if necessary followed by placing of ceiling tiles and laying of floor coverings.

BASIC MATERIAL

The basic material employed in the manufacture of the components is glassfibre reinforced plastic, surfaced with a maintenance free pigmented gelcoat surface.

A wide variety of colours is available and in the unlikely event of damage the material is easily repairable. Normal experience indicates a life of surface finish of up to 15 years in outside applications and indefinite life for the interior surfaces.

WALL SYSTEM

The panel and column joints which comprise the wall system provide for a finished floor to ceiling height of 2,6 metres and a 1,2 metre plan module.

The panels are of composite construction to ensure adequate strength, superior insulation value (thermal and acoustic) and have a high fire resistance rating. There are four basic types — a plain panel, a large window panel, a small top hung window panel and a door panel. These panels are available in various combinations of flat or profiled surfaces to customers choice.

When assembling the wall systems panels are bolted top and bottom with brackets in accordance with the plan. The column joint covers clip into place forming voids into which concrete grout is poured to form masonry columns every 1,2 metres resulting in an enormously strong structure.

The panels are lightweight and easily handled, weighing in the case of a plain panel some 45 kg.
The system therefore is a rapidly erected structure of masonry columns on 1,2 metre centres incorporating decorative, factory finished, insulated infill panels.

ROOF SYSTEM
Roof/Ceiling units which are available in spans of 3,4,5,6, and 7 modules of 1,2 metres, are self contained assemblies incorporating integral beams.

The ceiling mouldings take the form of a decorative and pleasing arrangement of cornices and panel recesses which accommodate any plan arrangement of the wall panels.

The units which are able to support a live load of 70 kg per metre squared are nevertheless easily handled, the 7 module span unit weighing approximately 100 kg.

Bolting the roof units to the wall panels by means of bolts in the panels completes the "Box" of the structure, resulting in strength and rigidity.

Rainwater disposal is provided for by moulded-in falls to roof sheets running to either ends of the roofs. These are shaped to facilitate the fitting of standard pattern P.V.C. gutter systems. Water is then drained to ground level or alternatively stored in gable end tanks which are also available with built-in solar heating panels.

CEILING SYSTEM
Each module of the roof units is provided with a pre-painted, plastic wrapped gypsum board panel, which completes the ceiling.

ELECTRICAL
Moulded into the panels are conduit paths facilitating the installation of electrical fittings and cables, all of which considerably reduce the cost of the electrical installation.

PLUMBING
The design provides for factory assembled piping systems within the confines of the structure made possible by the modular concept of the H.S. Building System and therefore requires only the site joining of a small number of couplings during erection which tasks would be performed by the operatives assembling the strucuture.

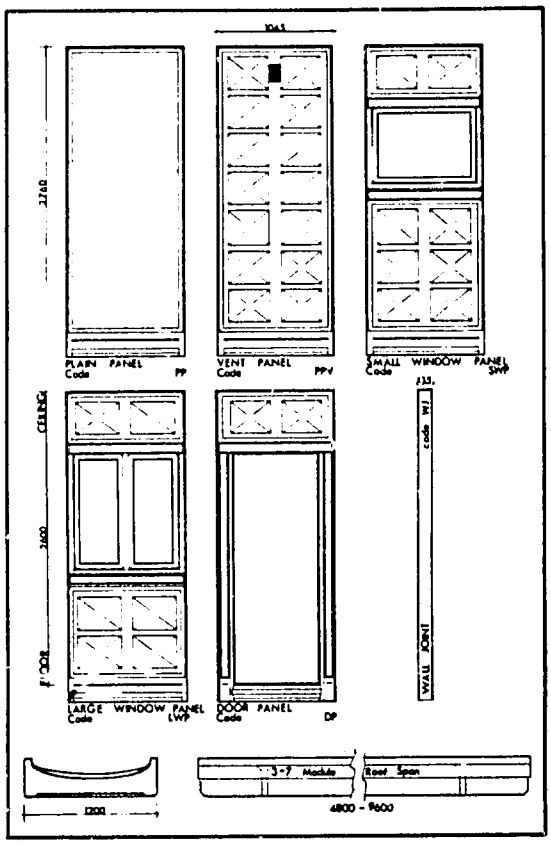
FLOORING
Standard flooring technique is the application of concrete on top of a plastic dampcourse, screeded to marker lines moulded into the panels, the screed being surfaced with flooring material to choice as required.

TRANSPORT
The components are extremely robust and resistant to structural damage and surface abrasion and in fact do not normally require packing for protection in transit. Shipping volume of a typical housing plan is approximately 0,50 cubic metres for every square metre of plan floor area.

TESTING AND DEVELOPMENT
The system is under constant development for improvement and extended application. The right therefore is reserved to make modification without notice.

Development has taken place for approximately five years and the system was patented in March, 1973.

The Components



Extensive testing has taken place to prove the adequacy of the concept and the practicability of the techniques.

Independent bureau testing was conducted with certification in conformity with standard building regulations and these tests included:

a) ability to provide for structural capability to meet live and static roof loads.
b) ability to meet lateral imposed wall loadings.
c) ability to meet impact damage criteria.
d) ability to resist moisture penetration through panels and joints.

DURABILITY
Glass reinforced plastic is acknowledged to be one of the most durable materials available today. This material is employed in the construction of shipping (including large warships). As a walling material glass reinforced plastic has an extensive maintenance free life span.

FLEXIBILITY AND EXTENSIBILITY
The system enables total flexibility of wall arrangement and provides also for the ready extension of construction, room-by-room, as well as for the dismantling of the components and the removal of the structures to an alternative location.

APPLICATION
The concept has many applications. These include housing, ranging from single units to townships, motels, schools, shopping units and office complexes and all manner of single level construction.

Thyssen Bausysteme GmbH Postfach 10 05 80 4220 Dinslaken

THYSSEN BAUSYSTEME GMBH

Grube, Zimmer, Inc.
Planning, Architecture, Engineering
c/o Mr. Richard Burling
2040 S.W. Jefferson St.

Portland, Oregon 97201
USA

Hagenstraße 2 · Einfahrt B 8
4220 Dinslaken

Ihre Zeichen	Ihre Nachricht vom	Unsere Zeichen	Durchwahl (0 21 34) 68	Dinslaken
		120 jvd/deh	8514	April 21, 1980

Betreff

re.: THYSSEN-House System

Gentlemen,

with reference to your inquiry of March 25, 1980, regarding prefabricated buildings for the Western Sudan Agriculture Research Project we would like to submit our price estimate of THYSSEN House System Type "E" based on todays material-, labour-, and freight-charges. In order to forward a detailed quotation we would need to know more details,i.e. lay-out, finishes, delivery-period, etc., and in particular more data regarding the offices and laboratories. However, enclosed please find some lay-outs indicating a few possibilities, a technical description, a brochure, and a few pictures representing our system "E". Please notice the window decorations of steel bars which can be provided for an additional charge, also kindly notice the excellent insulation. The co-efficient of heat transmission (k) of the double shelled wall is o.44 which represents a brick wall thickness of approx. 500 mm.

/2 -

Sitz der Gesellschaft: Dinslaken · Registergericht: Dinslaken HR B 1249
Vorsitzender des Aufsichtsrates: Dr. Ernst Höffken
Geschäftsführung: Gert Frensemeyer (Vorsitzender),
Ernst Dieter Haberkorn, Rainer Bröcker (stv.), Heinz Rosenstock (stv.)

Telefon: (0 21 34) 8 81 Telex: 08 551 933

		sqm/lay-out-No.			
		204 sqm E/GR-002	288 sqm E/GR-0067a	121 sqm E/GR-0109a	143 sqm E/GR-0110a
Building ex factory without concrete-slab	DM	308,-	345,-	375,-	370,-
Electrical installation	DM	26,-	26,-	26,-	26,-
Sanitary installation	DM	16,-	18,-	48,-	41,-
Freight up to Port Sudan	DM	175,-	175,-	175,-	175,-
Estimated TOTAL c+f Port Sudan	DM	525,-	564,-	624,-	612,-
Weight/building approx.	to.	33	46	20	23
Volume/building approx.	m^3	123	173	73	86

Erection time equals approx. 1.8 man-hrs/sqm.

Delivery can commence within 10-12 weeks after clearance of all technical and financial matters.

Terms of payment: 30 % with receipt of order

70 % by an irrevocable letter of credit confirmed by a major German bank, payable latest 7 days after notice of dispatch readiness.

Hoping that this information will find your approval, and assuring you to be of service at all times, we remain,

yours sincerely,

THYSSEN BAUSYSTEME GMBH

Encls.

ANLAGE NR:

DATUM:

ANGEBOT NR:

AUFTRAG NR:

ZEICHNUNG NR:

THYSSEN HAUS SYSTEM
TYP: "E" Wärmegedämmt

TECHNISCHE BESCHREIBUNG

1) Fundamente/Fußboden

Auf die vom Kunden vorbereitete Beton-Bodenplatte, die mit den Aussparungen für die Ver- und Entsorgungsleitungen versehen ist, wird die Stahlkonstruktion mittels Dübel befestigt.

Die Ver- und Entsorgungsleitungen für Wasser und Strom sind vom Kunden bis Oberkante Beton-Bodenplatte heranzuführen. Die erforderlichen Zeichnungen für die Ausführung der Beton-Bodenplatte werden dem Kunden kostenlos zur Verfügung gestellt.

2) Stahlkonstruktion

Die Stahlkonstruktion besteht aus Fachwerkelementen. Die einzelnen Fachwerkelemente werden vertikal und horizontal verbunden. Sie übernimmt alle Lasten sowohl des Daches als auch der Wände und der Windlasten.

3) Raumdecken und Dachaufbau

Das Dach ist als be- und entlüftetes Zweischalen-Flachdach ausgebildet. Es besteht aus der Dachoberschale und der Raumdekke. Dazwischen liegt die feuerverzinkte Unterkonstruktion.
Die Raumdecke besteht aus THYSSEN-Thermowand VE 30. Dachoberschale Trapezprofil T35/200 kunststoffbeschichtet.

TECHNICAL DESCRIPTION

1) Floor/Foundation

The steel supporting structure will be fixed to the concrete slab with the cutouts for the supply and retake lines by means of dowels. This concrete slab has to be prepared by the customer.

The supply and retake lines for water and electricity have to be provided by the customer up to the top edge of the concrete slab. The necessary drawings for the execution of the concrete slab will be placed at the customer's disposal free of charge.

2) Steel Supporting Structure

The steel supporting structure consists of frame work elements. These frame work elements will be tied together vertically and horizontally They support all the load of the roof as well as of the walls and of the wind.

3) Ceiling of the Rooms and Roof

The roof is a two-shell type ventilated flat roof. It consists of the upper shell of the roof and the ceiling of the rooms. Between them the hot galvanized under-structure is located. The ceiling of the rooms consists of THYSSEN thermal wall VE 30. Upper shell of the roof consists of trapezoidal sheel T 35/200, plastic-coated.

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4) Wände

Die Außen- und Raumtrennwände bestehen aus THYSSEN-Thermowand VE 30, kunststoffbeschichtet.

Sie werden von beiden Seiten an der tragenden Stahlkonstruktion angebracht.

Somit entstehen doppelschalige Wände mit einer Dicke von ca. 120 mm.

4) Walls

The external and room separating walls consist of THYSSEN thermal wall VE 30, plastic-coated. They will be fixed to the steel supporting structure from both sides.

So double-shelled walls with a thickness of 120 mm come into existence.

5) Fenster

Die Fensteröffnungen sind mit stranggepreßten natureloxierten Alu-Profilen eingefaßt. Die Verglasung der Fenster in Kristallspiegelglas 5 mm.

5) Windows

The window openings are bordered with extruded, nature-anodised aluminium sections. Glazing of the windows with crystal glass 5 mm.

6) Türen

Die Außen- und Innentüröffnungen sind mit stranggepreßten natureloxierten Alu-Profilen eingefaßt.

Die Außentür besteht aus einem doppelschaligen Stahltürblatt mit PVC-Beschichtung. Die Verglasung des ca. 1350 mm hohen Glasausschnittes erfolgt in Drahtornamentglas. Die Innentüren bestehen aus einem Holztürblatt. Die Außen- und Innentüren sind mit Drückergarnitur und Buntbartschloß ausgerüstet.

6) Doors

The openings of the external and internal doors are bordered with extruded nature-anodised aluminium sections.

The external door consists of a double-shelled door panel of steel with PVC-covering. Glazing of the ca. 1350 mm high glass cutout with ornamental wire-glass. The internal doors consist of a wooden door panel. The external and internal doors are equiped with fittings, handle and bit type lock.

7) Elektroinstallation

Sie beinhaltet je Raum eine Brennstelle und eine Steckdose mit der dazugehörigen Verkabelung und Verteilung ohne Zähler.

7) Electrical Installation

The electrical installation includes one lighting point per room and one plug socket with the corresponding cabling and distribution without meter.

8) Sanitärinstallation

Die Ver- und Entsorgungsleitungen sind durch die Ausbauteile unsichtbar verdeckt. Die genaue Lage der Leitungen richtet sich nach der jeweiligen Fußboden- bzw. Fundament-Ausführung.

Die Sanitäreinrichtungen sind im Grundriß dargestellt.

8) Sanitary Installation

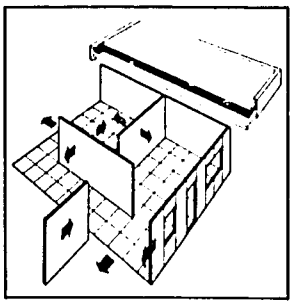
The supply and retake lines are invisibly covered by the completion parts. The exact situation of the lines varies according to the type of foundation/floor.

The sanitary equipment is shown in the floor plan.

120

THYSSEN

THYSSEN BAUSYSTEME GMBH



THYSSEN House System

THYSSEN-thermodach® – das montagefertige Komplettdach

Das THYSSEN-thermodach® ist ein im Werk weitgehend vorgefertigtes Komplettdach. Auf der Baustelle werden lediglich die Elemente befestigt und die Stöße abgedichtet. Die Elemente werden in Großserie gefertigt. Das sichert eine gleichbleibend hohe Qualität.

Die Ausgangswerkstoffe der THYSSEN-thermodach-Elemente sind:

- Stahl für das tragende Profil.
Der trapezförmig profilierte Stahl ist beidseitig bandverzinkt und im Farbton RAL 9002 (grau/weiß) kunststoffbeschichtet.

- Polyurethan-Hartschaum als Wärmedämmung.
Der gütegeschützte, geschlossenzellige Polyurethan-Hartschaum PUR verleiht dem Dach die hohe Wärmedämmfähigkeit.

Der weitere Dachaufbau kann spezifischen Kundenwünschen werksseitig angepaßt werden.

THYSSEN-thermodach® – a complete roof, ready for fitting

The THYSSEN-thermodach® is a prefabricated roof. On the construction site there is no more to do but to fit and secure the elements and to seal the joints. The elements are fabricated in a multiple production process. This ensures both uniform and high quality.

The basic materials for THYSSEN-thermodach® elements are the following:

- Steel for the load-bearing sections.
The trapezoidal steel sections are strip-galvanized and coated on both sides with grey/white plastic (colour shade RAL 9002).

- Polyurethane hard foam for thermal insulation.
The branded "PUR" rigid polyurethane foam with closed cellular structure imparts to the roof high thermal insulating properties.

The further roof construction and assembly may be adapted to the specific requests of the customer by the works.

THYSSEN-thermodach® – le toit préfabriqué prêt au montage

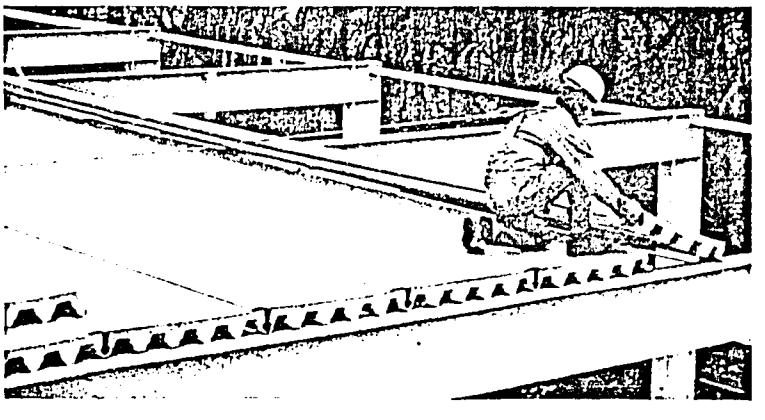
Le THYSSEN-thermodach® est un système de toiture complet préfabriqué en usine. Tel qu'il est livré il suffit, sur le chantier, de monter et fixer les éléments et de rendre les joints étanches. Ces éléments sont produits en grandes séries ce qui garantit un niveau de qualité élevé et constant.

Les parties constructives du THYSSEN-thermodach® sont:

- De l'acier pour les profilés structurels.
Les feuillards profilées en trapèzes sont en acier zingué à bande sur les deux faces et recouvertes d'une mince couche en matière synthétique teintée en gris/blanc (ton RAL 9002).

- De la mousse rigide de polyuréthane comme isolant thermique.
Cette mousse rigide (type PUR) à réseau cellulaire fermé confère au toit un haut degré de protection contre la chaleur.

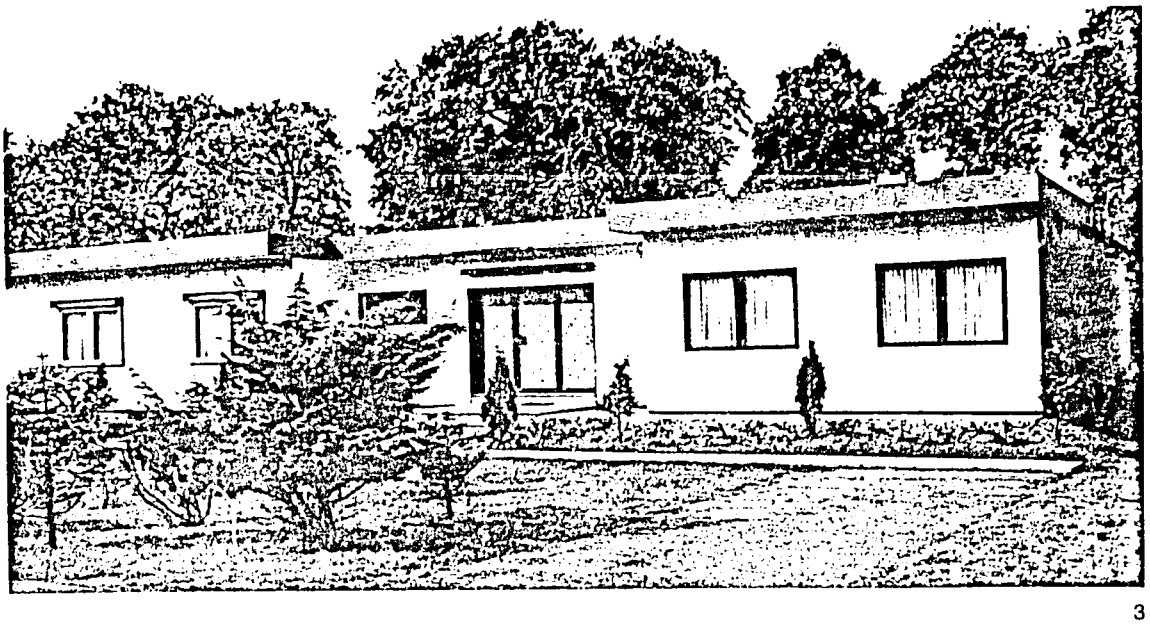
Le montage ultérieur de toit peut être adapté aux demandes spécifiques des clients.



Montage eines THYSSEN-thermodaches®

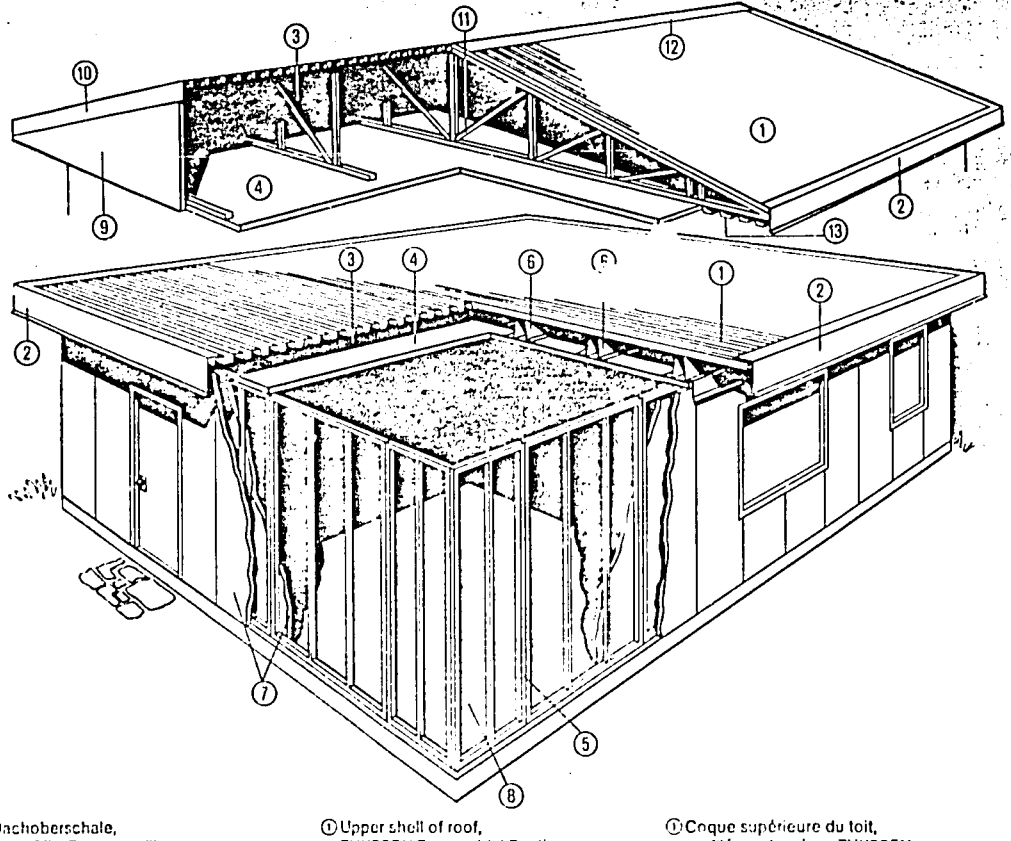
Assembly of a THYSSEN-thermodach®

Montage d'un THYSSEN-thermodach®



3

System E, wärmegedämmt · System E, insulated · Série E, calorifugée



① Dachoberschale, THYSSEN-Trapezprofil
② Attika
③ Belüfteter Dachzwischenraum
④ Decke, THYSSEN-thermowand®
⑤ Stahlkonstruktion
⑥ Pfetten aus Stahlprofil
⑦ Außenwand, zweischalig, THYSSEN-thermowand®
⑧ Fußboden
⑨ Giebelwand
⑩ Ortgang
⑪ Dachbinder
⑫ Firstkappe
⑬ Unterdach

① Upper shell of roof, THYSSEN Trapezoidal Section
② Attica
③ Aerated intermediate space of roof
④ Ceiling, THYSSEN-thermowand®
⑤ Steel structure
⑥ Steel purlins
⑦ External wall, double-shell, THYSSEN-thermowand®
⑧ Floor
⑨ Gable Wall
⑩ Cover blend
⑪ Roof truss
⑫ Ridge
⑬ Suspended trapezoidal section

① Coque supérieure du toit, profilés en trapèzes THYSSEN
② Attique
③ Espace intermédiaire aéré du toit
④ Plafond, THYSSEN-thermowand®
⑤ Construction en acier
⑥ Pannes en profilés d'acier
⑦ Paroi extérieure, coque double, THYSSEN-thermowand®
⑧ Plancher
⑨ Paroi pignon
⑩ Revêtement de pignon
⑪ Maîtresse ferme
⑫ Faîteau
⑬ Revêtement de la face intérieure de l'avant-toit

panelfab International Corporation
1600 N.W. LeJeune Road, Miami, Florida 33126

Direct replies to:
P. O. Box 2777, AMF, Miami, Florida 33159
Telephone: (305) 871-2100
Cable: PANFABINT Telex: 51-2494

May 12, 1980

Mr. Richard Burling
c/o Grube Zimmer
2040 S. W. Jefferson Street
Portland, Oregon 97201

SUBJECT: World Bank and AID Projects - Sudan

Dear Mr. Burling:

I have just received letter from a mutual friend, Mr. Ray Carpenter, (AID), confirming the fact that your organization has received a contract for the A&E entire project as you are completing the pre-contract award survey.

Based upon our conversation, it is my understanding that the following are the proposed installations under consideration:

1. Agricultural Research Station at Elobeid. This installation will require approximately 8100 m^2 of pre-engineered construction to include a 1400 m^2 of "Wet Lab" and small houses of 100 and 200 m^2, each to contain two bedrooms and one bath.

2. El Fasher. This installation will consist of 500 m^2 of laboratory space plus 14 houses, for a total of 2100 m^2.

3. Ghazala Gawazett. This installation is to have a 500 m^2 office and laboratory, with 12 samll homes to total 1800 m^2.

The installations will be utilized to house personnel from Washington State University and Sudanese on the basis of one to one, but will not be used for families until later in the project.

It is your desire that the toilets shall be "Asian," and that the ambient temperatures are 118° F in the Summer, with a minimum of 50° F to 60° F in the Winter. It is understood that you do not desire air conditioning, but rather air circulation so as to permit maximum air flow during hot weather, and sufficient insulation for the so-called colder weather.

It is also understood that electrical ranges will be used for cooking, and that your electricity will be generated at each location to produce 240 Volts - 50 Cycle, with spare generators at each installation.

Manufacturing Plants, Licensees and Distributors Throughout the World

Mr. Richard Burling
May 12, 1980
Page 2

The enclosed literature will provide you with an overview of the type of experience we have had in all parts of the world, and you will note that we have had extensive experience in housing, medical facilities, offices, laboratories, bachelor quarters, etc., etc., in many areas of Africa, including Sierra Leone, Ghana, Nigeria, Zaire, and have just finished processing a sizable group of structures for installation in Somalia.

A major American Oil company has just contracted to have us supply several sizable installations in Angola and one other area in the South Central area of Africa.

As I indicated, on site assembly is rapidly accomplished by the use of semi-skilled labor, under supervision, and the resultant structures have proven to have a life expectancy equal to conventional construction, in spite of the difficulties to be encountered in some of the jungle areas in Africa.

Your apprehension concerning possible termite damage can be put to rest, providing we supply our standard Panelfab honeycomb core sandwich doors. It has been found that our panels, doors, etc., are, due to the chemical makeup of our honeycomb, resistant to termites and other insect damage.

A prime example of the desirability of our structures in jungle areas is typified by the several million dollar installations of houses, etc., for the Pittsburgh Plate Glass Corporation Rutile mines in Sierra Leone in 1965. Three years after installation, the Titanium market collapsed and the installation was permitted to "return to the jungle." After a period of some eight years, the installation was re-activated by the Bethlehem Steel Corporation, who found, after clearing the jungle, that all of the structures were once again usable with only replacement of such items as broken window glass, and a few minor non-structural elements.

We would appreciate your supplying us with such additional information as may be available in terms of programming of the project, and we will be pleased to supply you with such technical information as you may require, to assist in our mutual rapid development of the entire projects noted above.

Your reply is awaited with interest.

Sincerely,

PANELFAB INTERNATIONAL CORPORATION

M. H. Shorago
Vice President

MHS:dk
Enclosures

cc: Mr. Ray Carpenter

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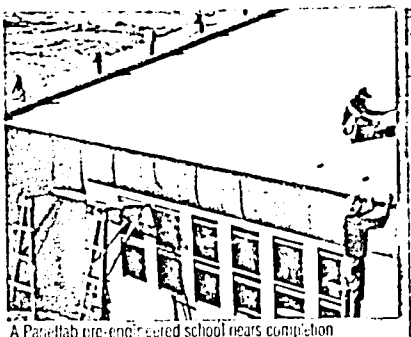
Housing and Building Systems

PANELFAB PERFORMS with pre-engineered building systems which meet the diverse construction needs of people, companies and governments worldwide. In recent years, Panelfab has significantly increased systems sales to such Middle Eastern nations as Saudi Arabia, the United Arab Emirates, Oman and Iran, as well as to other nations. In the Middle East alone, since 1976, Panelfab has designed, manufactured, shipped and completed more than 1,000 structures, including houses, schools, office buildings, health and resort facilities as well as community support structures.

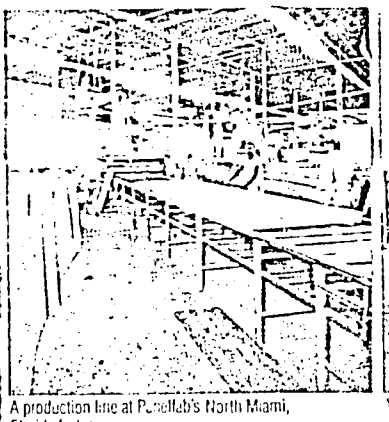
A major factor in the company's ability to meet growing demand for its products is advanced methods of manufacturing and shipping pre-engineered structures throughout the world. Panelfab's advanced building systems, combined with Panelfab's construction support services, enable the company to assume total responsibility for turnkey construction projects.

Panelfab building systems offer a number of features essential to efficient construction overseas. They are assembled on-site easily and economically and provide early occupancy. Maintenance costs are minimal. A variety of non-combustible surface materials, both exterior and interior, are available. Panelfab buildings are comfortable under extreme conditions, with hurricane and earthquake resistance and proven long-term performance in the tropics, coastal, mountain and desert areas.

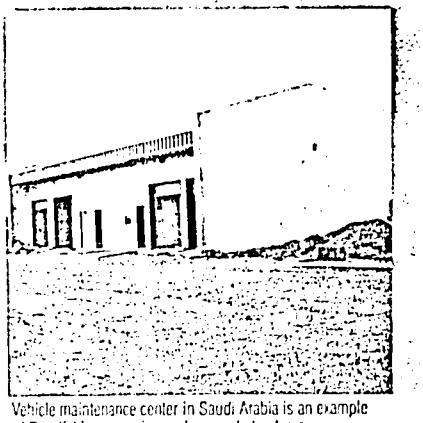
Whether used as basic housing, or for large public activities, Panelfab building systems are proving daily, 'round the world, their efficiency, ease of installation and ability to fulfill an escalating demand for structures which must perform efficiently over many years.



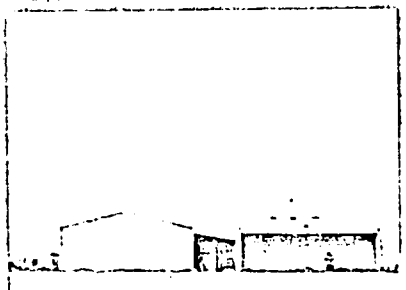
A Panelfab pre-engineered school nears completion in Tail, Saudi Arabia.



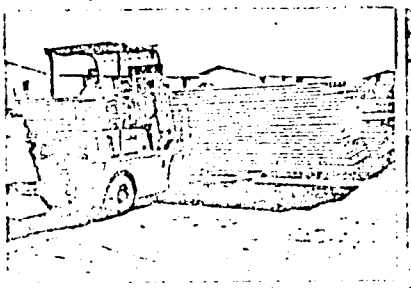
A production line at Panelfab's North Miami, Florida factory.



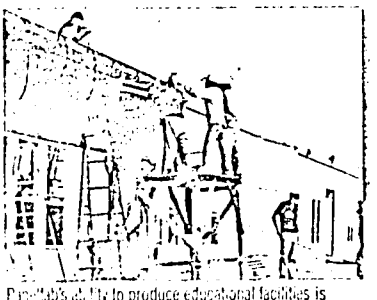
Vehicle maintenance center in Saudi Arabia is an example of Panelfab's pre-engineered support structures.



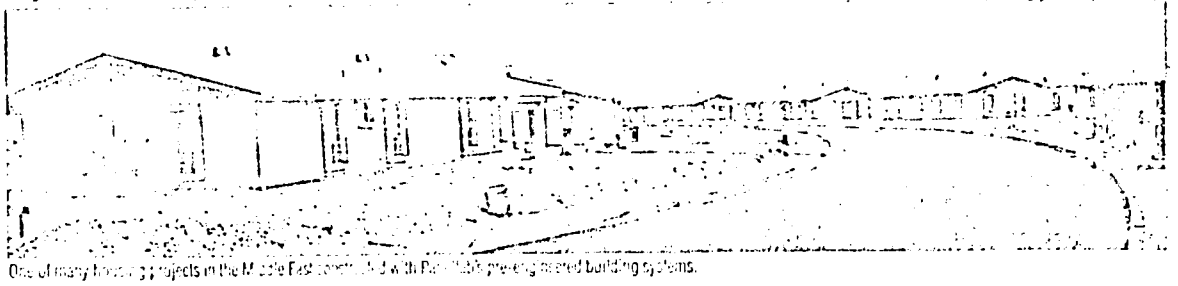
U.S. Armed Forces Post Office in Middle East was designed and manufactured by Panelfab International.



Sections of Panelfab pre-engineered housing systems are moved into place at Khamis Mushayt, Saudi Arabia job site.



Panelfab's ability to produce educational facilities is shown in school under construction in Middle East.



One of many housing projects in the Middle East constructed with Panelfab pre-engineered building systems.

Construction Support Services—Worldwide

Panelfab's construction support services include a skilled architectural, design and engineering capability.

PANELFAB PERFORMS internationally by providing construction support services, designed to fulfill highest standards of quality and performance control at all levels.

Panelfab's services capabilities result from long experience as a designer, manufacturer and exporter of pre-engineered building systems. Through the years, Panelfab has developed an expertise in the many skills and techniques required to complete buildings almost anywhere. Today, Panelfab is increasingly applying its construction services know-how to highly diverse projects throughout the world.

In all of its construction support management and construction administration as well as material supply services—Panelfab stresses on-time delivery, simplicity, labor and cost savings and quality assurance.

Architectural and Engineering

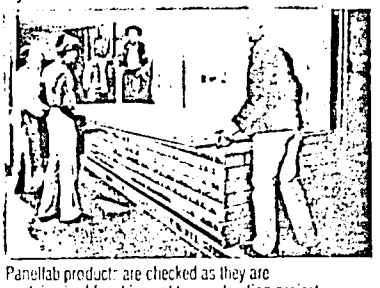
Panelfab performance includes an A & E and design capability which has been field-tested on almost every continent. Panelfab's in-house A & E staff is able to convert a customer's shelter requirements into working plans and specifications promptly and accurately. The A & E staff is familiar with site planning as well as overall community and facilities programming.

Purchasing

Panelfab long has been recognized for its ability to purchase, at competitive prices, construction materials, components, equipment, furniture, accessories and related services.

Panelfab's procurement staff, utilizing experience gained in thousands of Panelfab buildings around the globe, understands construction specifications and schedules. It can anticipate potential problem areas, supply builder needs efficiently in accordance with a customer's specialized requirements.

Products purchased by Panelfab include the needs of all kinds of buildings. These range from simple construction materials and furnishings to air conditioning systems, electrical generating and sewage and water treatment plants to recreational equipment, street lights and hydrants.



Panelfab products are checked as they are containerized for shipment to construction project.

Material Management

Pre-planning and implementation of material control at all stages permits Panelfab to maintain complete material management direction. Capabilities also include development of applicable systems of critical inventory procedures.

Construction Management

Panelfab's construction management includes supervising subcontractors and others to insure the effective completion of the specific project. Total awareness of critical schedules is a major commitment of Panelfab.

Construction Administration

Panelfab does far more than supply materials and services. It is prepared to assume partial, or total responsibility for projects, or individual buildings, from concept to delivery of a turnkey operation, incorporating all those essential factors resulting in effective construction support services. Included are staff support activities essential to efficient personnel utilization at construction sites.

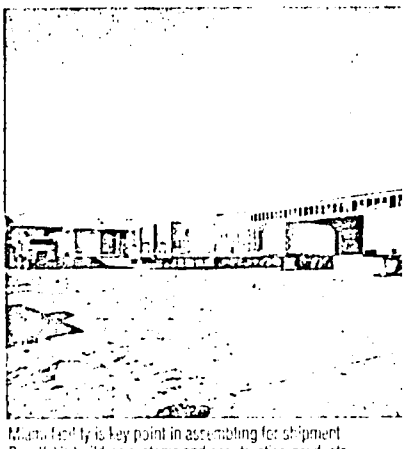
Warehousing

Panelfab warehousing ability stresses flexibility in Receiving, Quality Inspection, Quality Assurance, Inventory Control, Consolidation and Preparations for Overseas Shipments—all to customer requirements.

Panelfab is prepared to arrange warehousing at major job locations in the host country. Panelfab's warehousing material control management procedures emphasize strict inventory control so that work crews at construction sites can be properly supplied with required material as needed.

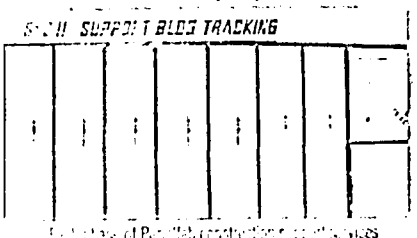
Shipping

Panelfabs transportation know-how is dramatized daily as the company moves hundreds of tons of pre-engineered buildings, plus an endless variety of construction products, to job sites worldwide. Company traffic specialists place heavy emphasis on planning and scheduling to avoid costly, time-consuming delays. At Panelfab's plants and warehouses, individual shipments are prepared for overseas shipment.



Manufacturing is key point in assembling for shipment Panelfab's building systems and construction products

In all stages of product movement, such as at ports of embarkation, Panelfab personnel are available to oversee and expedite shipments.



Each phase of Panelfab construction support services is carefully scheduled to achieve maximum efficiency

Société
Nouvelle
JOSSERMOZ

Société anonyme au capital de 1.000.000F - R.C. Annecy B 722001260

Siège Social,
Bureaux et Usines:
Boite postale N° 25 - 74370 Pringy
Téléphone (50) 67.81.12
Télex Josermo 385156F

GRUBE,ZIMMER,INC.
2040 S.W. JEFFERSON STREET
PORTLAND, OREGON 97201
U.S.A.

N/Référence: DRE.80.05.618/JCV/MC

Personne à contacter:

V/Référence:

LEVALLOIS le May 12th, 1980

SUDAN PROJECT

Attention Mr. Richard BURLING

Gentlemen,

Thank you for your letter dated march 25 which unfortunately was received only on april 28.

In fact our company is specialized in the type of prefabricated buildings you are looking for your Western Sudan Agriculture Research Centre and we are currently involued in such projects. We send enclosed some materials giving data and informations on our products.

As far as the costs are concerned they vary of course with the standards required but an average turnkey price in Sudan could be in the range of 375 US $ per SQ.M including 175 $ for materials ex works, 100 $ for the site works and erection, and 100 $ for transportation.

We are at your disposal to prepare more accurate quotations if you send us some drawings concerning the houses and other buildings.

Sincerely,

J.C. VIERS

Directions Régionales: Paris . 24, rue Chaptal . 92300 Levallois . téléph. (1) 757.31.15+ . télex Josserm 611257 F
Rhône-Alpes . Boite postale N° 25 . 74370 Pringy . téléph. (50) 67.81.12 . télex Josermo 385156F
Méditerranée . 99, rue Jean-Perrin . z.i. . 13290 Les Milles . téléph. (42) 27.27.46 . télex Josermo 440937 F

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S.N.JOSSERMOZ

MC CONSTRUCTION SYSTEM

GENERAL PRESENTATION

The MC construction system was developed to meet the requirements of the regions with a rigorous climate, both in the high temperature and low temperature ranges.

Another purpose of the design is to provide a ready solution to transport difficulties from France to distant countries.

Main features :

- low-cost housing ;
- strength and durability (all materials have been carefully selected to resist against the effects of temperature variations) ;
- an excellent insulation ;
- erection on site calls for no skilled labour thanks to the simplicity of the system, local labour under the supervision of an instructor is enough ;
- it is a modular construction system ;
- high adaptability to any programme.

DIMENSIONAL PARTICULARS

- basic modulation : multiple of 1.80 m for the panels
- possible widths without cross-walls : from 3.80 m to 5.60 m
- widths when there is a bearing cross-wall : from 7.40 m to 11.00 m
- all lengths possible in modules of 1.80 m and even 1.20 m
- clear ceiling height : 2.47 m (2.97 m upon request).

TECHNICAL PARTICULARS

PREFABRICATED COMPONENTS of the BUILDING :

- Peripheral steel bottom plate fixed on concrete slab bearing the external wall panels.
- External walls consist of :
  - . C-shaped steel framework 80 mm thick 20/10° thick (optional : timber frame - treatment of wood against fungus and insects),
  - . CTBH fibreboard outerskin 12 mm thick,
  - . CTB fibreboard innerskin 10 mm thick,
  - . Half-rigid glass-wool insulation with vapor-barrier 80 mm thick - total thickness 102 mm K = 0.50 K.cal/m2.h.°C,
  - . Plastic rough coating.
- Carpentry consists of :
  - . in basic solution : flat roof straight beams resting on external walls either of timber treated against fungus and insects or of metal,
  - . in option : double-pitched roof metal truss-beams compose the double-pitched roof (slope 8%) spaced of 1.80 m carried by the external walls (optional : wood trusses spaced of 0.90 m to 1.20 m, wood treated against fungus and insects).
- Vertical and horizontal wind-bracings ensure the stability of the building.
- Roof-covering consists of :
  - . in basic solution : galvanized steel sections with roof-projection of 0.50 m at long sides
  - . in option : shingle on CTBH fibreboard support 19 mm thick only in case of double-pitched roof-carpentry - peripheric roof-projection of 0.50 m.
- Ceiling :
  - . fibreboard 10 mm thick - couplings are concealed by wooden covers caps
  - . glass-wool insulation with vapor-barrier 80 mm thick K = 0.50 K.cal.m2.h.°C.
- External doors and windows :
  - . either of resinous wood in case of Italian opening (outwards projecting)
  - . or of anodized aluminium in case of sliding units.
- Our Joineries are glazed at workshop in factory.
- Blinds : optional . projecting fabric blinds
  . external Sunscreen blinds vertical guiding.
- Internal joinery-units : flush doors mounted in metal casing
- Partitions of fibreboard panels 50 mm thick secured to wood plate assembled by joint-keys.

ELECTRICAL INSTALLATION

Satisfies the French Standards NFC 15.100 and the requirements of the UTE.

General protection board with multiple circuits is manufactured in factory and set on the site as the works proceed.
The mains consist of U 500 V.G.V. cables.

Every circuit is protected by a fuse cut out.

General bonding to the earth is provided for by a main line to a galvanized post 1.00 m high.

Devices type "Legrand" - series "Neptune".
Lighting points are delivered with sockets at end of wires.

PLUMBING INSTALLATION

The installation starts at a water meter placed in the kitchen (this meter is excluded of our offer).
Cold water distribution to all fittings.
Hot water distribution in kitchen and bathroom.

Sanitary fittings

- sink of stainless steel with one compartment - size 1.20 x 0.60 m, a plate-rack placed on a stratified cupboard, mixing valves,waste and siphon;
- W.C. seated type of vitrified porcelain with flush tank ;
- bath-tub of enamelled steel - size 1.50 m x 0.70 m, mixing taps, flexible shower rose, waste plug and chain, overflow trap ;
- wash-basin of vitrified porcelain - size 0.55 m x 0.45 m, mixing valves, bott and small chain emptying ;
- supplying of hot water by electrical water-heater with accumulator.

AIR CONDITIONING - HEATING

- temperatures - 5°C + 40°C
- air-conditioning by individual units placed in the front panels,
- heating by electrical resistances incorporated into the air-conditioning units and electrical convectors in the water-rooms.

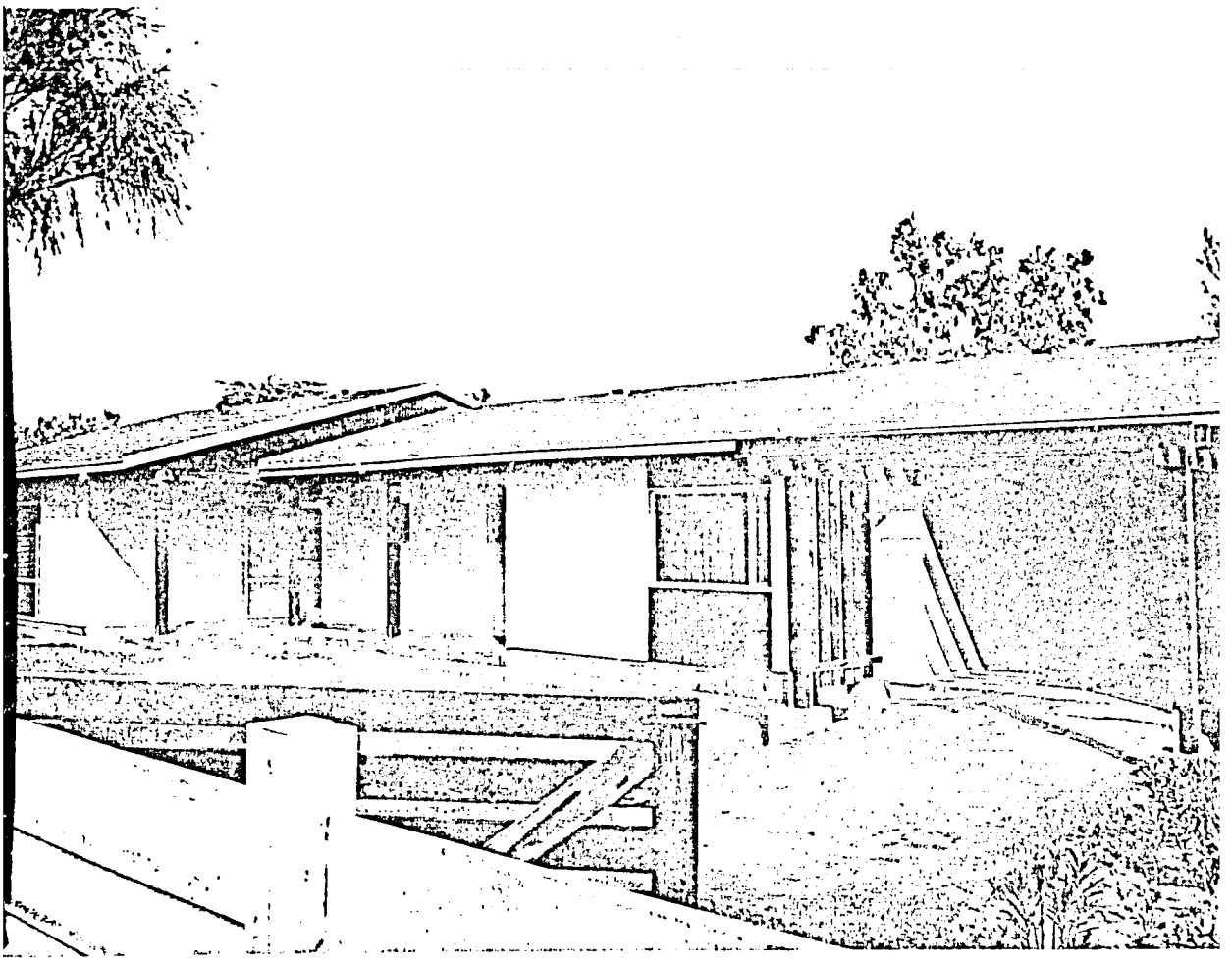
FLOOR-COVERING

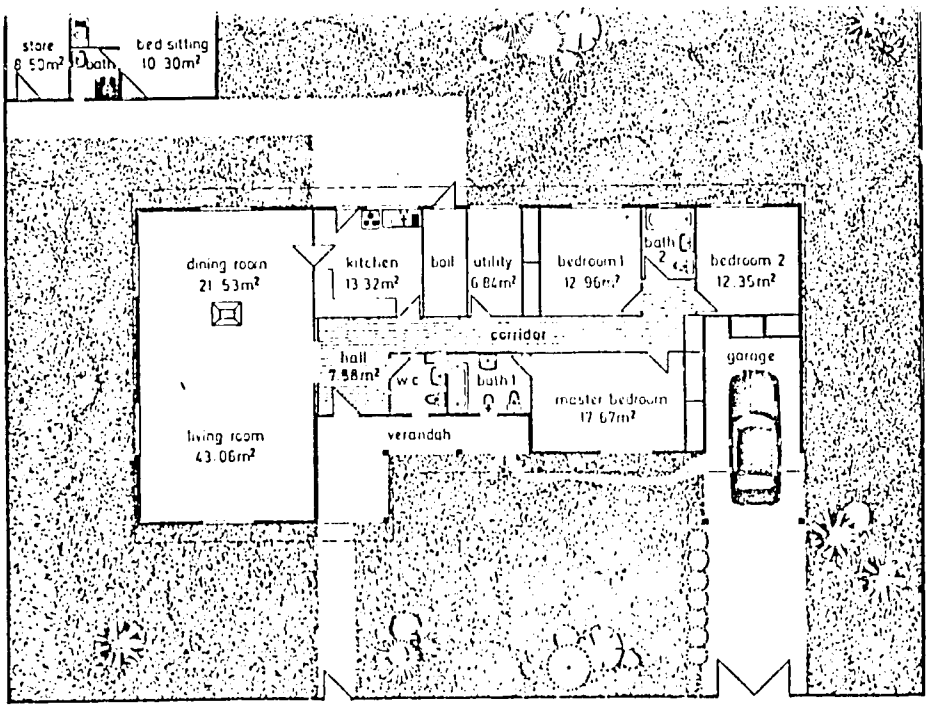
The floor of all rooms is covered with half-flexible thermo-plastic tiles - size 0.30 x 0.30 m - 16/10° thick.

INTERNAL PAINTING

Two glycerophtalic mat paint coats on walls, partitions and ceilings.

NOTE : this document is not binding, in a constant striving to improve our products and designs, we reserve the right to modify the MC construction system.





CH. 3 *Built for "KOWEIT OIL COMPANY" – HOUSE F4 with garage*

SOCIÉTÉ NOUVELLE JOSSERMOZ - B.P. n° 25 - 74370 Pringy (France) - tél (50) 57.39.12 - télex 385156

Société locataire gérante des sociétés JOSSERMOZ-ANNECY - R.C. Annecy B 325 820 875
et Compagnie Française du Groupe JOSSERMOZ - R.C. Annecy B 326 420 155

INDUSTRIES
TRADEMARK OF HF INDUSTRIES

HF INSULATED PANELS FIBERGLAS or FOAM

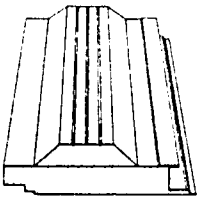
CONCEALED FASTENING

or those who prefer Fiberglas insula-on instead of a foam H/F offers five stinct concealed fastener panels with 6# density fiberglas as the insulation. hey are the Flatpanl and Monarch restige with 24" coverage and the onarch II, Demi-Prestige and Flat-anl with 12" coverage.

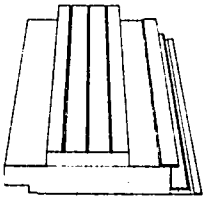
ur concealed fastening panel also ses our Artic Joint Design proven by ctual Artic use to prevent your warm r from escaping to the outside.

he factory assembled insulating anel offers many advantages to the ontractor and the owner. Erection me is greatly reduced compared to eld asembled systems, your crews will andle one panel compared to four or hore components. Full insulating alues are received since the fiberglas s not compressed. Consistent quality s assured by our assembly line echniques and our rigid quality ontrol standards.

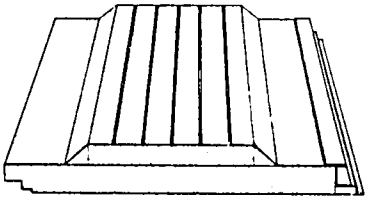
hese panels are also available with oam. SEE TABLE OF "U" VALUES elow.



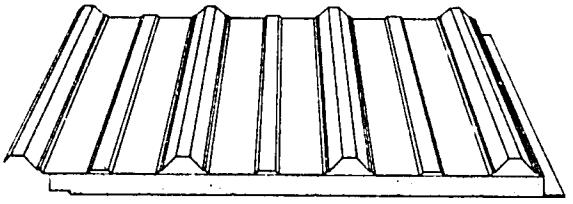
HF DEMI-PRESTIGE



HF MONARCH II



HF MONARCH-PRESTIGE



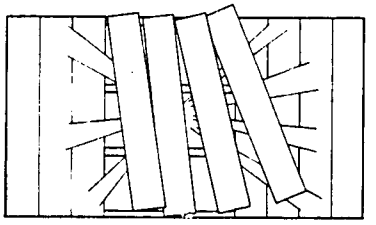
HF 757 N

EXPLOSION RELEASE FASTENING

The H/F Industries Explosion Release Fastening limits damage when an explosion occurs. Explosion Release Fasteners are designed to fail at 155# or 215# average. This method of fastening should be used in relief ports on buildings containing hazardous explosion potential materials.

The illustration shows the explosion release "blowing out" during an explosion.

H/F Industries recommends a "safety chain" be attached at the top of the panel to the structural steel to prevent additional damage from "flying" panels.



EXPOSED FASTENING

The H/F Exposed Fastening panel is a popular panel for use in warehouses, manufacturing plants and other industrial uses. Fastening is directly thru the panel into the building girts. These panels offer lowest initial cost, easy and quick erection, a selection of 7 colors in three different coatings and a range of thickness, and insulation types to provide the insulating values desired by the owner.

ABLE OF "R" VALUES

berglas thickness	2"	4½"
onarch Prestige with 12" additional insulation in rib	R-9	R-15
" Flatpanl	R-7	R-13
onarch II, Demi-Prestige, 12" Flatpanl	R-7	R-13

ABLE OF "U" VALUES

sing various thicknesses and types of insulation.

	Monarch Prestige - CF (Rib Inaulation same as core)		All Other Panels	
Thickness core	Special Formula Polystyrene 1# PCF	Isocyanurate 2½# PCF	Special Formula Polystyrene	Isocyanurate 2½# PCF
1½"	.102	.061	.145	.085
2"	.083	.050	.110	.065
2½"	.070	.042	.088	.052
3"	.061	.037	.074	.044
3½"	.054	.032	.064	.038
4"	.048	.029	.056	.033

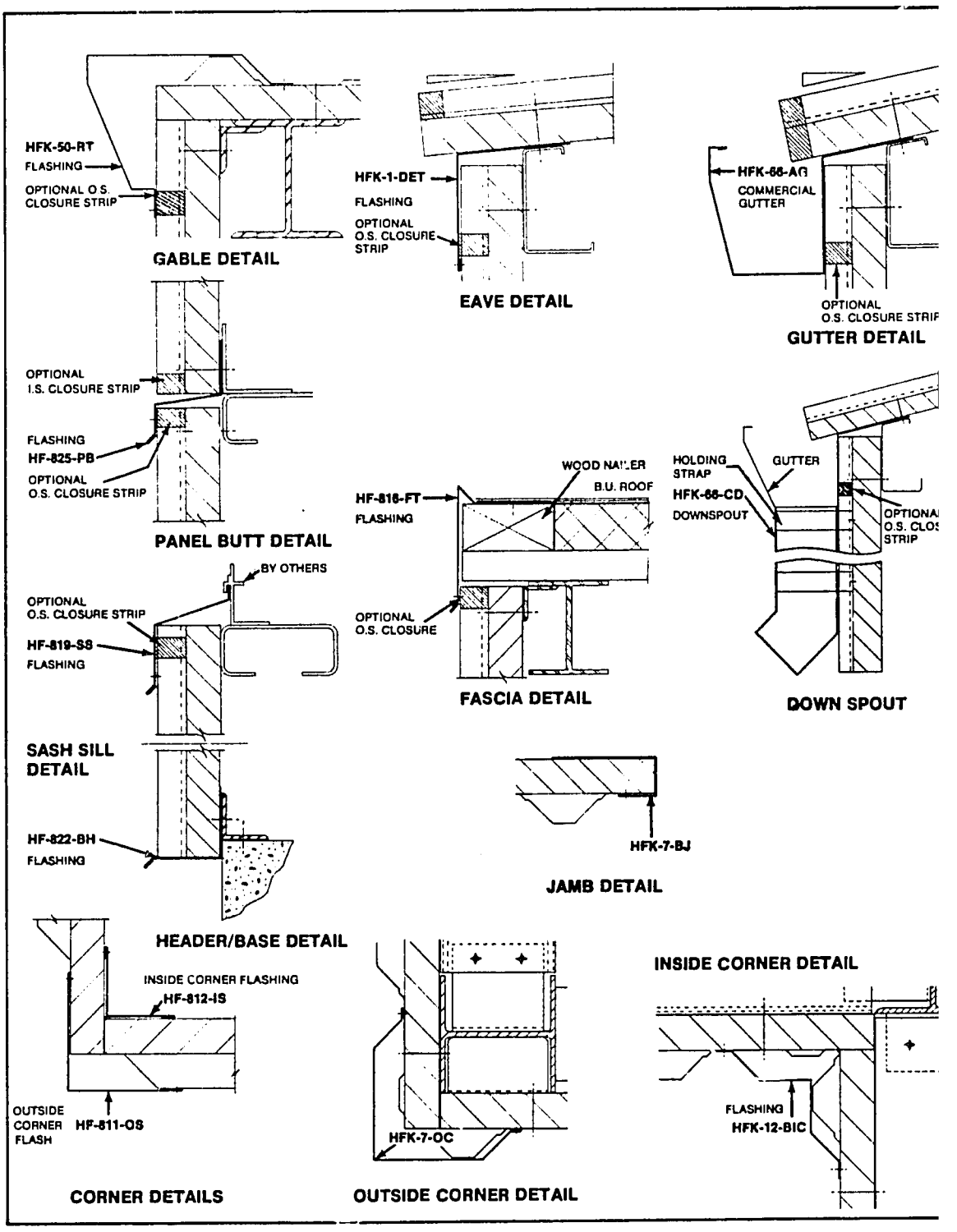
UNIFORM ROOF LOAD IN POUNDS PER SQUARE FOOT

GAUGE	SPAN(FT)	4'-0	5'-0	6'-0	7'-0
22	1 Span	89	57	40	29
	2 Spans	81	52	36	26
	3 Spans	102	65	45	33
24	1 Span	72	46	32	23
	2 Spans	65	42	29	21
	3 Spans	61	52	36	26
26	1 Span	67	43	30	22
	2 Spans	60	38	27	19
	3 Spans	75	48	33	24

NOTES: 1. Allowable loads shown are based on stress governing, Per A.I.S.I. Specifications.

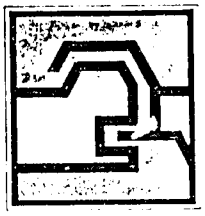
2. Allowable loads shown may be increased by 1/3 for wind loading.

FLASHING DETAILS



141

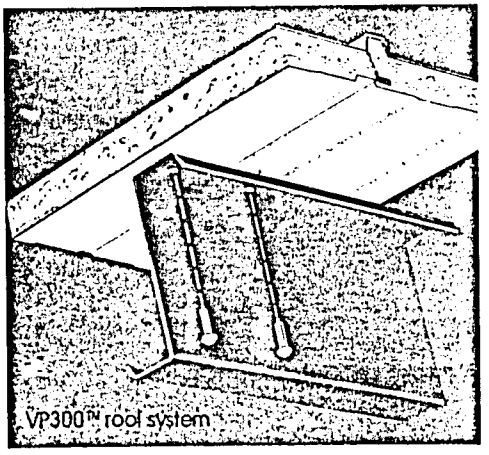
VP300™ Roof System



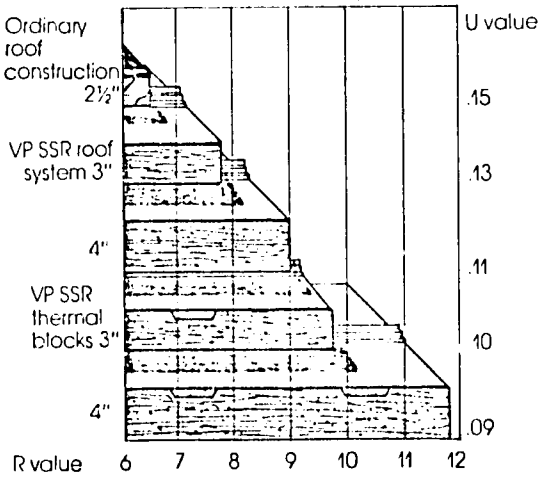
Insulation Values to R42

Today's demanding insulation needs pose an important problem to an energy conscious public. The VP300™ roof system is a premium insulated roof that offers long life, low maintenance and unexcelled performance that will meet the most demanding energy requirements.

Its rigid polyurethane core is factory foamed between two 26 gauge prefinished embossed steel facings. Factory fabrication eliminates the multiple step field assembly of conventionally insulated buildings and greatly reduces erection time.



Insulation and Thickness Comparison



Polyurethane insulation adds strength and workability to lightweight VP300™ roof panels. Plus insulation values to R42 demonstrate the excellant thermal integrity of VP300™ roof system.

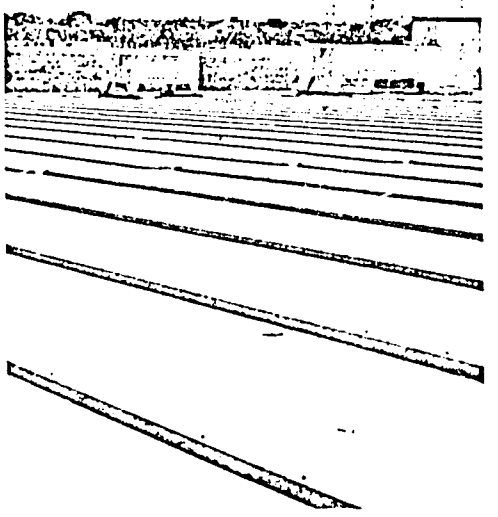
Prefinished embossed steel panels maintain their good looks for a long time with minimal upkeep. The Egyptian White finish is a baked-on polyester enamel that blends well with other Varco-Pruden finishes as well as conventional material.

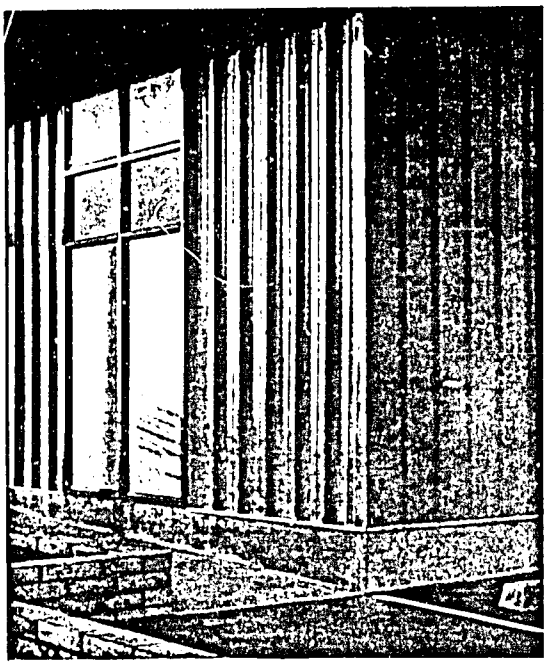
Tongue and Groove Connections

The key to the VP300™ roof system's performance is the tongue-in-groove connection on the interior facing for positive alignment. The sealant at this joint prevents the reduction of insulation efficiency and aids vapor barrier continuity. Fasteners attach to the interior facing leaving fewer exposed exterior fasteners for a cleaner appearance.

VP300™ roof system accommodates a full range of accessories from skylights to roof vents.

Thermal efficiency, good looks, versatility. Without exception, the VP300™ roof system offers you the most energy efficient roof system available today.





F-103® (1") WALL SYSTEM

a factory-insulated wall systen

0.10 "U" VALUE **1" Thick Foam**

Three foot covering width

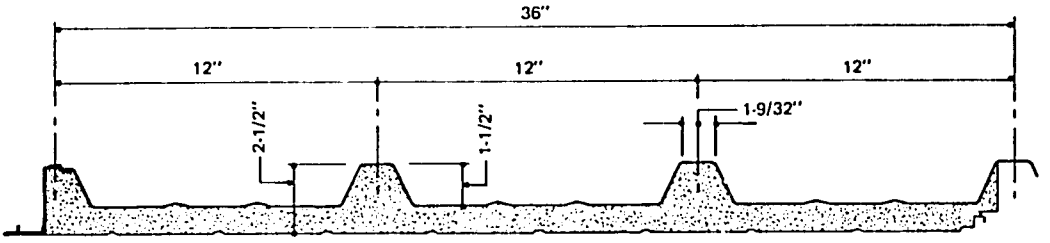
Butlerib II design configuration on exterior

Lengths up to 32 foot

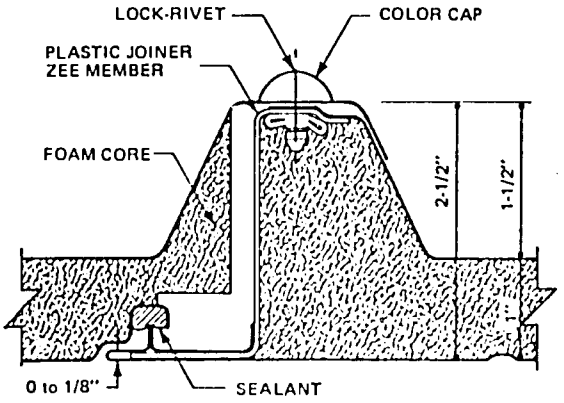
Outstanding thermal efficiency with foamed-in-place polyurethane core provides overall "U" value of 0.10.

Joining system provides positive vapor barrier

Factory color-finished interior and exterior faces



PANEL CROSS SECTION



JOINT DETAIL

MATERIAL
See specifications for material offering.

LOADING
F-103 (1") panels are designed for a wind load of 25 psf.

FASTENERS
Self-clinching Low Profile Aluminum Lock-Rivets are used for panel connections.

All organic plastic foam products exhibit a moderate hazard in event of fire exposure.

BUTLER MANUFACTURING COMPANY

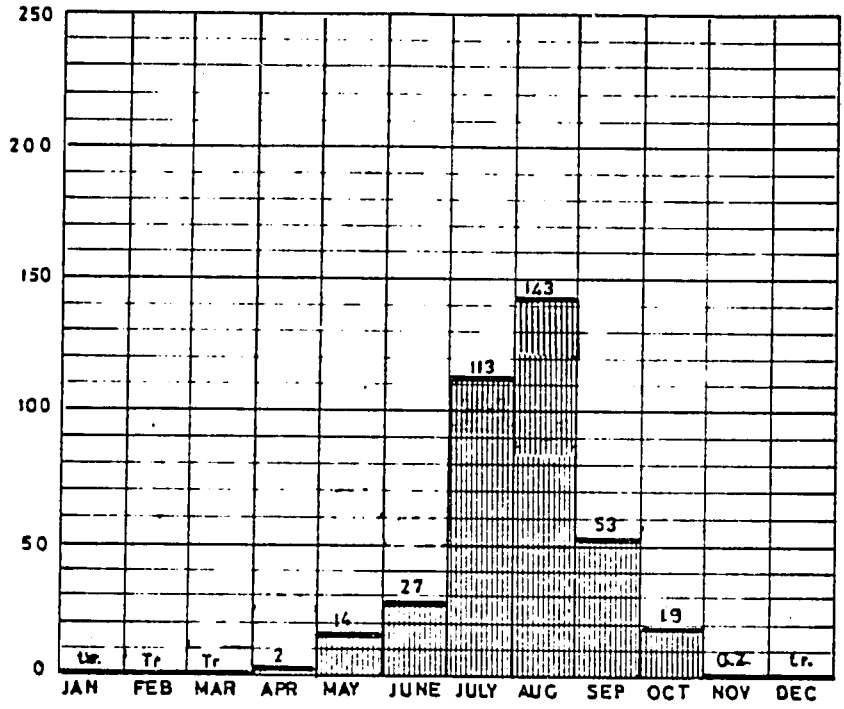
PRODUCT DESCRIPTION
F-103 WALL SYSTEM (1" THICK FOAM)

Printed in U.S.A.

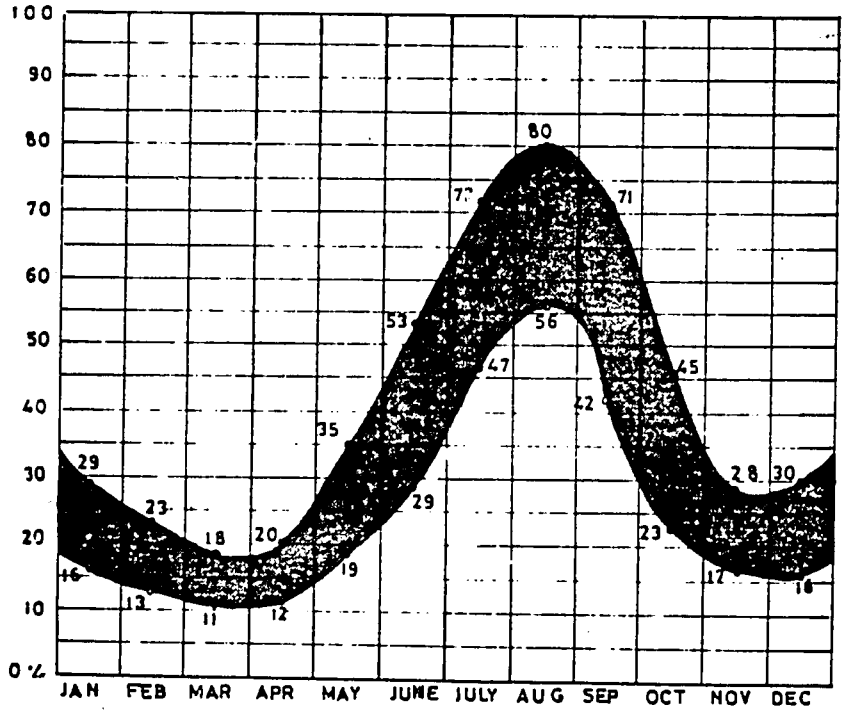
Form No. 2409-L/W-4-78

XII. GENERAL CLIMATE INFORMATION

CLIMATE DATA: El Obeid



RAINFALL mms
30 YEARS AVERAGE



RELATIVE HUMIDITY
30 YEARS AVERAGE

min at 1200 GMT
max at 600 GMT

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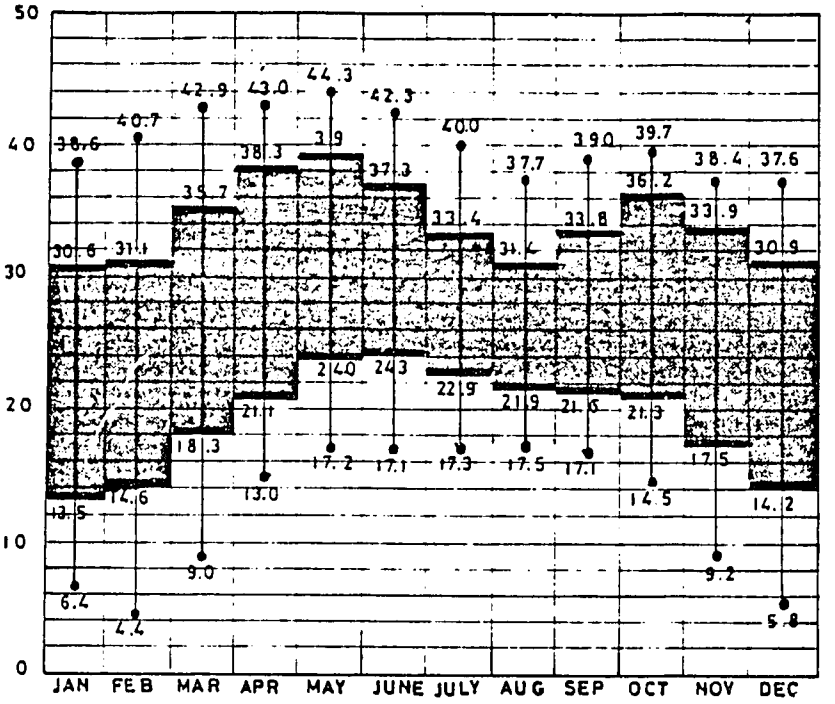
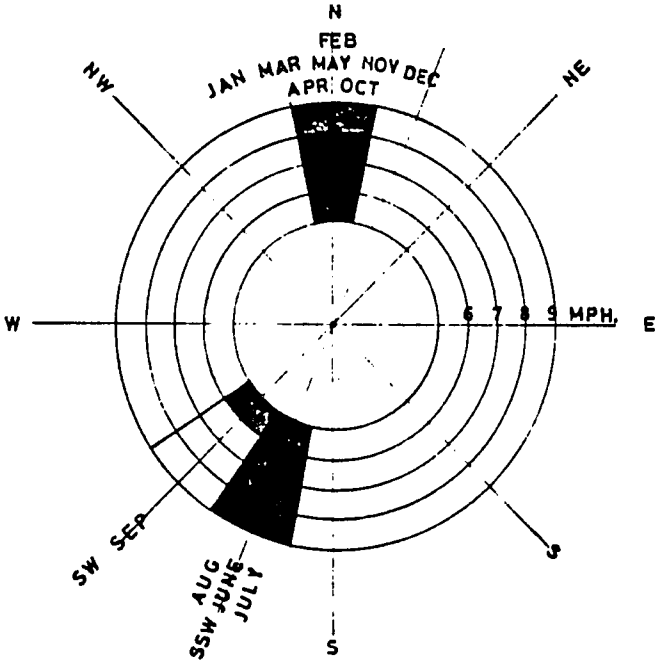
El Obeid



AIR TEMPERATURE
30 YEARS AVERAGE

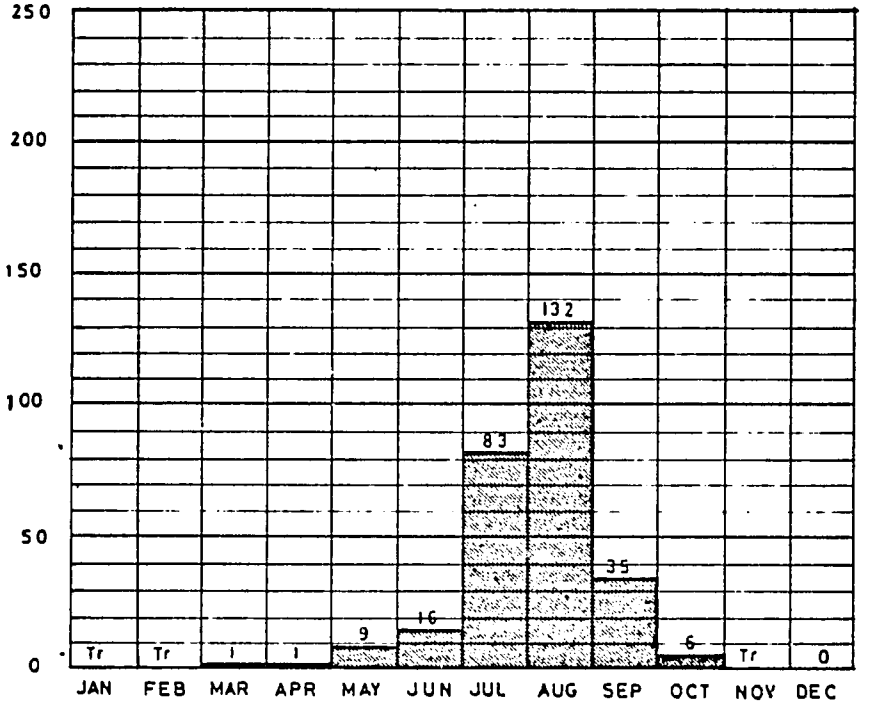
— mean average air temperature
• max & min air temperature



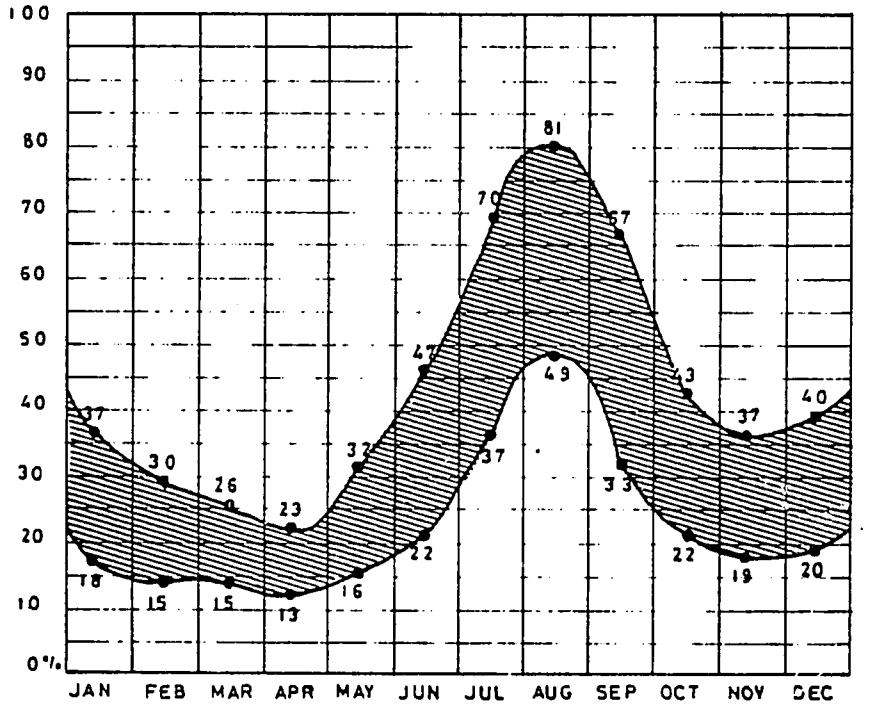
WIND PATTERN

FREQUENCY
DURATION
MEAN SCALER SPEED

CLIMATE DATA: El Fasher

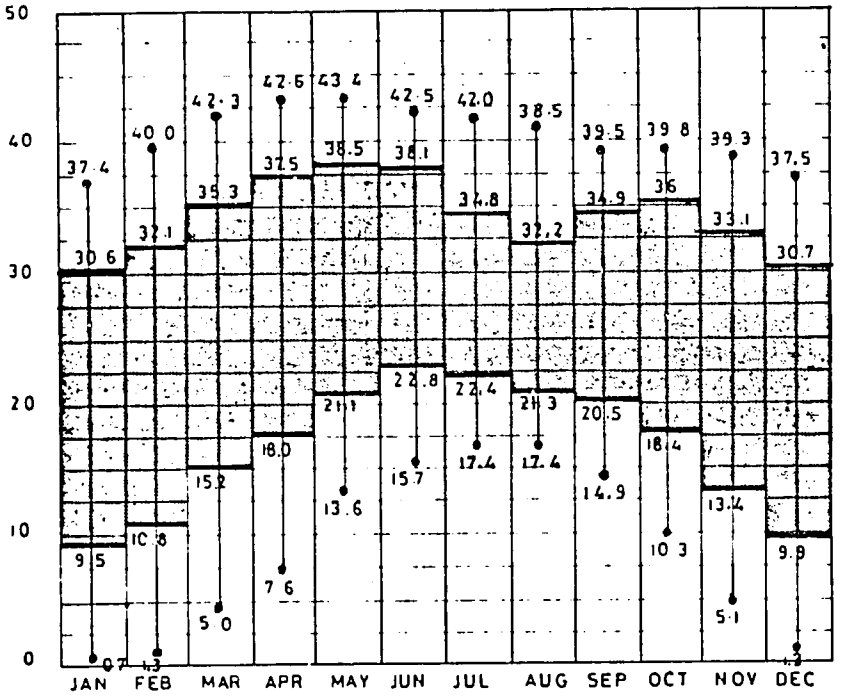


RAINFALL
30 YEARS AVERAGE



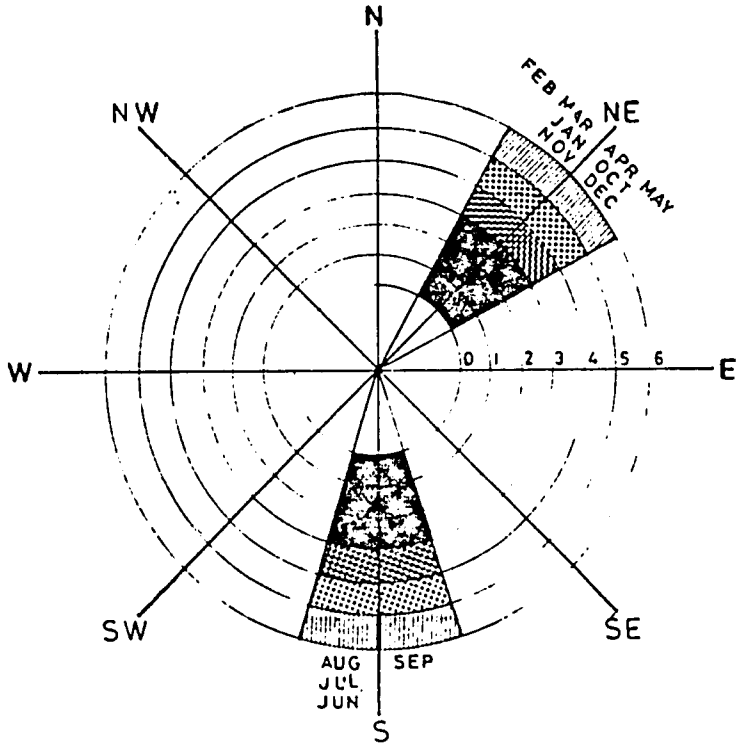
RELATIVE HUMIDITY
30 YEARS AVERAGE

min at 12 00 GMT
max at 6 00 GMT



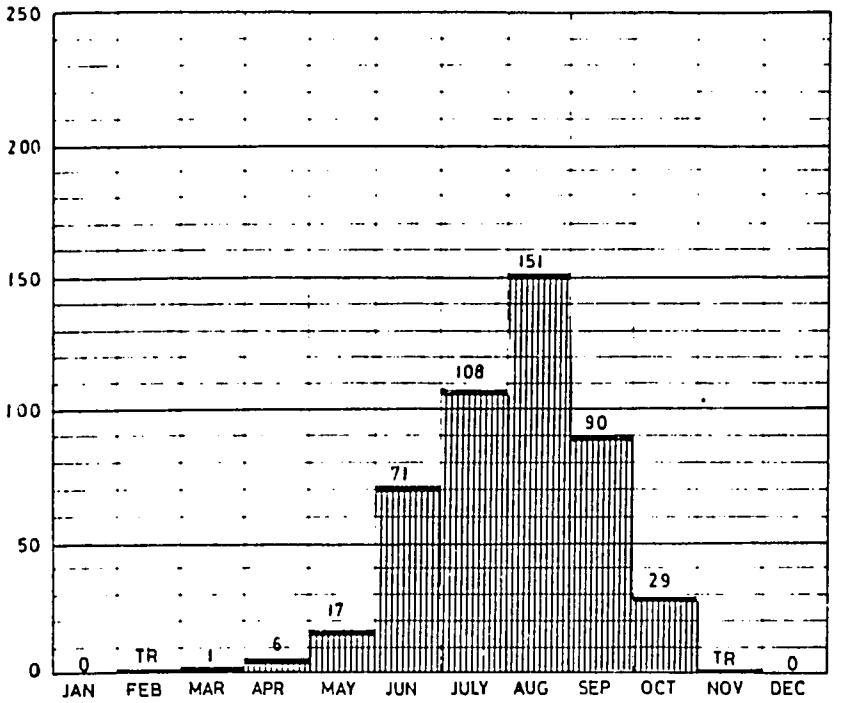
AIR TEMPERATURE
30 YEARS AVERAGE

mean average air temperature
max or min air temperature

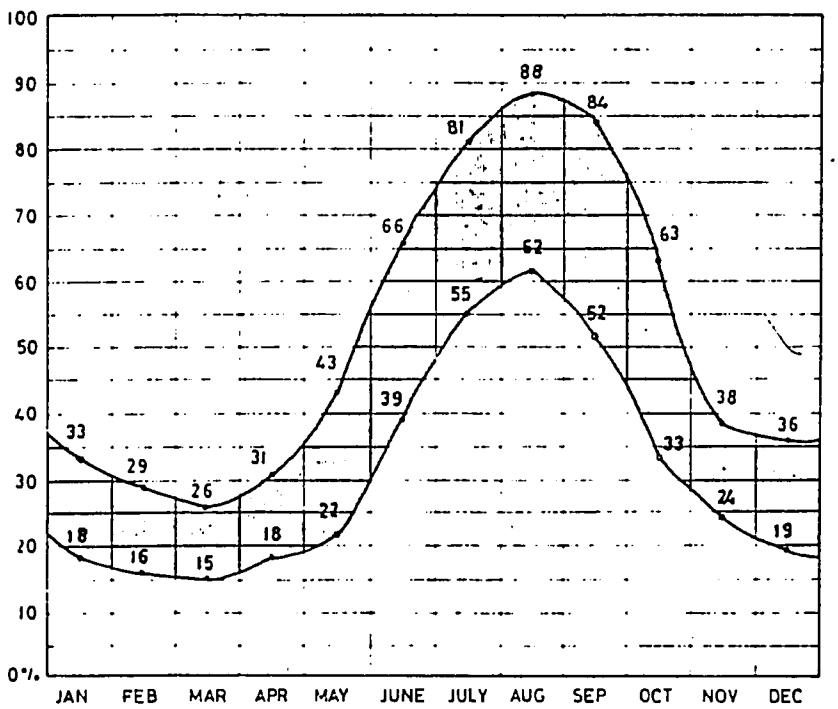


WIND PATTERN FREQUENCY
DURATION
MEAN SCALAR SPEED

CLIMATE DATA: Ghazala Gawazet



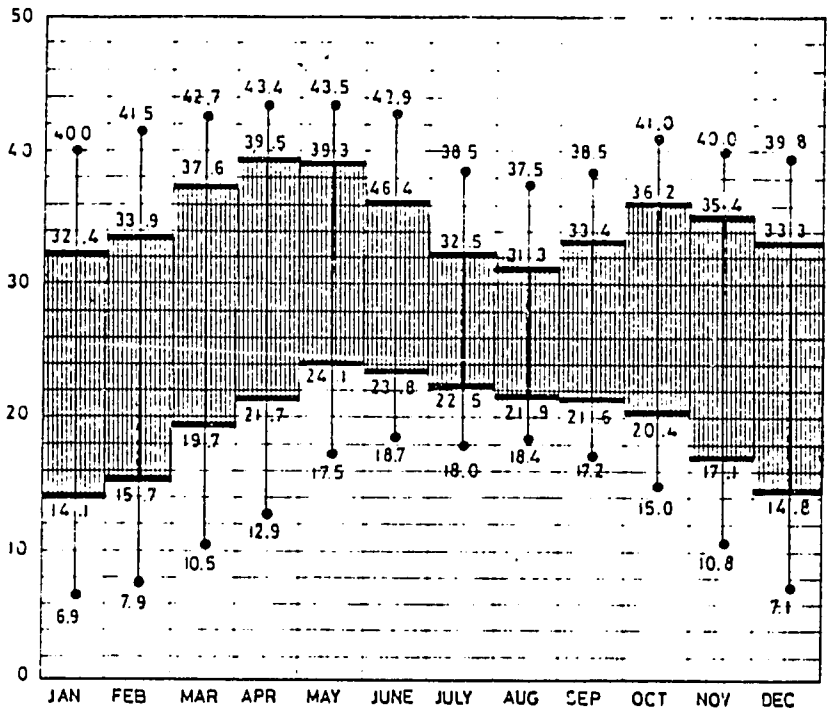
RAINFALL _mms
14 YEARS AVERAGE



RELATIVE HUMIDITY
13 YEARS AVERAGE

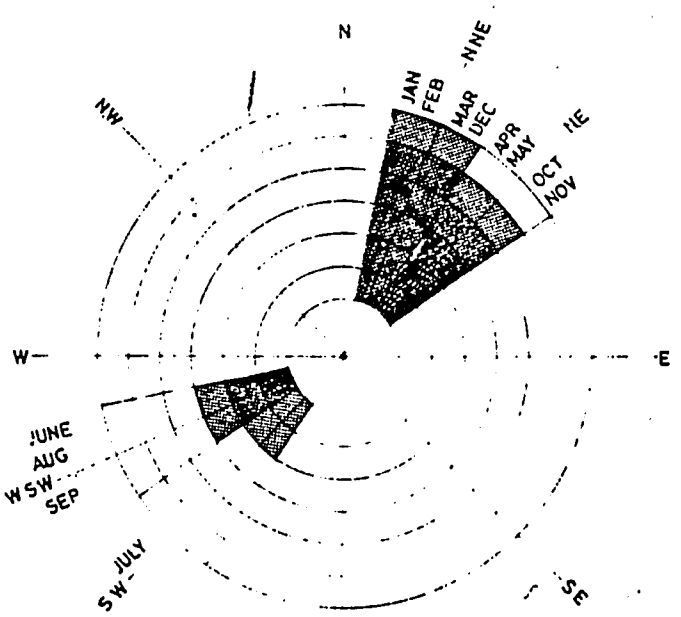
min at 12 00 GMT
max at 6 00 GMT

Ghazala Gawazet



AIR TEMPERATURE °c
14 YEARS AVERAGE

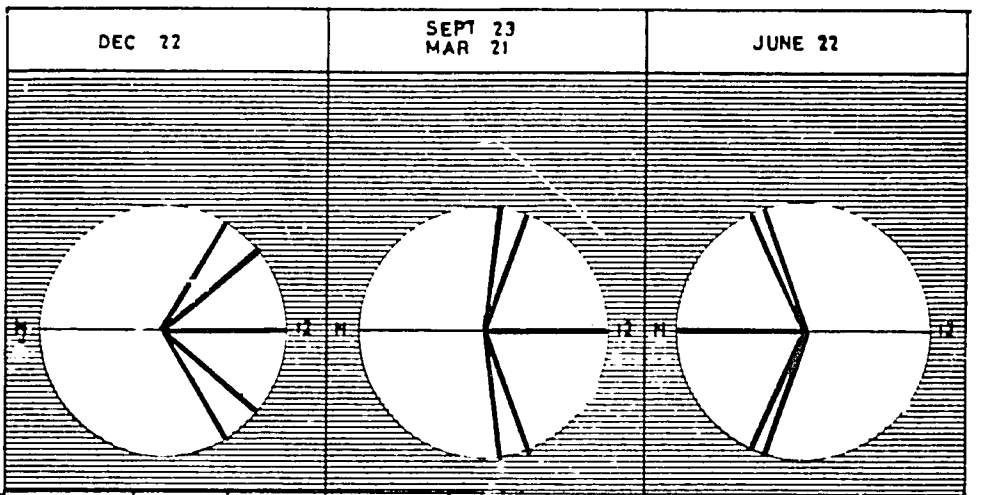
mean average air temperature
max & min air temperature



WIND PATTERN

frequency
duration
mean scaler speed

SOLAR ANGLES: All sites similar



AM PM	AZIMUTH	ALTITUDE	AM PM	AZIMUTH	ALTITUDE	AM PM	AZIMUTH	ALTITUDE
NOON	180°-0'	53°-0'	NOON	180°-0'	77°-30'	NOON	0°-0'	79°-0'
10-2	140°-30'	43°-30'	10-2	110°-30'	57°-30'	10-2	65°-0'	59°-0'
8-4	121°-30'	21°-30'	8-4	97°-0'	29°-0'	8-4	70°-0'	32°-30'

SOLAR ANGLES azimuth and altitude

SUDAN METEOROLOGICAL DEPARTMENT

EL OBEID (LAT 13° 10'N. LONG 30° 14'E ALT 570M

CLIMATOLOGICAL NORMALS 1941 - 1970

Element	Atmospheric Pressure (MB) Station Level (30 Years)			Air Temperature °C Dry Bulb (30 Years)			Daily Maximum (30 Years)			Daily Minimum (30 Years)			Vapor Pressure (MB) (30 Years)			Bright Sunshine Duration (10 Years)		Mean Day Temp.
Month	0600	1200	1800	0600	1200	1800	Mean	Highest	Date	Mean	Lowest	Date	0600	1200	1800	HRS.	%	-
January	947.9	945.1	946.3	17.0	29.4	23.0	30.6	38.6	27-46	13.5	6.4	17-66	5.7	6.6	6.5	10.4	91	22.1
February	947.2	944.5	945.1	18.5	30.8	24.7	31.1	40.7	25-41	14.6	4.4	5-57	4.9	5.7	6.0	10.6	91	22.9
March	946.7	943.0	943.4	23.3	34.4	28.3	35.7	42.9	21.41	18.3	9.0	2-59	5.3	5.8	6.3	10.0	91	27.0
April	944.9	942.1	942.1	27.3	37.0	30.6	38.3	43.0	20-41	21.1	13.0	3-68	7.4	7.5	8.2	10.3	83	29.7
May	944.8	942.2	942.1	29.1	37.6	31.6	39.0	44.3	15-61	24.0	17.2	11-56	13.7	11.6	12.8	9.7	76	31.5
June	945.6	943.3	943.1	27.9	35.7	30.5	37.3	42.3	6-61	24.3	17.1	10-48	19.8	16.1	17.7	8.5	65	30.8
July	945.8	943.9	944.0	25.3	31.9	27.7	33.4	40.0	7-47	22.9	17.3	9-68	23.2	20.7	22.1	7.0	56	28.1
August	946.1	944.2	944.2	24.3	30.0	26.1	31.4	37.7	23-68	21.9	17.5	28-61	24.3	23.1	24.5	6.9	55	26.7
September	946.0	943.5	944.1	25.3	32.6	26.7	33.8	39.0	17-68	21.6	17.1	27-64	22.6	19.9	22.5	8.4	69	27.7
October	945.7	942.8	942.6	26.4	35.1	28.1	36.2	39.7	18-60	21.3	14.5	31-63	15.5	12.7	15.7	9.4	80	28.7
November	946.9	943.8	945.1	23.3	33.1	25.9	33.9	38.4	3-67	17.5	9.2	28-64	8.1	8.6	9.0	10.3	90	25.7
December	948.1	945.0	946.2	18.6	29.9	23.0	30.9	37.6	20-52	14.2	5.8	25-51	6.6	7.2	7.1	10.6	94	22.5
Year	946.2	943.6	944.0	23.9	33.1	27.2	34.3	44.3	15+5 1961	19.6	4.4	5-2-57	13.1	12.1	13.2	9.3	78	26.9

CLIMATE DATA: El Obeid

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SUDAN METEOROLOGICAL DEPARTMENT

EL OBEID

CLIMATOLOGICAL NORMALS

1941 - 1970

Element	Relative Humidity % (30 Years)			Cloud Amount (0 - 8) (30 Years)			Rainfall (MM.) (30 Years)						Evaporation Piche (MM) (30 Years)	Wind (10 Years)	
							Total	No. of Day			Max. In One Day			Prevailing Direction	Mean Scalar Speed MPH
Month	0600	1200	1800	0600	1200	1800		0.1	1.0	10.0	Total	Date			
January	29	16	23	2.5	2.7	1.7	tr	0	0	0	tr	29-1966	15.6	N	8
February	23	13	19	2.3	3.4	1.9	tr	0	0	0	4.1	19-1942	17.9	N	9
March	18	11	16	3.4	3.3	2.5	tr	0.1	0.1	0	5.6	7-1957	20.7	N	8
April	20	12	18	3.4	3.3	2.5	2	0.6	0.5	0.1	14.4	25-1947	21.1	N	7
May	35	19	28	4.1	4.2	3.3	14	2.1	1.8	0.5	61.0	17-1951	18.9	N	8
June	53	29	42	4.7	5.2	4.5	27	4.6	4.0	0.9	50.7	25-1948	15.2	SSW	9
July	72	47	61	5.7	6.0	5.4	113	10.3	8.9	3.4	96.7	2-1956	9.7	SSW	9
August	80	56	74	5.9	6.2	5.1	143	13.1	11.5	4.7	78.1	12-1959	5.8	SSW	7
September	71	42	66	5.3	5.5	4.9	68	7.3	6.6	2.5	56.2	25-1953	7.3	SW	6
October	45	23	42	3.7	4.1	3.5	19	2.6	2.3	0.5	58.0	7-1952	13.2	N	7
November	28	17	26	2.4	2.7	1.6	tr	0	0	0	0.2	13-1963	16.8	N	8
December	30	16	25	2.1	2.3	1.4	tr	0	0	0	tr	21-1945	15.0	N	8
Year	42	25	37	3.8	4.1	3.2	386	40.7	35.7	12.6	96.7	2-1956	14.8		

El Obeid

SUDAN METEOROLOGICAL DEPARTMENT

EL FASHER (LAT. 13° 38'N. LONG. 25° 20'E ALT. 730 M)

CLIMATOLOGICAL NORMALS

1941 - 1970

Elements	Atmospheric Pressure (MB) Station Level (30 Yrs,)			AIR TEMPERATURE °C Dry Bulb (30 Yrs.)			Daily Maximum (30 Yrs.)			Daily Minimum (30 Yrs.)			Vapor Pressure (MB) (30 Yrs.)			Radi-ation (14 yrs)	Bright Sunshine Duration 10N (10 Yrs.)	
Month	0600	1200	1800	0600	1200	1800	Mean	High-est	Date	Mean	Low-est	Date	0600	1200	1800	Cal/CM²	Hrs.	%
January	932.4	929.3	929.8	12.6	28.8	22.8	30.6	37.4	28-42	9.5	0.7	31-69	5.4	7.5	6.7	466.0	10.1	89
February	931.8	928.9	928.9	14.3	30.2	25.0	32.1	40.0	28-58	10.8	1.3	5-57	4.9	6.4	6.2	527.3	10.4	89
March	930.4	927.5	927.1	19.4	33.6	28.7	35.3	42.3	21-41	15.2	5.0	1-46 7-59	5.9	7.7	7.5	565.9	9.7	81
April	929.6	926.8	926.2	23.6	36.2	30.9	37.5	42.6	26-60	18.0	7.6	12-51	6.8	7.9	7.9	577.8	10.0	80
May	929.4	926.9	926.3	26.3	37.1	32.2	38.5	43.4	23-52	21.1	13.6	4-43	10.9	10.0	10.4	578.4	10.1	79
June	929.8	927.5	926.7	26.8	36.7	32.3	38.1	42.5	1-63	22.8	15.7	9-69	16.5	13.1	13.7	542.7	9.3	73
July	929.4	927.5	927.2	25.0	33.2	28.7	34.8	42.0	4-44	22.4	17.4	29-79	21.9	18.0	19.5	524.9	7.9	61
August	929.6	927.9	927.7	23.7	30.8	26.5	32.2	38.5	Sev.	21.3	17.4	20-65	23.5	21.2	22.7	529.4	7.7	60
September	930.2	927.8	927.6	24.1	33.6	28.2	34.9	39.5	27-62 19-69	20.5	14.9	29-59	19.9	16.6	18.7	538.6	8.8	72
October	930.6	927.6	927.8	23.5	34.8	28.7	36.0	39.8	8-66	18.4	10.3	29-56	12.6	11.9	12.0	526.8	9.8	83
November	931.8	928.5	929.1	18.7	32.0	25.2	33.1	39.3	1-41	13.4	5.1	22-53	8.0	9.1	8.6	488.0	10.6	92
December	932.7	929.5	930.0	14.0	29.2	22.1	30.7	37.5	27-60	9.9	1.3	26-51	6.5	8.3	7.6	464.3	10.2	91
Year	930.6	928.0	927.9	21.0	33.0	27.6	34.5	43.3	23,5 1952	16.9	0.7	31,1 1969	11.9	11.5	11.8	527.5	9.5	78

CLIMATE DATA El Fasher

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SUDAN METEOROLOGICAL DEPARTMENT

EL FASHER CLIMATOLOGICAL NORMALS (1941 - 1970)

Element	Relative Humidity (%) (30 yrs.)			Cloud Mount (0-8) (30 yrs.)			Rainfall (MM) (30 Yrs.)						Evaporation 10N Piche (MM) (30 Yrs.)	Wind (10 yrs)	
							Total	No. of Days			Max. in one Day			Prevailing Direction	Mean Scalar Speed MPH
Month	0600	1200	1800	0600	1200	1800		0.1	1.0	10.0	Total	Date			
January	37	18	24	2.7	2.7	2.0	TR	0	0	0	TR	SEV.	11.9	NE	5
February	30	15	20	2.5	2.5	1.8	TR	0	0	0	0.2	10-1966	13.9	NE	6
March	26	15	19	3.5	3.5	2.6	1	0.2	0.1	0	6.4	21-1969	16.4	NE	6
April	23	13	17	3.4	3.3	2.3	1	0.2	0.2	0	18.0	27-1967	17.9	NE	6
May	32	16	22	3.7	3.8	2.9	9	1.8	1.6	0.4	24.6	29-1947	17.1	NE	6
June	47	22	30	4.3	4.3	4.1	16	3.3	3.0	0.5	38.0	17-1962	15.3	S	6
July	70	37	51	5.4	5.6	5.6	83	10.4	9.3	2.6	128.1	18-1953	9.6	S	5
August	81	49	66	5.9	5.9	5.2	132	13.0	12.2	4.9	77.9	1-1954	6.0	S	4
September	67	33	51	5.1	5.0	4.2	35	5.3	4.7	1.2	51.4	15-1945	9.1	S	4
October	43	22	32	3.5	3.3	2.6	6	1.4	1.3	0.2	20.1	19-1964	13.5	NE	5
November	37	19	27	2.9	2.8	1.9	TR	0	0	0	TR	1-1943 21-1946	12.9	NE	4
December	40	20	28	2.4	2.5	1.7	0	0	0	0	0	-	11.4	NE	4
Year	44	23	32	3.8	3.8	3.1	283	35.6	32.4	9.8	128.1	18-7-1953	12.9	-	-

El Fasher

SUDAN METEOROLOGICAL DEPARTMENT

NYALA (LAT 12° 4N. LONG 24 53E. LAT 675M)

CLIMATOLOGICAL NORMALS 1941 - 1970

Element	Atmospheric Pressure (MB)			AIR TEMPERATURE °C									Vapour Pressure (MB)			Bright Sunshine Duration (10 Yrs.)		Mean Day Temp.
	Station Level (30 Yrs.)			Dry Bulb (30 Yrs.)			Daily Maximum (30 Yrs.)			Daily Minimum (30 Yrs.)			(30 Yrs.)					
MONTH	0600	1200	1800	0600	1200	1800	Mean	Highes	Date	Mean	Lowest	Date	0600	1200	1800	Hrs.	%	-
January	938.9	936.2	..	19.8	30.0		31.6	38.6	29.46	15.5	5.0	10.51	4.9	5.2		NA		23.7
February	938.3	935.7		21.3	31.3		33.0	40.6	28.58	16.9	8.2	10.49	4.2	4.4		NA		26.1
March	937.0	934.5		24.8	34.4		36.0	42.5	16.59	19.9	10.0	1.47	4.8	5.2		NA		28.8
April	936.5	934.0		27.7	36.5		38.0	43.8	5.59	21.8	13.2	27.53	6.9	7.7		NA		30.7
May	936.7	934.3		28.2	36.6		38.0	42.4	23.52	22.9	15.3	5.43	13.5	11.3		NA		31.3
June	937.4	935.3		26.6	34.7		36.3	42.4	1.63	22.7	14.2	17.70	20.0	16.5		NA		30.5
July	937.5	935.8		24.3	30.7		32.2	40.2	5.44	21.4	15.5	8.50	22.9	21.2		NA		27.7
August	937.6	935.9		23.4	29.3		30.8	37.8	2.41	20.8	15.5	11.48	23.7	22.7		NA		26.5
September	937.7	935.5		24.3	31.7		33.3	38.9	6.45	20.8	15.5	1.50	22.1	10.5		NA		27.6
October	937.7	935.1		25.9	34.2		35.4	39.8	20.58	20.58	14.0	19.50	14.6	12.6		NA		29.4
November	938.3	935.5		24.8	32.9		34.0	39.4	2.41	18.9	11.3	30.53	7.8	8.0		NA		28.1
December	939.2	936.4		20.8	30.3		31.5	38.0	31.53	15.8	5.3	25.51	6.3	6.3		NA		25.1
YEAR	937.7	935.3		24.3	32.7		34.2	43.8	5.4.59	19.8	5.0	10.1.5	12.6	11.7		NA		27.9

SUDAN METEOROLOGICAL DEPARTMENT

NYALA

CLIMATOLOGICAL NORMALS 1941 - 1970

Element	Relative Humidity % (30 Yrs.)			Cloud Amount (0 - 8) (30 Yrs.)			Rain Fall (MM) (30 Yrs.)						Evaporation Piche (MM) (30 Yrs.)	Wind (10 Yrs.)	
							Total	No. of Days			Max. in one day			Prevailing Direct.	Mean Scalar Speed MPH
MONTH	0600	1200	1800	0600	1200	1800		0.1	1.0	10.0	Total	Date			
January	22	12		3.0	3.0		0	0	0	0	TR	30-1966	17.3	NE	8
February	17	10		2.9	2.9		TR	0	0	0	0.3	8-1961	19.6	NE	9
March	15	10		3.0	3.7		1	0.3	0.2	0	4.0	18-1966	21.2	NE	8
April	19	12		3.9	3.9		3	0.8	0.7	0.1	15.0	13-1969	21.1	NE	8
May	36	19		4.6	4.6		21	2.9	2.7	0.8	41.8	7-1942	17.6	NE	7
June	58	32		5.3	5.3		47	5.7	5.5	1.5	49.9	26-1946	12.5	SW	6
July	76	49		5.9	6.1		138	11.7	11.5	4.4	91.7	15-1946	6.8	SW	6
August	82	57		6.3	6.2		167	12.6	12.4	5.9	129.0	29-1969	4.6	SW	6
September	73	42		5.5	5.3		75	6.2	6.2	2.5	3.0	3-1970	6.8	SW	5
October	44	22		4.2	4.1		18	2.0	2.0	0.7	56.1	8-1951	12.9	NE	6
November	26	16		3.0	2.8		0	0	0	0	TR	5-1964	17.0	NE	7
December	26	15		2.6	2.5		0	0	0	0	0	-	16.2	NE	8
YEAR	41	25		4.3	4.2		470	42.2	41.2	15.9	129.0	29-8-1969	14.5		

Nyala

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XIII. CURRENT LOCAL PRICE DATA

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CURRENT PRICE DATA
EL OBEID

MATERIAL	PRICE & UNIT		SOURCE OF DATA
Brick	35 Ls per 1,000 Ordinary	(2)	1 = District Surveyor's Office North Kordofan, El Obeid
	40 Ls per 1,000 Select	(2)	
	35 Ls per 1,000 Ordinary	(6)	
Cement Brick	40 Ls per m^3	(2)	2 = Ministry of Construction & Public Works North Kordofan, El Obeid
Cement	100 Ls per ton, government allocation	(2)	3 = Contractor El Obeid
	180 Ls per ton, open market	(2)	
	60 - 80 Ls per ton, government allocation	(3)	4 = Beautification Engineer El Obeid
	180 Ls per ton, open market	(3)	
	90 Ls per ton, government allocation	(6)	5 = Water & Electric Corp.
	180 Ls per ton, open market	(6)	
			6 = Contractor
Aggregate	6 Ls per M^3	(2)	
	8 Ls per m^3	(6)	
Sand	5 Ls per m^3	(2) (6)	
Saffaya	4 Ls per m^3	(2)	
	3 Ls per m^3	(6)	
Lime	Not available locally		
Stone	30 Ls per m^3	(2)	
Concrete Block	Same as brick per m^3	(2)	
Steel, Reinforcing	600 - 700 Ls per ton, Khartoum	(2)	
	600 Ls per ton	(6)	

CURRENT PRICE DATA
EL OBEID

MATERIAL	PRICE & UNIT	SOURCE OF DATA
Water Pipe (Galvanized)		
3/4" dia.	12 Ls per 6m length	(2)
1" dia.	17 Ls per 6m length	(2)
1½" dia.	21 Ls per 6m length	(2)
2" dia.	25 Ls per 6m length	(2)
Wells		
8" Cased Borehole	4,000 Ls (240' deep)	(2)
Geophysical Investigation	Not Required	(2)
Septic Tank	1,100 Ls	(1)
Seepage Pit	1,500 Ls	(1)
Roads		
Asphalt	150,000 Ls per kilometer, 6m wide 1979 price	(4)
Gravel		
Electrical		
High Tension Pole 30'	Stocked at Public Electric & Water Corp., Khartoum. No local price available.	
High Tension Pole 36'		
100 KVA Transformer w/fittings		
High Tension Cable		
Low Tension Cable		
Low Tension Cable .06 sq.in. - 4 core		

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CURRENT PRICE DATA
EL OBEID

MATERIAL	PRICE & UNIT	SOURCE OF DATA
Steel, Structural	600 - 700 Ls per ton, Khartoum	(2)
	600 Ls per ton	(6)
Corrugated Roofing	8 Ls per m^2	(2)
	24 ga. (1 LF x 70 CM) 1.50 Ls per LF	(6)
	16 ga. (1 LF x 70 CM) 1.40 Ls per LF	(6)
Timber	2 x 6, 6 Ls per ML import, Russia	(2)
Labor		
Mason	6 Ls/day	(2)
	5-8 Ls/day	(6)
Welder	6 Ls/day	(2)
	10 Ls/day	(6)
Laborer	1.50-2 Ls/day	(2)
	1.50 Ls/day	(6)
Carpenter	6 Ls/day rough; finish piecework	(2)
	5-8 Ls/day	(6)
Plasterer	8 Ls/day	(6)
Electrician	4 Ls/day	(2)
	10 Ls/day	(6)
Plumber	Piece work, negotiated	(2)
	10 Ls/day	(6)
Painter	5 Ls/day	(6)
Foreman	300 Ls/month	(6)
Drainage Pipe (PVC)		
4" dia.	8 Ls per m installed	(2)
Water Pipe (Galvanized)		
½" dia.	8 Ls per 6m length (Open market prices. Only small quantities stocked locally.)	(2)

CURRENT PRICE DATA
EL OBEID

MATERIAL	PRICE & UNIT	SOURCE OF DATA	KADUGLI BID UNIT PRICE
Brick Walls - Ordinary Brick			
1 brick thick, mud mortar	10 Ls/m^2	(2)	
1½ brick thick, mud mortar	15 Ls/m^2		
1 brick thick, cement mortar	12 Ls/m^2	(2)	16.75 Ls/m2
1½ brick thick, cement mortar	18 Ls/m^2		40.6 Ls/m^2
Pointing	.70 Ls/m^2	(2)	
½ brick thick, cement mortar	30 Ls/m^2	(6)	13.0 Ls/m^2
1 brick thick, cement mortar	40 Ls/m^2	(6)	16.75 Ls/m^2
1½ brick thick, cement mortar	50 Ls/m^2	(6)	40.6 Ls/m2
Concrete			
Flatwork 1:3:6 mix	60 Ls/m^3	(2)	
Flatwork 1:3:6 mix	10 cm slab, 15 Ls/m2	(6)	8.70 Ls/m2
Foundations 1:2:4 mix unreinforced	90 Ls/m3	(2)	152.25 Ls/m3
Foundations 1:2:4 mix reinforced	120 Ls/m3	(2)	253.76 Ls/m3
Beams & Columns 1:2:4 mix Reinforced	150 Ls/m3	(2)	
Beams & Columns 1:2:4 mix Reinforced	250 Ls/m3	(6)	253.75 Ls/m3
Structural Slab 1:2:4 Reinforced	170 Ls/m3	(2)	
Structural Slab 1:2:4 mix Reinforced	300 Ls/m3	(6)	253.75 Ls/m3
Suspended Ceiling Wood Frame & Chipboard	10 Ls/m2	(2)	2 x 2 fiberglass, metal grid 31.0 Ls/m2
Cement Plaster Mix 1:6, beams & columns	2 Ls/m2	(2)	4.15 Ls/m2
Mix 1:8, walls			

CURRENT PRICE DATA
EL FASHER

MATERIAL	PRICE & UNIT	
Brick	34 Ls per 1,000	(7)
	17 Ls per m^3	
Cement	90 Ls per ton, government allocation	(7)
	140 Ls per ton, open market	(7)
	100 Ls per ton, government allocation	(10)
	280 Ls per ton, open market	(10)
Aggregate	7 Ls per m^3 on site	(7)
Sand	5 Ls per m^3 on site	(7)
Lime	55 Ls per m^3	(7)
	4.50 Ls per sack (100 kg)	(10)
Stone	7 Ls per m^3	(7)
Concrete Block	30 Ls per m^2 in place (or official cement price)	(7)
Steel, Reinforcing	700 Ls per ton, open market	(7)
	Open market price + transport	(10)
Steel, Structural	20 Ls per truss	(7)
	700 Ls per ton, open market	(10)
	Open market price + transport	
Corrugated Roofing	1.50 Ls per sq.ft., 26 ga., open market	(7)
	1.50 Ls per sq.ft., 24 ga., open market	(10)
	1.40 Ls per sq.ft., 26 ga., open market	(10)
Timber	8 Ls per truss	(7)

SOURCE OF DATA

7 = Ministry of Construction & Public Works
Northern Darfur, El Fasher

8 = District Surveyor's Office
Northern Darfur, El Fasher

9 = Rural Water & Electric Corp.
El Fasher

10 = Contractor, El Fasher

CURRENT PRICE DATA
EL FASHER

MATERIAL	PRICE & UNIT	SOURCE OF DATA
Labor		
Mason	3.4 Ls per day	(7)
	4 Ls per day	(10)
Welder	2-3 Ls per day	(7)
	4 Ls per day	(10)
Laborer	1 Ls per day	(7) (10)
Carpenter	2-3 Ls per day	(7)
	3 Ls per day	(10)
Plasterer	2-3 Ls per day	(7)
	3 Ls per day	(10)
Electrician	3-4 Ls per day	(7)
	Sub-contract	(10)
Plumber	2-3 Ls per day	(7)
	3 Ls per day	(10)
Painter	3 Ls per day	(10)
Foreman	280 Ls per month	(10)
Drainage Pipe (PVC)		
4" dia.	10 Ls per m	(7)
Water Pipe (galvanized)		
½" dia.	.75 ls per ft.	(7)
3/4" dia.	1.10 Ls per ft.	(7)
1" dia.	1.25 Ls per ft.	(7)
2" dia.	4.0 Ls per m	(7)
4" dia.	10 Ls per m (asbestos	(7)
Wells		
6" Cased Borehole	40 Ls per foot (150-200 ft. req.)	(9)
8" Cased Borehole	50 Ls per foot	(9)
13' dia. dug	20 Ls per foot	(9)
Geophysical Investigation	3,000 Ls max. per well	(9)

CURRENT PRICE DATA
EL FASHER

MATERIAL	PRICE & UNIT	SOURCE OF DATA	KADUGLI BID UNIT PRICE
Brick Walls - Ordinary Brick			
½ brick thick, mud mortar	10 Ls/m^2	(7)	
½ brick thick, cement mortar	15 Ls/m^2	(7)	13.0 Ls/m2
1 brick thick, mud mortar	18 Ls/m^2	(7)	
1 brick thick, cement mortar	25 Ls/m^2	(7)	16.75 Ls/m2
1½ brick thick, mud mortar	25 Ls/m^2	(7)	
1½ brick thick, cement mortar	30 Ls/m2	(7)	40.6 Ls/m2
Concrete			
Flatwork			
Reinforced slab 10 cm thick 1:2:4 mix	50 Ls/m^3	(7)	87.0 Ls/m3
Foundation			
Unreinforced 1:2:4 mix	100 Ls/m^3	(7)	152.25 Ls/m^3
Reinforced 1:2:4 mix	150 Ls/m^3	(7)	253.76 Ls/m^3
Stone Walls			
Mud mortar	22-23 Ls/m^3	(7)	
Cement mortar	30 Ls/m^3	(7) Laid with block or brick at jambs and corners	32.90 Ls/m2
Suspended Ceiling			
Cloth on wire grid	5 Ls/m^2	(7)	
Masonite on wood grid	15 Ls/m2	(7)	2 x 2 fiberglass, metal grid 31.0 Ls/m2

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CURRENT PRICE DATA
EL FASHER

MATERIAL	PRICE & UNIT	SOURCE OF DATA
Septic Tank	600 Ls	(7)
	100 Ls (labor only)	(10)
Seepage Pit	1,000 Ls	(7)
	200 Ls (labor only)	(10)
Roads		
Asphalt	20 Ls per m^2	(7)
Gravel	12 Ls per m^2	(7)
Telephone	2-3,000 Ls for 2 phones Installation free	(8)
Topsoil	4 Ls per m^3	(7)
Electrical		
High Tension Pole - 30'	120 Ls ea.*	(9)
High Tension Pole - 36'	150 Ls ea.*	
100 KVA Transformer w/fittings	2,000 Ls ea.*	(9)
High Tension Cable	3.0 Ls per m*	
Low Tension Cable	4.0 Ls per m*	
Low Tension Cable .06 sq.in., 4 core	10.0 per m*	

*Installed price using direct labor

CURRENT PRICE DATA
GHAZALA GAWAZET

MATERIAL	PRICE & UNIT		SOURCE OF DATA
Brick	30 Ls per 1,000	(11)	11 = Ministry of Construction & Public Works Southern Darfur, Nyala
	28 Ls per 1,000 at site	(13)	
Cement	90 Ls per ton at Nyala By rail, government allocation	(11)	12 = Contractor
	140 Ls per ton at Nyala By lorry, government allocation	(11)	13 = Brick manufacturer
	220-240 Ls per ton, open market	(11)	Ed Da'ein
	200 Ls per ton at Nyala, open market	(12)	
	240 Ls per ton at Ghazala, open market	(12)	
Aggregate	3 Ls per m^3 at Nyala	(11)	
	7-10 Ls per m^3 at Ghazala	(11)	
	20 Ls per m^3 at Ghazala	(12)	
Sand	3.5 Ls per m^3	(12)	
Lime	10 Ls per sack (70 kg)	(12)	
Stone			
Concrete Block			
Steel, reinforcing	5 Ls per 6m length	(13)	
Steel, structural			
Corrugated Roofing	1.6 Ls per foot (2' wide)	(12)	
Timber			

CURRENT PRICE DATA
GHAZALA GAWAZET

MATERIAL	PRICE & UNIT	SOURCE OF DATA
Labor		
Mason		
Welder		
Laborer	1.20 Ls per day	(13)
Carpenter		
Plasterer	6 Ls per day	(13)
Electrician		
Plumber		
Painter	40 P per m^2	(13)
Foreman	6 Ls per day (from Min. of Works)	(13)
Drainage Pipe (PVC)		
4" dia.		
Water Pipe (PVC)		
½" dia.	11 Ls per 6m length	(11)
3/4" dia.	22 Ls per 6m length	(11)
2" dia.		
4" dia.		
Wells		
6" cased borehole		
8" cased borehole		
13' dia. dug		
Geophysical investigation		
Septic Tank		
Seepage Pit		
Roads		
Asphalt		
Gravel		

CURRENT PRICE DATA
GHAZALA GAWAZET

MATERIAL	PRICE & UNIT	SOURCE OF DATA
Telephone		
Topsoil		
Electrical		
High Tension Pole 30'		
High Tension Pole 36'		
100 KVA Transformer w/fittings		
High Tension Cable		
Low Tension Cable		
Low Tension Cable .06 sq.in. 4 core		

XIV. TRANSPORTATION COSTS

BY RAILWAY

FROM	TO	MATERIAL	COST PER TON LS m/ms
Port Sudan	Nyala	Cement	57.700
Port Sudan	Nyala	Steel fabricated, not fabricated or otherwise	51.000
Port Sudan	Nyala	Ordinary Glass Sheets	68.600
Port Sudan	Nyala	Wood	45.000
Port Sudan	El Obeid	Cement	31.100
Port Sudan	El Obeid	Steel fabricated not fabricated rolled or otherwise	27.500
Port Sudan	El Obeid	Ordinary Glass Sheets	37.000
Port Sudan	El Obeid	Wood	25.000

BY ROAD

FROM	TO	COST PER TON	# DAYS FOR JOURNEY
Port Sudan	El Obeid	90.00	5
Port Sudan	Nyala	200.000	20
Port Sudan	El Fasher	200.000	20
Port Sudan	Ghazala Gawazet	180.000	8
El Obeid	Ghazala Gawazet	110.000	4
El Obeid	El Fasher	120.000	4
Nyala	Ghazala Gawazet	30.000	1
El Fasher	Ghazala Gawazet	75.000	2
Khartoum	El Obeid	55.000	2
Khartoum	Nyala	120.000	6
Khartoum	El Fasher	120.000	6
Khartoum	Ghazala Gawazet	110.000	5