3.2.3 Geology

(1) Geological Formations of Coastal Area

The Bengal basin has been filled in by sediment from the north, east and west. During this filling process, the basin has deepened and the sea level has varied considerably from its present position through a series of transgressions and regressions which have occurred over a 60 million year period. The alluvial plains and deltas formed in more recent periods by the Ganges, Brahmaputra and Meghna rivers cover the surface of the Bengal basin over a total area of 60,000 km^2. This huge delta is called the Bengal fan and consists of the world's largest-scale fan deposits.

The thickest Bengal basin deposit of some 18,000m is observed at the Patuakhali trough located in the coastal Hatiya, Barisal and Faridpur areas. As most soil studies in the coastal area in the past have dealt with the soil types upto approximately 20m below the ground surface, only some of the latest alluvial series have been examined. Fig. 3-2-3 shows the assumed geological sections of the coastal areas of the 3 major rivers based on data collected from deep tube wells in the relevant areas. The surface layer mainly consists of silt and clay and has a thickness of some 50m, except at the mouth of the Meghna river where the thickness is reduced to some 10m. A more detailed examination reveals that the soil texture of the surface layer differs from one area to another in both the horizontal and vertical directions. The grain size, density and consistency also largely differ from one area to another. These differences reflect the sedimentation environment and are caused by frequent changes of the well-developed river and water channel courses. In general, the deposits of the major rivers are coarser than those of the sea currents.

The fan deposits from the Chittagong hills and deposits of coastal currents are mixed in a complicated manner in the Chittagong coastal area. The geological formations and soil characteristics of this area are very complicated due to the multifold shallow bedrock of the above hills.

(2) Groundwater in Coastal Area

Groundwater in the coastal area is strongly influenced by saline water as shown in Fig. 3-2-4. Tube wells of more than 200m deep are dug in and around the Chittagong hills and hills near Moheskhali Island to avoid saline water intrusion. Some flowing artesian wells are also observed in these areas. The well depth in other parts of the coastal area of around 300m is generally much deeper. Some wells near Noakhali are more than 400m.

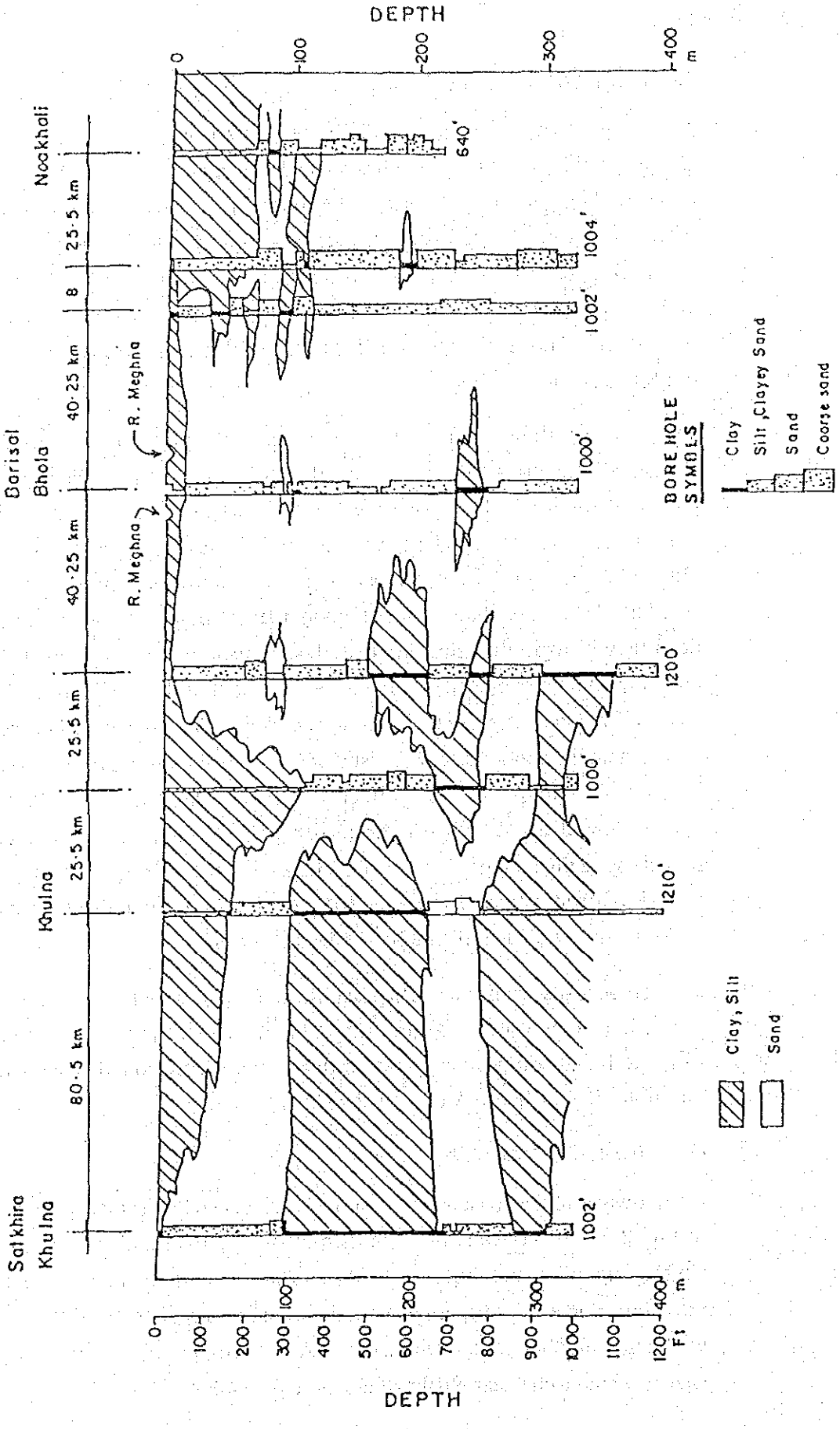


Fig. 3-2-3 Geological Sections of Coastal Area (MPO, 1987)

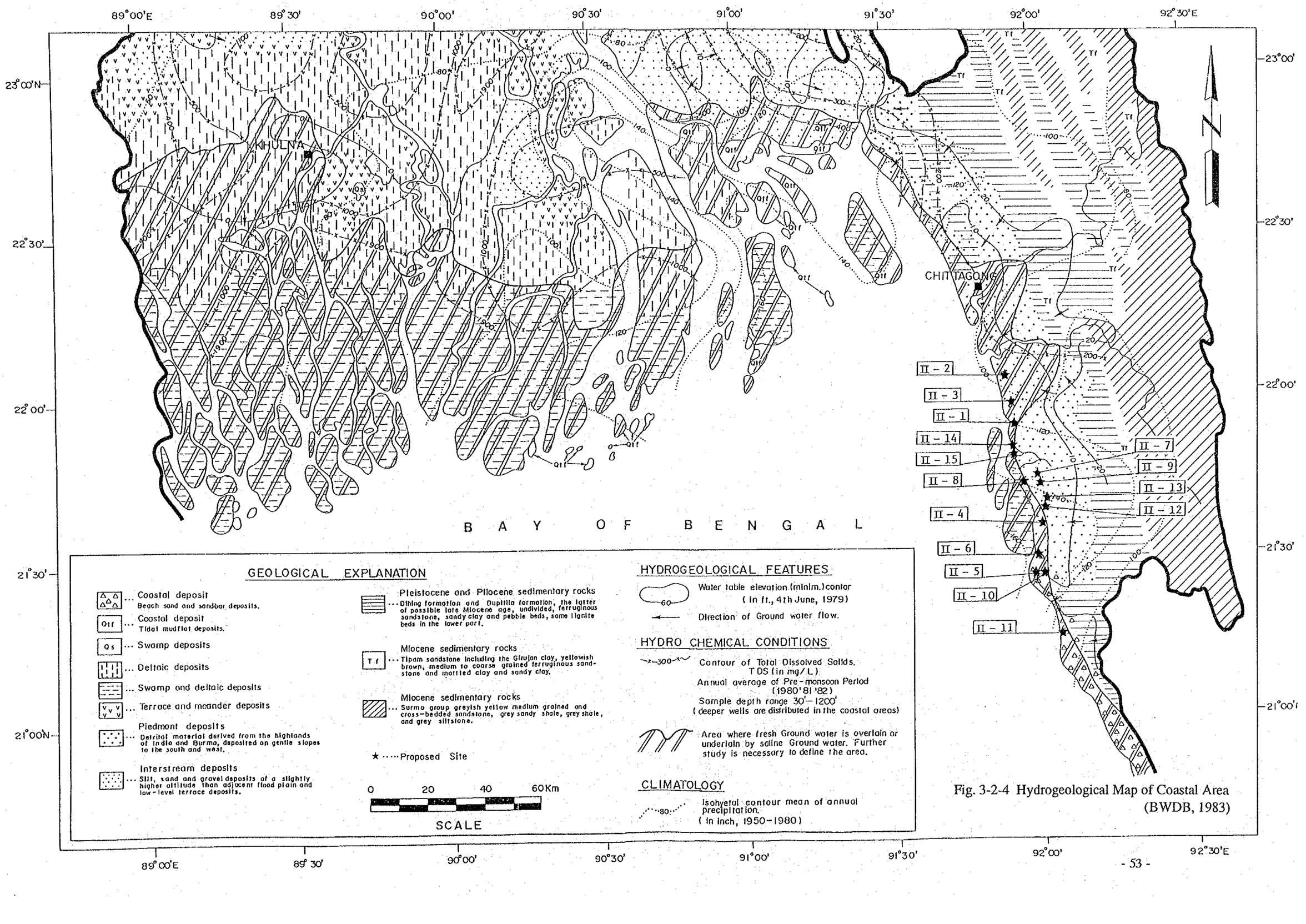


Fig. 3-2-4 Hydrogeological Map of Coastal Area (BWDB, 1983)

3.3 Social Infrastructure

3.3.1 Current Level of Infrastructure

(1) Roads and Transport

The locations of the Project Sites vis-a-vis major cities, trunk roads, local key towns and local roads are illustrated in Fig. 3-3-1.

In general, vehicle access to 15 Project Sites is possible, provided that a 4-wheel drive or small truck is used due to the relatively narrow and inadequately paved access roads.

In the case of Site No. II-6, vehicle access via the existing road is impossible, making the crossing of Bagkhali river by boat necessary. Vehicle access to Site No. II-14 is currently impossible as the coastal embankment which provides access has been shredded to pieces due to the repair or expansion of the drainage system. The insufficient crown width in some sections aggravates the difficulty of vehicle access.

The bus services using small buses between Satkania and Banskhali and between Baniachula and Magnama/Chiringa/Badarkhali are currently the only means of public transportation to the Project Sites although there are frequent large bus services between Chittagong and Cox's Bazar.

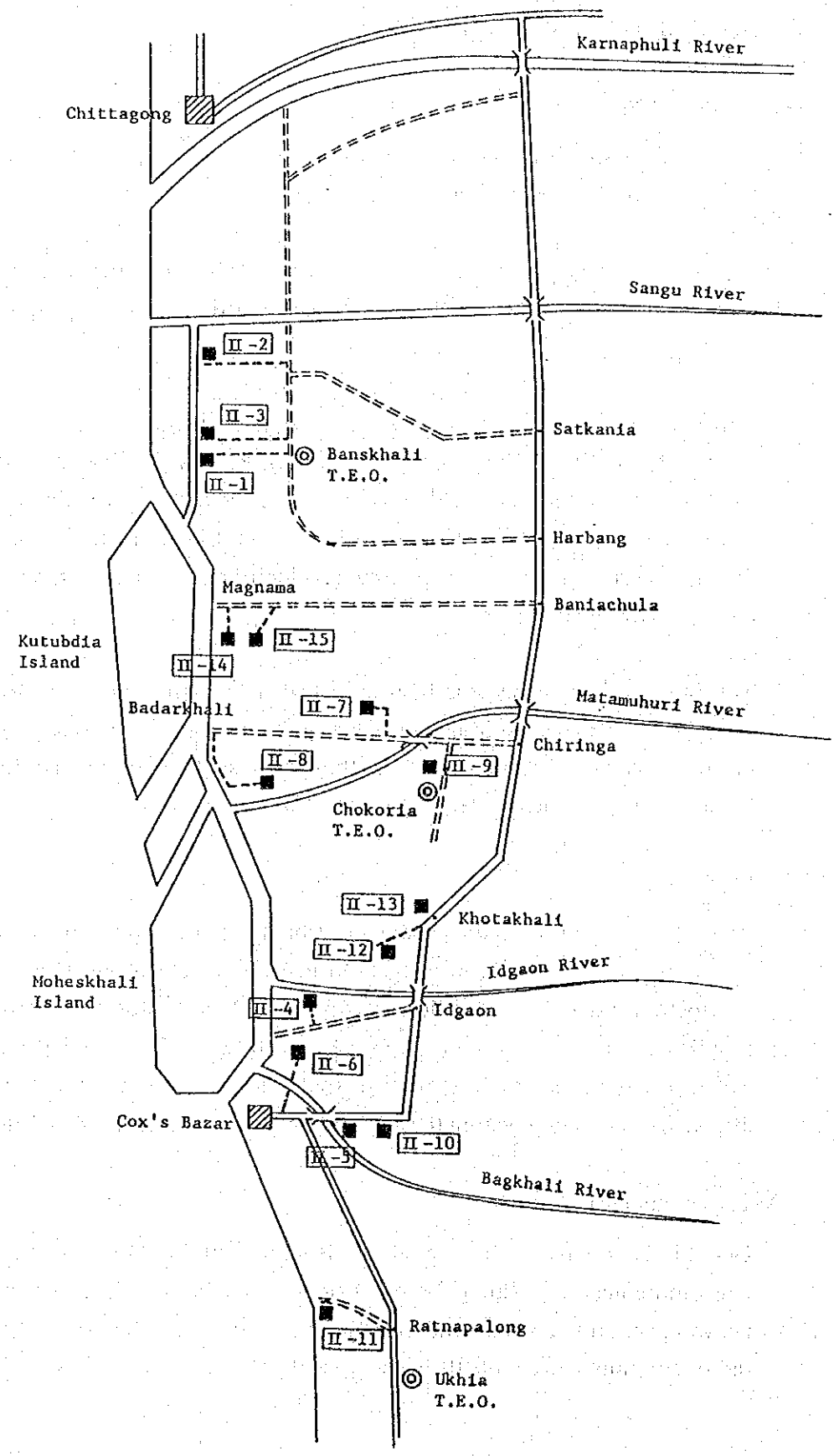
(2) Electricity

As the Project (II) basically intends the rebuilding of existing primary school buildings, most of which are located in densely populated areas, an electric distribution system is in operation around all the Project Sites. Electricity is not supplied to the existing schools, however, due to the lack of lighting facilities. No electricity distribution network is currently in place within a 100m radius of the existing primary school in the case of Site Nos. II-7, II-8, II-14 and II-15.

(3) Telecommunications

Due to the relatively low level of development in the Project Area, a telecommunication system for extension to the Project Sites is currently unavailable. Any communication requirement with other areas must rely on radio communication or the telephone system at the Thana offices of

Fig. 3-3-1 Location Map of the Project Sites



government agencies. However, the telephone connection between these offices and such large cities as Chittagong and Cox's Bazar is still inadequate.

(4) Water Supply

No communal water supply facilities are currently available at the Project Sites. Local inhabitants use groundwater from boreholes which is manually pumped. Due to the location of the Project Sites near the coast, the groundwater from shallow layers contains salt and, therefore, is unsuitable for drinking. A borehole depth of some 800 - 1,000 feet (240 - 300m) is required to obtain potable groundwater. There is a flowing artesian well at a private school in the Khotakhali Union where Site No. II-13 is located and this water is preferentially used by the school.

(5) Sewage Facilities

Although most parts of the Project Area are densely populated, no central sewage treatment facilities are in place at present. While some well-built houses have a septic tank, simple houses appear to lack any kind of sewage facilities.

Approximately one-half of the subject primary schools have toilet facilities using either a simple infiltration system or a septic tank. The schools with toilet facilities tend to be located in densely populated areas near the Chittagong - Cox's Bazar Road while those without toilet facilities tend to be located along the coast or in areas which are far from residential areas.

3.3.2 Progress of Coastal Embankment Construction

As already referred to in 2.3.2 - (2), the Government of Bangladesh has been constructing coastal embankments since the 1970's under the Coastal Area Rehabilitation Project. In addition, further efforts to improve coastal embankments and to construct new coastal embankments to protect newly reclaimed land have been in progress since 1986 under the National Cyclone Protection Project. Furthermore, during the design stage of the Cyclone Protection Project II (CPP II) which commenced in 1989 to study and design protection facilities vis-a-vis cyclones and storm surges, Bangladesh was hit by a powerful cyclone in April, 1991. Following extensive embankment damage due to this cyclone, the Priority Works Programme was prepared and is underway to rehabilitate the damaged embankments at sites required. The coastal embankment construction projects which relate to the Project Sites are summarised in Table 3-3-1.

Table 3-3-1 Coastal Embankment Construction Projects

Polder No.	Name	Embankment Length (km)	Current State	Related Project Sites
63/1A	Anwara	14.5	in progress (60% so far)	
64/1A	Banskhali	26.2	in progress (60% so far)	
64/1B	Banskhali	n.a.	n.a.	II-1, II-2, II-3
64/1C	Chanua	10.0	in progress (75% so far)	
64/2A	Barabakia	n.a.	n.a.	
64/2B	Chokoria	16.4	in progress (60% so far)	II-8, II-14, II-15
66/1	Cox's Bazar	5.0	not yet started	II-6
66/2	Cox's Bazar	n.a.	n.a.	
66/3	Cox's Bazar	4.6	n.a.	II-4

The standard embankment specifications are a crown width of 4.3m, a gradient of 1:7.0 for the outer slope (facing the sea) and a gradient of 1:3.0 for the inner slope (facing the land).

3.3.3 Housing Conditions

(1) Housing

While some public office buildings and some private houses in the Project Area have a concrete structure, most houses are single story buildings with either wood or bamboo walls and a thatched roof. These houses suffered devastating damage due to the cyclone in April, 1991. Most, however, have since been restored. The tremendous destructive effect of the cyclone can still be seen in the yet unrepaired, collapsed walls of many public office buildings and exposed damaged banisters of private houses.

As most public office buildings are 2-story, reinforced concrete structures, many people avoid the flooding-related disasters caused by cyclones by evacuating to the second story. This seems to reinforce the advantages, as well as necessity, of constructing tall concrete buildings in the RZ.

(2) Population, Households and Family Size

The population, number of households and average family size of those Unions in which the Project Sites are located are given in Table 3-3-2. According to this table, the average family size of the Project-related Unions in the Chittagong District is 5.77 persons which is almost equal to the average family size of 5.76

for the Chittagong District. In the case of the Cox's Bazar District, the average family size of 6.54 persons of the Project-related Unions is slightly higher than the 6.49 persons for rural areas in the Cox's Bazar District. In short, the family size in urban areas is one person less than the family size in rural areas.

Table 3-3-2 Population, Households and Family Size by Project-Related Union

Site No.	District	Thana	Union	Population	No. of Households	Average Family Size
II-1	Chittagong	Banskhali	Saral	29,731	4,691	6.34
II-2	Chittagong	Banskhali	Sadhonpur	19,791	3,550	5.57
II-3	Chittagong	Banskhali	Jaldi	24,505	4,584	5.35
II-4	Cox's Bazar	Sadar	Idgaon	46,330	7,348	6.31
II-5	Cox's Bazar	Sadar	Jhilwanja	46,515	7,029	6.62
II-6	Cox's Bazar	Sadar	Khoruskul	29,861	4,392	6.80
II-7	Cox's Bazar	Chokoria	East Boro Bheola	18,206	2,547	7.15
II-8	Cox's Bazar	Chokoria	Badarkhali	19,750	2,647	7.46
II-9	Cox's Bazar	Chokoria	Chiringa	34,075	5,362	6.35
II-10	Cox's Bazar	Ramu	Patakarkul	22,687	3,745	6.05
II-11	Cox's Bazar	Ukhia	Jaliaparo	24,437	3,796	6.44
II-12	Cox's Bazar	Chokoria	Khotakhali	23,745	3,669	6.47
II-13	Cox's Bazar	Chokoria	Khotakhali			
II-14	Cox's Bazar	Chokoria	Magnama	25,719	3,996	6.44
II-15	Cox's Bazar	Chokoria	Magnama			
Total				365,352	57,356	6.37

(3) Population Density

The population density of the Project-related Unions is given in Table 3-3-3 based on the relevant population and land area data.

Table 3-3-3 Population Density of Project-Related Unions

Site No.	Union	Land Area (km^2)	Population (persons)	Population Density (persons/km^2)
II-1	Saral	30.0	29,731	991
II-2	Sadhonpur	28.4	19,791	700
II-3	Jaldi	28.1	24,505	872
II-4	Idgaon	52.0	46,330	891
II-5	Jhilwania	28.8	46,515	1,615
II-6	Khoruskul	23.4	29,861	1,276
II-7	East Boro Bheola	25.7	18,206	708
II-8	Badarkhali	17.5	19,750	1,129
II-9	Chiringa	21.4	34,075	1,592
II-10	Patakurkul	9.7	22,687	2,339
II-11	Jaliaparo	21.8	24,437	1,121
II-12	Khotakhali	77.0	23,745	308
II-13	Khotakhali			
II-14	Magnama	49.5	25,719	520
II-15	Magnama			
Total		413.3	365,352	884

Judging from Table 3-3-3 and Table 3-1-2, the population density of the Unions in the Chittagong District where Project Site Nos. II-1, II-2 and II-3 are located, is 858 persons/km^2 which is some 85% of the population density of the Chittagong District of 1,002 persons/km^2. This indicates that these sites are located on the outskirts of urban areas of the Chittagong District.

In the case of the Unions of the Cox's Bazar District in which Project Site Nos. II-4 - II-15 are located, the population density is 891 persons/km^2 which is much higher than the district average of 763 persons/km^2. In particular, the population density of those Unions in which Project Site Nos. II-5 - II-11 are located is as high double or treble the district average.

(4) Number of School Age Children and Their Population Ratio

The number of school age children in each Union and their ratio vis-a-vis the Union population are given in Table 3-3-4.

Table 3-3-4 School Age Children and Their Population Ratio by Project-Related Union

SiteNo.	Union Population	5 - 9 Year Olds	%	10 - 14 Year Olds	%	18 Year Olds or Older	%	Literacy Rate	
								Boys	Girls
II-1	29,731	4,369	14.7	3,400	11.4	15,543	52.3	18.8	9.4
II-2	19,791	3,095	15.6	2,647	13.4	9,606	48.5	40.0	27.9
II-3	24,505	3,727	15.2	3,188	13.0	12,217	49.9	35.2	23.7
II-4	46,330	8,493	18.3	5,923	12.8	20,387	44.0	30.6	17.3
II-5	46,515	7,997	17.2	5,719	12.3	22,050	47.4	38.1	21.1
II-6	29,861	5,338	17.9	3,583	12.0	13,263	44.4	23.1	10.6
II-7	18,206	3,368	18.5	2,447	13.4	7,739	42.5	24.4	14.5
II-8	19,750	3,516	17.8	2,857	14.5	8,607	43.6	28.1	17.2
II-9	34,075	6,119	18.0	4,422	13.0	14,743	43.3	36.1	19.9
II-10	22,687	3,645	16.1	2,985	13.2	11,093	48.9	45.3	26.4
II-11	24,437	4,745	19.4	3,166	13.0	10,075	41.2	18.2	7.5
II-12 II-13	23,745	4,322	18.2	3,104	13.1	10,500	44.2	31.3	17.5
II-14 II-15	25,719	4,856	18.9	3,617	14.1	10,735	41.7	22.6	12.1
Total	365,352	63,590	17.4	47,058	12.9	166,558	45.6	30.2	17.3
Bangladesh National Average	-	-	16.5	-	12.1	-	50.0	38.9	25.5

The data given in Table 3-3-4 indicates that the ratio of lower school age children in the local population of the Project-related Unions is generally larger than the national average. The literacy rate of these Unions is far below the national average, suggesting the importance of introducing a policy emphasising primary education in these Unions. If such a policy is introduced, the literacy rate of the local population should significantly improve.

3.4 Current Situation of Cyclone Shelters and Primary Schools in Project Area

3.4.1 *Cyclone Shelters*

(1) Current State of Cyclone Shelter Construction

Refer to 2.1.1 - (3) for the current state of cyclone shelter construction.

(2) Planned Construction of Cyclone Shelters

In recent years, many aid organizations have made proposals to the Government of Bangladesh regarding the construction of cyclone shelters. For example, the Bangladesh Red Crescent Society (BDRCS) plans to construct cyclone shelters at 120 sites in the next 3 years with the financial assistance of the International Red Cross (original funds made available by 9 countries, including Japan). The FD of the Ministry of Education plans the construction of 140 cyclone shelters-cum-school buildings with OPEC funding, while the EC plans to construct an additional 80 cyclone shelters at their 2nd stage. Finally, the LGED is hoping to construct 30 additional cyclone shelters with Japanese grant aid following the construction of 10 cyclone shelters which is currently in progress.

3.4.2 Primary School Education

(1) Outline of Primary School Education

The literacy rate in Bangladesh is currently 24.8% and the government has been introducing various measures to achieve universal education by 2000. The actual targets include an enrolment rate of 95% and a graduation rate of 70% for primary education. To achieve these targets, 54,460 new classrooms must be constructed by 1995, which together with the 50,314 classrooms as of 1992, will result in a classroom total of 104,774 classrooms. A further 43,600 classrooms will require construction between 1996 and 2000 to achieve the planned figure of 148,374 classrooms.

(2) Planned Construction of Primary Schools

The General Education Project (GEP) has, since 1990, started to achieve the above targets with the assistance of the World Bank, ADB, Governments of Sweden and the Netherlands, UNICEF and UNDP, etc. All the projects under the GEP are planned to be completed by December, 1995.

CHAPTER 4

DESCRIPTION OF THE PROJECT (II)

CHAPTER 4 DESCRIPTION OF THE PROJECT (II)

4.1 Objectives

Bangladesh suffers from adverse natural conditions which consistently cause natural disasters resulting in a high death toll. To improve this situation, many internationally assisted projects are in progress to prevent the disastrous outcome of natural phenomena, such as cyclones. The construction of cyclone shelters is believed to be the most technically and financially feasible and quickly achievable disaster prevention measure for cyclones and, as such, an official call for the urgent construction of the required number of cyclone shelters to protect human lives and livestock has been made. As many as 2,500 cyclone shelters are required, the Government of Bangladesh is calling for further international aid efforts by donor countries and aid organizations to meet this massive task.

The Government of Bangladesh originally made a request to the Government of Japan through the LEGD for assistance for the construction of new cyclone shelters at 40 sites. In response to this request, the Government of Japan agreed to provide grant aid for the construction of 10 cyclone shelter-cum-educational facilities and the work commenced in December, 1993. During the basic design study period of the Project (I), both governments agreed that the use of the cyclone shelters as primary school buildings during normal times was desirable in view of the better maintenance of the shelters. The Government of Bangladesh then made a renewed request to the Government of Japan for assistance to construct the 30 remaining cyclone shelters at existing primary school sites where the buildings have been either damaged or are likely to be damaged by cyclones in view of the above agreement. Of the 50 candidate sites listed by the Government of Bangladesh, 15 sites were identified as being suitable for the construction of new cyclone shelter-cum-school buildings under the Project (II). The objectives of the Project (II) are, therefore, to construct cyclone shelters designed to protect human lives during cyclones and also to act as educational facilities during normal weather conditions. The Project (II) also intends the establishment of a reliable maintenance system for the long-term upkeep of these new cyclone shelters.

4.2 Examination of Requested Project Contents

4.2.1 Viability and Necessity of the Project (II)

The Government of Bangladesh has prepared the Master Plan for the Multipurpose Cyclone Shelter Programme as already described in 2.1.2 - (2) and, has requested that aid organizations neither arbitrarily select the locations for new cyclone shelters nor rely on their own principles and methods when constructing shelters, but refer to the Master Plan for the construction of new cyclone shelters.

When examining the suitability and necessity of the Project (II), it must be borne in mind that any cyclone shelter construction plan under the Project (II) must be compatible with and connected to the overall implementation of the Master Plan.

(1) Project Area

The Master Plan indicates that new cyclone shelters should be located within the HRA where storm surges can reach a height of 1m. It is, therefore, necessary that all the Project Sites be located within the HRA.

(2) Viability of Project (II)

The present Project (II) is viewed as the most feasible measure to protect the lives of more than 5 million people living in the HRA from both the technical and financial viewpoints and is judged both necessary and viable from a humanitarian point of view. The feasibility of the Project (II) is supported in terms of the topographical conditions, population density, social infrastructure and all other related factors.

The Project (II) aims at rebuilding those existing primary school buildings which have been either damaged or which are likely to be damaged by cyclones as cyclone shelter-cum-primary school buildings to ensure their proper maintenance during normal weather conditions and to improve the country's availability of physical facilities for primary education. While the successful completion of the Project (II) will far from satisfy the need to construct more than 3,000 new primary schools in the HRA as envisaged by the Master Plan, it must be pointed out that the primary objective of the Project (II) is the construction of cyclone shelters. The use of these shelters as primary schools will, however, definitely improve the level of physical facilities for primary education and will motivate not only school age children to attend school but

will also motivate parents to send their children to school, in turn leading to further improvement of the school enrolment rate.

The fact that the Project (II) is also in line with the objective of the International Decade for Natural Disaster Reduction (IDNDR) is an additional advantage of the implementation of the Project (II) in view of its appeal vis-a-vis the international community.

(3) Planned Number of Cyclone Shelters

The Master Plan predicts that the total population of 5.2 million people in the HRA in 1992 will increase to 6.4 million in 10 years which is also the target population of the Master Plan in the year 2002.

The total accommodation capacity of all cyclone shelters (including those currently under construction or planned) and secure public and private buildings (including those planned) is calculated to be 2.16 million, leaving 4.19 million people unprotected. Assuming a capacity of some 1,750 people/shelter, the further construction of some 2,500 shelters is called for by the Master Plan.

The number of new cyclone shelters anticipated by the Master Plan for the 5 Thanas in the Project Area is given in Table 4-2-1.

Table 4-2-1 Necessary Number of Cyclone Shelters in Project Area

District	Thana	Shelters Planned by Master Plan			Shelters Planned Under the Project (II)
		Priority A	Priority B	Total	
Chittagong	Banskhali	54	45	99	3
Cox's Bazar	Chokoria	67	54	121	7
Cox's Bazar	Ramu	-	7	7	1
Cox's Bazar	Sadar	36	3	39	3
Cox's Bazar	Ukhia	-	11	11	1
Total		157	120	277	15

The required number of new cyclone shelters in these 5 Thanas is 277, of which 157 are Priority Grade A shelters (to be constructed in the 3-year period from 1994 to 1996). The planned shelters under the Project (II) account for approximately 5.4% of the total shelter requirement.

Based on the above argument, the Project (II) has significant importance from the humanitarian point of view and the construction of cyclone shelters at 15 sites out of the originally 30 requested sites by the Government of Bangladesh under the Project (II) is deemed appropriate for Japanese grant aid.

4.2.2 *Implementation and Operation Plans*

(1) Implementation Agency

Given the objective of the Project (II) to provide safe public shelters in cyclone-prone areas to improve local welfare by means of protecting human lives and livestock, it is deemed appropriate for the Ministry of Local Government, Rural Development and Cooperatives to be assigned the responsibility for the overall implementation of the Project (II) while the LGED, a subordinate organization of the above Ministry and responsible for the technical aspects of regional development, should be assigned the task of the actual implementation of the Project (II).

[LGED]

The LGED is a national organization responsible for regional development. Its Head Office is in Dhaka and the LGED has 64 District Offices and 460 Thana Offices, employing a total of 9,600 people. Each District Office consists of 12 employees, including the manager, while each Thana Office consists of 19 employees, including the manager. The scope of work of the LGED includes the consolidation of local infrastructure, the construction of roads, the construction of government buildings and the construction and/or repair of government-owned school buildings, etc. in rural areas. Because of its rich experience in these fields, the LGED is deemed to be appropriate to act as the project implementation agency.

Upon completion of the Project (II), each Thana Office in the Project Area will be commissioned by the PMED to conduct the maintenance work for 1 - 7 cyclone shelters under the supervision of the LGED Headquarters. As these

cyclone shelters will have a concrete structure, requiring infrequent maintenance, the present staff level of the LGED is deemed adequate for the extra maintenance work.

(2) Organization Responsible for Management of Cyclone Shelters (Primary School Buildings)

While the project implementation agency will be the LGED as described in (1) above, the Directorate of Primary Education (DPE) will be responsible for the management of those shelters under the supervision of the PMED (which controls all primary schools in Bangladesh) in view of the fact that the cyclone shelters will be used as primary school buildings under normal circumstances.

The DPE is controlled by the Secretary responsible for the day-to-day business of the PMED under the overall supervision of the Prime Minister. Within the DPE itself, a Deputy Director, Primary Education Officer (PEO) and Thana Education Officer (TEO) are appointed under the Director General for each Division, District and Thana respectively. Assistant Thana Education Officers (ATEO), each responsible for the direct management of 15 - 20 primary schools, are under the above officers to ensure the smooth daily operation of primary schools.

Apart from the above official administrative arrangements, a School Management Committee (SMC) has been established for each primary school as required by the regulations introduced by the PMED in 1992 and the key members of these committees are local residents. These committees are designed to facilitate the active participation of local communities in the management of primary schools and have positively contributed to improving school management. Given the existing organization and experience of the PMED and SMCs described above, they are deemed to be well capable of maintaining the cyclone shelters as primary schools under normal circumstances.

[Budget of PMED]

The budget of the PMED for the last three fiscal years is shown in Table 4-2-2.

Table 4-2-2 Budget of PMED

(Unit: million TK)

Fiscal Year	Total	Education Total	Primary Education
1991/1992	150,500	18,226.4	10,258.9
1992/1993	166,810	22,674.3	11,649.7
1993/1994	190,500	27,155.0	13,608.2

In recent years, the budget for primary education has accounted for more than half of the total educational budget, i.e. Taka 10.25 billion (30.75 billion yen) in fiscal 1991/92, Taka 11.64 billion (34.92 billion yen) in fiscal 1992/93 and Taka 13.6 billion (40.8 billion yen) in fiscal 1993/94.

The annual maintenance cost of the planned 15 cyclone shelters is estimated to be Taka 640,000 which is approximately 0.0047% of the current primary education budget and which can be easily afforded by the PMED. The actual maintenance work will be entrusted to the LGED which is responsible for the construction and repair of government primary schools in local areas.

With regard to the management cost (teachers' wages and cost of stationary, etc.), while it will be necessary to increase the number of teachers at some schools, no new budgetary items will be generated due to the nature of the Project (II) which is the rebuilding of existing school buildings. Nevertheless, appropriate budgetary appropriation will be required to cover the cost of new teachers, i.e. one each for Site Nos. II-5 and II-12 and two for Site No. II-15.

(3) Cyclone Forecasting and Warning System

The protection of human lives, property and livestock in the Project Area, even with the successful completion of new cyclone shelters under the Project (II), will largely depend on an effective cyclone warning system. The 15 cyclone shelters to be constructed will be placed under the Cyclone Preparedness Programme which was jointly introduced in 1978 by the BDRCS and Ministry of Relief and Rehabilitation. The Programme has 2,430 Units (one Unit covering 2 - 3 villages) in 215 Unions in 25 Thanas along the Bay of Bengal and each Unit consists of 10 volunteers, i.e. one leader and one assistant for each of 5-activity areas (warning, guiding to shelters, rescue, first-aid and emergency relief). A two-way radio communication system has been set up between the Headquarters in Dhaka and 4 zonal offices (Chittagong, Cox's

Bazar, Barisal and Barguna), as well as 25 relay stations at the Thana level. When a warning is issued by the Storm Warning Centre and USAID, the Thana level relay stations use short distance radios or communication volunteers to forward the warning to the Union team leaders of an approaching cyclone. These Unit team leaders confirm the information using transistor radios and, together with other volunteers (Unit team members), warn the villagers using hand sirens and megaphones.

Actual warnings consist of 10 different signal levels which are largely classified into 3 groups, i.e. Signals 1 - 3, Signals 4 - 7 and Signals 8 - 10, as described below.

1) Signals 1 - 3 : These are early warning signals which are conveyed by a single flag hoisted on the roofs of cyclone shelters. Villagers are informed verbally of the birth of a cyclone.

2) Signals 4 - 7 : These are danger warnings which are conveyed by 2 flags hoisted on the roofs of cyclone shelters. Villagers are informed verbally of the direction and size of the storm area of the cyclone.

3) Signals 8 - 10 : These are ultra danger warnings which are conveyed by 3 flags hoisted on the roofs of cyclone shelters. Villagers are guided to the cyclone shelters by volunteers using a megaphone, hand siren and signalling torch.

The use of the above cyclone warning system operated by the BDRCS appears appropriate to evacuate local inhabitants to the new cyclone shelters to be constructed under the Project (II).

4.2.3 Similar Aid Projects

Some 400 cyclone shelters have been constructed since the 1960's by international aid organizations and NGOs as discussed in 2.1. Despite the wide recognition of the necessity of cyclone shelters, the construction of cyclone shelters has never become a pressing international problem and has made only slow progress. The horrifying death tolls of recent cyclones and the growing concern expressed by the international community had begun to speed up shelter construction when some 140,000 people were again killed by a violent cyclone in April, 1991. International

concern was instantly raised with the result of some 330 new cyclone shelters being completed or to be completed in the near future as a result of this concern.

The International Red Cross, EC and OPEC, etc. have decided to construct an additional 340 new cyclone shelters while another 100 shelters are planned by these organizations although no financial commitment has yet been made. Moreover, many NGOs have expressed their intention to construct more than a total of 150 cyclone shelters.

4.2.4 Requested Facilities

(1) Examination of Requested Facilities

1) Construction of Cyclone Shelters

In principle, the requested cyclone shelters will inherit the design used for those cyclone shelters constructed under the Project (I) with Japanese grant aid. These are RC, 2-story buildings with pile foundations (free standing on stilts) and with a capacity of a minimum of 1,650 persons.

2) Improved Primary School Facilities

The following facilities will be secured in view of the use of the cyclone shelters as primary school buildings during normal times.

a) Classrooms: minimum floor area of 37.15m^2 for a single classroom with the following furniture

- one teacher's desk and chair set
- desks and chairs for 50 pupils
- one blackboard

b) Teacher's Room: one desk and chair set for each teacher

c) Storage: one storage room

3) Auxiliary Facilities

a) Toilets (separate toilets for boys and girls) and one septic tank for each school

b) Water supply facilities (one borehole and one high head manual pump)

The requested cyclone shelters are judged to be appropriate as they have a minimum accommodation capacity of 1,650 persons each in line with the shelter size adopted by the Project (I) taking into consideration the requirements of the Master Plan. When considering their use as classrooms, the floor area of each room (classroom) meets the primary school design criterion set by the PMED. As the auxiliary facilities are essential for school life, the request for auxiliary facilities is also deemed appropriate.

While the minimum shelter size for each site is given, no description of the maximum number of classrooms per shift required at each site is found in the request. Given the fact that the Project (II) basically intends the rebuilding of existing primary school buildings as new cyclone shelter-cum-school buildings, it appears appropriate to calculate the maximum number of classrooms per shift to determine the total shelter size for each site.

[Calculation of Maximum Number of Classrooms Per Shift]

As described in 2.6.1, the site conditions survey identified the total number of pupils of the existing primary schools, most of which employ the 2-shift system due to the classroom shortage. The maximum number of classrooms per shift can be calculated by dividing the number of pupils of the first shift (Table 4-2-3), which is attended by more pupils than the second shift, by the standard class size of 50 pupils as shown in Table 4-2-4. Taking the above calculation results into consideration, the subject schools can be classified into 3 categories, i.e. 3-classroom type, 4-classroom type and 5-classroom type.

In the case of Site Nos. II-5, II-6, II-11 and II-12, there will be a shortage of one classroom, 4 classrooms, one classroom and one classroom respectively against the maximum number of classrooms required at each site, which should be compensated for by the use of the existing classrooms. As it is impossible to use the existing classrooms at Site No. II-12, the piloti (piling) section on the ground floor will be used to provide an extra classroom.

In the case of Site No. II-2, although the maximum number of classrooms required is 2, 3 classrooms will be constructed to meet the minimum accommodation capacity of 1,650 persons.

(2) Increase of Teachers

Judging from the present teacher strength shown in Table 4-2-4, the number of teachers should be increased by one for Site Nos. II-5 and II-12 and by 2 for Site No. II-15.

(3) Additional Land Requirement

As all the 15 sites which are judged suitable for the Project (II) are owned by the central government, no question of land ownership in relation to the construction work will arise. However, the existing land size is inadequate at Site Nos. II-3 and II-10 and it will, therefore, be necessary to acquire additional land to accommodate cyclone shelters of the planned size. It is desirable that the LGED supervise this land acquisition in view of its status as the project implementation agency.

Table 4-2-3 Number of Pupils by Class Type

Site No.	Total Number of Pupils	Class 1	Class 2	Class 3	Class 4	Class 5	Shifts	Number of Teachers
II-1	204	80	60	29	19	16	2	4
		140		64				
II-2	200	50	50	48	32	20	2	4
		100		100				
II-3	320	100	90	50	49	31	2	5
		190		130				
II-4	388	208	56	48	40	36	2	6
		264		124				
II-5	520	175	120	95	78	52	2	4
		295		225				
II-6	851	270	225	180	96	80	3	6
		270	405		176			
II-7	308	160	48	40	37	23	2	6
		208		100				
II-8	294	85	81	64	44	20	2	5
		166		128				
II-9	372	129	66	68	51	58	2	9
		195		177				
II-10	249	87	51	49	36	26	2	5
		138		111				
II-11	444	205	110	70	35	24	2	5
		315		129				
II-12	502	232	90	69	56	55	2	4
		322		180				
II-13	416	166	95	83	51	21	2	8
		261		155				
II-14	458	145	93	102	64	54	1	6
II-15	370	205	56	47	37	25	2	3
		261		109				

Table 4-2-4 Maximum Number of Classrooms Per Shift and Different Types of Schools

Site No.	Total Number of Pupils of Class 1 and Class 2 (Max. Number of Pupils under 2-Shift System)	Number of Existing Teachers	State of Existing Facilities[1)]	Max. Number of Classrooms per shift	School Type
II-1	140	4	×	3	3-classroom type
II-2	100	4	×	2 (3)[2)]	3-classroom type
II-3	190	5	Δ	4	4-classroom type
II-4	264	6	×	5	5-classroom type
II-5	295	4	O	6	5-classroom type
II-6	495	6	Δ	10	5-classroom type
II-7	208	6	×	4	4-classroom type
II-8	166	5	×	3	3-classroom type
II-9	195	9	O	4	4-classroom type
II-10	138	5	×	3	3-classroom type
II-11	315	5	Δ	6	5-classroom type
II-12	322	4	××	6	5-classroom type
II-13	261	8	Δ	5	5-classroom type
II-14	238	6	××	5	5-classroom type
II-15	261	3	×	5	5-classroom type

Notes 1) O Good
Δ Poor
× Very Poor
×× Unusable
2) Minimum number of classrooms to provide the required accommodation capacity for a cyclone shelter.

4.2.5 Basic Principles of Cooperation

The necessity and viability of the cyclone shelters to be constructed under the Project (II) have been verified through examination of the above items. Their necessity from the humanitarian point of view and their significance in terms of acting as primary school buildings, replacing buildings damaged by cyclones, to improve the quality of primary education in Bangladesh have also been confirmed. With regard to project implementation and the actual maintenance work of the cyclone shelter-cum-school buildings commissioned by PMED, the LGED is best judged to have the necessary manpower and expertise in the necessary fields among government organizations in Bangladesh. The schools will be run by the PMED in accordance with the efficient, existing school management system. The implementation of the Project (II) as a grant aid project of the Government of Japan is, therefore, deemed highly appropriate as the expected effects of the Project (II) meet the criteria of Japan's grant aid system. The outline of the Project (II) is examined next based on the provision of Japanese grant aid for the Project (II), followed by the Basic Design.

4.3 Outline of the Project (II)

4.3.1 Implementation Agency and Cyclone Shelter Management System

(1) Implementation Agency

The Project (II) intends the rebuilding of existing primary school buildings which have been damaged by cyclones as cyclone shelter-cum-primary school buildings in order to improve the welfare prospects of those people living in coastal areas and to improve the physical facilities for primary education in the said areas. Given these objectives, the MLGRD & C will have the overall responsibility for the implementation of the Project (II) on the Bangladesh side and the LGED, which is part of the MLGRD & C and which is responsible for technical issues relating to local development, will act as the implementation agency, taking the relevant examination results in 4.2.2-(1) into consideration. The organizational structures of the MLGRD & C and LGED are shown in Fig. 4-3-1 and Fig. 4-3-2 respectively.

As the cyclone shelter construction sites under the Project (II) are located over an extensive area, the implementation of the Project (II) will be carried out by the organized network of the LGED, involving its Headquarters in Dhaka, its District Offices in Chittagong and Cox's Bazar and its Thana Offices which supervise the areas in which the sites are located. The project implementation command structure of the LGED is shown in Fig. 4-3-3.

The organizational structure of the LGED's Thana Offices is shown in Fig. 4-3-4. Each Thana Office has 19 employees, including several technicians. It is, therefore, possible for these offices to conduct the assigned work under the Project (II) without new recruitment or new organization.

(2) Cyclone Shelter Management System

The management responsibility for the cyclone shelters after their completion will be assigned to the DPE under the supervision of the PMED in view of the fact that these shelters will be used as government primary schools under normal circumstances. The organizational structures of the PMED and DPE are shown in Fig. 4-3-5 and Fig. 4-3-6 respectively.

The actual management of the primary schools will rely on the existing school management system adopted by the PMED and DPE as already described in

4.2.2. In order to further facilitate effective primary school management by the ATEOs, it may be an idea to reduce the ATEO - school ratio from the current 1:20 to around 1:10. The main functions of the ATEOs are as follows.

- Teacher assessment (work performance and aptitude)
- Checking of pupil attendance
- Distribution of textbooks
- Encouragement of school enrolment by school age children
- Building maintenance

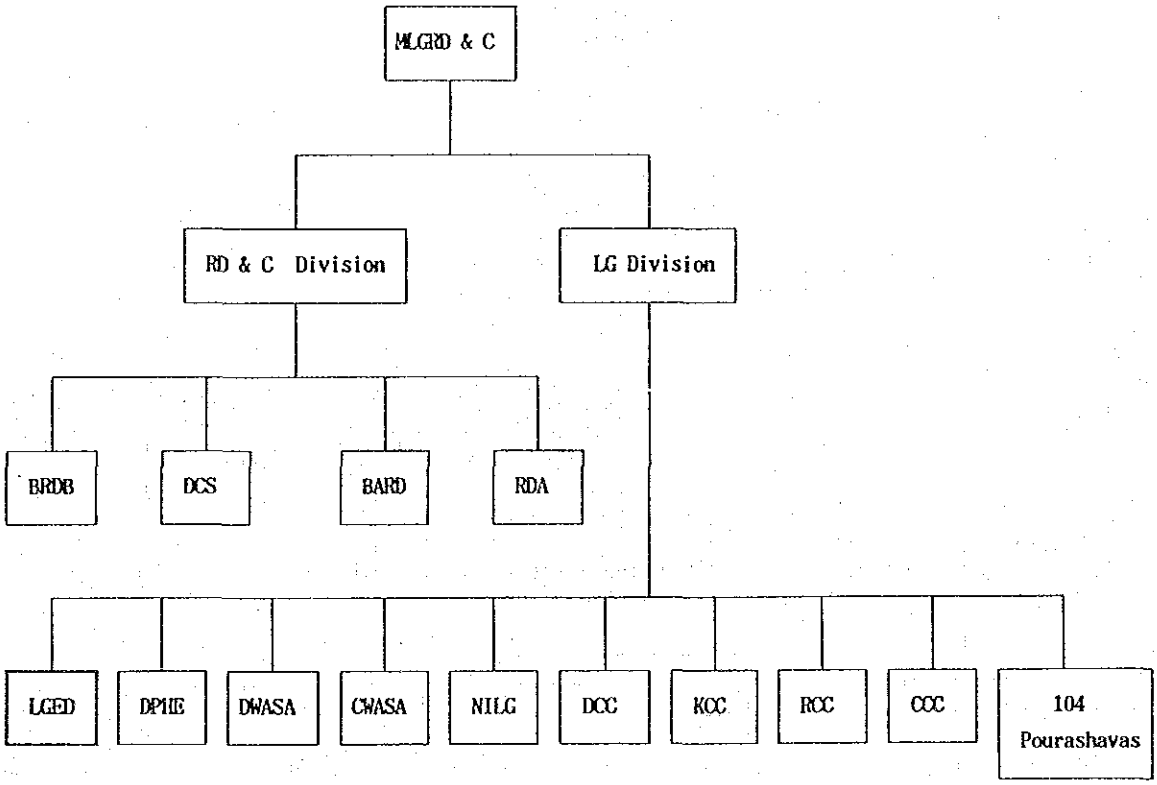
In addition, each primary school has a School Management Committee (SMC) as shown in Fig. 4-3-7 to promote the perception of schools by local inhabitants as "the school of the local community" or "our school". It is important to encourage the active participation of the SMCs in school management.

The maintenance of the new cyclone shelters (primary school buildings) will be financed by the PMED which will commission the actual maintenance/repair work to the Thana Offices of the LGED via the LGED's Headquarters.

(3) Cyclone Warning System

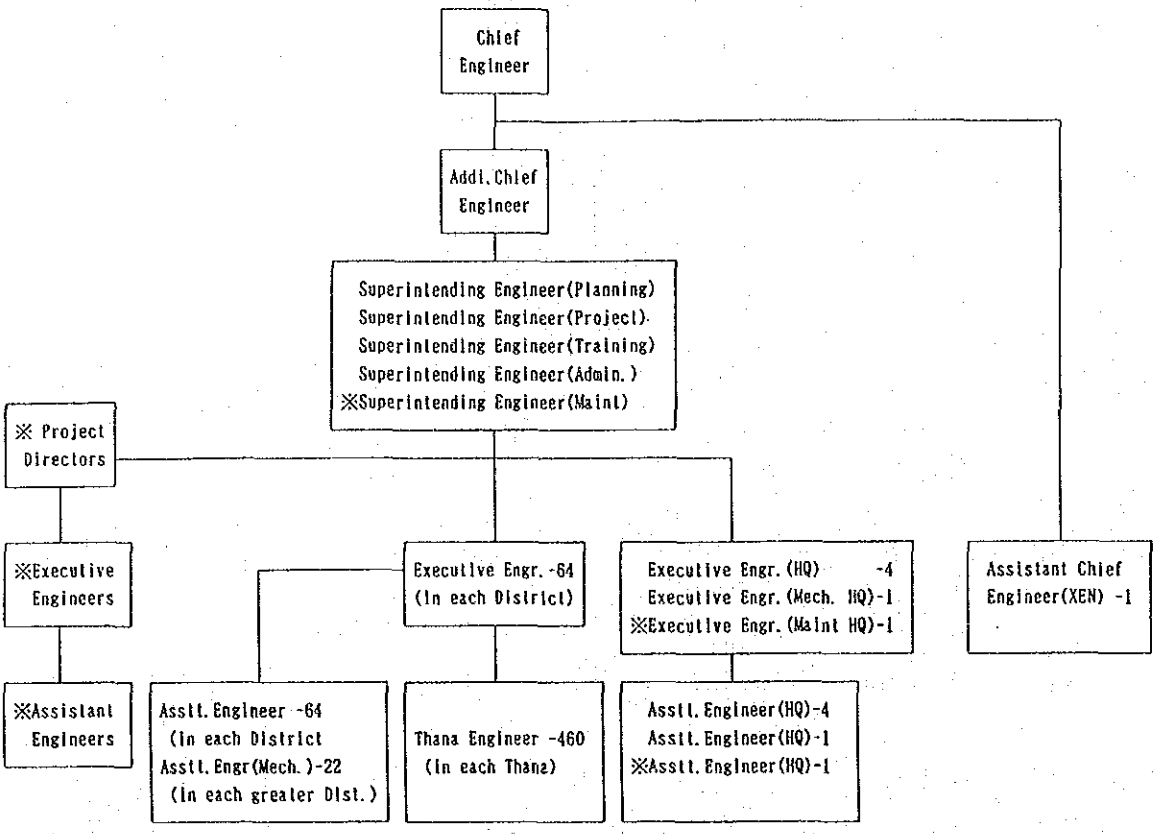
As described in 4.2.2 - (3), the existing warning system in the Project Area will be used as the cyclone warning system for the Project Sites. To be more precise, the warning system relating to the use of the new cyclone shelters will be the Cyclone Preparedness Programme jointly established by the BDRCS and Ministry of Relief and Rehabilitation as shown in Fig. 4-3-8.

Fig. 4-3-1 Organizational Structure of Ministry of Local Government, Rural Development and Cooperatives



BRDB : Bangladesh Rural Development Board, DCS : Directorate of Cooperative Societies,
BARD : Bangladesh Academy for Rural Development, RDA : Rural Development Academy, Bogra,
LGED : Local Government Engineering Department, DPHE : Department of Public Health Engineering,
DWASA : Dhaka Water and Sewage Authorities, CWASA : Chittagong Water and Sewage Authorities,
NILG : National Institute of Local Government, DCC : Dhaka City Corporation,
KCC : Khulna City Corporation, RCC : Rajshahi City Corporation, CCC : Chittagong City Corporation,

Fig. 4-3-2 Organizational Structure of LEGD



Total Posts(Revenue Budget)	
Chief Engineer	1
Add Chief Engineer	1
Superintending Engineer	4
Executive Engineer	68
Executive Engineer(Mech)	1
Executive Engineer(XEN)	1
Assistant Engineer/Thana Engineer	528
Assistant Engineer(Mech)	25
Sub-Assistant Engineer	994
Estimator(SAE)	2
Draftsman(SAE)	462
Laboratry Technician	64
Mechanical Foreman	1
Accountant	525
Stenographer	6
Head Assistant	1
UDA	68
Steno-Typist	70
Surveyor	460
Work Assistant	1840
Accounts Assistant	461
Office Assistant/LDA-cum-Typist	926
Store Keeper	460
Electrician	460
Other Support Staff	2131
TOTAL:	9548

HQ LEVEL	
Chief Engineer	1
Addl. Chief Engineer	1
Superintending Engineer	4
Executive Engineer	4
Executive Engineer(Mech)	1
Asstt. Chief Engineer(XEN)	1
Assistant Engineer	4
Assistant Engineer(Mech)	1
Estimator(SAE)	2
Draftsman(SAE)	2
Mechanical Foreman	1
Head Assistant	1
Accountant	1
Stenographer	6
UDA	4
Steno-Typist	1
LDA-cum-Typist	1
Accounts Assistant	1
Driver	12
Duplicating Machine Operator	1
Ammonia Machine Operator	1
MLSS	21
TOTAL:	82

Distict Level	
Executive Engineer	1
Assistant Engineer	1
Assistant Engineer(Mech)	1
(In 22 Greater Districts)	
SAE	1
Laboratory Technician	1
UDA	1
Accountant	1
Steno-Typist	1
Vehicle Driver	1
Truck Driver	1
Road Roller Driver	1
MLSS	1
Each District:	12
Total(All Districts):	726

Thana Level	
Thana Engineer	1
SAE(Construction)	1
SAE(Maintenance)	1
Draftsman(SAE)	1
Store Keeper	1
Accountant	1
Surveyor	1
Work Assistant	4
Electrician	1
Office Assistant	1
LDA-cum-Typist	1
Accounts Assistant	1
Chawkider	2
MLSS	2
Each Thana:	19
Total(All Thanas):	8740

※ : The posts are under the Development Budget.

Fig. 4-3-3 LEGD's Command Structure for Project (II)

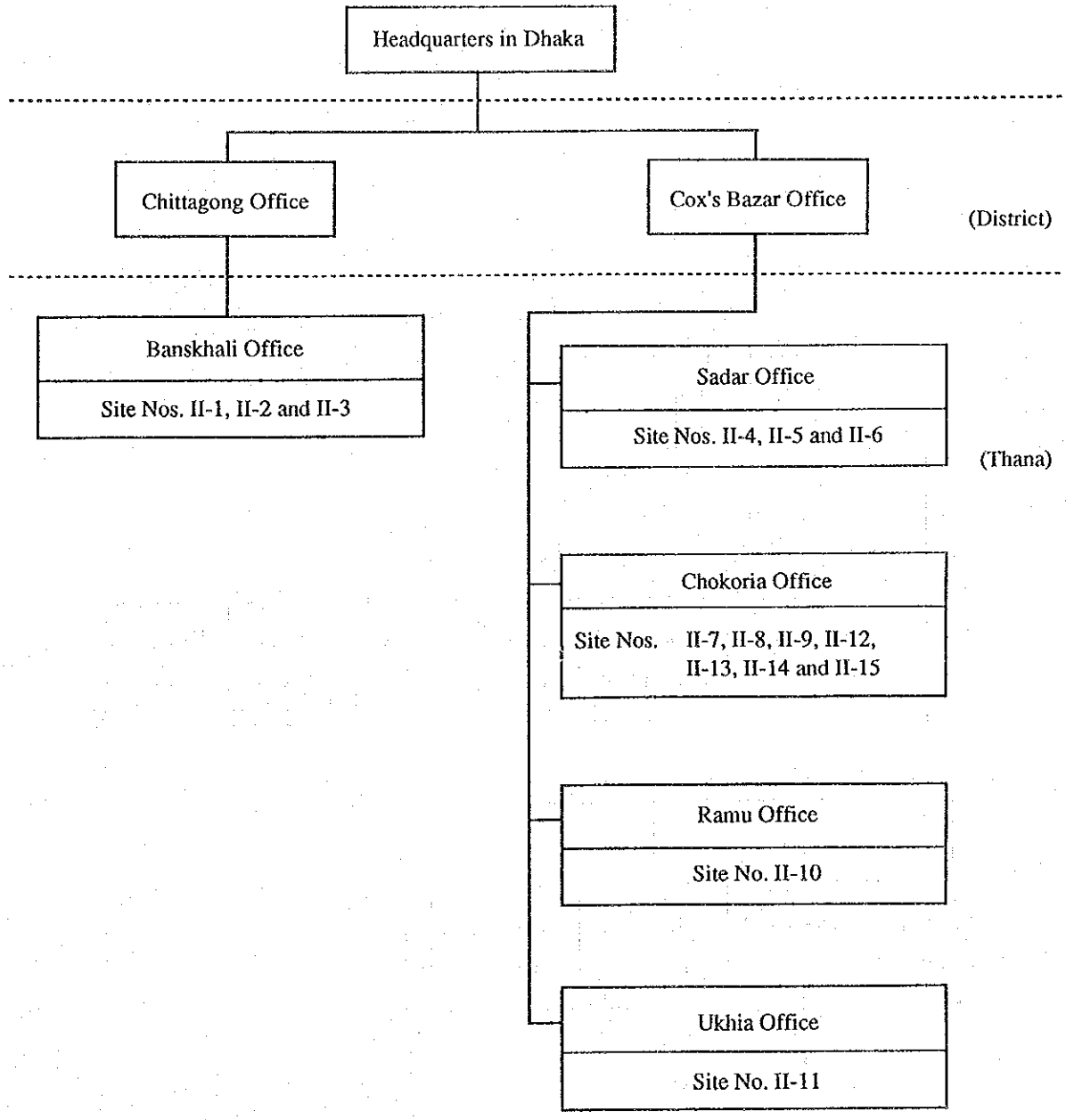
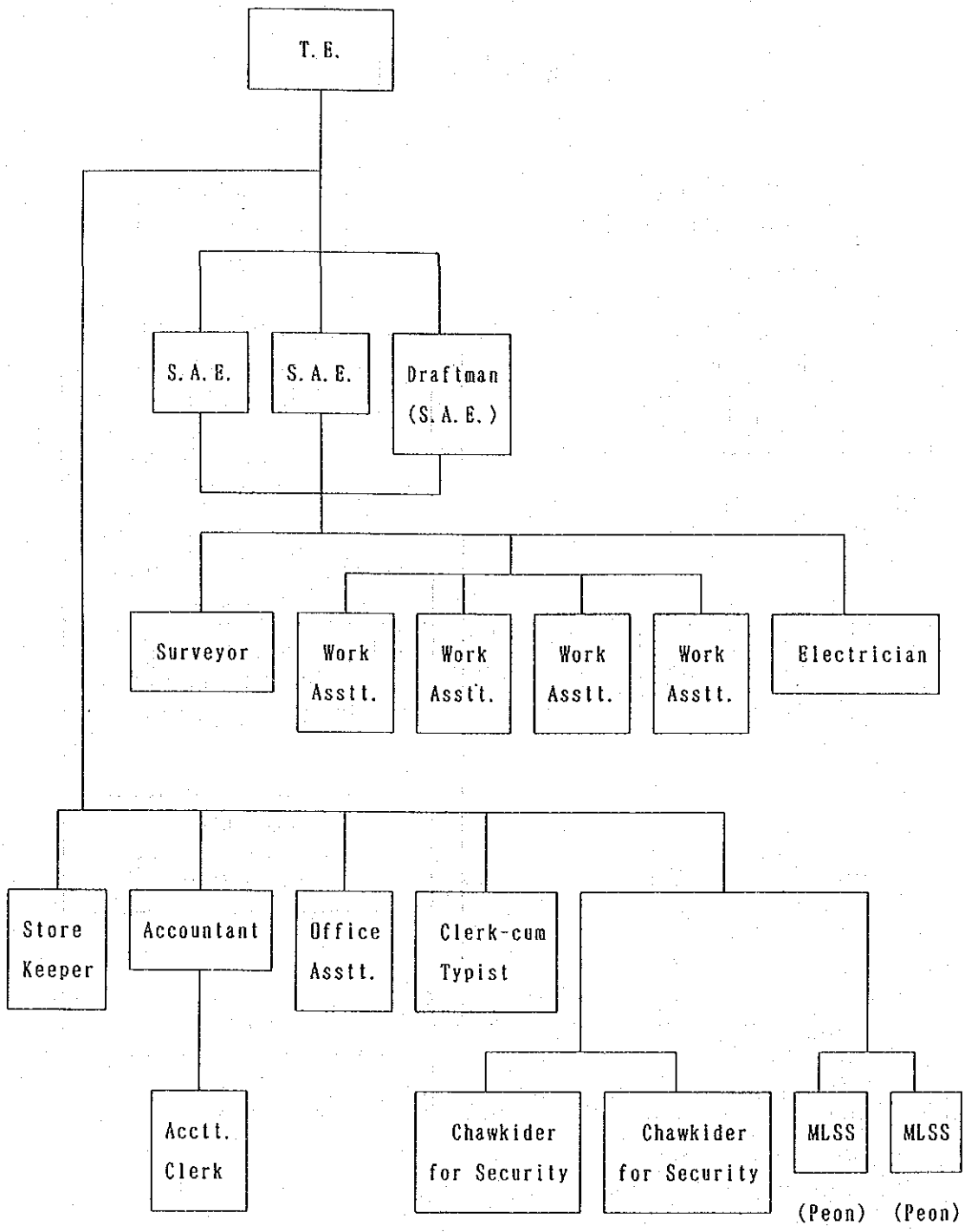


Fig. 4-3-4 Organizational Structure of Thana Office of LGED



Total 19 persons

Fig. 4-3-5 Organizational Structure of PMED

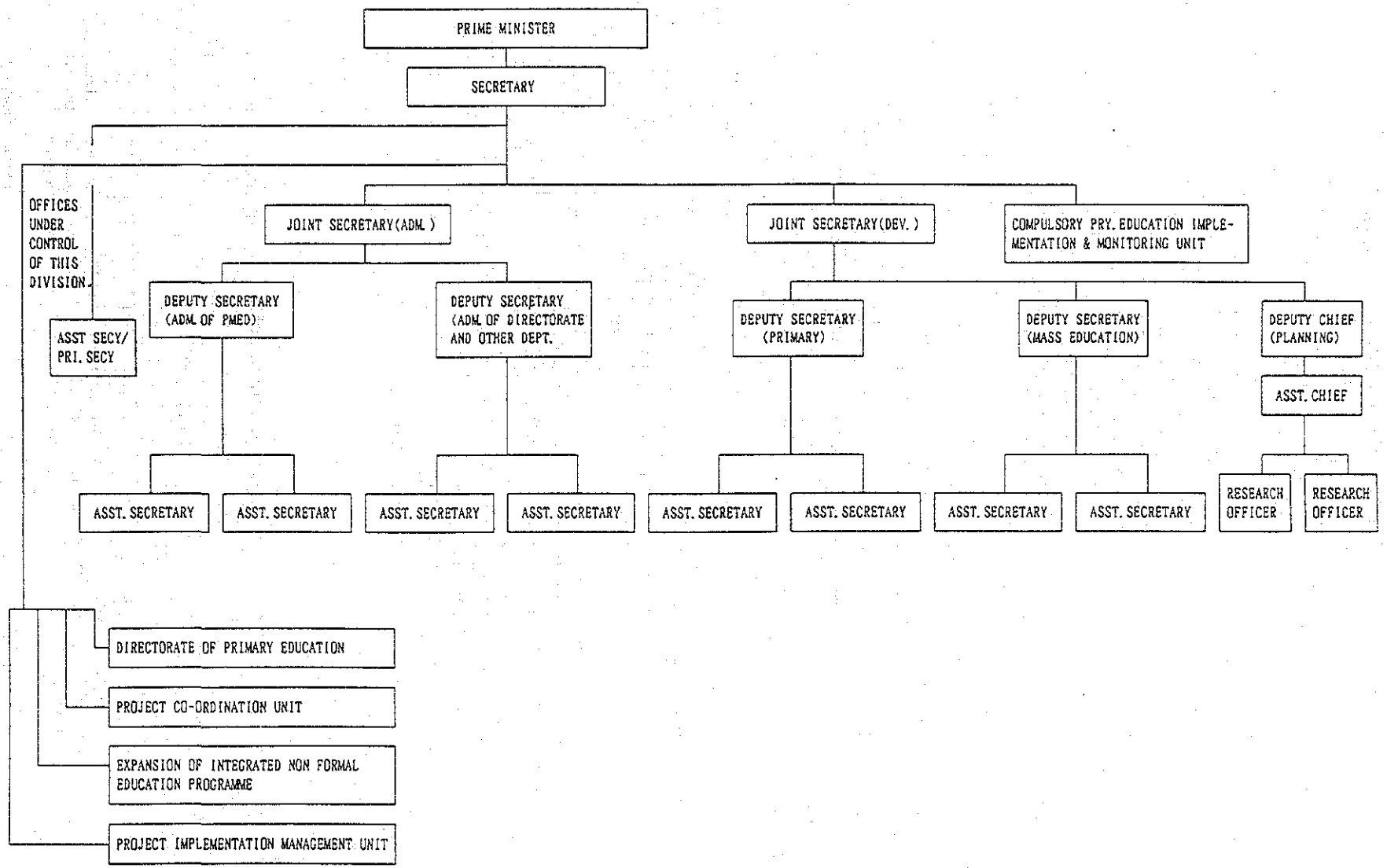
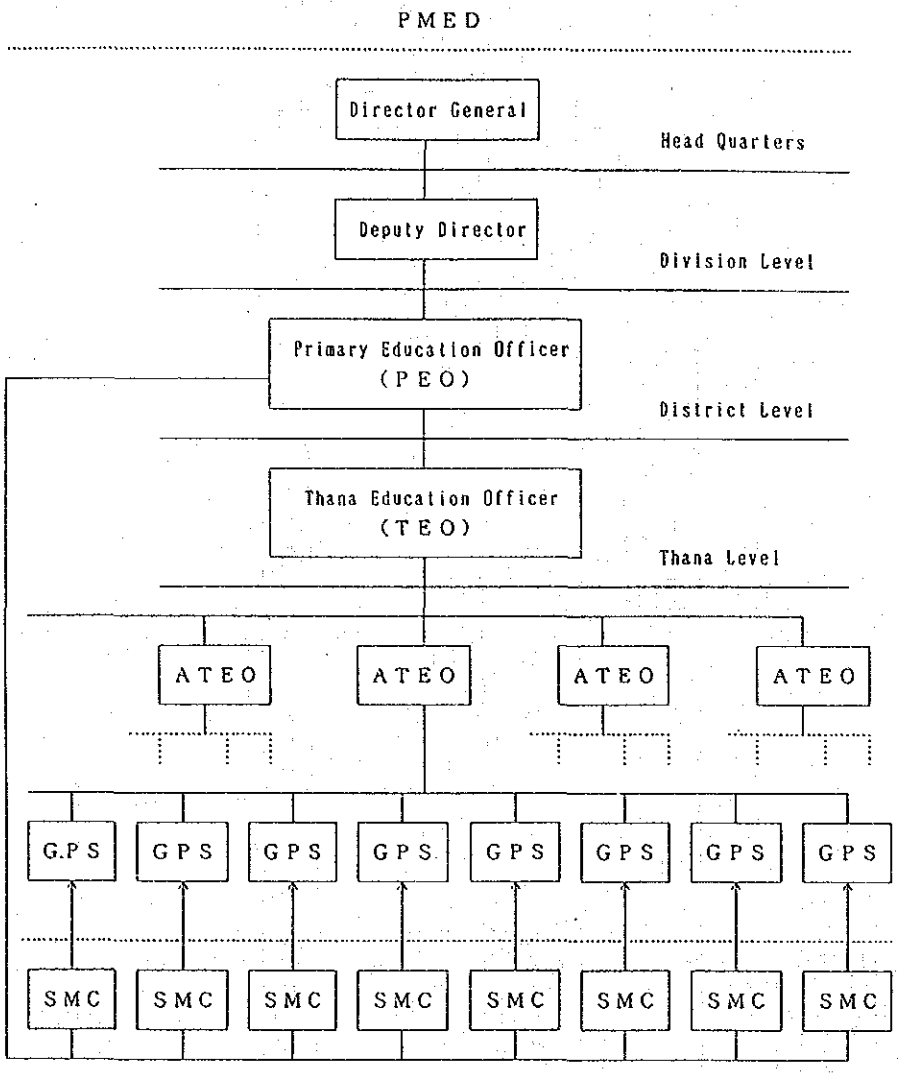
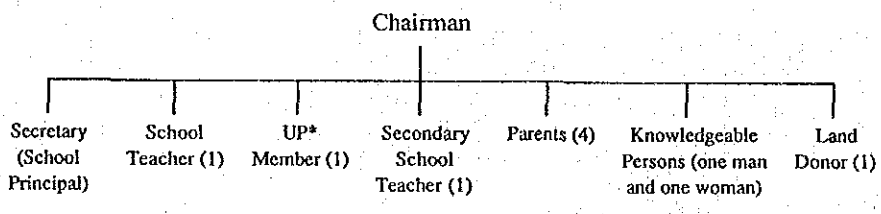


Fig. 4-3-6 Organizational Structure of DPE



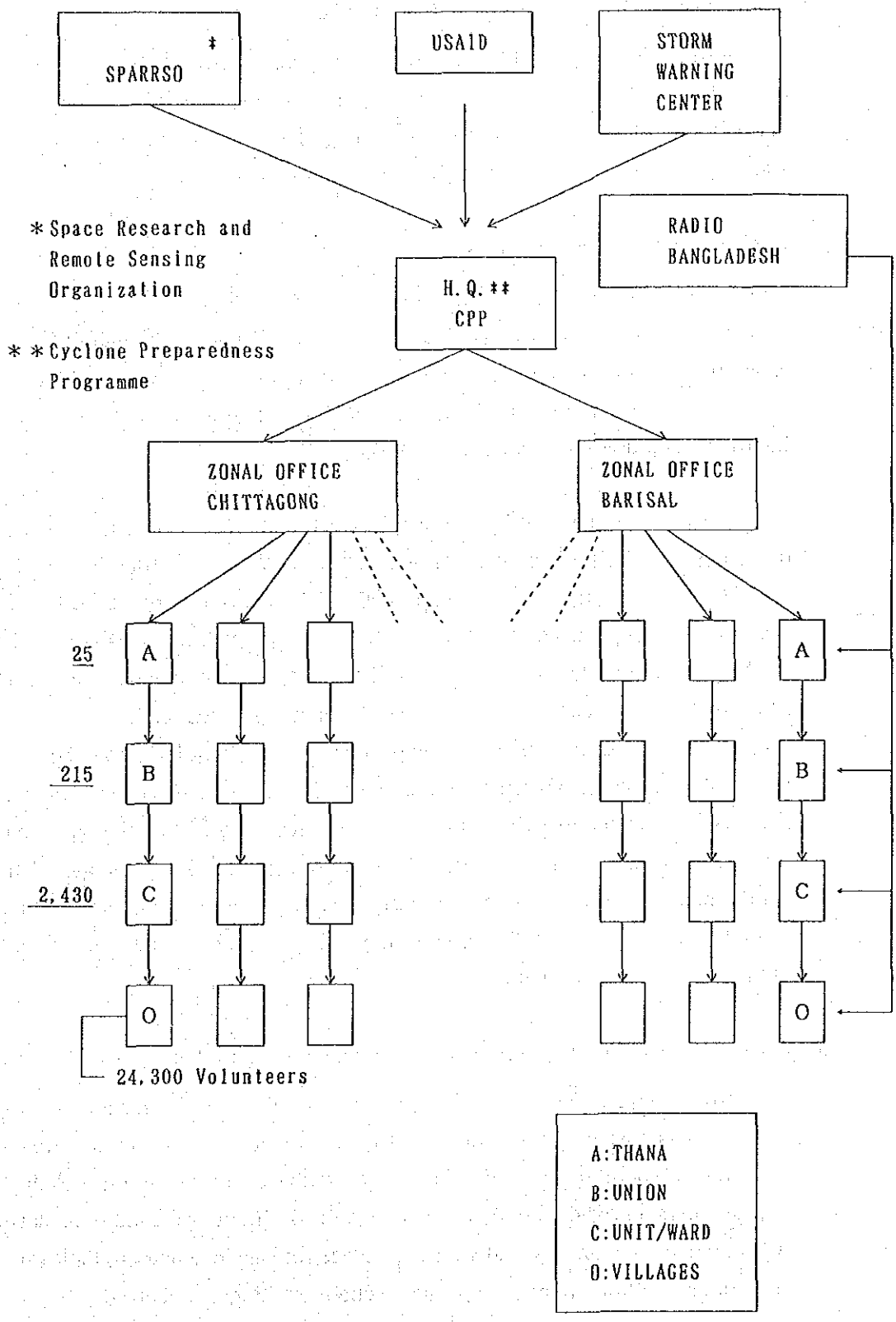
ATEO : Assistant Thana Education Officer
GPS : Government Primary School
SMC : School Managing Committee

Fig. 4-3-7 Organizational Structure of School Management Committee



* UP: Union Parishad

Fig. 4-3-8 Cyclone Warning System



4.3.2 Project Implementation Plan

(1) Number of Cyclone Shelters to be Constructed

As described in 2.4, the site conditions survey conducted at 23 sites out of the originally chosen 50 candidate sites identified 15 sites as being suitable for the construction of cyclone shelters under the Project (II). Accordingly, these 15 sites are now declared the Project Sites.

(2) Cyclone Shelter Accommodation Capacity

The cyclone shelter design size depends on the envisaged cyclone shelter accommodation capacity. At present, there is no uniform standard for the capacity or design of shelters which have already been constructed, which are under construction or which are planned to be constructed by various international aid organizations and NGOs.

The Master Plan prepared by the World Bank and UNDP concludes that the construction of 2,500 cyclone shelters, each capable of accommodating 1,750 people, is necessary by the year 2002. The UNDP excepts other aid organizations planning to construct cyclone shelters in Bangladesh to refer to the Master Plan as the proper construction manual. Consequently, the cyclone shelters to be constructed under the Project (II) will have a minimum accommodation capacity of 1,650 people each which is not far below the figure recommended by the Master Plan and which has been adopted for the Project (I). Bearing in mind that the planned cyclone shelters will be used as primary school buildings, the actual size of the cyclone shelter for each site is also determined based on the number of classrooms required to accommodate pupils using the capacity of providing shelter for 1,650 people at the time of a disaster as the minimum requirement.

(3) Use of Cyclone Shelters During Normal Weather Conditions

The proper maintenance of the cyclone shelters during normal weather conditions is essential in order to ensure their good conditions at times of emergency. Therefore, it is desirable that all the cyclone shelters should be maintained and used on a daily basis. Given the desirable use conditions during an emergency, i.e. orderly and well-kept space for easy evacuation, their use as educational facilities, mainly as primary school buildings, is planned.

(4) Different School Types

As the planned cyclone shelters will be used as primary school buildings, the size of the school at each site is determined based on the number of required classrooms discussed in 4.2.4.

Table 4-3-1 School Type at Each Project Site

Site No.	Number of Classrooms
II-1	3
II-2	3
II-3	4
II-4	5
II-5	5
II-6	5
II-7	4
II-8	3
II-9	4
II-10	3
II-11	5
II-12	5
II-13	5
II-14	5
II-15	5

(5) Lighting System

The site conditions survey found that none of the existing primary schools have a lighting system and that none of the schools provide evening classes. As there appears no specific initiative and leadership, or incentives, and no target community for providing evening classes (including the mass literacy programme and community welfare programme) by the Bangladesh side, lighting systems will not be installed under the Project (II).

(6) Killa Size

The main function of a cyclone shelter is to facilitate the swift and smooth evacuation of local inhabitants at the time of an approaching cyclone and it is also essential that the killas located next to shelters have sufficient capacity to

accommodate the livestock and household goods belonging to the evacuees. Accordingly, the Government of Bangladesh plans to construct killas next to the cyclone shelters to be constructed under the Project (II). The different sizes of the planned killas are given in Table 4-3-2.

Table 4-3-2 Killa Size

Site No.	Killa Size (m)
II-1	61 × 85 × 5.5
II-2	61 × 66 × 3.5
II-3	61 × 76 × 3.5
II-4	61 × 66 × 3.5
II-5	61 × 66 × 3.5
II-6	61 × 66 × 3.5
II-7	61 × 84 × 5.5
II-8	61 × 90 × 7.0
II-9	61 × 66 × 3.5
II-10	61 × 57 × 3.5
II-11	61 × 80 × 3.5
II-12	61 × 95 × 5.5
II-13	61 × 75 × 3.5
II-14	61 × 111 × 7.0
II-15	61 × 95 × 5.5

Notes: 1) Bottom Width × Bottom Length × Bottom Height
2) Slope Gradient 1:2.0

The killa size is determined based on the livestock holding data for each Thana given by the Master Plan, the accommodation capacity of each shelter and the killa specifications adopted by the Project (I) (see Appendix 5 for details).

4.3.3 Outline of Envisaged Facilities

Based on the thorough examination results of the request made by the Government of Bangladesh, the following items are deemed appropriate as facilities to be constructed in the case of the Government of Japan's provision of grant aid.

(1) Cyclone Shelters

While the main purpose of the cyclone shelters is to provide shelter for local inhabitants to protect them from frequent cyclones, their daily use is essential to

maintain them in good order for a long period of time. In this context, both the Bangladesh and Japanese sides have agreed to their use as primary school buildings to ensure their proper maintenance and also to achieve efficient building use.

• List of Facilities

Table 4-3-3 Facilities at Each Project Site

Site No.	Number of Classrooms	Size of Teacher's Room	Storage	Toilets
II-1	3	4 teachers	one room	separate toilets for boys and girls
II-2	3	4 teachers	"	"
II-3	4	5 teachers	"	"
II-4	5	6 teachers	"	"
II-5	5	6 teachers	"	"
II-6	5	6 teachers	"	"
II-7	4	5 teachers	"	"
II-8	3	4 teachers	"	"
II-9	4	5 teachers	"	"
II-10	3	4 teachers	"	"
II-11	5	6 teachers	"	"
II-12	5	6 teachers	"	"
II-13	5	6 teachers	"	"
II-14	5	6 teachers	"	"
II-15	5	6 teachers	"	"

Note: A classroom is designed to accommodate some 50 pupils.

• Structure, Number of Storys

- Main Body (pillars, beams and floors) : reinforced concrete
- Walls (interior and exterior) : brick masonry
- Number of Storys : 2

• Floor Height

- First Floor : GL + 3.5m, 5.5m or 7.0m
- Roof Top : 4m above first floor height

• School Furniture

Table 4-3-4 School Furniture by Each School Type

Item	3-Classroom School	4-Classroom School	5-Classroom School
Pupil's Desk and Chair	51 sets	68 sets	85 sets
Teacher's Desk and Chair	7 sets	9 sets	11 sets
Blackboard	4 schools	5 schools	6 schools

(2) Auxiliary Facilities

• Hand Pump
• Borehole (GL -300 to -400m)
• Septic Tank

4.3.4 Maintenance Plan

(1) Maintenance System

In addition to materials control and quality control during the construction period, regular maintenance after the completion of the cyclone shelters is essential to maintain these structures in good condition over a long period of time. The expected life of the cyclone shelters could be reduced if damage is left unrepaired for too long. Many badly damaged existing cyclone shelters were observed during the field surveys, damage probably resulting due to the lack of proper maintenance. If these shelters are left unrepaired, they will soon become incapable of fulfilling their declared purpose. The underlying reason for the poor state of maintenance could be a lack of sufficient maintenance funds on the part of the central government or due to particular local circumstances.

The adoption of a construction method and materials which do not involve an excessive maintenance cost in the future is, therefore, extremely important. While the cyclone shelters will be managed by the PMED in view of their normal use as primary school buildings, it should prove more practical for the PMED to assign the responsibility for the buildings to the LGED. The direct maintenance responsibility will fall on the District Offices of the LGED and the engineers of the LGED Thana Offices.

(2) Maintenance Work

The types of required maintenance work and the maintenance intervals are as follows.

- Repainting of exterior walls : every 10 years
- Repainting of interior walls : every 10 years
- Repair of damaged mortar finish of pillars, beams and walls : as and when discovered
- Inspection of borehole and pump : monthly
- Repair of damaged desks and chairs : as and when discovered

(3) Maintenance Cost (for 15 cyclone shelters)

Although all types of maintenance are not conducted every year, the average annual costs are calculated below for convenience.

- Repainting of exterior walls	: Taka 151,300 (approx. 413,000 yen)
- Repainting of interior walls	: Taka 477,230 (approx. 1,303,000 yen)
- Repair of damaged mortar finish of pillars, beams and walls	: Taka 11,720 (approx. 32,000 yen)
Total	Taka 640,250 (approx. 1,748,000 yen)

In addition, as described in 4.2.4-(2), salaries for four additional teachers (TK 96,000/year) as the personnel cost will be required.

The above maintenance cost as well as personnel cost are not particularly large and no problems are anticipated in regard to the appropriation of the required funds from the budget of the PMED.

CHAPTER 5

BASIC DESIGN

CHAPTER 5 BASIC DESIGN

5.1 Design Policies

5.1.1 Natural Conditions

The design policies of the Project (II) vis-a-vis the relevant natural conditions are discussed here.

(1) Wind Velocity

Cyclone wind velocities recorded in the past and wind velocities with various return periods have already been discussed in 3.2.1. Based on the analysis results, the wind velocity with a 50-year return period of 260 km/hr (72.0 m/sec) used as the standard design wind velocity in the Master Plan is also used in this report.

(2) Earthquakes

While there are no detailed architectural standards relating to earthquakes in Bangladesh, the country is classified into 3 zones and each zone has a separate standard earthquake factor (F).

Zone 1 (North)	:	F = 0.08
Zone 2 (Central and East)	:	F = 0.05
Zone 3 (Central and South)	:	F = 0.04

The Chittagong and Cox's Bazar Districts belong to Zone 2 (F = 0.05).

(3) Tide Level

The wave force associated with high tide is not considered here because it has little impact on cyclone shelters on stilts. In comparison, however, the tide level is important to determine the required floor height of these shelters. The method used for the preparation of the Master Plan (based on a tide level with a 50-year return period) is also used here for the analysis of storm surges. The following equation is suggested to calculate the storm surge height at the cyclone shelter sites.

$$H = h_{50} - (x - 1)K + h_w \quad \text{.....(5-1-1)}$$

h_{50} : Design surge height with a 50-year return period (m)
(See Table 3-2-10)
X : Distance of shelter from the beach (km)
K : Rate of decrease in surge height (m/km)
h_w : Amplitude of local wave in meters from mean water level
h_w : $[h_{50} - (x - 1)K] \cdot 1/4$ h_w is 1 if $h_w < 1$

(4) Temperature and Lighting

While the maximum temperature reaches more than 35°C at all the sites, no air-conditioning, mechanical or otherwise, or ventilation system will be provided. As no lighting system will be provided, as many windows as possible will be designed for ventilation and lighting purposes.

(5) Geology

1) Geological Conditions

Soil Investigation

As shown in Table 5-1-1, a boring survey was conducted at 2 points of each shelter site (a total of 30 survey points) and a laboratory soil test was conducted on the soil samples taken from each borehole.

Investigation Results

The geological survey results indicate the necessity to adopt pile foundations except in the case of Site Nos. II-6 and II-12 (see Appendix 7-2-2 in the Supplementary Volume). The long-term allowable bearing capacity and likely level of consolidation settlement must be established for Site Nos. II-6 and II-12 to determine the feasibility of using direct foundations at these sites.

2) Feasibility of Direct Foundations at Site Nos. II-6 and II-12

The long-term allowable bearing capacity for independent footing is calculated using the following equation suggested by Terzaghi's soil mechanics practices.

$$qa = \frac{1}{3}(\alpha C N_c + \beta \gamma_1 B N_r + \gamma_2 D_f N_q) \quad \text{.....(5-1-2)}$$

qa	:	Long-term allowable bearing capacity of ground (tf/m^2)
C	:	Cohesion of foundation ground (tf/m^2)
γ_1	:	Unit weight of soil below base of foundations (t/m^3) (Submerged unit weight is applied to the soil below groundwater level)
γ_2	:	Unit weight of soil above base of foundations (t/m^3) (Submerged unit weight is applied to the soil below groundwater level)
α, β	:	Shape factor of foundations (square shape: $\alpha = 1.3, \beta = 0.4$)
$N_cN_\gamma N_q$	:	Bearing capacity factor determined by angle of internal friction (Ø) of soil (see Table 5-1-4)
Df	:	Depth of footing (m)
B	:	Minimum foundation width (m)

Table 5-1-1 Geological Survey Locations and Number of Samples

Site Number	District	Thana	Boring Number	Boring Depth	Number of Samples
II-1	Chittagong	Banskhali	BH 1	26	2
			BH 2	23	2
II-2	Chittagong	Banskhali	BH 1	14	1
			BH 2	18	1
II-3	Chittagong	Banskhali	BH 1	22	2
			BH 2	20	2
II-4	Cox's Bazar	Sadar	BH 1	27	2
			BH 2	27	2
II-5	Cox's Bazar	Sadar	BH 1	30	1
			BH 2	30	2
II-6	Cox's Bazar	Sadar	BH 1	21	1
			BH 2	21	1
II-7	Cox's Bazar	Chokoria	BH 1	30	2
			BH 2	30	2
II-8	Cox's Bazar	Chokoria	BH 1	30	2
			BH 2	30	2
II-9	Cox's Bazar	Chokoria	BH 1	30	2
			BH 2	30	2
II-10	Cox's Bazar	Ramu	BH 1	20	2
			BH 2	18	2
II-11	Cox's Bazar	Ukhia	BH 1	22	2
			BH 2	21	1
II-12	Cox's Bazar	Chokoria	BH 1	28	2
			BH 2	28	2
II-13	Cox's Bazar	Chokoria	BH 1	20	2
			BH 2	26	2
II-14	Cox's Bazar	Chokoria	BH 1	30	2
			BH 2	30	2
II-15	Cox's Bazar	Chokoria	BH 1	25	2
			BH 2	25	2
Total			30		

Table 5-1-2 Bearing Capacity Factor

Ø	N_c	N_r	N_q
0°	5.3	0.0	3.0
5°	5.3	0.0	3.4
10°	5.3	0.0	3.9
15°	6.5	1.2	4.7
20°	7.9	2.0	5.9
25°	9.9	3.3	7.6
28°	11.4	4.4	9.1
32°	20.9	10.6	16.1
36°	42.2	30.5	33.6
40° or more	95.7	114.0	83.2

3) Examination of Consolidation Settlement

When there is a wide distribution of highly compressible clayey soil below the bearing stratum of a direct independent footing or pile foundations, it is possible for consolidation settlement to occur over a long period of time due to the weight of the structure or banking soil. The degree of settlement may vary depending on the changes of the ground, possibly causing the differential settlement of the structure concerned. If this differential settlement exceeds the resisting strength of the structure, cracks and other damage to the structure will occur. Although accurate calculation of differential settlement is extremely difficult, it is generally agreed that the amount of differential settlement is roughly proportional to the total amount of settlement.

Several methods can be used to determine the amount of total settlement based on the consolidation characteristics of the soil. The method given below uses the compression index (Cc) and tends to indicate a slightly exaggerated amount of settlement. Nevertheless, this method is often used to examine the volume of settlement for a soil layer for which a consolidation test is not conducted as the value of Cc which has a relatively good correlation to the liquid limit (WL).

$$Sc = \frac{C_c}{1+e_o} \cdot H \cdot \log \frac{P_z+\Delta P}{P_2} \quad \text{..... (5-1-3)}$$

where Sc : Consolidation settlement
eo : Initial void ratio of original ground
H : Thickness of compressible layer

Cc : Compression index
Pz : Effective overburden pressure of original ground
ΔP : Incremental vertical stress

5.1.2 Social Conditions

The Project (II) intends the rebuilding of existing primary schools in the HRA to improve the quality of educational facilities as well as to use the new facilities as cyclone shelters.

The two shift system is adopted for primary education in Bangladesh with Class 1 and Class 2 pupils being taught in the morning and Class 3, Class 4 and Class 5 pupils being taught in the afternoon. Consequently, the size of the planned building for each site should be based on the number of pupils attending the morning or afternoon classes. The use of the new buildings as cyclone shelters makes it necessary for the buildings to have a RC structure with a high floor.

5.1.3 Construction Conditions

(1) Construction Method

In general, low buildings in Bangladesh are made of brick masonry while larger/taller buildings are made of rigid frame reinforced concrete with brick masonry walls. The popularity of these methods can be justified by (i) the general availability of the required materials, equipment and skills, (ii) the high cost of other methods due to the necessity to import the required materials (structural steel and timber, etc.) and (iii) the absence of the necessary skills to employ other methods.

The Basic Design Study Team has confirmed that all cyclone shelters constructed or proposed by aid organizations or the Government of Bangladesh are or will be made of reinforced concrete. Given this confirmation, all the cyclone shelters to be constructed under the Project (II) will have a rigid frame reinforced concrete structure.

(2) Project Authorization System

No specific approval or authorization is required for construction of general facilities in Bangladesh.

(3) Relevant Laws and Standards

While there are no specific laws or standards relating to architectural design in Bangladesh, the following provision exists for seismic force.

Horizontal force of inertia : F = 0.05 - 0.1

(equivalent to the standard modulus of rigidity in Japan)

The following conditions are adopted for the present basic design purposes based on the conditions used in the Master Plan and those commonly used in Japan.

Floor Live Load	: 480 kg/m^2
Wind Load	: Mean wind velocity - 72 m/sec (50-year return period)
Water Load	: Revolution coefficient - 1.5 inertia coefficient - 2.5
Design Concrete Strength	: 210 kg/cm^2
Tensile Strength of Reinforcing Rods	: 2,100 kg/cm^2

(4) Technical Level of Local Construction Companies

The technical level of local construction companies in the Dhaka metropolitan area is adequate in terms of common construction methods. The cooperation of local construction companies is essential for the successful completion of the Project (II). Fortunately, there are many companies which have been employed as sub-contractors for Japanese aid projects in the past. The use of local companies is, therefore, assumed for the implementation of the Project (II).

(5) Quality and Quantity of Local Labour

As few special skills are involved in the construction of the facilities envisaged by the Project (II), the local construction level is deemed adequate. However, it must be made certain that any construction method employed by the Project (II) can be handled by local workers. With regard to the labour quantity, all general workers can be recruited from near each site although some skilled workers must be recruited from the Dhaka metropolitan area.

(6) Procurement and Quantity of Local Construction Materials and Equipment

The use of locally available construction materials and equipment is planned as long as the quantities and specifications satisfy the design conditions in order to keep the construction cost as low as possible. In short, all construction materials and equipment required for the Project (II) are available locally, the use of which is expected to stimulate the local economy. Nevertheless, the remote locations of the Project Sites along the Bay of Bengal and the difficult access by transport vehicles to the sites make it necessary to rely on the manual transportation (pushcarts, etc.) of the materials to some sites. The primary materials and planned procurement locations are listed below.

Material	Place of Procurement
Cement	Chittagong, Dhaka
Sand	North (Sylhet)
Pit Sand	North (Sylhet)
Cobble Stones	North (Sylhet)
Reinforcing Bars	Chittagong, Dhaka
Bricks	Chittagong, Cox's Bazar
Wooden Forms	Chittagong, Cox's Bazar
Paint	Chittagong, Dhaka
Fittings	Chittagong, Dhaka
Pumps	Chittagong, Dhaka
Furnishings	Chittagong, Dhaka

5.1.4 Maintenance of Cyclone Shelters

It has been confirmed that the PMED will be responsible for the management of the cyclone shelters which will normally be used as primary school buildings. The maintenance cost will be appropriated from the PMED budget although the actual maintenance work will be conducted by the LGED.

As the new buildings will be used as cyclone shelter-cum-primary school buildings, no technical or financial problems are anticipated in regard to their maintenance. Important points are the selection of construction materials which can be procured locally, selection of high quality materials and ensuring of high level quality control of the construction work.

5.1.5 Scope and Quality of Cyclone Shelters

(1) Scope

The scope of the buildings to be constructed under the Project (II) has been determined as follows.

1) The size of the new buildings (number of classrooms) will depend on the number of pupils at each school.

2) As a cyclone shelter, each building will have a minimum accommodation capacity of 1,650 people.

3) Each building will be provided with school furniture (desks, chairs and blackboards) in view of its use as a primary school building.

4) Each building will be provided with a water supply system using a borehole and hand pump.

5) Each building will be provided with toilet facilities and a septic tank which can be used at the time of a disaster.

(2) Quality

In principle, the construction materials and equipment to be used for the Project (II) will be procured locally as stated earlier and the building structure will be a rigid frame concrete structure which is common in Bangladesh. The quality of the structure and finishing work, etc. will be equivalent to that of other cyclone shelters constructed by the Government of Bangladesh and aid organizations. No special materials will be used in regard to the finishing and other aspects as long as the intended functions of the cyclone shelters are not compromised to keep the maintenance cost low.

5.1.6 Construction Schedule

The decision on the construction schedule must take the conditions of the local construction industry (including the labour and material supply conditions) and the meteorological conditions in Bangladesh into proper consideration. In addition to the above conditions, the construction schedule will also be largely affected by the building structure and construction method. The fact that the planned construction

sites are scattered over a wide area due to the nature of the cyclone shelters must also be taken into consideration in the preparation of the construction schedule.

Based on the above, the allocation of 10 - 12 months for the completion of the planned construction work is necessary and it is essential that the work commence at the beginning of the dry season.

5.2 Design Criteria

5.2.1 Planned Facilities

The buildings to be constructed under the Project (II) will be cyclone shelters which will be used as primary school buildings during normal times. Consequently, these buildings will, in principle, be designed to function as primary schools. With the incorporation of a high floor, they will be able to function perfectly as cyclone shelters. The planned facilities consist of classrooms, teacher's room, storage room, toilets (boys and girls) and common use areas, such as corridors, staircases and verandas.

5.2.2 Estimate of Required Facility Size

In principle, the size of the planned building for each site is determined by the required number of classrooms. However, it is essential to secure the minimum size required for a cyclone shelter as proposed in the Master Plan. The basic standards to determine the size of different rooms are given below.

(1) Classroom

- Number of Pupils : approximately 50 pupils
- Floor Area/Pupil : 8 ft^2 ($\fallingdotseq$ 0.74 m^2)
- Floor Area : approximately 37 m^2 (0.74 x 50)

(2) Teachers' Room

- Number of Teachers : number of classrooms plus one
- Floor Area/Teacher : 50 ft^2 ($\fallingdotseq$ 4.6 m^2)

(3) Toilets

As there are no specific design standards for school toilets in Bangladesh, the school facilities constructed by the LGED are referred to in order to determine

the size of toilets. The LGED provides 2 cubicles each for boys and girls for a school with 3 classrooms. In the case of the Project (II), 3, 3 or 4 cubicles each for boys and girls will be provided for a school with 3, 4 or 5 classrooms respectively. In addition, a hand-washing area for common use will be provided.

Based on the required facilities set in 4.3.3 - (1) (Table 4-3-3), the required floor area for each type of school is given in Table 5-2-1.

Table 5-2-1 Floor Area by School Type

School Type	First Floor (m^2)	Roof Top (m^2)	Total (m^2)
3 Classrooms	261.9	21.9	283.8
4 Classrooms	288.0	29.2	317.2
5 Classrooms	337.4	31.5	368.9

(4) Sheltering Capacity

The sheltering capacity of each planned building of the sizes described above is given in Table 5-2-2.

Required Sheltering Area/Person

- Indoor : 2 ft^2 (0.185 m^2)
- Roof Top : 8 ft^2 (0.74 m^2)

Table 5-2-2 Sheltering Capacity of Planned Buildings

School Type	Indoor Floor Area (m^2)	Roof Top Area (m^2)	Sheltering Capacity (persons)	Number of Buildings	Total Sheltering Capacity (persons)
3 Classrooms	232.0	298.0	1,656	4	6,624
4 Classrooms	270.2	334.8	1,912	3	5,736
5 Classrooms	312.2	392.7	2,217	8	17,736
Total				15	30,096

5.2.3 Design Strength

The following design strength and other standards are adopted for the design of the cyclone shelters.

- Floor Live Load : 0.48 tons/m^2
- Wind Load : mean wind velocity - 72 m/sec (50-year return period)
- Water Load : revolution coefficient - -1.5
  inertia coefficient - -2.5
- Design Concrete Strength : 210 kg/cm^2
- Tensile Strength of Reinforcing Rods : 2,100 kg/cm^2

5.3 Basic Plan

5.3.1 Site Plan

As the Project (II) intends the rebuilding of existing primary school buildings in the HRA as cyclone shelter-cum-school buildings, the existing school premises can be used. In the case of Site Nos. II-3 and II-10, however, the acquisition of additional land is required as the existing premises are too small to accommodate cyclone shelters of the planned size. There is an established approach road to the existing school buildings at all the sites. However, these approach roads are not necessarily ideal from the viewpoint of the construction work and improvement measures should be introduced. The demolition of existing buildings means that temporary classrooms should be constructed or rented to ensure the continuation of school activities. Given the difficulty of finding alternative buildings, it has been decided that new buildings will be constructed in empty space on the existing premises while school activities will continue at the existing buildings. Those buildings which have been extensively damaged or the use of which is dangerous will be demolished and new buildings will be constructed on the same site. The construction or renting of temporary school buildings following the demolition of damaged or unusable buildings will be the responsibility of the Government of Bangladesh to ensure the continuation of school education.

5.3.2 Architectural Design

The architectural design of the planned facilities (cyclone shelter-cum-primary school buildings) is based on the agreed details between the Governments of

Bangladesh and Japan and is also in line with the standards and criteria set by the PMED and LGED, etc.

(1) Facilities

The facilities at each site consist of the following and the ground floor is designed to be piloti (open space) throughout.

- Classrooms : 3 - 5 (50 pupils each)
- Teachers' Room : one (4 - 6 teachers)
- Toilets : separate toilets for boys and girls (3 - 4 cubicles each)
- Storage Room : one
- Common Use Areas : corridor, staircase and veranda

(2) Floor Area

• Classrooms	3 - 4 Classroom School	: 37.6 m^2
	5 Classroom School	: 37.8 m^2
• Teachers' Room	4 - 5 Teachers	: 18.8 m^2
	6 Teachers	: 28.4 m^2
• Toilets	3 - 4 Classroom School	: 18.8 m^2
	5 Classroom School	: 26.3 m^2

(3) Floor Plan

The building will have a simple rectangular shape with a central corridor for the efficient use of space. The staircase will be located at the centre to minimise the counterflow volume of pupils in the corridor. The veranda can be used for relaxation during breaks. Toilet cubicles will be provided on the first floor so that they can be also used during cyclones. The building will have 2 storys and the ground floor will be piloti (open space) to be used for various activities.

(4) Cross-Sectional View

The height of the first floor must be high enough so as not to be inundated by storm surges caused by cyclones. The tide level calculated for each site based on the principles vis-a-vis the natural conditions described in 5.1.1 is given in the Appendix 4 of this report. In principle, a margin of between 50cm and 1m has been added to the tide level to determine the required first floor heights given in Table 5-3-1.

Table 5-3-1 Design Floor Height

(Unit: m)

Site No.	Thana	Design Floor Height (GL+)
II-1	Banskhali	5.5
II-2	Banskhali	3.5
II-3	Banskhali	3.5
II-4	Sadar	3.5
II-5	Sadar	3.5
II-6	Sadar	3.5
II-7	Chokoria	5.5
II-8	Chokoria	7.0
II-9	Chokoria	3.5
II-10	Ramu	3.5
II-11	Ukhia	3.5
II-12	Chokoria	5.5
II-13	Chokoria	3.5
II-14	Chokoria	7.0
II-15	Chokoria	5.5

(5) Direct Foundations

Based on the geological survey results for each site (see Appendix 7-2 in the Supplementary Volume), the use of the direct foundation method is feasible at 2 sites, i.e. Site Nos. II-6 and II-12. The allowable bearing strength and volume of consolidation settlement at these 2 sites are examined below to determine the type of foundation construction method to be employed. All other sites will have pile foundations.

1) Site No. II-6

① Allowable Bearing Strength

The depth of the footing (D_5) is 2.0m and the subject layer consists of sand.

$\gamma_1 = \gamma_2 = \gamma_t - 1.0 = 1.9 - 1.0 = 0.9$ (t/m^3)

$C = 0$ (tf/m^3)

As $\phi = \sqrt{12N+15} = \phi 25$, Nc = 9.9, Nr = 3.3, Nq = 7.6

Using Equation 5-1-2 with a foundation width B = 3.0m,

$qa = \frac{1}{3}(0.4 \times 0.9 \times 3 \times 3.3 + 0.9 \times 2 \times 7.6) = 5.8$ (tf/m^2) > 4.9 (tf/m^2)*

* Load per m^2 to be borne by the foundations.

② Consolidation Settlement

It is inferred that no consolidation settlement should occur given the sand layer.

Based on the above, this site will have direct foundations.

2) Site No. II-12

① Allowable Bearing Strength

The depth of the footing (Df) is set at 0.5m and the subject layer consists of clayey soil.

$\gamma_1 = \gamma_2 = \gamma_t - 1.0 = 1.9 - 1.0 = 0.9$ (t/m^3)

$C = \frac{1}{2} qu = \frac{1}{2} \times 2.2 = 1.1$ (tf/m^3)

As $\phi = 0$, Nc = 5.3, Nr = 0, Nq = 3.0

Using Equation 5-1-2,

$qa = \frac{1}{3} (1.3 \times 1.1 \times 5.3 + 0.9 \times 0.5 \times 3.0) = 2.9$ (tons/m^2)

② Consolidation Settlement

$Pz = 2.2 \times (1.8 - 1.0) = 1.76$ (t/m^3)

$\Delta P = 1.0 \times 1.8 = 1.8$ (t/m^3)

Using Equation 5-1-3,

$Sc = 0.1003 \times 4.4 \times \log \frac{3.56}{1.76} = 0.135 = 13.5$ cm

The inadequate allowable bearing strength and expected volume of consolidation settlement given above suggest that it will be inappropriate to use direct foundations at this site.

3) Foundation Type for Each Site

Based on the examination results described in 2) above, the foundation type for each site has been decided as shown in Table 5-3-2.

Table 5-3-2 Foundation Type for Each Project Site

Site Number	District	Thana	Type of Foundations	Pile Length (m)
II-1	Chittagong	Banskhali	Pile Foundations	19
II-2	Chittagong	Banskhali	Pile Foundations	15
II-3	Chittagong	Banskhali	Pile Foundations	9
II-4	Cox's Bazar	Sadar	Pile Foundations	15
II-5	Cox's Bazar	Sadar	Pile Foundations	30
II-6	Cox's Bazar	Sadar	Independent Direct Foundations	-
II-7	Cox's Bazar	Chokoria	Pile Foundations	30
II-8	Cox's Bazar	Chokoria	Pile Foundations	13
II-9	Cox's Bazar	Chokoria	Pile Foundations	9
II-10	Cox's Bazar	Ramu	Pile Foundations	8
II-11	Cox's Bazar	Ukhia	Pile Foundations	9
II-12	Cox's Bazar	Chokoria	Pile Foundations	5
II-13	Cox's Bazar	Chokoria	Pile Foundations	29
II-14	Cox's Bazar	Chokoria	Pile Foundations	20
II-15	Cox's Bazar	Chokoria	Pile Foundations	12

The bearing strength of the foundation piles can be calculated using the following equation.

$$Ra = \frac{1}{3} \cdot 15 \cdot \bar{N} \cdot Ap \quad \text{..... (5-1-5)}$$

Where, Ra : Allowable bearing capacity of piles (tf/pile)
$\bar{N}$: Average N value at pile end
Ap : Cross-sectional area at pile end (m^2)

To get the allowable bearing capacity per pile of 30 tons with a pile diameter of 600mm which can be managed by local workers, the N value should be 22 using the above equation. The soil layer with the minimum N value of 22 is, therefore, considered the suitable pile bearing layer. The pile length is determined by evaluating the geological profile at each boring test point as shown in Table 5-3-2.

(6) School Furniture

The following school furniture will be provided.

[For Each Classroom]

- Pupils' Desks and Chairs (3 seaters) : 17 sets
- Teacher's Desk and Chair : one set
- Blackboard : one

[For Teachers' Room]

- Teachers' Desks and Chairs : one set for each teacher
- Blackboard : one

(7) Auxiliary Facilities

- Borehole : one/site (depth: approximately 400m)
- Pump : one manual pump/site
- Septic Tank : one of local design/site

5.3.3 Basic Design Drawings

The basic design drawings are given in the following pages.

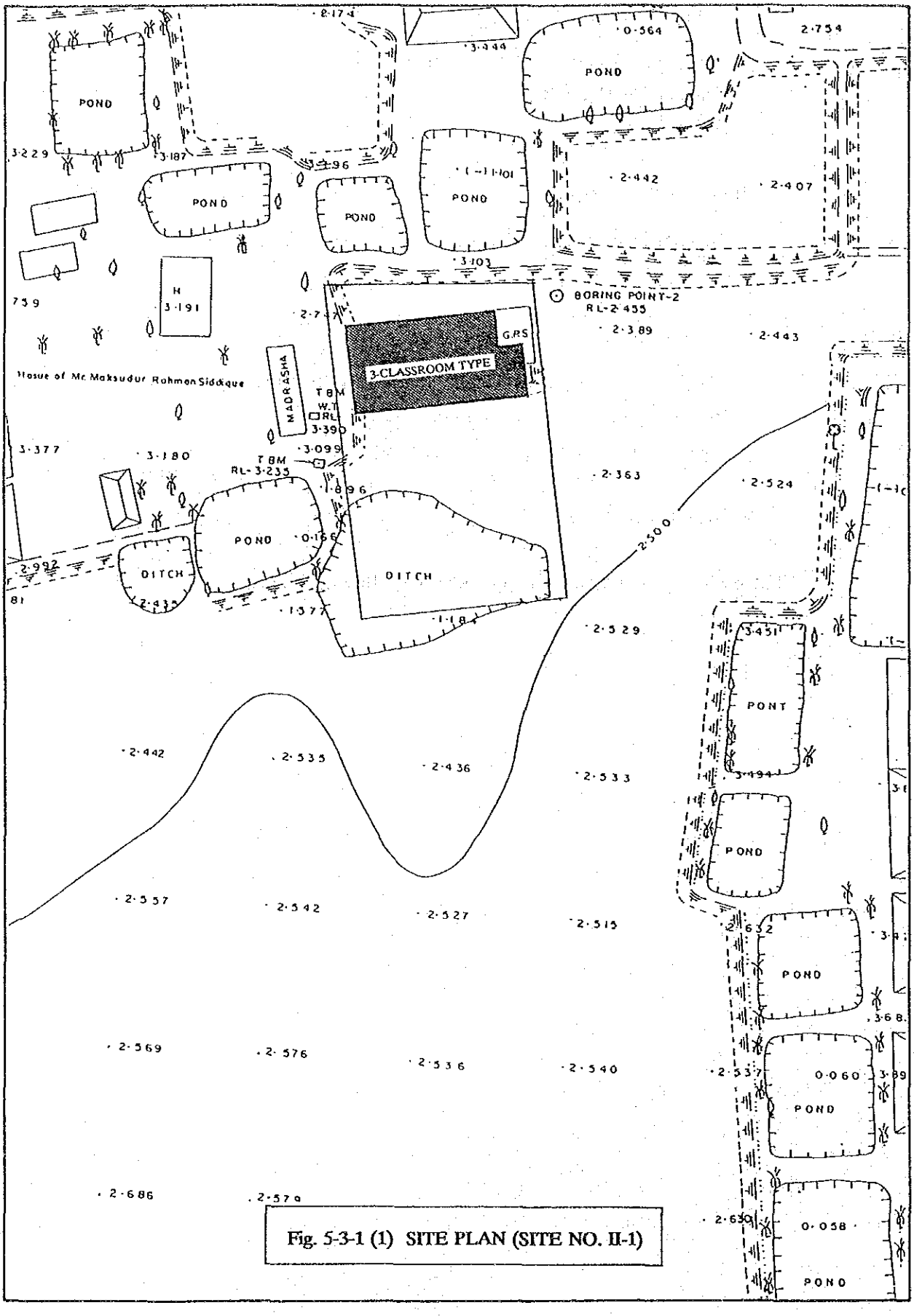


Fig. 5-3-1 (1) SITE PLAN (SITE NO. II-1)

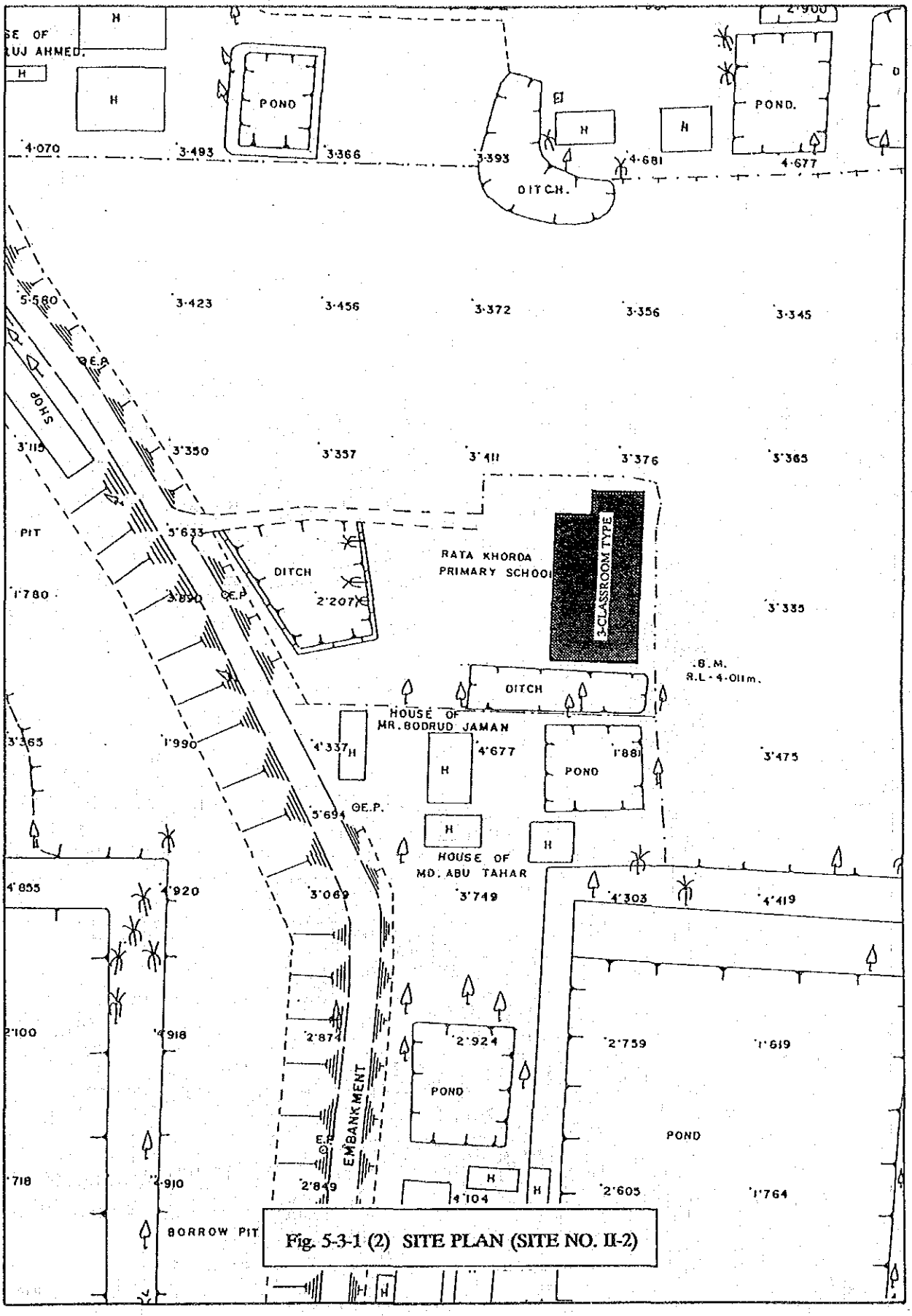


Fig. 5-3-1 (2) SITE PLAN (SITE NO. II-2)

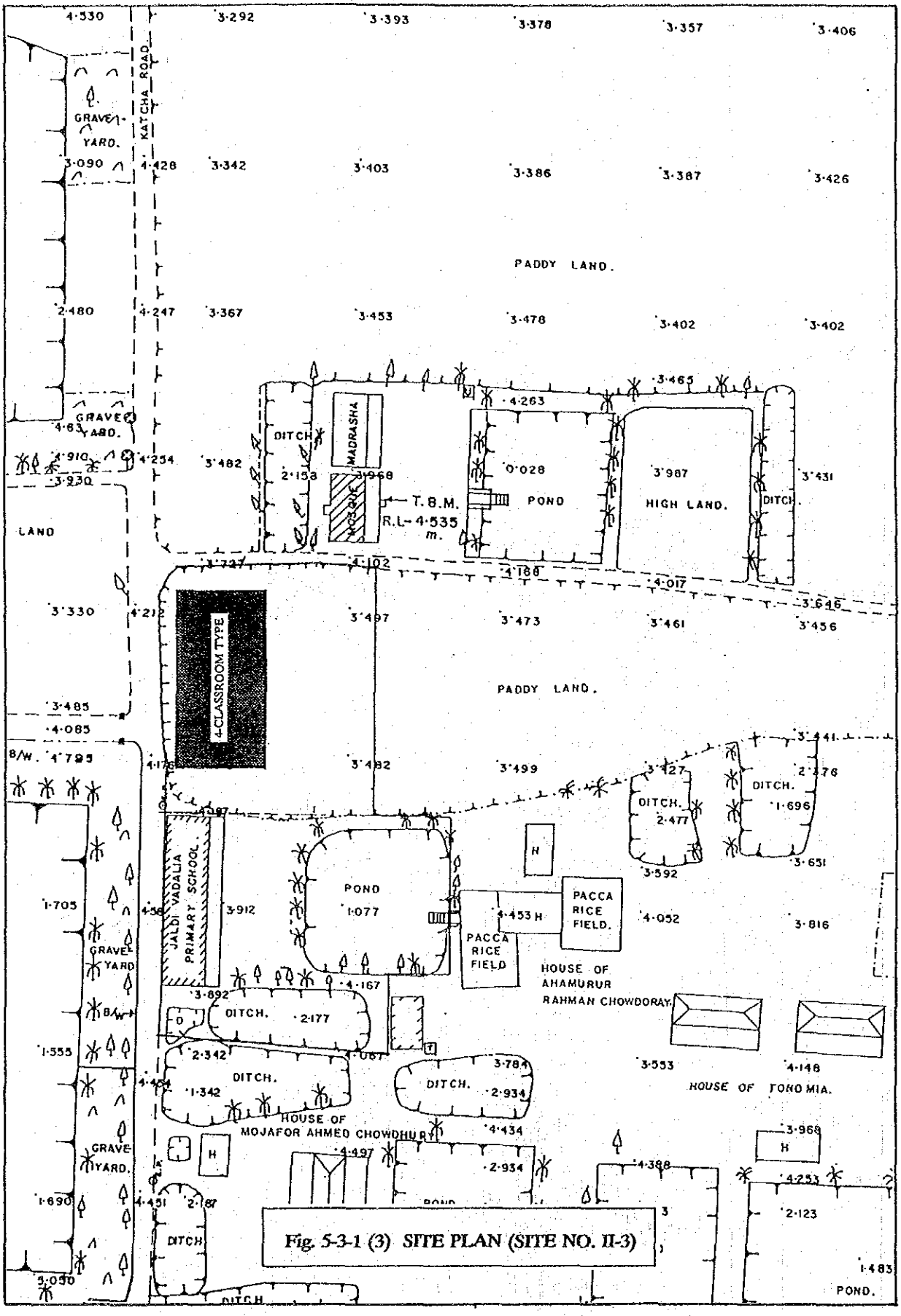


Fig. 5-3-1 (3) SITE PLAN (SITE NO. II-3)

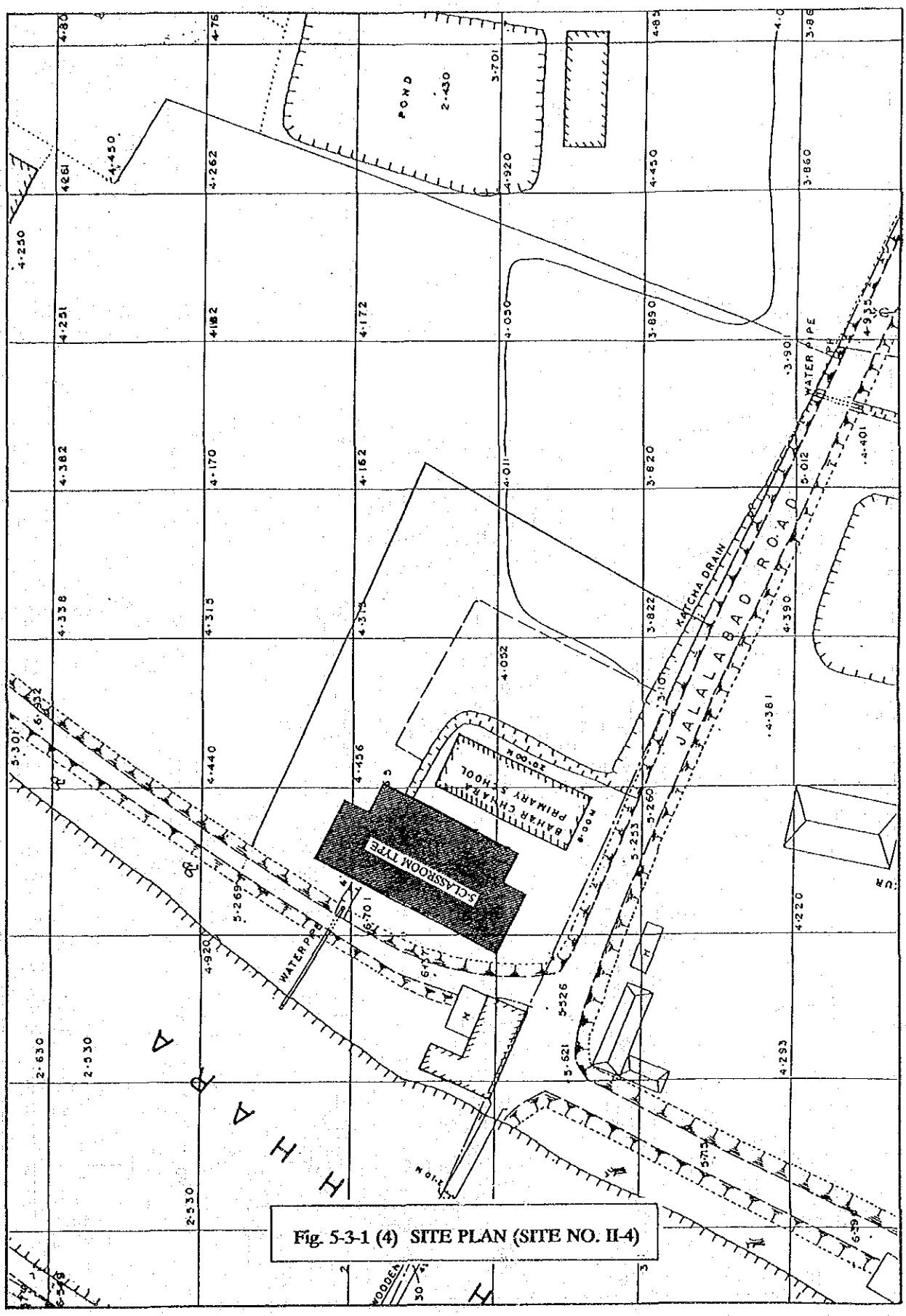


Fig. 5-3-1 (4) SITE PLAN (SITE NO. II-4)

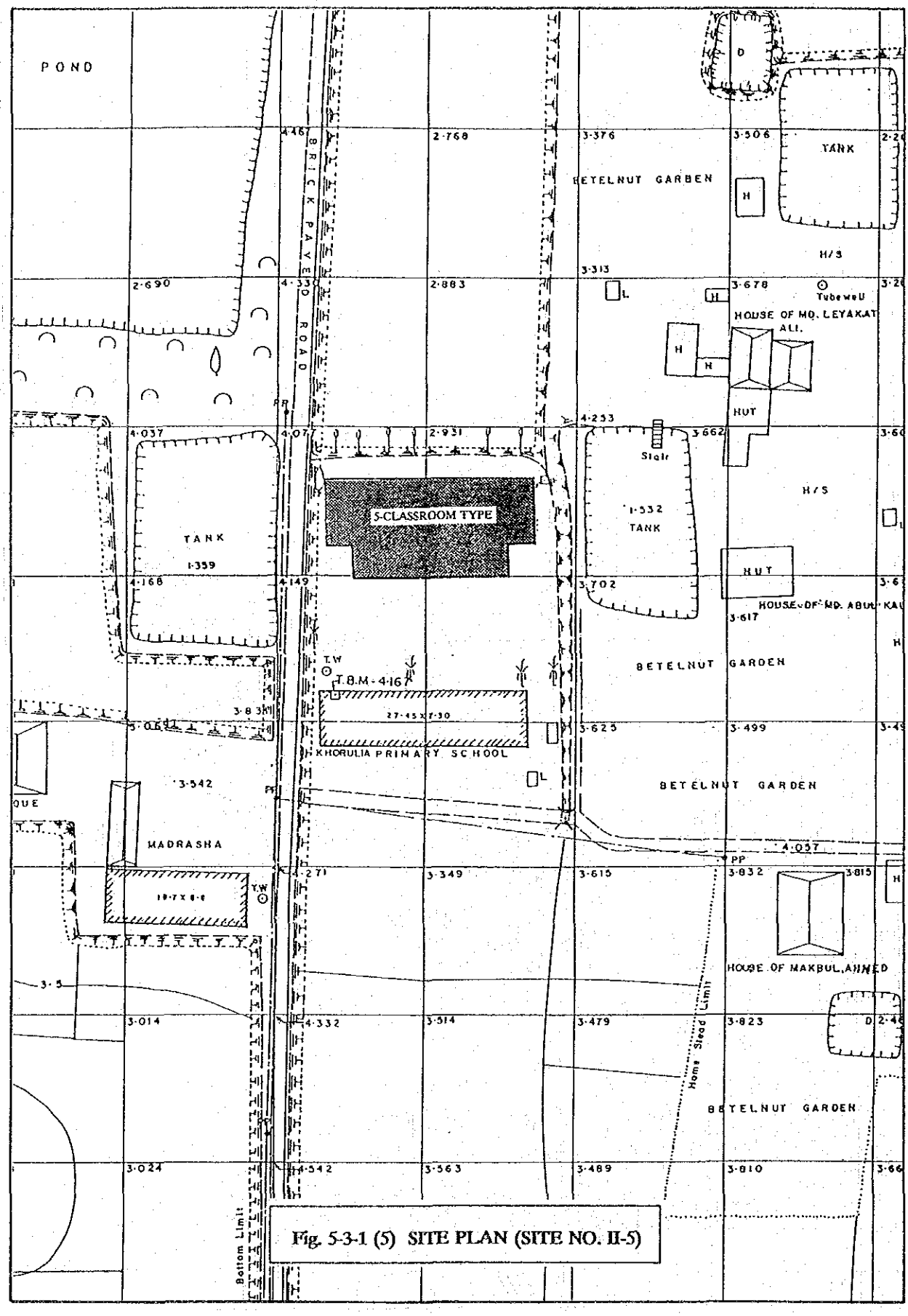


Fig. 5-3-1 (5) SITE PLAN (SITE NO. II-5)

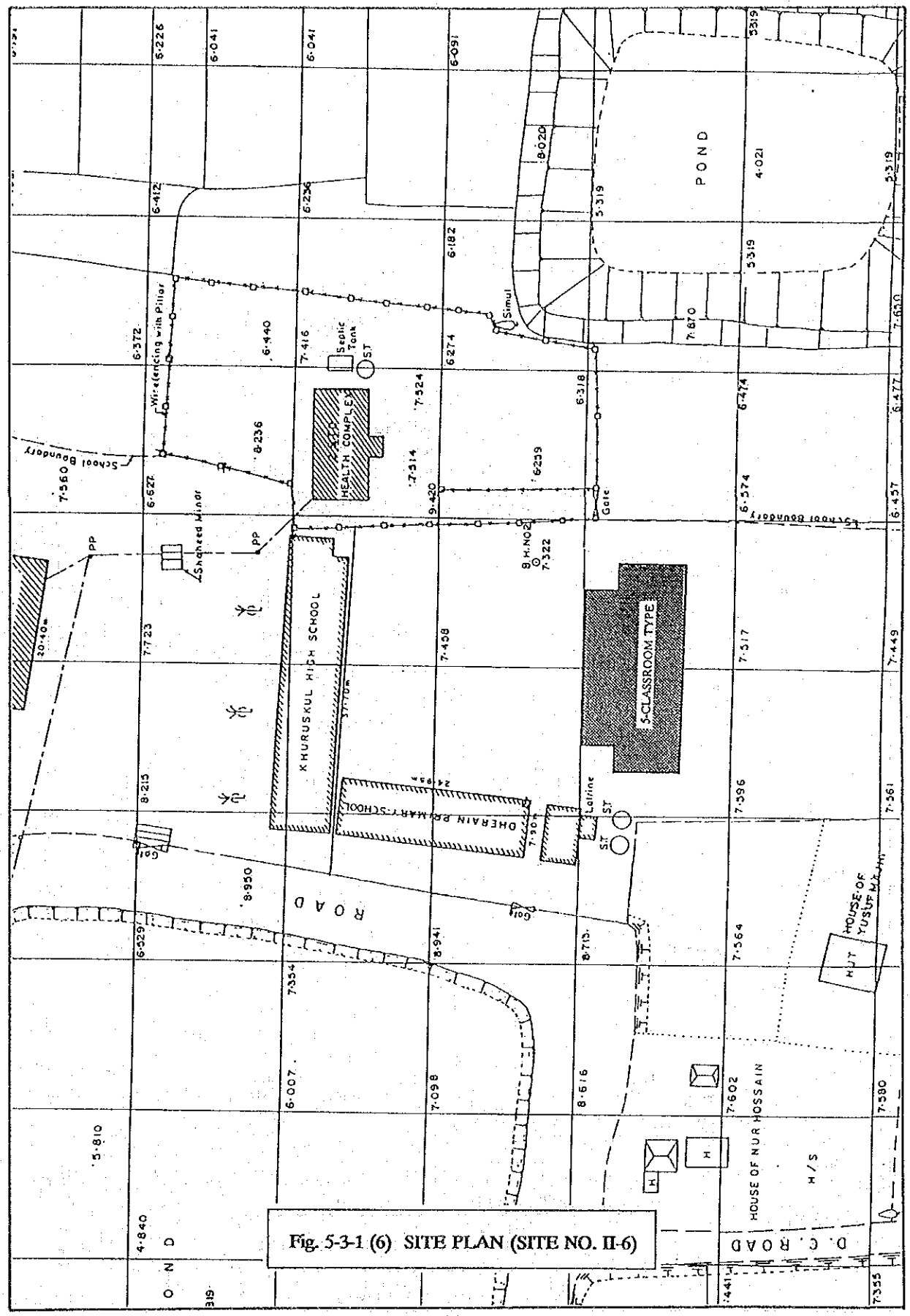


Fig. 5-3-1 (6) SITE PLAN (SITE NO. II-6)

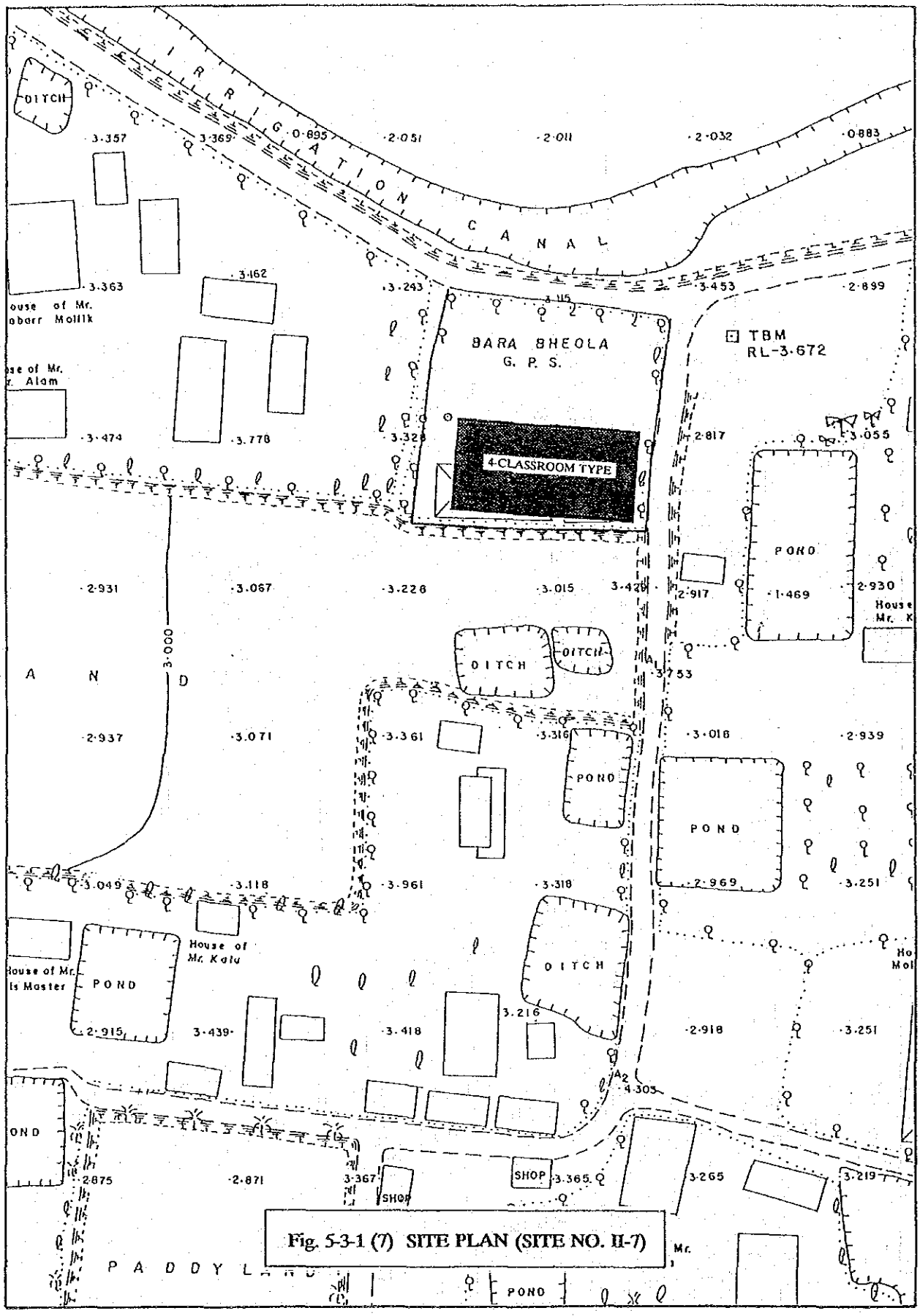


Fig. 5-3-1 (7) SITE PLAN (SITE NO. II-7)

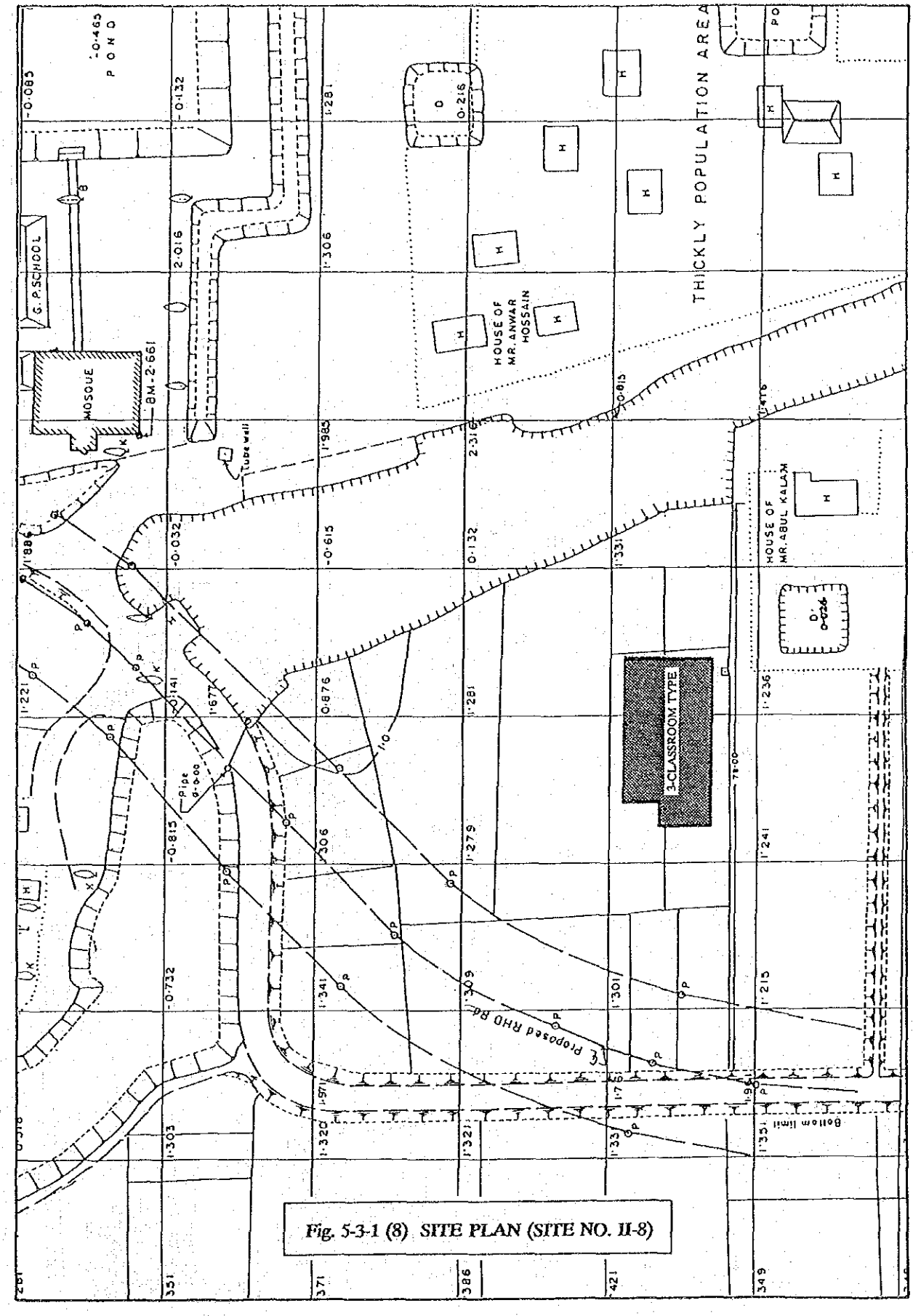


Fig. 5-3-1 (8) SITE PLAN (SITE NO. II-8)

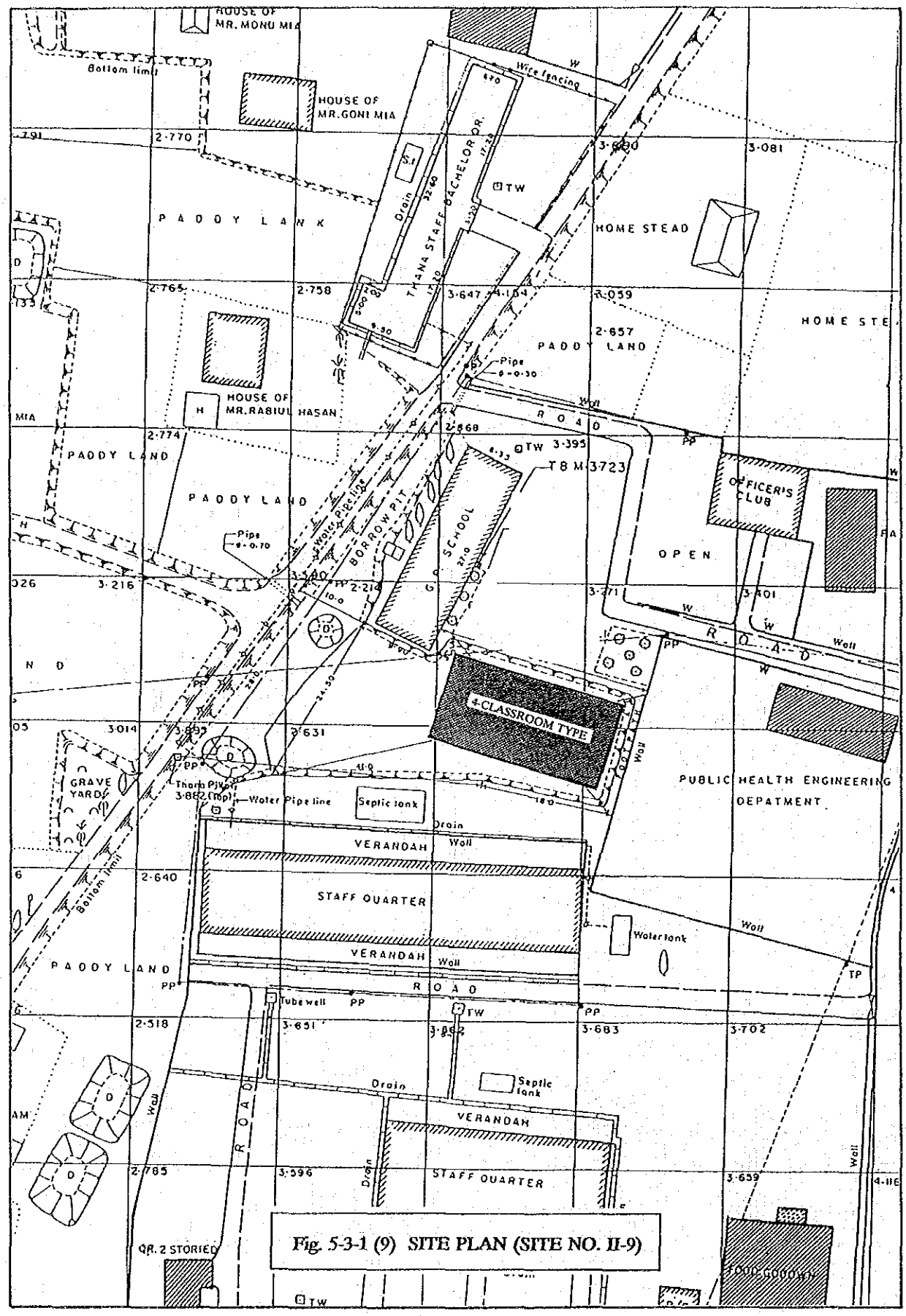


Fig. 5-3-1 (9) SITE PLAN (SITE NO. II-9)

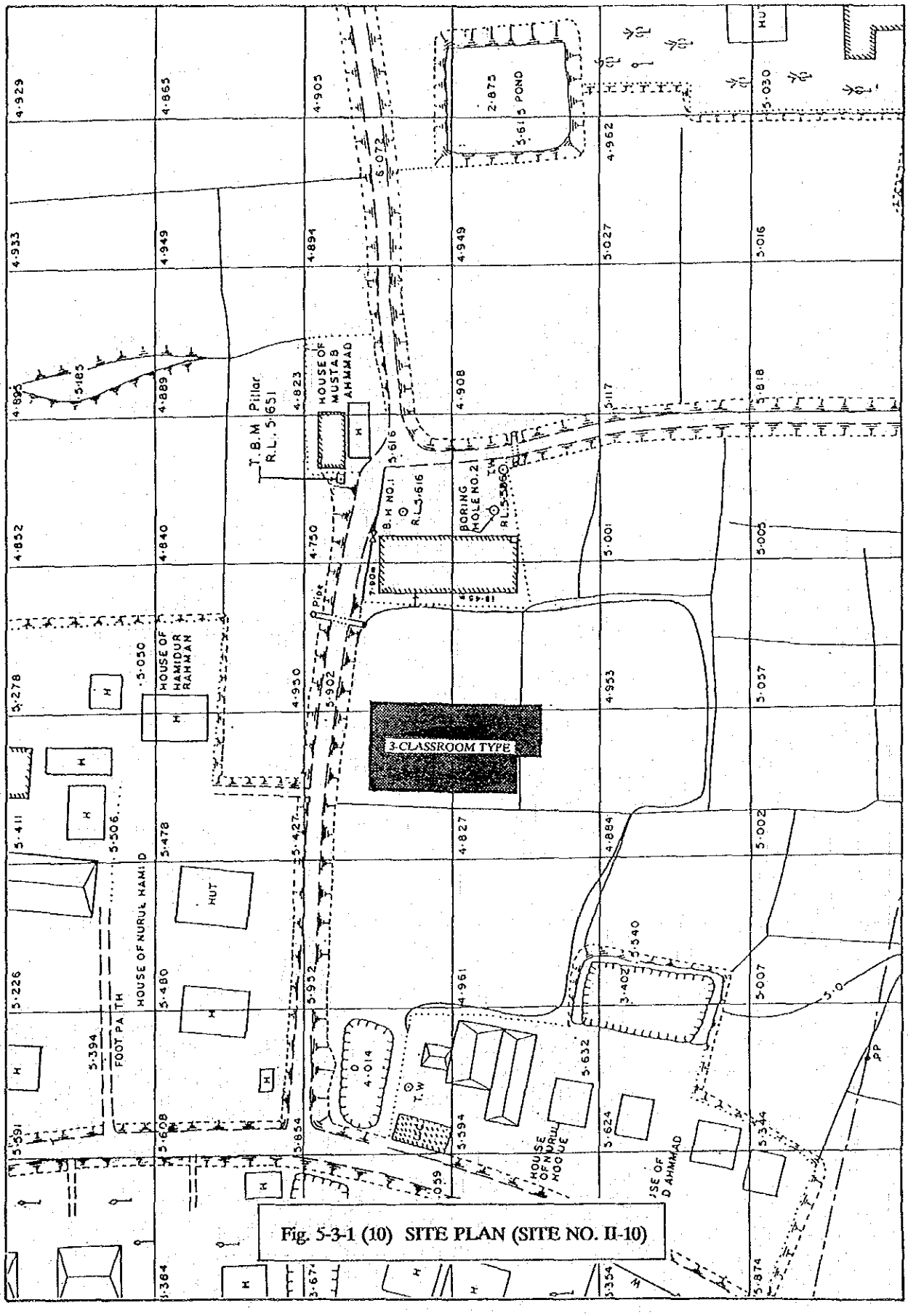


Fig. 5-3-1 (10) SITE PLAN (SITE NO. II-10)

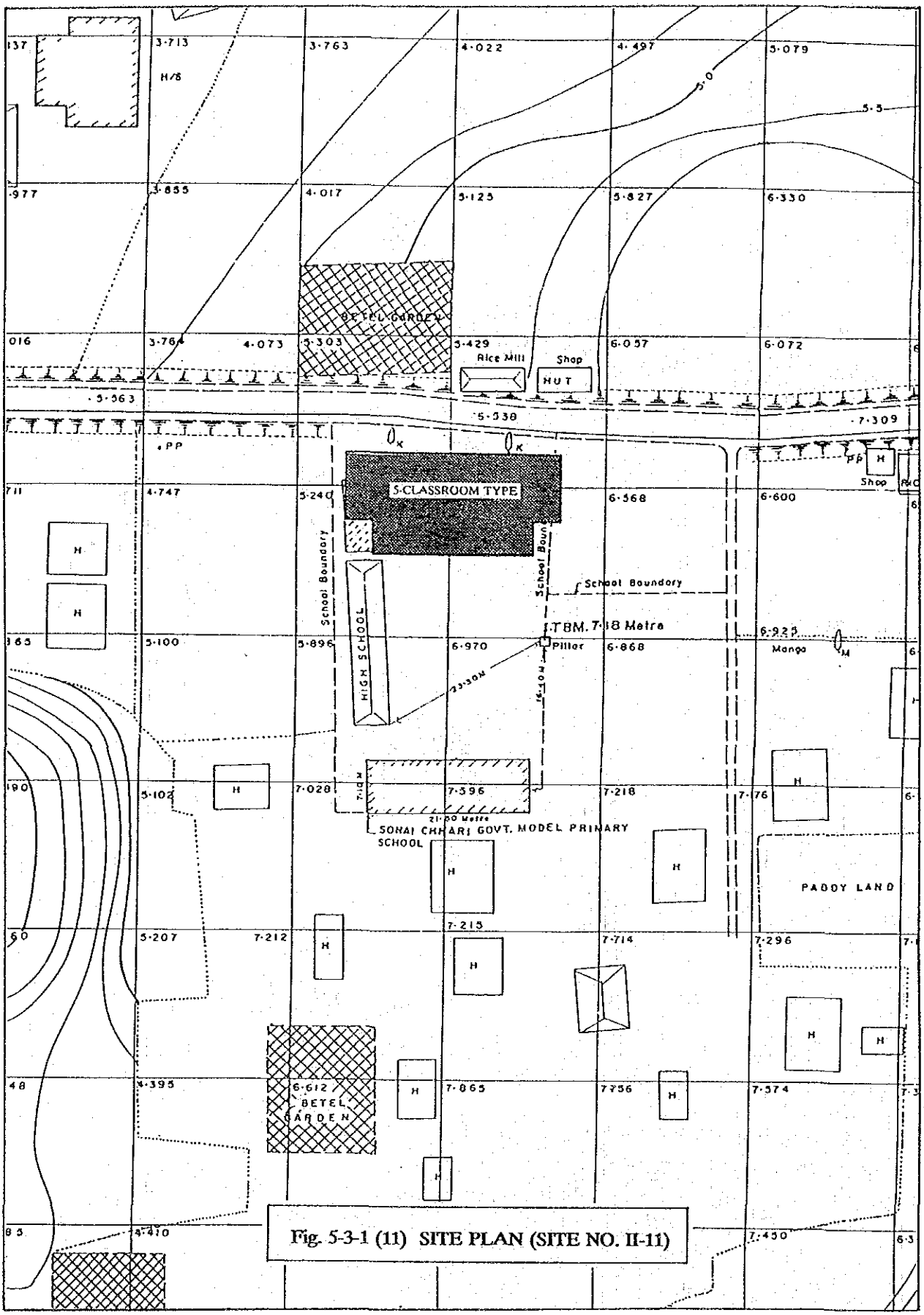


Fig. 5-3-1 (11) SITE PLAN (SITE NO. II-11)

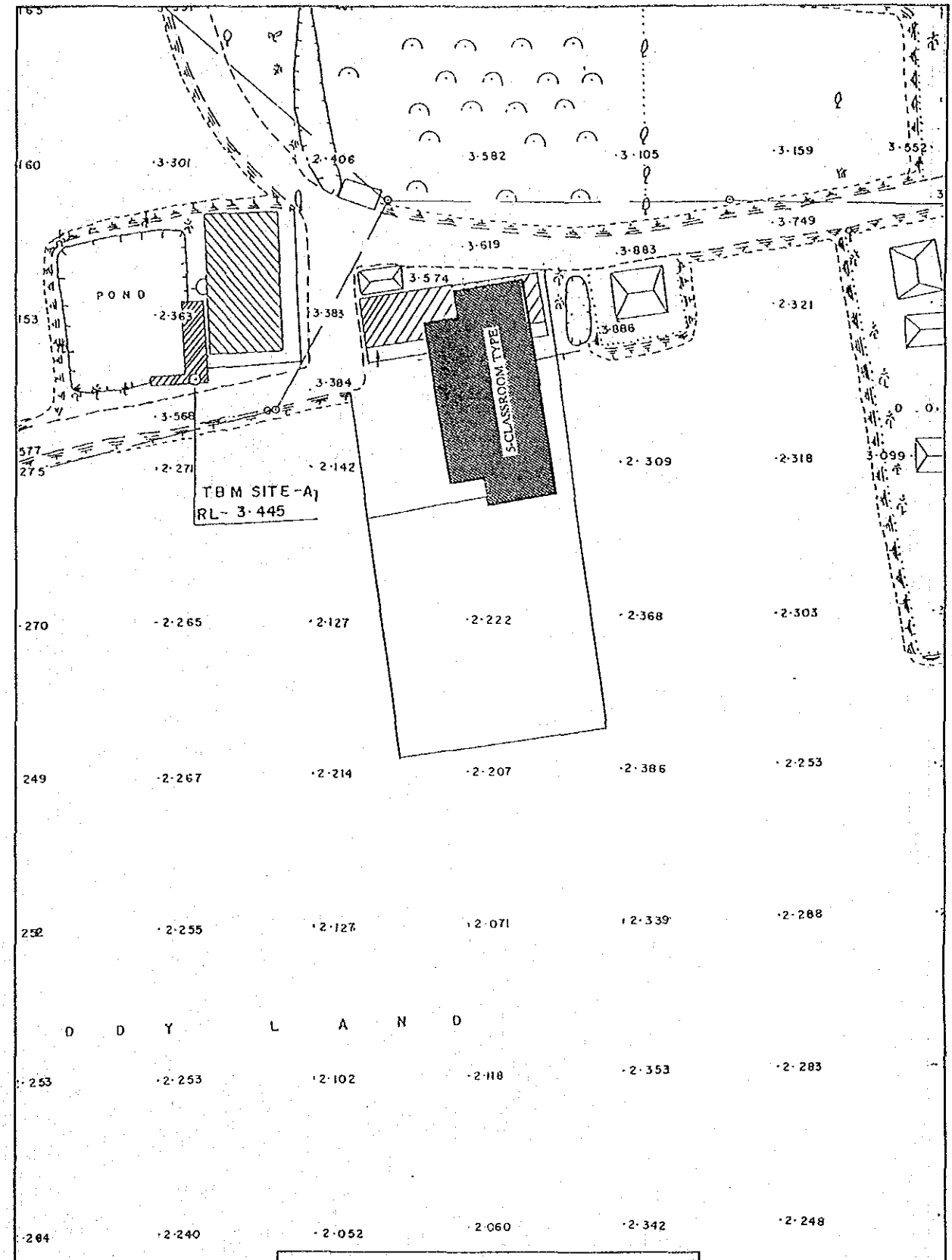


Fig. 5-3-1 (12) SITE PLAN (SITE NO. II-12)

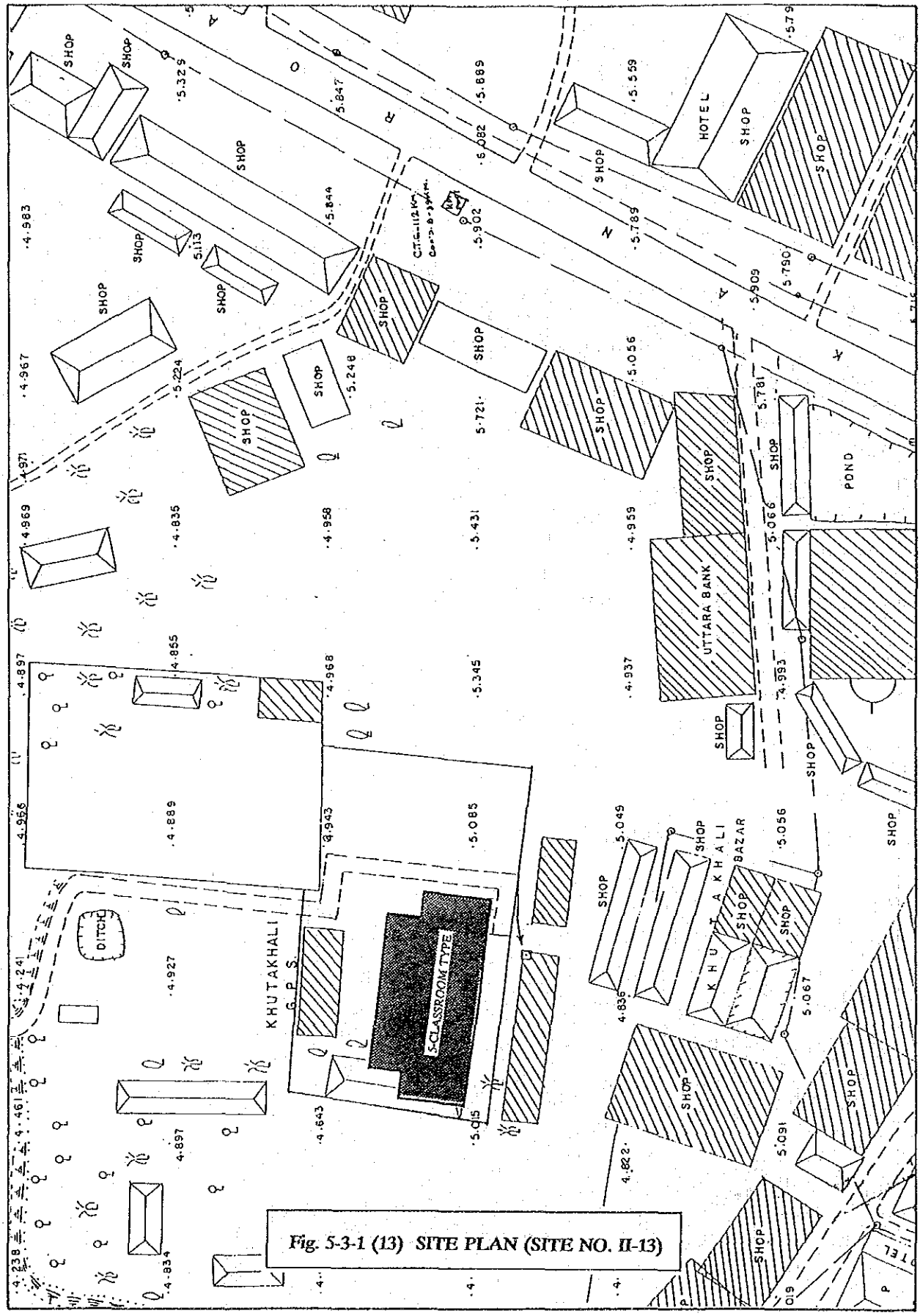


Fig. 5-3-1 (13) SITE PLAN (SITE NO. II-13)

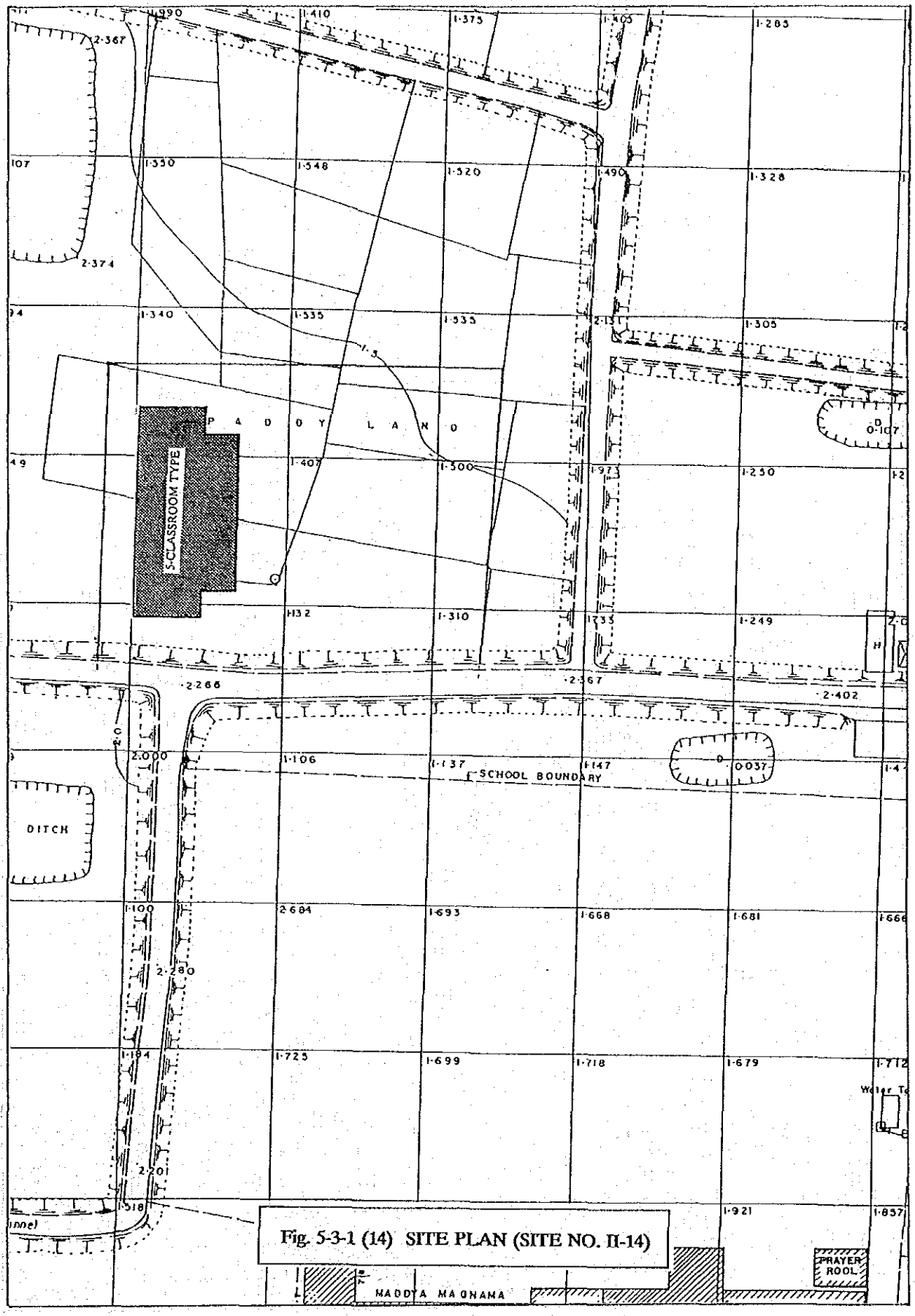


Fig. 5-3-1 (14) SITE PLAN (SITE NO. II-14)

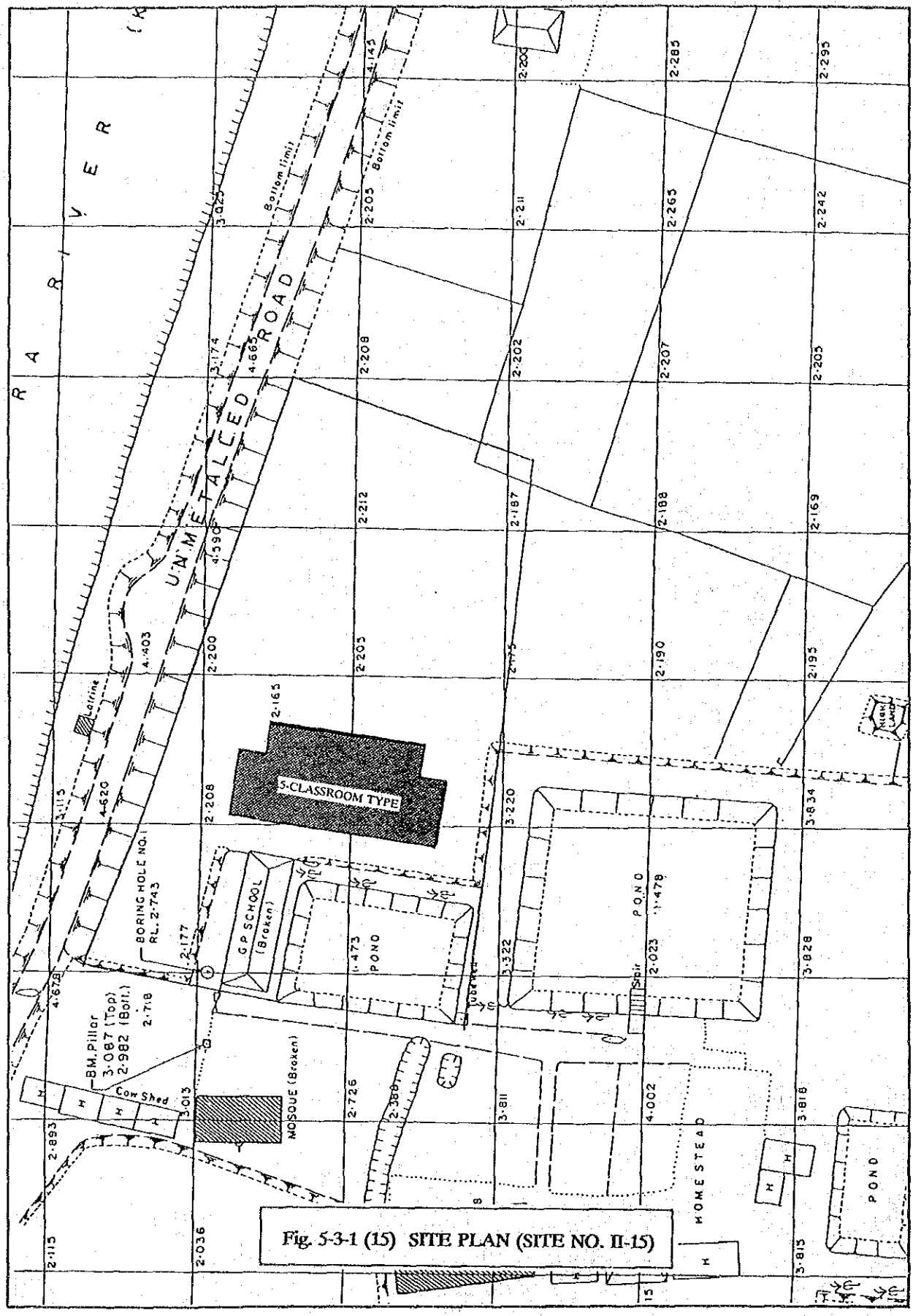


Fig. 5-3-1 (15) SITE PLAN (SITE NO. II-15)

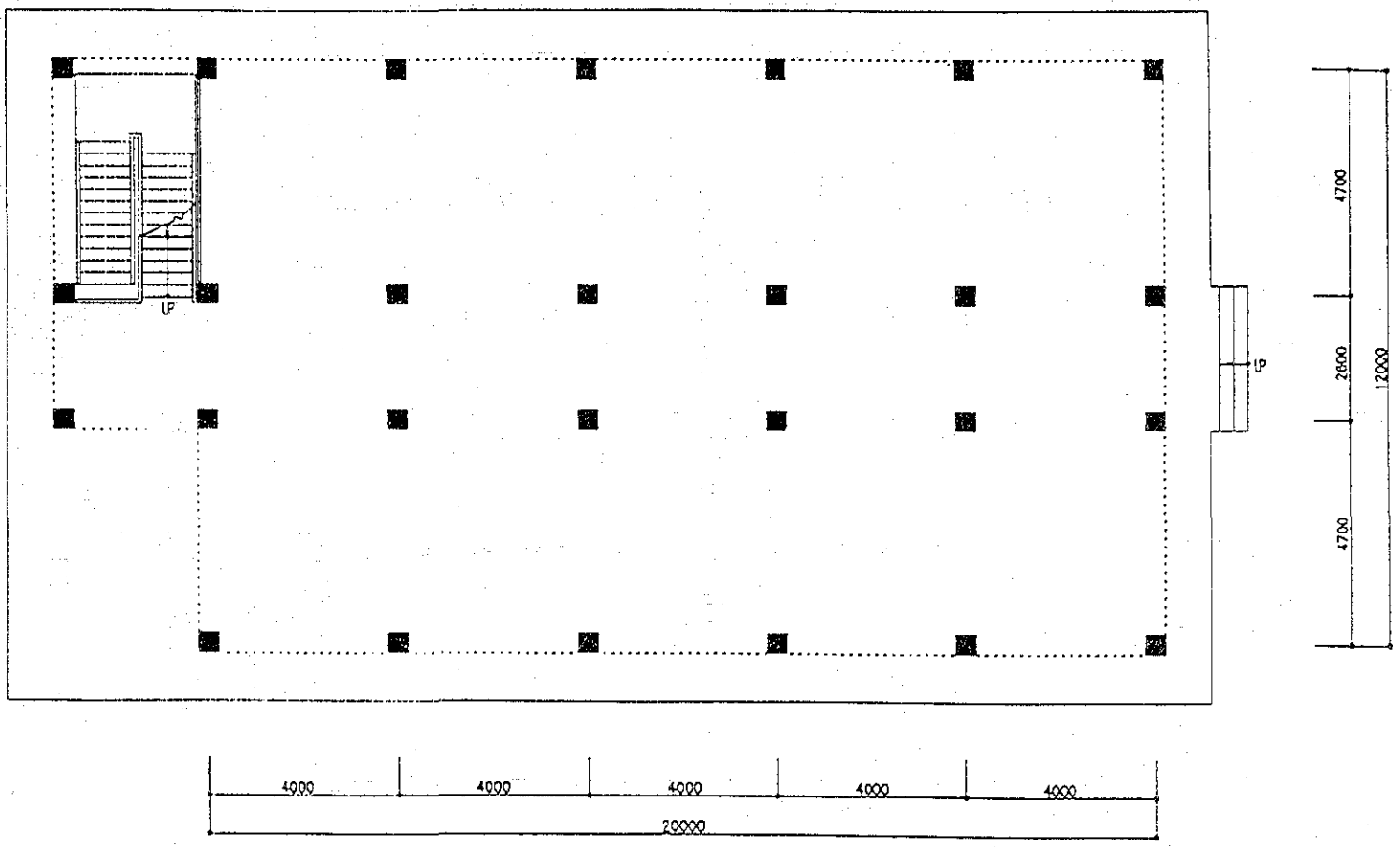


Fig. 5-3-2 (1) GROUND FLOOR PLAN (3-CLASSROOM TYPE)

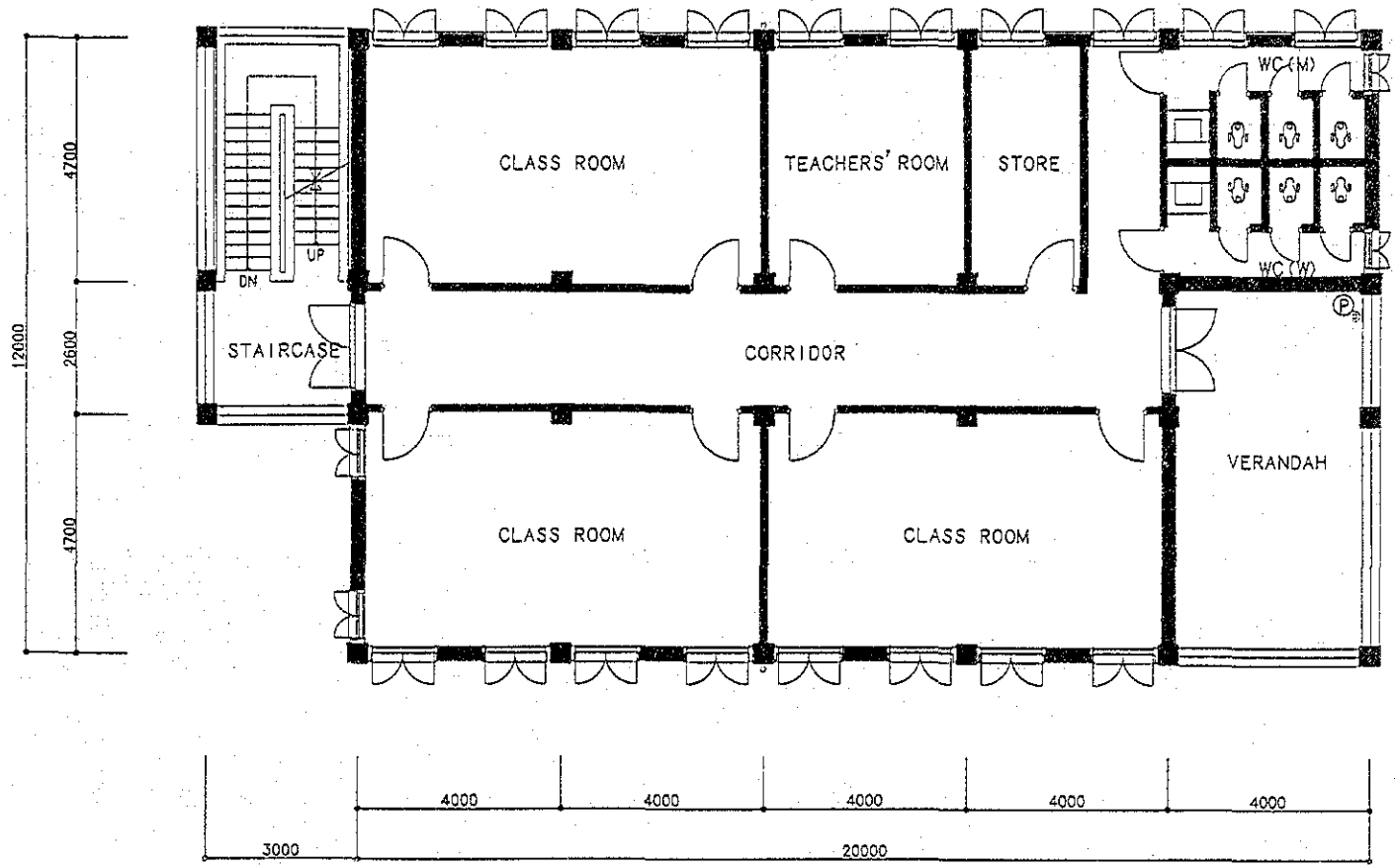


Fig. 5-3-2 (2) FIRST FLOOR PLAN (3-CLASSROOM TYPE)

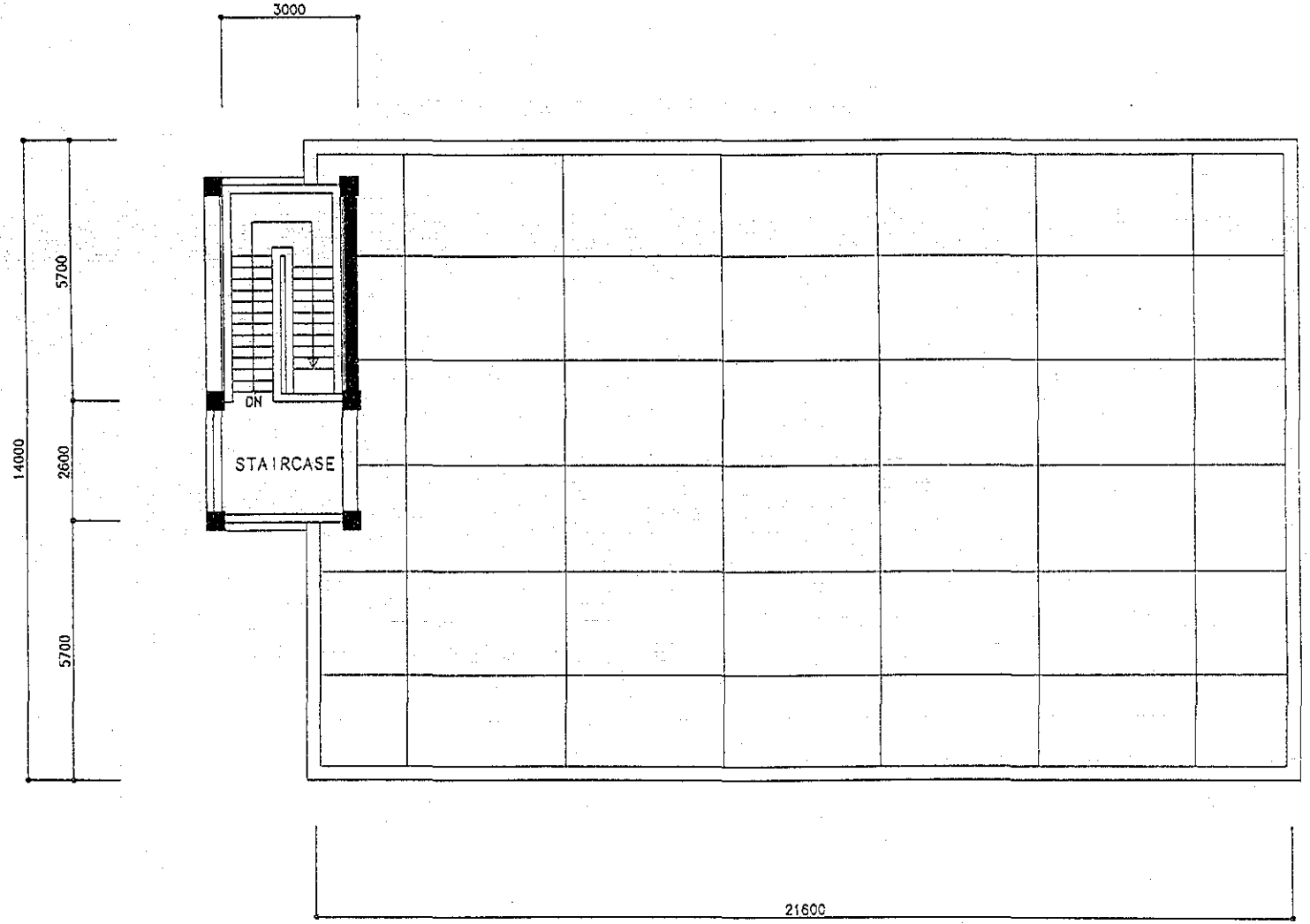


Fig. 5-3-2 (3) ROOF FLOOR PLAN (3-CLASSROOM TYPE)

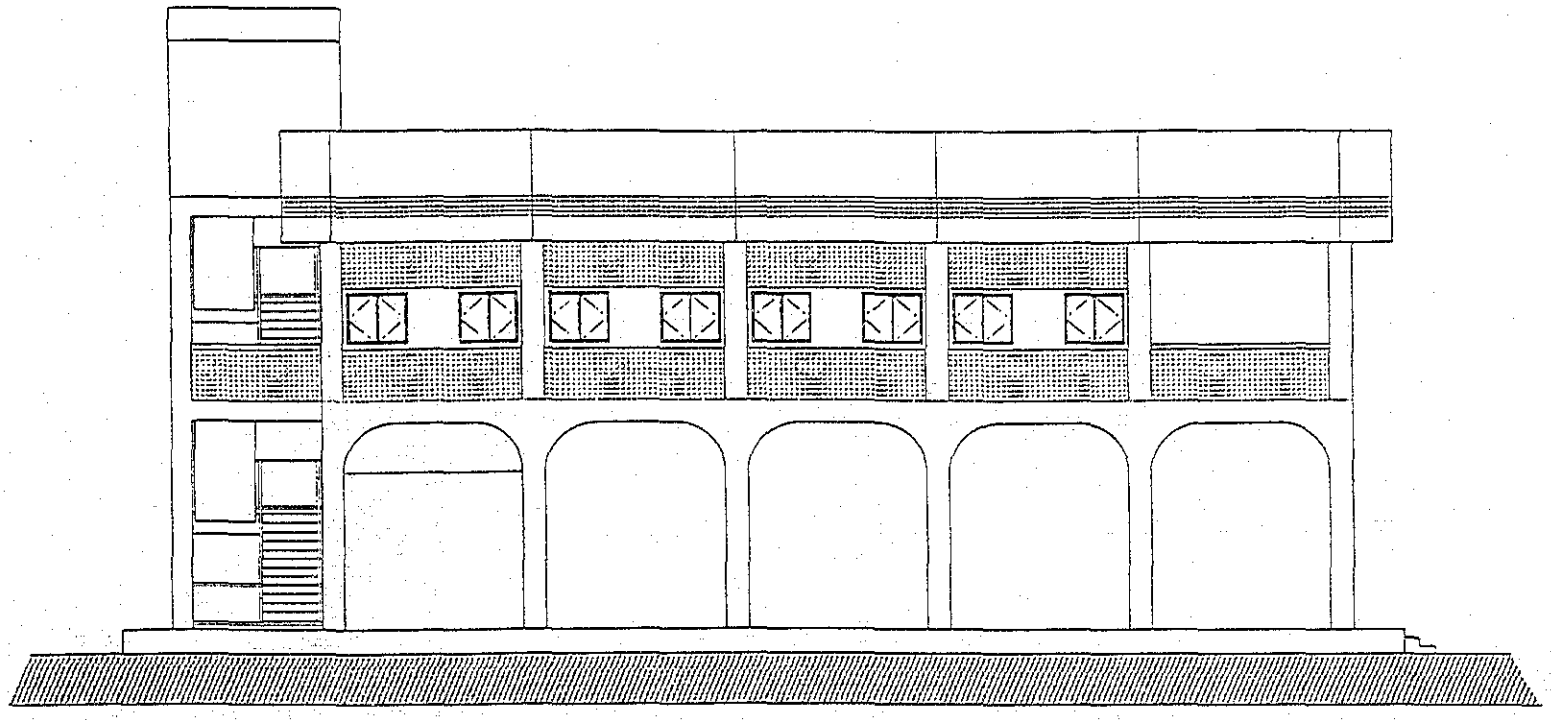


Fig. 5-3-2 (4) ELEVATION (3-CLASSROOM TYPE)

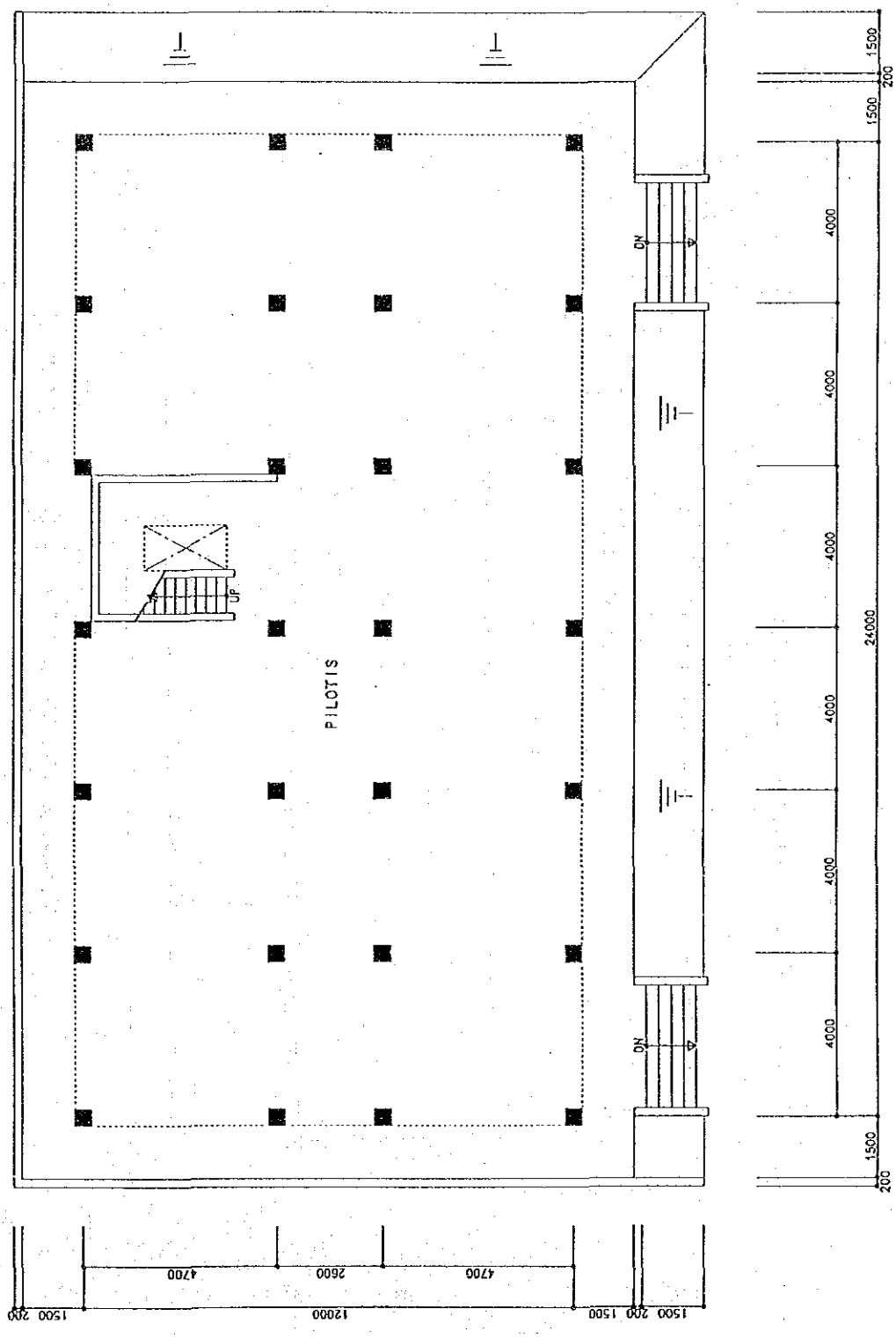


Fig. 5-3-3 (1) GROUND FLOOR PLAN (4-CLASSROOM TYPE)

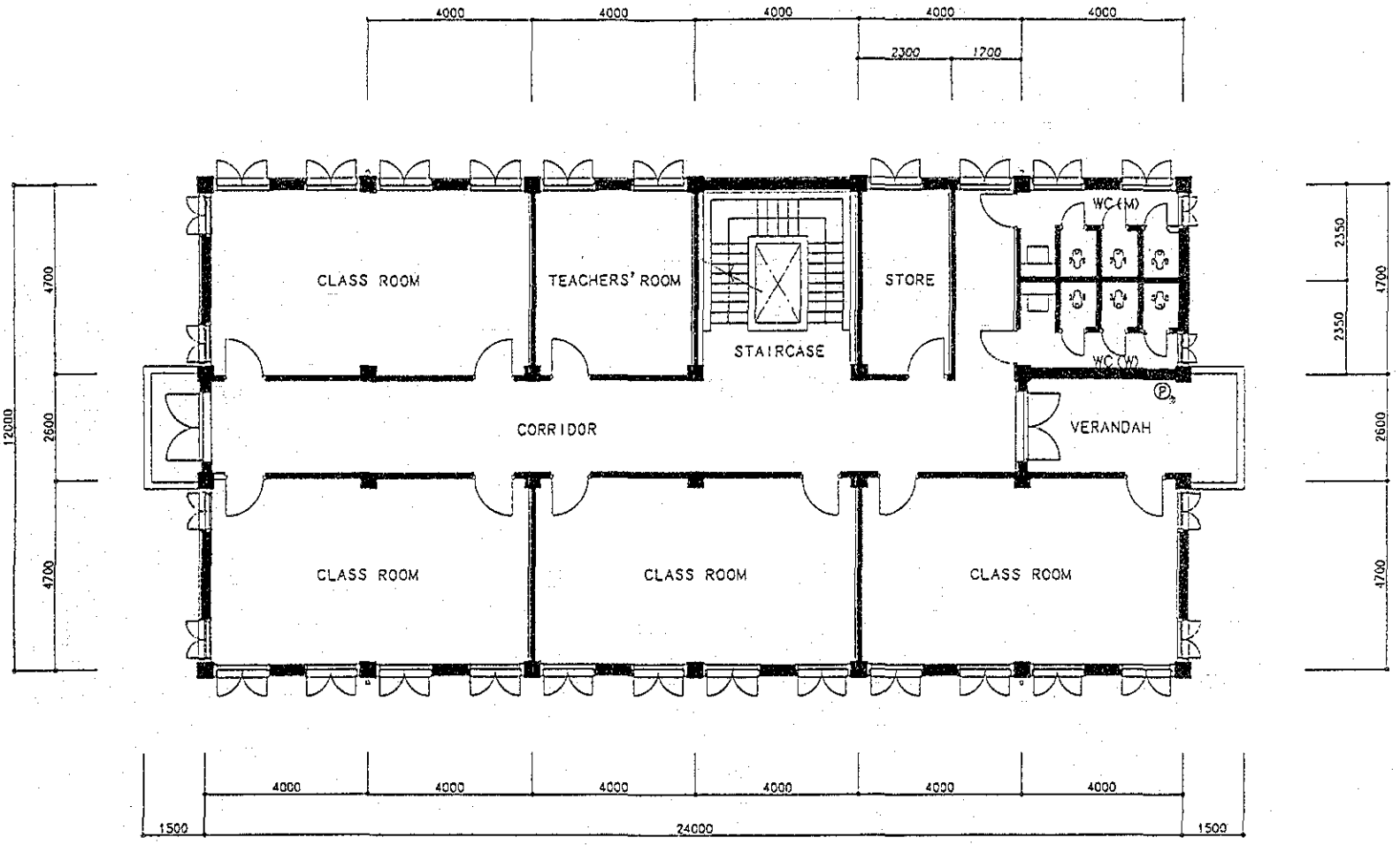


Fig. 5-3-3 (2) FIRST FLOOR PLAN (4-CLASSROOM TYPE)

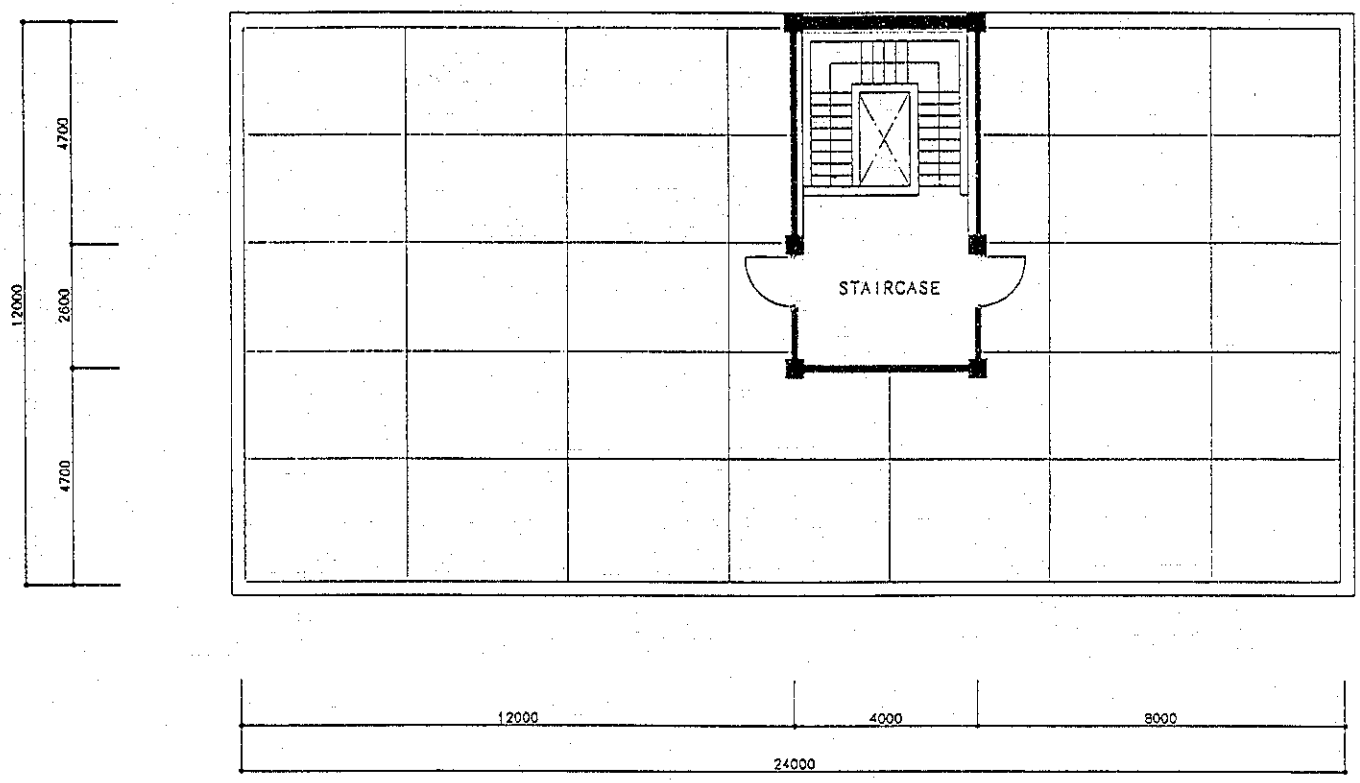


Fig. 5-3-3 (3) ROOF FLOOR PLAN (4-CLASSROOM TYPE)

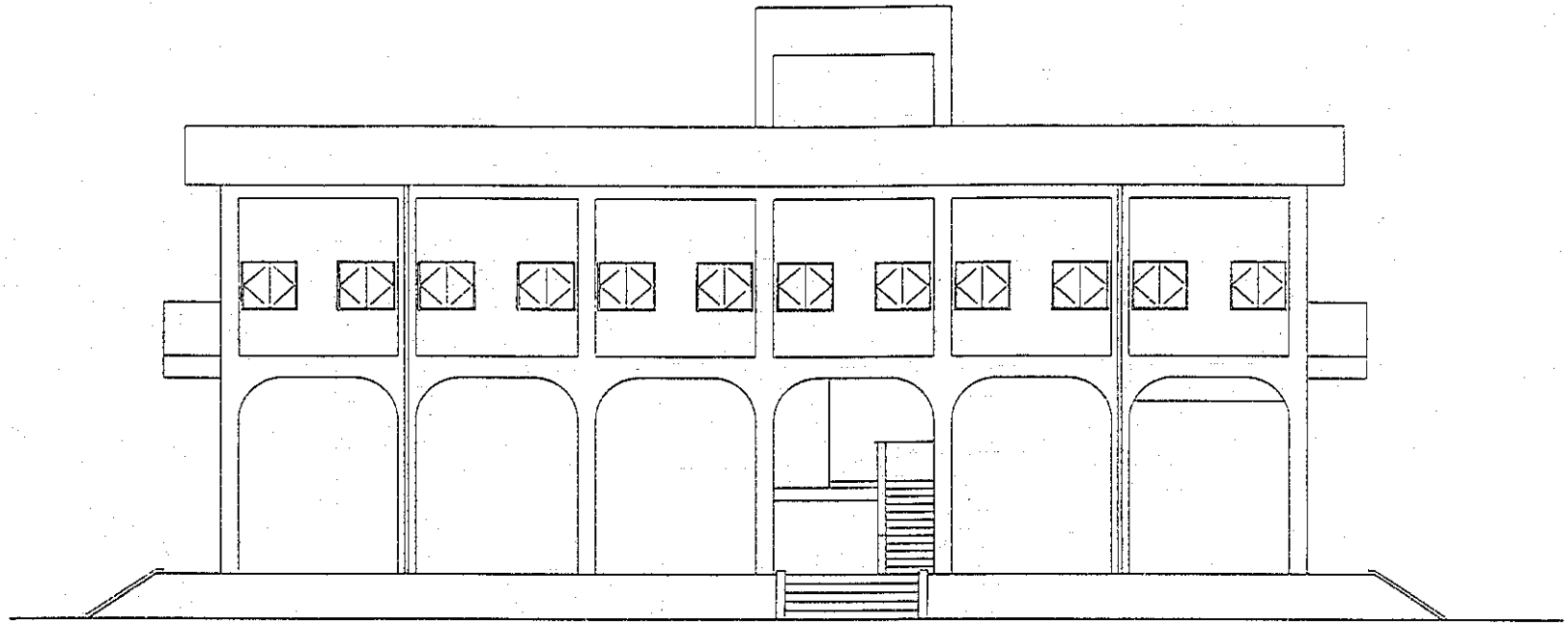


Fig. 5-3-3 (4) ELEVATION (4-CLASSROOM TYPE)

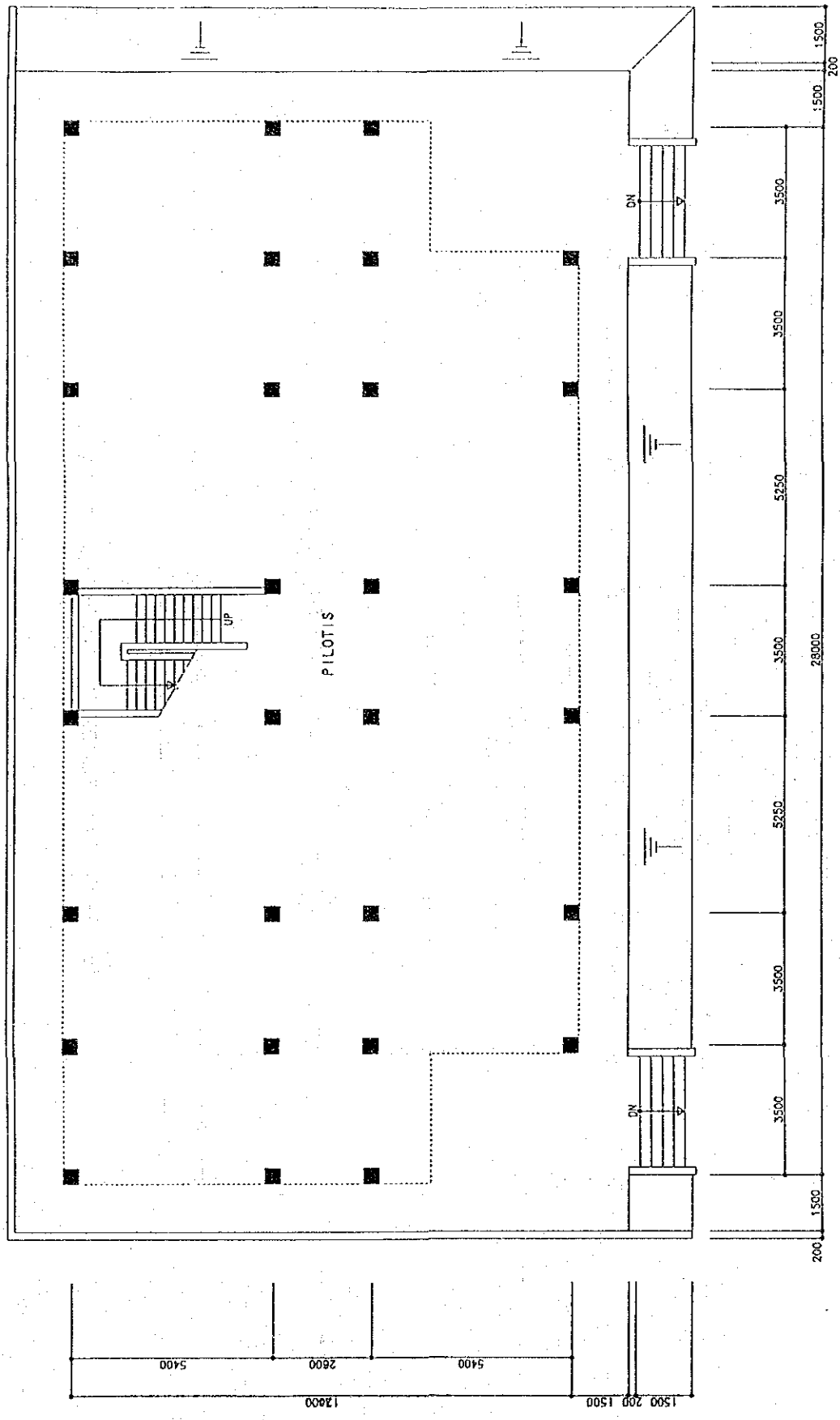


Fig. 5-3-4 (1) GROUND FLOOR PLAN (5-CLASSROOM TYPE)

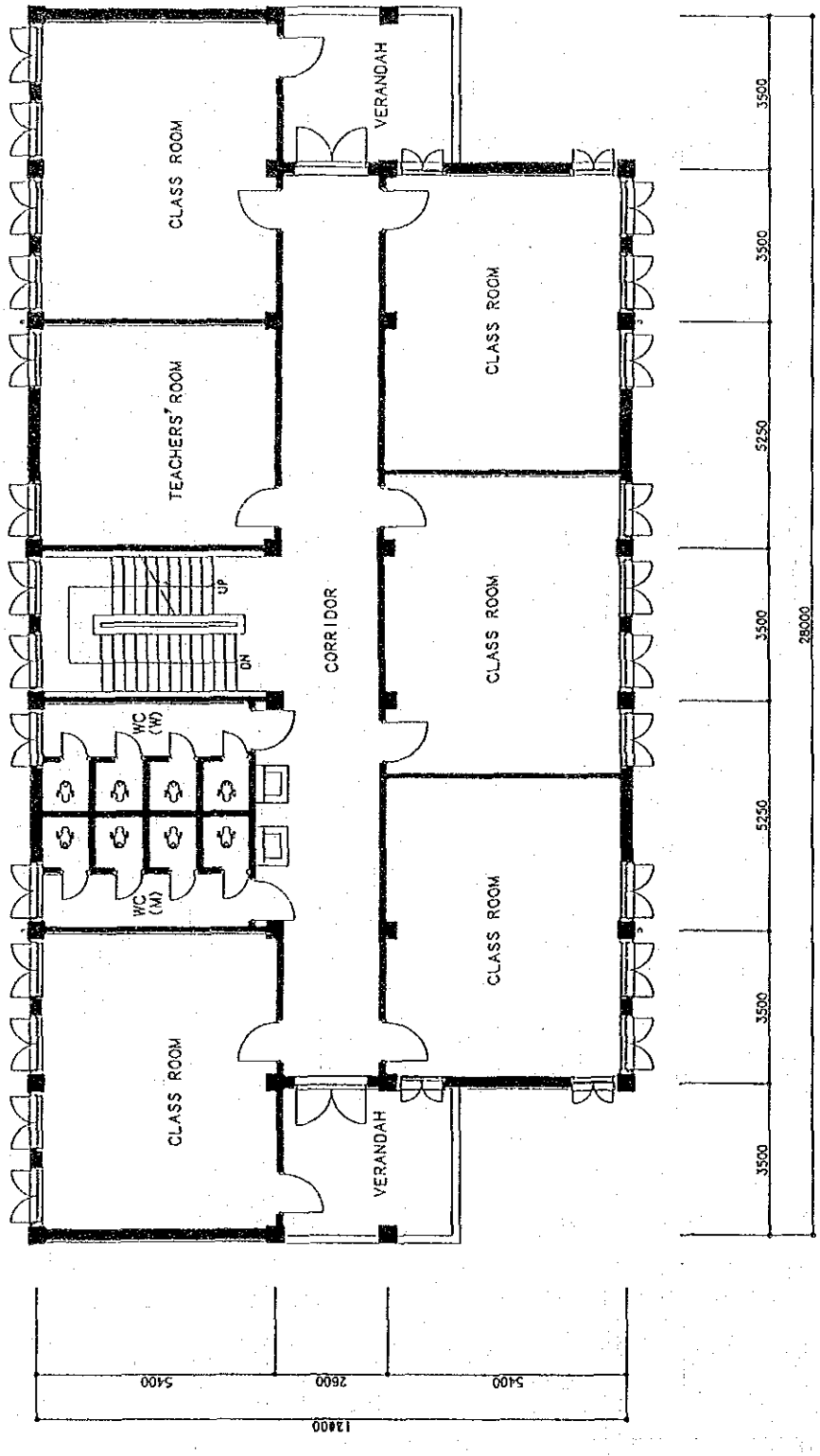


Fig. 5-3-4 (2) FIRST FLOOR PLAN (5-CLASSROOM TYPE)

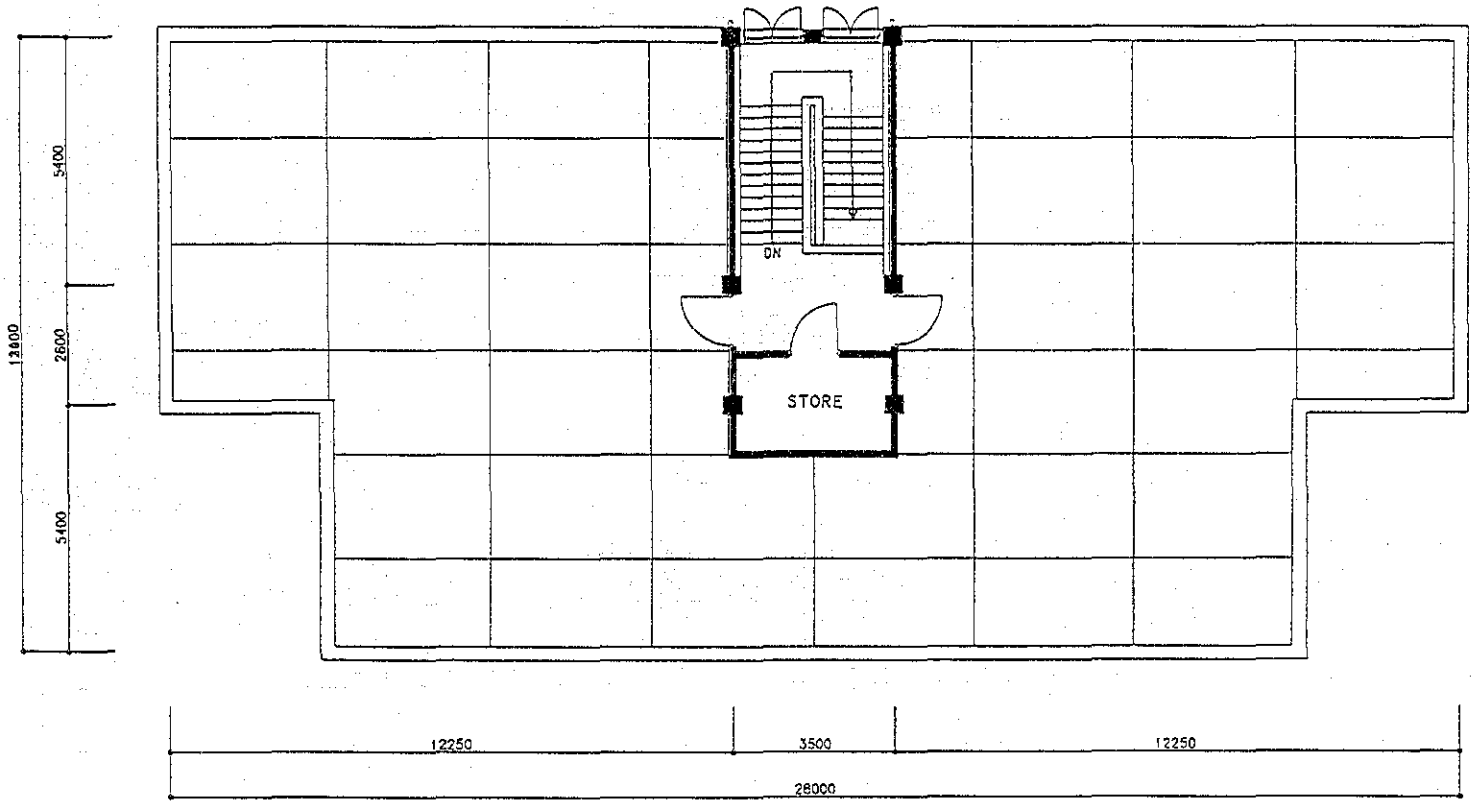


Fig. 5-3-4 (3) ROOF FLOOR PLAN (5-CLASSROOM TYPE)

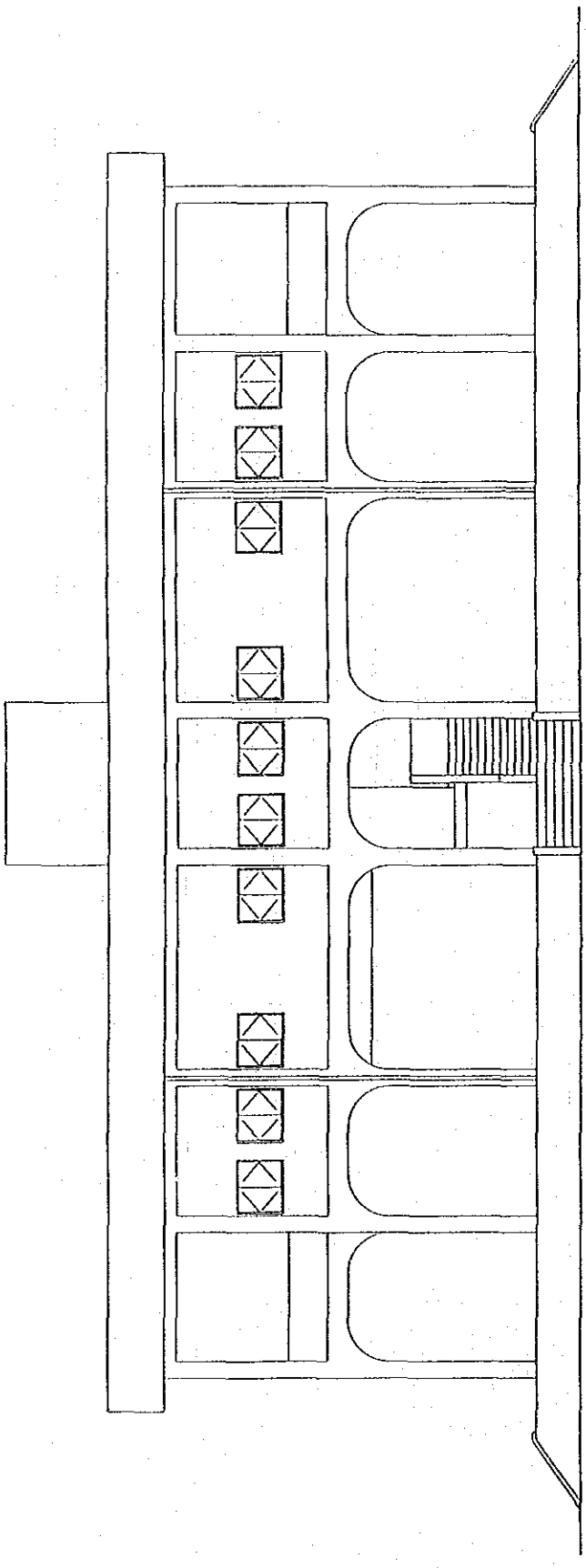


Fig. 5-3-4 (4) ELEVATION (5-CLASSROOM TYPE)

SITE NO.	L	H
II - 1	4.7	4.5
II - 2	4.7	3.5
II - 3	4.7	3.5
II - 4	5.4	3.5
II - 5	5.4	3.5
II - 6	5.4	3.5
II - 7	4.7	3.5
II - 8	4.7	4.5
II - 9	4.7	4.5
II - 10	4.7	3.5
II - 11	5.4	3.5
II - 12	5.4	6.0
II - 13	5.4	3.5
II - 14	5.4	6.0
II - 15	5.4	4.5

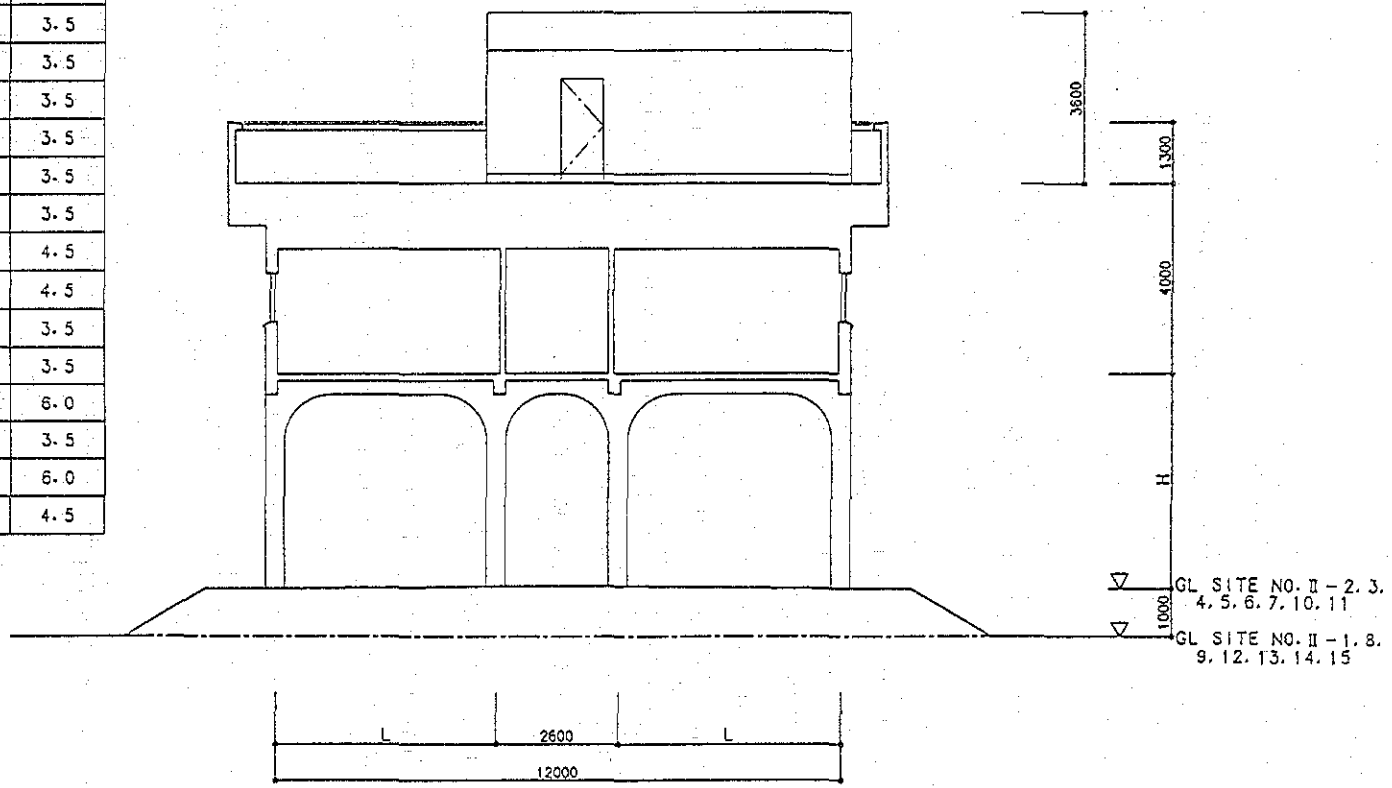


Fig. 5-3-5 SECTION (COMMON TO EACH TYPE)

5.4 Construction Plan

5.4.1 Construction Policies

(1) Project Implementation System

The responsible ministry for the Project (II) is the MLGRD & C and the implementation agency is the LGED of the MLGRD & C. Therefore, the local counterparts for the Detailed Design Study are the staff members of the LGED who will also be responsible for implementation of the construction work representing the Bangladesh side. The contracts with the consultant and contractor for the Project (II) will also be made by the LGED.

Following the signing of the E/N relating to grant aid for the Project (II), the LGED will conclude a consultancy contract with a Japanese consultant. The Japanese consultant will be assigned the preparation of the detailed design (preparation of detailed design documents and drawings and supervision of the tender procedure on behalf of the Government of Bangladesh) and supervision of the construction work. The actual construction work will be conducted by a Japanese contractor, selected by the LGED in accordance with the tender procedure supervised by the consultant.

(2) Scope of Undertakings of Both Governments

The Governments of Japan and Bangladesh will be responsible for the following for the successful completion of the Project (II).

The Government of Bangladesh will undertake the necessary measures which are described in the M/D dated the 2nd of February, 1994 (refer to the Appendix 1-4).

The Government of Japan will undertake the following.

1) Construction of 15 cyclone shelter-cum-primary school buildings
2) Provision of school furniture
3) Provision of a hand pump for each site
4) Construction of a borehole (GL: -300m - -400m) at each site
5) Provision of a septic tank for each site
6) Provision of consultancy services

5.4.2 Points to Note for Construction Work

Basic construction materials, such as cement, sand, gravel and reinforcing bars, etc. will be procured locally and local workers will be employed for construction purposes. Consequently, a local contractor will be appointed as the sub-contractor in view of his detailed knowledge of the conditions of the local construction industry. The local sub-contractor should have experience of similar work so that the assigned work under appropriate supervision and with advice provided by the Japanese contractor is properly conducted.

Earth work must be avoided during the rainy season in Bangladesh, i.e. from June to October. Careful planning of the staging of the construction work during the dry season, i.e. commencement of earth work at the beginning of the dry season and finishing work at the end of the dry season, is extremely important as these types of work are dependent upon weather conditions. In addition, special attention must be paid to the religious holiday of Ramadam (celebrated by Muslims in Bangladesh) in terms of planning and construction scheduling due to the drastic reduction of the work productivity by those Muslims who may be employed as construction workers.

5.4.3 Construction Management Plan

Following the signing of the E/N, the consultant which has secured the consultancy contract will prepare the detailed design and tender documents, conduct the tender process on behalf of the Government of Bangladesh and supervise the work to be conducted by the contractor who submits the successful bid.

(1) Preparation of Detailed Design and Tender Documents

The detailed design documents will be prepared by the consultant based on the survey maps prepared for the Basic Design, the boring survey results for the Basic Design and the findings of further field surveys for the Detailed Design. The consultant will also prepare the tender documents for approval by the Government of Bangladesh.

(2) Tender

The consultant will carry out the tender announcement, acceptance of tender applications, explanatory meeting on the tender process, distribution of tender documents, acceptance of bids and evaluation of bids on behalf of the Government of Bangladesh. The consultant will be an advisor for negotiations

between the Government of Bangladesh and the successful bidder in view of the conclusion of the construction contract.

(3) Work Supervision

Following the conclusion of the construction contract, the work supervision stage will commence. In Japan, the consultant will check and approve the documents presented by the contractor. At the actual construction sites, the consultant on behalf of the Government of Bangladesh will supervise the contractor (including sub-contractors) on all aspects of the construction work, including the transportation of materials and equipment, process control, quality control (including the quality tests carried out by the contractor) and materials control.

(4) Personnel Plan

The experts to be assigned at the detailed design stage will be responsible for project implementation, architectural design, building structure design, cost estimations and tender document arrangements. An architect (A) will be dispatched to Bangladesh as an on-site, full-time supervisor and an architect (B) will also be dispatched as a spot supervisor.

5.4.4 Procurement Plan

In principle, the materials and equipment required for the implementation of the Project (II) will be procured locally. Those materials and equipment which are unavailable in Bangladesh, the quality of which is unacceptable, the stable supply of which is not guaranteed or the cost of which is prohibitive will be procured in Japan in order to ensure reliability and cost-competitiveness.

(1) Main Materials and Equipment to be Procured in Bangladesh

1) Construction Materials

- reinforcing bars
- cement
- aggregate
- bricks
- water-resistant paint
- concrete forms

2) Facilities

- sanitary facilities
- hand pumps for boreholes

3) School Furniture

- desks
- chairs
- blackboards

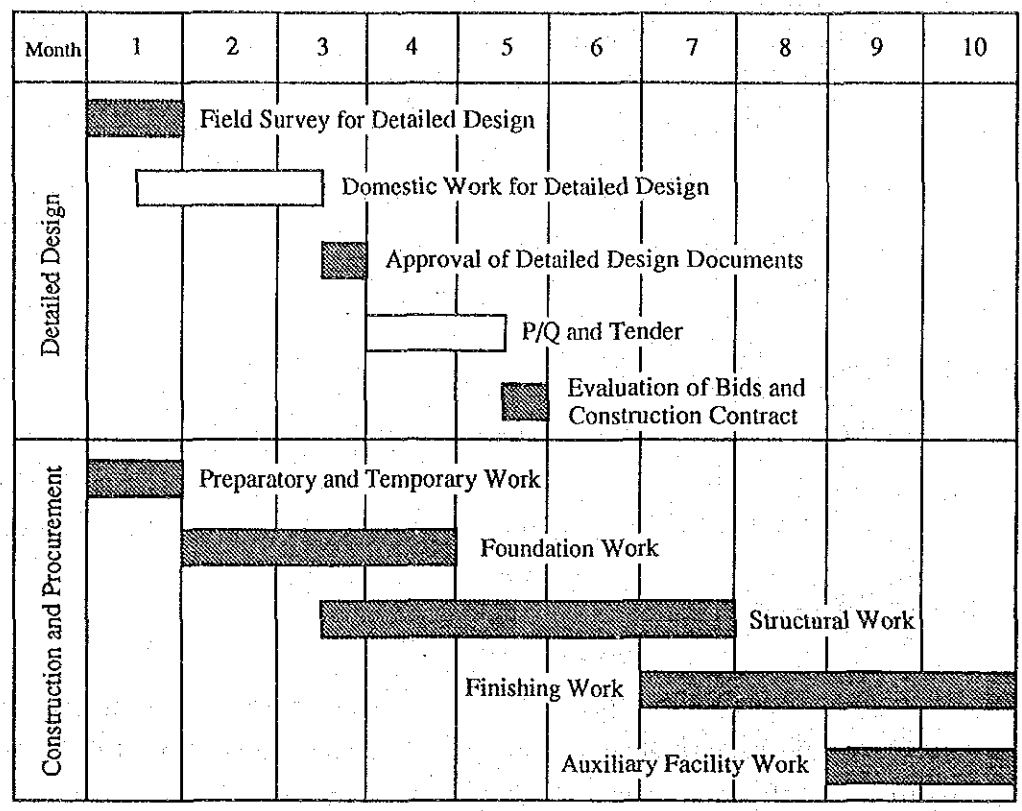
(2) Labour

All types of workers and skills required for the implementation of the Project (II) are available in Bangladesh and, therefore, all necessary labour will be recruited locally.

5.4.5 Implementation Schedule

The adoption of the following project implementation schedule after the signing of the E/N by both governments is desirable. Following the signing of the E/N, the Government of Bangladesh (LGED) will then immediately conclude the consultancy agreement to proceed with the detailed design. A period of 2.5 months will be required to complete the detailed design, including field survey, which will be immediately followed by the tender procedure to select the contractor. This tender procedure will be conducted by the consultant on behalf of the LGED and the contract will be made through negotiations between by the LGED and successful bidder. The construction period for the Project (II) will, in principle, be 10 months.

Table 5-4-1 Project Implementation Schedule



5.5 Estimated Project Cost

In the case of the implementation for the Project (II) with grant aid provided by the Government of Japan, the Government of Bangladesh will be required to meet the following costs for the successful completion of the Project.

(1) Bank Commission		: TK	1,336,000	(3,647,280 yen)
(2) Land Acquisition Cost	(access roads)	: TK	6,000	(16,380 yen)
	(shelters)	: TK	67,200	(183,460 yen)
	(Killas)	: TK	4,314,000	(11,777,220 yen)
(3) Killa Construction Cost		: TK	21,760,000	(59,404,800 yen)
Total		TK	27,483,200	(75,029,140 yen)

CHAPTER 6

PROJECT EVALUATION AND CONCLUSIONS

CHAPTER 6 PROJECT EVALUATION AND CONCLUSIONS

6.1 Project Evaluation

The Master Plan prepared by the Government of Bangladesh for the urgent protection of people living in the HRA from storm surges caused by cyclones calls for the construction of 2,500 new cyclone shelters. The Government of Bangladesh has already requested the assistance of donor countries, international aid organizations and NGOs for the construction of these cyclone shelters and work is underway by the World Bank to coordinate the aid efforts of various donor countries, including Japan. It is believed that the Project (II) is both an important and useful part of the international cooperation efforts to meet the requirements of the Master Plan.

The Master Plan identifies that the number of cyclone shelters required for the protection of people living in the HRA in the year 2002 is approximately 3,400. Given the number of existing cyclone shelters and those of which construction has been firmly pledged (some 900 shelters), the construction of 2,500 cyclone shelters is still required. The 5 Thanas in the Project Area require a total of 277 cyclone shelters and 15 shelters will be constructed under the Project (II).

The Project (II) is considered vital from the humanitarian point of view because it aims at protecting human lives. The implementation of the Project (II) is deemed urgent as the construction of cyclone shelters is a viable method of preventing cyclone disasters. The cyclone shelters envisaged by the Project (II) will have the important effect of protecting the lives of some 30,000 people living in the HRA. The shelters will also serve as primary school buildings during normal weather conditions, accommodating a total of some 6,000 pupils, thus greatly contributing to the consolidation of education in Bangladesh through the provision of safe and pleasant facilities.

Moreover, the implementation of the Project (II) will promote local employment during the construction period and will encourage the settlement of inhabitants in the HRA due to the additional safety provided by the cyclone shelters. The improvement of access roads will also contribute to economic development and improvement of the living standard of local communities.

From an international point of view, the objective of the Project (II) is in line with the objectives of the International Decade for Natural Disaster Reduction (IDNDR). Japan's positive commitment to the Project (II) can be regarded as being part of Japan's

responsibility vis-a-vis the international community in view of the importance of implementing such projects in Bangladesh.

6.2 Conclusions

The provision of Japanese grant aid for the Project (II) is deemed highly appropriate as the implementation of the Project (II) is expected to have numerous positive effects as described in 6.1 above, including the protection of human lives in coastal areas, the promotion of a stable and higher standard of living due to improved safety and the revitalization of local economies. Moreover, the use of the cyclone shelters as primary schools in normal times means the provision of safe and pleasant educational facilities. In view of these beneficial effects of the Project (II), its implementation with Japanese grant aid is judged to be viable.

The Project (II) envisages the construction of cyclone shelters at 15 sites instead of at the 30 sites originally requested by the Government of Bangladesh. Because of the viability and necessity of such cyclone shelters as verified by this report and also because of the urgent desire on the part of the Government of Bangladesh for the construction of cyclone shelters, the approval and implementation of the Basic Design Study for the remaining 15 sites is highly recommended.

A precondition of project implementation is that the various proposals made in the present report must be met for the smooth and effective implementation of the Project (II). The main proposals are outlined below.

(1) Land Acquisition at Project Sites

The government ownership of all 15 Project Sites has been confirmed through interviews with the counterparts and school representatives and no problems in regard to land ownership are anticipated. However, the existing land at Site Nos. II-3 and II-10 is too small to accommodate a cyclone shelter of the planned site. It will, therefore, be necessary for the Government of Bangladesh to proceed with land acquisition to secure the necessary land by June, 1994.

(2) Construction of Access Road

The existing access road at Site No. II-13 runs through the market area and its width is insufficient. It will, therefore, be necessary for the Government of Bangladesh to construct an alternative work road prior to the commencement of construction work at the site.

(3) Construction of Killas

The construction of killas to protect the household goods and livestock owned by evacuees from cyclone damage is essential. The Government of Bangladesh is, therefore, required to construct killas of a reasonable size vis-a-vis the capacity of the neighbouring cyclone shelters.

(4) Establishment of Maintenance System

As the planned cyclone shelters will be normally used as primary school buildings, the management responsibility will be transferred from the LGED to the PMED. In view of this responsibility, the PMED should establish a reliable maintenance system for the 15 cyclone shelters before the end of the construction work by means of strengthening its existing management and maintenance system.

(5) Increase of Teacher Strength

The construction of cyclone shelters under the Project (II) also means the rebuilding of existing primary school buildings. At some schools, the existing teacher strength is inadequate vis-a-vis the planned size of the new school. The teacher strength should, therefore, be increased by one for Site Nos. II-5 and II-12 and by 2 for Site No. II-15 in view of the provision of sound and efficient educational activities at these schools.

(6) Completion of Ministerial Arrangements

The Government of Bangladesh is required to complete the necessary arrangements between its ministries and agencies for the smooth implementation of the Project (II) within the framework of the grant aid system of the Government of Japan in line with the planned implementation schedule.

As revision of the Project Concept Paper relating to the Project (II) is needed as an internal requirement of the Government of Bangladesh, this revision must be urgently conducted to facilitate approval of the Project (II) by the Executive Committee for the National Economic Council (ECNEC).

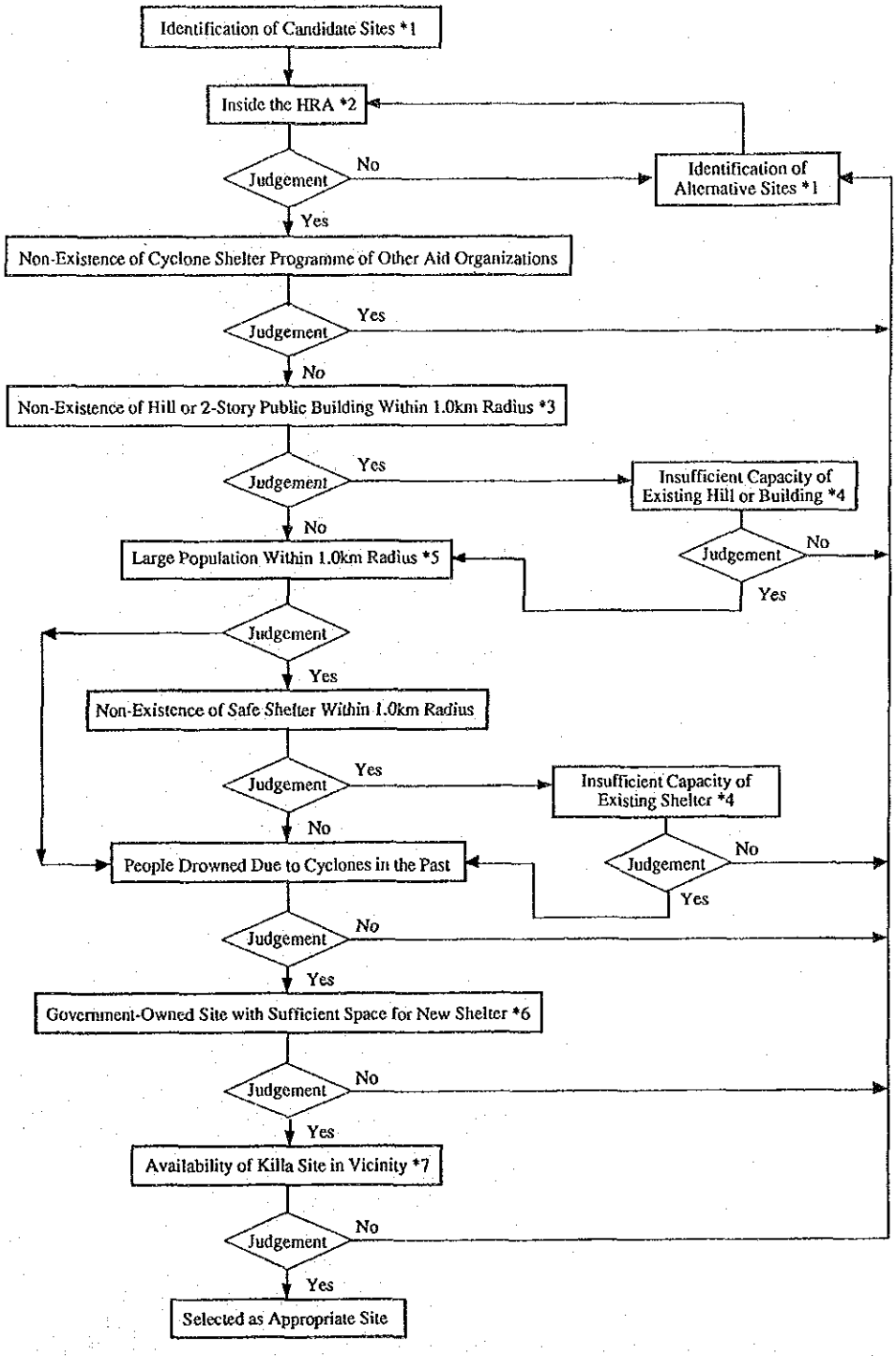
(7) Site Selection Process

The additional candidate sites suggested by the Government of Bangladesh this time included many sites unsuitable for Japanese grant aid, including those located outside the HRA, those with nearby hills for evacuation and those with new primary school building-cum-cyclone shelters under construction on existing

primary school premises. The field survey for the basic design without prior screening of the proposed sites would be unnecessarily long as every detail of the proposed sites require checking. Consequently, the actual implementation schedule for the Japanese grant aid cooperation would be adversely affected. Careful attention should, therefore, be paid to finalizing the selection of the candidate sites by the Government of Bangladesh in order to avoid any undesirable delay in project implementation.

Based on the latest field survey results, the flow to select the candidate sites has been formulated and is proposed here in Fig. 6-2-1 for future use.

Fig. 6-2-1 Flow Chart for Selection of Appropriate Sites



Notes *1 The candidates are government primary schools which have been damaged by cyclones in the past or which are likely to be damaged.
*2 The candidate sites should be inside the HRA as defined by the Master Plan for the Multi-Purpose Cyclone Shelter Programme of the UNDP.
*3 The height must be sufficient to provide safe evacuation in the case of a likely cyclonic surge.
*4 An accommodation capacity of some 1,700 people is the general yardstick for the planned cyclone shelter size.
*5 The general yardstick is some 4,000 inhabitants within a 1km radius of the site.
*6 The Project envisages a maximum of 5 classrooms, requiring a minimum land size of 35m × 20m.
*7 Given the killa's envisaged functions, the killa site must be within close view of the cyclone shelter (maximum distance: 50m).

APPENDICES

APPENDIX 1

APPENDIX 1.1 LIST OF STUDY TEAM MEMBERS

(1) Site Survey Team

Masayuki WATANABE	Leader International Cooperation Specialist, Institute for International Cooperation, Japan International Cooperation Agency (JICA)
Ichiro MUKAI	Project Coordinator Second Basic Design Study Division, Grant Aid Study and Design Department, Japan International Cooperation Agency (JICA)
Hisashi TAKADA	Chief Planner Japan Engineering Consultants Co., Ltd.
Sakae NAKAMURA	Facilities Planner Japan Engineering Consultants Co., Ltd.
Sumitada OKAMOTO	Construction Planner Japan Engineering Consultants Co., Ltd.
Hideharu YAMAMOTO	Natural Conditions Surveyor Japan Engineering Consultants Co., Ltd.

(2) Draft Final Report Explanation Team

Masayuki WATANABE	Leader International Cooperation Specialist, Institute for International Cooperation, Japan International Cooperation Agency (JICA)
Yukihiro KOIZUMI	Project Coordinator Second Basic Design Study Division, Grant Aid Study and Design Department, Japan International Cooperation Agency (JICA)
Hisashi TAKADA	Chief Planner Japan Engineering Consultants Co., Ltd.
Sakae NAKAMURA	Facilities Planner Japan Engineering Consultants Co., Ltd.

APPENDIX 1.2 SITE SURVEY SCHEDULES

(1) Site Survey Schedule

No.	Date (day)	JICA Officials	Consultants		
			Chief Planner	Facilities & Construction Planners	Natural Conditions Surveyor
1	Jan. 23 (Sun)	NRT → BKK	Same as left	Same as left	
2	24 (Mon)	BKK → DAC, Courtesy Call to JICA	Same as left	Same as left, Meeting with Local Consultants	
3	25 (Tue)	Courtesy Call to Embassy of Japan, Discussions with ERD	Same as left	- do -	
4	26 (Wed)	Discussions with LGED, DAC → CGP	Same as left	Same as left	
5	27 (Thu)	Site Survey	Same as left	CGP → CXB, Site Survey	
6	28 (Fri)	Visit to cyclone-damaged Area, CGP → DAC	Same as left	Site Survey	
7	29 (Sat)	Data Arrangement, Discussion with PMED	Same as left	- do -	
8	30 (Sun)	Discussions with LGED, Internal Team Meeting	Same as left	Site survey, CGP → DAC	
9	31 (Mon)	Discussions with BUET, SDC, Joint Meeting	Joint Meeting	Same as left, Discussions with BUET	NRT → BKK
10	Feb. 1 (Tue)	Arrangement of Data	Same as left	Same as left	BKK → DAC
11	2 (Wed)	Discussions with BDRCS, Signing of Minutes	Same as left	Same as left	Preparation of Site Survey
12	3 (Thu)	Report to Embassy of Japan, DAC → BKK	Report to Embassy of Japan	Data Collection	- do -
13	4 (Fri)	BKK → NRT	Preparation of Site Survey	Same as left	- do -
14	5 (Sat)		DAC → CGP, Site Survey	DAC → CGP, Site Survey	DAC → CGP, Site Survey (Supervision)
15	6 (Sun)		- do -	- do -	- do -
16	7 (Mon)		- do -	- do -	- do -
17	8 (Tue)		- do -	- do -	- do -
18	9 (Wed)		- do -	- do -	- do -

No.	Date (day)	JICA Officials	Consultants		
			Chief Planner	Facilities & Construction Planners	Natural Conditions Surveyor
19	10 (Thu)		Site Survey, CGP → DAC	Sam as left	- do -
20	11 (Fri)		Data Collection	Data Collection	- do -
21	12 (Sat)		- do -	- do -	- do -
22	13 (Sun)		- do -	- do -	- do -
23	14 (Mon)		Discussions with ERD, LGED, Data Collection	Same as left	- do -
24	15 (Tue)		Discussions with PMED, Data Collection	Same as left	- do -
25	16 (Wed)		Report to Embassy of Japan	Same as left	- do -
26	17 (Thu)		Data Collection	Same as left	- do -
27	18 (Fri)		Arrangement of Results	Same as left	Site Survey (Supervision) CGP → DAC
28	19 (Sat)		Report to LGED	Same as left	Supervision of Compilation of Survey Data
29	20 (Sun)		Report to JICA DAC → BKK	Same as left	- do -
30	21 (Mon)		BKK → NRT	Same as left	- do -
31	22 (Tue)				- do -
32	23 (Wed)				- do -
33	24 (Thu)				- do -
34	25 (Fri)				- do -
35	26 (Sat)				- do -
36	27 (Sun)				- do -
37	28 (Mon)				DAC → BKK
38	Mar. 1 (Tue)				BKK → NRT

LEGEND: NRT: Narita, BKK: Bangkok, DAC: Dhaka, CGP: Chittagong, CXB: Cox's Bazar, SDC: Swiss Development Corporation

(2) Draft Final Report Explanation Schedule

No.	Date (day)	JICA Officials	Consultants
1	Apr. 6 (Wed)	NRT → BKK	
2	7 (Thu)	BKK → DAC, Courtesy Call to Embassy of Japan, ERD	
3	8 (Fri)	DAC → NKL, Field Inspection	
4	9 (Sat)	NKL → HTY, Field Inspection	
5	10 (Sun)	Field Inspection	NRT → BKK
6	11 (Mon)	HTY → NKL → DAC, Internal Team Meeting	BKK → DAC, Internal Team Meeting
7	12 (Tue)	Discussions with LGED, PMED	Same as left
8	13 (Wed)	Pre-Joint Meeting	Same as left
9	14 (Thu)	Data Collection, Data Preparation, Internal Team Meeting	Same as left
10	15 (Fri)	– do –	Same as left
11	16 (Sat)	Joint Meeting	Same as left
12	17 (Sun)	Discussions with ERD Discussions with JICA, Embassy of Japan	Same as left, Discussions with LGED, Data Collection
13	18 (Mon)	DAC → CGP, Field Inspection (CGP-CXB) (Mr. Koizumi: DAC → BKK →)	DAC → BKK
14	19 (Tue)	Field Inspection (CXB-CGP) (Mr. Koizumi: NRT)	BKK → NRT
15	20 (Wed)	CGP → DAC, Discussions with ERD, LGED	
16	21 (Thu)	Discussions with ERD Report to JICA, Embassy of Japan DAC → BKK	
17	22 (Fri)	BKK → NRT	

LEGEND: NRT: Narita, BKK: Bangkok, NKL: Noakhali, HTY: Hatiya, CXB: Cox's Bazar

APPENDIX 1.3 LIST OF INTERVIEWEES

(1) Bangladesh Side

1. ERD

Mr. Dewan Zakir Hussain	Deputy Secretary
Mr. Sirajul Haq Talukder	Research Officer

2. Planning Commission

Mr. Nizamuddin Chaudhry	Assistant Chief

3. Ministry of L.G.R.D & Cooperatives

Mr. Md. Lokman Miah	Deputy Secretary
Mr. Serajul Islam	Assistant Chief

4. Local Government Engineering Department (LGED)

[Dhaka H.Q.]

Mr. Qamrul Islam Siddique	Chief Engineer
Mr. Md. Monowar Hossain Chowdhury	Additional Chief Engineer
Mr. Md. Ataullah Buiya	Superintending Engineer
Mr. Saroj Kumar Sarkar	Executive Engineer
Mr. Md. Zahangir Alam	Executive Engineer
Mr. Farazi Shahabuddin Ahmed	Project Engineer (GEP)

[Chittagong Xen. Office]

Mr. Bashir Uddin	Executive Engineer
Mr. Sarwar Ahmed	Thana Engineer, Banskhali

[Cox's Bazar Xen. Office]

Mr. Sarwar Jahan	Executive Engineer
Mr. Md. Nazim Uddin	Assistant Engineer
Mr. Delowar Hossain	Assistant Engineer
Mr. Md. Tazul Islam	Thana Engineer, Sadar
Mr. Abdul Latif	Thana Engineer, Ramu
Mr. Md. Khaled Chowdhury	Thana Engineer, Chokoria
Mr. Nazrul Islam	Thana Engineer, Ukhiya

5. Primary & Mass Education Division (PMED)

Mr. A.K.M. Anisur Rahman	Joint Secretary
Mr. Abul Hossain Chowdhury	Deputy Secretary
Dr. Md. Delwar Hossain	Deputy Chief of Planning

6. Directorate of Primary Education (DEP)

[Dhaka]

Mr. Saokat Ali	Director, Planning & Development
Mr. Md. Ibrahim	Assistant Director, Planning & Development

[Chittagong Division]

Mr. Md. Mahfuzul Islam	Assistant Director

[Cox's Bazar]

Mr. Md. Bashir Hossain	District Primary Education Officer

7. Project Coordination Unit (PCU)

Mr. Syed Shakhawat Hossain	Director, Planning & Engineering
Mr. Dhali Abdul Lalil	Deputy Director, Planning & Engineering

8. Project Implementation Management Unit (PIMU)

Mr. Md. Mafizul Islam	Deputy Director

9. Facility Department

Mr. M.A. Mannan	Director
Mr. P.K. Biswas	Superintending Engineer
Mr. Ali Asgar	Executive Engineer

10. Atomic Energy Commission

Mr. Obaidul Awal	Chief Engineer

11. Disaster Management Bureau (Ministry of Relief)

Mr. M.P. Gillham	Team Leader of UNDP
Mr. D.N. Bepari	Director

(2) International Organizations and Others

1. World Bank

Mr. Ross Wallace	Resident Flood Plan Coordinator

2. Swiss Development Corporation

Mr. Henri Francois Morand	First Secretary

3. Bangladesh University of Engineering & Technology (BUET)

Dr. J.R. Choudhury	Professor
Dr. Shamim Z. Bosunia	Professor
Dr. A.M. Hoque	Professor
Dr. A. Nishat	Professor

4. Bangladesh Red Crescent Society (BDRCS)

Mr. Kurt Granberg	Construction Team Leader
Mr. Tomoatsu Kayano	Delegate in Bangladesh

5. Caritas Bangladesh

Mr. S.C. Rozario	Manager
Mr. Azam Khan	Public Relations Officer
Mr. Zakir Hossain	Engineer-in-Charge

6. Shapla Neer

Mr. Makoto Nagahata	Director

(3) Japanese Side

1. Embassy of Japan in Bangladesh

His Excellency Mr. Shigeo Takenaka	Ambassador to Bangladesh
Mr. Yoshihisa Kuroda	Minister
Mr. Kenichi Yokoyama	First Secretary

2. JICA Bangladesh Office

Mr. Hironao Suzuki	Resident Representative
Mr. Yuki Aratsu	Deputy Resident Representative