3-3-4 Outline of Facilities and Equipment

Based on the results of the discussion with the Nigerian Government and of further studies, the following facilities and equipment are considered suitable for the implementation of the project.

A. Water Supply Facilities to Construct

Rural type facilities in 7 villages, semi-urban type facilities in 2 villages, and a combination of rural and semi-urban type facilities in 3 villages.

- Borehole Wells (4"and 6")	32 sets	(1,760m)
- Borehole wells for redevelopment	5 sets	
- Borehole with submersible motor pump set (4"and 6")	5 sets	
[Submersible motor pump (2 types, 1 spare each)	7 sets,	
Diesel engine generator (1 spare)	6 sets	]
- Borehole with hand pump set (4") (including 3 spares of hand pump set - a total of 35 sets)	32 sets	
- Generator House (Floor area 14m^2, height 3.0m)	5 sets	
- Reservoir tanks (capacity of 32m^3, height of 3~7m) and precast steel toweres	5 sets	
- Water supply pipes (25 - 100mm in diameter)	4,633 m	
- Communal Faucet Base with 2 taps	25 sets	

B. Materials for Maintenance Work

- Station Wagon fully equipped with repair tools for patrol service	2 sets
- Truck mounted well service machine	1 set
- Tools and spareparts	1 set

3-3-5 Operation and Maintenance Plan

(1) Operation and Maintenance Plan

Facility operation and maintenance pertains to repair, preservation and inspection work (maintenance), and operation, control and budgetary measures for the operation costs.

After the completion of the facility construction works, the Water Associations organized in each village and the Sokoto State Water Board (headquarters and area offices concerned) shall collaborate in the operation and maintenance of the facilities.

According to the current State Regulation, the State Water Board is fully responsible for the maintenance costs. Therefore, the sharing of the operation expenses and the management system of the constructed facilities shall be as follows.

The State Water Board shall shoulder the repair, preservation and inspection, and operation expenses.

- The State Water Board shall train the operators, and shall repair and inspect the pumping and water distribution facilities.
- The area office in charge shall conduct fuel provision and routine patrol services.
- The State Water Board shall secure the budget required for the operation and maintenance of the facilities. In addition, the facilities shall be operated independently by the villagers.
- Each village shall formulate a Water Association of their own, headed by a leader, an operator, public relations staff, and guardsmen. The maintenance and management work shall be conducted by them.
- The operator shall be in charge of the daily operation of the facilities.

However, the operation of the existing several semi-urban water supply facilities constructed except in the 12 project villages shall obstruct the satisfactory implementation of the system as they do not always operate smoothly.

The water supply works spread all over Nigeria when the country's economy was in its prime due to a prosperous oil industry. Accordingly, a customary law stating that water is for free was formulated, and during this time, the charge system was non-existent even in the urban areas. Even after the fall of the Nigerian economy, this customary law prevailed, and the Federal Government and the State Governments continued to shoulder the operation and maintenance expenses. These expenses weighed heavily on the finances of the Federal Government and the State Government, thus obstructing the outspread of the use of the water supply system, particularly

in the rural areas. Based on this circumstances, the Federal Government advocated the residents' sharing of the maintenance costs in the 1st Rolling Plan. However, this system cannot be implemented at the present study phase because the revision of water related State Laws has to be passed over to the Congress for approval.

Nevertheless, the Nigerian Government is presently studying the beneficiaries sharing of the cost system proposed by the Study Team. In the future, the following methods shall be adopted and the methods used in the Horo Birni pilot facility construction shall be used as a model.

- The Water Association in villages with motor pump water supply facilities shall consist of a leader, an accountant, an operator, public relations staff and guardsmen. The accountant shall collect charges from the inhabitants to cover maintenance expenses for expendable supplies like fuel, oil, oil filters, tap packing, etc. The operator conducts the daily pump operations and inspection of facilities in accordance with the instructions of the State Water Board. The rehabilitation of heavily damaged facilities shall be conducted by the staff of the Water Board Headquarters (mainly from the Water Depot) and the Supply Section.
- The Water Association in villages with hand pump facilities consists of a leader, an accountant and a public relation staff. Heavy works like well cleaning and pump changing are conducted by the Hydrology and Borehole Department and the Supply Section of the Water Board Headquarters.
  Routine patrol services shall be provided by the staffs of the Water Board Headquarters and Area Office in charge. The service expenses shall be shouldered of course by the State Water board.

(2) Operation and Maintenance Costs

The operation and maintenance costs are summed up by the operation and maintenance group who conducts periodical patrol services, preservation (including the provision of fuel for motorized pumps), inspection and repair twice a month.

The costs needed for the periodical inspection, repair and preservation of each of the 32 hand pump facilities (twice a year) and each of the 5 motorized

pump facilities (4 times a year) are estimated. Further, the costs for the cleaning of wells once every two years are estimated, too.

The operation and maintenance cost is computed according to the currency value prevailing upon the time of calculation and not the price increase rate.

The operation and maintenance costs is computed according to the currency values prevailing upon the time of calculation and not the increase in prices.

1) Details of Operation and Maintenance

- Preservation (including the provision of fuel to motorized pumps), inspection and repair (twice a month patrol services) of water supply facilities.

Objective Area:	12 villages in 5 districts
Vehicles:	two 4WD station wagons for patrol services
Staff:	1 managing supervisor, 1 mechanic, 1 plumber, 2 workers, and 1 driver (a total of 6 staffs).
Patrol Distance:	150 km x 1 round trip = 300 km/day

- Well Cleaning (once every two years)

Objective Area:	37 places
Vehicles:	1 well service machine, and one 4WD station wagon for patrol services (1 compressor)
Staff:	1 managing supervisor, 1 well technician, 1 well assistant technician, 1 mechanic, 2 workers, and 1 driver (a total of 7 staffs)
Patrol Distance:	100 km x 1 round trip = 200 km/day

2) Operation and Maintenance Costs

a. Labor expenses are not calculated as the Water Board's extra staff are to be employed.

- Water supply facility preservation, inspection and repair (twice a month patrol services): 6 staffs
- Well cleaning (one patrol service every two years): 7 staffs

b. The annual fuel expenses amount to 45,417 Naira.

- Fuel expenses of vehicles

  2 water supply facility preservation, inspection and repair vehicles (twice a month patrol services):

  0.7 Naira x 30 liters x 2 vehicles x 10 times (5 districts) x 12 months = 5,040 Naira

- Well Cleaning (once every two years):

  0.7 Naira x 12 liters x 2 vehicles x 37 places x 0.5 times a year = 518 Naira

- Compressor Fuel Expenses

  0.7 Naira x 20 liters x 1 vehicle x 37 places x 0.5 times a year = 259 Naira

- Diesel Engine Generator Fuel Expenses

  0.55 Naira x 40 liters/day/vehicle x 30 days x 12 months x 5 places = 39,600 Naira

c. The facility annual repayment cost amounts to 18,500 Naira.

- Compressor

  1,000 Naira/number of time x 37 places x 0.5 times/year = 18,500 Naira

d. The annual repair cost amounts to 116,600 Naira.

(Since a 2 year supply of equipment is included in the provision, only the 8 year cost is calculated.)

- Hand pump facilities

Rubber replacement and pump base repair--twice a year, 32 units
1,000 Naira x 16 x 32 units = 512,000 Naira

Cylinder replacement--once in 4 years, 32 units
1,500 Naira x 2 x 32 units = 384,000 Naira

A total of 896,000 Naira

- Motor pump facilities

Impeller replacement and overhaul-once in 2 years,
4 x 5 units;
11,500 Naira x 4 x 5 = 230,000 Naira
Generator overhaul--once in 4 years, twice x 5 units
4,000 Naira x 2 x 5 = 40,000 Naira

A total of 270,000 Naira

The 10 year repair cost estimate (by considering the 8 year cost and 10 year cost as one) totals 1,166,000 Naira.

The annual operation and maintenance costs:

Item	Amount
Labor Expenses	-
Fuel Expenses	45,417
Repayment costs	18,500
Repair Expenses	116,600
Total	180,517 Naira

The above amount is 0.17% of the average amount (103,163,000 Naira) of the 3 year, 1990-92, budget of the Sokoto State Water Board.

3-4 Technical Cooperation

The Sokoto State Water Board is technologically advanced, handles many water supply work in the urban areas and the construction and rehabilitation of wells.

As for the operation and maintenance aspect, however, the Water Board is beset with several problems like shortage of spare parts and service vehicles due to shortage of funds which is mainly the result of an inadequate accounting management of collected water charges. The resolution of these problems is considered to bring about a large improvement. Given these conditions, it is concluded, therefore, that technological assistance is not necessary at all during the implementation of this project.

CHAPTER 4. BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4-1 Design Policy

This project is designed to construct groundwater supply systems in the 12 middle to large scale villages in the northwestern part of Nigeria where surface water resources are poor, to supply stable and sanitary domestic water.

The basic design of the water supply facilities was conducted in consideration of the physical and social conditions of the project area and the basic policies below, which correspond with the concept of Japan's Grant Aid Program.

(1) The reserves of the groundwater basin are limited due to small precipitation and short rainy season. Water supply facilities of adequate dimensions shall be designed, therefore, to guarantee a long term use.

(2) This plan was formulated in accordance with the population of the villages and the needs of the local residents. In addition, this water supply plan intends to actualize the implementation of a maintenance system through the cooperation of the residents.

(3) To formulate a water supply plan which shall actualize the participation of the Water Board Headquarters and Area Offices in the maintenance and management of the facilities through patrol services and rehabilitation works.

(4) To design facilities which shall guarantee the provision of safe drinking water.

(5) To engage well drilling firms and facility construction firms in the project area or neighboring states with capabilities exceeding the norms as Sub-contractors, to efficiently construct the facilities and at the same time, conduct technological transfer.

(6) To procure, within a reasonable extent, the construction materials in the project area to re-activate socioeconomic conditions.

(7) To organize two or more groups and to divide the construction works among the groups in order to enable the completion of the works within a short period, that is within a year.

4-2 Design Criteria

4-2-1 Water Supply Amount and Service Population

The present population of the project villages shall be the service population. The population trend in Nigeria is not clear since a national census has not been conducted since 1964. The only population data obtained was from the results of the interview conducted during the development study. The basic design study estimated and confirmed the accuracy of the village population based on the (1) interview with the village chiefs concerning the number of families during a meeting, and (2) the survey on the population density per area during the study on the actual conditions of Horo Birni where detailed survey was conducted. The results indicate a total service population of 58,500 residents.

The amount of water to be supplied in the basement rock area per shall be 5~15 liters, /capita/day because it is difficult to safely supply water due to a restricted pumping amount. In the sedimentary area, the amount of water to be supplied through hand pump facilities shall be 10 liters/capita/day, and 20 liters/capita/day through motor pump facilities. Originally, the plan is supposed to abide by the guideline of international organizations or by the design standards of Nigeria. However, due to the uncommon hydrogeological characteristics of the project area and in order to facilitate the operation and maintenance work, the water supply was limited to a small amount.

The target value decided upon by the Ministry of Water Resources and the standard value recommended by WHO were used as reference values and are shown in Table 8.

Table 8 Target Water Supply Amount Guideline

Facility type	Reference Values		Plan Value	
	FMWR target value (l/c/d)	WHO standard value (l/c/d)	Basement rock area (l/c/d)	Sedimentary area (l/c/d)
A. Hand Pump Facilities (Rural Type)	60	5 ~ 25	5 ~ 15	10 ~ 15
B. Motor Pump Facilities (Semi-Urban Type)	90	20 ~ 50	10 ~ 15	20 ~ 30

4-2-2 Type Selection of Water Supply System

There are two types of water supply facilities; the point source (rural type) facility for hand pump wells and the motor pump-water distribution (semi-urban type) facility. The water supply amount for both facilities is determined differently. The water supply amount for the hand pump well is based on its pumping capacity (about 10m3/day per well), whereas that of the motor pump is determined from its production (specific capacity of the well).

The selection between these two facilities shall be carried out in accordance with the conditions enumerated below. Questionnaires regarding the maintenance and management of the facilities were handed out to local residents during the basic design study, and the opinion of the local residents shall be given importance in the selection.

a) Hand pump well facilities shall be selected for the following:

1. In areas with more than 40m of water level (dynamic water level of 45m) because the pumping depth of the hand pump well is only limited within 50m;

2. In areas with comparatively low groundwater potential and where the use of the motor pump is not suitable;

3. In villages with comparatively small population since the maintenance cost of motor pump facilities is not economically feasible in these areas;

4. In areas with unfavorable geographic conditions, where fuel/oil supply is difficult;

5. In largely but not densely populated villages if the construction of many hand pump facilities is more economical than the motorized system.

b) Motor pump facilities shall be selected for the following:

1. Villages with comparatively large population and where independent facility operation is possible;

2. Motorized pumping is necessary in areas where the groundwater level is less than 50m;

3. Motor pump facilities can be installed in areas with high groundwater potential;

4. The installation of motor pump facilities, instead of several hand-pump well facilities, in largely populated villages is considered economical in terms of construction expenses;

The selection of the motor pump facility entails the consideration of many maintenance and management related problems. An example of these is the securement of funds for fuel expenses, salaries of the operator and the guardmen, repair costs of the pumps, engine and distribution pipes, etc. In view of these problems, only very few facilities are currently operating smoothly. However,the basic design study results showed that after two years the pilot water supply system in Horo Birni is operating smoothly under the splendid maintenance and management of the local residents. Accordingly, the introduction of this type of water supply facility is considered to be possible and consequently a plan was formulated.

4-2-3 Other Design Conditions

The motorized pumping system and distribution pipe facilities shall be designed according to the following conditions.

1) Water Supply Pressure

A hydraulic pressure of more than 2.0m is designed for the terminal water tap.

2) Pipe Channel

The pipes are to be laid in the shoulder of the road to facilitate operation and maintenance work. Strong and durable steel pipes shall be used, because it is impossible to install the pipes at an adequate depth as more than half of the area is a basement rock area.

3) Water Distribution Loss

Water distribution loss shall not be considered since the pipelines to be installed are not long.

4) Time Variations of Water Demand

Since water demands vary by time, facilities that can provide maximum water amount regardless of time shall be designed. The water supply amount shall be based on the capacity of the pump, tank, and pipe diameter. Furthermore, the variation generally depends on the village population, that is, the larger the population the lesser the amount, the smaller the population the bigger the amount. Although the monitoring results of the pilot facility indicated a peak factor (maximum time ratio) of about 300%, the design shall be reduced to 250%.

5) Water Tank Capacity

In order to cope with the maximum hourly demand, a tank capacity which can cover 8 hours of peak demand shall be designed.

6) Management of existing facilities

Most of the test wells constructed during the development study shall be converted to motor pump wells. Therefore, the wells shall be re-developed and tested before the installation of the pump.

7) Future expansion

Future expansion of wells is not particularly considered in this project. In cases of population and demand increase, the capacity of the wells can be secured through the addition of several facilities.

4-3 Basic Plan

4-3-1 Outline of Water Supply Facility Plan

The outline of the water supply facility plan for the 12 villages in Sokoto State is as shown below (see Table 9, and the list of facilities shown in Table 10).

		Total
1. Boreholes	4" and 6" casing	32 wells
2. Borehole Improvement (existing wells)	4" and 6" casing	5 wells
3. Borehole with submersible motor pump	4" and 6" casing	5 wells
Borehole with hand pump	4" casing	32 wells
4. Generator House	floor area - 14m2 height - 3.0m	5 places
5. Reservoir tank and steel tower	tank storage capacity : 32m3 tank bottom height : 3~7m	5 sets
6. Total Length of Distribution Pipe (maximum diameter : 100mm final diameter : 25mm)		4,633m
7. Communal Faucet Base with two faucets (4 ~ 6 units/village)		25 units

4-3-2 Water Supply Facility Plan

(1). Type of water supply facilities

The selection of the type of water supply facilities depends on the population of the village, groundwater potential, and maintenance capabilities. The type of facilities are largely classified as, A. Semi-urban facilities (simple water facilities with motorized pumping and gravity distribution system), B. Rural type facilities (point sources of hand pump wells), C. the Combined Type (combination of A and B).

Table - 9 Outline of the Water Supply Facility Plan
(for the 12 villages in Sokoto State)

Village Name	Population	Geology	Well Construction	Hand pump facility	Pipeline length	Number of communal faucets	Volume of Reservoir of tower height	Utilization of Existing Boreholes
Tunga Ardo	2,000	Basement	4″,2pcsX50m=100m	3 sets	—	—	—	4″,1well
Bullake	1,000	〃	4″,2pcsX100m=200m	2 sets	—	—	—	—
Ruwan Bore	6,500	〃	4″,2pcsX40m=80m	2 sets	893m	5 sets	32m³,5m	4″,1well
Dokau	5,000	〃	6″,1pc X150m=150m	—	633m	5 sets	32m³,5m	—
Bamamu	2,000	〃	4″,3pcsX70m=210m	3 sets	—	—	—	—
Dauran	12,000	〃	4″,5pcsX40m=200m	5 sets	1,010m	4 sets	32m³,5m	6″,1well
Yambuki	10,000	〃	4″,4pcsX40m=160m	4 sets	1,103m	5 sets	32m³,3m	6″,1well
Daki Takwas	5,000	〃	4″,4pcsX40m=160m	4 sets	—	—	—	—
Zugu	6,000	〃	—	—	994m	6 sets	32m³,7m	6″,1well
Soro	2,000	Sedimentary	4″,2pcsX60m=120m	2 sets	—	—	—	—
Hallamawa	4,000	〃	4″,4pcsX50m=200m	4 sets	—	—	—	—
Samalu	3,000	〃	4″,3pcsX60m=180m	3 sets	—	—	—	—
Total	58,500		32pcs total 1,760m	32sets	4,633m	25sets	(5 sets)	(5 wells)

Table-10 Basic Design of Water Supply System in Sokoto State (12 Villages)

No.	Village	Hydrogeologi-cal Feature	Service Area (ha)	Service Population P.	Water Supply Consumption ℓ/c/d	Water supply Demand m³/d(ℓ/min)	Water Supply System Type	Basic Design					Test Drilling Data of Feasivility Study
								Number of Borehole	Well Diameter x Depth -m	Ground Water level - m	Pumping Facility	Reservoir Tank Dimension	
1	Tunga Ardo	Basement	2.3	2,000	10	20 (41)	Rural	2+(1)	4″×50	40	Hand	—	80m Depth, 13ℓ/min SWL 26.86, DWL38.86
2	Bullake	Basement	1.2	1,000	10	10 (20)	Rural	2	4″×100	40	Hand	—	—
4	Ruwan Bore	Basement	6.3	5,000 1,500	10 5	50 (34) 7.5 (15)	Semi-Urban Rural	(1) 2	(4″×90) 4″× 40	50 8	Motor Hand	4x4x2x5H —	90m Depth 34ℓ/min SWL 6.11m, DWL 44.96m
5	Dokau	Basement	4.7	5,000	15	75 (52)	Semi-Urban	1	6″×150	50	Motor	4x4x2x5H	—
6	Bamamu	Basement	1.6	2,000	10	20 (41)	Rural	3	4″× 70	40	Hand	—	—
7	Dauran	Basement	15.7	6,000 6,000	10 5	60 (42) 30 (62)	Semi-Urban Rural	(1) 5	(6″×84) 4″× 40	30 20	Motor Hand	4x4x2x5H	84m Depth, 120ℓ/min SWL 12.06m, DWL 18.36m
8	Yambuki	Basement	32.5	5,000 5,000	10 5	50 (34) 25 (52)	Semi-Urban Rural	(1) 4	(6″×102) 4″× 40	40 30	Motor Hand	4x4x2x3H —	102m Depth, 80ℓ/min SWL 29.41m, DWL 37.5m
14	Daki Takwas	Basement	40.6	5,000	10	50 (104)	Rural	4	4″× 40	10	Hand	—	—
15	Zugu	Basement	11.8	6,000	10	60 (41)	Semi-Urban	(1)	(6″×120)	20	Motor	4x4x2x7H	120m Depth, 140ℓ/min SWL 10.30m, DWL 15.72m
34	Soro	Sediment	2.7	2,000	10	20 (41)	Rural	2	4″× 60	10	Hand	—	150m Depth, 31ℓ/min SWL 1.71m, DWL 5.93m
46	Mallamawa	Sediment	5.2	4,000	10	40 (83)	Rural	4	4″× 50	10	Hand	—	—
47	Samalu	Sediment	4.1	3,000	10	30 (62)	Rural	3	4″× 60	10	Hand	—	—
	Total: 12 Villages	Basement 9 Sediment 3	128.7	58,500		547.5 (724)	Rural 7 Semi-Urban 2 Rural & Se-Ur.3	32	4″×1,290m 6″× 470m		Hand 7 Mator 2 Hand & Motor 3		

The motorized system in the above B and C type facilities are to be constructed in 5 villages with a comparatively large population, high groundwater development potential, and few problems concerning the operation of the system.

The plural numbers of hand pump wells in the above A and C type facilities are to be constructed in 10 villages (type B for 7 villages and type C for 3 villages) with a comparatively low groundwater development potential (where the production of large amount of water cannot be obtained from only 1 well). The target service population per well is 600~700 residents.

(2). Water supply facilities

The main water supply facilities are wells, hand-pumps, submersible motor pumps, generators, distribution pipelines, elevated reservoir tanks, towers, communal faucets, generator houses, etc.

1) Well

The water source of the 12 project villages are borehole wells. There are 32 wells (of which 31 are 4" casing borehole wells and the remaining one - a 6" casing borehole well) planned for the 12 villages. In addition, 5 existing wells are to be rehabilitated for re-utilization (2 of the 4" casing wells and 3 of the 6" casing wells).

The 4" borehole well is applicable to a). all wells equipped with hand pumps, and b). villages with relatively small water demands, but to be installed with motor pumps.

The 6" borehole well is usually used in villages with higher water demands. However, due to the use of the existing wells, this project shall include the 6" borehole wells even in area with rather low water demands.

In any case, the structure given is planned to guarantee the long term use of the well and the effective securement of pumped water. The existing wells have also been constructed under the same specification. The standard well structure is shown in Figure 9.

①. Screen setting should be in accordance with the depth of the good aquifer. The screen should be deeply positioned near the bottom of the well in the basement rock area.

②. A clearance of 2" or more should be made around the well casing and screen. Sieved gravel of proper size is to be packed in the annular space around the screen and casing (the drilling diameter should be more than 8" for 4" casing, and more than 10" for 6" casing).

③. In order to facilitate gravel packing, the open hole drilling method should be used.

④, A centralizer is to be attached when lowering the casing/screen to facilitate gravel packing.

⑤. One blind casing with plugged bottom is to be installed at the bottom of the well to trap sand.

⑥. Cement grouting should be conducted around the casing up to a depth of 5m from the ground surface to prevent the permeation of wastewater.

The casing and screen materials planned are as follows.

- 4" casing well
  Inexpensive, durable, lightweight, and easy to handle PVC pipes for 4" casing wells with a depth of 50m or less. PVC slot pipes with more than 3% openings for the screen. The width of the slit should be within 1mm since some part of the area consists partially of fine sandy materials.

- Very strong, lightweight and easy to handle FRP pipe/screen, which allow the use of screw joints, for 4" casing wells exceeding 50m in depth; FRP slot pipes for the screen. The width of the slit is identical to the above.

- 6" casing well
  Very strong steel pipe casing for the planned one 6" casing well, because it shall be very deep and because of its need for a large opening ratio for the use of a motorized pump. Johnson type stainless screen is to be used to ensure an opening ratio of more than 15%.

- The length ratio of the blind casing and the screen differs in the basement rock area and the sedimentary area, and also for the hand pump well and the motor pump well. In the basement rock area, the length of screens with large opening ratios for motor pump wells is around 20m, while the slot pipes for hand pump wells of less than 50m deep is around 15m, and around 20m for those exceeding a depth of 50m.

In the sedimentary area, the length of the slot pipes for hand pump wells is 30% of the total drilling length.

Based on the above, a total of 32 wells (1,760m), of which 1 is a 6" well, 21 are 4" wells with a depth of less than 50m, and 10 are 4" wells with a depth of more than 50m, are to be constructed and the following casing and screens are required. Table 11 shows the quantity list.

- 4" 5m PVC pipes
  - 117 (21 of these are used as bottom plugs)
  - 585m in length
  - 8 spares (a total of 125 pipes, and a total length of 625m)
- 4" 5m PVC slot pipe
  - 63 slot pipes
  - 315m in length
  - 3 spares (a total of 66 slot pipes, and a total length of 330m)
- 4" 4m FRP pipes
  - 129 (10 of these are used as bottom plugs)
  - 516m in length
  - 6 spares (a total of 135 pipes, and a total length of 540m)
- 4" 4m FRP slot pipe
  - 50 slot pipes
  - 200m in length
  - 5 spares (a total of 55 pipes, and a total length of 220m)
- 6" 6m Steel pipe
  - 22 (one is used as a bottom plug)
  - 130m in length
  - no spares (a total length of 132m)
- 6" 3m Screen
  - 7 screens
  - 21m in length
  - 1 spare (a total of 8 screens, and a total length of 24m)

2) Hand pump set

A total of 32 hand pump sets (31 for new wells and 1 for an existing well) are to be installed in 10 villages (including 3 spares, a total of 35 sets will be prepared). All the pumps are bottom cylinder in type. The total length of the riser pipes and rods is 1,765m by adding 5m to the estimate dynamic water level of each well. The

products to be chosen are those which are widely used in Nigeria. The selection also depends upon the availability of the spare parts and the repair work conditions.

3) Submersible motor pump set

A total of 5 submersible motor pump sets are to be installed in 5 villages (1 in each village), one set for the existing 4" wells and 4 sets for 6" wells. A 95mm external diameter can be used due to a comparatively small water demand. Based on the water demand and the dynamic water level of the wells in the 5 villages, pumps with the following capacities have been chosen.

- 2 pumps with a discharge of 70 l/min at 50m head;
- 3 pumps with a discharge of 90 l/m at 60m head.

With an additional spare for each of the pumps, a total number of 7 pumps have been planned. Although submersible motor pumps are available in Nigeria, it is better to import them from Japan because their obtainment in Nigeria takes a long time. Since the submersible motor pump and the generator should be well matched to operate effectively, it is also better to import the generator from Japan.

4) Generator

Diesel engine generators are the power sources of submersible pumps. A total of 6 10KVA generators (including a spare) in accordance with the capacity of the above-mentioned pumps have been planned. The specification and the quantity of the pump and the generator are in Table 12 (List of Pumping Facilities).

5) Water distribution pipes

The total length of the distribution pipeline to be installed in the 5 villages is 3,893m. By adding the 740m length of the transmission pipes from the well to the reservoir tank, the total length of the pipelines totals 4,633m. The diameter of the water supply pipeline varies from 25 to 100mm. An 80mm diameter pipe is planned for all transmission pipes. Strong steel pipes are planned for the basement rock area where deep underground excavations are difficult. Table 13 shows the water supply pipeline length plan for each village, and the total length of each pipe diameter is as shown below. Since the obtainment of large quantities

of steel pipes with tightly secured and durable (leakage-resistant) joints of standard sizes is difficult in Nigeria, they are to be imported from Japan.

	Diameter	Length
Water supply pipe	25mm	250m
	50mm	428m
	80mm	1,961m
	100mm	1,254m
Transmission pipes	80mm	1,961m
	Total	4,633m

6) Elevated reservoir tank and tower

- Reservoir tanks are to be constructed in the 5 villages with motor pumping facilities. The capacity of the tank is 32m3 (4m × 4m ×2m). Rust proof, and easy to maintain FRP materials are selected for the tanks,and they are to be procured from Japan. Steel plates are the most popularly used material for the construction of water tanks in Nigeria, however, they are corrosive, not easy to maintain, and are susceptible to cracks that leads to leakage problems.

- Steel towers are to be constructed in the 5 places where reservoir tanks are planned. The tower is planned to be of bolted assembly to guarantee an effective assembly and to maintain enough strength (welding is very ineffective and will make assembling according to the design difficult). The dimension of the tower is 4m × 4m, and the height ranges from 3 to 7m; one (1) 3m tower, three (3) 5m towers, and one (1) 7m tower, a total of 5 towers. The height of the tower was determined to estimate the headloss of the water supply pipes and to establish the headloss of the terminal faucet water supply pressure at more than 2m.

The materials for the steel assembly towers are to be procured from Japan, but the materials for the tower base shall be purchased in Nigeria.

7) Communal faucet base and generator house

As shown in Table 13, 25 communal faucet bases are to be installed in 5 villages.

With the exclusion of the types of pipes, all materials for the above facilities will be procured in Nigeria. Cast-in-place concrete is to be used for the communal faucet base. Concrete blocks which are easy to obtain in the project area is planned for the construction of the generator house.

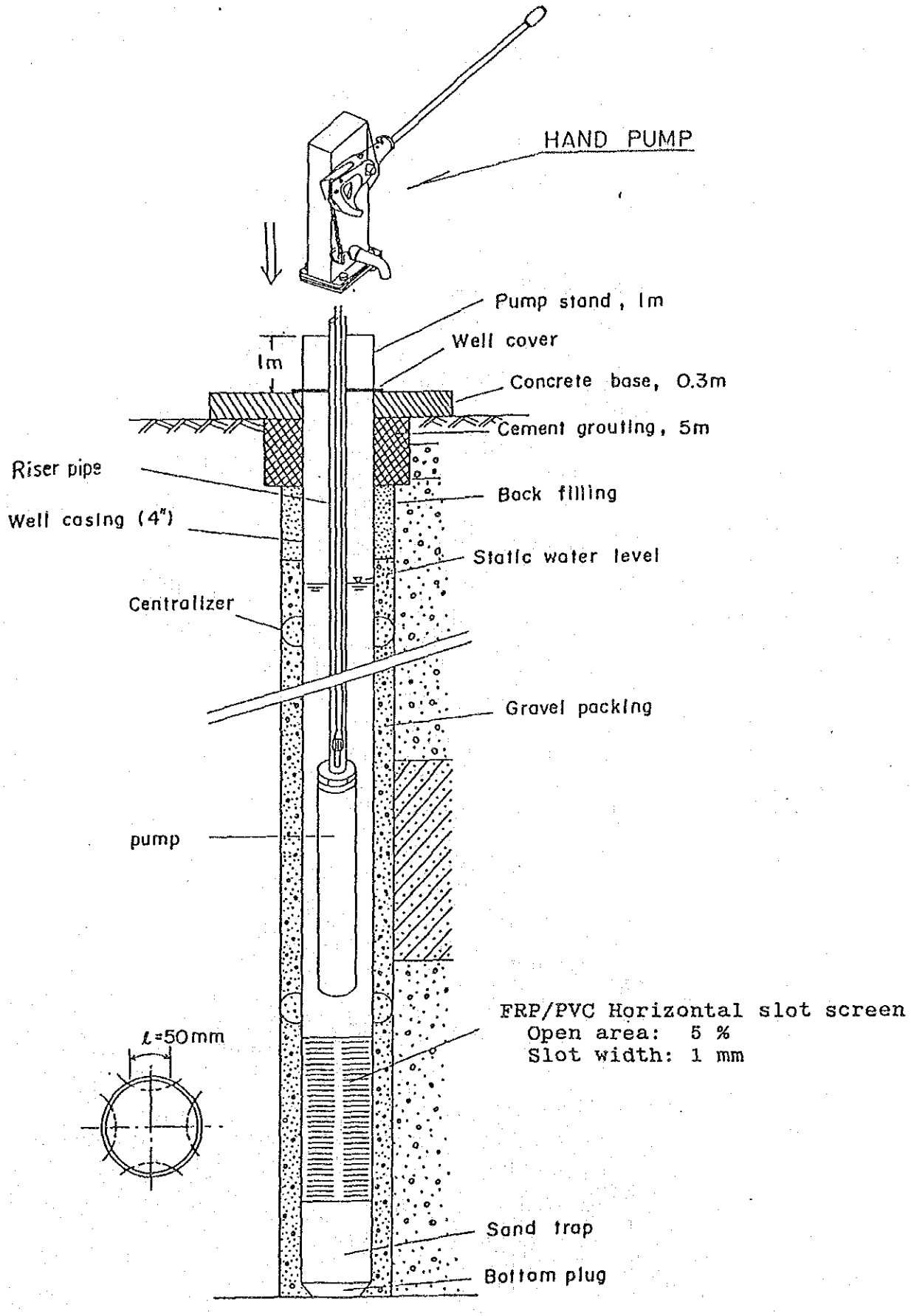


Fig. 9-1 Standard Design of the Well (Hand pump)

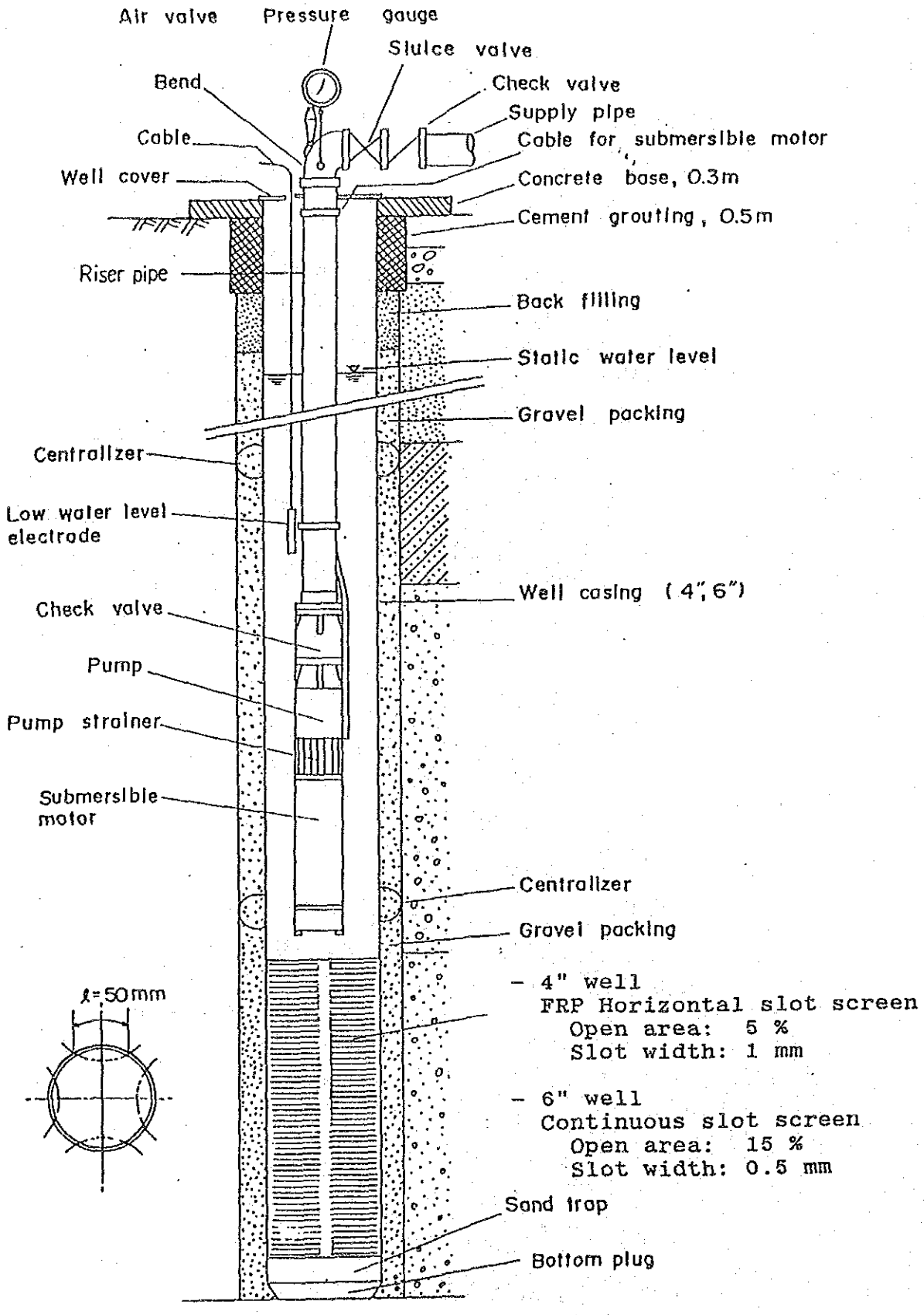


Fig. 9-2 Standard Design of the Well (motorized pump)

Table - 11 Number of Casing / Screen Materials

Material	Drilling Diameter (inch)	Casing Diameter (inch)	Depth of Well (m)	Number of Well	Total DrillingDepth (m)	Blind Casing						Screen		
						Non plug Casing			Bottom Plug		Total			
						Unit length (m)	Number for 1 Well	Total Number	Number for 1 Well (m)	Total Number	Sum Total	Unit length (m)	Number for 1 Well	Total Number
P	8″	4″	40	15	600	5	4	60	1	15	75	5	3	45
V			50	6	300		6	36	1	6	42		3	18
C	Total			21	900			96pcs		21pcs	117pcs			63pcs
F	8″	4″	60	5	300	4	9	45	1	5	50	4	5	25
R			70	3	210		12	36	1	3	39		5	15
P			100	2	200		19	38	1	2	40		5	10
	Total			10	710			119pcs		10pcs	129pcs			50pcs
Steel	10″	6″	150	1	150	6	21	21	1	1	22	3	7	7
	Total			1	150			21pcs		1pc	22pcs			7pcs
Grand Total				32	1,760m			236pcs		32pcs	268			120pcs

*Note－1 Total length of screen : 15～20m per well at basement rock area
30% of drilling length at Sedimentary rock area

Note－2 Spare Ratio : Good for 1 well respectively, except for those made of steel

Table-12 Quantity of Pump Facilities

No.	Village name	Tank volume (m3)	Required capacity			No. of pumps	Pump items	Pump capacity	Submersible pump generator	Utmost external diameter of the pump (mm)	Generator (KBA)
			Depth (m)	Number (n)	Length (m)						
1	Tunga Ardo										
2	Bullake										
4	Ruwan Bore	32	68	7	50	1	34 ℓ/min×60m×2 Pole×1.1 kw	70 ℓ/min×60m	2 Pole × 1.1 kw	95	10
5	Dokau	32	68	7	50	1	68 ℓ/min×60m×2 Pole×1.1 kw	70 ℓ/min×60m	2 Pole × 1.1 kw	95	10
6	Bamamu										
7	Dauran	32	84	6	30	1	42 ℓ/min×40m×2 Pole×1.1 kw	90 ℓ/min×47m	2 Pole × 1.1 kw	95	10
8	Yambuki	32	68	7	40	1	34 ℓ/min×45m×2 Pole×1.1 kw	90 ℓ/min×47m	2 Pole × 1.1 kw	95	10
14	Daki Takwas										
15	Zugu	32	82	6	20	1	41 ℓ/min×30m×2 Pole×1.1 kw	90 ℓ/min×47m	2 Pole × 1.1 kw	95	10
34	Soro										
46	Mallamawa										
47	Samalu										
Total						5					

Table-13 Quantity of Distribution Pipes

No.	Village name	Hydrogeological feature	Distribution pipes						Faucet	Water conveyance pipes connected to reservoir tanks	Total pipe length (m)
			Diameter								
			ø125 (m)	ø100 (m)	ø80 (m)	ø50 (m)	ø25 (m)	Length (m)	Q'ty (n)	ø85 (m)	
1	Tunga Ardo	Basement	0	0	0	0	0	0	0	0	0
2	Bullake	Basement	0	0	0	0	0	0	0	0	0
4	Ruwan Bore	Basement	0	0	510	110	50	670	5	223	893
5	Dokau	Basement	0	185	295	88	50	618	5	15	633
6	Bamamu	Basement	0	0	0	0	0	0	0	0	0
7	Dauran	Basement	0	150	500	0	40	690	4	320	1,010
8	Yambuki	Basement	0	0	656	0230	50	936	5	167	1,103
14	Daki Takwas	Basement	0	0	0	0	0	0	0	0	0
15	Zugu	Basement	0	919	0	0	60	979	6	15	994
34	Soro	Sedimentary	0	0	0	0	0	0	0	0	0
46	Mallamawa	Sedimentary	0	0	0	0	0	0	0	0	0
47	Samalu	Sedimentary	0	0	0	0	0	0	0	0	0
Total			0	1254	1961	428	250	3893	25	740	4.633

4-3-3 Plan on Equipment and Materials

The plan on equipment shall be based on the operation and maintenance aspect. The operation and maintenance plan in this project entails the carrying out of twice a month periodical patrol services for the hand pump and motor pump facilities, and the preservation (including motor pump fuel provision), inspection and repair of the facilities by an operation and maintenance group made up of 6~7 members.

The hand pump facilities to be installed in 32 places shall receive the above services at an average of twice a year (rubber replacement, pump base repair work, and the once every 4 years cylinder replacement work). On the one hand, the motor pump facilities to be installed in 5 places shall be serviced at an average of once every 4 years (impeller replacement and overhaul, and generator overhaul). Further, the plan also includes the washing of all wells once every 2 years.

- Preservation (including motor pump fuel provision), inspection and repair (twice a month patrol services).
  Objective Area: 5 districts
  Transportation: Two 4WD station wagons for patrol services
  Staff: 6
  Patrol Distance: 150km x 1 round trip = 300km/day

- Well Washing (once every two years service)
  Objective Area: 37 places
  Transportation: 1 well service machine
  1 station wagon
  Staff: 7
  Patrol Distance: 100km x 1 round trip = 200km/day

Accordingly, the following are the equipment required for the maintenance of the constructed facilities.

(1) Vehicles for inspection and repair services 2

(2) Truck mounted well service machine 1 set

(3) Tools and spare parts 1 set

(1) Vehicle for inspection and repair services

Two 4WD station wagons with no rear seats, but installed instead with a rack for inspection and repair tools, are to be procured.

(2) Well service machine

All the water sources in the project area are borehole wells and the maintenance of the wells is the most important maintenance work of all. Therefore, one set of truck mounted well service machine has been planned to quicken the lifting of pumping facilities (pumps and pipes), and the cleaning and re-development of wells.

(3) Tools and spare parts

The tools and spare parts for the well service machine and vehicles have been planned.

A two year supply of vehicle parts, mainly expendable supplies such as tires, filters, fan belts, shock absorbers, batteries, etc., are to be provided.

4-3-4 Basic Design Drawings

The structure of the hand pump base is shown in Fig. 10. The structural combinations of the semi-urban type water supply system constructed in the 5 villages are enumerated below. The standard layout of the structure of these facilities is shown in Fig. 11 - 1 - 4.

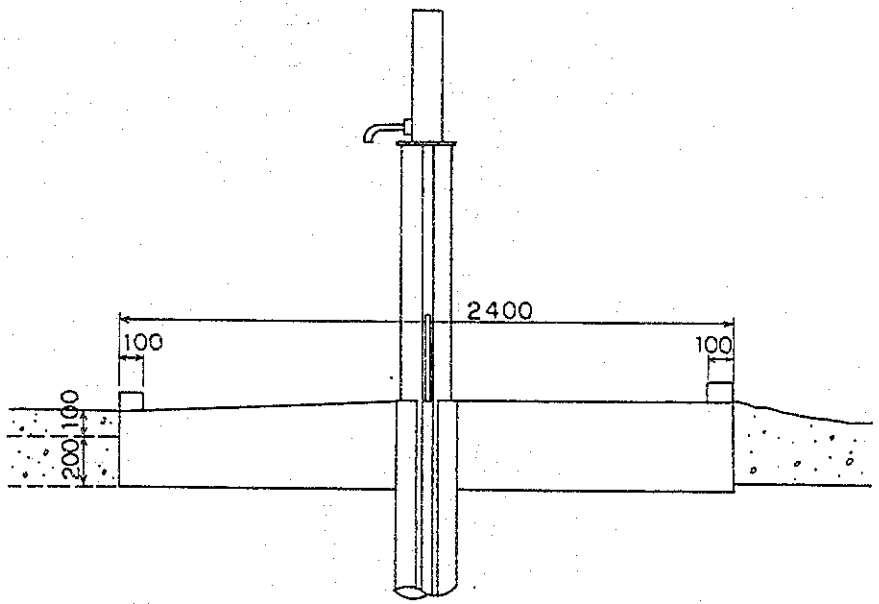
(1) FRP made reservoir tank (tank volume : 32m3)
..... 1 set/village (Fig. 11 - 1)

(2) Steel tower (tower height : 3m, 5m, and 7m) ..... 5 sets (Fig. 11 - 2)

(3) Communal faucet base of reinforced concrete with two faucets
..... 4 - 6 sets/village (Fig. 11 - 3)

(4) Joints, standard cross-section of excavation and others (connection of riser pipe and tank inlet, valve, reducer, union joint, etc.) ..... (Fig. 11 - 4)

(5) Generator house made of concrete block with deck plate roof. Floor area : 14m^2 (with spaces for a generator base, control panel and storage area for spare parts, fuel and oil). ..... 1 house/village (Fig. 11 - 5)



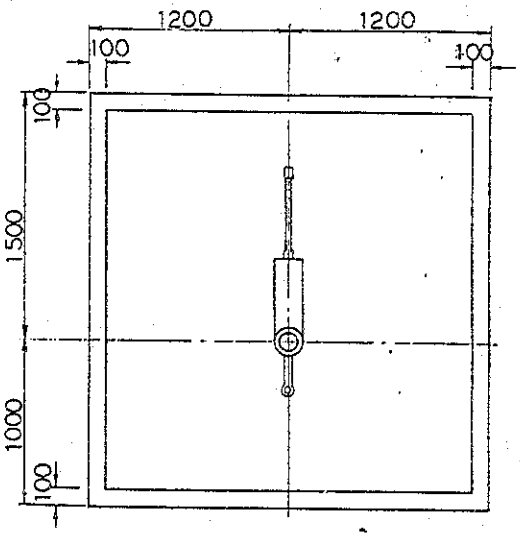
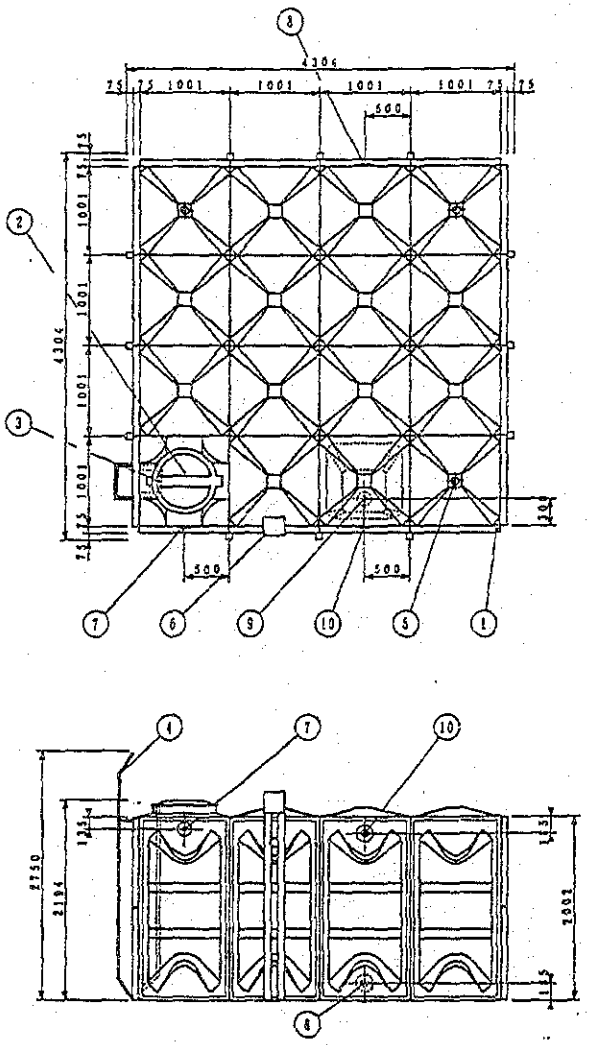


Fig. 10 Standard water supply facility (1)
Hand pump pase strudure



No.	NAME		MATERIAL	Q'TY	REMARKS
10	OVER FLOW	(2")	STEEL	1	STEEL FLANGE
9	DRAINAGE	(2")	STEEL	1	STEEL FLANGE
8	OUTLET	(3")	STEEL	1	STEEL FLANGE
7	INLET	(2")	STEEL	1	STEEL FLANGE
6	WATER LEVEL INDICATOR			1	
5	AIR VENT		A. Z. S.	3	2" COWL TYPE
4	EXTERNAL LADDER		S. G. P.	1	HOT DIPPED GALVANIZED
3	INTERNAL LADDER		P. V. C.	1	
2	MANHOLE		G. R. P.	1	
1	WATER TANK		G. R. P.	1	COLOUR:GRAY

Fig. 11-1 Standard Water Supply facility (2)-①
32 m^3, Elevated Reservior tank Structure

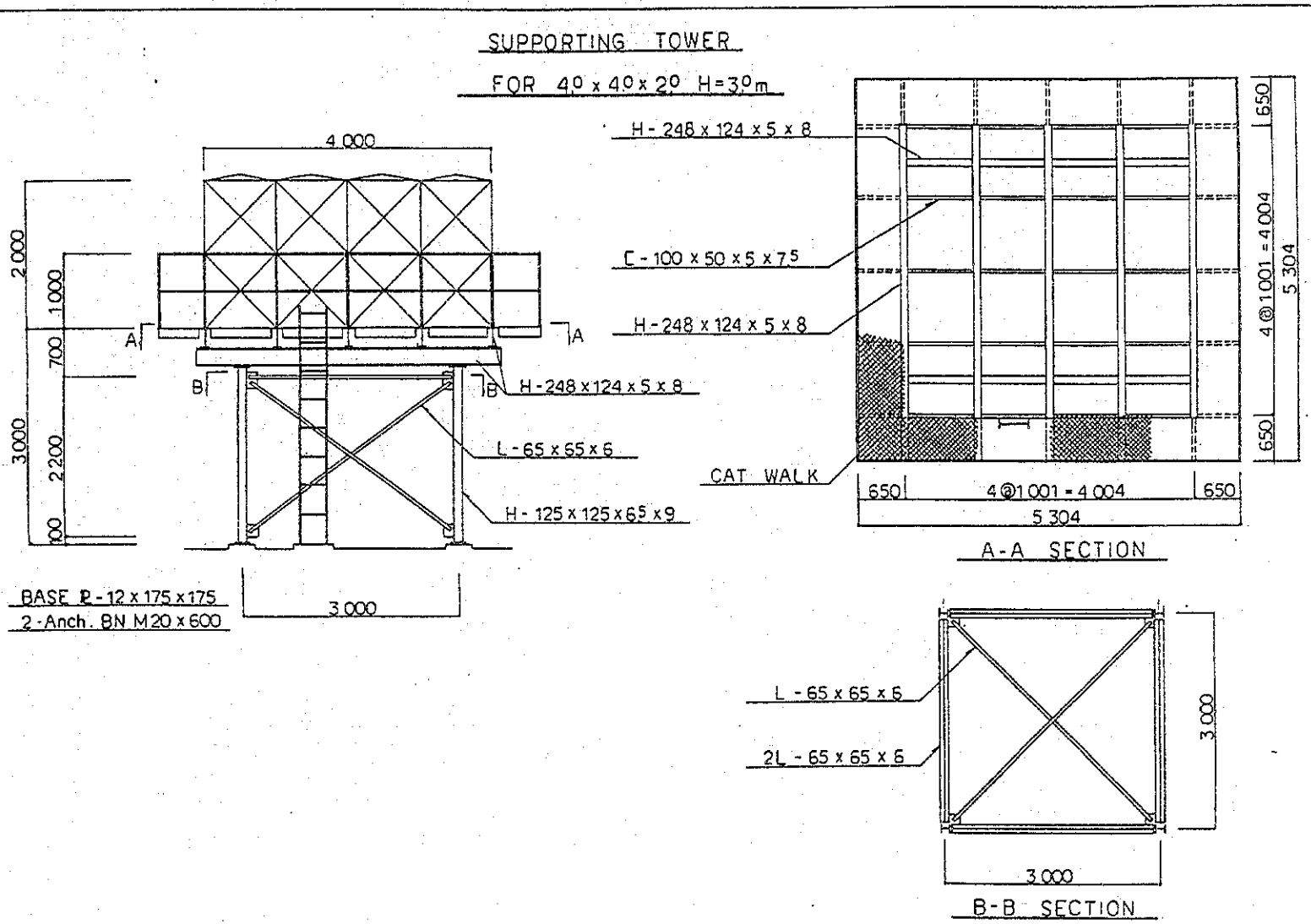


Fig. 11-2-1 Standard Water Supply facility (2)-②
3 m high, Elevated tank tower Structure

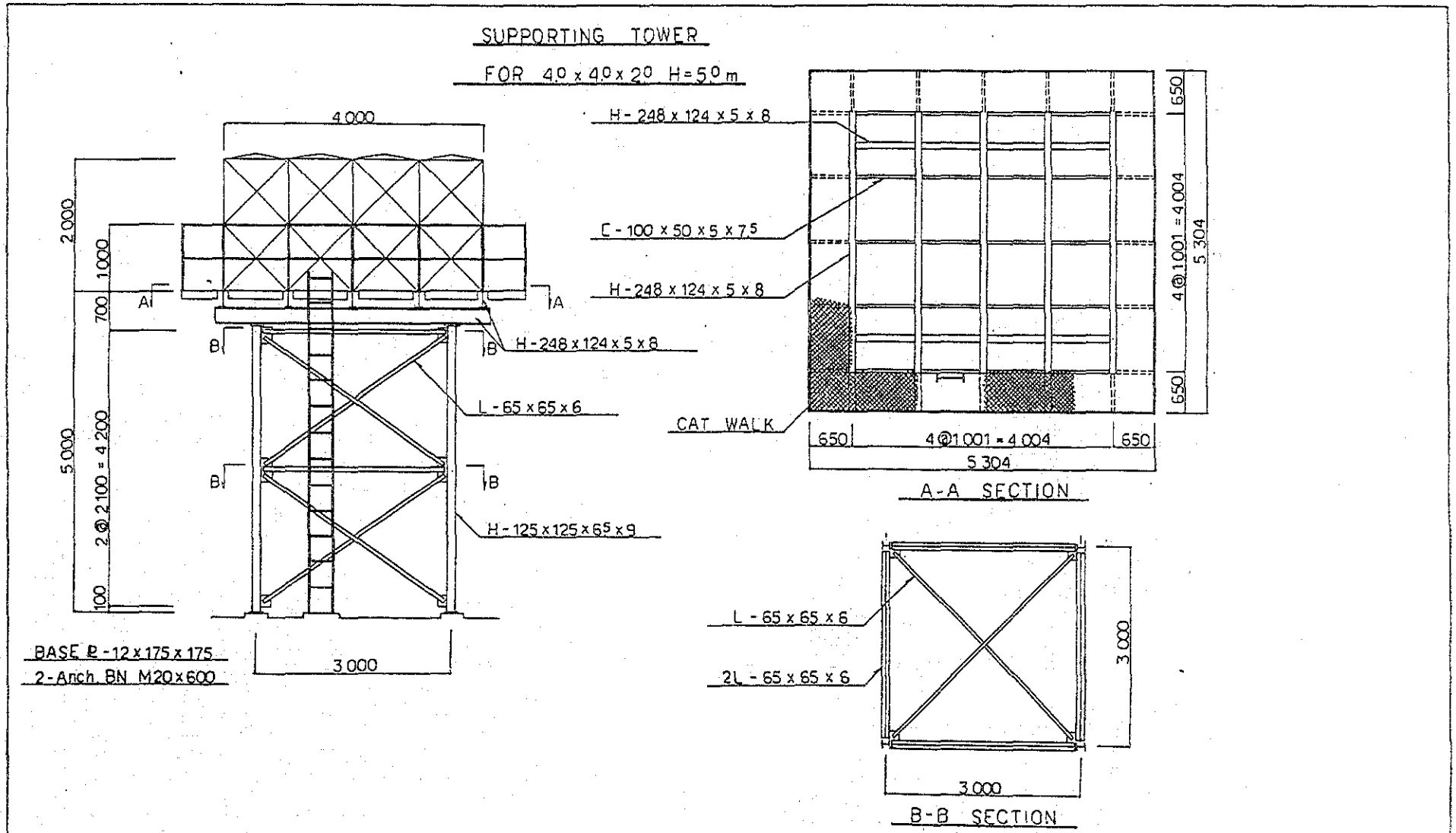


Fig. 11-2-2 Standard Water Supply facility (2)-③
5 m high, Elevated tank tower Structure

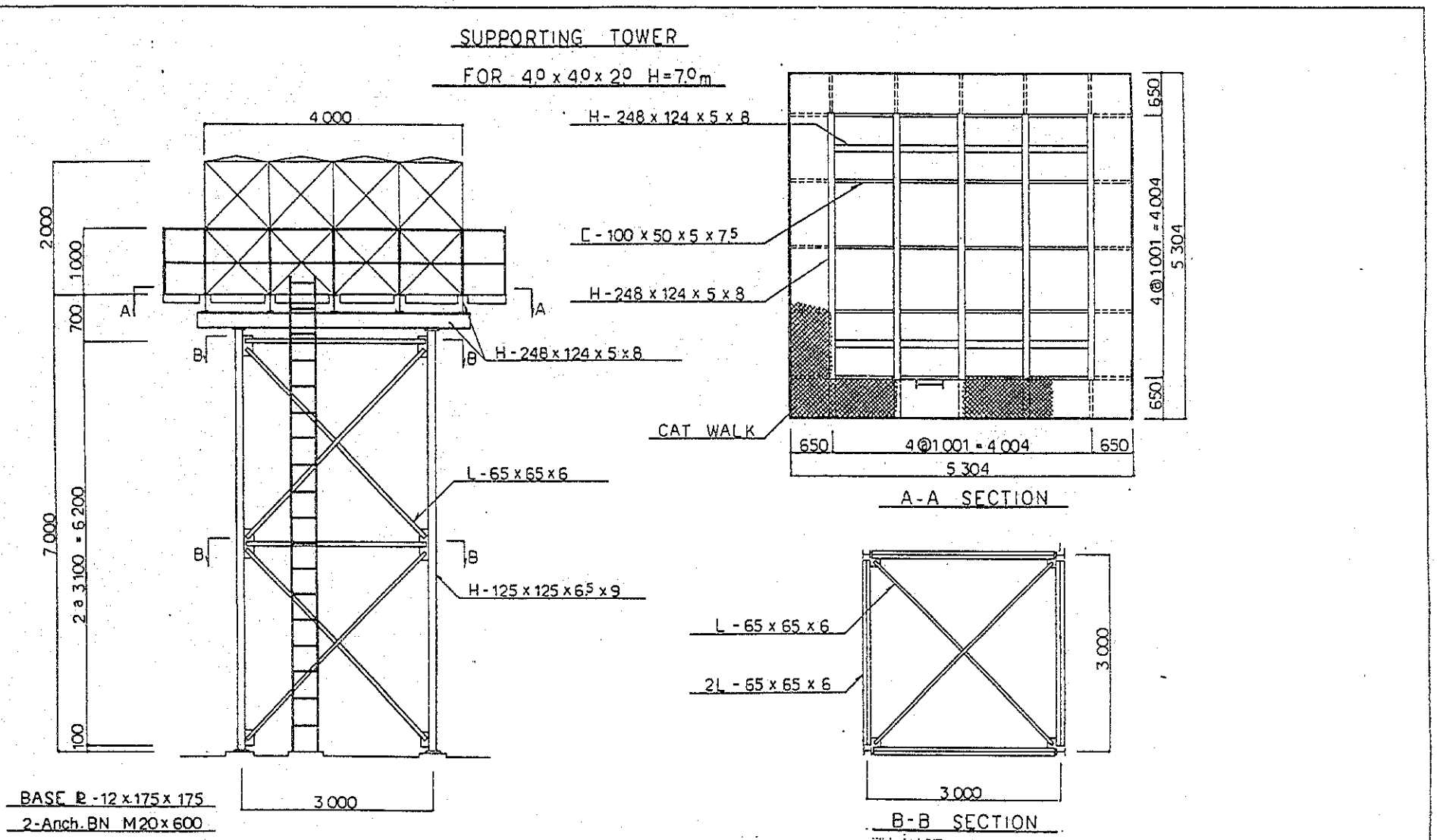


Fig. 11-2-3 Standard Water Supply facility (2)-④
7 m high, Elevated tank tower Structure

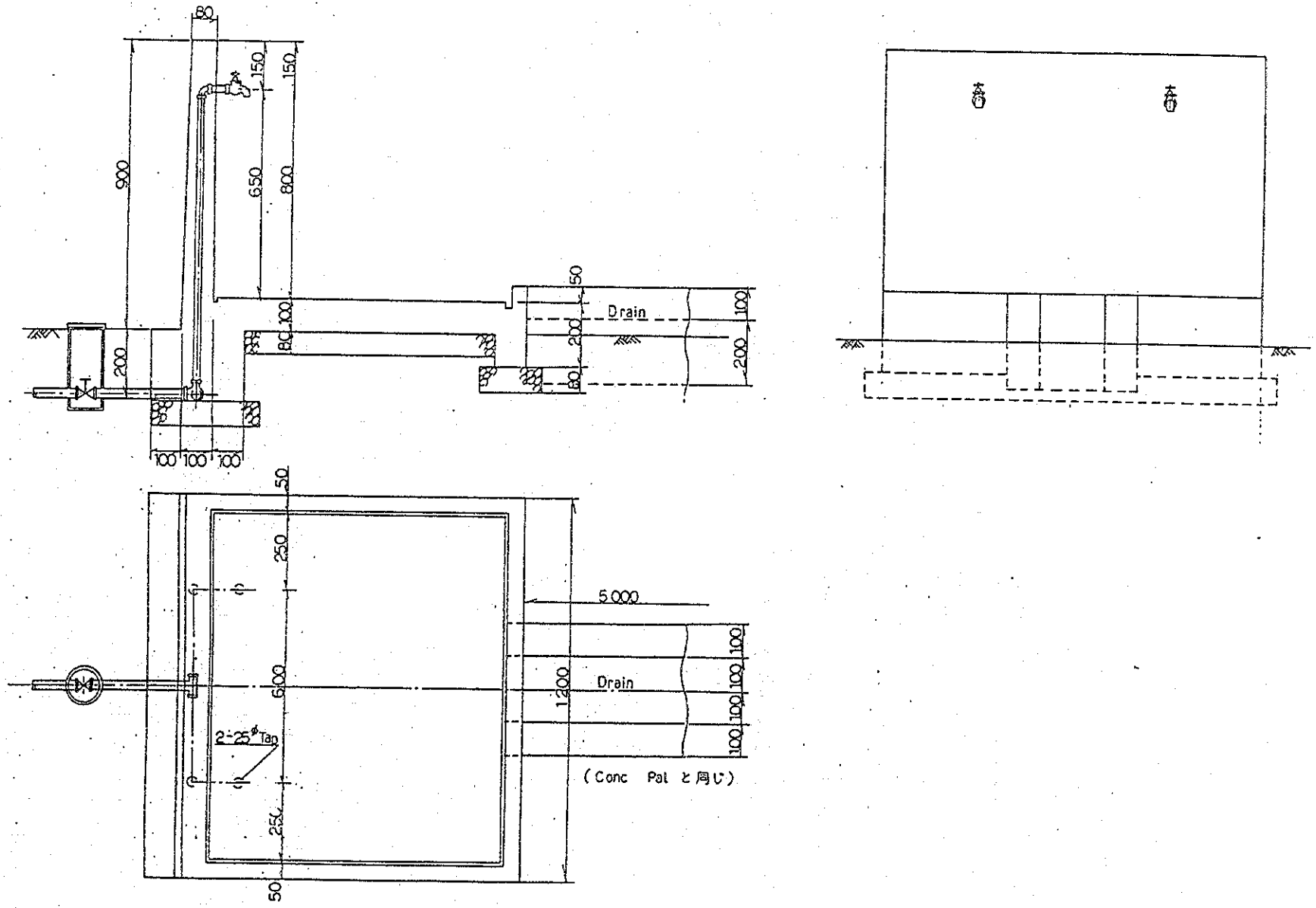
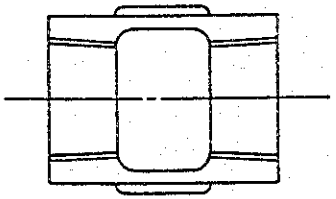
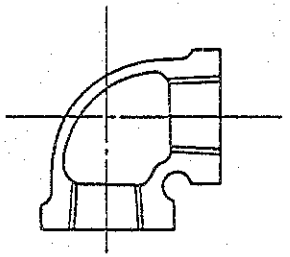


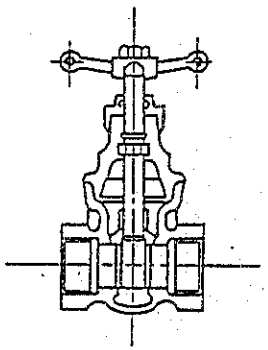
Fig. 11-3 Standard Water Supply facility (3)
Commural faucet base Structure



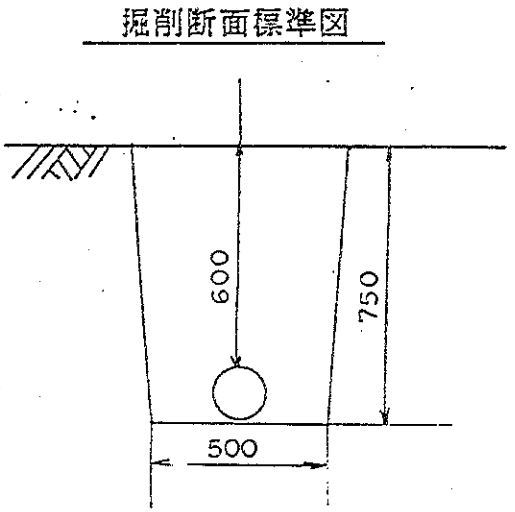
ソケット
Socket

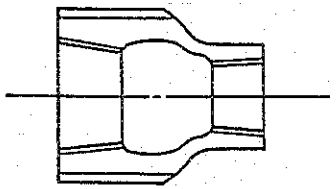


エルボ
Elbow

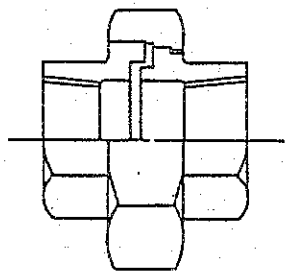


スルース弁
Sliding Valve

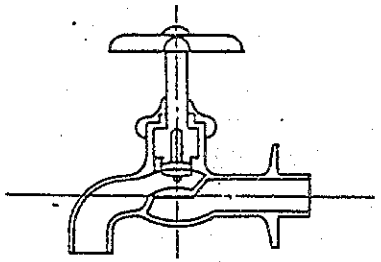




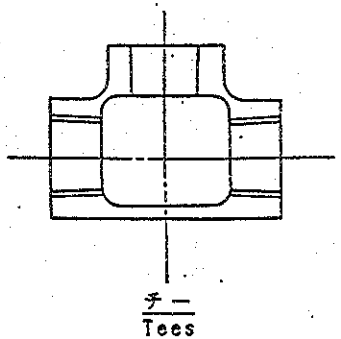
径違いソケット
Reducing Socket



ユニオン
Unions Standard



蛇口
Tap



チー
Tees

Fig. 11-4 Standard Water Supply facility (4)
Joints, standard cross-section of excavation and others

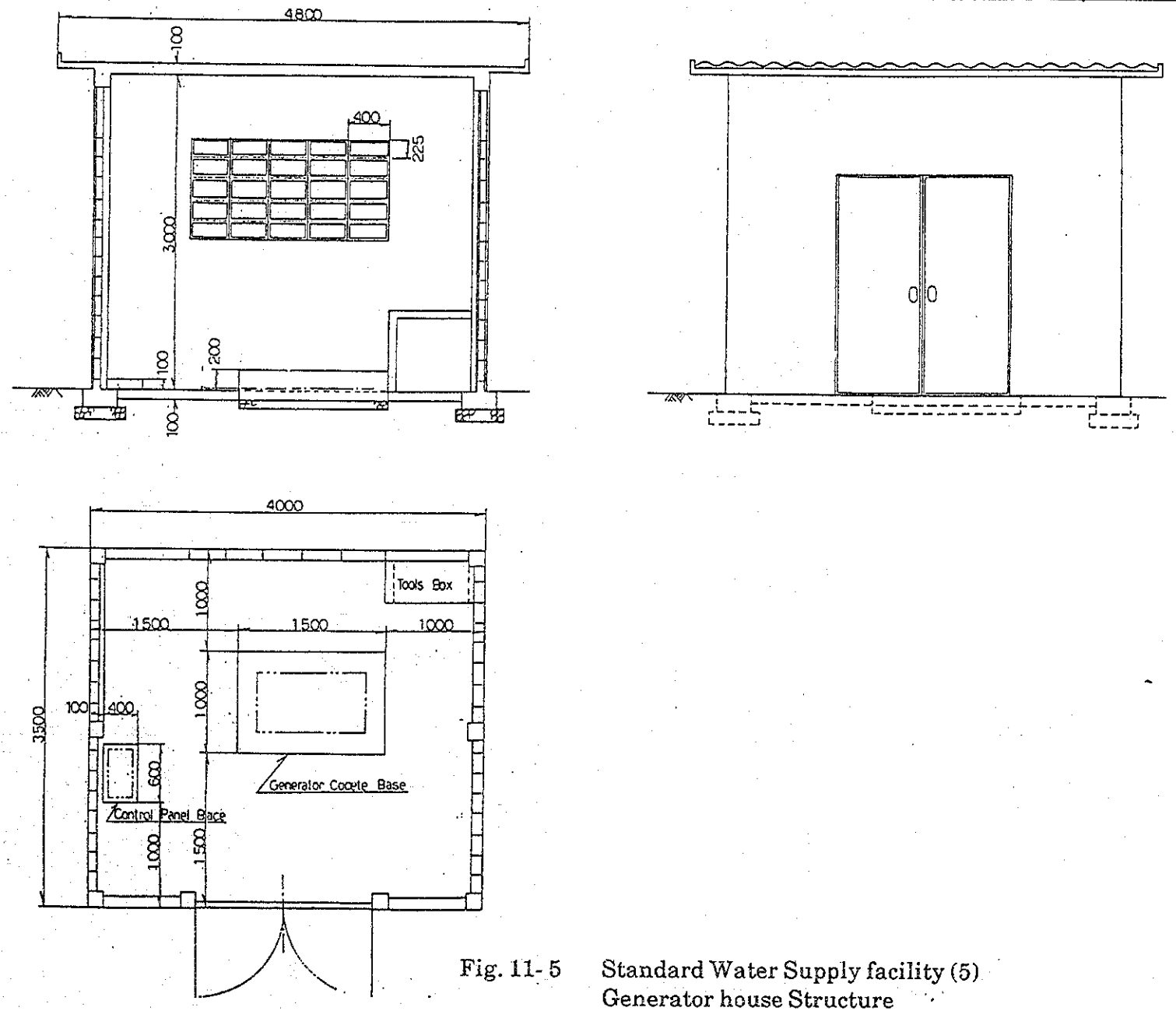


Fig. 11- 5 Standard Water Supply facility (5)
Generator house Structure

(2) Water Supply Facility Plan by Village

The Layout and Vertical figure of the 12 villages are shown in Fig 12-1~12. Only the Vertical Figure of the Semi-urban water supply system is indicated though.

Water Supply Facility Plan by Village

No.	Village name	Water supply system (type)	Water supply facility graph	
			Arrangement graph	Vertical graph
No. 1	Tunga Ardo	A	Figure 12-1-1	
No. 2	Bullake	A	Figure 12-2-1	
No. 4	Ruwan Bore	C	Figure 12-3-1	Figure 12-3-2
No. 5	Dokau	B	Figure 12-4-1	Figure 12-4-2
No. 6	Bamamu	A	Figure 12-5-1	
No. 7	Dauran	C	Figure 12-6-1	Figure 12-6-2
No. 8	Yambuki	C	Figure 12-7-1	Figure 12-7-2
No. 14	Daki Takwas	A	Figure 12-8-1	
No. 15	Zugu	B	Figure 12-9-1	Figure 12-9-2
No. 34	Soro	A	Figure 12-10-1	
No. 46	Mallamawa	A	Figure 12-11-1	
No. 47	Samalu	A	Figure 12-12-1	

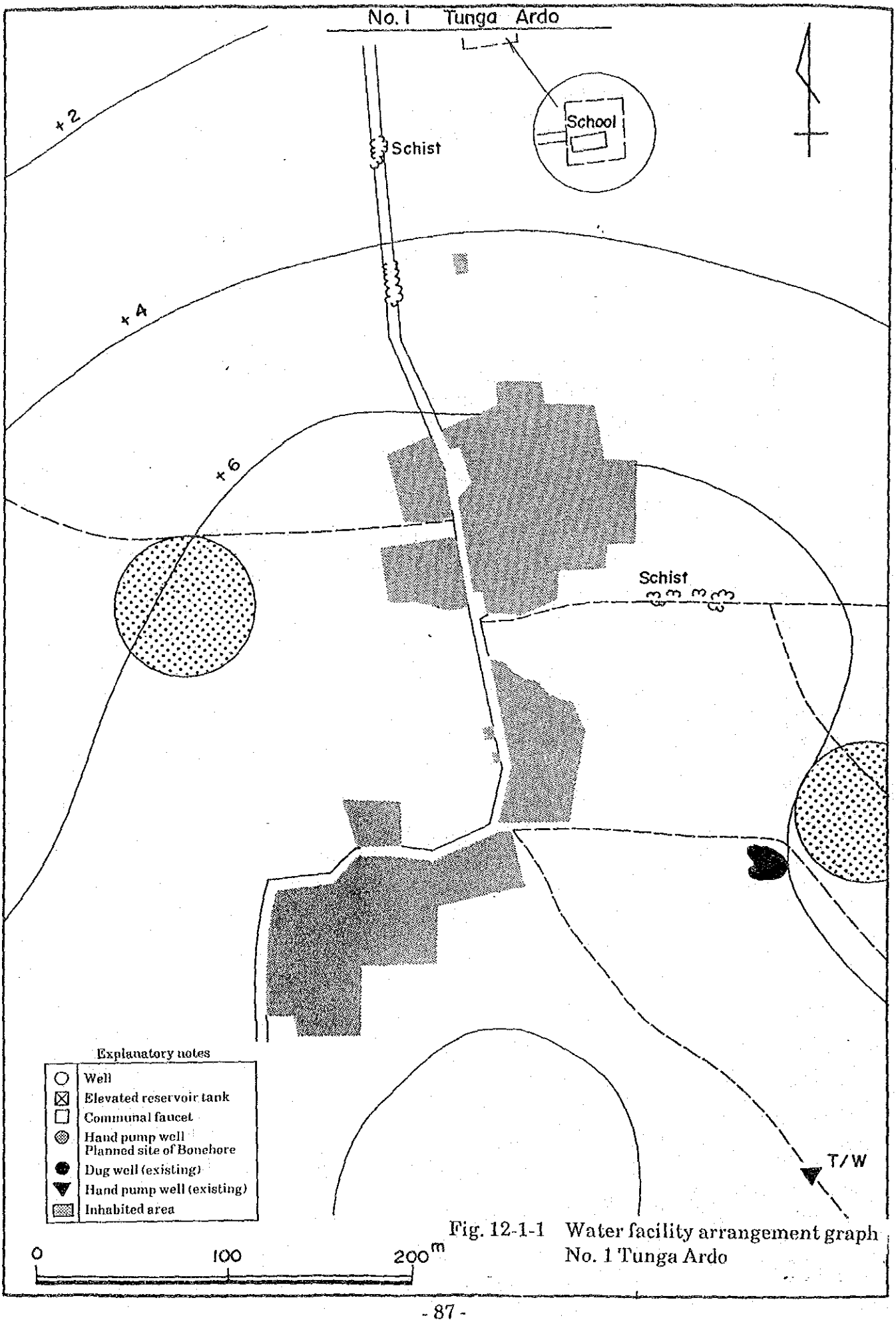


Fig. 12-1-1 Water facility arrangement graph No. 1 Tunga Ardo

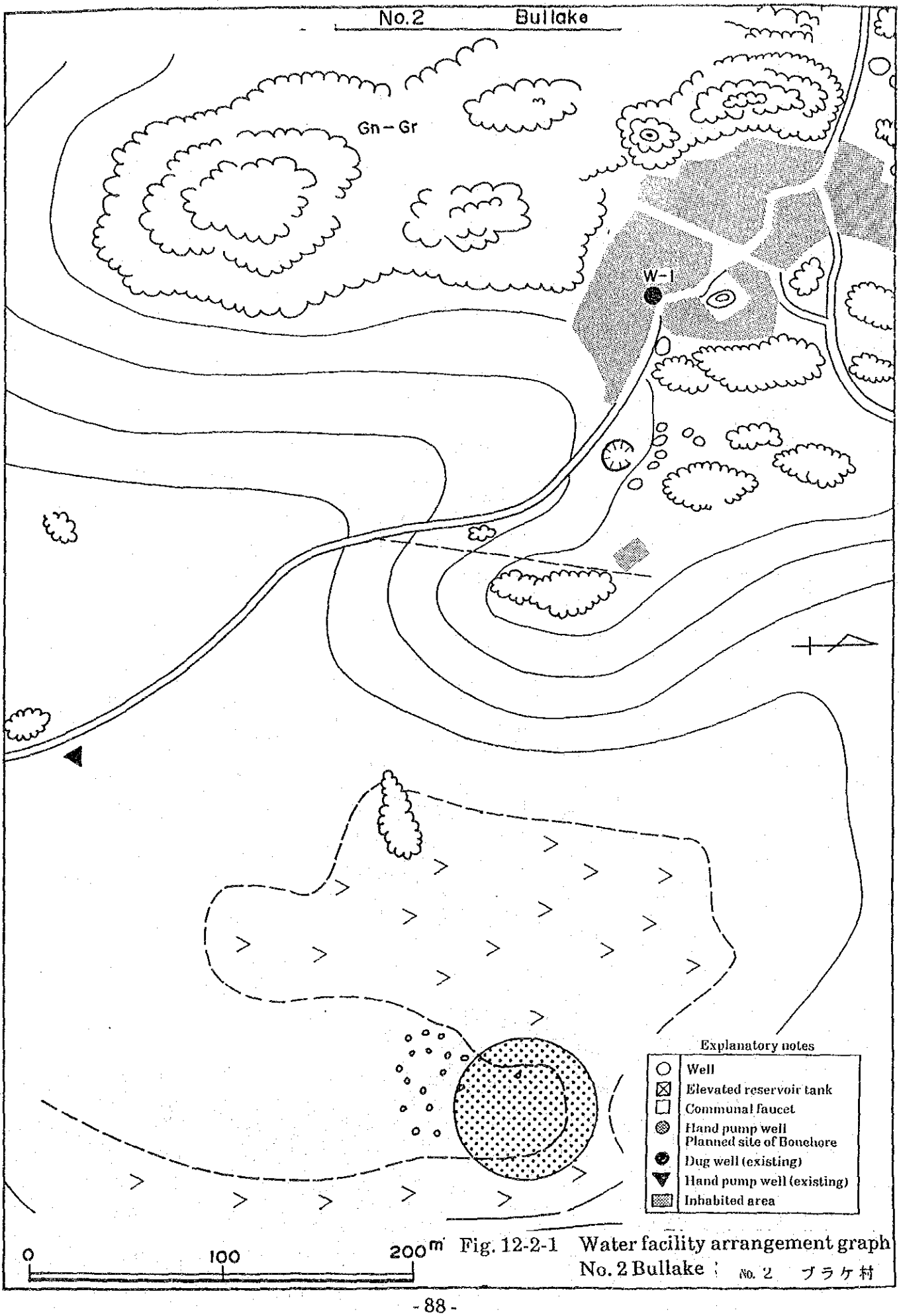


Fig. 12-2-1 Water facility arrangement graph
No. 2 Bullake : No. 2 ブラケ村

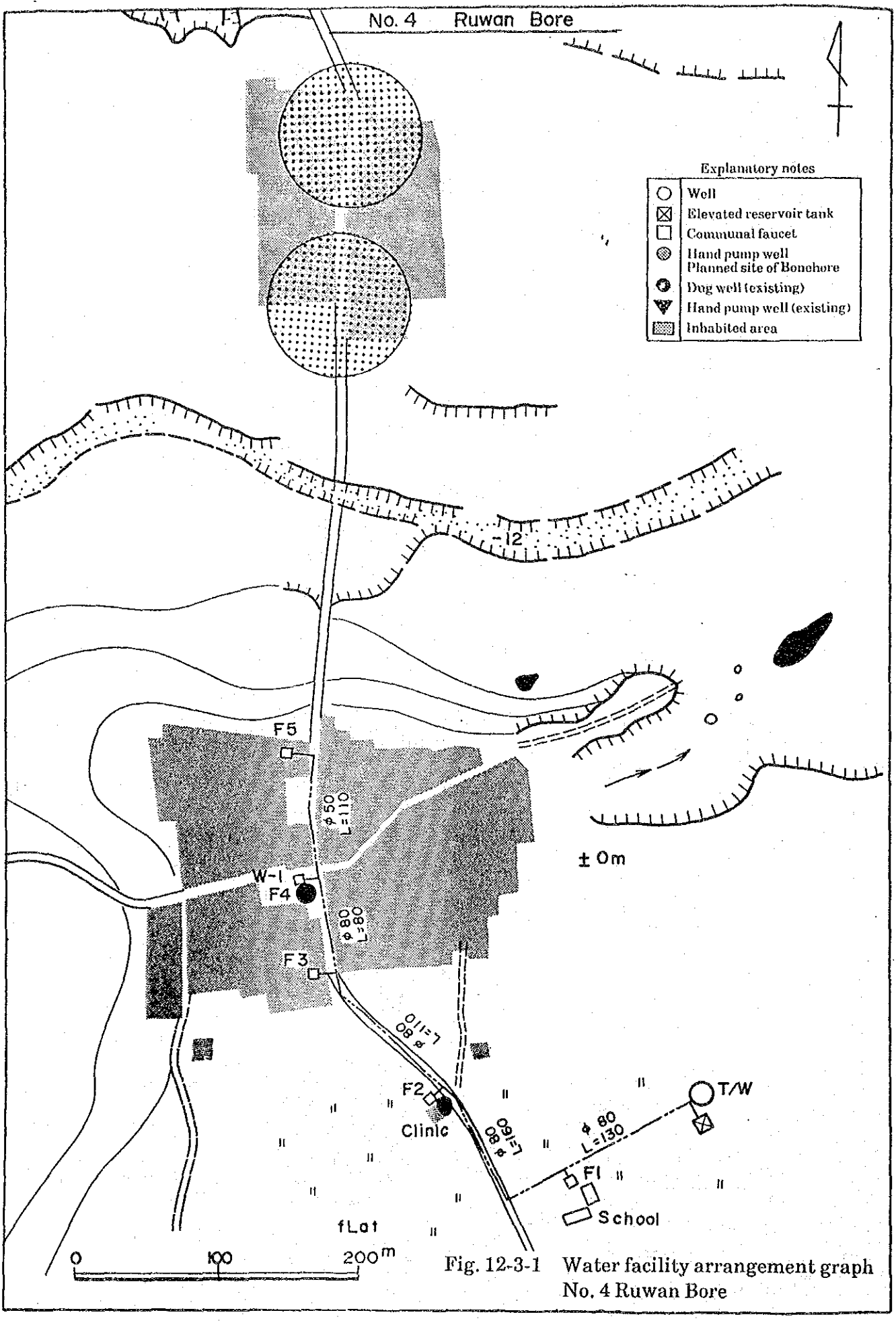


Fig. 12-3-1 Water facility arrangement graph No. 4 Ruwan Bore

No. 4 Ruwan Bore

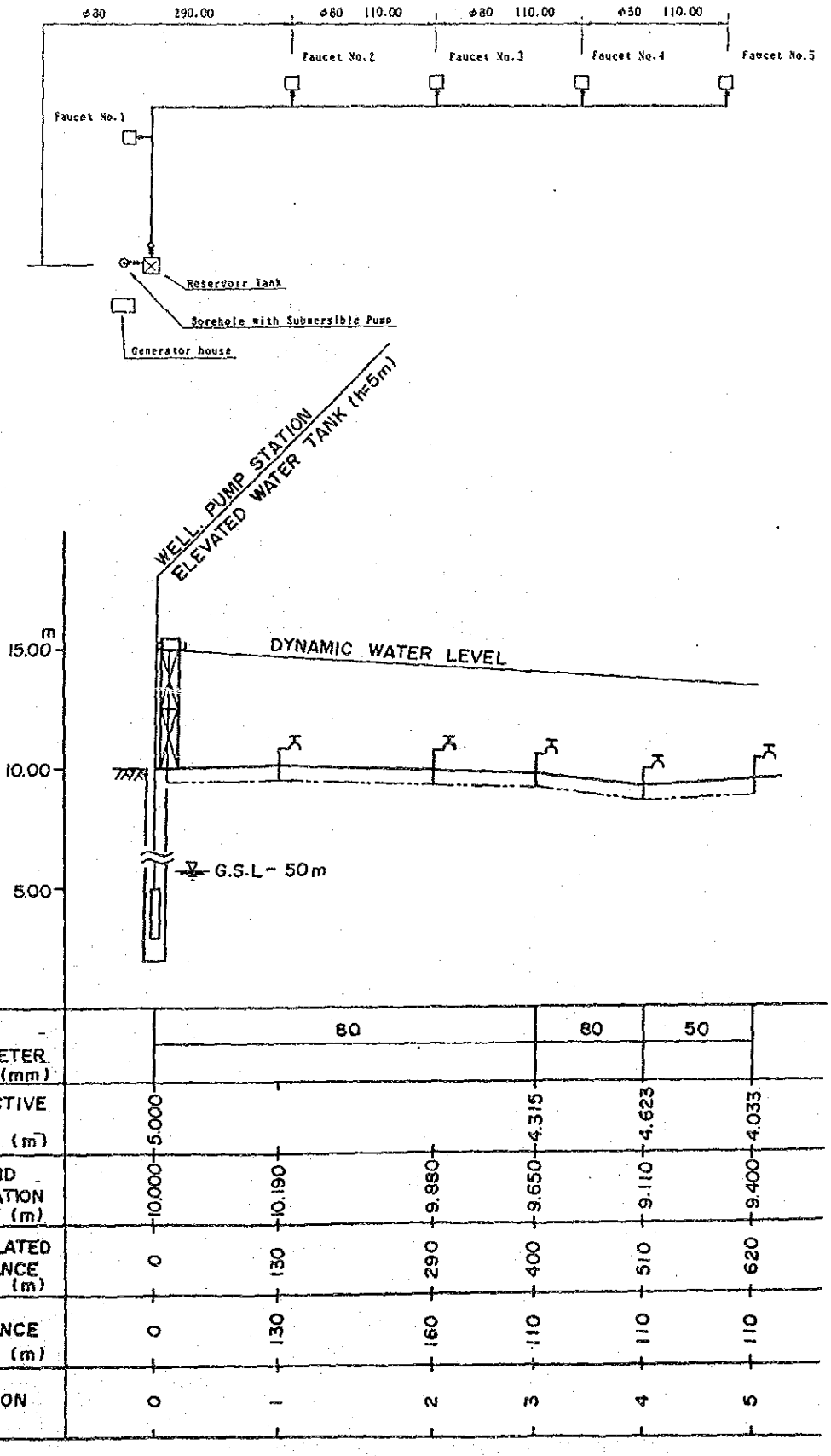


Fig. 12-3-2 Water supply facility vertical graph
No. 4 Ruwan Bore

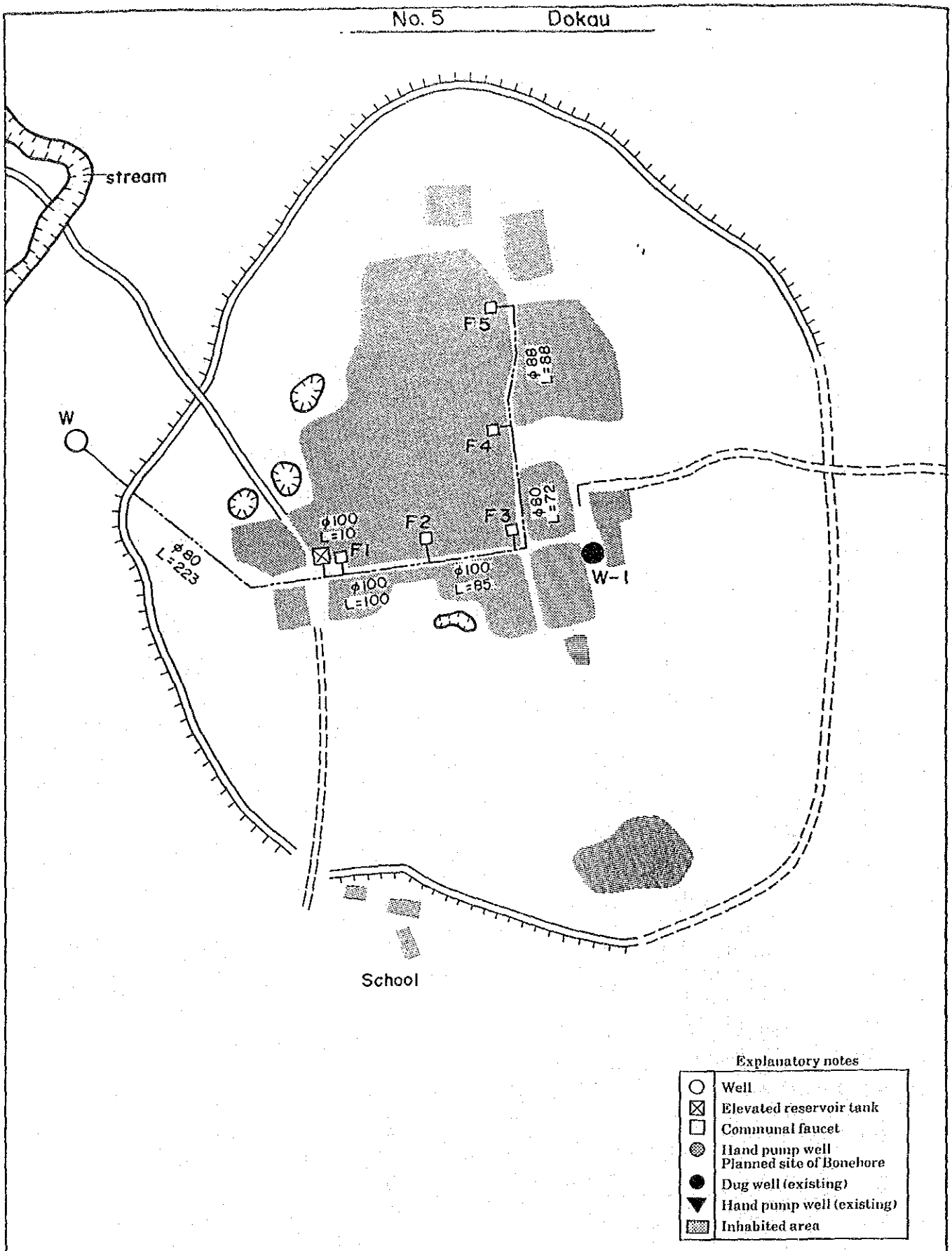


Fig. 12-4-1 Water facility arrangement graph
No. 5 Dokau

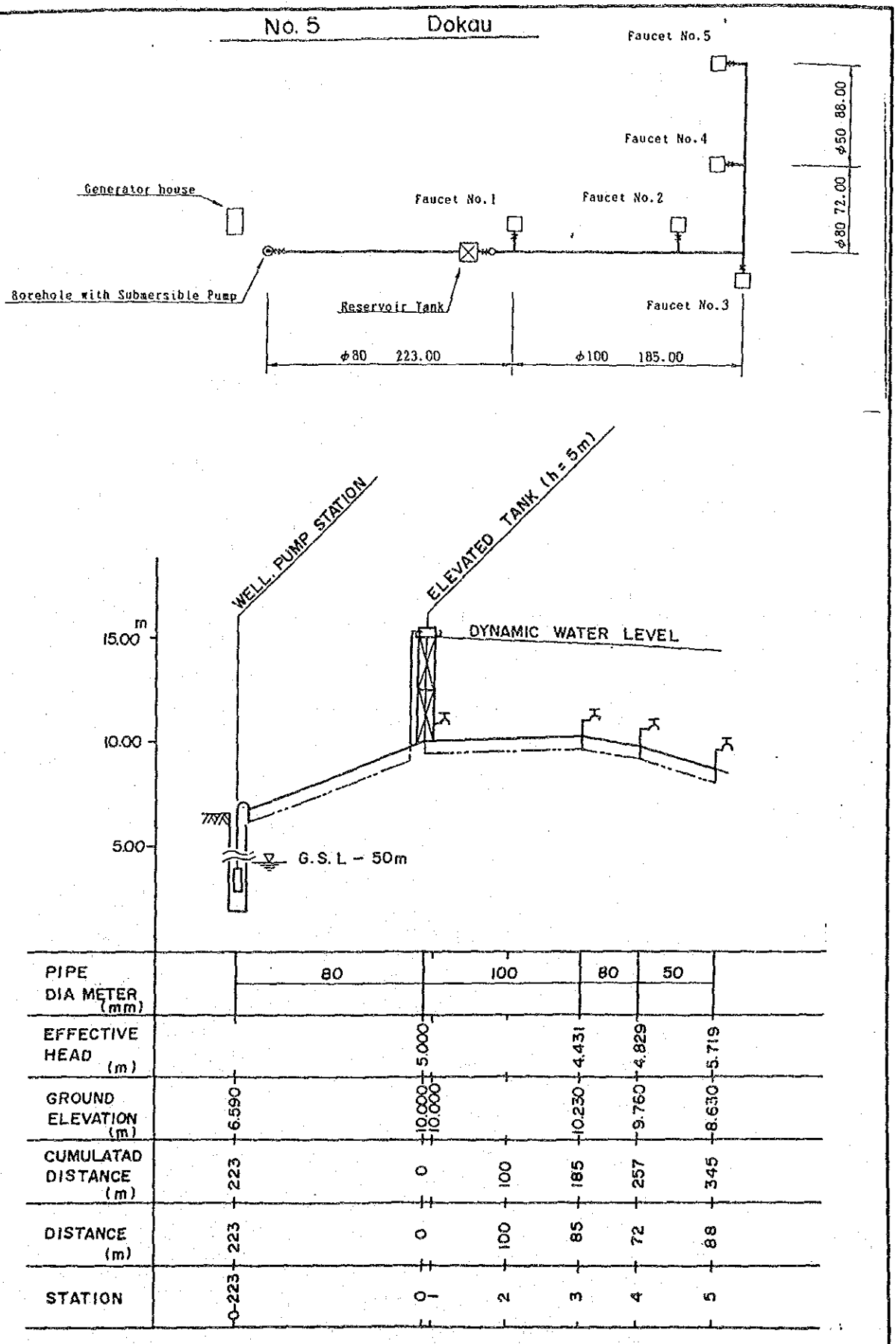


Fig. 12-4-2 Water supply facility vertical graph
No. 5 Dokau

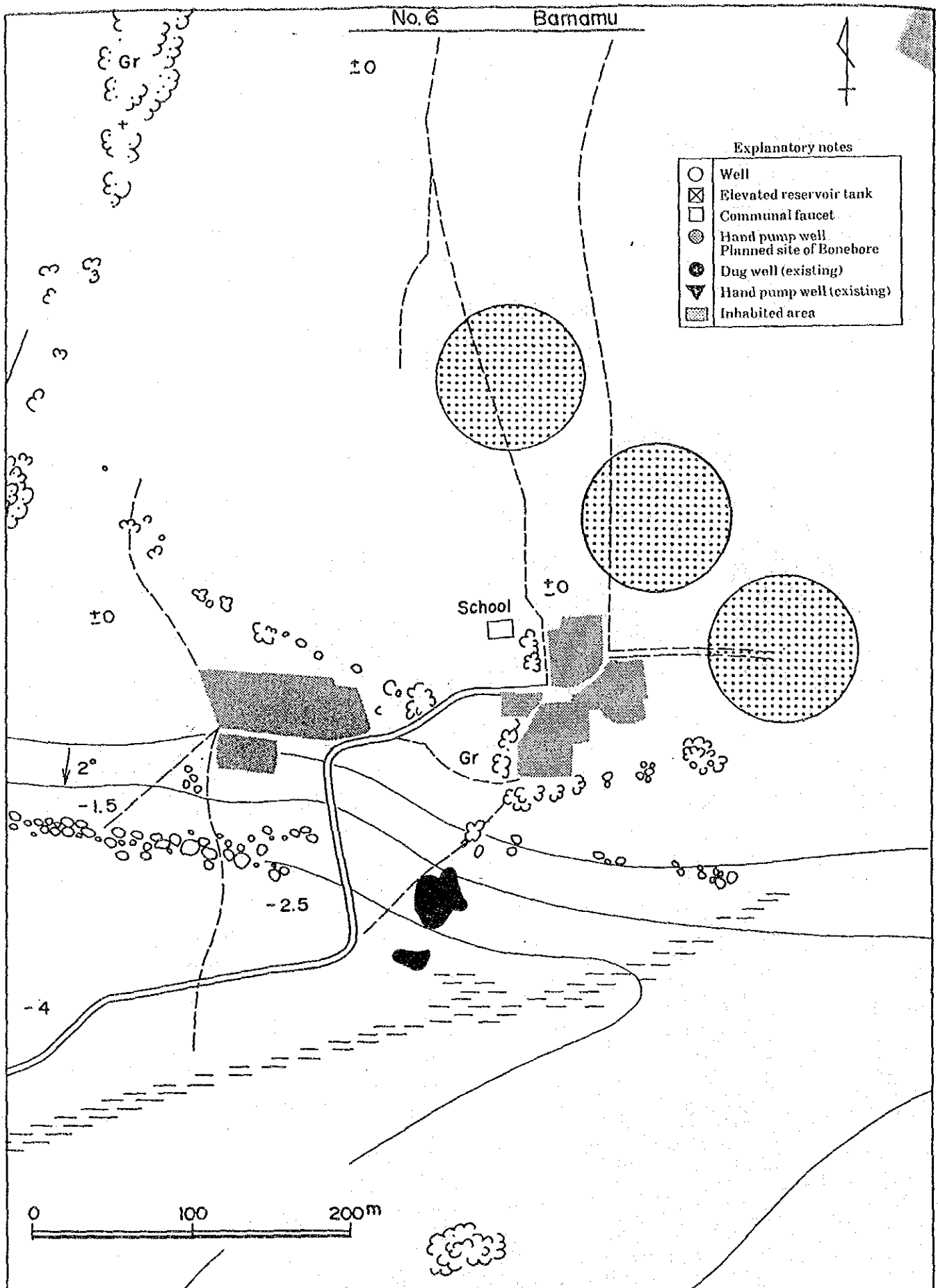


Fig. 12-5-1 Water facility arrangement graph
No. 6 Bamamu

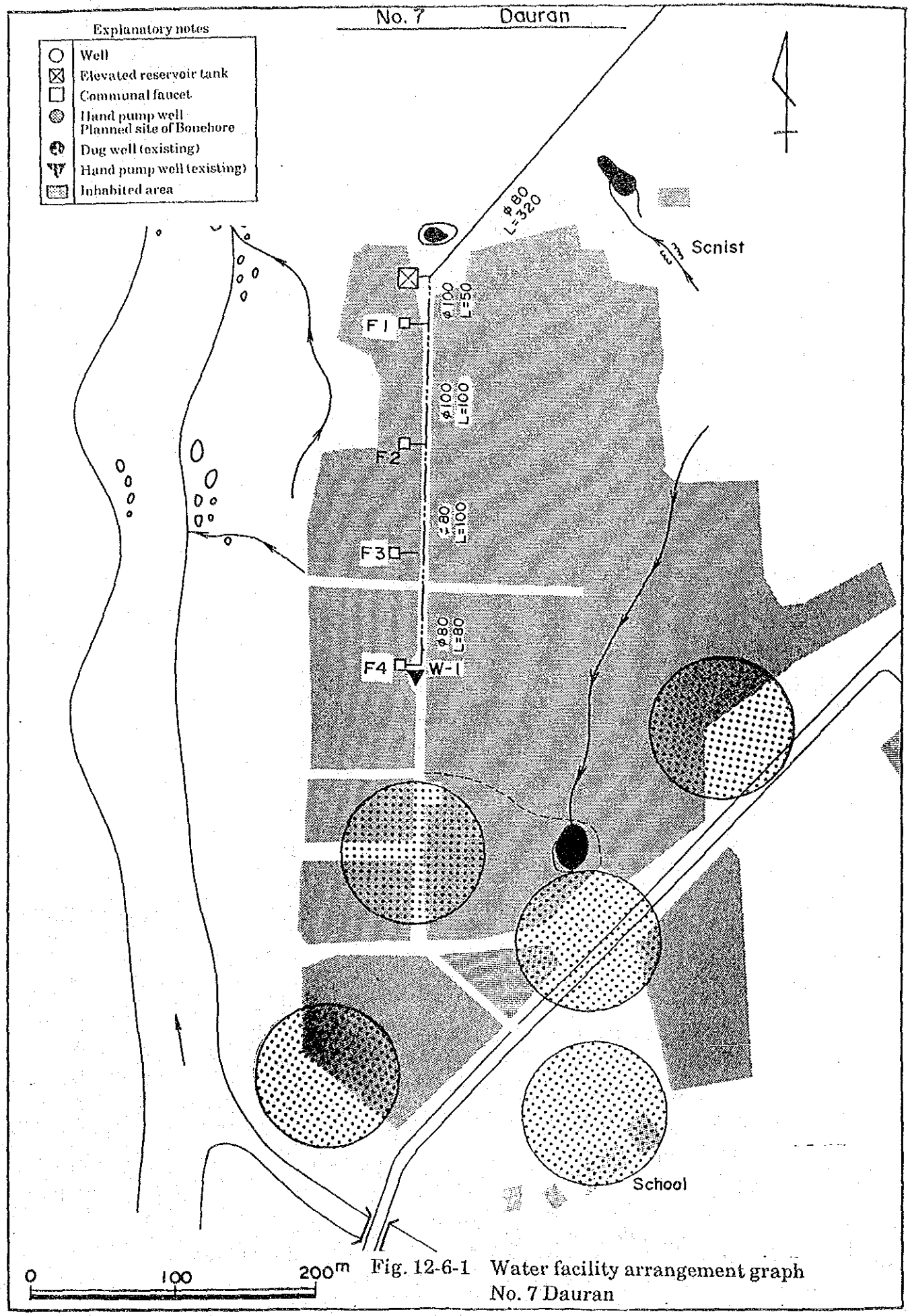
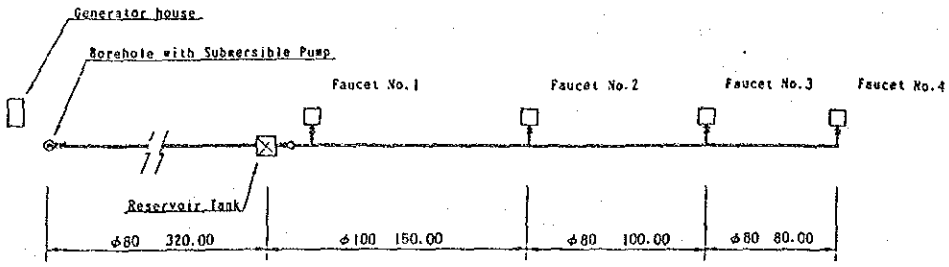
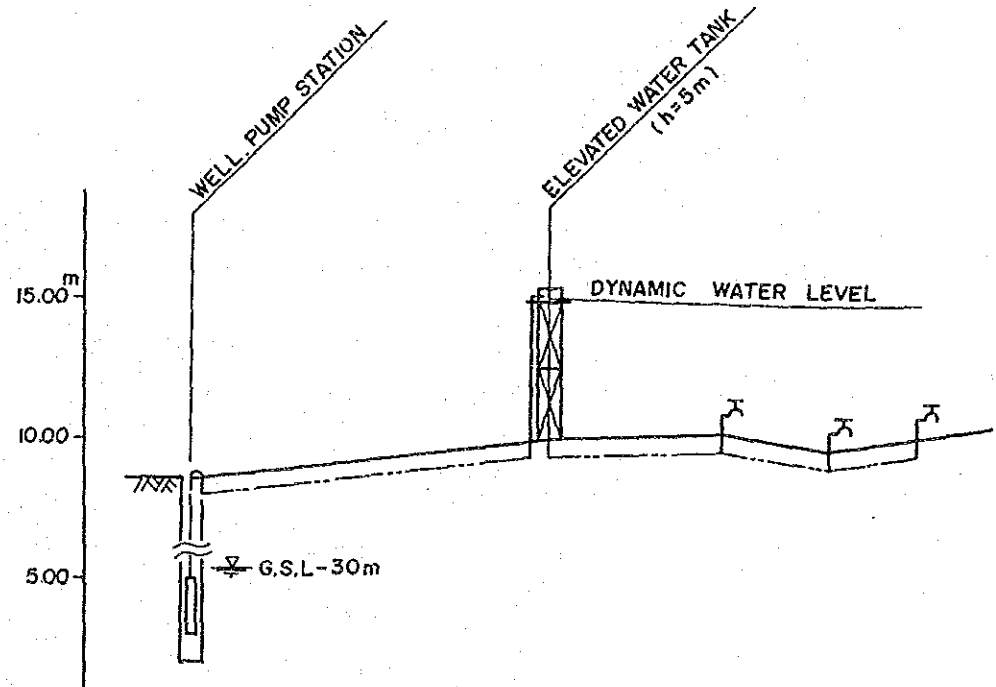


Fig. 12-6-1 Water facility arrangement graph No. 7 Dauran

No. 7 Dauran





PIPE DIAMETER (mm)		80	100	80
EFFECTIVE HEAD (m)		5.000	4.518	5.148	4.716
GROUND ELEVATION (m)	8.530	10.000	10.300	9.570	9.980
CUMULATED DISTANCE (m)	320	0	150	250	330
DISTANCE (m)	-320	0	150	100	80
STATION	0-320	0	1	2	3

Fig. 12-6-2 Water supply facility vertical graph
No. 7 Dauran

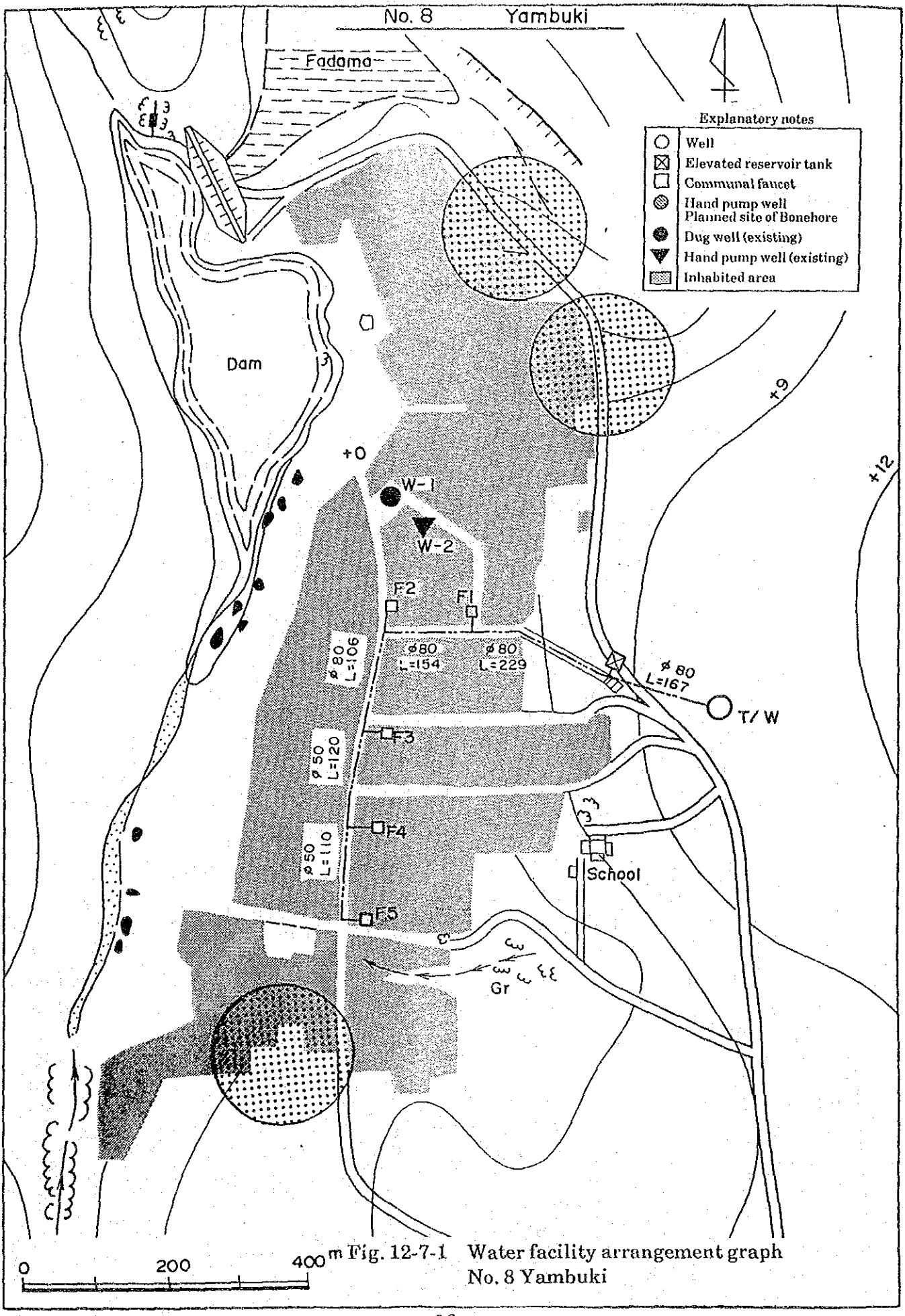


Fig. 12-7-1 Water facility arrangement graph
No. 8 Yambuki

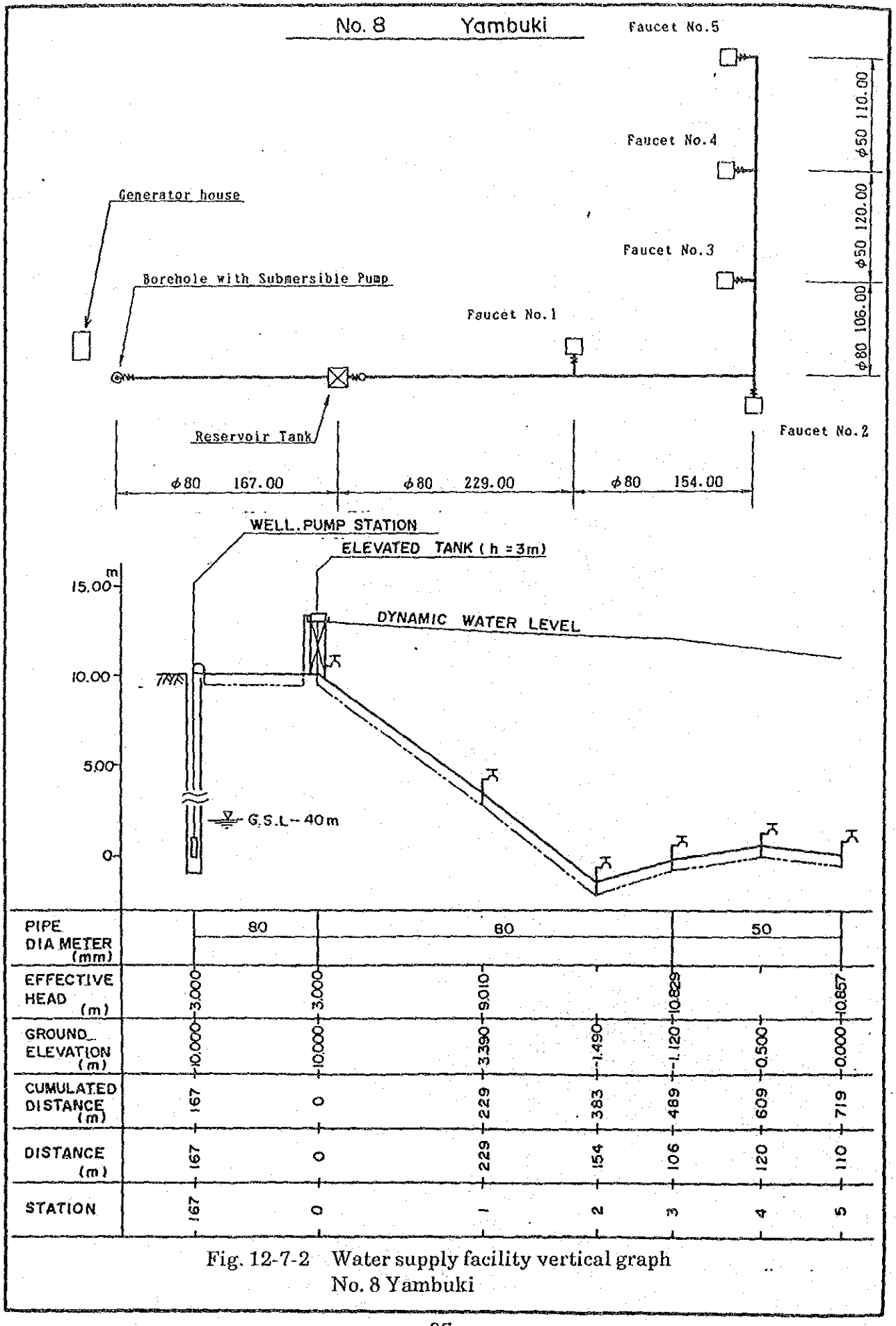


Fig. 12-7-2 Water supply facility vertical graph
No. 8 Yambuki

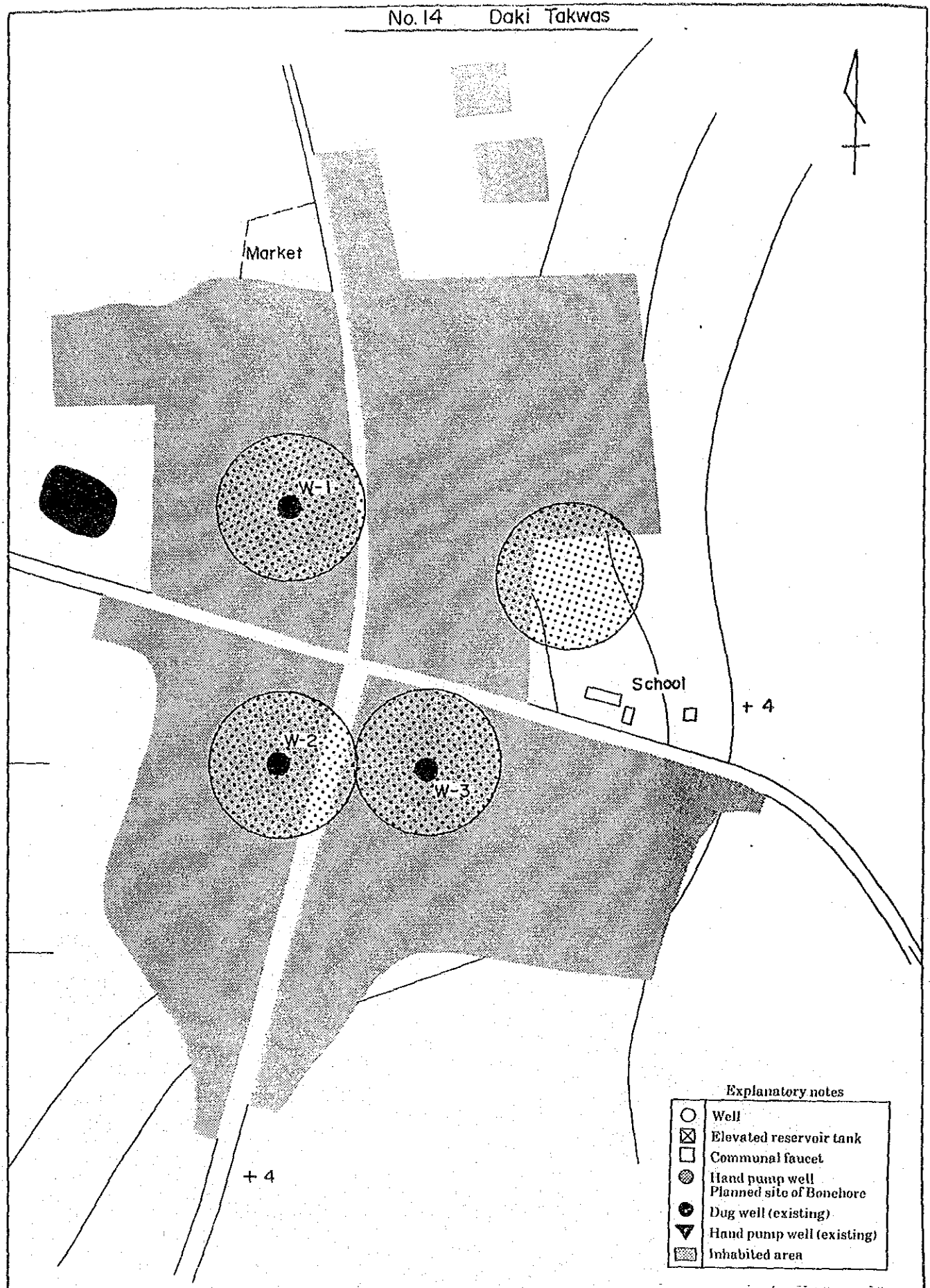


Fig. 12-8-1 Water facility arrangement graph
No. 14 Daki Takwas

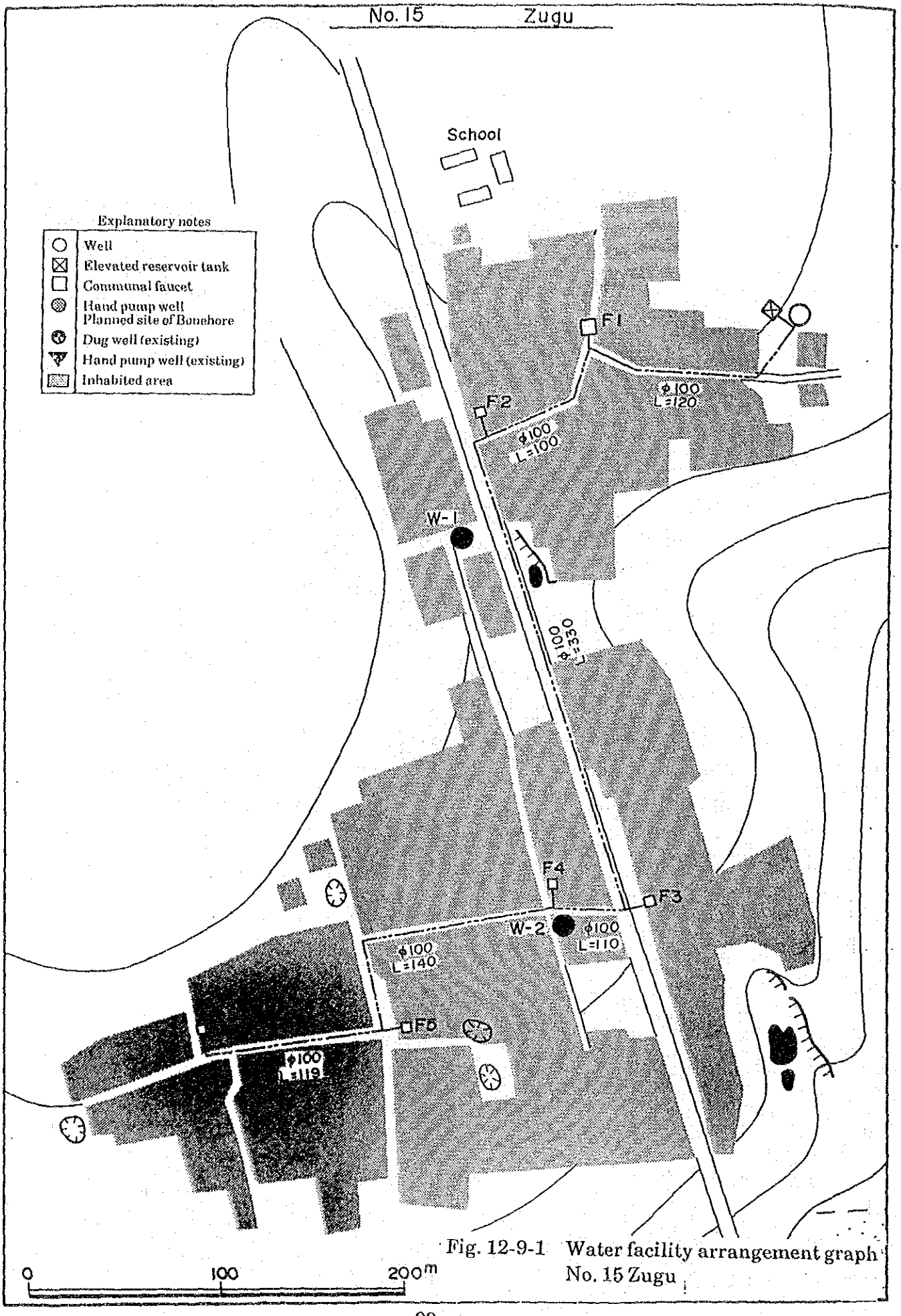


Fig. 12-9-1 Water facility arrangement graph No. 15 Zugu

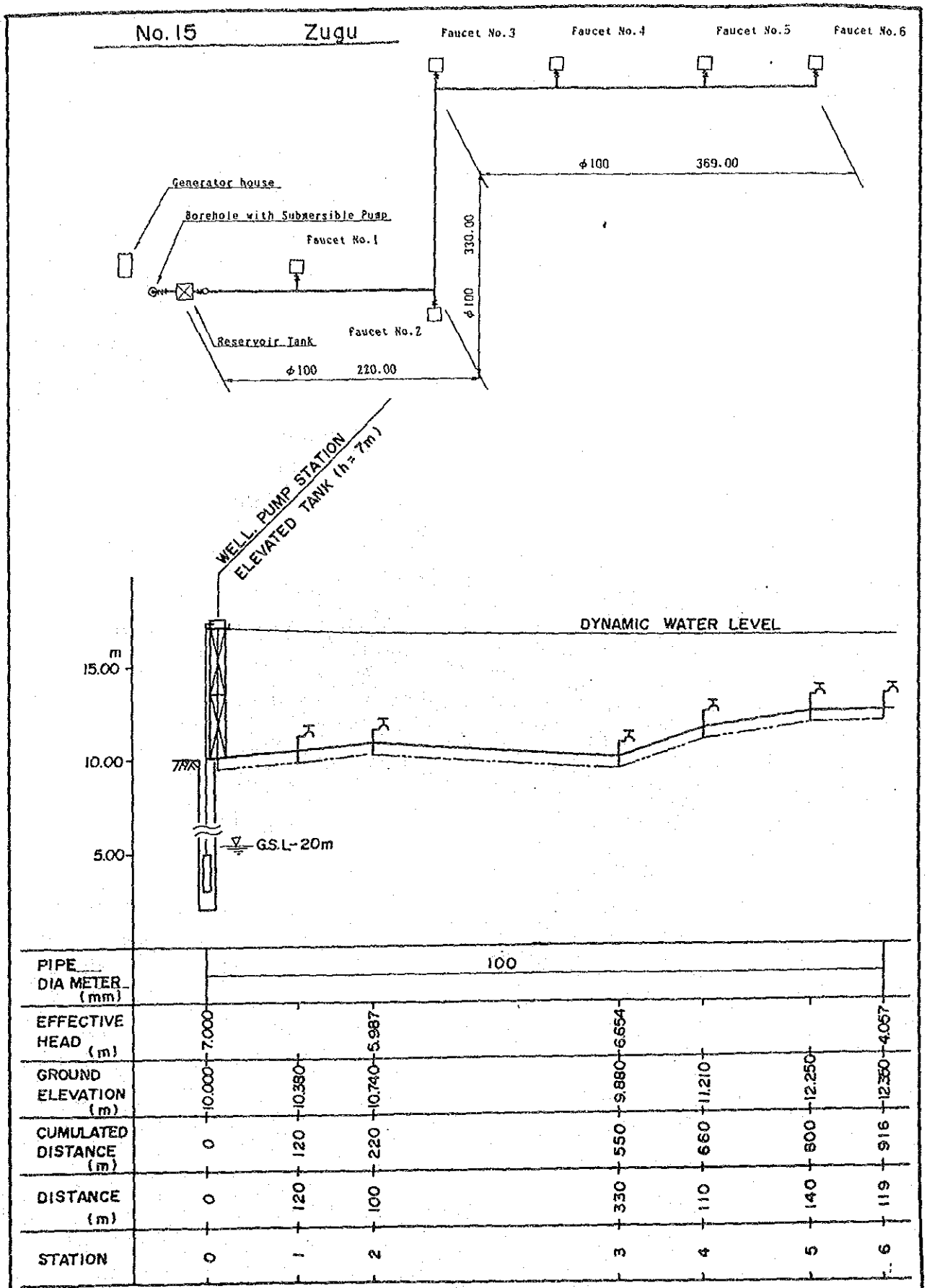


Fig. 12-9-2 Water supply facility vertical graph
No. 15 Zugu

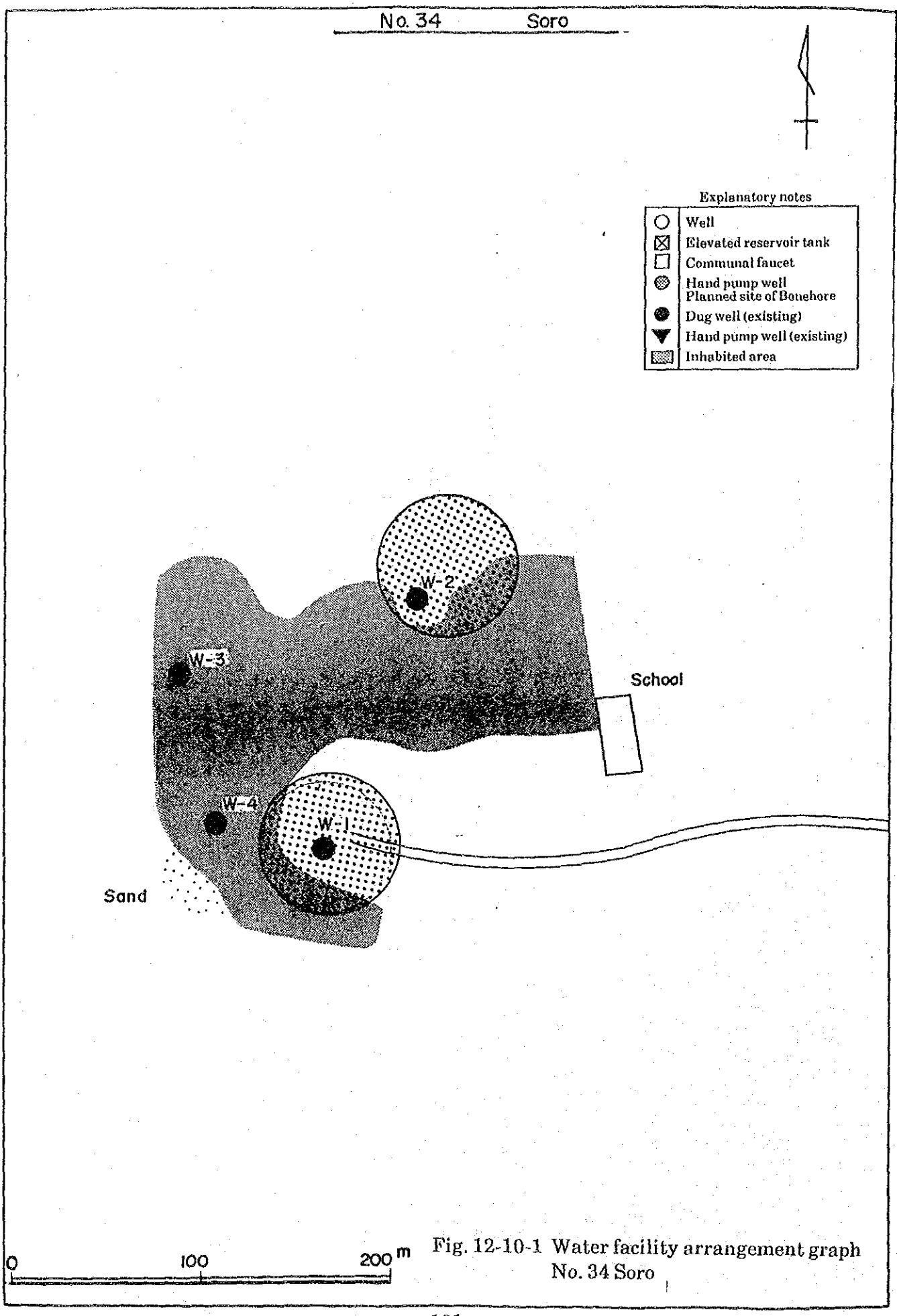


Fig. 12-10-1 Water facility arrangement graph
No. 34 Soro

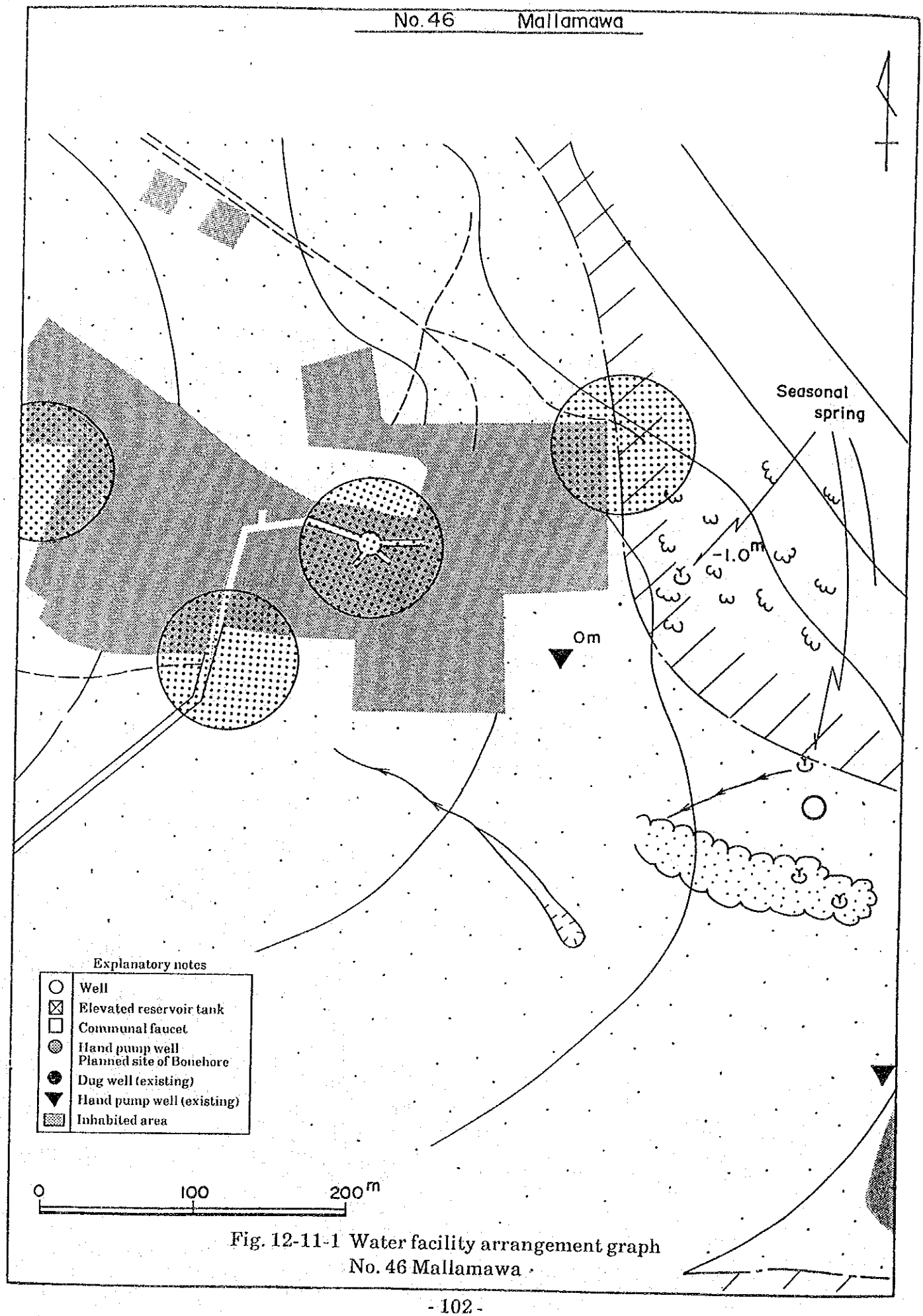


Fig. 12-11-1 Water facility arrangement graph
No. 46 Mallamawa

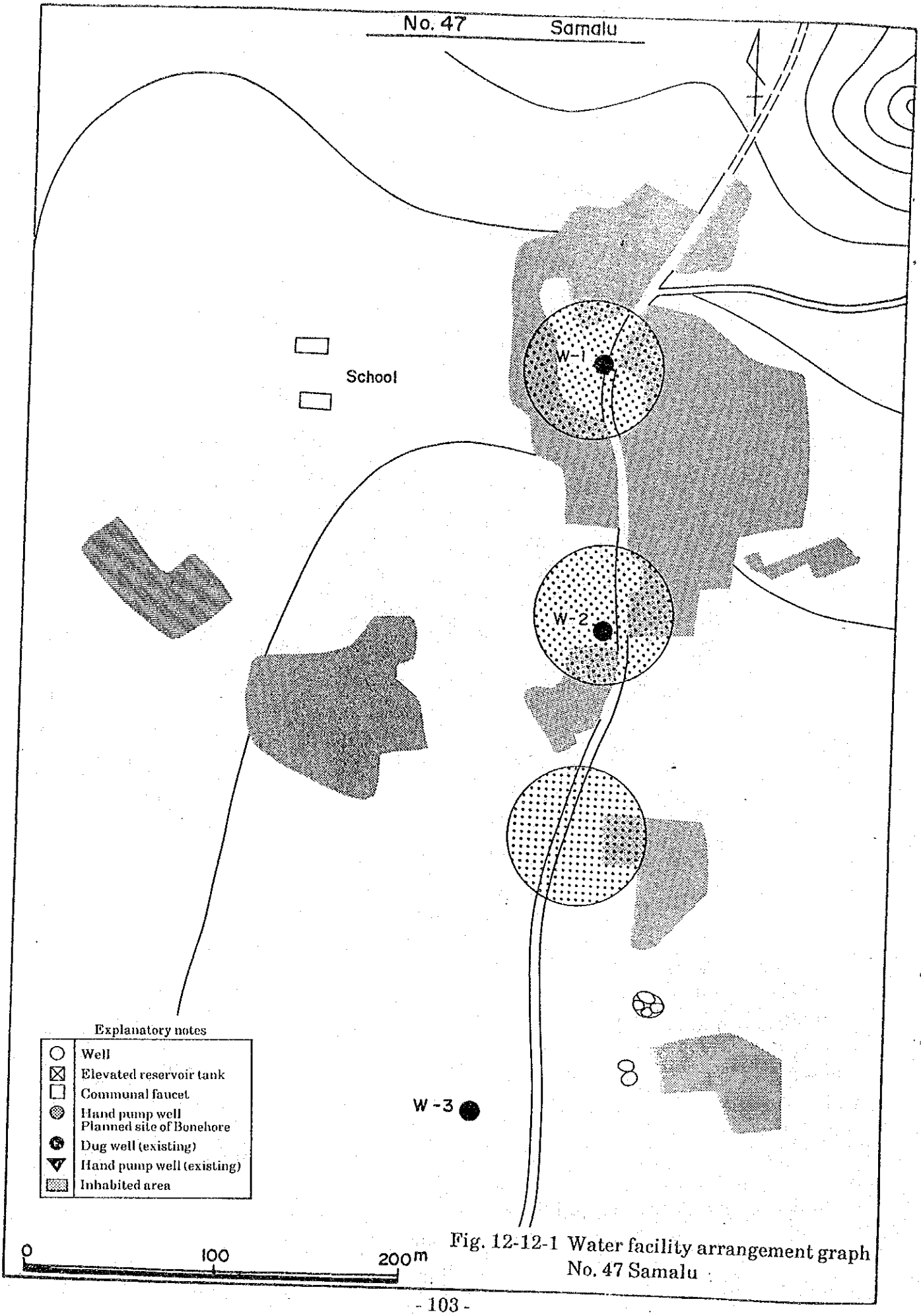


Fig. 12-12-1 Water facility arrangement graph
No. 47 Samalu

4-4 Implementation Plan

4-4-1 Implementation Policy and Personnel Required

The details of the implementation plan are as written below.

- Procurement and delivery of equipment and materials;
- Site preparation work (base camp construction);
- Washing and re-development of existing wells (conversion of 5 wells to hand pump wells and motor pump wells);
- Well construction (32 wells in 11 places; total length of the new wells is 1,760m);
- Water supply facility construction:
  (1) Hand pump facilities (32 places in 10 villages)
  (2) Semi-urban type facilities (5 facilities in 5 villages)

Since the construction works can be accomplished within 9 months by organizing more than 2 construction teams both for wells and other facilities, the overall construction period including material procurement/transportation is estimated to be not longer than 1 year as shown in Table 16.

The following three bodies shall take part in the implementation plan in case Japan's Grant Aid Program is applied.

- Sokoto State Water Board (the executing agency)
- Consultant
- Contractor (for material procurement and construction works)

The description of the role, system and personnel arrangement of the above bodies are as follows.

(1) The Role and System

1) The Role and System of the Sokoto State Water Board

The Sokoto State Water Board is the executing organ of the project. It smoothens banking arrangements and the processing of tax exemption papers for imported

materials after the exchange of notes pertaining to Japan's Grant Aid Program. It must also take the following measures to ascertain the smooth and effective progress of the project.

- To appoint the State Water Board's General Manager as the project's overall coordinator, to establish the project headquarters within its headquarters, and to appoint a project manager to take charge of the working level.

- The project headquarters, in accordance with the progress of the construction works, shall choose suitable counterpart personnel from the Water Board headquarters and area offices, and consider the effective execution of technological transfer through the associated management of construction works.

- In accordance with the construction site, a branch of the project headquarters is to be established in the Water Board's area office, and the project headquarters' personnel is to be stationed to the branch office for the duration of the construction works.

- To formulate special budgetary measures for the project headquarters to cover up management costs and the travel expenses, etc., of the staff.

- To train the area residents and LGA staff who are in charge of the work, and to establish a system that entails the independent operation and maintenance of the facilities by the area residents and LGA staff during the construction period.

- After the completion of the construction of water supply facilities, the trained personnel will continue to inspect the facilities in the 12 Sokoto villages under the direction of the project manger.

2) The Role of the Consultant

After the exchange of notes, the Consultant enters into a contract with the Sokoto State Water Board concerning his services, which are written below, in order to smoothly implement the project.

- The formulation of the tender documents for the construction works and the procurement of materials.

- Administration of the construction work and the procurement and delivery of the materials and equipments.

- tendering and evaluation of documents.

- Witnessing and counselling the contract negotiations between the Nigerian Government and the successful bidder of the above mentioned tender.

- To carry out a geophysical survey to pinpoint drilling sites, and other field surveys to prepare the detailed design study report.

- To give advice on the establishment of the facility maintenance system.

In order to smoothly and effectively conduct the above services, the Consultant should secure skilled personnel for each field and stage of work, and organize the most suitable working team.

3) The Role of the Contractor

The Contractor procures and transports the equipment and materials stipulated in the contract. By utilizing the procured equipment and materials, the Contractor carries out the following construction work under the supervision of the State Water Board Headquarters which is assisted by the Consultant.

- Drilling and finishing works of 32 wells (total length of 1,760m)

- Cleaning and re-development of the 5 existing wells for their conversion to motor pump wells.

- Installation of hand pumps on 34 wells (10 villages) and the construction of 32 pump bases.

- Construction of semi-urban type water supply system in 5 villages and the test run of these facilities.

- Dispatchment of Japanese technical experts in various fields to the project site to conduct the works, and through the construction works, consider the transfer of technological skills on well drilling and management, pumping test, pump installation,water supply facility construction, inspection of materials, supply and facilities, etc., to the Nigerian engineers.

- To show the local contractors employed as subcontractors the proper way of managing the works and to adequately carry out technology transfer during the construction of water supply facilities.

(2) Personnel Arrafngement Plan

The personnel arrangement plan of the three bodies mentioned above is shown in Table - 14.

(3) Organization of Work Groups

The Japanese Contractor, who enters into a construction contract with the State Water Board, can employ local contractors as Sub-Contractors for the well and supply system construction work. In order to complete the work within the contract period,the contractor is suggested to organize more than two work groups.

1) To conduct the re-development of the existing wells in the 5 villages and convert them into motor pump wells within a short period of less than 5 days (for each village). Furthermore, to be able to start the work before the arrival of the construction materials from Japan, one of the work groups consisting of several members including the 3 below must be organized.

- 1 drilling equipment or crane truck operator
- 1 assistant operator
- 1 pumping test technician

2) The well construction works should be conducted by two work groups, that is , Group A for the DTH drilling method used mainly in the basement rock area (23 wells, 1,260m in length), and Group B for the mud drilling work using tricone-bits used mainly in the sedimentary area (9 wells, 500m in length).

Group B should join Group A after finishing its work assignment to shorten the drilling period in the basement rock area.

Each group consists of 10 to 15 workers including :

- 1 engineer to supervise the drilling works
- 1 experienced operator
- 2 assistant operators
- 1 pumping test engineer
- 5 labourers

Table 14 Project Personnel Distribution Plan

Item		Position	Number of Personnel	Participation Period
SOKOTO STATE WATER BOARD	HEADQUARTERS	Overall Supervisor	1	entire period
		Project Manager	1	entire period
		Hydrogeological Engineer	2	facility design survey period
		Well Construction Supervising Engineer	2	well related work period
		Civil and Construction Engineer	3	water supply facility construction period
		Operation and Maintenance Engineer	2	periodically appropriate after the construction of several facilities
	AREA OFFICE (5 AREA OFFICES CONCERNED)	Civil and Construction Engineer	1 each	construction of the water supply facilities in area of jurisdiction
		Operation and Maintenance Engineer	1 each	all throughout the work in area of jurisdiction
		Control Personnel	1 each	〃
		Operators	1 each	〃
CONSULTANT		Chief Engineer	1	facility design survey period ; about a month from the commencement of the project up to its completion
		Facility Design Engineer	1	facility design survey period
		Hydrogeological Engineer	1	facility design survey period ; well construction period
		Tender Document Formulation and Accounts Expert	1	facility design survey period
		Resident Engineer	1	entire period
CONTRACTOR		Overall Manager	1	entire period after the signing of contract
		Well Drilling Works Supervising Engineer	2	entire period for well related works
		Well Test Engineer	2	same as the above
		Facility Construction Supervising Engineer	2	preparatory work and entire water supply facility construction period
		Distribution Pipe Installation Supervising Engineer	2	entire water supply facility construction period
		Electricity and Machine Repair Engineer	1	entire construction period
		Clerical, Accounting, and Materials Managing Staff	1	entire preparatory work and construction period

3) As for the construction of the hand pump facilities, the drilling group should carry out the simple pump test after the drilled well is completely cleaned, and the base construction work group should immediately follow to complete the facilities. The hand pump facility construction group shall consist of several workers including the engineers and special workers listed below.

- 1 construction supervisor
- 1 formworker; 1 reinforcing-bar placer
- 1 plasterer

4) The semi-urban type water supply facility construction works are to be undertaken by the following four work groups. Each work requires 1 construction supervisor, 5 to 20 general workers and the following specialists.

a) Pipe laying and communal faucet construction

- 2 surveyors
- 4 pipe fitters
- 2 plasterers

b) Installation of elevated reservoir tanks (foundation works, tower assembly works, assembly and installation of reservoir tank).

- 5 to 6 plasterers and reinforcing-bar placers
- 1 crane operator
- 1 assistant operator
- 4 to 6 scaffolding men

c) Construction of generator house

- 1 construction engineer
- 6 plasterers and carpenters
- 1 scaffolding man

d) Installation and test run of submersible pumps and generators

- 1 crane operator
- 2 electricians
- 1 mechanic

4-4-2 Construction Condition and Points to Pay Attention

(1) Obtainability of Construction Materials

The construction materials produced and sold in the project area are limited to cement, sand, gravel, bricks, concrete, building blocks, roofing materials and timber.

The kind of materials sold in the project area and neighboring States are steel pipes of small diameter, faucets, reinforcing iron bars, steel, hand pump sets, submersible pumps, generators and small reservoir tanks made of steel plates.

All the construction materials for water supply facilities are basically available. They are imported items though and,therefore, their procurement would involve various problems such as difficulty in the immediate purchasing of large amounts, the long interval between the time of order and delivery, and the unreasonable margin of the distributor. The equipment and materials to be procured in Nigeria are limited, therefore, to those produced in the area and few imported items. Among the imported materials, reinforcing bars, hand pump sets, and steel pipes of small diameter (ϕ50mm or less) can be procured because they are highly in demand, hence, they have large stocks, established import routes and are easily obtainable. However, the steel pipes sold in the area are of poor quality with joints in need of new screws.

(2) Constructors

With regard to well construction, there are more than 5 private construction companies with deep well drilling equipment in the neighboring Kano and Katsina State, and one of these construction companies can be employed as the project's Sub-Contractor. There are well drilling construction companies in Sokoto State, too. However, they can not be employed because their equipment are small and superannuated, and because of the absence of fully experienced drillers.

As for the construction of water supply facilities, many of the general civil engineering construction firms in the project area and in the neighboring States are well experienced and can be, therefore, employed as Sub-Contractors of the project. However, these workers are only used to the method which is generally adopted in this area, that is ,by constructing the elevated water reservoir tank by welding the steel and by setting a box type water tank made of steel on top of it.

Furthermore, the local contractors are not familiar with the general concept of the construction term, hence the need to strictly manage the construction, particularly the progress of the work.

4-4-3 Construction Supervisory Plan

The construction work in this project, as well as the procurement of the equipment and materials are to be consigned to the Japanese constructors. Construction work shall commence after the arrival of the equipment and materials from Japan.

The General Manager of the State Water Board is generally responsible for the construction work while the full time project managers of the Water Board should supervise the works with the assistance of the technical experts selected for each field of work by the State Water Board and the area offices.

The Japanese Consultant acts as an adviser and helps smoothen the well drilling and water supply facility construction work. The supervisory plan formulated by the Water Board Project Office based on the advice given by the Consultant are as listed below. The supervisor of the well drilling and water facility construction work shall conduct on the job training to the counterpart staff involved in the said works.

(1) Project Supervision

- Coordination and Communication with related ministries and local municipalities
- Preliminary arrangement with the Consultant; Reporting to the State Ministry of Public Works, Housing and Water Resources
- Administration of the Overall Work Progress
- Checking of Project Records, Work Report; Various Field Site Instructions
- The organization of a Water Association in each village, and Guidance in the Maintenance Work
- Labor Management and Accounting

(2) Supervision of the well drilling work

- Confirmation of Drilling Site and Transportation Routes
- Management of Drilling Work and Well Finishing Work

- Measurement of drilling depth
- Witnessing of well logging work
- Checking of the quality and quantity of gravel to be packed
- Witnessing of casing and screen installation
- Witnessing of well cleaning work
- Witnessing of pumping test, confirmation of results
- Confirmation of supplementary gravel packing and grouting work
- Witnessing of pump installation work and test run
- Confirmation of water quality analysis results

- Administration of the progress of the well drilling and finishing work
- Checking and arrangement of drilling work records and borehole log.
- Preliminary arrangements with the Consultant; reporting of the situation to the project managers.

(3) Supervision of water supply facility construction work

- Checking of the working diagram. (elevated reservoir tank, tower, distribution pipes, communal faucets and generator house)
- Meeting with the representatives of the beneficiaries, and the explanation of the operation and maintenance system
- Supervision of pipe laying work (checking of the earth work, water pipe materials, pipe connection work and the water flow test)
- Supervision of elevated reservior tank and tower construction work (checking of the foundation earth work, the formwork and the arrangement of the reinforcement, observation of concrete placing work, confirmation of concrete strength, witnessing and checking the assembly of the water tank and the tower, witnessing of the water loading test)