b) Regulation Facility

For the control of water flow and water level, stop valves will be installed at the inlets/outlets of the main pipeline.

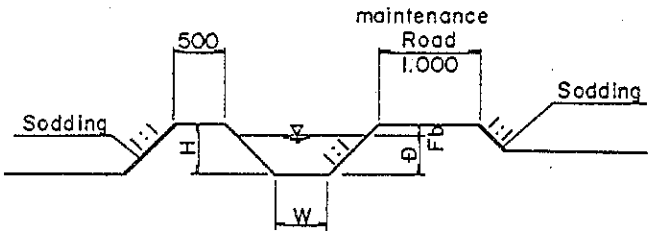
4) Protection Facility

From the viewpoint of structure of the intake facility, although grit coming into the pipeline will be minimal, a screen will be installed at the entrance of the intake for catching tree leaves.

5.1.4 Basic Design Drawings

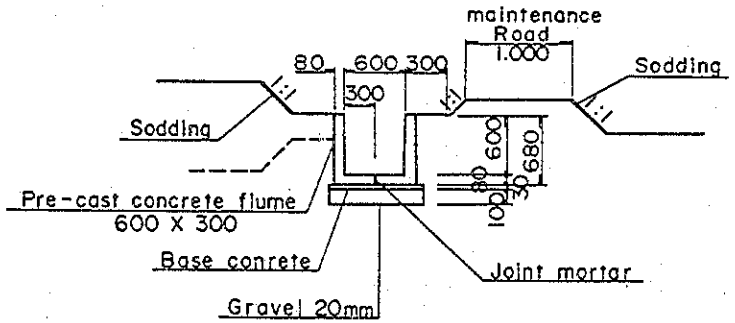
Basic design drawings are shown in the following sheets.

Name of Type : E.C. W×H

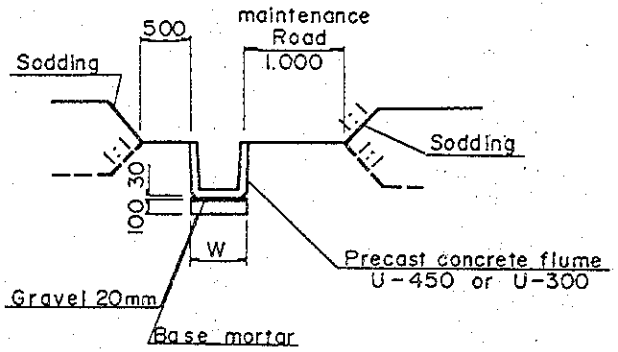


W = 600 ~ 300
H = 600 ~ 300

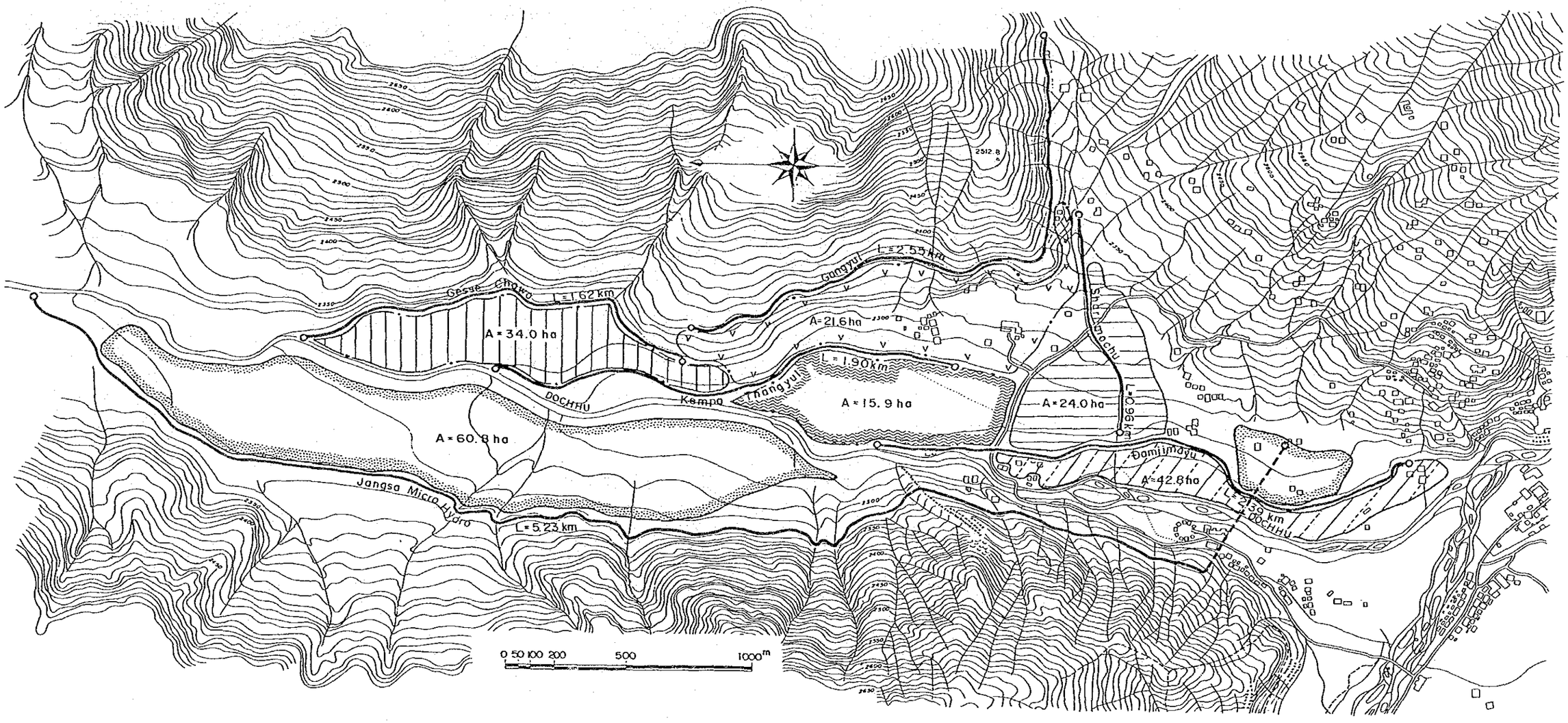
Name of Type : P.F.L-600

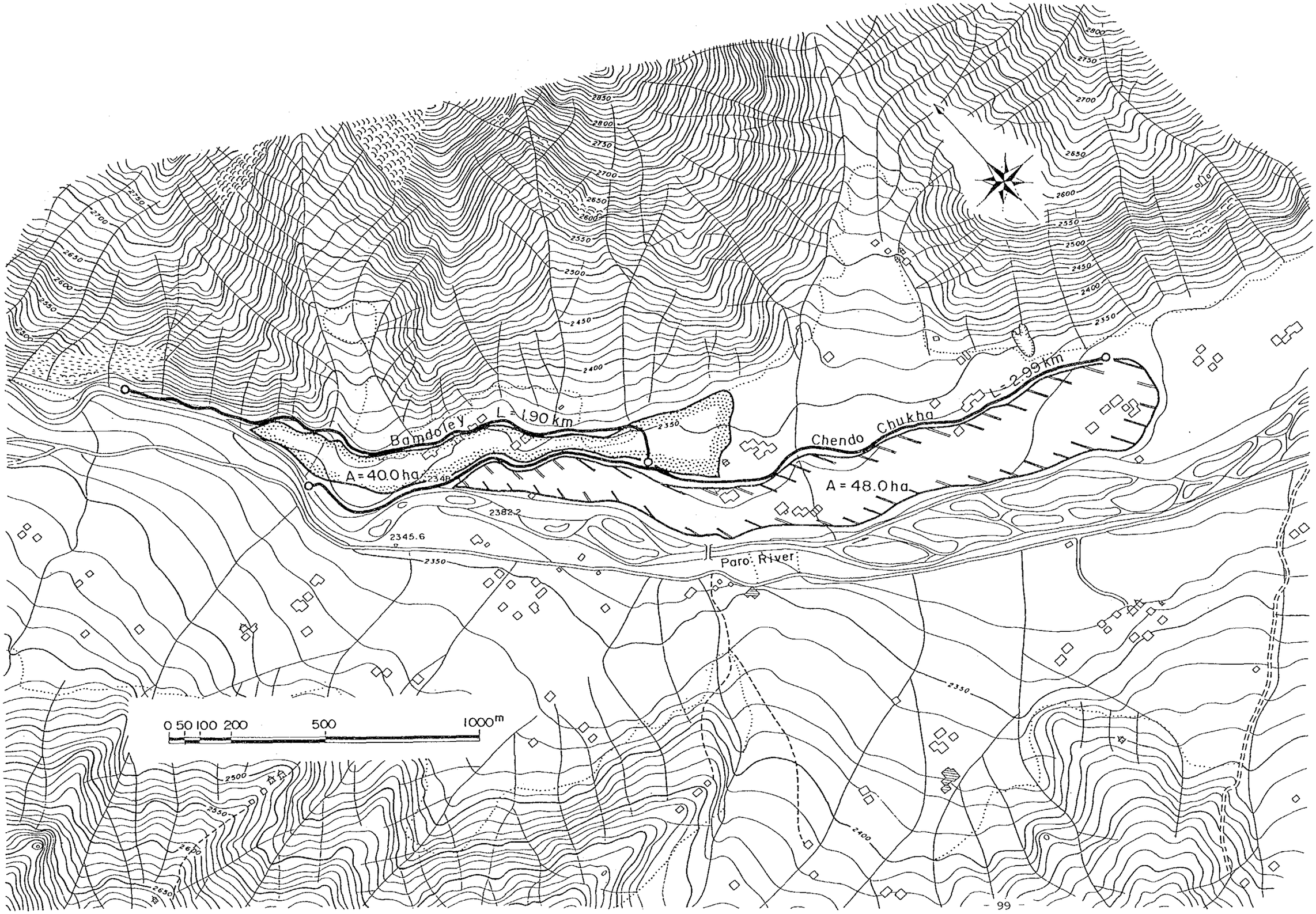


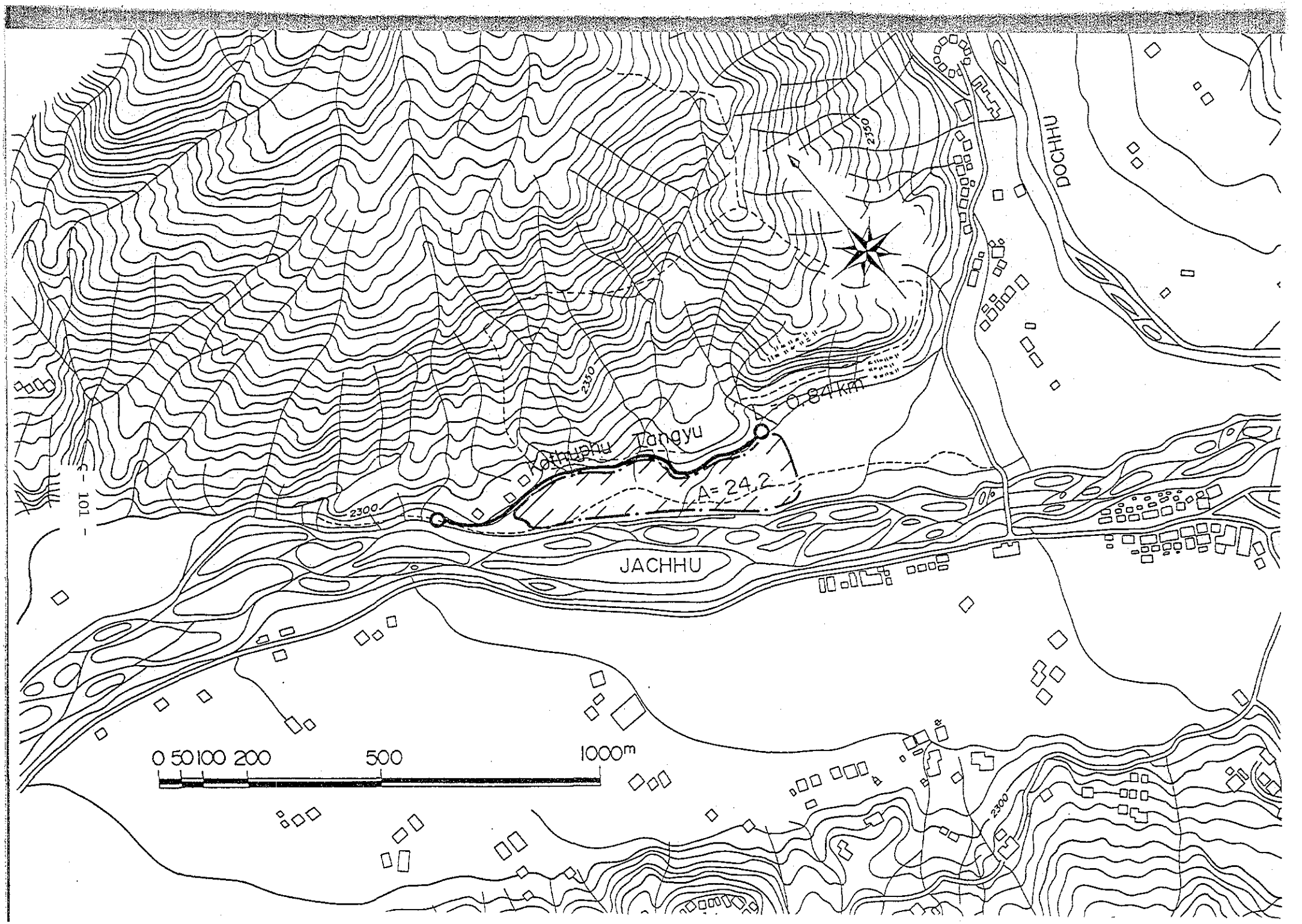
Name of Type : P.F.U-450
P.F.U-300

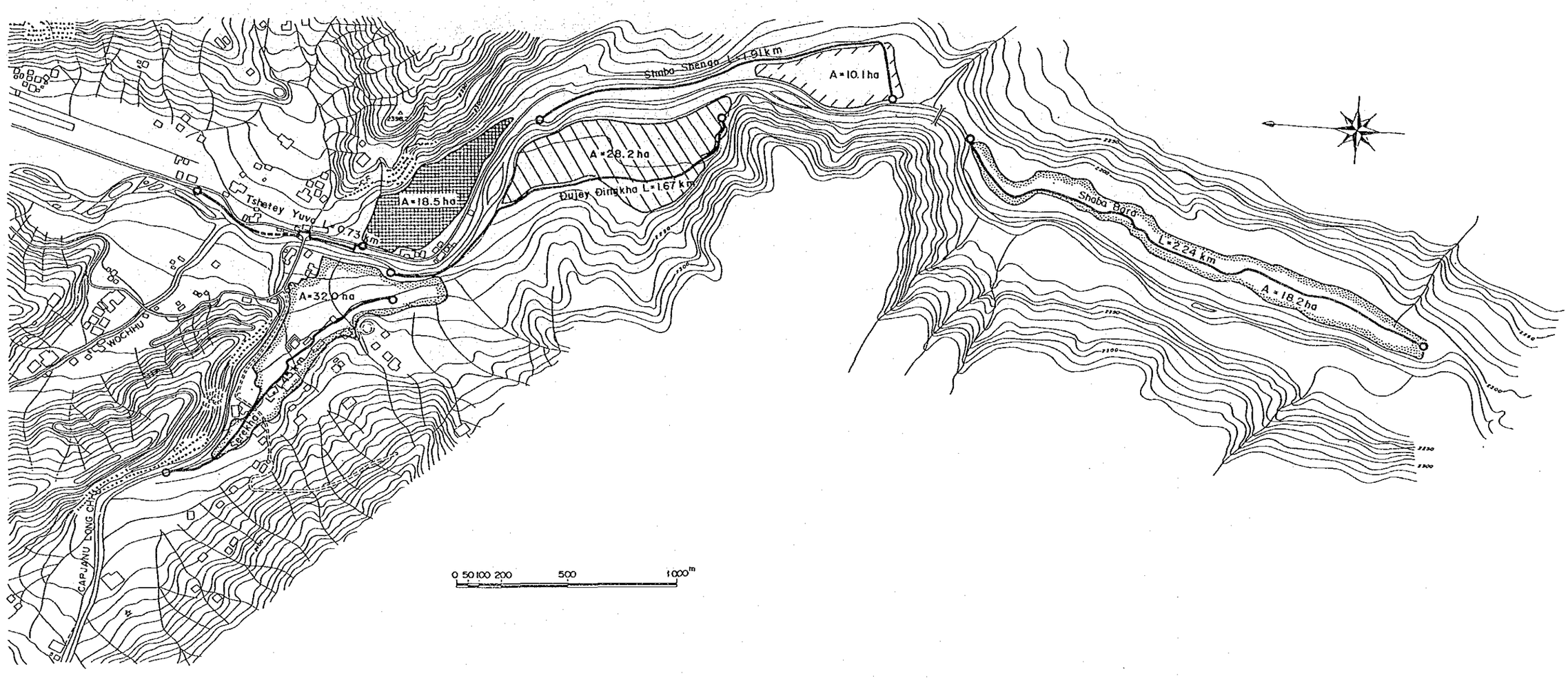


W = 560(U-450)
H = 400(U-300)


Gesye Chhawo L=1.62km
A=34.0 ha
DOCHHU
Kempo Thangyul L=1.90km
A=60.8 ha
Jangsa Micro Hydro
L=5.23 km
A=21.6ha
Gangyul L=2.55km
A=15.9 ha
Dochu
L=0.96km
A=24.0 ha
Damjimdyu
A=42.8ha
L=2.39 km
DOCHHU
0 50 100 200 500 1000m


Bamdoley L = 1.90 km
A = 40.0 ha
Chendo Chukha L = 2.99 km
A = 48.0 ha
Paro River
2345.6
2382.2
0 50 100 200 500 1000m


DOCHHU
2350
2350
2300
0.84km
Tangyu
Kathuphu
A=24.2
JACHHU
2300
0 50 100 200 500 1000m


Shaba Shenga L=1.91 km
A=10.1 ha
A=28.2 ha
Dujey Dingkha L=1.67 km
A=18.5 ha
Tshetey Yuva L=0.73 km
Shaba Bora L=2.24 km
A=18.2 ha
A=32.0 ha
WOCHHU
Tegong L=1.45 km
CAPJANU LONG CHHU
0 50 100 200 500 1000m

5.2. Farm Roads

5.2.1 Design Policy

Of farm roads to be constructed in the project, the basic plan for an existing farm road linking the Shari Bridge and the Jabji Suspension Bridge on the left bank of the Dotey River has been completed in Phase 1. All of the other 5 routes are to be newly constructed, and the road structure is proposed to be the same as that of the above-mentioned road.

The Bamdoley=Jangsa, Nyemi-Zam=Khangku and Shorten-Sarpa=Deankha roads are to be designed in combination with river revetment work. The elevations of these 3 roads are to be calculated in relation to flood water levels.

The Sa-Tsam Chorten=Tshongdu road will pass through paddy fields. In view of this, the route will be situated in flat lands where there is a high possibility of agricultural mechanization.

The Bondey=Gebji road will pass through orchards and paddy fields. The main purpose of the road will be the transportation of the cash crops produced in Gebji village.

The above two roads must be designed with the balance of soil cutting and banking volumes in mind, since there are difficulties in using the forests nearby the site as a source area.

All of the above roads will act as trunk farm roads. Access roads to farmlands and farmhouses are to be constructed by the Government of Bhutan.

5.2.2 Study of Design Conditions

As the existing roads network in the project area is inadequate, the proposed farm roads will be planned so that they can be used as general use roads in the future. The designs were proposed with the above

considerations in mind.

- Design speed : 30 km/hour
- Design load : 14 tons
- Design conditions

Minimum curve radius	:	30 m
Minimum curve length	:	50 m
Maximum longitudinal gradient	:	8.0%
Minimum longitudinal curve radius	:	250 m
Minimum longitudinal curve length	:	25 m
Maximum steep composite gradient	:	11.5%

The installation of transition curves is deemed to be unnecessary, since the running speed is low and they have not been included in the national highways.

5.2.3 Basic Design

(1) Arrangement of Road Routes

The Bamdoley=Jangsa, Nyemi-Zam=Khangku and Shorten-Sarpa=Deankha roads are to serve as riverbanks too. Therefore, their routes should be planned so as not to drastically change existing river sections. On the opposite bank of the Bamdoley=Jangsa road is the national highway, maintained by the Indian government. On the opposite bank of the Nyemi-Zam=Khangku road, is the Paro Airport, which is also maintained by the Indian government and is protected by the existing revetment bank. As is shown by the fact that the opposite bank of the Bamdoley=Jangsa route was damaged by a flood which occurred in May 1989 which had a discharge 150 cu.m/sec, it would be impossible to protect roads from flooding in the future with the existing facilities, as future flood discharges are estimated at 710 cu.m/sec up to the Paro confluence, and at 1,040 cu.m/sec after the confluence. This estimate is based on the traces of the 1968 flood. Hence it is not recommended to merely raise the bank height in the span of the road to be constructed in the project. In conclusion, the span of Bamdoley=Jangsa is to have the same elevation as the national highway, and the span of Nyemi-Zam=Khangku to have the same elevation as the opposite bank.

As the Sa-Tsam Chorten=Tshongdu route will run for a long distance,

access roads to the national highway will be constructed at both Lango and Ngopa. There is little possibility of the acquisition of material source areas, because all forests along the road belong to private owners. Therefore, the balance of soil cutting and banking volumes and the minor discrepancy between elevations of road surfaces and farmlands must be borne in mind.

The Bondey=Gebji route will require a considerable amount of excavation. Stability of the excavated surface should be borne in mind.

The Shorten-Sarpa=Deankha route is scheduled to be linked with the national highway at both ends of the route.

(2) Design

1) Route and Distance

Route	Distance in km
Bamdoley = Jangsa	6.6
Sa Tsan Chorten = Tshongdu	8.6
Nyemi-Zam = Khangku	1.7
Bondey = Gebji	1.6
Shorten-Sarpa = Deankha	3.3

2) Structure

i) Width

According to the traffic volume survey, the total volume consisting of passenger cars, buses, trucks, power tillers and tractors was 223 at Taju and 275 at Shaba, both on the national highway. As traffic volume on gravel-surface farm roads is estimated at less than 100 vehicles a day, the road will be designed to have one lane of 3.0 m in width. All of the existing bridges, reinforced concrete bridges on the national highway in the Paro area, the Shari Ramna Bridge, the Paro Market Bridge, the steel-truss Bondey Bridge and the Isna Bridge located outside the project area, have one lane carriageway of 3.6 m in width. Thus, the above 3.0 m width is considered appropriate.

ii) Road Shoulders

On both sides of the road, 50 cm wide shoulders will be constructed as protection for major structures, a temporary stopping area for car accidents, safety and ease of traffic flow, and as space for pedestrians and livestock.

iii) Slopes

Banking material taken from borrow-pits is mainly reddish brown soil. Excavated soil will be used as banking material, with the exception of soil containing lots of organic matter. The height of the banks will be less than 3.0 m, and the gradient of the side slopes will be 1:1.50. In excavation spans on the Sa-Tsam Chorten=Tshongdu route and the Bondey=Gebji route, alignment should be so designed as to make the excavation elevation lower. The gradient of the excavated slope is to be 1:50, a common figure in the project area. The slope of the bank facing the river is to be 1:2.0, since the present river gradient is as high as 1.5-2.0%, and the bank should be protected by gabions.

iv) Sub-base and Base Course

The base course shall be made of materials that can withstand friction, stirring and shock, as well as abrasion, smashing and weathering caused by weather and so on. It shall also be of a composition of materials that will not easily move. The road surface must be easy to maintain and repair. To satisfy the above requirements, crushed stones of a 20 mm size will be used.

For distributing vehicle loads and preventing the roadbed from excessive settlement, the sub-base will serve as a stable layer that will withstand drainage and sudden changes in weather conditions.

The sub-base and base course is determined by roadbed materials. Since roadbed materials are reddish brown soil, silty sand and fine gravel, and tamping is to be done using a 10-ton vibrating roller, the layer shall be 30 cm thick. Thus CBR values ranging from 3 to 5 can be expected as an approximation. Of these, the base course will be 3 cm thick, and the sub-base, 27 cm.

v) Typical Cross-Section

The typical cross-section drawn up on the basis of the results of the aforementioned factors, is shown in the attached drawing. Gabions will be 40 cm thick and extend 3 m horizontally at the riverbed from the foot of the slope in order to protect it from erosion. Protection sheeting will be installed under the gabions. This is to prevent erosion of the slopes and banks by rainwater and the river's flow. Sodding work will be executed on the slopes of the inner sides of the embankment and the road banking which is independent from the river protection works.

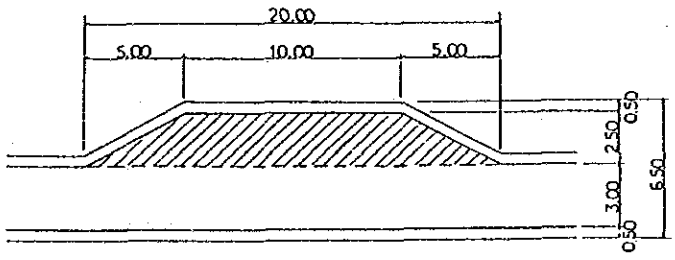
Poles will be installed in the gabions to prevent slippage. The upper end of the gabions will be protected by plain concrete and wrapped in a construction sheet.

3) Appurtenant Structures

i) Turnout

Since the road under discussion is a single-lane farm road, a turnout will be provided every 500 m, so as to ensure the smooth flow of traffic in cases when there is an on-coming vehicle. The size of these turnouts are shown below.

TURNOUT



ii) Crossing Structures

Small streams, canals and drainage lines to cross the proposed alignment will be planned to pass under the banking for new roads by way of reinforced concrete pipes. In spans where the banking height is low, the wheel load of running vehicles will directly act on the pipe walls. In such spans, the pipes should be protected with wrapping-concrete.

The diameter of the pipes is to be determined based on the canal discharge. The reinforced concrete pipes will be products of Bhutan. Diameters will be selected from a choice of 225mm, 300mm, 450 mm, 600mm, 750mm, 900mm, 1050mm and 1200mm pipes.

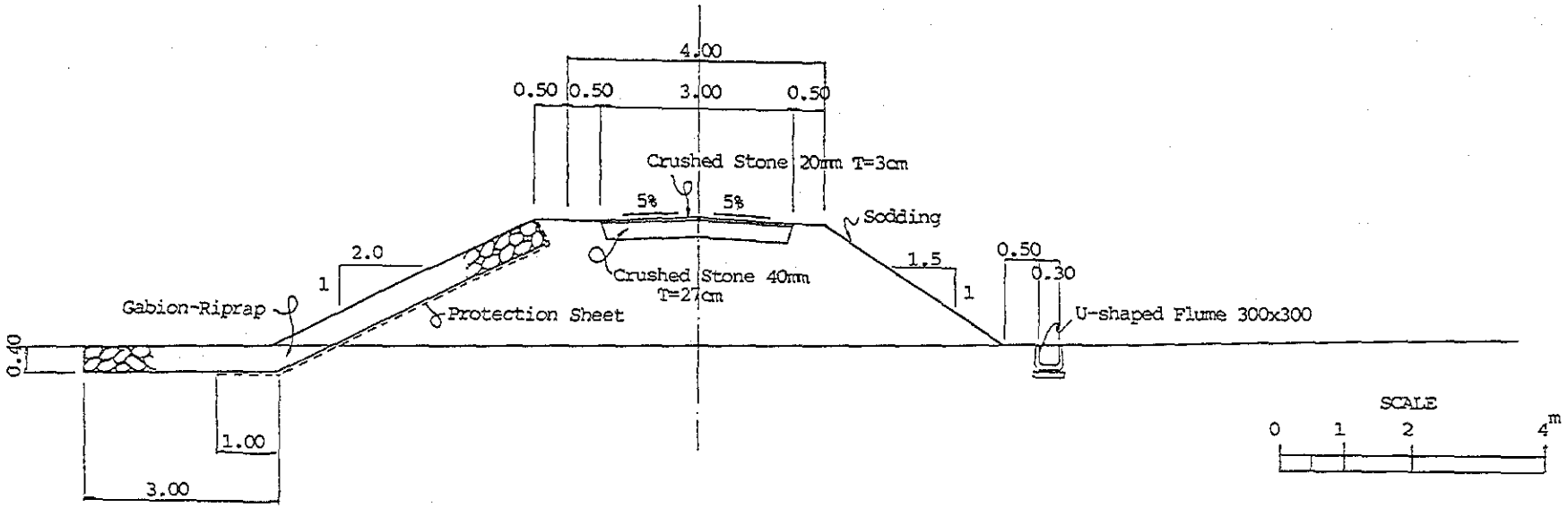
Small streams which were flooded in the 1968 flood or other floods are to be modified to submersible bridges.

(3) Construction Materials

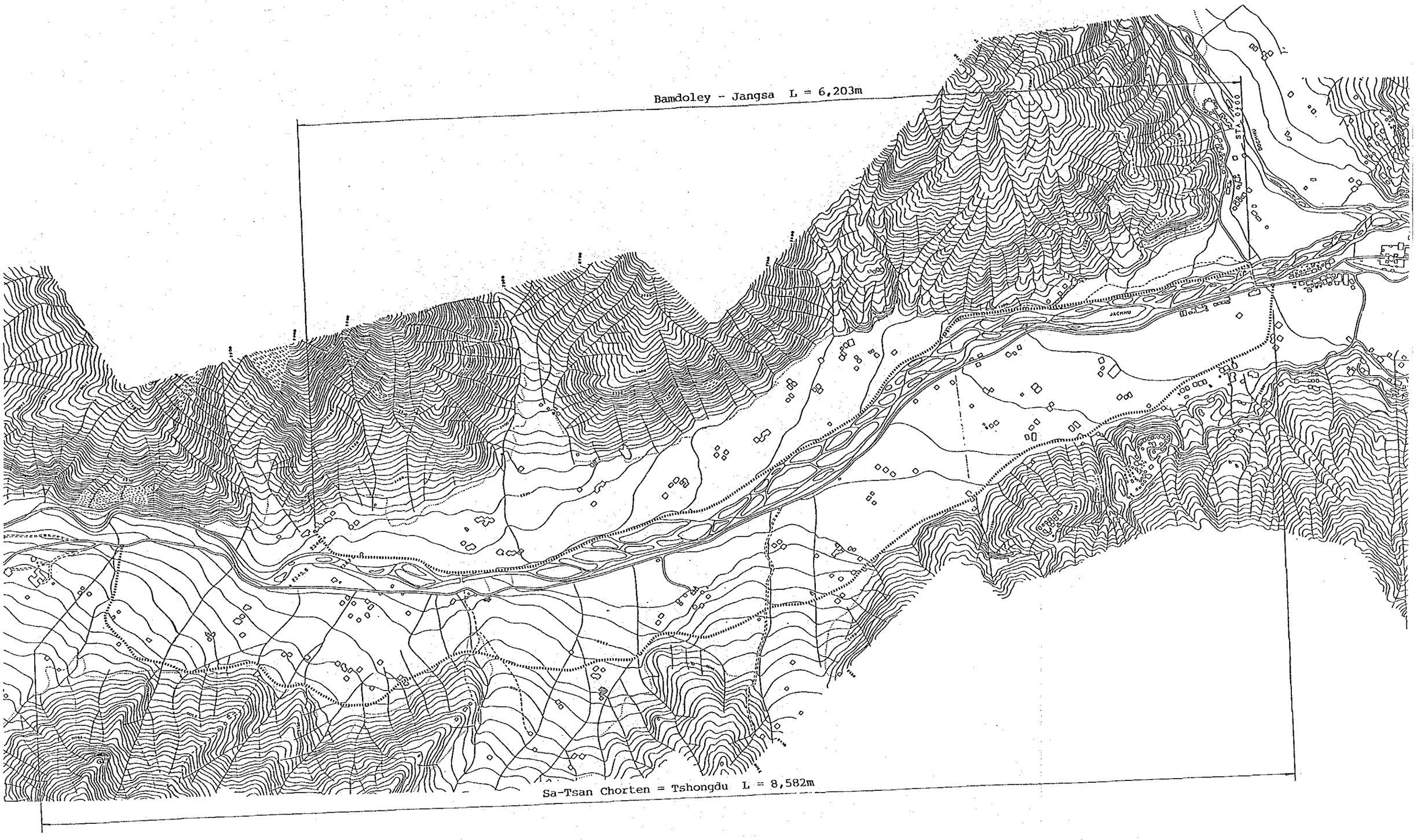
Earth is the main material for road construction, and the types of construction machinery required are few in number. Cement and reinforced concrete pipes will be products of Bhutan. Reinforcing steel bars and other steel materials will be imported from India.

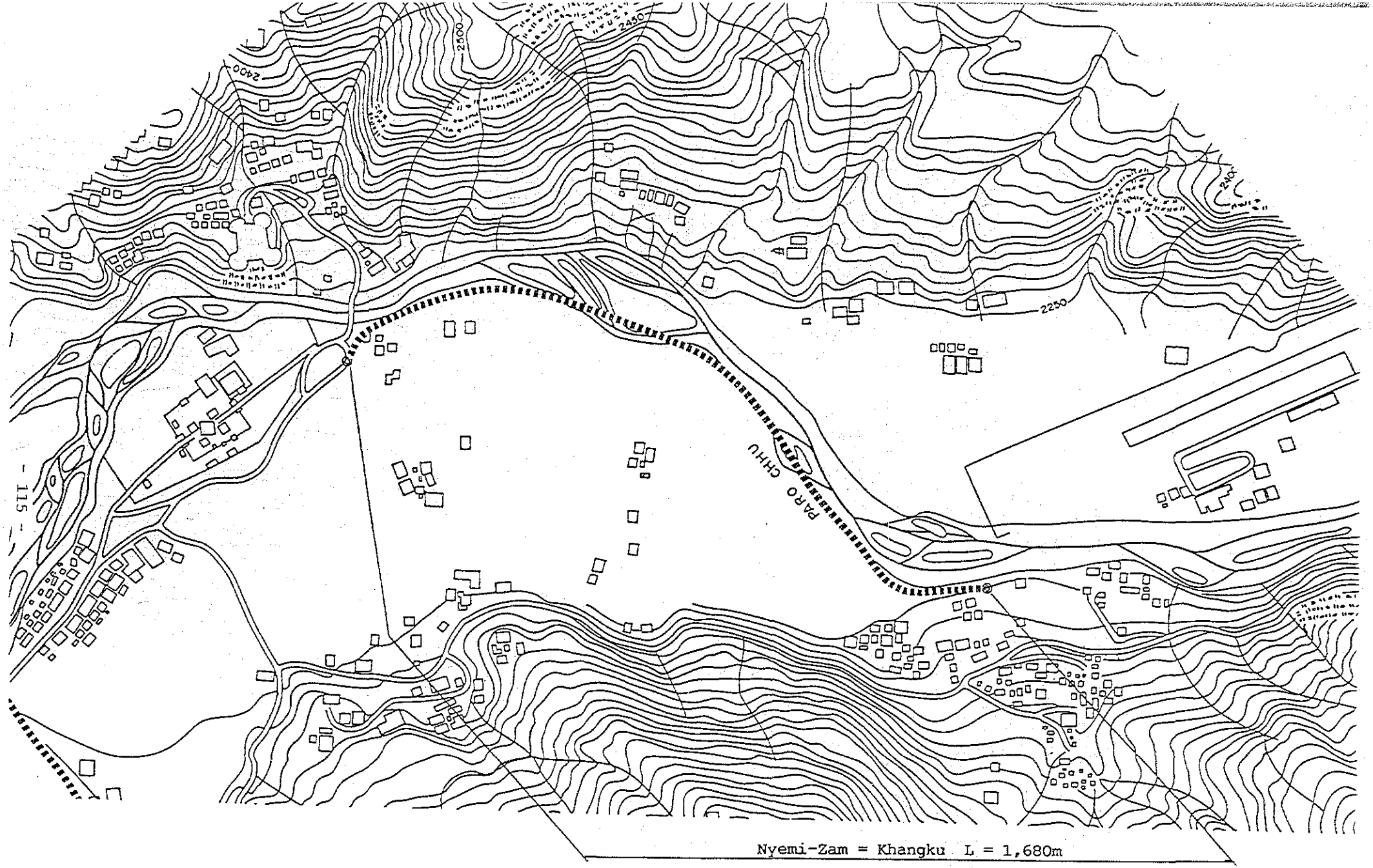
5.2.4 Basic Design Drawings

Basic design drawings for farm roads are shown in the following pages.

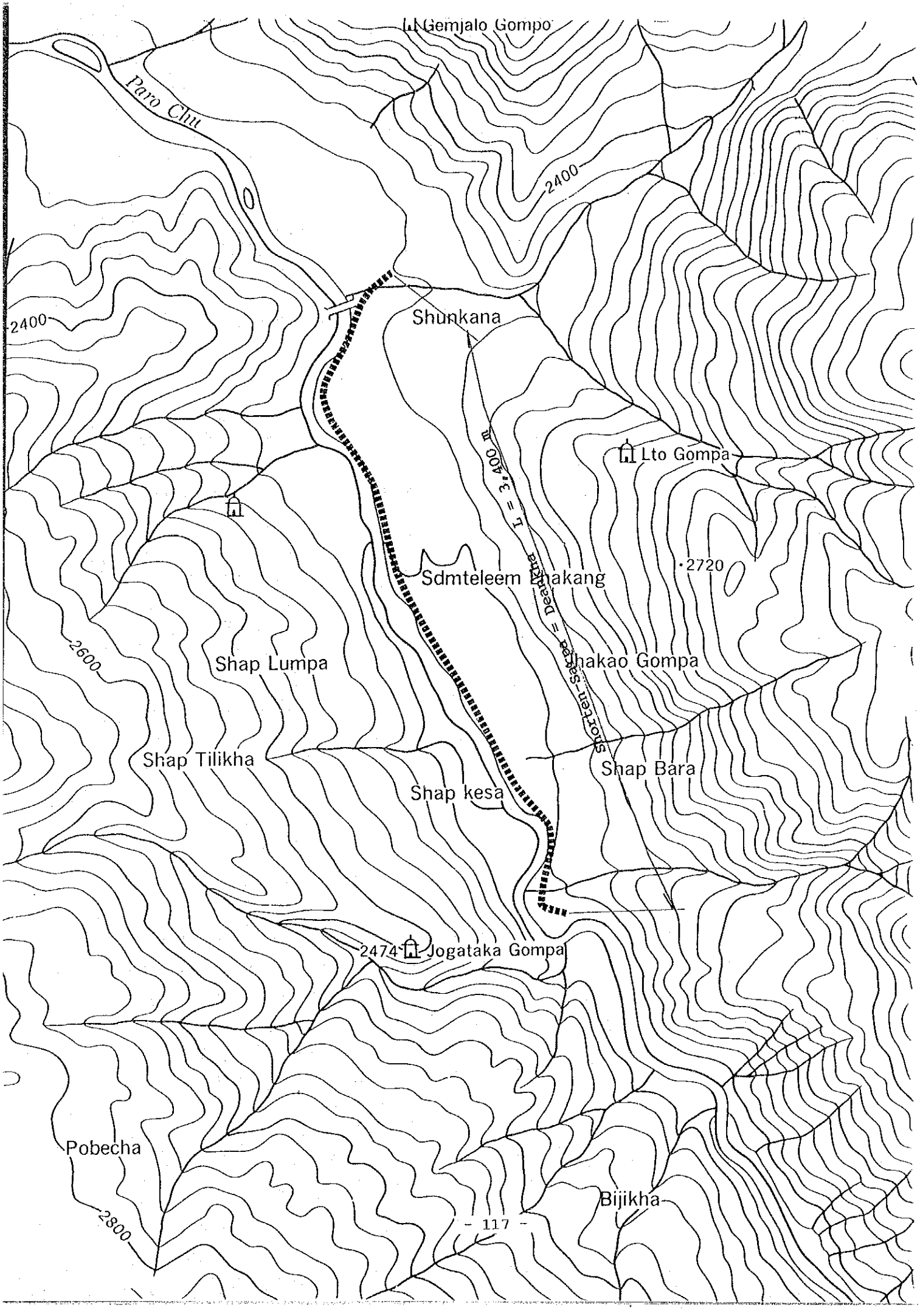


TYPICAL CROSS SECTION


Bamdoley - Jangsa L = 6,203m
Sa-Tsan Chorten = Tshongdu L = 8,582m


2500
2400
2250
PARO CHHU
Nyemi-Zam = Khangku L = 1,680m


2250
△2398.2
LONG CHHU
116
Bondey - Gedu
2400
2675m


Gemjalo Gompo
Paro Chu
2400
2400
Shunkana
L = 3,400 m
Lto Gompa
2720
Sdmteleem Thakang
Shap Lumpa
2600
Thakao Gompa
Shap Tilikha
Shap kesa
Shap Bara
2474
Jogataka Gompa
Pobecha
2800
Bijikha

5.3 River Protection Works

5.3.1 Design Policy

Flood discharge has been estimated based on the traces of the 1968 flood, as given below:

- Dotey River : 330 cu.m/sec
- Paro River, upstream of confluence : 710 cu.m/sec
- Paro River, downstream of confluence : 1,040 cu.m/sec

A flood discharge of 151.9 cu.m/sec in May 1989 overflowed in the Lango area while a flood of 152.6 cu.m/sec in June 1989 did not overflow. Judging from this, changes of water routes and riverbeds affect flooding to a major extent.

The hydraulic condition of the initial movement of riverbed material is defined by non-dimension shearing stress τ^*_{50} given in the following formula (Andrew.E.D. 1984):

$$\tau^*_{50} = \frac{DS}{(\rho s/\rho w - 1)d_{50}}$$

wherein
- D : Mean water depth
- S : Gradient of riverbed
- ρ_s : Density of riverbed material
- ρ_w : Density of fluid
- d_{50} : Mean diameter of riverbed-surface material

Movement of riverbed material will occur at the critical value of the above shearing stress, 0.031. The riverbed gradient of the Paro River is 1-2%. In the case of riverbed cobbles with a mean diameter of 15 cm and more than 1 m of water depth, movement of cobbles is certain to occur. If water depth exceeds 1.5 m, even cobblestones 30 cm in mean diameter would start to move. In fact, gabions were damaged by the former flood on account of scour at the foundation.

As flooding depends upon sediments on the riverbed, mere discharge

analysis is insufficient for planning countermeasures. Therefore, river revetments are to be planned from the point of view of farmland erosion, rather than just flood control. It is planned that routes of stone movements be directed and scour at the foot of the river bank be prevented.

5.3.2 Study on Design Conditions

In a span between Chuba & Atso and Jangsa, along the left bank of the Dotey River, is the farm road to be constructed in the project, but on the right bank there is no farm road proposed. Thus, a river revetment is planned for that bank, which is easily scoured by floods, so that it will be protected by gabions, and new banking need not be constructed.

In a span between Bamdoley and Jangsa, the elevation of the bank is to be no higher than that of the national highway managed by the Indian government. Expansion of the river section is planned in order to provide a discharge capacity of 170 cu.m/sec.

In the area of Nyemi-Zam and Khangku, the elevation of the bank is to be higher than that of Paro Airport, located at the opposite side.

In a span between Sengo-Tsekha and Sorten-Sarpa, elevation of the bank is to be effected by adding to river water level to accomplish a 1,040 cu.m/sec discharge and 40 cm of freeboard. The bank will act as a road.

The Gyebjana Rongchu River is to be rehabilitated to accommodate the ordinary rainy season discharge and to stabilize the river course.

5.3.3 Basic Design

(1) Design of River Protection

The existing river revetment is composed mainly of gabions. The only exception to this is the concrete revetment constructed in 1973 in the Shaba area (See Photo 1). Currently, wire nets of gabions are supplied

by the government and construction work is executed with the cooperation of the farmers. The nets are hand-made, using 4 mm diameter wires. At present, a gabion 60 cm in width and about 1 m in height is fixed at the upper part by cobblestones wrapped with wire nets. As a result, the wire nets can be easily loosened and their shape adjusted. Box-type gabions are used in 4-5 layers only at the Paro Airport bank. Although water stoppers made of gabions have been constructed on the airport banks, evidence of erosion has been found in parts where the water route approaches the bank.

Concrete blocks, interconnected blocks, cylinder-type gabions, box-type gabions, concrete-made banks, etc., are being considered as possible river revetment works. Among the above, the gabion method is recommended for the project, since gabion materials are abundant at the sites and are at present in common use. They are of the box-type, taking installation method and stability into account. Box dimensions will be 40 cm high, 1.2 m wide and 4.0 m long at the maximum.

In order to protect the gabions' foundations from scour, protection sheets will be inserted between the gabion and its foundation. As explained in 5.3.1, stones with a mean diameter of 15 cm move in 1 m of water, and 30 cm stones move in 1.5 m of water. To prevent this movement, gabions will be installed to a 3 m width horizontally from the foot of the bank.

(2) River Course Planning

In the Bamdoley=Jangsa and Nyemi-Zam=Khangku spans, one can see shrubberies and willow trees (See Photo 2). These plants act as natural water stoppers, but those which grow in the middle of the river course make depths vary more than necessary, raise water levels, resulting in floods, and create bank foundation scour. Therefore, in a span between Bamdoley and Jangsa, only plants growing within 10 m of the bank on both sides of bank should be left, and others are to be removed.

In parts where the river cross-section is narrow, expansion of the width should be carried out in order to increase discharge capacity.

Photo 1 CONCRETE RIVER PROTECTION AT SHABA AREA

PHOTO 2 PARO RIVER AT LANGO AREA

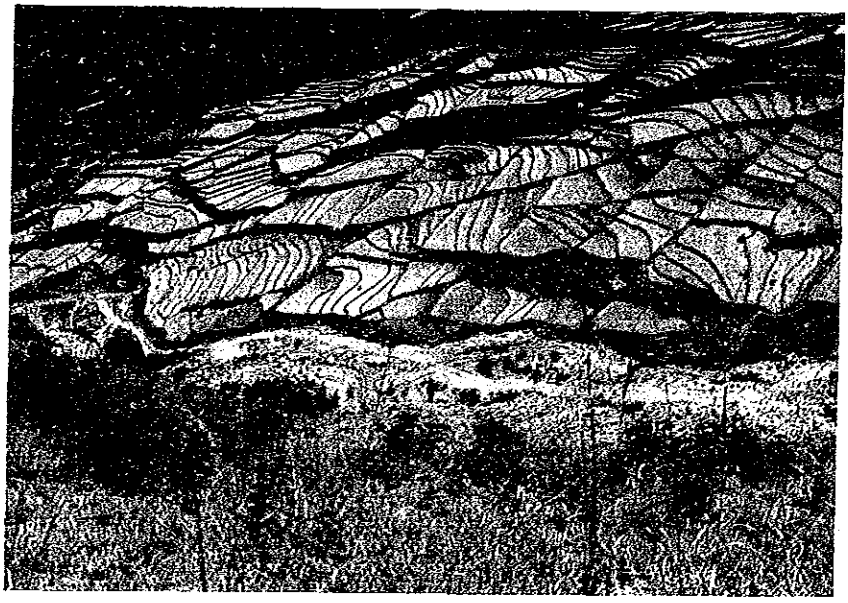
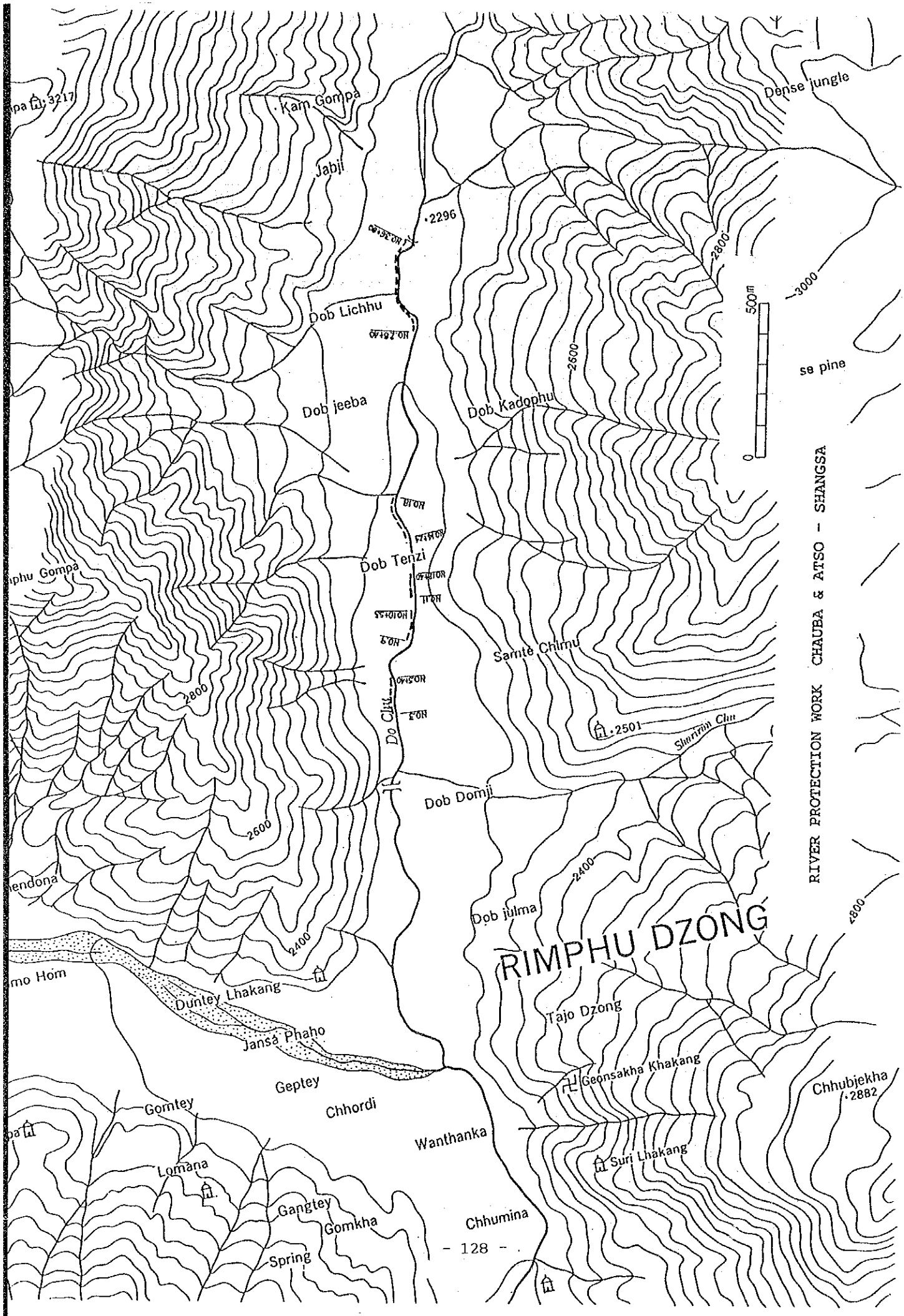


Photo 3 GYEBJANA RONGCHU PRESENT CONDITION

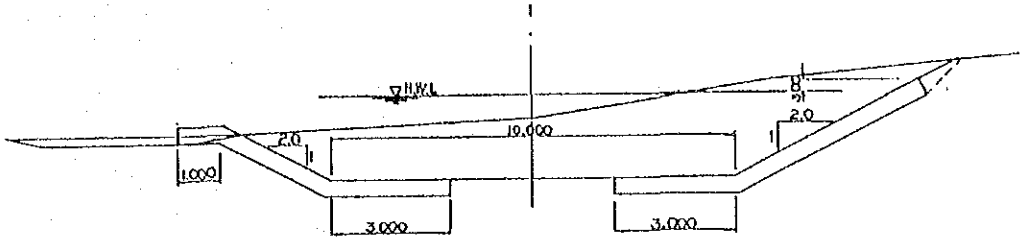
In Gyebjana Rongchu, the river cross-section is narrow at the concrete bridge on the national highway, but rehabilitation of the bridge will not be undertaken in the project since such work has nothing to do with the protection of farmlands from floods. Upstream of the Bondey Farm, Gyebjana Rongchu is shown in Photo 3. The river course at the site is unstable and has been changed by each flood.

5.3.4 Basic Design Drawings

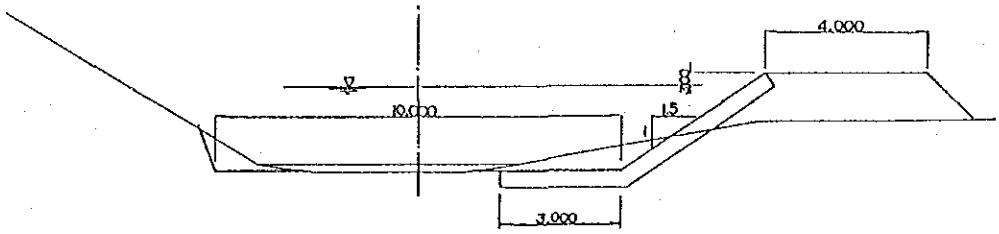
Basic design drawings for river protection work are shown in the following pages.


RIVER PROTECTION WORK CHAUBA & ATSO - SHANGSA
RIMPHU DZONG
Kam Gompa
Jabji
Dense jungle
Dob Lichhu
Dob jeeba
Dob Kadophu
Dob Tenzi
Samte Chimu
Dob Domji
Dob julma
Tajo Dzong
Geonsakha Khakang
Chhubjekha
Suri Lhakang
Chhumina
Wanthanka
Chhordi
Geptey
Gomtey
Lomana
Gangtey
Gomkha
Spring
Duntey Lhakang
Jansa Phaho
se pine
2296
2501
2882
3217
2800
2600
2400
3000
500m
0

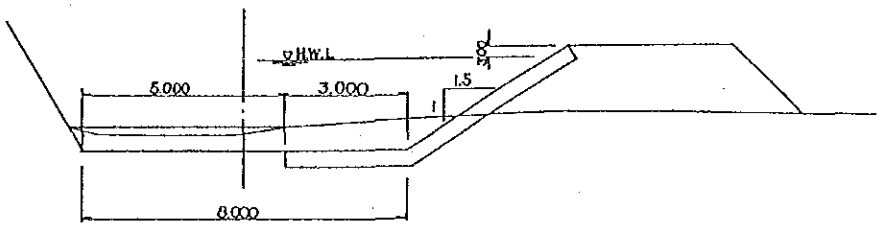
NO.0 - NO.7+80



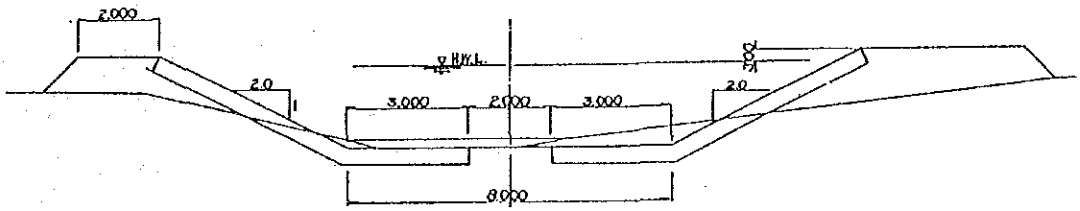
NO.7+80 - NO.11



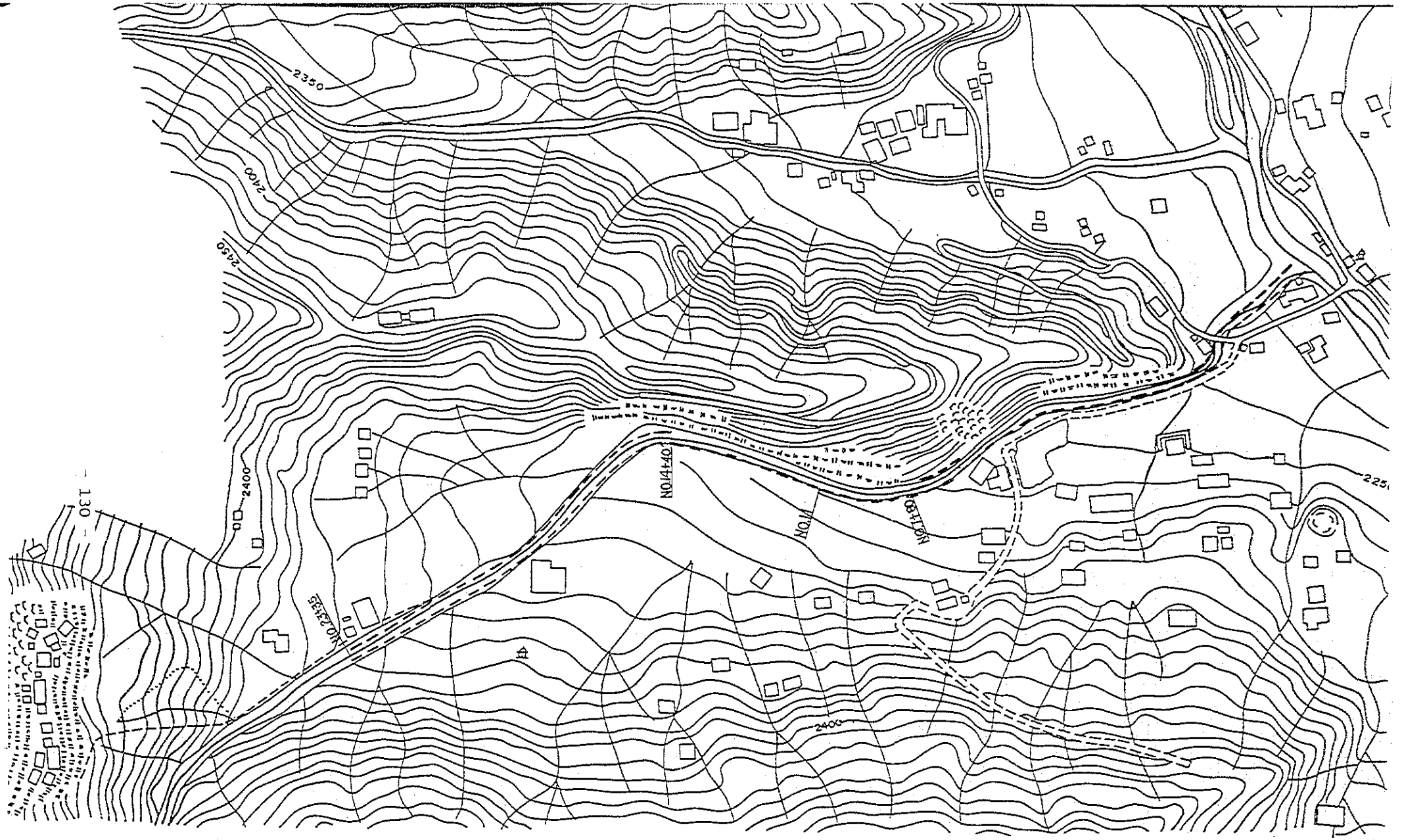
NO.11 - NO.14+40



NO.14+40 - NO.23+35



TYPICAL CROSS SECTION - GYEBJANA RONGCHU



RIVER PROTECTION WORK - GYEBJANA RONGCHU

5.4 Farmland Consolidation

5.4.1 Design Policy

(1) Basic Policy

Regarding the agricultural infrastructure of the project area, although there has been work concentrating on the consolidation of irrigation channels, farm roads and other infrastructure have not been developed well. A major factor arresting the development and increased productivity of the land and the labor force was that infrastructure facilities as well as their functioning have been insufficient. As a countermeasure, the development of farmland capable of reducing the labor input and still being productive is of the utmost urgency for the Government of Bhutan. Such farmland consolidation is eagerly awaited by farmers. However, it is considered quite difficult for much farmland consolidation to be implemented immediately in all areas. The farmland consolidation in this project is to be executed as pilot farmland which will lead to future extension in the whole project area. Planning will be done taking into account future development programs.

The proposed farmland for consolidation is located in the Changkha-Thang area of Wangchang Gewog and is situated downstream of the Bondey Bridge, on the left bank of the Paro River. The farmland is surrounded by the foothills of steep mountains and the national highway which passes along the left bank of the Paro River. Farmland is comparatively flat in this area. As a result of a topographical survey and an interview survey of farmers, both of which were carried out in the Phase 2 period, it was found that contents requested by the Bhutanese side were considerably different from actual conditions. The actual land area and number of holders were 18.5 ha and 27, respectively.

The land area held by each farmer is for the most part less than 1.0 ha as shown in Annex 13. The existing wetland is subdivided into 370 small plots (0.05 ha per plot on the average) of irregular shapes. In addition, the ground is quite uneven and the depth of each plot unbalanced, resulting in difficult optimum water distribution.

Current irrigation of farmland is done through branched channels of the Tshetey Yuva irrigation channel, which takes water from the Paro River. Water goes directly from the channels to the farmland, using the flowing irrigation method. There are, however, no drainage channels for exclusive use. Rainwater and irrigation run-off water drain into the river, so reasonable water management has not been carried out.

There exist no farm roads whatsoever in the farmland, therefore farmers pass along edges of plots or occasionally through plots belonging to others. In keeping with the trend toward agricultural mechanization, the necessity of transport services for agricultural input and products will increase dramatically in the near future. In order to facilitate this growth, farm roads are to be rationally planned and constructed.

The present situation of the irrigation system and farm roads mentioned above is similar in the entire Paro Valley area. Thus, consolidation of the pilot farmland area is expected to play a pioneer role in the modernization of agriculture.

The present scheme for farmland consolidation is intended to improve the arrangement of farm plots, irrigation channels, drainage channels, farm roads and soil, changing the current land ownership as little as possible. The design policy for each area of concern is dealt with hereinafter.

(2) Design Policy

1) Plot Arrangement

To decide the layout, shape and sizes of farm plots, items such as water management, effectiveness of agricultural machinery use, topographic conditions including land slopes, and the farming intensity of beneficiaries are to be taken into consideration, with the following conditions:

a) Mechanization : Medium-to-small sized agricultural machinery.
b) Crops : Paddy and cash crops (second crops) by intensive cultivation.
c) Water management : Irrigation channels and exclusive drainage channels.

d) Farm roads : To be located along drainage channels.
e) Land formation : Cutting and banking volume to be balanced.

In planning the farmland consolidation, it is necessary to retain effective farming land. Presently there is land damaged by a flood in 1986 which left the area covered with sediments. This land is to be utilized by removing the sediments.

2) Irrigation Channels

Irrigation channels and drainage channels are to be separately planned and constructed for the purpose of proper water management and rational drainage. As the land slope is comparatively small, branched channels for irrigation and drainage will be arranged on both sides of the farm roads. In addition, small branch channels for irrigation and drainage will be arranged so as to serve as one side of the farm road.

All of the channels will be constructed as open channels and use U-shaped concrete flumes. These will be manufactured at the project site.

3) Drainage Channels

Drainage channels which have yet to be constructed are an important element of the project plan. They are to be incorporated for the following reasons:

It is important to drain excess water from paddy fields as soon as possible in order to maintain the fertile soil which is necessary for agricultural mechanization and in order to increase productivity of both land and labor. In addition, rational water management can be achieved by the installation of drainage facilities as well as irrigation facilities.

If the drainage construction plan were to take into account the probability of years of excess rainfall, higher construction costs, and a larger land area would be required. Accordingly, the drainage facility has been planned within limits that will not disturb farming activities.

Generally in wet field areas, water storage and water retention within the area are desirable to some extent during the paddy-growing season. Taking this fact into consideration, the drainage system in the farmland consolidation plan will be a continuously-flowing type of system which will allow limited flooding.

4) Farm Roads

There are no existing farm roads at present. Farmers use edges of farm plots or farmlands belonging to others for access to the national highway, located south of the farmland area and running from east to west, for purposes of the transportation of agricultural products, etc. The planning of the farm road will be done with due consideration to access for farming work, and the transportation of agricultural products on the assumption that medium-small sized agricultural machinery is to be used in the project. The roads will be defined as farm road feeders which have access to farmlands and connecting plots.

The planning of the farm road feeders will be done in consideration of the relation between the existing national highway and the operation and maintenance of irrigation/drainage facilities.

5) Soil Dressing

According to soil investigation results, as detailed in the Annex, the soil in the proposed farmland area was found to consist of three layers. The first is a cultivation layer (of between 20-30 cm). Below this is a sandy layer (70 cm in average thickness) containing some gravel. The last layer is a gravel layer (gravel content above 50%), containing sand, which has high permeability. The water requirement investigated in depth was 46 mm/day on the average, being comparatively higher than that of other survey areas, and it was judged that much leakage probably occurred from the lower soil layers in the proposed area.

For the purpose of satisfying the water requirement, plans for soil dressing will be made. A clayey soil available in land adjacent to the Training Centre of AMC will be placed below the cultivation layer. The

clayey soil, however, is not fertile and therefore not suitable as material for a cultivation layer. Therefore, although costs will be increased, further surface soil handling should be executed in the land formation. It is feared that both porosity and permeability in the soil may be reduced by both compaction and repeated loads that occur due to construction machinery during the construction period, so the soil should be well mixed with the lower layer.

5.4.2 Study on Design Conditions

(1) Plot Layout

1) Shape and Area of Plots

a) In principle the shape of a plot will be rectangular. In cases of plots where the land slope is steep or other land is adjacent to it, their shapes will be curved.

b) The area of each plot will be decided according to the slope of the site, the land ownership situation and the farming efficiency of agricultural machinery to be used. The efficiency of the machinery, power-tillers and 4-wheel tractors, should be about 70%.

c) When planning plot shapes to consolidate large or steep farmlands, as a rule, the longer side of the plot is set parallel to a contour line. The shorter side is at a right angle to the contour line. However, for the project site, the land slope is relatively gentle (1/120). The area of each plot proposed must be on a small-scale due to the land ownership situation. Therefore, setting the the short side parallel to a contour line will not yield a large difference in actual plot size. Thus the method of this project (short sides of rectangles set parallel to contour lines) enables roads and irrigation/drainage channels to be arranged in a desirable fashion. This method contributes to the conservation of irrigation water. The short side will be about 20 m taking into consideration the turning of machinery, the movement of machinery from one adjacent plot to another and protection of farm plots from collapse. The long side will be about 50 m to avoid an increase of soil volume to be moved, in view of plot area, as far as it

is not in parallel to a contour.

2) Shape of Field Blocks and Farm Blocks

For the future extension of farmland, a layout of blocks will be made so that some will be uniform in ground formation and have an interval of one road each between them, or so that each farm drain will be more than 100 m. Accordingly, the length of the long side of field blocks and of both short and long sides of farm blocks (both of which are enclosed by fixed facilities) will be more than 100 m.

3) Earth Moving

Regarding the relationship between the present topography and the proposed plot arrangement, the volume of earth to be moved will be calculated by weighted average. Earth moving will be so done that the total volume will be almost balanced within 2-4 plots.

(2) Irrigation Facilities

1) Design Discharge

The peak water requirement in the case of paddy planting is to be the design discharge.

2) Structure and Cross-Section of Channels

Branch channels will be constructed of concrete U-shaped flumes so as to be capable of handling projected peak flows. This type was selected for the following reasons:

- Earth channels will have high seepage loss or be damaged from erosion due to sandy soil conditions.
- Concrete flumes save land and are easy to maintain.

Farm ditches will be made of earth because of their small size as well as small construction volume. Their cross-sections will supply sufficient water to farm plots. The cross-section will not be changed either upstream or downstream.

3) Elevation of Channels

In order to facilitate the access of machinery to farm plots, a lower channel elevation of is preferable. However, when watering paddy fields, a higher position is desirable. In consideration of this, the elevation of the channel bed will be set at about 10 cm higher than the paddy field surface.

4) Inlet

An inlet will be constructed at the upstream end of each farm ditch.

5) Levee

Earth levees will be made at the boundary of each farm plot. Their cross-sections will be a trapezoid, measuring 30 cm on the top and 30 cm high, with a side-slope of 1:1.

6) Hydraulic Design of Channel

Design criteria for channels and ditches in the farmland area will follow those for irrigation channels. The coefficient of roughness of farm ditches, however, is to be 0.025, which is applied to weed-free straight channels made of earth.

(3) Drainage Facilities

1) Design Drain Discharge

The discharge is to be decided taking the following factors into account.

a) Normal Drain Discharge

- Irrigation season : 2.0 - 5.0 ltr/sec/ha
- Other seasons : 0.5 - 1.0 ltr/sec/ha

b) Rainy Day Discharge

In the flooding season, retaining water in the farmland area will be allowed to a certain extent. For daily rainfall, the design discharge of drainage facilities is estimated with the following formula:

$$Q = (Rxfx10^{**}3)/86,400$$

where Q : Design flow (m3/sec/km2)
R : Daily rainfall (mm)
f : Coefficient of runoff = 0.8

2) Cross-Section and Structure of Drains

A cross-section of the drains will be designed based on the surface water discharge to be drained, and taking topographic slope and earth volume into account. The structure will be a channel dug to a depth of about 50 cm below the paddy field.

3) Pond Water Release

A facility for pond water release to farm drains will be constructed at the end of a side along farm drains.

4) Hydraulic Design

Design criteria for drains will follow those for irrigation channels. The coefficient of roughness of farm drains, however, is to be 0.033, which is applied to weedy straight channels.

(4) Farm Roads

1) Width and Shoulder

The width of each vehicle passing along farm roads is as follows:

Passengers car	: 1.7 m
Truck (5 ton)	: 2.4 m
Power-tiller (5 PS)	: 0.7 m
Riding tractor (Class 30 ps)	: 1.7 m
Combine (Class 20 ps)	: 2.3 m

The effective width is designated as 3.0 m, considering the traffic of tractors and combines. Furthermore, shoulders will be set on both sides of the road for the safety of pedestrians and vehicles.

2) Height of Road Surface

The road surface in principle will be placed at least 30 cm higher than the paddy field surface. This height takes into consideration machinery access from the road to the farming plots.

3) Structure

The road is to be used for agricultural production activities, and its surface is to be paved with 30 cm of gravel.

(5) Soil Dressing

1) Volume of Soil dressing

The volume of soil dressing is determined by the following formula:

$$r = (W1 \times H \times (P3-P1))/(W2 \times (P2-P3))$$

where r : Depth of soil dressing
H : Thickness of soil to be improved
W1: Apparent specific gravity of original soil
W2: Apparent specific gravity of soil to be dressed
P1: Ratio of clay content in original soil
P2: Ratio of clay content in soil to be dressed
P3: Ratio of clay content in dressed soil after improvement
(Target value = 20 - 30%)
Standard apparent specific gravity:
Clayey soil: 1.1 - 1.2
Sandy soil : 1.6 - 1.8
Organic soil : 1.0

5.4.3 Basic Design

(1) Plot Arrangement

1) Plot Unit

Taking into consideration the beneficiaries' land ownership situation shown below, and in view of the working efficiency of agricultural machinery, the proposed size for one rectangle area is to be about 0.1 ha, measuring 50 m by 20 m.

a) Land Ownership Situation

Size of holding in ha	Number of holders	
More than 1.00	4	
0.50 - 0.99	7	
0.10 - 0.49	14	
Less than 0.09	2	
Total	27	Average : 0.69 ha

Size of each plot in ha	No. of plots	
More than 0.10	25	
0.05 - 0.099	126	
less than 0.049	216	
Total	367	Average : 0.05 ha

Judging from the land ownership situation, about 0.1 ha is appropriate for one plot.

b) Working Efficiency of Agricultural Machinery

The relation between the working efficiency of agricultural machinery and plot area is given below:

Working efficiency	60%	65%	70%	80%
Power-tiller	0.02 ha	0.04 ha	0.05 ha	0.10 ha
4-wheel tractor	0.07 ha	0.10 ha	0.15 ha	0.25 ha

Tractor-driven rotary tillers, combines and other harvesting machines to be introduced in the future will require at least 20 m along the short side of a plot. Therefore a 0.1 ha plot will be a 50 m x 20 m rectangle.

2) Plot Standard

According to the results of a study on plot planning, the standard dimensions of farm plots will be as follows:

Plot	Short-side	Long-side	Area	Remarks
Field plot	20 m	50 m	0.1 ha	
Field block	50 m	160 m	0.8 ha	8 plots
Farm block	100 m	160 m	1.6 ha	2 field blocks

(2) Irrigation Facilities

1) Branch Channels

As a result of hydraulic calculations for the design flow of 4.73 ltr/sec/ha, branch channels will be designed as follows:

Type of Channel	Type I	Type II
Structure	Concrete flume	Concrete flume
Standard	U-450	U-450
Width at bottom	0.45 m	0.45 m
Height	0.30 m	0.30 m
Distance	720 m	960 m

2) Farm Ditches

The farm ditches should have a capacity that will maintain a pond depth of 60 mm in the farm plots. Dimensions will be as follows:

Structure	Width(Bottom)	Height	Side slope	Distance
Earth ditch	0.15 m	0.20 m	1:1.0	3,390 m

(3) Drainage Facilities

1) Design Discharge

Normal discharge and flood discharge are shown below. Design discharge is set at 6.9 ltr/sec/ha.

Case	Drain Flow	Remarks
Normal flow	5.0 ltr/sec/ha	Maximum of standard values
Flooding flow	6.9 ltr/sec/ha	75 mm/day on 28 May 1989

2) Drains

As a result of hydraulic calculations made with a design flow of 6.9 ltr/sec/ha, dimensions of drains are set as shown below:

Drain	Lateral Drain	Farm Ditch
Structure	Earth	Earth
Width(Bottom)	0.5 m	0.3 m
Height	1.0 m	0.5 m
Side slope	1:1.0	1:1.0
Distance	1,510 m	1,910 m

(4) Lateral Roads

1) Standard Structure

Effective width : 3.0 m
Shoulder : 0.5 m on both sides
Pavement : Gravel with 0.1 m thickness
(40 mm crushed stone)
Side slope : 1:1.5
(Because of low banking, less than 1.5 m)

A standard section of the road, based on the above parameters, is shown in the basic design drawings.

2) Routes and Lengths

Ten new lateral roads are proposed, of which the routes and lengths are shown below:

Route	Length	Route	Length
R-1	823 m	R-6	337 m
R-2	805 m	R-7	298 m
R-3	286 m	R-8	235 m
R-4	170 m	R-9	157 m
R-5	423 m	R-10	117 m

(5) Soil Dressing

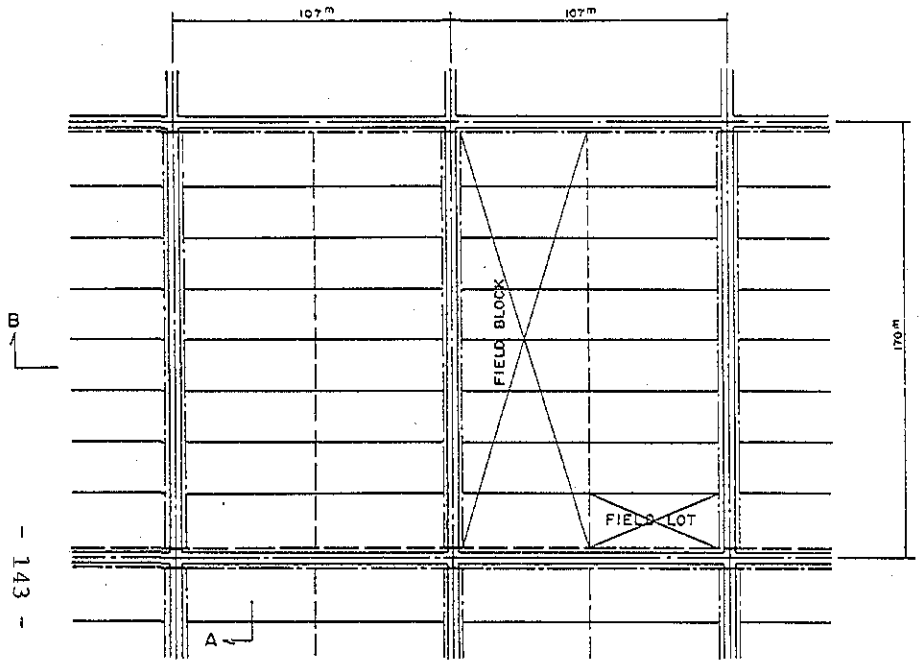
1) Volume

Soil is to be added 10 cm beneath the cultivation layer. The area and volume of the soil dressing are as given below:

Area : 18.5 ha
Volume : 18,500 cu. m

5.4.4 Basic Design Drawings

Basic design drawings are shown in the following pages.



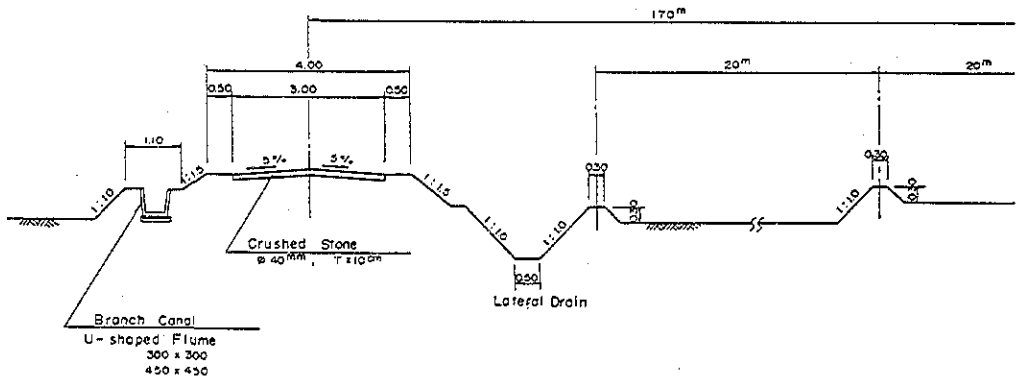
LEGEND

- Lateral Road
- Branch Canal
- Farm Ditch
- Lateral Drain
- Farm Drain

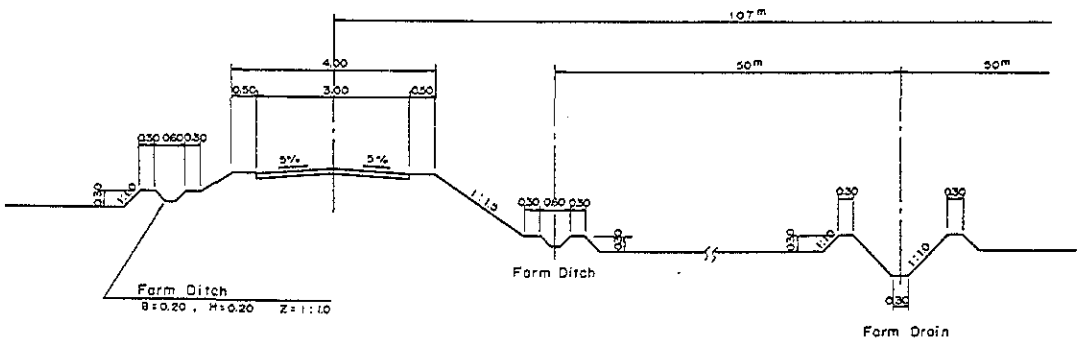
STANDARD LOT

SCALE 0 10 50 100 m

TYPICAL FARM BLOCK



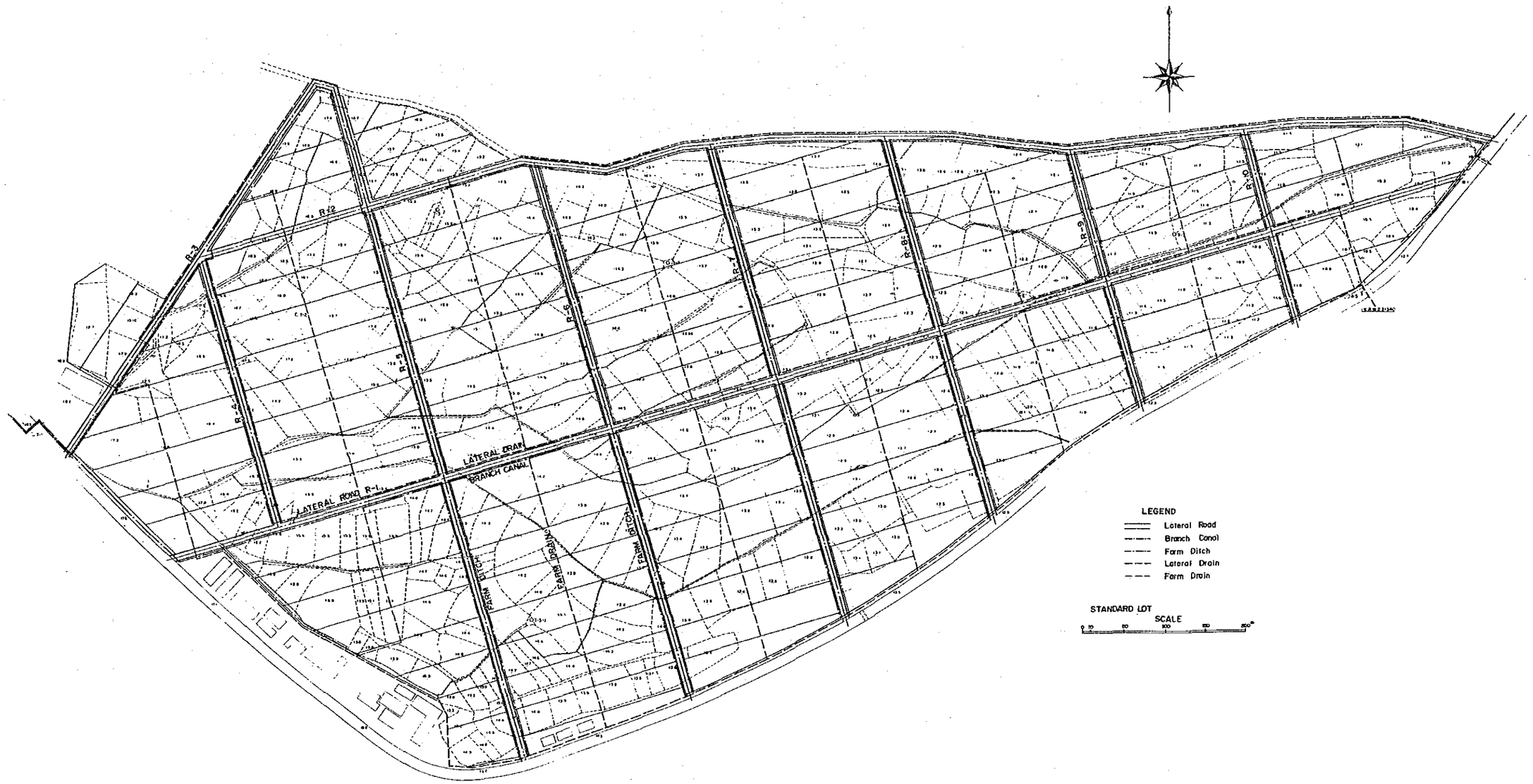
A SECTION



B SECTION

CROSS SECTION

SCALE 0 1 2 3 4 5 m



LAND CONSOLIDATION PLAN

5.5 Implementation Plan

5.5.1 Construction Situation

(1) Private Contractors

A-rank contractors in Bhutan numbered 14 at the time of the Phase 2 on-site survey. Since a contractor is designated as an A-rank firm when the volume of work done on contract for a year exceeds a certain level, the number of A-rank contractors has increased sharply in recent years. Questionnaires were mailed out to the 14 companies, of which seven were returned answered. The numbers of machines owned by these seven firms are shown in Table 5.2. Reflecting the fact that Bhutan's national highways are managed by the Government of India (BRTF), most of the machines these contractors own are concrete construction machines, principally concrete mixers. On the other hand, they own only a few earth working machines, and only two owned a bulldozer. Most of the contractors lease their machines from the government. Although the numbers of machines are limited, only one firm had a whole set of earth working machines.

To improve this situation, as was examined in the Phase 1 survey, it will be necessary to procure various construction equipment from Japan and also train people to operate it.

(2) Labor Force

Although the National Work Force, the domestic work force for construction, could be utilized for the project because of the prohibition of the employment of foreign workers, it is planned to execute the project by employing local farmers. But it is almost impracticable to treat the local farmers as technicians, so technical instructors who will train the farmers are needed from around the area. On the other hand, concerning the river protection works included in the rehabilitation of the existing farm roads, the local farmers have enough experience for the job.

TABLE 5.2 NUMBER OF MACHINES OWNED BY A-RANK CONTRACTORS

A Company

Concrete Mixer 35 cu.ft/hr	4 Nos.
Vibrator	3 Nos.
Water Pump	3 Nos.
Stone Crusher 1000 cu.ft/day	1 No.
Truck 10 M.T.	4 Nos.
Steel Shuttering Plate	2,000 sq.ft

B Company

Truck 6 cu.m	2 Nos.
Concrete Mixer 21/12 cu.ft	5 Nos.
Vibrator 10 HP	5 Nos.
Kirloskar Pump 5 HP	2 Nos.
Tullu Pump 0.5 HP	10 Nos.
Jack Hammer	3 Nos.
Steel Shuttering Plate	10,000 sq.ft
Welding Machine	5 Nos.

C Company

Lease/Hire
Base

D Company

Hollow Block Machine 8'	1 No.
- do - 6'	1 No.
Mixer 1 bag & 2 bags	1 No.
Bulldozer D50	1 No.
Truck 1200S	2 Nos.
Tractor	1 No.
Vibrator	1 No.

E Company

Concrete Mixer 7/10 cu.ft	2 Nos.
Nozzle Vibrator	2 Nos.
Plate Vibrator	1 No.
Mosaic Grinding Machine	3 Nos.
Electrical Drill	2 Nos.
Tractor with Trailer 2 M.T.	1 No.
Truck 5 & 8 M.T.	2 Nos.
Power Chain Saw 18'	1 No.

F Company

Tata Tippen Truck	2 Nos.
SE Truck	2 Nos.
Stone Crusher	1 No.
Concrete Mixer	2 Nos.
Vibrator	2 Nos.
Steel Shuttering Plate	1,000 sq.ft

G Company

Dozer D7G/47	
- do - TD-20/35	
- do - TD-12/38	
Air Compressor CPS-400/68	
- do - CPS-400/69	
- do - VT-6/53	
- do - VT-6/57	
Front End Loader CAT-416/20 with Backhoe CAT-930/4	
Tipping Truck	
Concrete Mixer Welimix/9	
Fuel-Tanker 400 ltr. BWH-0147	
- do - 2000 ltr. MEDICO/8	
Vibratory Road Roller SU91/42	
Payloader CAT-926/15	
Water Tanker BCH-0084	
Stone Crusher SC-B12/6	
Compressor CPS-400/61	
Welding Set	3 Nos.
Concrete Vibrating Machine	4 Nos.
Hollow Block Brick Making Machine	2 Nos.
Tractor Trailer	2 Nos.
Stone Crushing Plant 15 T/hr	1 No.

(3) Other Considerations

With the participation of local inhabitants, the members to be engaged in the project will change irregularly as time passes. This may reduce the productivity of construction work and, additionally, retaining the manpower will be difficult. To avoid these problems, it is necessary to select long-term participants from among farmers for the main construction work.

In the project, the crushing plant will not necessarily have to be placed only at the site of the precast concrete plant. It can be moved to the farm road construction sites so that the work can be carried out economically.

5.5.2 Implementation Method

The proposed construction work will be divided into Stage 1 and Stage 2. In Stage 1, the Dotey River Basin and the left bank of the Upper Paro River will be the construction sites. In Stage 2, construction work will be done at all other sites. The stage divisions of the proposed area are shown in Fig. 5.1. Stage 1 is divided into three phases, Stage 2, two. Equipment will be procured in the first and third phase of Stage 1. Those pieces procured in the first term are machines for use at every step of the construction process, while those procured in the third phase are machines for use only in Stage 2.

Although construction is concentrated in Stage 1, some of the work will be started in Stage 2. In the first phase of Stage 1, the only work that will be done is equipment procurement.

5.5.3 Construction Supervision Policy

A supervisor will be assigned to the site during the entire period of construction to keep an eye on the execution of irrigation facilities, farm roads and river protection work. The supervisor will perform the following duties:

- To inspect and approve working diagrams,
- To inspect and guide construction work,

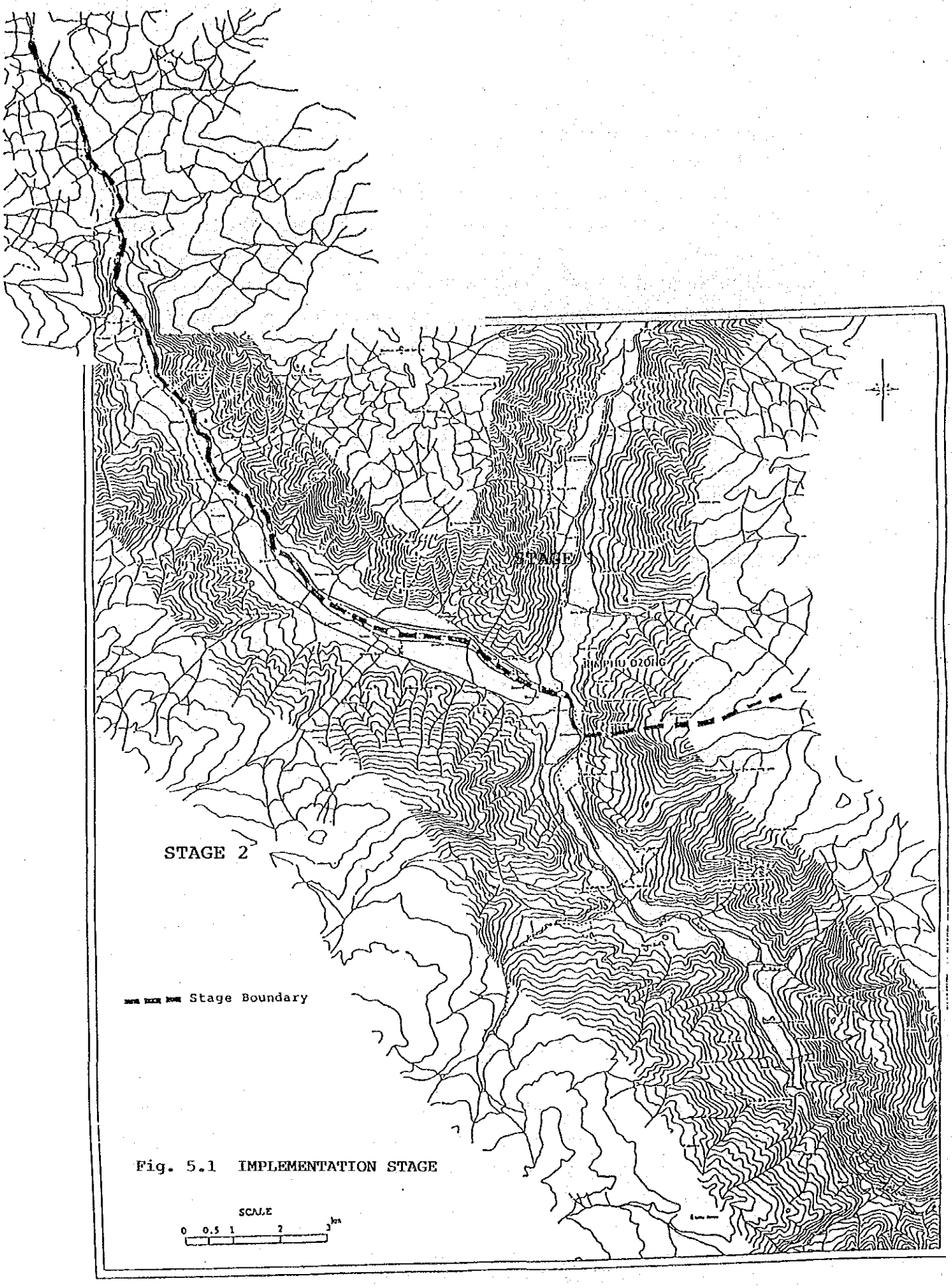


Fig. 5.1 IMPLEMENTATION STAGE

- To ascertain and report on the progress of the construction,
- To cooperate in preparing documents for paying contractors, and
- To witness trials of facilities.

5.5.4 Procurement Plan

Equipment used in this project, as stated in 5.5.2, will be procured during the first and third phases of Stage 1. Basically, it will be procured from Japan.

The ultimate objective of this project is to build infrastructure for the entire Paro Valley area. But at this stage, infrastructure will be built with grant aid from Japan and on a scale that the Bhutan side will be able to handle given its level of technical development so as not to drastically change the country's form of production nor its social configuration. Thus, priority will be placed on procuring materials made in Bhutan or those that can be procured from India. Materials produced in Bhutan are given below.

Portland cement	: 50 kg sacks
Reinforced concrete pipe	: Inner diameter (mm): 225, 300, 450, 600, 750, 900, 1050, 1200
Polyethylene pipe	: Outer diameter (mm): 20, 25, 32, 40, 50, 63, 75, 90, 110, 140, 160, 225
Timber	
Stone	

Materials produced at the plant procured from Japan are presented below.

U-shaped concrete flume	: U-300, U-450
L-shaped concrete flume	: L-600x300
Ready mixed concrete	
Crushed stone	

The wire netting machine procured with the grant aid provided by Japan and set up in Bondey Farm for use in making industrial fences will be used to produce the gabion net. The maximum width of the wire netting will be 4 m; the diameter of the bases of the wire netting 4 mm.

Materials procured from India are given below.

Deformed steel bar	: D8, D10, D12, D16, D20, D22, D25
Steel plate	
Galvanized corrugated iron sheet	

Galvanized plain iron sheet
Galvanized iron wire
Protection sheet
Sulphuric acid (as a neutralizer for Precast Concrete Plant)
Oil for forms, Diesel fuel, Petrol, Kerosene, Engine oil and Grease

Due to difficulty in procurement from India, materials being considered for procurement from Japan other than these are of the following two kinds:

Corrugated steel pipe
U-shaped steel flume

5.5.5 Implementation Schedule

The implementation schedule after the signing of the consultant contract is given in Fig. 5.2.

D/D : Detailed Design T : Tendering

		Month	1	2	3	4	5	6	7	8	9	10	11	12	Remarks
Stage 1 Phase 2	D/D T		Field survey Home work												(Total 3 months)
	Work		Preparation Channel Farm road and river revetment Precast concrete production							Channel				Land formation	(Total 12 months)
Stage 1 Phase 3	D/D T		Field survey Home work												(Total 2 months)
	Procurement		Manufacturing Ocean freight Inland transportation												(Total 6 months)
	D/D T		Field survey Home work												(Total 3 months)
	Work		Preparation Channel Farm road and river revetment Precast concrete production							Channel				Land formation	(Total 12 months)
Stage 2 Phase 1	D/D T		Field survey Home work												(Total 4 months)
	Work		Preparation Channel Farmland consolidation Farm road and river revetment Precast concrete production							Channel Farmland consolidation				Land formation	(Total 12 months)
Stage 2 Phase 2	D/D T		Field survey Home work												(Total 3 months)
	Work		Preparation Channel Farmland consolidation Farm road and river revetment Precast concrete production Plants rehabilitation							Channel Farmland consolidation				Land formation	(Total 12 months)

Fig. 5.2 IMPLEMENTATION SCHEDULE

Chapter 6. EFFECTS OF THE PROJECT AND CONCLUSION

6.1 Effects of the Project

There are two main effects that can be expected through the implementation of this project:

a) Increase in paddy production
b) Increase in cash crop production

(1) Possibility of Paddy Production Increase

Paddy production by gewog is recorded in Table 3.7 and Annex 6. It ranges widely from the maximum 7.71 M.T./ha in Shari Gewog to the minimum 1.98 M.T./ha in Tsento Gewog. The average production is 4.30 M.T./ha. The area's 1989 production had not been tabulated at the time of the survey (December 1989). The levels of rice production recorded on Bondey Farm in recent years are shown below. The kind of rice grown was Japanese Variety No. 11. The important point to note here is the growth rate of production.

Year	Production (M.T./ha)	Rate of increase to the previous year
1985	1.236	-
1986	2.472	100 %
1987	2.966	18 %
1988	4.103	38 %
1989	4.672	13 %

From the above rates of increase, rice production is predicted to reach more than 5.0 M.T./ha within one-two years.

The level of fertilizer input on Bondey Farm was:

Fertilizer	Input
Suphala	247 kg/ha
Farmyard manure	10.4 M.T./ha
Urea	59 kg/ha
Butachlor	37 kg/ha

The above level of fertilizer input, which involved mainly farmyard

manure, was several times that of ordinary farmers. The reason production on Bondey Farm has been increasing since 1985 is believed to be due to improvements in soil quality resulting from the practice of organic fertilizer management. Thus, if water management is properly carried out based on improved irrigation, and shipment of agricultural products and agricultural input are made easier, carriage of farm manure from house yards to farmlands becomes easier and the input of the farm manure increases; chemicals are added to the traditional farmyard manure. It will then be easy to properly manage fertilization of fields.

In the Paro Valley area, rice planting has been carried out by transplanting method, and not by direct planting. But due to a severe man power shortage, it is practiced not by straight rows planting but by random planting. Accordingly, transplanters for weeding can not be used and most of farmers do not have rotary weeders. Introduction of transplanters will be promoted by consolidation of farm roads. Then, introduction of rotary weeders also can be possible and weeding work can be improved, resulting in production increase. As a result of that fertilizer management and weeding work be improved, the production level of 4.30 M.T./ha on the average at present will become 5.0 M.T./ha, by an increase of about 15 %. Paddy production will increase by the 15% in the gewogs of Lango, Wangchan, Hore, Dotey, Shari, Luni and Shaba where consolidation of agricultural infrastructure is in progress, bringing the total to 902 M.T.

The labor force presently required for paddy production per ha, dealt in Section 3.4 "Agriculture in the Project Area" and that in the future, after mechanization, are comparatively shown below:

	Man-days Requirement		
Work Item	Present (man-days)	After mechanization	(man-days)
Land preparation	18.8	Power tiller	4 (Machine 4 days)
Transplanting	41.1	Transplanter(4-lines)	4 (Machine 1 day)
Weeding	91.8	Rotary weeder	10
Total	151.7 man-days	Total	18 man-days Operators : 5, and Labors : 13

In consideration of an ordinary labor cost by a contract (Nu.30 and 3 meals daily), a contract price in practice for planting with power tillers (Nu.240 and 3 meals daily) and an estimated cost of transplanters to be developed (Nu.480 and 3 meals daily), the cost for land preparation, transplanting and weeding per ha will be decreased from the present (Nu. 4,551 and 455.1 meals) to (Nu.1,830 and 54 meals) after mechanization. Provided a meal cost is Nu.10, farming cost per ha is estimated to be saved by Nu. 6,732. Presently a power tiller is sold at the price of Nu. 30,000 and a transplanter is much expensive than that; hence, it is not economical for each farmer having a 0.8 ha farmland on the average to have his own machinery. In other words, it is recommended that machinery owners work for others with contracts in a way currently practiced. The introduction of agricultural machinery is carried out through AMC and excess of the machinery input can be controlled.

(2) Possibility of Increase in Cash Crop Production

In parallel with consolidation of agricultural infrastructure, expansion of cash crops acreage and improvement of cropping intensity are expected. Cash crops grown in the project area are expected to become diversified with apple and potato as the principal crops. Farmers in this area are coping positively with market diversification.

Apple and potato are cash crops which market is in Bangladesh and India. However, due to their heavy weight, transportation of the products is difficult and it has stopped increase of their planting land areas. Upon completion of access roads to the national highway, by the farm roads construction in the project, shipment of the products become easier without hurting them. Hence, the increase of planting areas of cash crops, mainly consisting of the above two, will be accelerated particularly in the area around the new farm road.

According to Annex 7, the project area is supplied with 6,820 young apple trees annually, or equivalent to 27.6 ha of orchards. If this tendency continues for the next five years, 138 ha of dry fields or wilderness will be converted to orchards. In tandem with the increase in orchards, production will be increased by 3,409 M.T. According to

the progress of consolidation of agricultural infrastructure, a considerable deal of the labor force currently put on rice farming work such as plantation and weeding can be converted on orchards' work. The conversion to the orchards is presently in progress in reflection of labor force saving and favorable marketing, furthermore, by utilizing labor force to be in excess on rice plantation work and by proper management for orchards, both of production and quality can be improved.

By rehabilitation of irrigation facilities, a secondary crop of rice can be practiced and various cash crops are considered to be planted. Potato is another important cash crop grown in the project area as well as apple. Potato yield by gewog does not vary significantly, and hence it is considered a stable crop. The acreage under potato cultivation given in Table 3.6 shows different rates of potato acreage by gewog. A simple comparison on farming areas of wet fields, wheat and barely, as a second crop, and potato reveals that there is still room to increase potato acreage by 130.0 ha in Lango Gewog, 81.0 ha in Shari Gewog, and 11.9 ha in Shaba Gewog. The potential production increase resulting from this is estimated at 2,815 M.T. The results of the survey on potential demand in the Indian market (1988) for cash crops produced in Bhutan are summarized in Annex 9.

6.2 Conclusion

The Paro Valley is an advanced agricultural region in Bhutan. But it lags behind in infrastructure consolidation and the cultivated land of the farmers is so scattered as to render effective farming nearly impossible. To make farming more efficient and promote agricultural mechanization, it is advisable to expand plots through farmland consolidation. But the topography of the Paro Valley, which is on a slope along a long, narrow valley in the Himalayas, makes it difficult to carry out such consolidation efforts. It is hoped that through the construction of a pilot farm for farmland consolidation the farmers will come to understand the effects of land substitution and positively deal with the problem.

The irrigation channels targeted for repair were selected on the basis of a comprehensive judgment in terms of their flow capacity, and facilities were planned that would make water management possible. Both the U-shaped and L-shaped flumes to be used in the work are to be produced in this area. Thus it is hoped that local farmers participate in this project to construct irrigation facilities and even after this project the Bhutan side will be able to implement these same works in other areas on their own.

Agricultural mechanization is believed to be promoted through construction of farm roads, but the local residents still highly regard the importance of livestock, and the farmers in this area intend through future agricultural mechanization to maintain their present mixed system of agriculture and livestock raising without significantly reducing the number of animals.

As noted in the previous section, this project should result in increase of paddy and cash crop production. The expected increase are as follows:

Paddy	902 M.T.
Potatoes	2,815 M.T.
Apples	3,409 M.T.

The increase in production of these three products combined is equivalent to around ¥ 370.9 million when plugged into this year's farm gate prices, or ¥ 192,200 per household. In proportion to the increase of farmers' income, agricultural mechanization will be promoted and agricultural productivity be improved, as well as leveling up of farmers' living standards. Further, the project will greatly contribute to progress of the National Development Plan, as a model of a self sufficient area.

From the effects outline above, it is deemed appropriate greatly to implement this project with Japanese grant aid.

ANNEX 1 MEMBER LIST OF SURVEY TEAM

Name	Speciality	Organization
Mr. Yasuhiko YAMAMOTO	Team Leader	Director of Planning Division Hokuriku Agricultural Administration Office, MAFF
Mr. Tadanori SUZUKI	Project Coodinator	First Basic Design Study Div. Grant Aid Planning & Survey Department Japan Internationa Cooperation Agency (JICA)
Mr. Masamitsu FUJIOKA	Chief Engineer	Hokkaido Engineering Consultants
Mr. Kazuo MIBAYASHI	Farm Road & River Bank Protection Engineer	Hokkaido Engineering Consultants
Mr. Kaoru HOSHII	Irrigation Engineer	Hokkaido Engineering Consultants
Mr. Makoto KOBAYASHI	Land Consolidation Engineer	Hokkaido Engineering Consultants
Mr. Yoshimasa KAWABATA	Chief Surveyor 1	Hokkaido Engineering Consultants
Mr. Yasuyoshi IGARASHI	Chief Surveyor 2	Hokkaido Engineering Consultants
Mr. Hidefumi INOUE	Cost Estimation Engineer	Hokkaido Engineering Consultants

ANNEX 2 SURVEY SCHEDULE

No.	Date	Activities
1	Nov. 7 (Tue)	- Departure of Study team from Narita
2	Nov. 8 (Wed)	- Arrival in Delhi. Courtesy call to Embassy of Japan. Meeting with JICA India Office.
3	Nov. 9 (Thu)	- Arrival in Paro and shift to Thimphu.
4	Nov. 10 (Fri)	- Courtesy call and meeting with Ministry of Agriculture and Ministry of Home Affairs. Shift to Paro except Team Leader, Project Coordinator and Chief Engineer.
5	Nov. 11 (Sat)	- Team Leader, Project Coordinator and Chief Engineer shift to Paro. Other staff attend to ceremony of King's Birthday. Site reconnaissance.
6	Nov. 12 (Sun)	- General site reconnaissance. Topographic survey.
7	Nov. 13 (Mon)	- Topographic survey. Site reconnaissance.
8	Nov. 14 (Tue)	- Meeting with Steering Committee, Topographic survey, soil survey and interview.
9	Nov. 15 (Wed)	- Signing of meeting minutes with Ministry of Agriculture, topographic survey, soil survey and interview.
10	Nov. 16 (Thu)	- Arrival of team leader and project coordinator in Delhi, meeting with JICA India Office. - Team meeting, topographic survey, soil survey and interview.
11	Nov. 17 (Fri)	- Arrival in Bangkok. - Topographic survey, soil survey, survey for channel rehabilitation and interview.
12	Nov. 18 (Sat)	- Arrival in Tokyo. - Topographic survey, soil survey, survey for channel rehabilitation and interview.
13	Nov. 19 (Sun)	- Team meeting, interview and analysis of collected data.
14	Nov. 20 (Mon)	- Topographic survey, water requirement survey and interview.
15	Nov. 21 (Tue)	- Topographic survey, water requirement survey and interview.

No.	Date	Activities
16	Nov. 22 (Wed)	- Farm road & river protection engineer shift to Thimphu, data collection at Royal Monetary Authority, Central Statistical Office and construction survey. - Topographic survey and water requirement survey.
17	Nov. 23 (Thu)	- Meeting with Department of Animal Husbandry and Public Works Department, construction survey and farm road & river protection engineer shift to Paro. - Topographic survey, water requirement survey. -Chief engineer shift to Thimphu.
18	Nov. 24 (Fri)	- Meeting with Ministry of Home Affairs and Planning Commission and chief engineer shift to Paro. - Topographic survey, water requirement survey, meeting with District Animal Husbandry Office and interview.
19	Nov. 25 (Sat)	- Topographic survey, water requirement survey, land use survey and channel survey.
20	Nov. 26 (Sun)	- Team meeting and analysis of collected data.
21	Nov. 27 (Mon)	- Farm road & river protection engineer shift to Phuntsholing and construction survey. - Topographic survey, water requirement survey and farm management survey at land consolidation site.
22	Nov. 28 (Tue)	- Meeting with State Trading Corporation of Bhutan and construction survey. - Topographic survey and farm management survey at land consolidation site.
23	Nov. 29 (Wed)	- Meeting with state Trading Corporation of Bhutan and shift to Paro. - Topographic survey, farm management survey at land consolidation site and construction survey.
24	Nov. 30 (thu)	- Topographic survey, farm management survey at land consolidation site and land use survey.

No.	Date	Activities
25	Dec. 1 (Fri)	- Topographic survey, survey for existing irrigation and drainage facilities, survey for land consolidation site. - Farm roads & river protection engineer shift to Thimphu, contractor survey and visiting crushing plant on the way back to Paro.
26	Dec. 2 (Sat)	- Topographic survey, survey for existing irrigation and drainage facilities, land use survey and survey for land consolidation site.
27	Dec. 3 (Sun)	- Team meeting, Water quality test and analysis of collected data.
28	Dec. 4 (Mon)	- Topographic survey, survey of lots in land consolidation site and meeting with Dzongkhag staff.
29	Dec. 5 (Tue)	- Topographic survey, survey of lots in land consolidation site, construction road survey and channel survey.
30	Dec. 6 (Wed)	- Topographic survey, survey of lots on land consolidation site, traffic survey, forest survey.
31	Dec. 7 (Thu)	- Chief engineer shift to Thimphu, meeting with Ministry of Agriculture and back to Paro. - Topographic survey, survey of lots in land consolidation site and survey for river section.
32	Dec. 8 (Fri)	- Topographic survey, survey at land consolidation site with farmers, survey for river section and meeting with Dzongkhag staff.
33	Dec. 9 (Sat)	- Topographic survey, survey at land consolidation site with farmers and survey for river section.
34	Dec. 10 (Sun)	- Team meeting, analysis of collected data.
35	Dec. 11 (Mon)	- Topographic survey and discussion policy for land consolidation.
36	Dec. 12 (Tue)	- Arrival of farm roads & river protection engineer in Culcutta and survey for on-road transport survey. - Topographic survey and survey at proposed bridge site.

No.	Date	Activities
37	Dec. 13 (Wed)	- Survey for on-road transport and construction materials. - Discussion on strategy of development.
38	Dec. 14 (Thu)	- Arrival of chief engineer in Delhi and meeting with JICA India Office. - Survey for on-road transport and construction materials. - Preparation work for leave.
39	Dec. 15 (Fri)	- Arrival of chief engineer in Bangkok. - Other members arrival in Culcutta.
40	Dec. 16 (Sat)	- Arrival in Tokyo.

ANNEX 3 LIST OF PARTICIPANTS

Ministry of Agriculture	
Dasho Leki Dorji	Secretary
Department of Agriculture	
Dasho Khandu Wangcuk	Secretary
Mr. Pem L. Dorji	Joint Director (Project & Programme Coordination Div. and Research and Extension Div.)
Mr. Tshering Dorji	Director (Irrigation Div.)
Mr. Tseten Rabgay	Planning Officer
Department of Animal Husbandry	
Dr. M.K. Rai	Director
Mr. Sangay Dorji	District A.H. Officer
Planning Commission	
Dasho C. Dorji	Deputy Minister
Mr. Jack Colwell	Adviser Statistics, Central Statistical Office
Ministry of Home Affairs	
Dasho Dago Tshering	Deputy Minister
Dasho Sherab Tenjin	Deputy Secretary
Ministry of Social Services	
Public Works Department	
Mr. Brij Bhushan Kalra	Executive Engineer, Planning Buildings
State Trading Corporation of Bhutan	
Mr. L.B. Rai	Joint Managing Director
Steering Committee Members	
Dasho Kipchu Dorji	Zonal Administrator
Dasho Pasang Tobgay	Dzongdag
Dasho Richen Dorji	Thrimpon
Dasho Kyoji Nishioka	Colombo Expert
Mr. Sherub Gyeltshen	Officer-in-charge A.M.C.
Mr. B.P. Rai	P & MO
Mr. R.C. Nair	Assistant Engineer (Irrigation)
Mr. Tandi Dorji	District Agriculture Officer
Mr. Gyaltshen	Luni Village Headman
Mr. Gem Tshering	Wangchang Village Headman
Mr. Kinley Wangchuck	Lango Village Headman
Mr. Chen Tshering	Shari Village Headman
Mr. Tshe Dorji	Hore Village Headman
Mr. Tandin	Dotey Village Headman
Mr. Sonam Richen	Tsento Village Headman
Mr. Dorji Tshering	Assembley Member
Counterpart	
Mr. Penden Norgay	Sectipon Officer
Mr. Kezabg Dawa	Irrigation Division
Mr. Thomas	Section Officer
Mr. Kuenga	Section Officer
Mr. Babu Sivgh	Sub-section Officer
Embassy of Japan	
Mr. Eijiro Noda	Ambassador
Mr. Masamichi Saigo	First Secretary
JICA India Office	
Mr. Taroh Kurabayashi	Representative

ANNEX 4

MINUTES OF DISCUSSIONS ON THE BASIC DESIGN STUDY OF THE PARO VALLEY AGRICULTURAL DEVELOPMENT PROJECT (PHASE II) IN THE KINGDOM OF BHUTAN

In response to the request made by the Royal Government of Bhutan, the Government of Japan decided to conduct a Basic Design Study on the Paro Valley Agricultural Development Project(Phase-II) (hereinafter referred to as "the Project") and entrusted the study to the Japan International Co-operation Agency(JICA). JICA has sent to the Kingdom of Bhutan the Basic Design Study Team headed by Mr.Yasuhiko Yamamoto, Director, Planning Department, Hokuriku Agricultural Administration Officer, Ministry of Agriculture, Forestry & Fisheries, from November 7 to December 18, 1989.

The Team had a series of discussions with the authorities concerned of the Royal Government of Bhutan and conducted a field survey in the Paro Valley.

As a result of the study, both parties have agreed to recommend to their respective Government that the major points of understanding reached between them, as attached herewith, should be examined further towards the realization of the Project.

Thimphu, December 15, 1989

山本泰彦

Yasuhiko Yamamoto
Leader,
Basic Design Study Team,
JICA

Dasho Leki Dorji
Secretary,
Ministry of Agriculture,
Royal Government of Bhutan.

ATTACHMENT

1. Objective of the Project
The objective of the Project is to improve agricultural infrastructure in selected gewogs of Paro Dzongkhag in support of its efforts so far made and thus to contribute to the modernization of the agriculture sector of the Kingdom of Bhutan.

2. Scope of the Study
Based on the rough improvement plan, for necessary agricultural infrastructure in the Project area, prepared by the basic design study team (Phase I), the basic design study team (Phase II) conduct›detail survey and make a basic design plan of the necessary facilities such as rural and/or farm roads, river banks, irrigation canals and pilot land consolidation.

3. Executing Organization
The executing organization for the Project is the Department of Agriculture (DOA), Ministry of Agriculture.

4. Project Sites
Proposed Projects sites are located at Paro Valley

5. Request a nd assurance of the Royal Government of Bhutan
The Study Team will convey request and assurance given by the Royal Government of Bhutan, which is listed in Annex I to the Government of Japan. The latter will make the necessary arrangement for the Project within the scope of Japanese Grant Aid Program.

6. Japanese Grant Aid Program
The Royal Government of Bhutan has understood the Japanese Grant Aid Program explained by the Team.

7. Measures to be taken by the Royal Government of Bhutan
The Royal Government of Bhutan will take necessary measures as listed in Annex II on condition that the Grant Aid by the Government of Japan would be extending to the Project.

Contd..2/-

8. Budget and Personnel

The Royal Government of Bhutan shall prepare the necessary budget and personnel for the operation and maintenance of the existing farm road and plants and construction equipments studied in the Phase I study on condition that the Grant Aid by the Government of Japan would be extended to the Project.

ANNEX I

1. The Royal Government agrees with the Master Plan.

2. Labourers required for the project shall be to the possible extent met from the farmers of the beneficial areas and the balance shall be met from National Work Force.

3. Two persons to be identified by the Department of Agriculture to undergo training in Japan for 6 months one in concrete Plan Management and one in operations of concrete plant. For this, official request to be made immediately.

4. Department of Agriculture to train twenty persons in operating heavy earth-moving equipments. In addition, to train thirty persons for maintenance and operation of concrete plant/workshop.

5. The Royal Government will take necessary measures to acquire land for construction of farm-road, river bank protection and land consolidation.

6. The Department of Agriculture to take electrical line to the concrete plant prior to the construction works. In addition, to provide budget for running and maintenance of the electrical line.

ANNEX II

The necessary measures to be taken by the Royal Government of Bhutan are shown as follows:

1. To ensure prompt unloading, tax exemption, customs clearance at ports of disembarkation and prompt internal transportation therein, of the products procured under the grant Aid.

2. To bear the following commissions to the Japanese foreign exchange bank for the banking services, based upon the Banking Arrangement.
   (i) Advising commission of authorization to pay
   (ii) Payment commission

3. To exempt Japanese Nationals involved in the Project from custom duties, internal taxes and other fiscal levies which be imposed in the Kingdom of Bhutan with respect to the supply of the products and services under the Verified Contracts.

4. To accord Japanese Nationals whose services may be required in connection with the supply of the products and the services under the Verified Contracts such facilities as may be necessary for their entry into the Kingdom of Bhutan and stay therein for the performance of their works.

5. To bear all the expenses other than those to be borne by the Grant, necessary for the execution of the Project.

6. To provide necessary data and information for detailed design.

7. To make necessary arrangement for securing skilled and/or unskilled labour as required for the implementation of the Project, taking into consideration the policy of the Royal Government of Bhutan on mechanisation of construction.

8. The concrete plant and the heavy equipments will be solely utilized for the Paro Valley Agricultural Development Project during the life of the Project. After completion of the Project, these equipments and the concrete plant will be utilized for Agriculture Development Programmes of the Country.

ANNEX 5 DISCHARGE DATA OF PARO RIVER AT DZONG BRIDGE - 1987

Unit : cu.m/sec

Date	January	February	March	April	May	June	July	August	September	October	November	December
1	0.00	0.00	7.01	7.01	7.01	7.57	51.27	145.30	100.74	39.65	15.87	12.59
2	0.00	7.68	7.12	7.01	7.12	8.13	39.35	143.79	96.65	39.65	15.05	11.93
3	0.00	7.35	7.01	7.23	7.02	19.88	82.91	138.48	85.48	34.76	15.05	12.09
4	0.00	7.79	7.12	7.23	7.01	20.12	82.91	117.47	100.74	32.85	15.05	12.23
5	0.00	7.35	7.23	7.23	7.01	22.22	70.00	103.54	97.37	32.85	15.05	11.93
6	0.00	7.46	7.23	7.01	7.12	24.79	72.33	103.54	36.33	32.10	13.76	11.60
7	0.00	7.79	7.12	6.80	7.12	26.67	81.87	103.54	31.16	31.15	13.95	11.94
8	0.00	7.23	7.35	7.01	7.01	27.13	82.91	82.71	63.98	31.78	10.83	11.99
9	0.00	7.35	7.13	6.91	7.12	25.50	109.56	79.62	59.84	29.49	11.99	11.83
10	0.00	7.79	7.23	7.01	7.12	28.07	137.25	74.62	59.84	28.81	14.39	10.55
11	0.00	7.51	7.34	7.12	7.01	27.84	105.26	93.80	63.98	29.49	13.49	10.83
12	0.00	7.57	7.01	7.12	7.01	27.37	131.05	117.47	116.83	29.25	12.59	12.63
13	0.00	7.57	7.01	7.23	7.90	28.77	138.86	121.63	100.74	30.86	10.61	11.19
14	0.00	7.57	7.12	7.12	7.24	28.07	105.26	109.60	69.04	30.86	8.46	11.03
15	0.00	7.12	7.12	7.12	7.24	27.84	81.87	103.54	63.98	29.85	9.42	10.99
16	0.00	7.12	7.12	7.01	7.35	27.84	54.99	88.09	54.18	25.05	10.81	10.89
17	0.00	7.12	7.24	7.01	7.55	28.07	66.43	81.67	49.97	25.14	9.63	10.59
18	0.00	7.34	7.22	7.01	7.13	27.84	51.47	75.28	38.70	25.51	8.61	10.88
19	0.00	7.23	7.22	7.12	7.13	28.07	54.99	88.09	44.45	40.24	9.12	10.88
20	0.00	7.34	7.12	7.01	7.57	27.13	75.45	101.92	61.75	55.73	10.07	10.74
21	0.00	7.34	7.23	7.01	7.01	42.49	66.43	100.40	49.17	44.90	10.86	10.59
22	0.00	7.23	7.12	7.12	7.01	46.51	72.14	81.67	56.88	36.51	8.52	10.74
23	0.00	7.34	7.22	7.12	7.13	42.49	81.87	118.92	61.75	34.53	9.58	10.88
24	0.00	7.45	7.46	7.12	7.01	44.00	137.25	110.39	57.58	33.52	10.08	11.88
25	0.00	7.34	7.12	7.01	7.90	32.95	149.21	94.89	57.65	29.70	8.76	10.59
26	0.00	7.12	7.35	6.91	7.01	32.28	169.12	87.82	93.28	27.19	8.92	10.89
27	0.00	7.29	7.23	7.12	7.13	30.17	169.12	104.15	62.04	29.42	8.76	10.30
28	0.00	7.53	7.01	7.12	7.13	46.51	142.09	106.65	62.80	28.29	8.92	10.59
29	0.00	0.00	7.01	7.23	7.13	45.76	137.25	100.23	47.16	26.66	8.66	10.45
30	0.00	0.00	7.01	6.91	7.01	32.28	145.33	96.79	46.62	26.66	8.83	10.30
31	0.00	0.00	6.90	0.00	6.90	0.00	167.30	90.98	0.00	25.64	0.00	10.30
TOTAL	0.00	199.92	221.73	211.89	222.16	884.36	3113.10	3167.03	1989.68	998.09	335.69	346.84
AVERAGE	0.00	7.40	7.15	7.06	7.16	29.47	100.42	102.16	66.32	32.19	11.18	11.18
MIN.	0.00	7.12	6.90	6.80	6.90	7.57	39.35	74.62	31.16	25.05	8.46	10.30
MAX.	0.00	7.79	7.46	7.23	7.90	46.51	169.12	145.30	116.83	55.73	15.87	12.63

DISCHARGE DATA OF PARO RIVER AT DZONG BRIDGE - 1988

Unit : cu.m/sec

Date	January	February	March	April	May	June	July	August	September	October	November	December
1	9.42	8.07	4.68	6.50	14.06	10.46	21.98	63.99	47.42	45.67	20.16	14.56
2	9.56	8.16	7.56	6.26	15.04	10.78	28.13	41.78	47.42	40.63	19.41	13.83
3	8.68	6.50	7.18	5.66	13.90	11.08	24.64	41.78	41.82	35.37	18.85	13.51
4	9.56	6.24	7.92	6.38	13.90	10.62	29.76	41.78	40.64	31.89	18.83	13.66
5	9.12	7.90	7.67	6.87	12.96	16.53	30.72	41.78	39.47	27.38	18.61	13.51
6	9.12	7.99	7.67	6.87	12.96	16.36	44.47	52.50	53.50	26.73	18.27	14.51
7	9.12	8.51	6.94	6.50	12.96	15.37	46.23	66.80	38.58	25.65	18.64	13.83
8	8.38	8.12	6.58	6.02	13.27	21.83	52.18	63.99	52.50	24.56	18.10	14.12
9	8.38	8.25	6.58	6.96	12.96	21.95	44.47	60.60	53.72	22.65	17.16	13.83
10	8.38	7.73	7.31	7.82	13.11	23.59	54.63	52.50	52.50	21.41	17.00	14.12
11	8.38	8.63	7.92	6.82	12.81	27.49	50.09	52.50	47.42	20.87	17.16	13.31
12	8.38	8.50	7.67	7.43	13.90	28.37	49.79	60.97	37.40	20.30	16.97	12.77
13	9.12	7.73	7.79	6.94	14.86	25.21	55.84	55.30	38.88	19.56	16.09	13.05
14	9.56	7.99	7.30	6.20	19.34	33.06	52.18	55.50	36.59	19.56	15.71	12.62
15	9.42	7.47	8.04	6.20	16.69	32.32	53.67	59.16	35.66	19.56	15.30	12.19
16	9.56	7.14	8.55	7.95	9.24	37.42	50.39	63.99	35.66	19.56	15.00	12.04
17	4.77	8.07	9.88	7.95	10.98	44.49	50.39	52.20	36.59	19.39	15.44	12.04
18	4.89	7.69	8.07	6.78	12.90	43.59	53.40	57.34	36.59	19.21	15.44	12.04
19	5.02	7.44	8.07	7.07	19.64	44.51	49.50	49.50	35.42	18.86	15.30	11.90
20	5.28	7.44	7.71	7.32	18.20	37.23	48.01	63.99	35.48	18.14	15.00	11.60
21	4.63	7.82	7.95	7.75	16.40	31.05	58.55	49.80	35.66	17.96	15.44	11.32
22	4.25	8.10	7.56	9.00	12.06	27.01	54.30	63.99	35.66	17.79	15.44	11.18
23	5.41	8.35	8.30	8.81	12.22	28.37	55.84	63.99	35.81	17.43	14.53	11.31
24	4.76	6.73	7.70	11.32	11.56	28.23	47.71	63.99	33.74	17.43	14.53	10.90
25	4.51	7.48	7.10	12.36	9.99	36.65	50.39	63.99	34.04	17.43	14.53	10.76
26	7.00	7.15	7.70	12.31	9.99	36.26	53.40	63.99	33.74	17.26	14.53	11.60
27	5.67	7.89	7.80	12.57	12.81	28.38	44.43	55.40	35.48	17.26	14.53	12.77
28	5.92	7.40	7.35	14.54	13.90	25.47	52.18	55.40	35.66	17.26	14.38	12.77
29	4.46	7.77	8.19	19.65	17.52	26.17	53.40	55.40	36.59	17.26	14.38	12.77
30	4.46	0.00	6.93	20.79	15.04	24.66	44.45	55.40	34.42	17.26	15.00	11.33
31	4.46	0.00	6.74	0.00	14.21	0.00	44.45	45.32	0.00	17.26	0.00	11.47
TOTAL	219.63	224.26	234.41	265.60	429.37	804.51	1449.57	1734.62	1194.06	688.55	489.73	391.21
AVERAGE	7.08	7.73	7.56	8.85	13.85	26.81	46.76	55.95	39.80	22.21	16.32	12.62
MIN.	4.25	6.24	4.68	5.66	9.24	10.46	21.98	41.78	33.74	17.26	14.38	10.76
MAX.	9.56	8.63	9.88	20.79	19.64	44.51	58.55	66.80	53.72	45.67	20.16	14.56

DISCHARGE DATA OF PARO RIVER AT DZONG BRIDGE - 1989

Unit : cu.m/sec

Date	January	February	March	April	May	June	July	August	September	October	November	December
1	11.30	7.77	7.30	12.09	15.91	54.97	59.03	96.41	58.95	79.53	30.00	0.00
2	10.90	7.44	7.30	12.09	15.91	54.97	69.18	95.85	58.95	79.52	29.70	0.00
3	10.35	7.44	7.30	12.09	15.91	54.97	73.67	81.90	68.23	71.13	28.71	0.00
4	10.49	7.44	7.30	12.09	15.91	54.97	74.12	80.07	71.31	68.23	25.71	0.00
5	10.21	7.44	7.30	12.09	15.37	54.97	58.14	80.07	81.48	68.22	23.57	0.00
6	9.94	7.11	7.30	12.09	15.37	54.97	76.29	76.06	88.80	58.95	22.70	0.00
7	9.26	7.11	7.30	12.09	15.37	63.59	82.21	80.07	95.94	58.95	22.49	0.00
8	9.93	7.03	7.30	12.09	15.37	63.59	77.51	81.90	92.08	58.43	22.07	0.00
9	10.34	7.03	7.30	12.09	15.37	80.34	76.29	95.85	88.80	58.43	21.86	0.00
10	9.79	7.03	9.24	13.22	15.37	80.34	59.03	96.41	88.80	58.43	22.49	0.00
11	10.06	7.03	9.24	13.22	15.37	85.04	58.94	96.41	88.80	58.43	20.89	0.00
12	9.52	7.03	9.24	13.23	15.37	97.08	58.30	84.43	88.80	54.81	20.70	0.00
13	11.33	7.03	9.24	13.23	15.37	99.44	76.29	83.53	88.80	54.80	21.08	0.00
14	9.93	6.95	9.24	13.23	15.37	99.44	80.26	80.67	92.08	53.82	20.89	0.00
15	9.65	6.95	9.24	13.23	15.37	113.82	85.97	76.06	88.80	53.81	20.70	0.00
16	9.52	6.87	9.24	15.91	15.37	152.55	85.97	76.06	79.53	48.28	21.08	0.00
17	8.99	6.87	9.24	15.91	15.37	130.01	84.97	72.32	79.53	48.26	20.89	0.00
18	8.87	6.87	9.24	15.91	14.89	115.85	80.33	76.06	81.48	44.16	20.70	0.00
19	9.80	6.95	9.24	15.91	14.89	113.19	80.16	80.07	88.80	40.36	20.89	0.00
20	9.80	7.03	9.24	15.91	17.79	94.63	77.51	80.07	88.80	40.35	21.08	0.00
21	9.11	7.11	9.24	15.91	21.98	85.97	77.51	81.60	79.53	40.36	20.89	0.00
22	8.01	7.44	9.24	15.91	24.43	75.98	59.03	81.60	79.53	40.36	20.70	0.00
23	8.36	7.44	9.24	15.91	24.43	67.79	58.30	80.07	79.53	40.35	18.88	0.00
24	8.25	7.52	11.07	15.91	30.52	63.59	56.65	76.06	74.02	34.40	18.09	0.00
25	8.25	7.52	11.07	15.91	30.52	60.59	59.03	81.48	70.84	34.40	17.90	0.00
26	8.12	7.44	11.07	15.91	30.52	57.92	77.51	81.48	74.02	34.39	18.09	0.00
27	8.16	8.48	11.07	15.91	147.58	56.81	77.51	81.48	88.80	34.38	17.28	0.00
28	8.03	8.12	11.07	15.91	151.90	57.55	59.03	76.06	88.80	34.39	18.88	0.00
29	7.65	0.00	11.07	15.91	111.92	54.95	58.96	62.34	88.80	34.40	17.28	0.00
30	7.65	0.00	11.07	15.91	81.14	53.83	73.67	62.34	88.80	34.41	13.03	0.00
31	7.52	0.00	11.07	0.00	64.64	0.00	77.51	62.34	0.00	34.40	0.00	0.00
TOTAL	289.09	203.49	283.62	426.82	1030.60	2353.71	2208.88	2497.12	2471.43	1553.14	639.22	0.00
AVERAGE	9.32	7.26	9.14	14.22	33.24	78.45	71.25	80.55	82.38	50.10	21.30	0.00
MIN.	7.52	6.87	7.30	12.09	14.89	53.83	56.65	62.34	58.95	34.38	13.03	0.00
MAX.	11.33	8.48	11.07	15.91	151.90	152.55	85.97	96.41	95.94	79.53	30.00	0.00

ANNEX 6 AGRICULTURAL SURVEY RESULT

Number of Family Members

unit : No. of farmers

Site	Number of Members						
	2 & below	3-4	5-6	7-8	9-10	11-14	15 & above
Tsento	2	1	1	4	0	2	0
Wangchang	0	1	2	3	2	2	0
Land Consolidation Site	0	1	2	3	2	2	0
Shaba	0	1	5	3	0	1	0
Total	2	4	10	13	4	7	0

Land Ownership

unit : No. of farmers

Site	Area in ha							
	0	0.01 -0.49	0.50 -0.99	1.00 -1.49	1.50 -1.99	2.00 -2.99	3.00 -4.99	5.00 & above
Tsento	0	0	3	4	2	1	0	0
Wangchang	0	0	1	5	2	0	2	0
L/C Site	1	1	1	1	2	1	0	3
Shaba	0	1	4	1	2	1	1	0
Total	1	2	9	11	8	3	3	3

Cultivating Land

unit : No. of farmers

Site	Area in ha							
	0	0.01 -0.49	0.50 -0.99	1.00 -1.49	1.50 -1.99	2.00 -2.99	3.00 -4.99	5.00 & above
Tsento	0	0	3	3	2	2	0	0
Wangchang	0	0	1	5	2	1	1	0
L/C Site	0	1	2	1	2	1	0	3
Shaba	0	1	4	1	2	2	0	0
Total	0	2	10	10	8	6	1	3

AGRICULTURAL SURVEY RESULT

Wet Land

unit : No. of farmers

Site	Area in ha							
	0	0.01 -0.49	0.50 -0.99	1.00 -1.49	1.50 -1.99	2.00 -2.99	3.00 -4.99	5.00 & above
Tsento	0	9	1	0	0	0	0	0
Wangchang	0	2	3	4	1	0	0	0
L/C Site	0	2	2	3	1	0	2	0
Shaba	0	4	4	2	0	0	0	0
Total	0	17	10	9	2	0	2	0

Dry Land

unit : No. of farmers

Site	Area in ha							
	0	0.01 -0.49	0.50 -0.99	1.00 -1.49	1.50 -1.99	2.00 -2.99	3.00 -4.99	5.00 & above
Tsento	0	3	3	2	2	0	0	0
Wangchang	8	1	0	1	0	0	0	0
L/C Site	4	4	0	1	0	0	1	0
Shaba	1	8	0	0	1	0	0	0
Total	13	16	3	4	3	0	1	0

Kitchen Garden

unit : No. of farmers

Site	Area in ha							
	0	0.01 -0.49	0.50 -0.99	1.00 -1.49	1.50 -1.99	2.00 -2.99	3.00 -4.99	5.00 & above
Tsento	1	9	0	0	0	0	0	0
Wangchang	2	8	0	0	0	0	0	0
L/C Site	3	7	0	0	0	0	0	0
Shaba	1	9	0	0	0	0	0	0
Total	7	33	0	0	0	0	0	0

AGRICULTURAL SURVEY RESULT

Orchard

unit : No. of farmers

Site	Area in ha							
	0	0.01 -0.49	0.50 -0.99	1.00 -1.49	1.50 -1.99	2.00 -2.99	3.00 -4.99	5.00 & above
Tsento	3	7	0	0	0	0	0	0
Wangchang	0	8	2	0	0	0	0	0
L/C Site	0	8	1	0	0	0	0	1
Shaba	1	8	1	0	0	0	0	0
Total	4	31	4	0	0	0	0	1

Yield of Main Crops

unit : M.T./ha

Site	Paddy	Wheat	Potato
Tsento	1.415	0.565	6.237
Wangchang	3.863	0.720	6.590
Land Consolidation Site	3.965	1.533	7.646
Shaba	2.731	1.131	5.738
Average	2.994	0.987	6.553

Harvested Crops by 40 Farmers at 4 Sites

unit : No. of farmers

Site	Paddy	Wheat	Barley	Potato	Chilli	Cabbage	Radish Turnip	Mustard	Apple
Tsento	10	10	0	10	6	4	9	2	1
Wangchang	10	10	0	6	10	5	10	2	6
L/C Site	10	9	3	9	7	6	7	0	3
Shaba	10	9	0	7	10	3	7	1	6
Total	40	38	3	32	33	18	33	5	16

Site	Spinach	Tomato	Millet	Beans Pulses	Cauliflower	Corn	Pumpkin	Eggplant
Tsento	1	2	6	2	1	0	0	0
Wangchang	0	2	0	4	1	1	0	0
L/C Site	0	4	1	4	1	0	1	1
Shaba	0	5	0	9	0	0	0	0
Total	1	13	7	19	3	1	1	1

AGRICULTURAL SURVEY RESULT

Fertilizer Input

unit : No. of farmers

Suphala

Site	Paddy	Wheat	Barley	Potato	Apple	Beans	Cabbage	Radish Turnip	Tomato
Tsento	1	0	0	8	0	0	0	1	0
Wangchang	3	0	0	1	2	0	1	2	0
L/C Site	4	4	2	6	2	0	3	4	2
Shaba	3	0	0	1	2	2	2	1	1
Total	11	4	2	16	6	2	6	8	3

	Cauliflower	Chilli	Mustard
Tsento	0	2	0
Wangchang	0	1	1
L/C Site	1	4	0
Shaba	0	2	0
Total	1	9	1

Urea

Site	Paddy	Wheat	Chilli	Potato	Apple	Cabbage	Radish/Turnip	Tomato
Tsento	0	0	0	0	0	0	0	0
Wangchang	1	0	1	0	0	0	0	0
L/C Site	5	1	4	3	1	2	4	2
Shaba	0	0	1	0	1	0	0	0
Total	6	1	6	3	2	2	4	2

Insecticide

Site	Apple
Tsento	0
Wangchang	2
L/C Site	1
Shaba	0
Total	3

Weedicide

Site	Paddy
Tsento	0
Wangchang	3
L/C Site	0
Shaba	0
Total	3

Bone Meal

Site	Apple
Tsento	0
Wangchang	0
L/C Site	1
Shaba	0
Total	1

AGRICULTURAL SURVEY RESULT

Fertilizer Input

unit : No. of farmers

Farmyard Manure

Site	Paddy	Wheat	Barley	Potato	Apple	Beans	Radish Turnip	Chilli	Tomato
Tsento	10	2	0	10	2	0	4	4	1
Wangchang	10	10	0	4	1	3	7	7	1
L/C Site	10	7	2	8	5	1	6	7	4
Shaba	10	9	0	6	7	7	5	7	5
Total	40	28	2	28	15	11	22	25	11

Site	Cabbage	Millet	Mustard	Cauliflower	Corn	Eggplant
Tsento	3	3	1	1	0	0
Wangchang	3	0	1	1	1	0
L/C Site	5	0	0	0	0	1
Shaba	2	0	0	0	0	0
Total	13	3	2	2	1	1

Livestock

Cattle

Breeding Farmers unit : No. of farmers

	No. of Adult Male Animal							No. of Young Male Animal				
Site	0	1-2	3-4	5-6	7-8	9-10	11& above	0	1-2	3-4	5-6	7& above
Tsento	2	4	4	0	0	0	0	7	3	0	0	0
Wangchang	1	6	2	1	0	0	0	3	6	1	0	0
L/C Site	2	4	3	0	0	0	1	4	5	0	0	0
Shaba	2	5	2	1	0	0	0	7	3	0	0	0
Total	7	19	11	2	0	0	1	21	17	1	0	0

AGRICULTURAL SURVEY RESULT

Number of Male Cattle in Age Groups

Site	0-11month	1	2	3	4-5	6-7	8-9	10-11	12-13	14& above
Tsento	0	0	0	3	6	4	5	2	2	1
Wangchang	0	1	4	7	4	6	7	2	1	1
L/C Site	0	3	1	4	7	2	6	2	0	1
Shaba	1	1	1	1	1	3	6	1	1	1
Total	1	5	6	15	18	15	24	7	4	4

Breeding Farmers unit : No. of farmers

	No. of Adult Female Animal							No. of Young Female One				
Site	0	1-2	3-4	5-6	7-8	9-10	11& above	0	1-2	3-4	5-6	7& above
Tsento	2	8	0	0	0	0	0	3	6	1	0	0
Wangchang	1	6	3	0	0	0	0	3	7	0	0	0
L/C Site	1	3	4	0	0	0	2	1	6	1	0	0
Shaba	5	2	1	0	1	0	1	7	1	1	0	1
Total	9	19	8	0	1	0	3	14	20	3	0	1

Number of Female Cattle in Age Groups

Site	0-11month	1	2	3	4-5	6-7	8-9	10-11	12-13	14& above
Tsento	1	2	5	3	6	3	1	1	2	0
Wangchang	0	3	2	5	4	7	5	0	0	1
L/C Site	0	4	4	4	3	8	4	1	1	0
Shaba	0	0	1	0	2	1	0	0	0	0
Total	1	9	12	12	15	19	10	2	3	1

Horse

Breeding Farmers unit : No. of farmers

	No. of Adult Male Animal					No. of Young Male Animal			
Site	0	1-2	3-4	5-6	7& above	0	1-2	3-4	5-6
Tsento	8	2	0	0	0	9	1	0	0
Wangchang	9	1	0	0	0	10	0	0	0
L/C Site	8	0	1	0	0	8	1	0	0
Shaba	10	0	0	0	0	10	0	0	0
Total	35	3	1	0	0	37	2	0	0

AGRICULTURAL SURVEY RESULT

Number of Male Horses in Age Groups

Site	0-11month	1	2	3	4-5	6-7	8-9	10-11	12-13	14& above
Tsento	0	0	1	0	1	0	0	2	0	0
Wangchang	0	0	0	0	0	1	0	0	0	0
L/C Site	0	0	0	1	?	?	?	?	?	?
Shaba	0	0	0	0	0	0	0	0	0	0
Total	0	0	1	1	1	1	0	2	0	0

Breeding Farmers unit : No. of farmers

	No. of Adult Female Animal					No. of Young Female Animal			
Site	0	1-2	3-4	5-6	7& above	0	1-2	3-4	5-6
Tsento	8	2	0	0	0	9	1	0	0
Wangchang	8	2	0	0	0	8	2	0	0
L/C Site	7	2	0	0	0	9	0	0	0
Shaba	9	1	0	0	0	10	0	0	0
Total	32	7	0	0	0	36	3	0	0

Number of Female Horses in Age Groups

Site	0-11month	1	2	3	4-5	6-7	8-9	10-11	12-13	14& above
Tsento	0	0	0	1	0	1	2	0	0	0
Wangchang	0	0	0	2	1	0	1	0	0	0
L/C Site	0	0	0	0	0	1	1	0	0	0
Shaba	0	0	0	0	1	0	0	0	0	0
Total	0	0	0	3	2	2	4	0	0	0

Pig

Breeding Farmers unit : No. of farmers

	No. of Adult Male Animal					No. of Young Male Animal			
Site	0	1-2	3-4	5-6	7& above	0	1-2	3-4	5-6
Tsento	5	5	0	0	0	7	2	1	0
Wangchang	2	8	0	0	0	5	4	1	0
L/C Site	2	5	2	0	0	6	2	0	0
Shaba	3	6	1	0	0	7	3	0	0
Total	12	24	3	0	0	25	11	2	0

AGRICULTURAL SURVEY RESULT

Number of Male Pigs in Age Groups

Site	0-11month	1	2	3	4	5& above
Tsento	3	3	3	3	1	0
Wangchang	2	5	5	1	4	0
L/C Site	2	2	11	3	1	0
Shaba	0	3	3	5	2	1
Total	7	13	22	12	8	1

Breeding Farmers unit : No. of farmers

	No. of Adult Female Animal					No. of Young Female Animal					
Site	0	1-2	3-4	5-6	7& above	0	1-2	3-4	5-6	7-8	9& above
Tsento	3	7	0	0	0	7	2	1	0	0	0
Wangchang	3	7	0	0	0	4	4	0	0	1	1
L/C Site	3	2	4	0	0	7	0	2	0	0	0
Shaba	3	7	0	0	0	8	2	0	0	0	0
Total	12	23	4	0	0	26	8	3	0	1	1

Number of Female Pigs in Age Groups

Site	0-11month	1	2	3	4	5& above
Tsento	5	2	6	2	3	0
Wangchang	13	5	5	5	1	1
L/C Site	4	3	9	3	6	0
Shaba	0	2	1	5	1	0
Total	22	12	21	15	11	1

Poultry

Breeding Farmers unit : No. of farmers

	No. of Adult Male Animal					No. of Young Male Animal					
Site	0	1-2	3-4	5-6	7& above	0	1-2	3-4	5-6	7-8	9& above
Tsento	6	4	0	0	0	10	0	0	0	0	0
Wangchang	3	7	0	0	0	10	0	0	0	0	0
L/C Site	3	7	0	0	0	9	1	0	0	0	0
Shaba	2	8	0	0	0	10	0	0	0	0	0
Total	14	26	0	0	0	39	1	0	0	0	0

AGRICULTURAL SURVEY RESULT

Breeding Farmers unit : No. of farmers

	No. of Adult Female Animal					No. of Young Female Animal					
Site	0	1-2	3-4	5-6	7& above	0	1-2	3-4	5-6	7-8	9& above
Tsento	3	7	0	0	0	10	0	0	0	0	0
Wangchang	1	4	4	1	0	10	0	0	0	0	0
L/C Site	4	2	4	0	0	9	0	0	0	0	1
Shaba	1	5	4	0	0	10	0	0	0	0	0
Total	9	18	12	1	0	29	0	0	0	0	1

Cow Milk Production

unit : No. of Cows

Site	Milk Production in ltr./day/animal				
	0	0.01-0.49	0.50-0.99	1.00-1.49	1.50& above
Tsento	6	5	2	0	0
Wangchang	11	0	4	0	2
L/C Site	11	4	1	2	1
Shaba	31	1	0	8	0
Total	59	10	7	10	3

Animal Slaughtering in Each Family

unit : No. of family

Site	No. of Pig/year				No. of Yak/year			
	0	1	2	3	0	1	2	3
Tsento	4	4	2	0	10	0	0	0
Wangchang	0	5	5	0	10	0	0	0
L/C Site	2	4	3	1	8	1	1	0
Shaba	1	9	0	0	10	0	0	0
Total	7	22	10	1	38	1	1	0

ANNEX 7 DELIVERY RECORD FROM AGRICULTURE EXTENSION CENTRES

from November 1988 to October 1989

	Fertilizer in M.T.				Weedicide in M.T.
Gewog	Urea	Suphala	K.G.Mix	Bone Meal	Punch
Tsento	3.75	1.65	-	-	1.12
Lango	4.059	2.398	0.25	0.25	2.30
Wangchang	3.1	7.0	-	-	1.65
Hore	2.6	0.2	-	-	-
Dotey	3.55	1.75	-	-	0.53
Shari	23.15	7.9	-	-	4.59
Luni	0.15	0.4	-	-	1.64
Shaba	1.15	0.34	-	-	0.5
Total	41,509	21.638	0.25	0.25	12.33

	Apple Trees	Seed		
	in Nos.	Paddy in kg	Wheat in kg	Potato in M.T.
Tsento	380	65	75	2.5
Lango	480	956	250	2.0
Wangchang	1,580	131	60	10.75
Hore	450	-	75	5.0
Dotey	320	340	225	-
Shari	1,400	484	-	8.65
Luni	2,110	500	175	5.55
Shaba	100	159	40	2.0
Total	6,820	2,635	900	36.45

	Vegetable Seed in gms					
	Cabbage	Cauliflower	Ch.Cabbage	Radish	M.Green	Bulb Onion
Tsento	2,790	500	880	2,500	1,050	310
Lango	-	120	870	2,320	-	250
Wangchang	5,650	2,860	4,370	14,760	3,640	2,610
Hore	2,250	400	-	800	200	-
Dotey	-	-	-	320	-	-
Shari	-	-	-	-	-	-
Luni	1,620	310	-	4,880	-	-
Shaba	2,940	-	4,000	-	-	-
Total	15,250	4,190	10,120	25,580	4,890	3,170

Vegetable Seed in gms

	Tomato	Cucumber	Green Peas	Beans	Chilli	J.Green	Carrot
Tsento	400	200	8,000	-	-	-	-
Lango	200	960	-	210	-	-	-
Wangchang	6,600	-	11,500	3,700	1,600	1,620	-
Hore	-	-	-	-	-	-	-
Dotey	-	-	-	-	-	-	-
Shari	-	-	-	-	-	-	-
Luni	80	-	-	-	-	-	-
Shaba	300	-	-	-	-	-	350
Total	7,580	1,160	19,500	3,910	1,600	1,620	350

Tools and Implements

	Spade	Paddy Weeder	Crowbar	Nylon Rope	Sickle	Pickax	Spade Fork	Shovel
Tsento	17	1	4	1	95	0	0	0
Lango	0	0	1	0	0	0	0	0
Wangchang	132	11	29	76	130	40	40	13
Hore	0	0	0	0	0	0	0	0
Dotey	4	0	4	0	0	4	0	4
Shari	0	0	0	0	0	0	0	0
Luni	53	21	0	8	0	1	18	25
Shaba	5	0	0	0	0	0	0	0
Total	221	33	38	85	225	45	58	42

Tools and Implements

	Rake	Pruning Saw	Pruning Shears	Axe	Hammer	Paddy Thresher	Winnower
Tsento	0	0	0	0	0	1	0
Lango	0	0	0	0	0	0	0
Wangchang	18	4	55	34	1	36	13
Hore	0	0	0	0	0	0	0
Dotey	0	0	0	0	0	0	0
Shari	0	0	0	0	0	0	0
Luni	0	9	4	0	0	3	0
Shaba	0	3	0	0	0	0	0
Total	18	16	59	34	1	39	13

	Pesticides				
	Endosulfan in ltr.	Zineb in kg	Cypermethion in ltr.	Fenitrothion in ltr.	Tenvalerate in ltr.
Tsento	20	0	0	0	0
Lango	60	0	2	0	5
Wangchang	32	0	0	1.5	0
Hore	0	0	0	0	0
Dotey	0	0	0	0	0
Shari	84	4.5	5	24	0
Luni	40	5	1	5	0
Shaba	0	0	0	0	0
Total	236	9.5	8	30.5	5

	Pesticide					
	Cythion Dust 5% in kg	Foltaf in kg	Captan in kg	Bavistin in kg	Luxam in kg	Furadon in kg
Tsento	75	0	10	0	4	80
Lango	80	10	10	3	20	40
Wangchang	120	10	10	41	10	304
Hore	0	0	0	5	0	120
Dotey	80	0	0	0	0	1
Shari	0	0	2	24	30	331
Luni	115	10	10	15	10	46
Shaba	0	0	0	0	5	20
Total	470	30	42	88	79	942

	Pesticide					
	Malathion in ltr.	Coper Oxchloride in kg	Mancozeb in kg	Primphos in kg	Kelex in pkt	Sumicidon in ltr.
Tsento	50	60	15	0	0	0
Lango	22	4	0	10	0	5
Wangchang	22	53.5	15	10	0	0
Hore	22	13	0	0	0	0
Dotey	22	0	0	0	0	0
Shari	44	31.5	0	0	0	0
Luni	21	0	15	10	25	0
Shaba	24	30	0	0	0	0
Total	227	192	45	30	25	5

ANNEX 8

LABOUR REQUIREMENT FOR EACH CROP

LABOUR REQUIREMENT OF PADDY

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage					17(15)/1								17(15)
2. Nursery		5(2)/1		4	4								13(2)
3. Seedbed Preparation													
4. Sowing/Transplanting						25							25
5. Fertilization					15			2					17
6. Plant Protection								1					1
7. Cultivation/Weeding							22	23	15				60
8. Irrigation							1	1	1				3
9. Harvesting										16			16
10. Post Harvesting										25			25
Total		5(2)		4	36(15)	25	23	27	16	41			177(17)

Note : /1 Figures in parenthesis represents bullock power in pairs.

LABOUR REQUIREMENT OF PADDY

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage					17(15)/1								17(15)
2. Nursery		5(2)/1		4	4								13(2)
3. Seedbed Preparation													
4. Sowing/Transplanting						25							25
5. Fertilization					15			2					17
6. Plant Protection								1					1
7. Cultivation/Weeding							22	23	15				60
8. Irrigation							1	1	1				3
9. Harvesting										16			16
10. Post Harvesting										25			25
Total		5(2)		4	36(15)	25	23	27	16	41			177(17)

Note : /1 Figures in parenthesis represents bullock power in pairs.

LABOUR REQUIREMENT OF WHEAT

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage											13(12)/1		13(12)
2. Nursery													
3. Seedbed Preparation													
4. Sowing/Planting											0.5		0.5
5. Fertilization										10/2	0.5		10.5
6. Plant Protection													
7. Cultivation/Weeding			12/3										12
8. Irrigation	1											1	2
9. Harvesting					25								25
10. Post Harvesting										20/4			20
Total	1		12		25					30	14(12)	1	83(12)

Note : /1 Figures in parenthesis represents bullock power in pairs
/2 Roughly 1 man carry 20 basket of compost
/3 Sometimes farmers carrying weeding operation
/4 After harvesting farmers keep the wheat at house and thresh in the mouth of September and October.

LABOUR REQUIREMENT OF BARLEY

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage											13(12)/1		13(12)
2. Nursery													
3. Seedbed Preparation													
4. Sowing/Planting											0.5		0.5
5. Fertilization										10	0.5		10.5
6. Plant Protection													
7. Cultivation/Weed			12/2										12
8. Irrigation	1											1	2
9. Harvesting					25								25
10. Post Harvesting										20/3			20
Total	1		12		25					30	14(12)	1	83(12)

Note : /1 Figures in parenthesis represents bullock power in pairs
/2 Sometimes farmers carrying weeding operation
/3 After harvesting farmers keep the wheat at house and thresh in the mouth of October.

LABOUR REQUIREMENT OF BUCKWHEAT

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage								12(10)/1					12(10)
2. Nursery													
3. Seedbed Preparation													
4. Sowing/Planting								1					1
5. Fertilization								8					8
6. Plant Protection													
7. Weeding													
8. Irrigation													
9. Harvesting												12	12
10. Post Harvesting												10	10
Total								21(10)				22	43(10)

Notes : /1 Figures in parenthesis represents bullock power in pairs.

LABOUR REQUIREMENT OF BUCKWHEAT

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage				12(10)/1									12(10)
2. Nursery													
3. Seedbed Preparation													
4. Sowing/Planting				1									1
5. Fertilization				8									8
6. Plant Protection													
7. Cultivation/Weeding													
8. Irrigation													
9. Harvesting							12						12
10. Post Harvesting							10						10
Total				21(10)			22						43(10)

Notes : * Farmers in Tsento sow buckwheat in April also.
/1 Figures in parenthesis represents bullock power in pairs.

LABOUR REQUIREMENT OF POTATO

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage		7(7)/1										10(10)	17(17)
2. Nursery													
3. Seedbed Preparation													
4. Sowing/Planting		30											30
5. Fertilization	20												20
6. Plant Protection			1	1									2
7. Cultivation/Weeding Earthing up				30		20/2							50
8. Irrigation			1	1									2
9. Harvesting/Post Harvesting						40/3							40
Total	20	37(7)	2	32		60						10(10)	161(17)

Notes : /1 Figures in parenthesis represent bullock power in pairs
/2 In dry land earthing up and weeding operations carried out 2 times
/3 In dry land harvesting operation carried out in the month of August. Hence labour requirement for this operation may be shown in August instead of June. In wet land harvesting done in general in June when potato is still immature.

LABOUR REQUIREMENT OF CHILLI

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage					12(10)								12(10)
2. Nursery			3(3)										3(3)
3. Seedbed Preparation													
4. Sowing/Planting					15								15
5. Fertilization					10								10
6. Plant Protection													
7. Weeding							15	15					30
8. Irrigation													
9. Harvesting/Post Harvesting								5	8	10	4		27
Total			3(3)		37(10)		15	20	8	10	4		97(13)

Notes : /1 Figures in parenthesis represent bullock power in pairs.

LABOUR REQUIREMENT OF VEGETABLE

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage				12(10)/1									12(10)
2. Nursery			3(1)										3(1)
3. Seedbed Preparation													
4. Sowing/Planting				15									15
5. Fertilization			10										10
6. Plant Protection					1	1							2
7. Weeding					15								15
8. Irrigation													
9. Harvesting/Post Harvesting						10	10						20
Total			13(1)	27(10)	16	11	10						77(11)

Note : /1 Figures in parenthesis represents bullock power in pairs.

LABOUR REQUIREMENT OF SOYA BEANS

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage	10(8)/1												10(8)
2. Nursery													
3. Seedbed Preparation													
4. Sowing/Planting	3												3
5. Fertilization	10												10
6. Plant Protection													
7. Weeding				15									15
8. Irrigation													
9. Harvesting									10				10
10. Post Harvesting									8				8
Total	23(8)			15					18				56(8)

Note : /1 Figures in parenthesis represents bullock power in pairs.

LABOUR REQUIREMENT OF BEANS

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage		10(8)/1											10(8)
2. Nursery													
3. Seedbed Preparation													
4. Sowing/Planting		8/2											8
5. Fertilization	10												10
6. Plant Protection													
7. Weeding				15									15
8. Irrigation													
9. Harvesting/Post Harvesting						10							10
Total	10	18(8)		15		10							53(8)

Notes : Beans consumed when it is green
/1 Figures in parenthesis represents bullock power in pairs
/2 Beans grow as dibbling method.

LABOUR REQUIREMENT OF GREEN PEAS

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage		10(8)											10(8)
2. Nursery													
3. Seedbed Preparation													
4. Sowing/Planting		3											3
5. Fertilization	10												10
6. Plant Protection													
7. Cultivation/Weeding													
8. Irrigation													
9. Harvesting/Post Harvesting				5	10	6							21
Total	10	13(8)		5	10	6							44(8)

Note : /1 Figures in parenthesis represents bullock power in pairs.

LABOUR REQUIREMENT OF MUSTARD

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage								10(10)/1					10(10)
2. Nursery													
3. Seedbed Preparation													
4. Sowing/Planting								0.5					0.5
5. Fertilization													
6. Plant Protection										1			1
7. Cultivation/Weeding													
8. Irrigation													
9. Harvesting											12		12
10. Post Harvesting											10		10
Total								10.5(10)		1	22		33.5(10)

Note : /1 Figures in parenthesis represents bullock in pairs.

LABOUR REQUIREMENT OF TURNIP

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage								20(20)/1					20(20)
2. Nursery													
3. Seedbed Preparation													
4. Sowing/Planting								2.5					2.5
5. Fertilization							12						12
6. Plant Protection													
7. Weeding									20				20
8. Irrigation													
9. Harvesting/Post Harvesting											16		16
Total							12	22.5(20)	20		16		70.5(20)

Note : /1 figures in parenthesis represents bullock power in pairs.

LABOUR REQUIREMENT OF RADISH

unit : man-days/ha

Operation	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1. Preparation of Tillage		20(20)/1											20(20)
2. Nursery													
3. Seedbed Preparation													
4. Sowing/Planting		2.5											2.5
5. Fertilization	12												12
6. Plant Protection													
7. Cultivation/Weeding				20									20
8. Irrigation													
9. Harvesting/Post Harvesting					16								16
Total	12	22.5(20)		20	16								70.5(20)

Note : /1 Figures in parenthesis represents bullock power in pairs.

ANNEX 9 POTENTIAL MARKETS IN INDIA FOR AGRICULTURAL PRODUCT OF BHUTAN

Unit : MT

Sl. No.	Market	Commodity	Total Amount Arrivals (1987-1988)	Bhutan Arrivals	Additional Potential	Optimum Period for Sales
1.	GAUHATI	1. Apple	2000	300	200	Aug-Oct
		2. Orange	3250	400	250	Dec-Feb
		3. Potato - table	60000	Negligible	-	-
		- seed	NA	Negligible	150 (Kufri Jyoti)	Oct
		4. Green peas	1500	Small qty.	30	May-Jun
		5. Tomato, cauliflower, cabbage, capsicum	5000	Small qty.	Occasional	May-Aug
		6. Dry chillies	NA	200	200	Dec-Mar
		7. Large cardamom	10	10	-	-
		8. Soyabean	NA	100	100	(For seed to Assam
		9. Rajmah & cowpea	NA	100	50	markfed any time)
2.	RANGIA	1. Potato - table	2500	500	100	Jul-Nov
		- seed	NA	300	100	Oct-Nov
		2. Orange	50	50	-	-
3.	NALBARI	1. Potato - table	2000	600	150	Jul-Nov
		2. Orange	125	100	25	Nov-Feb
		3. Dry chillies	15	5	-	-
		4. Soyabean	80	80	-	-
4.	TAMALPUR	1. Potato - table	1500	100	-	-
		2. Orange	Small qty.	Small qty.	-	-
5.	PATSHALA	1. Potato - table	2000	400	100	Jul-Nov
		- seed	150	50	-	-
		2. Orange	600	600	250	Nov-Feb
		3. Large cardamom	5	5	-	-
6.	BARAPETTA	1. Potato - table	10000	1200	400	Jul-Nov
		- seed	NA	300	100	Oct-Nov
		2. Orange	400	400	100	Nov-Feb
		3. Apple	300	175	60	Aug-Oct
7.	BONGAIGAON	1. Potato - table	4000	500	150	Jul-Dec
		2. Orange	450	450	50	Nov-Feb
		3. Apple	1100	300	200	Aug-Nov
		4. Green ginger	NA	100	-	-
		5. Large cardamom	5	5	-	-
		6. Green vegetables (Green peas, cabbage, cauliflower, beans, capsicum, tomato)	NA	Small qty.	20	May-Aug

Sl. No.	Market	Commodity	Total Amount Arrivals (1987-1988)	Bhutan Arrivals	Additional Potential	Optimum Period for Sales
8.	KOKRAJHAR	1. Potato - table	750	150	-	-
		- seed	NA	30	20 (Kufri Jyoti)	Oct-Nov
		2. Orange	75	50	50	Nov-Feb
		3. Green ginger	NA	30	-	-
		4. Apple	50	40	10	Aug-Nov
9.	GASSAIGAON	1. Potato -table	300	50	-	-
10.	ALIPURDUAR	1. Potato - table	6750	500	200	Jul-Nov
		- seed	450	150	50	Oct-Nov
		2. Apple	200	180	20	Aug-Nov
		3. Orange	1050	1000	250	Nov-Feb
		4. Green vegetables (Green peas, cabbage, tomato, beans, squash etc.)	NA	Small qty.	50	May-Sept
11.	MADARIHAT	1. Potato - table	500	50	-	-
12.	COOCHBIHAR	1. Potato - table	5400	640	100	Jul-Nov
		- seed	300	80	50	Oct-Nov
		2. Orange	500	500	100	Nov-Feb
		3. Apple	100	80	40	Aug-Nov
		4. Green vegetables (Green peas, cabbage, tomato, beans, squash)	NA	Small qty.	100	May-Sept
13.	SISUBARI	1. Potato - table	800	300	50	Jul-Nov
14.	BIRPARA	1. Potato - table	3200	1200	200	Jul-Nov
		- seed	150	-	50	Oct-Nov
		2. Orange	1500*	1500*	250	Nov-Feb
			(*This includes supplies from Totapara areas in India)			
15.	FALAKATA	1. Potato - table	1000	120	-	-
		- seed	500	30	50	Oct-Nov
		2. Apple	30	30	10	Aug-Dec
16.	BANARHAT	1. Potato - table	1150	150	-	-
		2. Apple	35	20	-	-
		3. Orange	150	150	-	-
17.	CHAMURCHI	1. Potato - table	500	Small qty.	-	-
		2. Orange	1500	1500	500	Nov-Feb
18.	BINAGURI	1. Potato - table	1500	500	100	Jul-Nov
		- seed	50	-	-	-
		2. Orange	100	100	50	Nov-Feb
		3. Apple	100	90	20	Aug-Dec

Sl. No.	Market	Commodity	Total Amount Arrivals (1987-1988)	Bhutan Arrivals	Additional Potential	Optimum Period for Sales
18.	BINAGURI	4. Green vegetables (Green peas, tomato, cabbage, cauliflower, beans, capsicum)	25	20	10	May-Sept
19.	NAGARKATA	1. Green ginger	120	120	-	-
		2. Potato - table	1200	150	-	-
20.	DHUPGURI	1. Potato - table	3700	700	200	Jul-Nov
		- seed	800	100	100(K.Jyoti)	Oct-Nov
		2. Orange	300	300	100	Nov-Dec
		3. Apple	70	50	10	Aug-Nov
		4. Green vegetables	2000	Small qty.	-	-
21.	SILIGURI	1. Potato - table	122000	2200	1000	Aug-Nov
		- seed	11000	300	300	Oct-Nov
		2. Apple	3327	500	100	Aug-Dec
		3. Orange	15000	3250	800	Nov-Feb
		4. Green peas	895	70	100	May-Sept
		5. Cauliflower	2328	20	30	Jun-Aug
		6. Cabbage	5993	80	50	Jun-Aug
		7. Tomato	3310	Small qty.	30	May-Jul
		8. Capsicum	60	Negligible	30	May-Sept
		9. Squash	4750	Negligible	100	Apr-Aug
		10. Green ginger	57500	300	-	-
		11. Large cardamom	4500	750	-	-
		12. Green chillies	1000	10	-	-
		13. Green beans	400	Negligible	-	-
22.	JALPAIGURI	1. Potato - table	2000	500	100	Jul-Nov
		- seed	100	-	50	Oct-Nov
		2. Orange	400	375	100	Nov-Feb
		3. Apple	100	50	20	Aug-Nov
		4. Green vegetables (off season)	NA	Small qty.	100	May-Sept
23.	CALCUITA	1. Potato - table	35800	100(large size)	100(large)	Jul-Dec
		- seed	5000	-	100 (to West Bengal Seed Corpn. in Oct-Nov)	
		2. Apple	24300	250	200	Aug-Sept
		3. Orange	33285	3500	1000	Nov-Feb
		4. Green peas	17400	100	200	May-Sept
		5. Cauliflower	50300	Negligible	-	-
		6. Cabbage	39400	Negligible	-	-
		7. Tomato	35000	Negligible	-	-
		8. Capsicum	841	Negligible	50	May-Jul
		9. Green ginger	13000	250	-	-
		10. Large cardamom	250	40	-	-
24.	PATNA	1. Large cardamom	30	10	-	-
		2. Green ginger	250	Small qty.	-	-

Sl. No.	Market	Commodity	Total Amount Arrivals (1987-1988)	Bhutan Arrivals	Additional Potential	Optimum Period for Sales
25.	DELHI	1. Large cardamom	1500	400	-	-
		2. Green ginger	17200	150	-	-

Source : Marketing of agricultural produce of bhutan in Indian Market 1988.

ANNEX 10 LIST OF IRRIGATION CHANNELS

Sl.No.	Name of Channel	Gewog	Length in km	Command Area in ha
1.	Chento Shari	Tsento	2.77	26.60
2.	Domphu	Tsento	1.70	20.20
3.	Chenzi	Tsento	3.80	39.00
4.	Namjey	Tsento	1.65	15.20
5.	Kulungpa	Tsento	0.80	4.00
6.	Chenjey	Tsento	4.25	52.00
7.	Chencho/Rimo	Tsento	0.72	14.80
8.	Langkhutyo	Tsento	0.87	12.30
	Total		16.56	184.10
1.	Conju	Lango	2.50	60.80
2.	Chendo Chunkha	Lango	3.00	48.00
3.	Nyongmey	Lango	4.54	32.00
4.	Bamdaley	Lango	1.92	40.00
5.	Gechukha	Lango	3.30	16.80
6.	Shemo	Lango	1.73	60.00
	Total		16.99	257.60
1.	Jachey (Khankoo)	Wangchang	3.13	30.60
2.	Gaptheymayu	Wangchang	3.00	40.80
3.	Namgkhar	Wangchang	3.00	24.60
4.	Cheng Phintsho	Wangchang	2.00	23.10
5.	Lungkha	Wangchang	1.70	62.80
6.	Seena	Wangchang	3.00	26.00
7.	Jachey and Jamy	Wangchang	2.50	24.20
8.	Cheng Changkhar	Wangchang	1.00	8.60
9.	Dechengphug	Wangchang	2.00	14.20
	Total		21.33	254.90
1.	Dashomenchu	Dotey	3.30	46.40
2.	Tshokona	Dotey	1.56	64.00
3.	Damba	Dotey	2.88	23.60
	Total		7.74	134.00

LIST OF IRRIGATION CHANNELS

Sl.No.	Name of Channel	Gewog	Length in km	Command Area in ha
1.	Jangsa Tangyuva	Shari	1.50	25.20
2.	Tachukhamayu	Shari	1.80	11.30
3.	Damjimayu	Shari	2.64	42.80
4.	Sharimochu	Shari	1.23	24.00
5.	Kempa Tangyul	Shari	1.86	15.90
6.	Kothuphu Tangyu	Shari	3.00	7.20
7.	Gangyul	Shari	2.38	21.60
8.	Jangsa Hydel Channel	Shari/Hore/ Dotey	5.26	60.80
9.	Gesse Chawa	Shari	1.50	34.00
	Total		21.17	251.80
1.	Serekha	Luni	1.10	32.00
2.	Talung Yuva	Luni	1.70	30.60
3.	Darsaking Yuva	Luni	0.85	12.20
4.	Bondey Yuva	Luni	5.30	8.90
5.	Gim Tsho	Luni	1.00	24.00
6.	Rimay Yuva	Luni	2.00	14.00
7.	Woochu Phakhar	Luni	2.00	8.20
8.	Chichi Thangkhar	Luni	1.50	2.80
9.	Jauphu	Luni	2.00	2.40
10.	Mayukha	Luni	3.93	28.00
11.	Gungyul Yuva	Luni	1.50	45.50
12.	Baryul Yuva	Luni	2.00	2.80
	Total		24.88	211.40
1.	Dujey Dingkha Tongyuva	Shaba	2.10	28.20
2.	Dunjey Dingkha Chithey Yuva	Shaba	5.00	20.30
3.	Garey Chithey Yuva	Shaba	2.60	17.00
4.	Garey Chekha Yuva	Shaba	2.00	10.10
5.	Tilley Dobeyba	Shaba	6.00	14.30
6.	Shaba Bara	Shaba	2.31	18.20
7.	Tshetey Yuva	Shaba	1.50	19/60

LIST OF IRRIGATION CHANNELS

Sl.No.	Name of Channel	Gewog	Length in km	Command Area in ha
8.	Shingkhana	Shaba	2.30	16.20
9.	Shaba Shengo	Shaba	1.77	4.00
10.	Lholing Tong Yuva	Shaba	2.00	3.60
11.	Nephu Bayu	Shaba	4.00	24.30
	Total		31.48	175.80

Source : Paro Dzongkhag

ANNEX 11 WATER REQUIREMENT

Paddy is the main crop in the project area. The amount of water for irrigation will be calculated in terms of the amount of water used in growing paddy. This is because paddy is grown in nearly all areas of the Paro Valley with irrigation facilities, and also because more water is needed to grow paddy than to grow other crops. Water requirement is evaluated below:

$$GWR = ETc + PL + Ps$$

$$NWR = (GWR - RE)/IE$$

wherein, GWR : Gross water requirement
ETc : Evapotrasnpiration of crop ; ETc = Kc x ETo
PL : Seepage loss ; for small scale irrigation 3 mm/day
Ps : Amount of Puddling Water
NWR : Net water requirement
IE : Irrigation efficiecy
Kc : Crop efficiency
ETo : Evapotranspiration estimated by Blaney-Criddle method

The average length of daylight time by latitude, the average sunshine hours, estimated evapotranspiration, crop coefficient, and effective precipitation are calculated based on the FAO IRRIGATION AND DRAINAGE PAPER NO.24.

1) Estimated Evapotranspiration (ETo)

The estimated Evapotranspiration is calculated under the following conditions and according to the Blaney Criddle method:

- Latitude of Paro Dzongkhags : North 27°30'
- Average temperature : Taking the safety factor, the actual values recorded in 1986 were used, when the total annual precipitation was low and effective rainfall was also low.

The result is shown in next page.

4) Amount of Puddling Water

Amount of Puddling Water is determined as a function of void ratio of topsoil.

Soil type	Sand	Sandy loam	Loam	Clay loam	Clay	Peat
Void ratio in %	40	45	50	55	60	65

$$Ps = (t \times P \times 0.8 + d_f)/D$$

where, Ps : Amount of puddling water

t : Thickness of cultivating soil ; average 25 cm

P : Void ratio ; Sandy loam 45%

d_f : Ponding depth

D : Term for puddling ; 20 days

$Ps = (0.25 \times 0.45 \times 0.8 + 0.06)/20 = 0.0075 m/day = 7.5 mm/day$

5) Water Requirement during Puddling Period

Daily water requirement during puddling period is estimated as follows:

$$GWRn = (n/20) \times I + Ps$$

where, n : number of elapsed days

I : Water required to keep ponding depth ; ETo + PL

6) Normal Water Requirement

Normal water requirement is estimated as follows:

$$GWRn = Kc \times ETo + PL$$

7) Effective Rainfall (RE)

Effective rainfall is estimated using data measured in 1986 when annual rainfall is small.

8) Total Irrigation Efficiency (IE)

Total irrigation efficiency is approximately 60%, considering apply efficiency, facility efficiency and conducting efficiency.

Water requirement estimated according the above conditions is shown in next page.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
T mean(C)	7.0	8.0	10.3	13.4	15.8	20.0	20.6	20.6	18.8	13.3	11.4	6.7
P <1	0.24	0.26	0.27	0.29	0.30	0.31	0.31	0.29	0.29	0.26	0.25	0.24
P(0.46T+8)	2.7	3.0	3.4	4.1	4.6	5.3	5.4	5.1	4.7	3.7	3.3	2.7
RHmin	med	med	med	high	high	high	high	high	high	high	high	med
	43.5	40.0	43.5	50.5	52.5	64.0	70.0	74.5	72.5	65.5	58.5	43.0
n/N <2	med	low	low	low	low	low	low	low	low	low	med	low
	0.61	0.52	0.50	0.38	0.39	0.30	0.20	0.29	0.34	0.51	0.60	0.50
U daytime	"U daytime" is assumed approximately 3.5 m/sec.											
ETO	2.0	2.0	2.5	2.3	2.8	3.5	3.6	3.2	2.9	1.8	2.0	1.5

<1 :Mean daily percentage(p) of annual daytime hours

<2 :n; Sunshine hours per day; Bhutan average
N; Mean daily duration of maximum possible sunshine hours for different month and latitude

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov
n	6.5	5.8	6.0	4.9	5.3	4.2	2.7	3.8	4.2	5.9	6.9
N	10.6	11.2	12.0	12.8	13.5	13.4	13.7	13.1	12.4	11.6	10.8
n/N	0.61	0.52	0.50	0.38	0.39	0.30	0.20	0.29	0.34	0.51	0.60

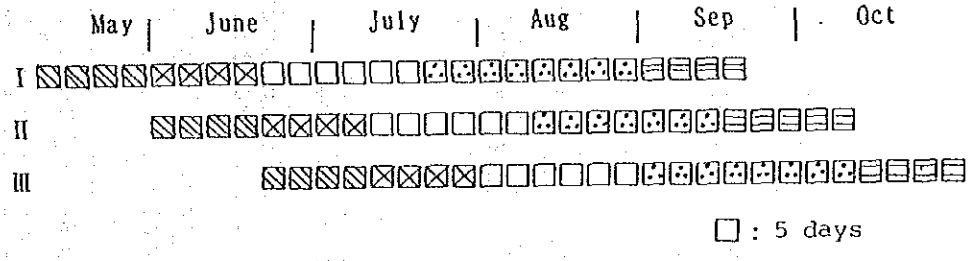
2) Crop Coefficient (Kc)

Crop Coefficient is determined for growth stages as follows:

Growth Stage	Term in days	Kc	Mark
(Nursery)	40		
(Presaturation)	20		
Initial	20	1.1	
Crop development	30	1.1	
Mid-season	40	1.05	
Lata-season	20	0.95	

3) Cropping Pattern

Paddy cropping is assumed that cultivation activities would shift from upstream to downstream in 3 stages.



Lowland Paddy

		ETO		Step -1 ETcrop	Step -1 Presat.		Step -2 ETcrop	Step -2 Presat.		Step -3 ETcrop	Step -3 Presat.	Effective Rainfall		Total	GWR	NWR
		mm/day	kc-1	mm/day	mm/day	kc-2	mm/day	mm/day	kc-3	mm/day	mm/day	mm/day		ton/day	lit./sec	lit./se
May	1	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	2	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	3	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	4	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	5	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	6	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	7	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	8	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	9	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	10	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	11	2.8		0.00			0.00			0.00		1.35	-1.35	-13.50	-0.16	-0.26
	12	2.8		0.29	7.50		0.00			0.00		1.35	6.44	64.40	0.75	1.24
	13	2.8		0.58	7.50		0.00			0.00		1.35	6.73	67.30	0.78	1.30
	14	2.8		0.87	7.50		0.00			0.00		1.35	7.02	70.20	0.81	1.35
	15	2.8		1.16	7.50		0.00			0.00		1.35	7.31	73.10	0.85	1.41
	16	2.8		1.45	7.50		0.00			0.00		1.35	7.60	76.00	0.88	1.47
	17	2.8		1.74	7.50		0.00			0.00		1.35	7.89	78.90	0.91	1.52
	18	2.8		2.03	7.50		0.00			0.00		1.35	8.18	81.80	0.95	1.58
	19	2.8		2.32	7.50		0.00			0.00		1.35	8.47	84.70	0.98	1.63
	20	2.8		2.61	7.50		0.00			0.00		1.35	8.76	87.60	1.01	1.69
	21	2.8		2.90	7.50		0.00			0.00		1.35	9.05	90.50	1.05	1.75
	22	2.8		3.19	7.50		0.00			0.00		1.35	9.34	93.40	1.08	1.80
	23	2.8		3.48	7.50		0.00			0.00		1.35	9.63	96.30	1.11	1.86
	24	2.8		3.77	7.50		0.00			0.00		1.35	9.92	99.20	1.15	1.91
	25	2.8		4.06	7.50		0.00			0.00		1.35	10.21	102.10	1.18	1.97
	26	2.8		4.35	7.50		0.00			0.00		1.35	10.50	105.00	1.22	2.03
	27	2.8		4.64	7.50		0.00			0.00		1.35	10.79	107.90	1.25	2.08
	28	2.8		4.93	7.50		0.00			0.00		1.35	11.08	110.80	1.28	2.14
	29	2.8		5.22	7.50		0.00			0.00		1.35	11.37	113.70	1.32	2.19
	30	2.8		5.51	7.50		0.00			0.00		1.35	11.66	116.60	1.35	2.25
	31	2.8		5.80	7.50		0.00			0.00		1.35	11.95	119.50	1.38	2.31
June	1	3.5	1.10	6.85			0.33	7.50		0.00		2.70	11.98	119.75	1.39	2.31
	2	3.5	1.10	6.85			0.65	7.50		0.00		2.70	12.30	123.00	1.42	2.37
	3	3.5	1.10	6.85			0.98	7.50		0.00		2.70	12.63	126.25	1.46	2.44
	4	3.5	1.10	6.85			1.30	7.50		0.00		2.70	12.95	129.50	1.50	2.50
	5	3.5	1.10	6.85			1.63	7.50		0.00		2.70	13.28	132.75	1.54	2.56
	6	3.5	1.10	6.85			1.95	7.50		0.00		2.70	13.60	136.00	1.57	2.62
	7	3.5	1.10	6.85			2.28	7.50		0.00		2.70	13.93	139.25	1.61	2.69
	8	3.5	1.10	6.85			2.60	7.50		0.00		2.70	14.25	142.50	1.65	2.75
	9	3.5	1.10	6.85			2.93	7.50		0.00		2.70	14.58	145.75	1.69	2.81
	10	3.5	1.10	6.85			3.25	7.50		0.00		2.70	14.90	149.00	1.72	2.87
	11	3.5	1.10	6.85			3.58	7.50		0.00		2.70	15.23	152.25	1.76	2.94
	12	3.5	1.10	6.85			3.90	7.50		0.00		2.70	15.55	155.50	1.80	3.00
	13	3.5	1.10	6.85			4.23	7.50		0.00		2.70	15.88	158.75	1.84	3.06
	14	3.5	1.10	6.85			4.55	7.50		0.00		2.70	16.20	162.00	1.88	3.13
	15	3.5	1.10	6.85			4.88	7.50		0.00		2.70	16.53	165.25	1.91	3.19
	16	3.5	1.10	6.85			5.20	7.50		0.00		2.70	16.85	168.50	1.95	3.25
	17	3.5	1.10	6.85			5.53	7.50		0.00		2.70	17.18	171.75	1.99	3.31
	18	3.5	1.10	6.85			5.85	7.50		0.00		2.70	17.50	175.00	2.03	3.38
	19	3.5	1.10	6.85			6.18	7.50		0.00		2.70	17.83	178.25	2.06	3.44
	20	3.5	1.10	6.85			6.50	7.50		0.00		2.70	18.15	181.50	2.10	3.50
	21	3.5	1.10	6.85		1.10	6.85			0.33	7.50	2.70	18.83	188.25	2.18	3.63
	22	3.5	1.10	6.85		1.10	6.85			0.65	7.50	2.70	19.15	191.50	2.22	3.69
	23	3.5	1.10	6.85		1.10	6.85			0.98	7.50	2.70	19.48	194.75	2.25	3.76
	24	3.5	1.10	6.85		1.10	6.85			1.30	7.50	2.70	19.80	198.00	2.29	3.82
	25	3.5	1.10	6.85		1.10	6.85			1.63	7.50	2.70	20.13	201.25	2.33	3.88
	26	3.5	1.10	6.85		1.10	6.85			1.95	7.50	2.70	20.45	204.50	2.37	3.94
	27	3.5	1.10	6.85		1.10	6.85			2.28	7.50	2.70	20.78	207.75	2.40	4.01
	28	3.5	1.10	6.85		1.10	6.85			2.60	7.50	2.70	21.10	211.00	2.44	4.07
	29	3.5	1.10	6.85		1.10	6.85			2.93	7.50	2.70	21.43	214.25	2.48	4.13
	30	3.5	1.10	6.85		1.10	6.85			3.25	7.50	2.70	21.75	217.50	2.52	4.20
July	1	3.6	1.10	6.96		1.10	6.96			3.63	7.50	3.45	21.60	216.00	2.50	4.17
	2	3.6	1.10	6.96		1.10	6.96			3.96	7.50	3.45	21.93	219.30	2.54	4.23
	3	3.6	1.10	6.96		1.10	6.96			4.29	7.50	3.45	22.26	222.60	2.58	4.29
	4	3.6	1.10	6.96		1.10	6.96			4.62	7.50	3.45	22.59	225.90	2.61	4.36
	5	3.6	1.10	6.96		1.10	6.96			4.95	7.50	3.45	22.92	229.20	2.65	4.42
	6	3.6	1.10	6.96		1.10	6.96			5.28	7.50	3.45	23.25	232.50	2.69	4.48
	7	3.6	1.10	6.96		1.10	6.96			5.61	7.50	3.45	23.58	235.80	2.73	4.55
	8	3.6	1.10	6.96		1.10	6.96			5.94	7.50	3.45	23.91	239.10	2.77	4.61
	9	3.6	1.10	6.96		1.10	6.96			6.27	7.50	3.45	24.24	242.40	2.81	4.68
	10	3.6	1.10	6.96		1.10	6.96			6.60	7.50	3.45	24.57	245.70	2.84	4.73
	11	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	12	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	13	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	14	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	15	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	16	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	17	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	18	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	19	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	20	3.6	1.10	6.96		1.10	6.96		1.10	6.96		3.45	17.43	174.30	2.02	3.36
	21	3.6	1.05	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	22	3.6	1.05	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	23	3.6	1.05	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	24	3.6	1.05	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	25	3.6	1.05	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	26	3.6	1.05	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	27	3.6	1.05	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	28	3.6	1.05	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	29	3.6	1.05	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	30	3.6	1.05	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33
	31	3.6	1.05	6.78		1.10	6.96		1.10	6.96		3.45	17.25	172.50	2.00	3.33

ANNEX 12 LAND CONSOLIDATION AREA

Name (No.)	Chang-Changkha	No.of family	Working members	Size of land (ha) Register	Survey
W1.Gembo	Wang chang gup	M;3 F;4	M;1 F;1	0.676	0.654
W2.Pem Bida	"	M;5 F;3	M;1 -	0.354	0.469
W3.Tsheri	"	M;4 F;5	M;1 F;3	0.162	0.186
W4.Lam Chencho	"	M;3 F;4	M;1 F;1	0.152	0.153
W5.Paso Bida	"	M;1 F;2	- F;1	0.121	0.125
W6.Paso Rinchen	"	M;10 F;8	M;1 F;2	0.911	0.950
W7.Sangay Om	"	M;4 F;3	M;1 -	0.668	0.612
W8.Sangay Bida	"	- F;3	- F;1	0.101	0.198
W9.Sagina Dem	"	M;2 F;1	M;1 F;1	0.607	0.512
W10.Tsheri Om	"	M;3 F;5	M;1 F;2	0.890	0.824
W11.Pem Zam	"	M;10 F;7	M;1 F;1	2.246	2.097
W12.Bokhu	"	M;8 F;4	M;1 F;1	0.607	0.539
W13.Sangay Bida	"	M;2 F;3	M;1 -	0.486	0.400
W14.Sangay Lham	"	M;5 F;5	M;2 -	2.833	2.517
W15.Lhagang Yo-jey	"			0.344	0.323
W16.Paychum	"	M;4 F;4	M;1 F;2	1.841	1.790
W17.Lam Tenzing	"	M;7 F;4	M;1 F;1	3.646	3.608
W18.Daw Tsheri	"	M;1 F;1	- F;1	0.172	0.105
S1.Phaju Om	Shaba Gewog	M;4 F;8	- F;1	0.162	0.123
S2.Pjaju Om	"	M;3 F;3	M;1 -	0.202	0.158
S3.Sangay Dem	"	M;2 F;4	M;1 F;1	0.324	0.262
S4.Dhendup	"	M;5 F;4	M;2 F;3	0.121	0.469
S5.Gyetshey	"	M;4 F;5	M;1 F;1	0.081	0.069
S6.Jachu	"	M;1 F;2	- F;1	0.101	0.147
S7.Kangchu	"	M;1 -	M;1 -	0.081	0.062
S8.Gup Phintsho	"	M;3 F;2	M;2 F;2	1.032	0.947
S9.Ta Tsewang	"	M;3 F;2	M;1 F;1	0.162	0.209
			Total Area	19.083	18.508

ANNEX 13 ACREAGE OF EACH FARM LAND PLOT IN LAND CONSOLIDATION AREA

Farmland (No.)	Field Number (Area in sq.m)												Total Area in sq.m	(ha)
Gembo (W1)	1	2	3	4	5	6	7	8	9	10	11	12		
	90	680	445	1,145	175	770	210	110	265	555	730	1,360	6,535	(0.6535)
Pem Bida (W2)	1	2	3	4	5	6	7	8	9					
	1,100	545	90	320	385	525	550	700	470				4,685	(0.4685)
Tsheri (W3)	1	2												
	1,680	175											1,855	(0.1855)
Lam Chencho (W4)	1	2												
	1,065	460											1,525	(0.1525)
Paso Bida (W5)	1	2	3											
	655	95	495										1,245	(0.1245)
Paso Rinchen (W6)	1	2	3	4	5	6	7	8	9	10	11	12		
	610	385	600	865	875	160	215	360	370	305	490	360	9,495	(0.9495)
	13	14	15	16	17	18	19	20	21					
	215	150	405	470	630	180	845	915	90					
Sangay Om (W7)	1	2	3	4	5	6	7	8	9	10	11	12		
	25	245	295	160	410	180	375	325	505	615	655	940	6,120	(0.6120)
	13	14	15											
	290	185	915											
Sangay Bida (W8)	1	2	3	4										
	665	430	745	140									1,980	(0.1980)
Sangina Dem (W9)	1	2	3	4	5	6	7	8	9					
	280	485	500	255	605	1,010	565	610	810				5,120	(0.5120)
Tsheri Om (W10)	1	2	3	4	5	6	7	8	9	10	11	12		
	345	590	495	235	530	280	105	170	90	965	150	255		
	13	14	15	16	17	18	19						8,235	(0.8235)
	160	685	280	920	615	330	1,040							

Farmland (No.)	Field Number (Area in sq.m)												Total Area in sq.m	(ha)
Pem Zam (W11)	1	2	3	4	5	6	7	8	9	10	11	12		
	510	365	340	330	275	140	410	1,080	325	800	1,020	345		
	13	14	15	16	17	18	19	20	21	22	23	24		
	510	445	495	345	1,240	700	465	680	185	60	335	255	20,970	(2.0970)
	25	26	27	28	29	30	31	32	33	34	35	36		
	155	335	620	255	220	410	295	570	245	360	575	340		
	37	38	39	40	41	42	43	44	45	46				
	430	270	960	820	485	555	200	415	190	610				
Bokhu (W12)	1	2	3	4	5	6	7	8	9	10	11			
	900	105	245	365	670	340	485	400	1,365	360	150		5,385	(0.5385)
Sangay Bida (W13)	1	2	3	4	5	6	7	8	9					
	625	555	560	175	225	150	295	1,105	265				3,955	(0.3955)
Sangay Lham (W14)	1	2	3	4	5	6	7	8	9	10	11	12		
	250	245	370	800	310	345	580	275	685	545	860	350		
	13	14	15	16	17	18	19	20	21	22	23	24		
	385	355	235	720	105	115	325	535	285	345	450	350		
	25	26	27	28	29	30	31	32	33	34	35	36		
	455	290	840	340	160	400	655	915	700	350	395	895	25,165	(2.5165)
	37	38	39	40	41	42	43	44	45	46	47	48		
	380	390	985	390	415	480	525	295	1,080	350	380	445		
	49	50	51	52	53	54								
	575	600	485	225	455	495								
Lhagang Yo-jey (W15)	1	2	3	4	5									
	900	615	435	1,040	235								3,225	(0.3225)
Paychum (W16)	1	2	3	4	5	6	7	8	9	10	11	12		
	200	230	115	105	740	275	650	525	225	590	400	615		
	13	14	15	16	17	18	19	20	21	22	23	24		
	585	505	695	470	1,230	3,795	535	675	800	545	290	225	17,895	(1.7895)
	25	26	27	28	29	30	31							
	245	290	345	630	135	770	460							

Farmland (No.)	Field Number (Area in sq.m)												Total Area in sq.m	(ha)
Lam Tenzing (W17)	1 1,665	2 525	3 2,230	4 790	5 905	6 30	7 260	8 1,775	9 1,465	10 325	11 550	12 200	36,080	(3.6080)
	13 170	14 710	15 1,150	16 625	17 275	18 435	19 140	20 215	21 345	22 675	23 395	24 845		
	25 400	26 145	27 360	28 200	29 290	30 310	31 1,020	32 495	33 700	34 55	35 655	36 485		
	37 645	38 1,100	39 910	40 80	41 740	42 870	43 535	44 325	45 255	46 160	47 140	48 225		
	49 935	50 815	51 290	52 740	53 170	54 635	55 715	56 280	57 425	58 475	59 330	60 335		
	61 805	62 585	63 110	64 635										
Daw Tsheri (W18)	1 775	2 270											1,045	(0.1045)
Phaju Om (S1)	1 365	2 290	3 200	4 370									1,225	(0.1225)
Pjaju Om (S2)	1 305	2 620	3 655										1,580	(0.1580)
Sangay Dem (S3)	1 670	2 420	3 830	4 695									2,615	(0.2615)
Dhendup (S4)	1 465	2 540	3 835	4 485	5 355	6 1,010	7 995						4,685	(0.4685)
Gyetshey (S5)	1 690												690	(0.0690)
Jachu (S6)	1 185	2 235	3 275	4 310	5 460								1,465	(0.1465)
Kangchu (S7)	1 620												620	(0.0620)

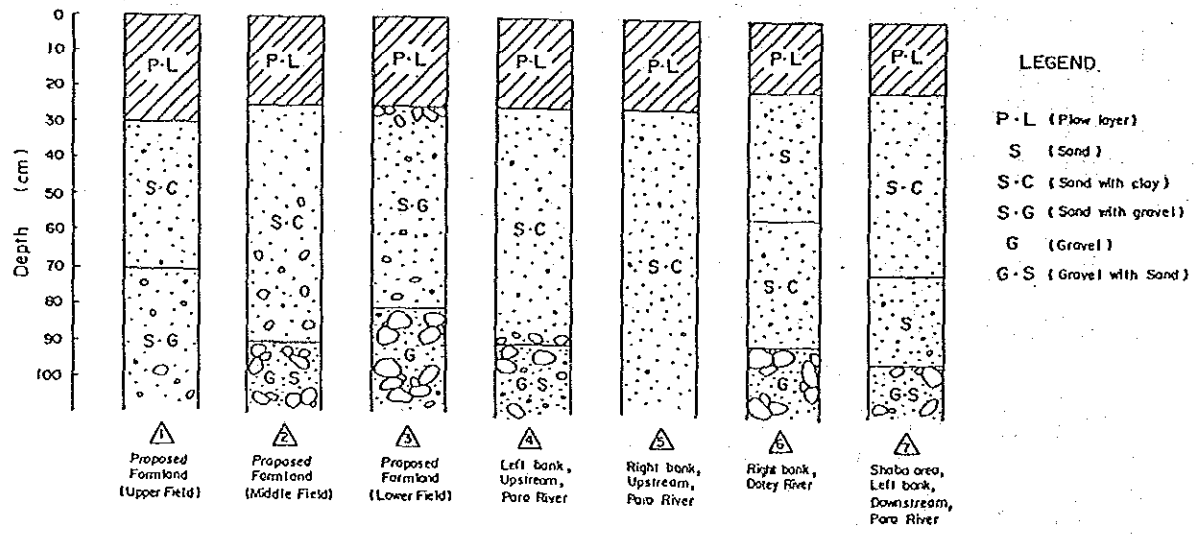
Farmland (No.)	Field Number (Area in sq.m)												Total Area in sq.m	(ha)
Gup Phintsho (S8)	1	2	3	4	5	6	7	8	9	10	11	12	9,465	(0.9465)
	645	720	365	425	420	610	240	590	1,295	440	75	670		
	13	14	15	16	17	18								
	515	445	520	730	405	355								
Ta Tsewang (S9)	1	2	3	4	5	6							2,085	(0.2085)
	525	415	490	115	185	355								
Grand Total													184,945	(18.4945)

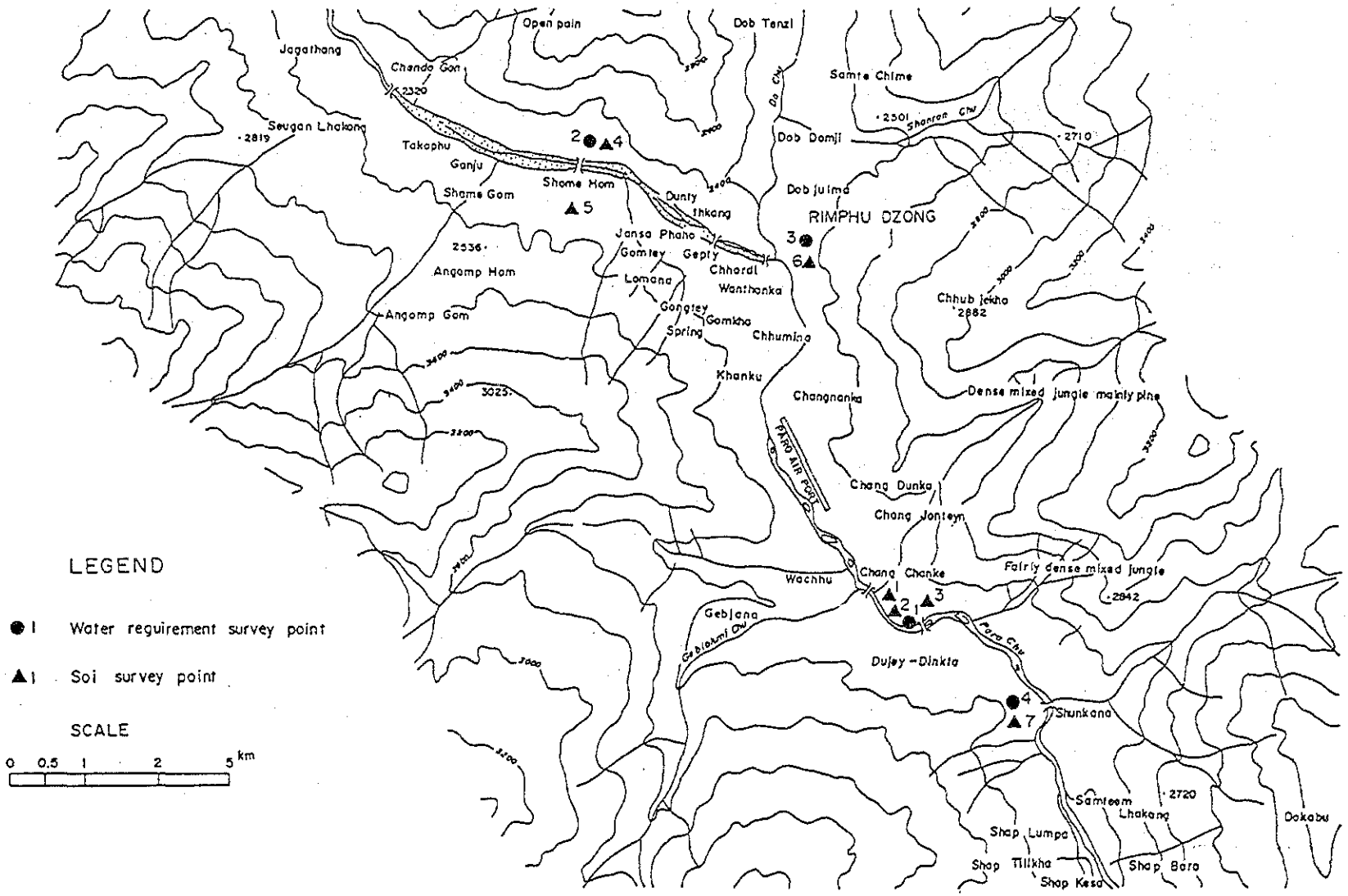
ANNEX 14 WATER REQUIREMENT SURVEY RESULT

Date of survey	Survey Point ①Bonday	②Paro-chenthang	③Shari	(mm/day) ④Shaba
11/20	(238.2)	–	–	(150.9)
21	63.2	–	(267.7)	16.9
22	57.6	(112.9)	180.5	16.5
23	48.8	19.9	184.8	16.5
24	45.3	14.8	162.8	5.0
25	48.2	9.0	166.2	6.3
27	44.1	9.2	306.9	3.2
28	46.3	9.5	296.7	3.3
29	47.3	6.7	–	3.4
30	43.2	8.1	–	3.1

ANNEX 15 SOIL SURVEY RESULT

SOIL LOG





LOCATION MAP OF SURVEY POINT

ANNEX 16 MEMBER LIST OF DRAFT FINAL REPORT EXPLANATION TEAM

Name	Speciality	Organization
Mr. Norio UCHIYAMA	Team Leader	Executive General, Agricultural Development Technical Information Center
Mr. Masamitsu FUJIOKA	Chief Engineer	Hokkaido Engineering Consultants
Mr. Kazuo MIBAYASHI	Farm road & River Bank Protection Engineer	Hokkaido Engineering Consultants
Mr. Makoto KOBAYASHI	Land Consolidation Engineer	Hokkaido Engineering Consultants

ANNEX 17 SURVEY SCHEDULE OF DRAFT FINAL REPORT EXPLANATION TEAM

No.	Date	Activities
1	Mar. 13 (Tue)	- Departure from Narita and Arrival in Delhi.
2	Mar. 14 (Wed)	- Courtesy call to Embassy of Japan. Meeting with JICA India Office.
3	Mar. 15 (Thu)	- Arrival in Paro and shift to Thimphu.
4	Mar. 16 (Fri)	- Courtesy call to Ministry of Agriculture. Submission and explanation of Draft Final Report.
5	Mar. 17 (Sat)	- Shift to Paro. Meeting with Steering Committee.
6	Mar. 18 (Sun)	- Site reconnaissance. Shift to Thimphu.
7	Mar. 19 (Mon)	- Confirmation on implementation agency and budget arrangement of the government of Bhutan.
8	Mar. 20 (Tue)	- Meeting and Signing of meeting minutes with Ministry of Agriculture.
9	Mar. 21 (Wed)	- Shift of team leader and chief engineer to Paro. Others meeting on labor force and lot rearrangement in land consolidation area and receiving information on Geyleghug Area Development.
10	Mar. 22 (Thu)	- Arrival of team leader and chief engineer in Delhi and meeting with JICA India Office. Others shift to Paro and meeting on AMC organization.
11	Mar. 23 (Fri)	- Arrival of team leader and chief engineer in Bangkok. Others aarival in Culcutta.
12	Mar. 24 (Sat)	- Arrival in Tokyo.

ANNEX 18

MINUTES OF DISCUSSIONS

ON

THE REPORT OF THE BASIC DESIGN STUDY

ON

THE PROJECT FOR THE PARO VALLEY AGRICULTURAL DEVELOPMENT(PHASE II)

IN

THE KINGDOM OF BHUTAN

In response to the request made by the Royal Government of Bhutan, the Government of Japan decided to conduct a Basic Design Study on the Project for the Paro Valley Agricultural Development (Phase II) (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to the Kingdom of Bhutan the study team from November 9 to December 15, 1989.

As the result of the survey and discussions, JICA prepared a Draft Final Report on the study and dispatched the second mission headed by Mr. Norio Uchiyama, Executive General, Agricultural Development Technical Information Center, to explain and discuss it from March 15 to 23, 1990.

Both parties had a series of discussions on the Report and have agreed to recommend to their respective Governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Thimphu, March 20, 1990.

Norio Uchiyama

Mr. Norio Uchiyama
Leader
Draft Final Report Explanation
Team of Basic Design Study
JICA

Dasho Leki Dorji
Secretary
Ministry of Agriculture
Royal Government of Bhutan

ATTACHMENT

1. The Royal Government of Bhutan has agreed in principle to the basic design proposed in the Draft Final Report.

2. The Royal Government of Bhutan has understood Japan's Grant Aid System and reconfirmed the necessary measures to be taken by the Royal Government of Bhutan which are manifested in the Annex II of the "Minutes of Discussions" on the Project signed on December 15, 1989, on condition that the Grant Aid by the Government of Japan would be extended to the Project.

3. The Royal Government of Bhutan will release the necessary budget at the proper time according to the construction schedule.

4. The Final Report (10 copies in English) on the Project will be submitted to the Royal Government of Bhutan within May 1990.

5. The overall comments of the Royal Government on the details of individual components of the Draft Final Report will be submitted latest by the end of April 1990.

JICA