7. Geologic Assessment of the Project Site

The geologist of the JICA Study Team carried out the reconnaissance of the project site. The following summarizes the finding of this geologist. Further detailed assessment of the geology on the project site will be carried out on the basis of the geologic explorations which are in progress on the site.

7.1. Dam Sites

7.1.1. No.1 Dam Site

The topographic and geological features of this dam site just downstream of the junction area of the Kakiduguen River and the Diduyon River, are generally similar to those of the No.2 dam site. The slopes of both banks are comparatively gentle and the mountain ridges at the both banks are low and thin. The mountain slopes are weathered and do not expose fresh rocks. There is the possibility that part of the dam slope on the upstream side may reach to the Kakiduguen River.

The diorites underlying the right bank just upstream of the junction area will be made available for the embanking materials of the dam. The same problem as for the No.2 Dam Site will face the procurement of the core materials for this dam. This dam site is not suitable for the construction of the dam for the above reasons and will be dismissed for further investigation.

7.1.2. No.2 Dam Site

The mountain ridges on the both banks present gentle slopes. The slopes are not more than 20° inclined except in the part of the right bank. The width of most of the ridges is thin; particularly the part of about 700 m high ridges on the left bank is 140 to 200 m wide at EL 680 and such thin ridges continue in a distance of about 500 m. Therefore, some water leakage through the thin ridge will occur if the high water level in the reservoir is fixed at EL 680. The gentle slopes on the both banks, wide riverbed and about 70 m wide river terrace on the right bank

which is several meters higher from the riverbed will make the dam volume larger. Moreover, a large amount of the terrace gravel bed will be required to be excavated if the terrace gravel bed is thick.

The rocks underlying the No.2 Dam Site are composed of agglomerates and diorites intruding those agglomerates. The distribution of the agglomerates is generally prevailing but the diorites are distributed widely over the riverbed upstream of the proposed dam axis and on the logging road from the top of the mountain ridge on the left bank to Kamamasi. Fresh rock exposures are seen on the riverbed upstream of the proposed dam axis and the riverbed of the Kamamasi Creep, but the rocks underlying the mountain slopes and ridges are almost clayey. No rock exposure is seen on the right bank except on the logging road. The overburden on the right bank is estimated to be 1 to 3 m thick. The geologic structure of the site is quite unknown, and any fault could not be identified because there is no continuous exposure of the rocks.

The dam type suitable for this site will be a rockfill dam, considering the site feature that the mountain slopes are gentle and a large amount of excavations will be required to get fresh foundation rocks. The dam embanking materials will be made available from the left bank near the No.3 Dam Site or the right bank upstream of the No.1 Dam Site. Weathered rocks will be used as the core materials but the weathered rocks are clayey and of much water content. The core material will be made available from the weathered zones on the both banks along the Kamamasi Creek near Kamamasi or by spoil excavated for the construction of the intake.

7.1.3. No.3 Dam Site

The average mountain slopes between EL 600 and EL 700 are generally steep, and are inclined at an angle of 35° on the left bank and 45° on the right bank. On the left bank a cliff

of fresh rocks rises up to the top of the mountain at Elevation 1,000. On the right bank, fresh rocks are exposed from Elevation 700 to the halfway of the mountain on the upper stream side of the dam site and with an inclination of more than 50° from the riverbed to the halfway of the mountain on the lower stream side. The riverbed on the site is narrow. The gradient of the riverbed becomes steep from about 200 m upstream of the dam axis and many large boulders lie down on the riverbed. There is a narrow ridge at elevation 700 behind the cliff on the right bank.

The rocks underlying the dam site are agglomerates which are intruded by several dykes of diorites less than several meters wide. Most of the dykes measured in the field trend toward N20°W.

The agglomerates form a monoclinic structure trending toward N40°E 30°SE. On the left bank, the dip of the monoclinic structure corresponds to the inclination of the slope. The bedding plane in the hollow between the ridge at the dam axis and the ridge upstream of the dam site presents the riverbeds of several small creeks. This phenomenon may be an evidence of the small scale slidedown of the layer. There is also the possibility that the mountain slope upstream of the hollow may correspond to the bedding plane. Some countermeasures should be taken to prevent any landslides which may take place on the bedding plane.

A several 10 cm wide fault striking toward EW70° ~ 80°N is recognized to exist on the left bank side about 300 m upstream of the dam axis. But this fault will not give effect on the construction of the dam on this site. Along the left bank from the dam axis to 500 m upstream, fresh rocks are exposed continuously except two rock non-exposed places where large scale faults which may affect adversely the construction of the dam may strike accross the river. However, fresh rocks

are exposed above the halfway of the right bank which corresponds with the left bank on the lower stream place out of the two places where no rocks are exposed. Accordingly, the possibility of a fault striking at the very place is very small. Any fault on the upper stream rock non-exposed place, even if its existence is confirmed by the further detailed investigation, will not cause any problem for the construction of the dam. As aforementioned, there is another possibility that a considerably large fault strikes 1 km upstream of the dam axis. The continuous exposure of rocks downstream of the right bank lessens the possibility of a large scale fault striking along the riverbed.

The important geologic problem on this site may lie on the saddle part on the right bank. The topographic feature and weathering condition of the saddle which will be described afterward imply the existence of a fault striking toward ENE-WSW in parallel with the river course. But it is located about 300 m distant from the river course. Different from the other proposed sites this site has a continuous exposure of fresh rocks on both banks up to the tops of the mountains. But there is a thin ridge with a saddle part behind a small peak on the right bank, and heavily weathered and clayey agglomerates are distributed over the thin ridge. The rocks underlying the lower stream ridge neighbouring to the thin ridge are also clayey except the rocks on the extreme of the ridge. The border line of the distribution of fresh agglomerates and clayey agglomerates is not clear, but fresh rocks covered directly by overburdens which seem to be surface soil are exposed on the creek between the both ridges as above-mentioned, therefore an abrupt change in the rock facies is assumed.

The dam type suitable for the construction on this site will be a concrete dam. The dam volume of the concrete dam will not be so much large and foundation rocks of enough force

will be made available by a small quantity of excavation. The site is not suitable for the construction of a rockfill dam, because the steep slopes on the both banks will cause cracks in the core part of the dam and the narrow riverbed on the dam site will make it difficult to carry the large construction machinery and equipment into the site. The most important concern in the construction of concrete dam is a fault which is assumed to exist across the saddle part. If the fault exists, the distribution of fresh rocks become strikingly narrow and water leakage through the fault will be occurred.

The agglomerates available on the left bank may be used for the dam embanking materials or the concrete aggregates and the deorities or porphyrites distributed at Biyoi for the fine aggregated. The core materials may be procured from the conglomeratic clay distributed on the right bank 500 m upstream of the dam site.

The geologic features of those 3 sites are summarized in Table 7-1. This table shows that the No.3 Site may be the best dam site.

7.2. Conventional Type Powerhouse One-stage Development Plan

7.2.1. Powerhouse Site

The rocks underlying the powerhouse site consist of agglomerates and diorites which intrude the agglomerates. Thin layers of sandstones and conglomerates are intercalated in the agglomerates which are inclined with a gentle slope toward the upstream side. The proposed powerhouse site overlies a wide river terrace which seems to consist of boulders more than 1 m in diameter beneath the 1 to 2 m thick clayey surface layer. The agglomerates are exposed on the riverbed of the Diduyon River 500 m upstream of the dam site and downstream of it. This fact suggests that the terrace deposits are not thick and rocks suitable for the foundation underlie not so deeply. Any indications implying the existence of a large fault were not recognized on or near the powerhouse site.

7.2.2. Penstock Route

Seen on the mountainside near the penstock route are agglomerates and diorites. The rocks on or near the top of the mountain are weathered completely to be clayey, but fresh rocks are exposed at the riverbed of the creek and at the top of the mountain near the proposed surgetank site. This fact suggests that the weathered layer along the penstock route is thinner than the weathered layer on the dam site. There are no rock exposures and many boulders are scattered along the upper part of the penstock route. Most of the penstock route may generally consist of the talus deposits, and the anchor blocks should be provided for its foundation after the talus deposits were excavated.

7.2.3. Tunnel Route

There is a little exposure of rocks along the tunnel route. But fresh and hard rocks which seem to be a dyke of andesites or andesitic lavas are exposed in a small area on the riverbed and at the mountainside near the riverbed. Accordingly, it is expected that fresh and hard rocks exist in the tunnel route. However, several faults are assumed to cross the tunnel route and the ground surface in the Kasibu basin is assumed to be weathered deeply, judging from its topographic feature. The predominent trend of the faults is NE-SW. Besides the NE-SW faults, the NW-SE and N20°W trending faults which strikes the east end of the Kasibu basin are recognized. The tunnel route from the No.2 Dam Site seems to intersect with the NE-SW faults at an small angle and come across the N20°W trending faults. Moreover, the overburden in the upper stream part of the penstock route is thin and weathered.

7.3. Upper Stream Underground Type Powerhouse Plan

Fresh and hard autobrecciated lavas and agglomerates are exposed continuously on or around the powerhouse site. These rocks have a few joints at intervals of more than 1 m. But some of the joints are rather clear and open. The outcrop which seems to be part of the altered zone or part of the large fault exists 200 to 500 m upstream of the powerhouse site. The outcrop is supposed to continue almost eastwest. The crossing of the altered zone with the Didipio creek is weathered heavily which results in the unstable condition of the mountainside slope and the occurence of many small scale land collapses on the slope. The location of the powerhouse is recommended to be determined away from the altered zone after the distribution and size of the altered zone or the fault are clarified.

7.4. Quarry Sites for Rock Material and Aggregates

It is envisaged that rock material for No.2 dam and fine aggregates will be made available from Biyoi, and coarse aggregates will be at the mountain immediately downstream of No.3 dam site.

As for the fine aggregates at Biyoi, the rocks underlying the quarry site consist of andesites and porphyrites belonging to the Manparang Formation and the Caraballo Group which is older than the Manparang Formation.

The rocks underlying the quarry site are microcrystalline rocks containing much phenocrysts of feldspars and pyroxenes and they present dark purple or dark green. Part of the phenocrysts is 2 to 3 mm wide in diameter and another part of the phenocrysts are about 1 mm in diameter. The fresh rocks are compact and hard but some of the rocks have dense joints. Most of the rocks on the southern half of the quarry site present like breccias and are considered to be lava flows. Most of the lava flows exposed on the banks or in the Kakiduguen River are heavily weathered and altered. The boundary line of these igneous bodies

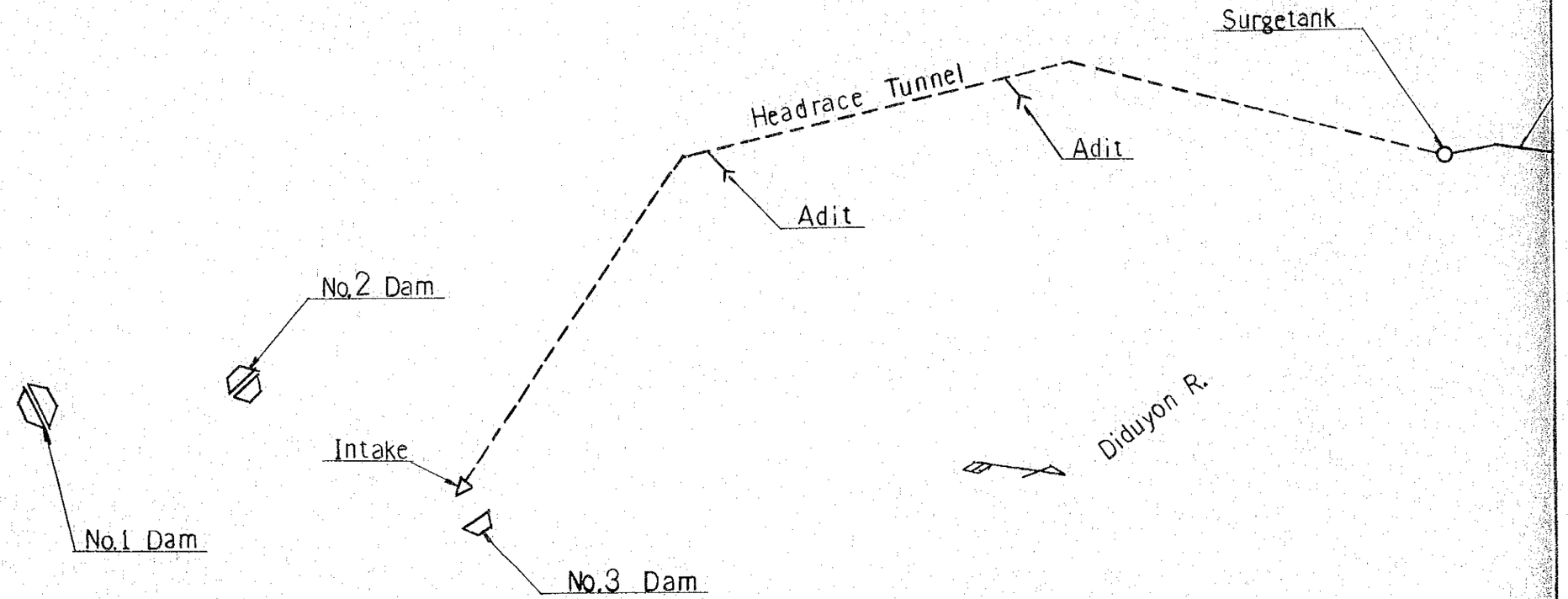
With the agglomerates exposed at 150 m upstream of the crossing point with the Kakiduguen River seems to change irregularly or gradually. Judging from the topographic feature, the rocks underlying the northern half of the quarry site which consist of homogeneous and comparatively coarse crystals occur as a dyke. However, since the dyke is originated in volcanophetonism, it is easily understood that there is no essential difference between both rocks.

The rocks except the northern river banks are hard weathered on the surface. The grade of the weathering varies from place to place, and the surface weathered layer from a depth of several meters to more than 10 meters will be required to be removed. The depth of the weathered layer should be examined by the drilling work.

The rocks are considered to be suitable as the fine aggregates, but the rocks under the southern half of the site seem to be inferior to those on the northern half in the property as the concrete aggregates considering the difference in the rock facies.

Table 7-1 Geological Comparison of Dam Sites

	Item	No.1 Site	No.2 Site	No.3 Site
Topography	Slopes of both banks	Gentle	Gentle	Steep
	Thickness of Ridges	Thin, especially at the right bank	Thin, especially at the left bank	Thin behind the right bank
	Width of riverbed	Wide	Wide	Narrow
	Others	At the conjunction of the Kakiduguen river	A difference in height between the dam crest and the top of the mountain is small.	-
Geology	Bedrocks	Heavily weathered at both banks	Heavily weathered at both banks	Fresh
	Existence of faults	Not clear	Not clear	Assumed fault behind the right bank
	Outcrops	A few	A few	Mostly continuous outcrops
Dam type		Fill	Fill	Concrete
Materials quarry site	Rock Materials	Hear but questionable in available quantity	Far	-
	Core Materials	-	A little far	-
	Aggregates	Near	Far	Near
Problems		1. Topographically difficult for the construction because the Kakidugeun river flows in the dam site.	1. Large excavation volume and large dam body	1. Fault behind assumed the right bank
		2. Large excavation volume and large dam body	2. Thin ridge and water leakage	
		3. Thin ridge and possibility of water leakage	3. Transportation of rock materials	
		4. Core materials	4. Core materials	
		5. Geologically unclear	5. Geologically unclear	


Surgetank
Headrace Tunnel
Adit
Adit
No.2 Dam
Intake
Diduyon R.
No.1 Dam
No.3 Dam

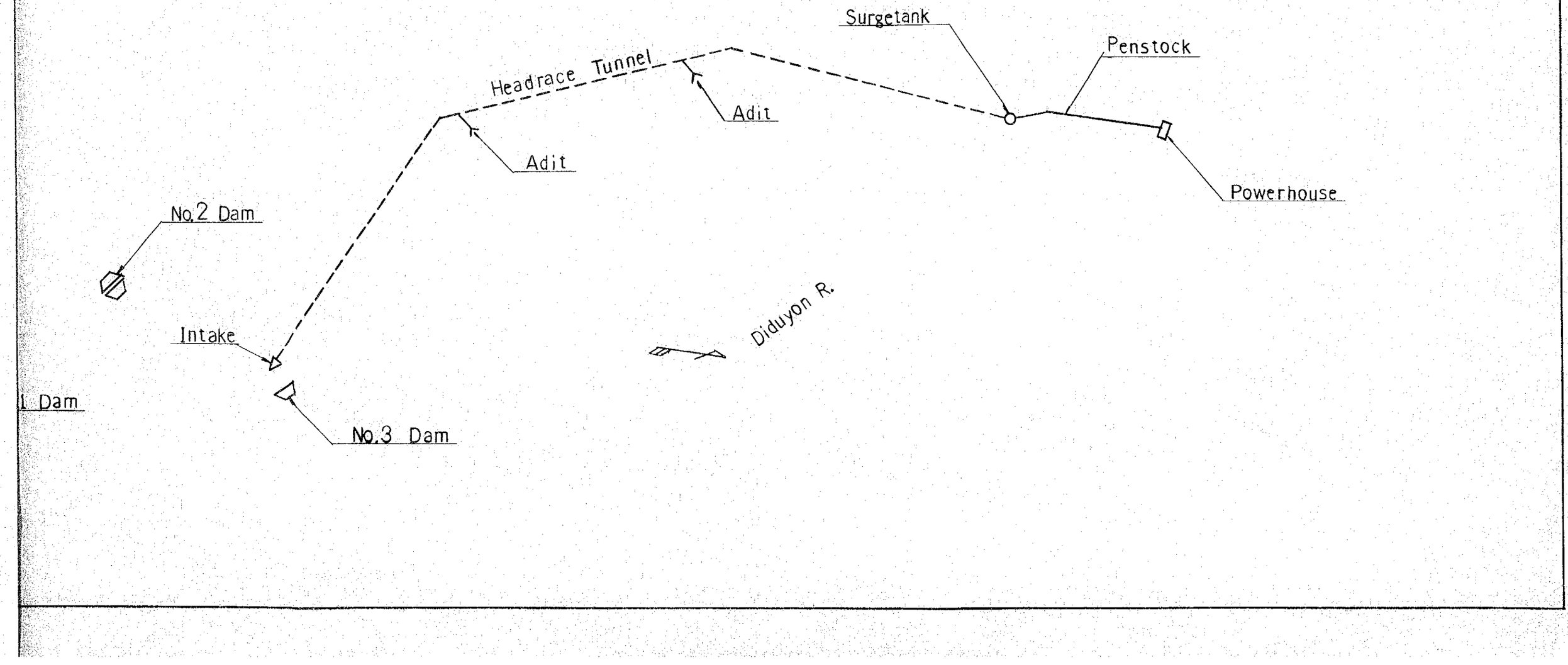

Surgetank
Penstock
Headrace Tunnel
Adit
Adit
No.2 Dam
Powerhouse
Intake
Diduyon R.
No.3 Dam

Fig. 7-1 Geological Map of Project Site

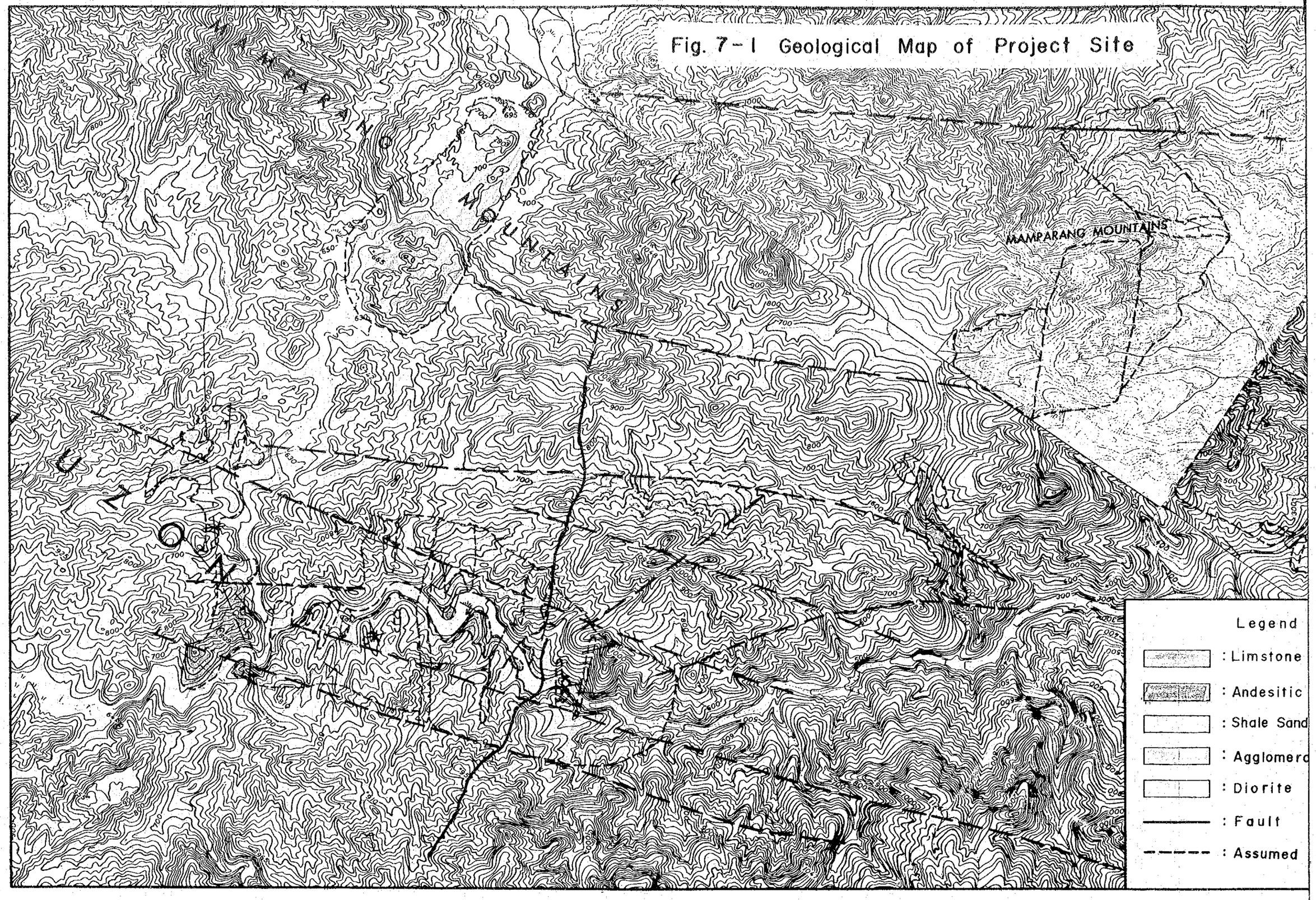
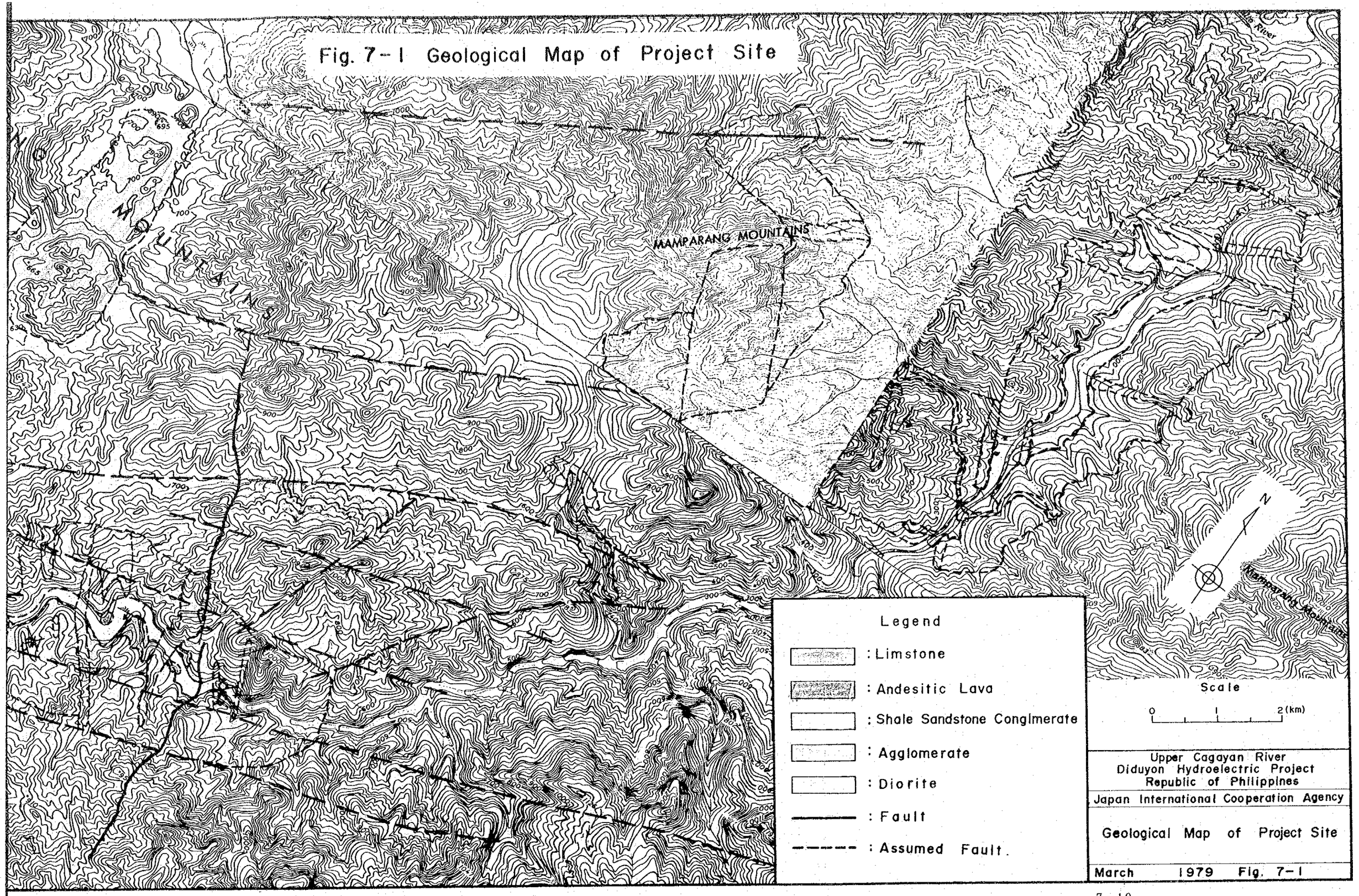


Fig. 7-1 Geological Map of Project Site



8. Transportation Program

8.1. Present Conditions of Roads and Ports

Access to the project site can be made through either Kasibu, Nueva Vizcaya or Dibibe, Quirino. And either of three international ports, namely, Manila, San Fernando and Casambalangan (Port Irene) can be considered as unloading port of the equipment and materials for the Project. The following alternative routes are considered for the transport to the site.

i) starting from Manila Port

a) Manila - San Jose - Aritao - Bambang - Kasibu (310 km)

b) Manila - San Jose - Aritao - Bambang - Cordon - Luna - Dibibe (460 km)

ii) starting from San Fernando Port

a) San Fernando - Baguio - Aritao - Bambang - Kasibu or Dibibe (250 km or 390 km)

b) San Fernando - Rosario - San Jose - Aritao - Bambang - Kasibu or Dibibe (320 km or 480 km)

iii) starting from Casambalangan Port

a) Casambalangan - Tuguegarao - Santiago - Cordon - Dibibe (370 km)

b) Casambalangan - Tuguegarao - Santiago - Cordon - Bambang - Kasibu (520 km)

Routes i) a) and i) b)

Manila Port is the largest in the Philippines with all necessary facilities such as anchorage, piers, loading/unloading cranes, warehouses, and customs offices. Therefore, the port does not pose any problem in handling the heavy equipment and other construction equipment and materials necessary for the Project.

The road from Manila Port to Bambang is a concrete paved road more than 8 m wide. The disadvantage of this route is the heavy traffic in Manila City and the possible suspension of roads due to land collapses which take place frequently at the mountain area near the Dalton Pass during the wet season. Besides, more than 10 bridges out of the existing bridges will be required to be reinforced for the transportation of heavy equipment weighing more than the load limitations of such bridges.

The road from Bambang to Kasibu is an unpaved gravel road having a road width of 4-5 m. This road, except its portion, can be used even during the wet season. The change of the route of part of the road will be required because there are steep slopes and curving sections at the mountainous section on the way to the pass higher than EL 900. There are about 16 bridges at this section, most of which are wooden. Therefore, it is necessary to improve or reconstruct the wooden bridges for the use of the transportation of the heavy equipment.

There is no problem on the road from Bambang to Cordon because it is a part of the National Road Route No.5. The road from Cordon to Dibibe is a non-paved gravel road 8 m wide and can be used even during the wet season. However, the road surface condition is bad in the section between Luna and Dibibe. Therefore, the rehabilitation will be required for this section. There is no problem on the bridges in the section.

Routes ii) a) and ii) b)

The Route ii b) is longer than the Route i) a). The route length of the Route ii) a) is shorter than the previous i) a) by 50 km, however,the road between Baguio and Aritao is unpaved and the slope of the road is steep.

San Fernando Port does not pose any probelm in the handling of the heavy equipment because it is well equipped and it has a capacity to accommodate 20,000 tons class ships.

Routes iii) a) and iii) b)

Until Dibibe the length of the Route iii) a) is the shortest among all the alternative routes i), ii) and iii) above. And the road condition is generally good except some portion. However, Casambalangan Port has some problem in loading/unloading facilities and warehouses.

The Route iii) b) is the most disadvantageous due to its long length. Therefore, this route is the only alternative route when all other roads are not feasible.

8.2. Logging Road

A 27 km long logging road leads from Kasibu to the dam site and a 15 km long logging road from Dibibe to the powerhouse site. The roads can be used for the transport of heavy equipment by special vehicle in the dry season. However, the alignments, steepest slopes and surface conditions of the roads satisfy only the minimum requirements. Therefore, the repair of the whole roads and the new construction of bridges will be required for the access by general vehicle.

There is no connecting road between the dam site and the powerhouse site at the right bank side. But there is a logging road connecting the dam site and Dibibe at the left bank side. Accordingly, the dam site and the powerhouse site is to be connected via Dibibe. The road condition of this logging road is not good. Therefore, the repair of the whole road and the new construction of bridges will be required.

With the completion of the reservoir, so many logging roads will be inundated in the reservoir. Therefore, detailed study should be carried out on the relocations of the logging roads and the compensation for the relocations.

8.3. New Construction of Construction Road

Besides the existing roads so far mentioned, the construction roads connecting the existing logging roads with main structures of the dam, power stations, quarry site, intake, tunnel adits and surge tank will be required. Any difficulties in the construction are not expected judging from the topographic and geological conditions of the roads routes. However, the maintenance work of the roads after construction may be difficult, considering the characteristics of the mountain covered by heavily weathered layers and the unstable ground surface due to the deforestation. Therefore, careful attention should be paid to the drainage, surface protection and stability of the cut slopes when the design of the construction roads is made.

9. Transmission Line Associated with the Project

The installed capacity of the Project is proposed to be 350 MW. The transmission line from this power station is designed to be double circuits in order to supply the power stably even if one of the circuits become out of service. The transmission line will be 230 kV double circuits of ACSR 795 MCM which are the present NPC standard.

As the alternative connecting points of this associated transmission line with the Luzon Grid, the following places were considered:

1. Ambuklao Power Plant
2. Binga Power Plant
3. Pantabangan Power Plant
4. Beckel Substation
5. San Manuel Substation
6. Santiago Substation
7. Solano Substation
8. Muñoz Substation

a) Ambuklao and Binga Power Plants

Binga has no more space available for the new switchyard and incoming transmission facilities. Ambuklao is the takeoff point of the 230 kV transmission line to the Santiago Substation for Cagayan Valley Electrification Project. The connection of the transmission line to either of these plants will require an additional transmission line to the load centeres. It is, therefore, considered that both are incompetent as the connecting points.

b) Pantabangan Power Plant

This plant is planned to have an addition of 100 MW in the future. When the addition is completed, the site will not have enough yard for receiving the power from Diduyon and the existing transmission line from Pantabangan will become insufficient in the capacity to transmit the additional power. Accordingly, this site is also to be dismissed.

c) Beckel Substation

At present, the EHV substation is envisaged for construction in the north of the existing 230 kV Substation. Considering its topography and available space restriction, first priority should be given to construct the proposed EHV substation to receive the power transmitted on the EHV transmission line from Northern Luzon.

d) San Manuel Substation

This substation serves now as a key station receiving the hydro power transmitted from Northern Luzon and transmitting it to Metro Manila area on the 230 kV transmission lines. It is considered as one of the alternative EHV substations in the future.

e) Santiago Substation and Solano Substation

The proposed Santiago Substation site has a wide space and makes possible the takeoff of the transmission line to any direction. In the future, most of the power plants in the north such as Magat will be linked to the Santiago Substation rather than the Solano Substation. It is, therefore, expected that this substation may be a key station for the future EHV system.

f) Muñoz Substation

This substation is now the junction point of the 230 kV transmission line from Pantabangan and has a large load center in its vicinity. This is also one of the prospective EHV stations to receive the power transmitted on the EHV transmission line from Northern Luzon.

After the above-mentioned considerations, the following three (3) routes were selected and the field reconnaissance of the three routes were carried out.

1) Diduyon - Santiago - San Manuel or Muñoz
2) Diduyon - Kasibu - Bone South - Muñoz
3) Diduyon - Kasibu - Carranglan - Muñoz

The Route 1) will pass first along the lower reaches of the Diduyon River and will turn its course to the north at the confluence with the Dumatalto River, passing through a flat terrain to reach the Santiago Substation. This route is considered the best in the viewpoints of the construction work and maintenance of the transmission line. After Santiago, the transmission line will take a route in the south of the proposed 230 kV transmission line from Ambuklao and will be connected to San Manuel, passing the south of Mt. Imangan via Bone South, or connected to Muñoz, crossing the mountains in the north of San Jose along the highway.

The Route 2) will traverse the mountains in the north of the proposed dam site and will go to the west until Muñoz from Kasibu via the mountains located at the south of Dupax and Bone South.

The Route 3) will go to the south from Kasibu and will enter Carranglan, passing between Mt. Nadumla and Mt. Deu Gurung via Danguit. From Carranglan, it will traverse west of the Pantabangan Dam and reach Muñoz.

With respect to the relation of these routes with the Luzon Grid, further study will be required on;

a) Necessity of the EHV transmission line from the Santiago Substation
b) Technical feasibility of the construction work of the section between Kasibu and the Diduyon Power Station.
c) Transportation method of construction materials and possibility of stringing work in the mountainous area between Kasibu and Carranglan.
d) Power flow study.

The optimum route will be selected based on the above studies.

10. Environmental Study

10.1. Present Environment

10.1.1. Physical Aspects

The river water carries soil and sands, and its contamination is 8.5 ppm and its transparency is as low as 60 cm. But it does not contain so much organic matters and its nitrogen content is only 0.015 ppm. Accordingly, the quality of the river water is considered rather good.

10.1.2. Biologic Aspects

Farm land is developed on the area of less slope in the project area. Tropical weeds grow on a little bit inclined hilly land. Higher elevations in the project area than the hilly land are covered by trees. The trees are mainly evergreen trees including lauan apitong, mayapis pine, narra and ipil.

Main wild animals living in the project area are monkeys, wild pigs and wild deer. Main birds living there are kalao, Philippine eagles, king fishers, parrots, mountain doves, mayas and wild ducks. Main reptiles inhabiting there are rattle snakes, lizards and small crocodiles.

Kinds of fish inhabiting the Cagayan River are tilapia, carp, mullet, goby, gurami, mud fish, eel and cat fish.

10.1.3. Social Aspects

a) According to the census in 1975, the population, number of villages and number of households in the Kasibu Municipality were 11,490 persons, 28 villages and 2,219 households. The increase in the population from 1970 to 1975 was 3,838 persons, and the rate of the increase was 44.5 % of which about 10% were immigrants from the other municipalities from 1970 to 1975.

b) The native tribe in the Kasibu Municipality is the Ilonggot Tribe. At present, the largest tribe is the Ifugao Tribe, the second largest the Igorot Tribe, the third the Ilocano Tribe, and the fourth the Ilonggot Tribe. They use their own dialects in their daily conversations.

c) The public facilities in the Kasibu Municipality include the municipal office, public schools, a private school, and churches. 16 members of the Municipal Council, 1 nurse and 2 midwives, 1 policeman and 8 forest patrols are engaged in the public services.

d) 90% of the working people in the Kasibu Municipality are engaged in the agriculture. The average farm land owned by a farmhouse consists of 0.51 ha of rice field, 0.08 ha of corn field and 1.55 ha of cropland area. The products are rice and fruits and vegetables including banana, gingers, beans, pumpkins, coffee and gabi. The farmers raise livestock including cows, horses, pigs, goats, chickens and ducks. The annual income is estimated to be 1,800 to 2,500 Pesos per household. Surplus agricultural products are sold at Bambang 34 km distant from Kasibu.

e) There are 39 small shops in the Kasibu Municipality. These shops sell mainly canned food, daily necessaries, tobacco and beer. There are 6 rice-cleaning mills.

f) 99% of the households in the Kasibu Municipality get drinking water from wells and springing waters. The river water is used for washing of tablewares and clothes.

g) There is a rapid in the lower reach of the dam site, and the velocity of the river flow is very fast. Accordingly, the river is not used for navigation going upstream and downstream.

h) The mortality in the Kasibu Municipality is high. Pneumonia and tuberculosis make up a greater part of the mortality.

10.2 Environmental Consequences of the Project Development

10.2.1. Physical Aspects

a) The water stored in the reservoir will be nourished by dissolution of organic matters and inflow of fertilizer, agricultural medicines, and sewerage. However, the nourishment of the reservoir will not bring serious environmental problems because the living conditions seem not to be changed suddenly.

b) The annual inflow into the reservoir is estimated to be less than ten times of the gross storage capacity of the reservoir. This will result in the formation of cold water layer at the bottom part of the reservoir.

c) The drawdown in the reservoir is about 30 m. The variation in the water level of the reservoir will have the possibility to cause the erosions of the slopes in the reservoir area.

d) In the dry season, the river section between the dam and the powerhouse will be fed only by the small discharge from the mountain creeks in the river section. The discharge released from the powerhouse will make faster the river flow downstream of the powerhouse as well as increase the water level.

10.2.2. Biologic Aspects

a) The project development will not cause serious effect on the vegetation in the project area. But the logging of trees not directly related to the project development will give more influence on the vegetation. Accordingly,

the vegetation control should be studied, considering the plans of logging.

b) The animals resident in the project area will not be affected seriously by the project development. They will be affected more by the change in the vegetation which will result from the logging.

c) The nourishment of the water stored in the reservoir will result in the extinction of the organism apt to live at the bottom of the water, the growth of aquatic plants, and the generation of aquatic insects will in turn give influences to fishes. The river flow will be cut by the construction of the dam. This will make it impossible for fishes to go up and down the stream. The environment for the life of adhesive duckweeds and aquatic insects growing in the shallows and in the coast will be changed after the completion of the dam. However, the creation of the reservoir will result in the propagation of fishes suitable to live in the stationary water. The environment for the aquatic life at the riverbed and in the coast downstream of the dam will be made unstable by the extreme change in the discharge downstream of the power station. The aquatic life will be able to adjust themselves to the change in the circumstance, considering the fact that they adjust themselves to the seasonal and daily variations of the water discharge including flood.

There found experiences of fish culture and seeding projects in Region II which includes the project area. These projects can be applied for the reservoir created by the dam. Therefore, there would be few adverse effects.

10.2.3. Social Aspects

a) With the creation of the reservoir, 9 villages will be inundated, most of the irrigated rice field cultivated on the flats near the river will be submerged, and 60% of the housing lots in the proposed reservoir area will be inundated.

b) Upon the completion of the access road to the project area, the project area will be connected to the National Road Route No.5 on the route a Bambang - Kasibu - the dam site - Cabarroguis - Cordon. The connection with the National Road will activate and diversify the transport of agricultural products from the area and the inflow of consumable goods thereto.

c) The hourly variation of the water level in the downstream, which will be caused by the discharge released from the power station, will jeopardize the safety of people working at and animals pastured at the river.

d) The reservoir, on its completion, will provide an opportunity of developing the tourism.

10.3. Countermeasures for Environmental Consequences

a) Discharge announcing system should be installed to give adequate warnings to the people downstream of the reservoir.

b) Any possible sites for landslides in the reservoir area should be investigated. And countermeasures for the possible landslides should be taken.

c) The most important problem is the way and compensation for the resettlement. The resettlement is proposed in the Subsection 10.4.

10.4. Resettlement

10.4.1. Concept for Resettlement Planning

The plan for the resettlement was made with the following basic concept;

i) The compensation for the resettlement should be made in

such a way that the lost property will be recovered.

ii) The plan for the resettlement should be prepared in the overall context of the development of the area on or near the dam site.

iii) The progress of the development of the area which will embark with the execution of the resettlement plan should be geared to the labour force, technical level and economic level of the resident in the area.

With the creation of the reservoir at H.W.L. 680, about 540 households in the 9 villages will be affected. The land proposed for the relocation of the affected households should fulfil the following requirements;

a) The land will be suitable to reconstruct the agricultural activities.

b) The land will facilitate the intercommunications inside the resettled community.

c) The land will be located so as to promote the economic interchanges with the society outside the community.

10.4.2. Plan for Resettlement

Following the concept mentioned in the paragraph 10.4.1., the three plans were worked out for comparison. (See Figs. 10-1 and 10-2)

a) Plan 1 (Dispersion Type Relocation)

The lands for the resettlement will be developed dispersedly upstream of the dam site.

b) Plan 2 (Intension Type Relocation)

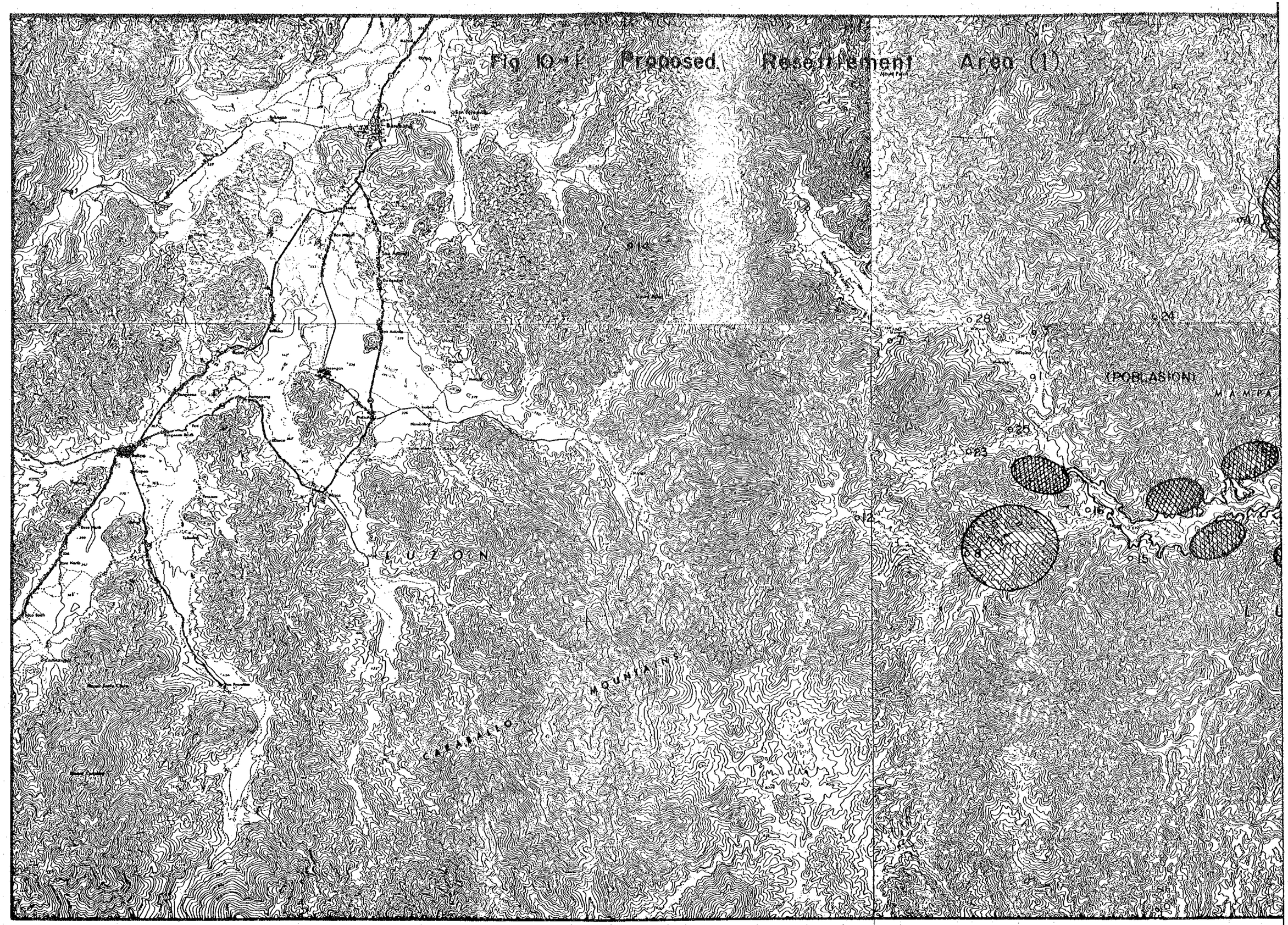
The lands for the resettlement will be developed in rather instensive lots upstream of the dam site.

c) Plan 3 (Complete Removal Type Relocation)

The area on the right bank 5 km upstream of the confluence of the Diduyon River with the Cagayan River will be developed for the land for the resettlement. This area will be enriched with water for irrigation by the regulation of the river flow at the dam.

The Plan 3 will produce the largest effect of the investment, which will meet the governmental policy for the regional modernization. The Plan 2 will serve to reconstruct and strengthen the Municipality of Kasibu. The Plan 1 will not make a drastic reform of the mode of life of resettlers and provide similar condition of life to that before the resettlement. Detailed studies should be carried out, particularly on the costs of the resettlements under those plans, before the selection of the final plan.

Fig 10-1 Proposed Resettlement Area (1)



Proposed Resettlement Area (1)

(POBLACION)

MAMPARANG MOUNTAINS

LUZON

OUNTAINS

Mamparang Mountains

P/S Site

NO.3 Dam Site

Legend

Plan 1 : D

Plan 2 : I

on : A

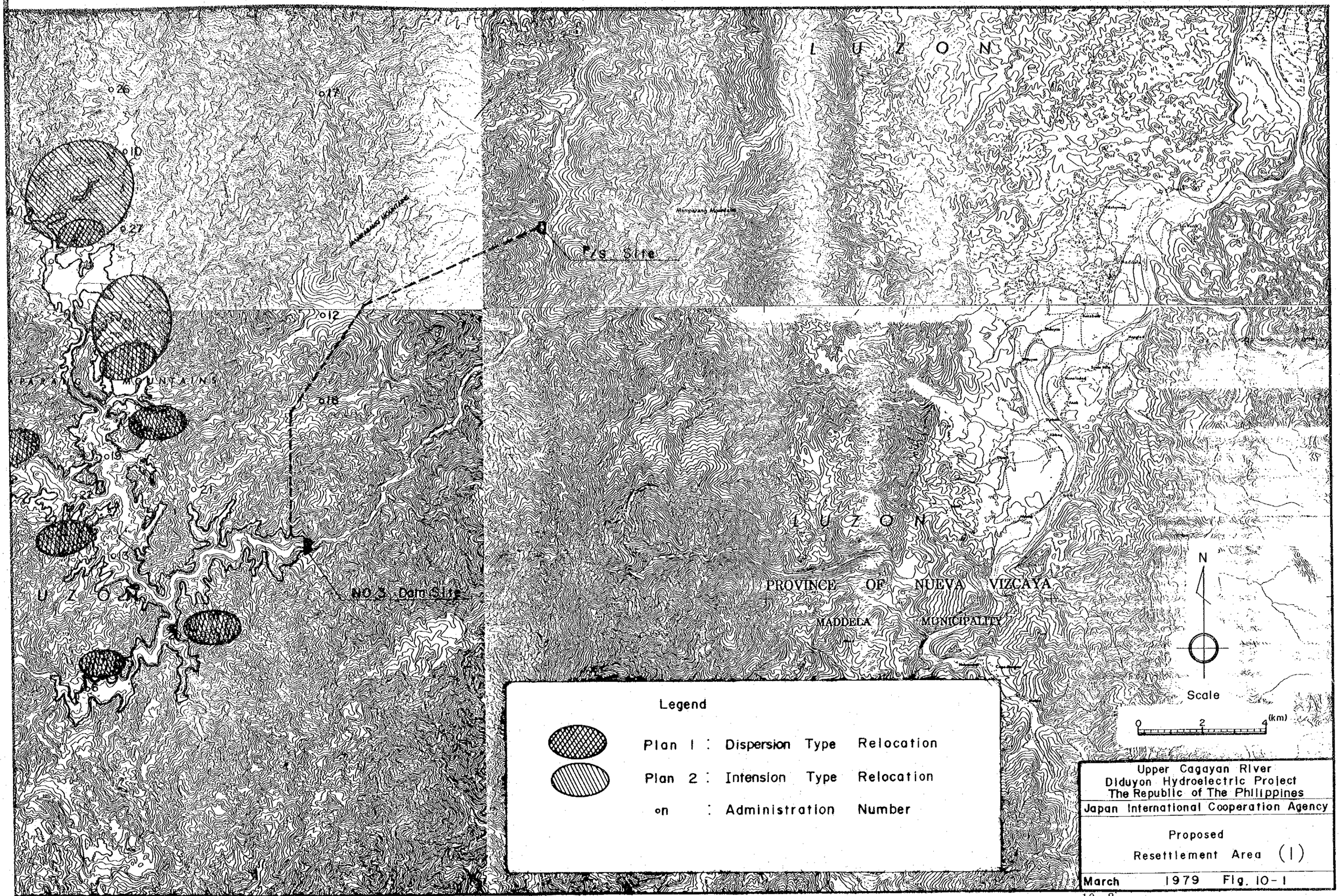

L U Z O N
Mamparang Mountains
F/S Site
MAMPARANG MOUNTAINS
PARANG MOUNTAINS
L U Z O N
PROVINCE OF NUEVA VIZCAYA
MADDELA MUNICIPALITY
No.3 Dam Site
N
Scale
0 2 4 (km)
Legend
Plan 1 : Dispersion Type Relocation
Plan 2 : Intension Type Relocation
on : Administration Number
Upper Cagayan River
Diduyon Hydroelectric Project
The Republic of The Philippines
Japan International Cooperation Agency
Proposed
Resettlement Area (1)
March 1979 Fig. 10-1

Fig. 10-2 Proposed Resettlement Area (2)