REPUBLIC OF THE PHILIPPINES

NATIONAL IRRIGATION ADMINISTRATION

FEASIBILITY STUDY
ON
THE MATUNO RIVER DEVELOPMENT PROJECT

VOLUME 1
MAIN REPORT

FEBRUARY 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

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FEASIBILITY STUDY

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PREFACE

In response to the request of the Government of the Republic of the Philippines, the Government of Japan decided to conduct a feasibility study on the Matuno River Development Project and entrusted the study to the Japan International Cooperation Agency (JICA).

Considering the importance of this project for the socio-economic development of the Philippines, the JICA despatched to the Philippines the first study team from January to March 1982 and the second study team from July 1982 to March 1983. The study took two years including these field surveys for 8.5 months and the work carried out in Japan.

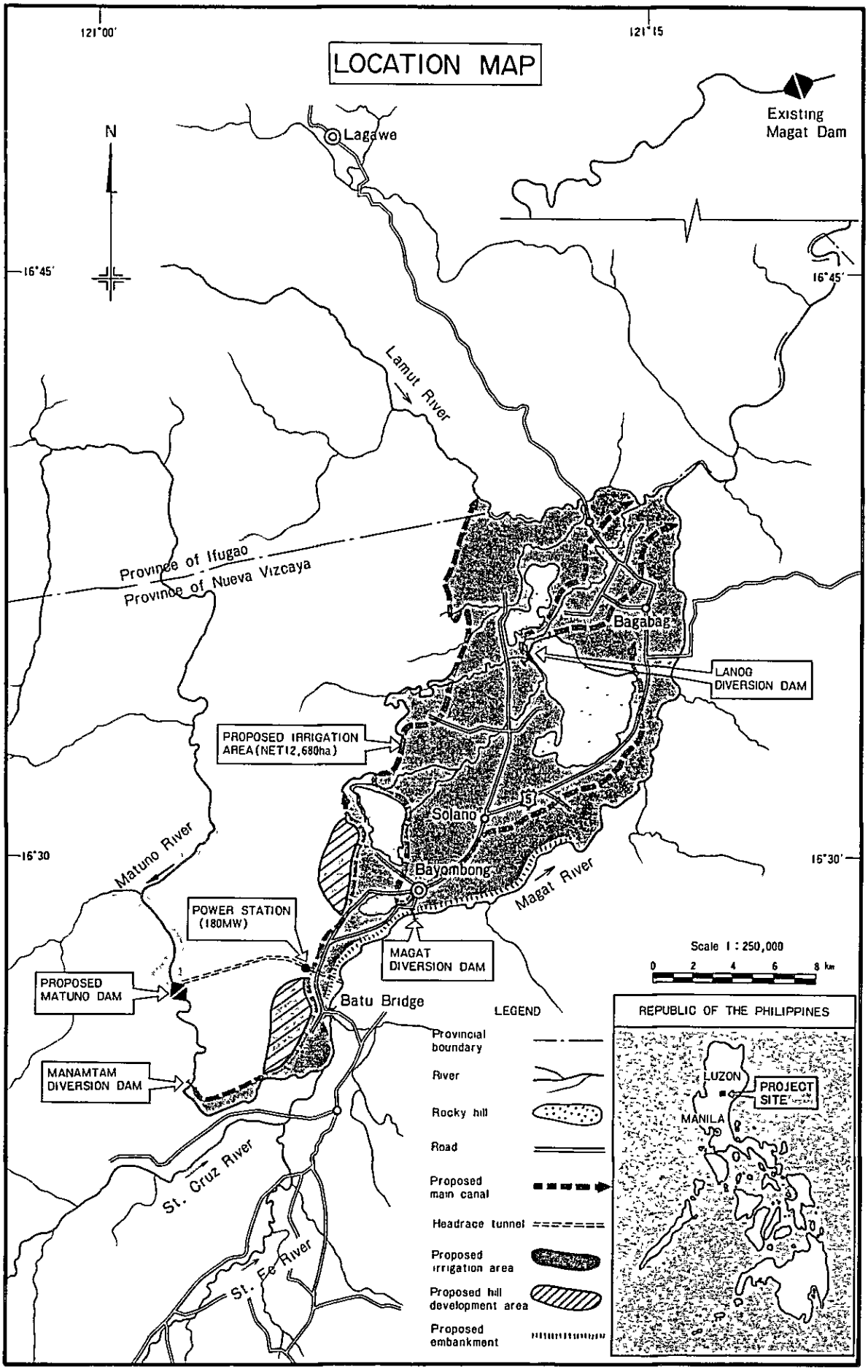
The study on the agricultural development plan was headed by Dr. Takashige Kimura (Chuo Kaihatsu Corporation), and the hydroelectric power development plan by Mr. Makoto Tsuda (Nippon Koei Co., Ltd.) with the participation of 26 Japanese consultants who had close cooperation of a number of Government officials of the Philippines. As a result of the above field surveys and the subsequent studies conducted in Japan, this report has been prepared.

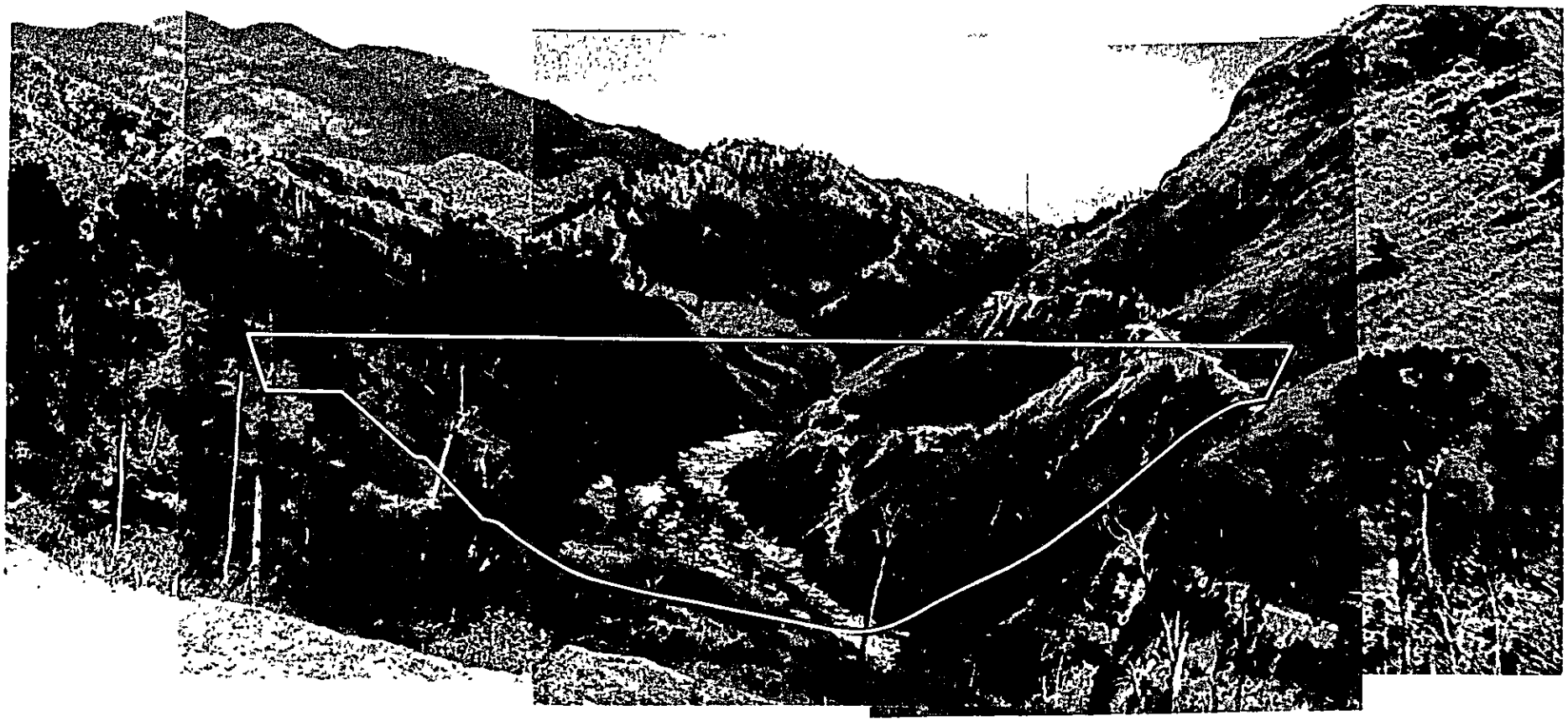
I hope that the report will serve for the economic and social development of Central Luzon and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the teams.

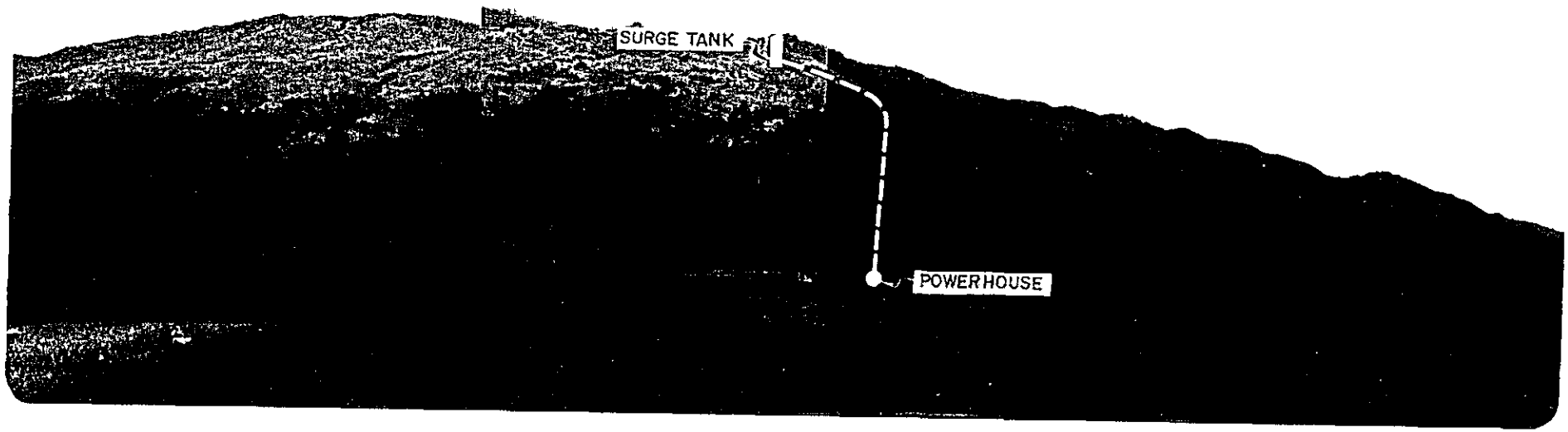
February 1984

KEISUKE ARITA
President,
Japan International
Cooperation Agency


LOCATION MAP
121°00'
121°15
16°45'
16°30
15°30'
N
Lagawe
Existing
Magat Dam
Lamut River
Province of Ifugao
Province of Nueva Vizcaya
Bagabag
LANOG
DIVERSION DAM
PROPOSED IRRIGATION
AREA(NET12,680ha)
Solano
Bayombong
Matuno River
Magat River
POWER STATION
(180MW)
MAGAT
DIVERSION DAM
PROPOSED
MATUNO DAM
Batu Bridge
MANAMTAM
DIVERSION DAM
St. Cruz River
St. Fe River
Scale 1 : 250,000
0 2 4 6 8 km
LEGEND
Provincial boundary
River
Rocky hill
Road
Proposed main canal
Headrace tunnel
Proposed irrigation area
Proposed hill development area
Proposed embankment
REPUBLIC OF THE PHILIPPINES
LUZON
PROJECT SITE
MANILA



VIEW FROM DOWNSTREAM SIDE ON B_1 - DAM SCHEME



VIEW FROM DOWNSTREM SIDE ON PENSTOCK AND POWER HOUSE SCHEME

SUMMARY, CONCLUSION AND RECOMMENDATION

A. SUMMARY

1. CONCEPTION OF THE PROJECT

This plan is defined as one of several projects included in the overall water resources development plan for the Cagayan Valley. In the 1960's a multi-purpose development plan entailing the construction of a dam was formulated for effective use of the water resources of the Matuno River, blessed with the most stable water flow among the branches of the Magat River. The Matuno River has a catchment area of 593 km^2 with an annual gross discharge amounting to 1,200 MCM, while its upstream area is situated in the Ambaguio mountain range covered with tropical rain forests.

As a number of suitable dam locations have been sited along the Matuno River, many tentative development plans were examined for feasibility by the government agencies concerned during the 1970's. In order to promote stable socio-economic development in Central Luzon and to generate greater employment opportunities for area residents, the National Irrigation Administration (NIA) proposed a dam plan, mainly for irrigation development, for the Bayombong Solano Basin, an area of about 20,000 ha suffering habitual irrigation water shortages. On the other hand, the National Power Corporation (NPC) was interested in a plan for hydropower development proposing a storage dam with a capacity of more than 600 MCM and more than 250 MW.

The schemes were conceived in the 1960's, a decade of aspiration and development throughout the world. The following decade, the 1970's, was one of trial and experiment during which concentrated efforts were made for concrete realization of such development plans. Development was hampered however, by various world events, particularly by the middle east war of October, 1973 which resulted in the first oil crisis. Many elaborate development projects were interrupted before full realization of their objectives, with only a few of superior quality selected for continuation.

In view of the above situation, the Government of the Philippines requested the Government of Japan to conduct a feasibility study for the Project in May, 1979.

2. BASIC POLICY OF THE SURVEY

In response to the above request, the Government of Japan sent a preliminary survey mission to discuss the scope of works and implementing arrangement for technical cooperation with the Government of the Philippines. As a result, both Governments agreed that a feasibility study (F/S) was necessary, focusing on construction of a multi-purpose dam as the main means for developing the water resources of the Matuno River.

At first, there were many opinions regarding the main emphasis of the multi-purpose dam, i.e. focus on providing a stable supply of irrigation water for agricultural development of the river basins, and focus on the development of hydroelectric power. Upon careful deliberation by both Governments, however, it was finally decided that the most effective approach for development of the Matuno River water resources was a 2-phase plan with both an agricultural development and an electric power development phase. The plan of each phase was to be reviewed and adjusted upon completion of field surveys.

In addition, it should be noted that during discussions with the said preliminary survey mission, NIA (executing agency) and NEDA expressed their hope for a realistic plan in due consideration of the recent financial condition of the Philippines.

Field surveys were consequently commenced in January, 1982 and completed in March, 1983 involving a total of 8.5 months. Since April, 1983, various data obtained and basic plans formulated during these surveys and studies have been examined and analyzed by the experts concerned, with frequent consultation and exchange of views. The result was unanimous agreement on procedure and the subsequent incorporation of plans formulated for the two sectors with their conclusions and recommendations for the same into a single report.

3. PROJECT APPROACH

For successful implementation in face of the present economic difficulties in the Philippines it is unrealistic to evaluate the Project in such a manner as to make execution of the feasibility study only in terms of EIRR while ignoring the investment involved. Despite the urgent need for development, any public project requring a large investment can be expected to intensify the burden on the national economy. In this report, therefore, the following four approaches are proposed to counter said difficulties, with due importance to be attached to each in Project formulation.

i) To select a project plan which will provide maximum effectiveness for minimum investment;

ii) To facilitate a multi-purpose project having geometrically proportionate effects rather than simple projects which are designed for only one effect (more-culture paddy irrigation projects);

iii) To give first priority to those areas of a plan in which objectives are most quickly realized, namely, introduction of stage development method; and

iv) To minimize project expenses as much as possible.

After evaluation according to the above-mentioned basic approaches, three alternative plans in each of the two fields of agricultural development and hydropower development were formulated. The plan subsequently selected as most appropriate was a composite plan including both of the above development fields.

4. STAGE DEVELOPMENT APPROACH

The Teams have selected the most effective project from among the various proposed alternative plans through detailed economic and technical studies. In February 1983 it was clarified that about US$420 million of investment would be required for this comprehensive project including agricultural, power and flood control components. Hydropower development will require US$370 million and the agricultural scheme will cost only US$54 million.

It seemed to the Teams that the above total amount is rather large to implement the whole project simultaneously taking into consideration the financial conditions prevailing now. This matter has been officially discussed among the parties concenred in March 1983, in which NIA suggested the Teams pay close attention to a stage development approach in order to mitigate the potential financial burden.

Since then further detailed economic evaluation studies have been made by the Teams. In July 1983 it was revealed that the power sector would obtain 14.1% of the internal rate of return with US$370 million investment which would create a US$43 million net incremental benefit, while the economic internal rate of return of the agricultural sector would be 18.9% with US$54 million investment and a US$9.04 million net benefit. Based upon this fact, NIA and the Teams agreed in the official meeting in August 1983 that the entire project shall be implemented in two stages to mitigate the heavy financial burden and to obtain earlier benefits for a rather small initial investment. From the above point of view, it was agreed that agricultural development should be implemented in the first stage with smaller initial investment and hydropower development in the second stage in succession. In that meeting NIA also suggested that even in the first stage of implementation some gradual phase development could be considered.

In this final report, therefore, the Teams made the utmost effort to formulate the Project in line with the above agreement and suggestions as stated hereinafter.

The outline of the stage development program is as follows:

Stage I aiming at agricultural development including flood protection, will commence from 1985 and be completed by 1990, covering 13,690 ha of benefited area.

Stage II aiming at sufficient water supply for irrigation as well as power generation and flood control, will be commenced from 1989 for the detail design and pre-project arrangement. The actual main works will be commenced from 1991 and completed by the end of 1995.

5. OBJECTIVE AREA

In establishing this plan, the Teams studied the Cagayan River area, the largest river in Luzon with the largest river basin in the Republic of the Philippines (27,000 km^2), This region, situated within a typical monsoon climatic zone, is a vast area of unutilized natural resources, in which the formation of social infrastructures, the development of the industrial sector, and the introduction of modern technology to agricultural and forestry industries have been delayed. Consequently the Project area, located in the center of Luzon, is gradually being depopulated despite the emphasis put on economic development and social stabilization of this region by national administration.

For survey outside the Project area, valuable data and advice were received from the Magat River Multi-purpose Project which will commence start-up operation in the near future. In addition, more data was obtained by a survey of the Santa Cruz and Santa Fe river basins which join the Magat River at the same point as the Matuno River.

6. PROJECT A REA

The Project in Stage I will include the following five municipalities and 55 barangays, with a total area of about 20,600 ha, an estimated 13,680 ha of which will be directly benefited.

Bagabag: : post town along National Highway No.5;

Bambang: base for shipping agricultural products out of the Province;

Bayombong: center of administration in Nueva Vizcaya;

Solano: center of commercial activities; and

Villaverde: oldest city in the area.

The Office of the Governor of Nueva Vizcaya is located in Bayombong, the province's administrative center, 270 km from Manila via National

Highway No.5. The paved National Highway No.5 provides access to and from Manila and, although most of the roads in the region are not paved, the above five municipalities and 55 barangays can be reached by vehicle except some localities in the rainy season.

7. PHYSICAL CONDITIONS OF THE PROJECT AREA

The Project area is a flat alluvial plain with a slope of 1/100-1/300 and an elevation of 200-300 m above sea level formed by the Magat River which flows in the southeast, while the northwest sector is composed of small river deltas having their water sources in the Colderela mountains.

The climate of the region has two distinct seasons, rainy season from June to November and dry season from December to May. The average temperature and humidityare 26°C and 84%, respectively, and, since the area is within a basin, temperature fluctuation between day and night is greater than that in coastal areas. This fact makes the area especially suitable for rice cultivation.

Average annual precipitation is 1,480 mm, one of the lowest rates in the Philippines. The higher reaches of the Matuno River are located in the Ambaguio mountains which receive annual precipitation ranging from 2,520-3,000 mm locally, approximately 85% of which occurs in the rainy season. As the Matuno River derives its water from this high precipitation area, harnessing of the same for hydroelectric power will be very effective. To ensure adequate water supply during the dry season, however a reservoir should be constructed to store surplus water during the rainy season.

Floods caused by the Magat River in the southeast portion of the area have recently been increasing. This phenomenon results from drastic soil and sand erosion by the Santa Fe and Santa Cruz rivers which collects in the Magat riverbed, and from rapid flood reaching time fevastated mountains. In particular, the accumulation of silt produced by the great flood in November, 1980 has been left untouched, increasing flood danger in the Bayombong area. Most farmers in Bambang Municipality are pressing for measures to counter floods caused by the Magat.

To eliminate floods caused by the Magat River, it is essential to establish a flood and sand control basin-wide program in the Santa Fe and Santa Cruz river basins in the future. However the construction of a dam on the Matuno River will contribute somewhat to flood control and also to store 350,000 m^3 of sediments per annum.

8. STUDY OF PRESENT STAGE OF AGRICULTURAL DEVELOPMENT

Present agricultural production in the Project area is predominantly single crop rice cultivation with upland fields found only in sandy loam areas along the rivers. Despite the fact that the Project area is located in a production center with a vast distribution area, it has failed to satisfy the area's demand for agricultural projects other than rice. Vegetable production within the area supplies only 30% of the demand, while quality and market value are low.

Although use of high yielding rice varieties has spread due to recent efforts made by the Ministry of Agriculture, cutbacks in fertilizer subsidies and lack of protection against Tungro Virus prevents efficient farm production. In spite of the latter however, the local farmers have succeeded in maintaining a 135% cropping intensity, which is almost equal to the national average in irrigated areas, using traditional irrigation methods passed down through the generations. In addition, the average cultivated area per household is 1.64 ha, slightly larger than the provincial average of 1.55 ha.

Present population increases and demands for improvement of the standard of living among farmers who do not own land have resulted in increased interest in double cropping and the introduction of each crops. Utilization of water resources and agricultural development in the area however, despite the availability of the Magat River supply with an average low water flow of 20 m^3/s throughout the year, is still insufficient at present.

9. AGRICULTURE DEVELOPMENT PLAN

(1) Selection of the Area

Of the 12,780 ha of arable lowland on the Magat River's left bank 12,680 ha will be subjected to irrigated agriculture while the remaining 100 ha of orchard is eliminated from the development plan. As for the western hill pasture land, 1,000 ha of the total 1,300 ha will be developed as an integrated agricultural program area.

(2) Proposed Land Use

Based on soil and land classifications, the Project area is divided into five blocks of flat lowland area and one block of upland area. The land in blocks 1 to 4 will be used predominantly for double paddy cultivation with some portion reserved for a triple cropping combination of rice and mung beans. Block 5 will be used for irrigated cultivation mainly of peanuts, corn and vegetables, while Block 6 will be used for re-development of pasture, and development of livestock, cashew plantations, and dendro forest plantations.

(3) Proposed Cropping Pattern

Under the project, cropping intensity of paddy is targeted for increase from the present 143% to 233%, while that for upland crops for increase from 97.7% to 200% by introducing intensive agricultural techniques. The overall cropping intensity will thus increase from the present 135% to 227%.

(4) Agricultural Extension System

A combination of seminars and instruction through personal visists is planned for extension of agricultural techniques. Accordingly, the area is divided into distribution blocks and a system organized which will, by moving the instruction center in order of priority and by establishing distribution sub-centers, cover the entire Project area.

(5) Net Incremental Benefit with Project

The net incremental benefit with Project is calculated as the difference between the net crop production with and without the Project. The net crop production in turn is calculated as the difference between gross crop production and crop production costs. The net crop production with Project is estimated at US$17.13 million while the amount without Project is estimated at US$6.03 million. With increased agricultural labor costs estimated at US$2.51 million, the net incremental benefit becomes US$8.~~95~~ 69 million.

10. WATER RESOURCES DEVELOPMENT

Water resources for the irrigation scheme were originally planned to be derived solely from an initially proposed dam on the Matuno River. However, completion of the topographical map (1/10,000) revealed that the benefited area was not as large as first expected and, consequently, dam construction costs per unit area might exceed the original estimate. Therefore, possible use of the Magat River in conjunction with the Matuno River was considered and an investigation of the same initiated.

Three alternatives for water resources development were formulated and subsequently evaluated in terms of effective agriculture and hydropower development. The selected plan as most appropriate involved construction of a dam for hydropower on the Matuno River with a 6 km tunnel to divert water into the Magat River and construction of diversion dams on both the Magat and Matuno rivers which would irrigate 11,590 ha and 1,090 ha respectively. Construction of a diversion dam on the Magat River will not only provide irrigation water but, at the same time, result in maximum benefits from the electric power scheme. Furthermore the proposed Matuno Dam ensures stable agricultural development in periods of severe drought which occur twice in a 20-year period. These diversion dams will accordingly continue effective service even after construction of the proposed Matuno Dam.

As irrigation water for the Lanog River downstream area can be effectively supplied by return flow, a diversion dam will also be

constructed on the Lanog and any shortage in return flow will be supplied by the Magat River source. The details of water resource facilities according to Stage I and II development are as follows:

Stage I

Name of Diversion Dam	Name of River	Length of Weir (m)	Height of Weir (m)	Irrigable Area (ha)
Magat diversion dam	Magat	305	1.6	11,590
Manantam diversion dam	Matuno	127	2.5	1,090
Lanog diversion dam	Lanog	35	1.8	(2,745) return flow area

Stage II

Name of Dam	Name of River	Crest Length of Dam (m)	Height of Dam (m)	Power Plant Installed Capacity
Matuno dam	Matuno	580	147	180 MW

11. IRRIGATION SYSTEM

(1) Irrigation System

Site investigations revealed that non-irrigated area in the Project area is 27% in the rainy season and 67% in the dry season. This condition results from inadequate intake and canal facilities. Efforts were therefore concentrated on developing a plan for most effective utilization of the existing system based on thorough site investigation. Equal distribution of water supply throughout the system and establishment of water management facilities where needed were duly considered. At the same time canal density is to be increased to 88 m/ha, making maximum use of the present density of 26 m/ha. The unit design discharge is 2.0 ℓ/s/ha.

(2) Proposed Organization for Water Management

Upon completion of construction, NIA will administer the diversion dams and the main/lateral canals, while the existing communal irrigators' associations will continue management of on-farm facilities as before. With the development of the association's maintaining and operating abilities in future, however, it is expected that NIA will be responsible only for diversion dams while the associations will effectively manage the entire canal systems.

A new organization for operation and maintenance was proposed based on study of 1983 data on similar projects throughout the country. Annual operation and maintenance cost was estimated at US$23.00/ha or 0.5% of total Project cost.

12. DRAINAGE CANALS AND ROADS

(1) Drainage Canals

Portions of natural rivers and creeks will be improved to function as the main and lateral drainage canals; however, on-farm canals are non-existant at present and must be newly constructed. Canal density will be increased from 10 m/ha to 40 m/ha to facilitate appropriate water control for cultivation.

(2) Roads

The low road density, less than 9 m/ha including national highways, hampers cultivation and harvest operations. In this Project, therefore, the main emphasis with regard to roads will be the construction of canal inspection roads, increasing the density to 42 m/ha.

13. FARMERS ORGANIZATIONS

(1) Communal Irrigators' Assocation (CIA)

75 Communal Irrigators' Associations are existing in the Project area. Of these, the Colocol Federal CIA has the largest irrigation area being composed of 30 small-scale communal irrigation systems along the Colocol Main Canal.

(2) Area Marketing Cooperative (AMC)

The Area Marketing Cooperative is organized by the Samahang Nayon, a farmers organization, as an associate agricultural communal cooperative. 113 Samahang Nayons are organized in the area with an enrollment of 8,310 farmers.

(3) Other Farmers' Organizations

Besides the said farmers' organizations, the Cooperative Rural Bank of Nueva Vizcaya is organized as a financing arm of Samahang Nayon and its members in the district. There are also 3 financial associations and 1 consumers' association in the Project area.

The Nueva Vizcaya Seeds Growers' Association is organized by 64 farmers who produce chiefly high quality seeds for rice paddies in an area of 135.5 ha. The Fishpond Operators' Association is composed of 103 members with a total fishpond area of 80 ha.

14. ON-FARM CONDITIONS

Field level irrigation and drainage canals in the Project area are either underdeveloped or non-existant. Improvement and expansion of these canals as well as the full provision of basic facilities are important Project tasks. The expenses required for this work are included in this Project costs under the assumption of force-account work by NIA.

15. PRESENT POWER SUPPLY CONDITION AND DEVELOPMENT POLICY

As of the beginning of 1983, the total installed capacity of power generating facilities connected with the Luzon Grid under NAPOCOR is 3,511 MW, of which 2,105 MW is oil-fired plants occupying 60% of the total, while hydropower plants provide 856 MW accounting for 24.4% of the total. The remaining 550 MW is from geothermal power plants which occupy 15.6% of the total.

The Philippines imports about 93% of her crude oil requirement from OPEC countries. The sky-rocketing of crude oil prices in 1974 and 1979 naturally makes power generating costs far higher than before as

oil-fired plants occupy 60% of total capacity. The higher prices of crude oil also caused more outflow of foreign currency required for imports. The Government of the Philippines, therefore, established the power development policy to convert from oil-fired plants to other indigenous energy resources, such as geothermal, coal, hydropower and dendropower resources. Along with this national policy, the NAPOCOR has established a 10-year power development plan for 1981-90.

The maximum peak power demand recorded in 1982 reached 2,364 MW. However, the dependable power supply capacity of Luzon Grid is 3,216 MW, which indicates a 848 MW surplus. The annual increasing rate of peak power demand before 1972 was more than 10% per annum, but it decreased to 6% after 1973. The energy demand also showed the same tendency, the rate of increase, which exceeded 10% before 1972 dropped to the level of 7% between 1973 and 1978, and sharply decreased to the level of 4% per annum after 1979. This lower demand increase is mostly attributable to the energy saving measures resulting from higher power tariffs and economic depression in the Philippines affected by the world-side slump.

The annual load factors in Luzon Grid during recent years were very stable at about 70%. This high, stable load factor is attributable to the fact that 24-hour continuous industries consume much higher power than daytime factories. The high power demands for home cooking and cooling also make the hourly fluctuation smaller.

The average plant factor of the existing hydropower plants during recent years is 33.3%. In the Matuno Project, the selected installed capacity of power generating equipment was 180 MW which is three times the annual average of 60 MW. Even if the present load factor of 70% drops due to some demand, the Kalayaan pumped storage power plant has a potential extension of up to 1,800 MW in total. In addition to the Magat hydropower plant (540 MW in total) to be put into commission by the end of 1984, there are many promising hydropower projects left for future development in Luzon. Therefore, the future peak power supply will be sufficient for development of the same.

16. PRESENT REGIONAL POWER DEMAND AND CHARACTERISTICS

The Luzon Grid can be divided into three major regions according to main transmission lines, namely Metro Manila Area, Northern Luzon Area and Southern Luzon Area. In 1982, the Metro Manila Area, the largest demand center in the Philippines, consumed 9,747 GWh out of the total of 13,081 GWh in Luzon Grid occupying about 75% of the total. Northern Luzon consumed 2,683 GWh, accounting for about 20% of the total, while Southern Luzon consumed only 651 GWh, equal to 5% of the Grid. As for power generation, the three regions have quite different characteristics as mentioned below.

Only the Southern Luzon Area has much surplus power, generated mainly by two geothermal power plants, namely, Tiwi and Mak-Ban. Due to very low demand in this area, surplus energy of 2,644 GWh was transmitted to Metro Manila and Northern Luzon in 1982.

On the contrary the Northern Luzon area has most of the major hydropower plants such as Ambuklao, Binga, Angat, Pantabangan, etc. Still, its energy supply capability is not enough to suffice the consumption demands in this area. In 1982, deficit energy of 107 GWh was transmitted from Southern Luzon or Metro Manila. In particular, the storage capacity of hydropower plants is insufficient to fully regulate the seasonally fluctuating natural run-off. It is normal to send surplus power to the Metro Manila Area in the rainy season while the deficit power in dry season is compensated by the Metro Manila Area.

The Metro Manila Area, equipped with major oil-fired plants, has sufficient installed capacity to meet energy consumption, but use of oil-fired plants are being stopped as much as possible by power supply from the other two regions in order to save high oil costs.

When the first stage of the Magat Hydropower Plant is completed by the end of 1983, about 1,100 GWh will be generated by four units of 90 MW generators which will compensate all deficit in the Northern Luzon Area and annual surplus energy will be transmitted to Metro Manila. The same will make possible the abolition of the three old 60 MW oil-fired generator units in the Rockwell Power Plant in Metro Manila as scheduled in the NAPOCOR's 10-year development plan.

17. PROSPECT OF MATUNO HYDROPOWER DEVELOPMENT

As mentioned in Paragraph 15, the power demand shows a dull increase in recent years. Consequently, present dependable power supply capacity has a reasonable stand-by reserve. The 10-year power development plan for 1981-90 established by NAPOCOR paid reasonable attention to the demand trend and the priorities of various power projects in line with the national policy.

It is quite reasonable to give the highest priority to geothermal and coal-fired plants to save on diesel oil consumption of oil-fired plants and thus to enable savings on foreign currency required for imports of oil.

However, from the long-range viewpoint, the present dull demand increase would not always last so long, because industrialization up to the level of self-sufficiency in domestic consumption commodities should be achieved sooner or later in order to save on imports. Exports heavily depending on the primary goods, such as agricultural, forestry, fishery products, etc., can not earn enough foreign currency to import required manufactured goods. Therefore, the dull power demand increase will be recovered within several years with re-activiation of the world economy.

Not only the industrial power demand, but also the domestic power demand will further increase with the increase of national income. The present development of power supply networks connect only the major cities and towns while distribution lines to the local villages are lacking. Local demands are still in the latent stage. This fact was well proved by the fact that when the distribution lines were extended by the Nueva Vizcaya Electric Power Cooperative after September 1981, the previous power demand of only 450 kW rapidly increased to 2,300 kW within five months and to 2,970 kW by November 1982. The same tendency was also clearly observed in Mindanao Grid. When the transmission lines were extended to many towns in Mindanao in recent years, the consumption increased by about 12% per annum. One strong reason for the rapid demand increase is that the power tariff was lowered after NPC transmission lines were connected with the cooperative diesel generators.

NAPOCOR is now making the utmost effort to extend the main and secondary transmission networks even between Luzon-Layte-Mindanao. It is anticipated that the expansion of distribution lines will follow in the 1990's due to the limits of time, manpower and finance.

The mountain areas in Luzon are blessed with much rainfall, suitable geology and topography for storage dams. The storage dam with hydropower plant is very effective for various purposes, such as irrigation water supply, flood control, silt deposit control, and power generation without air pollution. In addition, it contributes to fresh water fisheries and recreation for the people. Therefore the high merits of hydropower development will not be reduced but will be increased in future.

The hydropower project with a high storage dam has the following disadvantages compared with other thermal power plants.

i) Initial investment is considerably large in amount.

ii) Land acquisition and compensation for the required lands involve complicated social problems.

iii) Required construction period is as long as 5 or more years compared with 2 or 3 years for thermal plants.

It is therefore reasonable for the government to give the higher priority to geothermal and coal-fired power plants in order to save oil as soon as possible. However, from the long range view point hydropower development is indispensable for the following reasons:

i) Peak power supply can be easily met by hydropower plants.

ii) Easy operation with far less outage.

iii) Immediate increase or decrease of power supply to meet load fluctuation is easily accomplished.

iv) No air pollution.

v) Long economic life of civil works and power generating equipment.

In the case of the Matuno dam and hydropower development, it is advisable to implement the same as Stage II works succeeding agricultural development in the Stage I in order to mitigate the heavy financial burden. Also it is most realistic to develop the power sector between 1991 and 1995 in consideration of present power supply and demand trend as well as the future expansion of distribution lines as discussed herein above.

18. INVESTMENT COST FOR STAGE I DEVELOPMENT

Investment costs for Stage I development are calculated according to current prices and costs as of May, 1983.

Major Item	Construction Cost (10^3 US$)		
	F.C.	L.C.	Total
1. Civil works	18,267	13,830	32,097
2. Land acquisition	-	698	698
3. O & M equipment	530	300	830
4. Engineering & administration	2,396	1,316	3,712
5. Physical contingency	2,119	1,615	3,734
Direct Cost	23,312	17,759	41,071
6. Price contingency	5,525	7,471	12,996
Grand Total	28,837	25,230	54,067

Note: Price escalation factor is assumed at 5% for F.C., 8% for L.C., US$1 = 10 Peso = ¥240

19. ECONOMIC AND FINANCIAL EVALUATION OF STAGE I DEVELOPMENT

(1) Economic Evaluation Criteria

The criteria for economic evaluation are as follows:

i) Economic life: 50 years (1991-2040)

ii) Construction period: 6 years including detail design

iii) Benefit:

Agricultural

Partially realized before Project completion with total target benefit to be attained after a two year build-up period.

Flood Protection

Benefit: projected benefit will be attained immediately after completion of Project.

iv) Economic cost and benefit are based on current prices as of May, 1983.

(2) Evaluation of Agricultural Benefit

Agricultural benefit is evaluated based on the annual net incremental benefit of agricultural production between "with" and "without" Project. Estimated net incremental agricultural benefit is US$8.59 million per annum. In addition the annual benefit created by flood protection is estimated to be US$0.75 million, making the total benefit to be US$9.34 million. But in the transition period between Stage I and II, negative benefits of US$0.15 million in power generation may happen in the downstream Magat Project. And before completion of Matuno dam, annual average negative benefit of US$0.15 million occurs due to a little deficit of irrigation water. Therefore, the net annual benefit during 5 years between Stage I and II is estimated to be US$9.04 million. However upon the completion of the Matuno Dam it will again recover to US$9.34 million because the above negative benefits will be compensated by increasing flow from Matuno Dam.

(3) Economic Cost

In order to standardize the economic cost of Stage I development with the benefit calculation, the shadow rate was adopted and the cost was converted to the border price. Accordingly, taxes and price contingency were excluded. As a result, the estimated economic cost is US$35.2 million.

(4) Internal Rate of Return

The economic internal rate of return is 18.9%, which shows that irrigated agricultural development and construction of river embankments is economically feasible.

20. SENSITIVITY ANALYSIS

Economic sensitivity of Stage I development was analysed based on the following conditions:

Case	EIRR (%)
1. Benefit decrease by 20%	15.6%
2. Cost increase by 20%	16.2%
3. Delay of construction by 2 years	16.4%
4. Simultaneity of above cases 1 & 2	13.3%

From the results obtained, the Project is assumed sufficiently viable in the event of the above mentioned economic changes.

21. FINANCIAL ANALYSIS

To evaluate the financial feasibility of the Project, farm budget analysis of the average farm household in the Project area was conducted, and accordingly, capacity to pay of the same per year after Project completion and consequent attainment of production increases is estimated at US$846.6. This increase in capacity to pay is sufficient to enable the farmer to bear the irrigation fee providing incentive for participatation in the proposed development.

22. SOCIO-ECONOMIC IMPACT

Project implementation is expected to have the following socio-economic impact.

(1) Increased Employment Opportunities for Local Residents

Due to the substantial increase of agricultural production, employment opportunities in the fields of transport, warehousing,

rice milling, and marketing will increase. Moreover, through practical experience gained, the workers' technical knowledge in each field may be enhanced. The various techniques and skills learned through the Project are expected to be multilaterally utilized in the future development of the region.

(2) Expansion of the Scale of Local Economy

Increased agricultural production will also result in increased supply of capital goods and the expansion of the scale of the agricultural market. This in turn will increase wages and profits, as well as consumption and savings. Future capital investment will be stimulated by savings, expanding the scale of the economy of both the area involved and neighboring areas and affecting both farmers and non-farmers alike.

(3) Contribution to Securing Sources of Revenue for Public Investment

The expansion of local economy will increase tax revenues, which can then be appropriated for public utilities increasing sources of revenue for public investment.

(4) Foreign Currency Savings

Increased annual rice production after Project completion is expected to reach about 57,300 tons. The remainder, or 39,900 tons, obtained by subtracting the amount to be locally consumed from increased production, is presumed marketable, resulting in a foreign currency saving equivalent to US$7.8 million.

23. INVESTMENT COST FOR STAGE II DEVELOPMENT

Dam and hydropower development in Stage II will require a total investment equivalent to US$370 million estimated at current price levels as of May, 1983. This includes US$46.0 million for interest paid during the construction period and US$51.5 million as a contingency for future price escalation. The net direct construction cost therefore is estimated to be equivalent to US$272.5 million including about 10% of the physical contingencies.

The details of the total investment cost are tabulated on the following.

Major Item	Construction Cost (10^3 US$)		
	F.C.	L.C.	Total
1. Land acquisition & compensation	-	2,000	2,000
2. Civil works			
2-A. Dam & spillway	89,277	44,443	133,720
2-B. Civil works for power	35,911	20,562	56,473
3. Generating equipment	25,280	6,527	31,807
4. Physical contingencies	15,047	7,353	22,400
5. Engineering & administration	16,700	9,400	26,100
Direct Cost	182,215	90,285	272,500
6. Price escalation	30,000	21,500	51,500
7. Interest during construction	17,000	29,000	46,000
Grand Total	229,215	140,785	370,000

As the above table shows, a total foreign currency of US$229 million will be required. This figure accounts for about 62% of the total construction cost.

The annual price escalation rate for the foreign currency portion is assumed to be 5% per annum and that for the domestic currency to be 8% per annum. The annual interest rates during the construction period are assumed to be 4%, 8% and 12% for foreign currency for civil works, foreign currency for electro-mechanical works and local currency, respectively.

The annual fund requirement is tabulated in the following table:

	Required Funds (10^6 US$)					
	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total
F.C.	19.2	28.3	44.8	47.5	88.5	228.3
L.C.	21.3	17.7	24.6	30.9	47.2	141.7
Total	40.5	46.0	69.4	78.4	135.7	370.0

24. ECONOMIC AND FINANCIAL EVALUATION OF POWER SECTOR

The Matuno dam and hydropower facilities have a planned installed capacity of 180 MW which will generate 528 GWh/year. The energy output consists of 353 GWh of firm energy and 175 GWh of secondary energy.

As explained in detail in Chapter VI in this report, the annual gross benefit amounts to US$45.06 million equivalent, with a US$1.97 million equivalent operation and maintenance cost. Therefore the net incremental benefit is estimated at US$43.09 million equivalent.

Assuming the economic life of this Project to be 50 years, the economic internal rate of return is calculated at 14.1% for power benefit alone. This fact in itself demonstrates the economic feasibility of the Project.

The financial analysis mentioned in Chapter VI presents the financial internal rate of return as 7.2%. The total capital and interest of the loan can be fully repaid after 22 years from the completion of the Project. The analysis also shows that the cumulative profit after 50 years will amount to US$649 million equivalent, again illustrating the feasibility of hydropower development.

25. IMPLEMENTATION OF THE PROJECT

(1) Operating Agency

NIA is charged with development during the first stage and NPC during the second stage under the jurisdiction of the National Water Resources Council.

Prior to commencement of construction work a Project Office is to be established which will subsequently function as the "Operation and Maintenance Office after construction completion.

(2) Construction Plan

1st year (1984): Pre-project preparation (see Chapter VII) RECOMMENDATIONS) including funding arrangement

2nd year (1985): Pre-project preparation, detail design, etc.

3rd to 7th year (1986 & 1990): Construction work for Stage I development

6th & 7th year (1989 & 1990): Detail design and funding arrangement for Stage II development

8th to 12th year (1991 to 1995): Construction work for Stage II development

13th year (1996): Commencement of power generation

B. CONCLUSION

(1) Socio-economic development and stabilization of Central Luzon and Nueva Viscaya Province are important for the nation as a whole. The Matuno River development plan will result in 180,000 kW of hydropower generation as well as in agricultural development through irrigation of 12,680 ha out of 20,600 ha in Bayombong-Solano basin which presetly suffer chronic water shortages. These two accomplishments will in turn become the basis for economic development in the region, increased farm income and stabilization of the standard of living for area residents.

(2) Provision of the capital investment required for simultaneous implementation of such a multi-purpose project however, (estimated cost: US$474 million) would be difficult under present economic conditions in the Philippines. It was judged therefore, that the most economic and immediately effective approach whould be a stage development plan, Stage I, implementing agricultural development including construction of river embankments and Stage II, the construction of a dam and hydropower development.

(3) In Stage I, the agricultural development plan, traditional paddy cultivation will be developed into irrigated double cropping throughout the entire Project area by means of provision of two diversion dams and related facilities which enable a sufficient and stable irrigation water supply. At the same time, to increase farm income, the plan includes a) formation of cashew nut plantations, b) promotion of a dendroforest industry through planting of ipil-ipil, and c) livestock farming with dairy cattle, etc., utilizing the western hill area. Also the improvement of post-harvest facilities is proposed for comprehensive development. This development plan directly benefits the local residents and economy and thereby is given first priority among the two stages.

(4) Stage II entails the construction of a 147 m rockfill dam at site B_1 on the Matuno River with a 6 km pressure tunnel connecting it to the 180,000 kW power plant in the Bayombong foothills. The

water used in power generation will then be discharged to the Magat River via a tailrace to the proposed Magat Diversion Dam. As a result, the proposed reservoir will fully provide supplemental water for agricultural development. It can also be expected that the proposed reservoir will reduce the design flood at the damsite from 10,300 to 6,800 m^3/s and mitigate the rising of riverbed elevation caused by sediment deposite which average 350,000 m^3/year.

(5) Flood control by the Matuno dam alone will not, however, be sufficient to completely protect the Bayombong and Solano areas from flood damage, unless inflow of silt and flood waters from the neighbouring Santa Fe and Santa Cruz rivers shall be controlled. For the time being therefore, embankments should be constructed along a 13.5 km portion of the Magat River's left bank to protect the above areas from flood damage and mitigate the effects of large floods which occur at a 50-year return period. The construction costs for such embankments have accordingly been included in Stage I of the development plan.

(6) Total Project Cost for agricultural development including the construction of embankments was estimated at US$54 million and those for hydropower development at US$370 million.

On the basis of economic analysis, estimated EIRRs for agricultural and hydropower development were 18.9% and 14.1% respectively. As for the financial analysis, farm budget analysis for the average farm household showed that the farmers' earnings would be significantly improved by agricultural development even with additional irrigation fees. On the other hand, EIRR for hydropower development was estimated at 7.2%, with completion of payment of the principal and interest within 22 years.

Total EIRR for the multi-purpose development plan was estimated at about 15.7% suggesting the sound financial feasibility.

(7) Based on the above described study, the proposed multi-purpose development plan is judged as fully and practically feasible from technical, economic and social viewpoints.

C. RECOMMENDATIONS

(1) From submittal of this report (March, 1984) until the commencement of construction work, it is recommended that NIA will investigate and collect data on construction equipment and material cost, hydro-meteorological records, etc., for the preparation of detailed design.

(2) Rain gauges and water level gauges installed by the Team and NIA in the Magat and Matuno river basins should be periodically inspected to obtain reliable data.

Long term investigation of back sand effects of the Magat dam should be conducted at appropriate locations up and downstream of the confluence of the Magat and Lamut rivers, and a profile and cross-sectional survey of the riverbed along the reaches is strongly recommended.

(3) To encourage participation of local beneficiaries in the Project area, preliminary explanations should be made and in such a manner as to be easily understood. To this end, introductory pamphlets should be prepared at an early date, after consideration of the opinions of leading members of the local CIA.

(4) Although existing Communal Irrigation Systems was investigated, the survey was not sufficient. It is recommended therefore that the PIO, on the basis of the attached 1/10,000 area map, conducts a more detailed survey, including at least demarkation of existing systems and the canal alignment including on-farm ditches of the same.

(5) Field surveys by the Team indicate that only 13% of the farmers in the Project area are owner cultivators, a lower percentage than anticipated. This data should be carefully checked and reviewed by NIA along with the figures for landless farmers.

(6) The 1/4,000 and 1/10,000 topographical maps prepared in cooperation by NIA and the Team should be utilized for the detail design. But

the present 1/4,000 maps are incomplete for the detailed design. Therefore it shall be fully improves by aerophotos or by additional on-site surveys.

(7) NIA officials will have to be well prepared in water management skills and technical knowledge in order to transmit the same to area farmers. NIA officials are therefore preferably to be instructed through on-farm training.

(8) For smooth Project implementation, it is desirable to establish a Project Execution Committee consisting of both private and public sectors. This Committee shall coordinate the various Government organizations concerned and push the Project implementation in consideration of trends in the national economy in the Philippines when promoting the Project and thus appreciative of the local farmers position.

(9) As most of the Cadastral maps of the area were prepared in the 1920's, the soonest revision is preferable. Such maps will in turn be indispensable for future land aquisition and designing of on-farm facilities.

(10) Before commencement of the detailed design of dam and hydropower facilities for Stage II in 1990, additional detailed surveys and investigations are necessary in the areas of topography, geology, construction materials, etc. in 1989.

(11) The results of the feasibility study on the hydropower sector presented herein, should be reviewed once more in 1989 to up-date price fluctuations occurring in the intervening period.

(12) As aforementioned, construction of the recommended Matuno dam and embankments alone cannot effect complete flood control unless sediment runoff and flood waters of the Sta. Fe and Sta. Cruz rivers are also sufficiently controlled. It is recommended therefore that, in future, flood and sediment control studies be conducted for the said river basins.

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ABBREVIATIONS AND UNIT

NIA	National Irrigation Administration of Philippines
JICA	Japan International Cooperation Agency
MOE	Ministry of Energy
NEA	National Electrification Administration
NAPOCOR (NPC)	National Power Corporation of Philippines
MERALCO (MECO)	Manila Electric Company
NUVELCO	Nueva Vizcaya Electric Cooperative, Inc.
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
MPWH	Ministry of Public Works and Highways
US$	United States Dollars
₱	Philippine Pesos
FC	Foreign Currency
LC	Local Currency
EIRR	Economic Internal Rate of Return
FIRR	Financial Internal Rate of Return
O & M	Operation and Maintenance
L.F.	Load Factor
AMSL	Above mean sea level
EL.	Elevation in m AMSL
W.L. (WL)	Water level in m AMSL
H.W.L. (HWL)	High water level in m AMSL
L.W.L. (LWL)	Low water level in m AMSL
F.W.L. (FWL)	Flood water level in m AMSL
D.F.W.L. (DFWL)	Design flood water level in m AMSL
mm	millimeter
cm	centimeter

m	meter
km	kilometer
m^3	cubic meter
km^2	square kilometer
ha	hectare
m^3/sec (CMS)	cubic meter per second
m^3/sec month	Water volume equivalent to the discharge of 1 m^3/sec for the duration of 1 month
kg	kilogram
t (ton)	metric ton
l	liter
%	percent
^oC	degree centigrade
o	degree (angle or temperature)
N	north latitude
S	south latitude
rpm	revolution per minute
Hz	Hertz (cycles per second)
kcal	kilocalorie
kV	kilovolt
kVA	kilovolt ampere
MVA	megavolt ampere
W	Watt
kW	kilowatt
MW	megawatt
kWh	kilowatt hour
MWh	megawatt hour
GWh	gigawatt hour
V	Volt
BTU	British Thermal Unit

CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

1.1 Authority

This report is prepared in accordance with the Implementation Arrangement for the feasibility study on the Matuno River Development Project as agreed upon by the Government of the Philippines and the Government of Japan in October 1981.

This report presents the results of field survey, the findings on the upper Magat River basin of Nueva Vizcaya Province, Central Luzon Island. As water resources development is the main objective of the envisaged Project, the report examines, synthesizes and presents a concrete regional development plan in light of the present socio-economical conditions of the Philippines in a feasible, realistic approach. Finally, this report presents economical and financial justification of the Project.

1.2 Project History

The Five-Year Development Plan (1978-82) of the Philippines emphasized development of the agricultural sector which plays a major role in national economy. The plan also stressed the need for an overall development program especially in depressed areas such as the Cagayan Valley.

In response to the above plan, National Irrigation Administration (NIA) has targeted 1.8 million ha for irrigation expansion as set out in the Five-Year Irrigation Development Plan. In this plan, the Matuno Project is ranked among those with highest priorities.

The basic Project concept envisages comprehensive development of the upper Magat River basin, Cagayan Valley through construction of a multi-purpose dam (irrigation, hydropower and flood control) on the Matuno River, a tributary of the upper reaches of the Magat River.

The fundamental outline of the Project was formulated initially by NIA during the 1960's, at which time the Matuno River was recorded as a highly favorable site for dam construction. Based on the recognition of the importance of the early project implementation, the Government of the Philippines requested the Japanese Government to provide technical cooperation in the form of a feasibility study in May 1979.

In response to the request, the Japanese Government offered technical assistance in the form of the feasibility study as part of the technical cooperation program. Japan International Cooperation Agency (JICA) dispatched a preliminary investigation mission to the Philippines in March 1981 to discuss the approach to the feasibility study with the Philippine Government.

On the basis of the mission's report, JICA recommended that the feasibility study be approached from two inter-related angles; i) agriculture and, ii) hydropower development, finally to be formulated into one integrated project of the optimum scale. Based on this recommendation and the subsequent concurrence of the Philippine Government, JICA dispatched a mission headed by Mr. T. Yoshimitsu, Director of Himi Irrigation and Drainage Project Office, Hokuriku Regional Agricultural Administration Bureau, Ministry of Agriculture, Forestry and Fisheries, to discuss and conclude the Implementation Arrangement for technical cooperation in October 1981.

Following Implementation Arrangement, JICA dispatched two feasibility study teams, one for agriculture and one for hydropower development, to the Philippines in January 1982. Both the Teams completed interim reports after formulation of the development plan on the basis of survey, investigation and study, and submitted the same to the Philippine Government in February 1983.

In the course of the presentation of the Interim Report, NIA strongly requested that a staged development plan which synthesized agriculture and hydropower development be formulated. Upon return to Japan, the Teams reported to and obtained the concurrence of agencies concerned within the Japanese Government with regards to NIA's proposal and subsequently prepared this report.

1.3 Objectives of Study and Summary of Scope of Works

The purpose of the study is to formulate a feasible plan for development and effective development of the water resources of the Matuno River, upper branch stream of the Magat River, and the planning of river basin development. Accordingly, the feasibility study contains two major objectives as given below:

(1) to formulate a multi-purpose development project considering various potential development components such as agriculture, hydropower and flood control and to evaluate the feasibility of the Project, and

(2) to undertake training of Philippine counterparts in the course of the survey and study, both in the Philippines and Japan.

Works undertaken by the Team include field and office works in the Philippines and office works in Japan as shown below:

(1) Field Works

a. Collection and analysis of existing data and information
b. Reconnaissance survey of general conditions in the Project and surrounding area
c. Meteorological, hydrological, topographical and geological investigations
d. Soil and land use survey
e. Water resources survey
f. Inventory survey of present irrigation and drainage facilities and their uses
g. Agriculture and agro-economy survey
h. Flood damage survey
i. Power market survey
j. Socio-economic survey

(2) Office Works in the Philippines

Scope of office works in the Philippines are listed below.

a. Study on agricultural development plan
b. Study on irrigation development plan
c. Study on flood control plan
d. Study on hydropower development plan
e. Study on optimum use of water resources
f. Preparation of a multi-purpose development plan

(3) Office Works in JAPAN

Scope of office works in Japan are listed below.

a. Review of Interim Report submitted upon completion of works in the Philippines
b. Formulation of multi-purpose development plan for agriculture, hydropower and flood control
c. Preliminary design and cost estimate
d. Economical and financial evaluation
f. Recommendations

1.4 Activities of Study Team

(1) The first survey was conducted from January 18 to March 18, 1982. Prior to actual field survey, the Team discussed the plan of operation with officials concerned and on that basis prepared an inception report. The inception report was submitted to NIA on January 22, 1982, and the plan of operation was basically agreed during meetings held at the same. In the course of the meetings NIA requested the Team to formulate a realistic development approach.

(2) On the basis of information obtained through the first survey, the scope of works was reviewed and subsequently presented within the Field Survey Report along with the major conditions of the Project area as found by the Team. The Field Survey Report was submitted to NIA on March 16, 1982 prior to the JICA Team's departure from the Philippines.

(3) The second survey was conducted from July 4 to September 1, 1982. This survey placed particular emphasis on the site conditions during the rainy season.

(4) The third survey was conducted from October 22, 1982 to March 5, 1983. At the last stage of services in the Philippines, an Interim Report was prepared and submitted to NIA on February 25, 1983. During discussions between the Team and NIA the development concept was explained, and the basic project formulation was subsequently agreed by NIA.

(5) After arriving in Tokyo, the Team commenced to prepare the draft final report. In mid-July 1983 when the outline of the development plan was established, the Team together with the Supervisory Group of the Government of Japan visited Philippines and discussed the said development plan and program with NIA. All the parties concerned agreed to formulate this Project as one integrated project and to formulate in two stages for the actual implementation, namely agricultural development in Stage I and power development in Stage II in consideration of the financial conditions.

(6) The Team prepared a draft final report in line with the above formulation policy. The draft was discussed in Manila in December 1983 among the Team, Supervisory Group, NIA, NPC and MPWH. The several comments were raised by the Philippine Government side, which were reported and discussed among the Ministries of the Japanese Government concerned. This final Feasibility Report was thus prepared with revisions for those comments and submitted at the end of February 1984.

(7) All the names of staff members concerned in the Team, Philippine Government and Japanese Government including the Supervisory Group are listed in the attached Table 1 with deep appreciation and respect.

CHAPTER II

PROJECT BACKGROUND

CHAPTER II

PROJECT BACKGROUND

2.1 Population and Land Area

The total population of the Philippines in 1980 was 48,098,000, with a 2.86% average annual population growth rate from 1975-80. The total land area of the nation is 290,386 km^2, with a population density of 166 persons/km^2.

The Philippines is composed of 47 provinces. In terms of administration, the country consists of 13 regions, namely, the National Capital Region (Metropolitan Manila) and Regions I through XII. Administratively, the Project area belongs to Nueva Vizcaya Province, Region II. As the following table shows, the population of Region II as of 1980 is 2,215,000, with an area of 34,645 km^2, and a population density of approximately 64 persons/km^2, which is the lowest regional density in the country. The population of Nueva Vizcaya Province is estimated at 242,000 inhabiting an area of 3,904 km^2. This is equivalent to approximately 10.9% of the population and 11.3% of the total area of Region II, or a population density of about 62 persons/km^2 which is also one of the lowest in the Philippines.

	Population ('000)	Area (km^2)	Density (persons/km^2)
Philippines	48,098	290,386	165.6
Region II	2,215	34,645	63.9
Nueva Vizcaya Province	242	3,904	61.9

Source: 1982 Philippine Statistical Yearbook (NEDA)

2.2 Gross Domestic Product

The Gross Domestic Product (GDP) of the Philippines in 1981 was 313,563 million Pesos (97,256 million Pesos at 1972 prices), or 1.9 times as large as the GDP of 42,448 million Pesos (51,014 million Pesos at 1972 prices) for 1970. After 1981 however, the annual growth rate declined to 3.7% following still further to 2.6% in 1982.

The annual average growth rate in the agriculture, forestry and fisheries sector over the last 10 years is 4.3% which is lower than the overall average as indicated in the table below (Industrial and service sectors are 36.6 and 38.0% respectively in 1981). Percentage of GDP shared by this sector in 1981 with regard to the total was slightly over 25%, showing a slight decline in comparison with 28.9% prevailing in 1970.

Gross Domestic Product

Million Pesos (1972 Constant Price)

Industry	1970	%	1981	%
Agriculture, Fishery and Forestry	11,782 (14,834)	28.9	79,706 (24,722)	25.4
Industrial Sector	12,581 (15,048)	29.5	114,710 (35,579)	36.6
Service Sector	18,085 (21,232)	41.6	119,147 (36,955)	38.0
Gross Domestic Product	42,448 (51,014)	100.0	313,563 (97,256)	100.0

Source: 1982 Philippine Statistical Yearbook (NEDA)

2.3 Labor Force

As the following table indicates, in 1978, the potential labor force of the country was estimated at 17,363,000, with 16,668,000 employed. The number of unemployed workers was 695,000 persons, an unemployment rate of 4.0%. This indicates a decrease in the unemployment rate, from 2.5% in 1976.

('000)

Year	Employed		Unemployed		Total Labor Force
	Number	Percent	Number	Percent	
1975	14,517	95.8	643	4.2	15,161
1976	14,238	94.8	780	5.2	15,018
1977	14,323	95.5	671	4.5	14,994
1978	16,668	96.0	694	4.0	17,363

Source: 1982 Philippine Statistical Yearbook (NEDA)

Analysis of the following table shows that the number of persons employed by major industry in the Phillippines evidences that the agriculture, fisheries and forestry sector absorbs 8,702,000 of the work force, or approximately 52% of the total. The total number of persons employed in Region II is 798,000, with 589,000 absorbed by the same sector, corresponding to approximately 74% of the total Region's work force. The percentage of workers absorbed by this sector in the Region is thus much higher than the national average, indicative that the major industry of Region II is agriculture, fishery and forestry.

('000)

	Agriculture Fisheries & Forestry	Other Sectors	Total	Percentage
Philippines	8,702	7,966	16,668	52.2
Region II	589	209	798	73.8

Source: 1982 Philippine Statistical Yearbook (NEDA)

2.4 Agricultural Production

The nation's total harvested area in 1980 comprising various crops was 12,123,400 ha, with paddy representing 3,503,000 ha, or 29% of the total, while commercial and other crops represent 32% and 39% respectively (see following table). Paddy production was 7,504,400 ton, corresponding to 25% of total production. Income from paddy production totaled ₱8,030.8 million equivalent to 21.4% of the total value of all agricultural production.

Crops	Area Harvested (1,000 ha)	Quantity (1,000 t)	Value (₱1,000,000)
Paddy	3,503.0	7,504.4	8,030.9
Commercial Crops	3,905.9	7,970.3	14,396.0
Other Food Crops	4,714.5	14,080.1	15,102.5
Total	12,123.4	29,554.8	37,529.4

Source: 1982 Philippine Statistical Yearbook (NEDA)

The production of paddy in 1970 was 5,233,400 tons, with an average yield of 1.681 t/ha. Total production and yield fluctuated during the first half of the '70s, but from 1975, these two parameters present a trend of constant increase. In 1980, total production of paddy in the country was 7,504,400 tons, while the average yield was 2.142 t/ha. The following table clearly depicts this trend.

Crop Year	Area Harvested (1,000 ha)	Production (1,000 t)	Average Yield (t/ha)
1970	3,133.4	5,233.4	1.681
1975	3,538.8	5,660.1	1.599
1976	3,579.3	6,159.5	1.721
1977	3,547.5	6,456.1	1.820
1978	3,508.9	6,894.9	1.965
1979	3,468.9	7,197.6	2.075
1980	3,503.0	7,504.4	2.142

Source: 1982 Philippine Statistical Yearbook (NEDA)

Statistical data regarding production of paddy in the various regions (see following table) indicates that in 1980 the harvested area of Region II was 369,600 ha, with a production of 785,600 tons, while the nation as a whole was 3,133,400 and 6,718,800 tons respectively. The average yield was 2.13 t/ha, which is practically the same as the average yield prevailing in the country as a whole (2.14 t/ha).

	Area Harvested (1,000 ha)	Production (1,000 t)	Average Yield (t/ha)
Region II	369.6	785.6	2.126
Other Regions	3,133.4	6,718.8	2.144
Total	3,503.0	7,504.4	2.142

Source: Bureau of Agricultural Economics

2.5 Food Demand and Supply

In the early '60s, during the so called "Rice Crisis", the food supply situation in the Philippines was critical. In the period from 1963-65, annual rice imports increased from 250,000 to 570,000 tons. After this period, technical renovations like the development and extension of high yield varieties, application of fertilizers, etc., were introduced in the agricultural sector. As a result rice imports were not required in 1968.

In the early '70s, production of paddy in the Philippines declined due to unfavorable weather conditions and the spread of disease and insects, and rice imports were once again resumed. Annual rice imports in the period from 1973 through 1975 ranged from 360,000 to 460,000 tons. However, since 1976 the trend of the rice demand and supply seems to be gradually stabilizing. This trend is mainly due to the steady increase of average yield which was brought about by the expansion of irrigated area enthusiastically developed since the 70's.

In the on-going review of the Ministry of Agriculture, future rice consumption per capita is estimated at 95.0 kg for 1987 against 92.5 kg in 1982, with an increase rate of 0.5% per annum. Generally, per capita food consumption is directly correlated with income; as income increases, the level of food consumption also increases. In the Five Year Development Plan of the Philippines (1983-87), future estimated caloric consumption per capita will increase to 2,264 Cal in 1987 from 1996 Cal in 1982 at the rate of 2.55% annual growth. In addition, based on an annual growth rate of 2.6%, the Philippine population, 48.7 million in 1981, is projected to reach 53.7 million by 1985 and 60.7 million by 1990.

Regionally speaking, the demand and supply of Regions IV, V, VII, VIII, X, XI and National Capital Region (Metro Manila) are presently rice deficit areas.

On the supply side, estimated production is extremely sensitive to irrigated area, cropping intensity and yield levels. Cultivated rice area in 1981, was about 3.12 million ha including 1.23 million for irrigated area.

Average cropping intensity in national irrigation systems for the last five years is about 132%. Palay yield levels as of 1979 are 2.6 t/ha in irrigated areas, 1.60 t/ha in rainfed areas and 1.20 t/ha in upland areas. Estimated total rice supply in 1981 was 3.9 million tons. The same is projected to reach 5.1 million tons by 1985 and 6.2 million tons by 1990. Annual rate of increase in supply for this period is targeted about 4.9%.

Consequently, rice demand and supply of the Philippines is gradually proceeding towards stabilization by recent government endeavors. The steady expansion of rice production, however, is still a major subject against recent unstable weather conditions such as typhoon, drought, etc, in addition to population increase and alimentation improvement.

2.6 Electric Power Supply and Demand

The major agencies for electric power supply are National Power Corporation (NAPOCOR or NPC), National Electrification Administration (NEA) and Manila Electric Company (MERALCO or MECO) under the administrative control of the Ministry of Energy (MOE). The organizations of NEA and NAPOCOR are shown in the attached FIG. 1 and 2.

The MERALCO is responsible for power distribution in Metro Manila area and NEA is responsible to electrify the rural areas which are isolated from the Luzon Grid of NAPOCOR. The NAPOCOR, Government-owned corporation, is responsible for all other power generation, transmission and distribution through the transmission line networks all over Philippines.

The total power generating capacity in January 1983 under the Luzon Grid is 3,511 MW, out of which 60% is supplied by oil-fired plants, 24.4% by hydropower and 15.6% by geothermal plants. The location of power plants and the Luzon Grid are shown in the attached FIG. 3.

The annual load factors in recent years are very stable as high as 70%. The hourly load variation and the duration curve are shown in the attached FIG. 4 and FIG. 5 of the weekday and sunday respectively. The highest peak demand in the past is 2,364 MW.

The energy consumption in 1982 in three major region under the Luzon Grid has a quite different characteristics, namely, the Southern Luzon consumes as little as 651 equal to only 5% of the Grid total, while Metro Manila consumes 9,747 GWh, about 75% of the total, and the Northern Luzon 2,683 accounting for 20%.

The Metro Manila, the largest demand center, received 2,537 GWh surplus from the Southern Luzon area which was generated by geothermal power plants in order to save oil consumption for oil-fired plants in Metro Manila area. Northern Luzon area, although equipped with major hydropower plants, has an annual shortage of 107 GWh supplemented from the Southern Luzon area.

However, the power shortage of Northern Luzon area will be solved by the completion of Magat hydropower plant first phase equipped with 360 MW at the end of 1983. The annual electric energy of about 1,100 Gwh to be generated by Magat first phase will not only suffice the power shortage in the dry season in Northern Luzon area, but also the surplus will be transmitted to Metro Manila area, which will make possible to abolish the three old units of 60 MW oil-fired generators in the existing Rockwell power plant in Metro Manila.

As mentioned above, the present dependable power supply capacity of 3,216 MW has enough reserve to the peak demand of 2,364 MW recorded in 1982. However, the present power supply is mostly limited within major cities and towns connected by the transmission line networks. Many other small towns and villages are not yet connected with the networks. Those high latent demand will come up to the surface when enough extension of transmission and distribution networks is realized in near future.

2.7 Economic Development Plan

The Five-Year Development Plan (1983-1987) of the Philippines establishes the following national development goals;

i) sustained economic growth;
ii) equitable distribution of development benefits; and,
iii) total human development.

An overriding concern of the development program is to increase participation in productive and gainful activities. The employment opportunities generated by development will represent a maximum of 4%. The Kilusang Kabuhayan at Kaunlaran or livelihood program (KKK) was planned as a major scheme for achievement of these goals. However, the annual growth rate has dropped year by year to 5.4% in 1980, 3.7% in 1981 and 2.6% in 1982. Therefore a rational economic policy and firm resolution are required to achieve the projected targets of the present Five-Year Development Plan.

To achieve an upward trend in economic growth, it is necessary that viable investments are made on reasonable and feasible projects. If large investments are made on less feasible projects, the national economy will immediately aggravate. Therefore, any project that falls in the former catagory requires immediate attention.

2.8 Government Policy for Agriculture Development

The Ministry of Agriculture is in the process of decentralizing its activities under P.D. 803 which orders agencies to transfer decision making to provincial offices. The Ministry's approach to decentralization is by way of integrated area management. The regional government accordingly owes obligation and responsibility for the development plan. The initial step taken by the Ministry is to select six depressed areas, and six productive areas as pilot schemes.

The general goals of the Ministry for the next 10 years are to increase and stabilize income and to improve nutrition through improvement of food quality. In order to attain these national goals the Ministry is attempting to:

i) improve the farming system;
ii) enforce an integrated approach;
iii) strengthen farmers associations;
iv) integrate financing structures; and,
v) increase nutrition education.

To this end, the Ministry plans to coordinate all the concerned private sectors, whether individuals, groups or institutions. The government for its part is concerned with moblizing appropriate technology. Since the staple food of the Philippines is still rice, the main efforts of the Ministry are being focused on this crop.

In this connection, the government has developed the so called 'Intervention Program' aimed at attaining an increase in rice production and permanent self sufficiency. This objective is expected to be acheived by price incentives for rice and corn.

2.9 Government Policy for Power Development

The energy development policy, in response to the drastic rise in oil prices in 1979, aims to develop indigenous energy sources, such as geothermal, coal, hydro and dendropower, wherever possible, thereby reducing oil imports. With in the framework of this national policy, NPC established the 10-year power development plan for 1981-90 and is thereby concentrating its efforts on expansion of geothermal power generation as first priority and coal-fired plants as its second priority. Hydropower development, despite its environmental advantages and multi-purpose utilization, is given only third priority due to i) high initial investment, ii) longer construction period, and iii) difficulty of resettlement for inhabitants of land submerged under the reservoir area.

It is inevitably required to convert urgently from the oil-fired plants to geoghermal and coal-fird plants in order to save the foreign currency requirement jumped up by price-hike of oil.

The 10 year power development program from 1981 established by NPC envisages development of energy resources, stressing development of geothermal, coal and hydropower in the order of geo coal hydro. NPC projects that the annual growth rate of peak power demand for 1981-85 will be 7.8% gradually decreasing to 7.0% for 1986-90, according to the past trend of growth. This range of growth seems resonable considering present nation-wide economic stangnation for the time being. At present the NPC is paying much effort to expand the main and secondary transmission lines to connect many islands urgently needed. However, in 1990's, expansion of rural distribution lines will be much required.

2.10 Regional Sectoral Development Plan and Review

The implementation of the overall plan and the various schemes under each sectoral development program on the regional or provincial level is closely interrelated with the proposed Project. These plans involve the participation both of government agencies and private

sectors. In some sectors however, government participation in the implementation plan is more dominant at the regional level as may be noted from the discussion below:

1) Irrigation

In Region II, there are 8 medium-scale national irrigation projects and Magat River Project in the area, however, no particular medium or large-scale implementation plan in the Nueva Vizcaya Province is projected or on-going except the proposed Project.

2) Agriculture

Among the various development plans in Region II, the most important are the Masagana 99 and Mainsagana programs. From a view point of agricultural policy, the Government promotes agricultural structure improvement projects consisting of agriculture deversification including vegetable production. The establishment of Land Settlement Package II by the Ministry of Agrarian Reform in the Quirino province involving 40,000 ha is particularly related to the socio-economic activities of the Project.

3) Power and Reservoir

Several power and reservoir development projects in the region are included in the portfolio of NPC, NEA and NIA.

4) Infrastructure

Among the many on-going projects in Region II and the Project province, major plans for the development of infrastructure include the Fifth IBRD Highway Project extending 182 km, Pangasinan-Nueva Vizcaya Road Project (69 km), and the Provincial Water Supply III Project. The two former projects are under the implementation of MPWH while the latter is under LWUA.

5) Social Services

The present portfolio includes the on-going major social services scheme in the region, "Hospital Development for Region I and II". Other related schemes in the area are nationwide programs dealing with development of such areas as telecommunication technology, nutrition and health.

6) Industries

There are no specific development programs or industrial schemes presently on-going or proposed in the region which have any direct relation to the Project. However, various national and local government agencies are now promoting many projects which aim at developing forest products, commerce and agro-industries.

CHAPTER III

P R O J E C T A R E A

CHAPTER III

PROJECT AREA

3.1 General Features

3.1.1 Geographical Location

The Project which covers a gross area of about 20,700 ha, is located in the center of the northern part of Nueva Vizcaya Province in Region II. The Project area includes 5 municipalities: Bagabag, Villaverde, Solano, Bayombong and Bambang with a total of 55 barangays as tabulated below.

Municipality	Total Barangays	Barangays in Project Area
Bagabag	16	15
Villaverde	8	6
Solano	18	18
Bayombong	15	14
Bambang	23	2
Total	80	55

As can be noted from the above all municipalities, except Solano, are only partially covered by the Project area. The provincial headquarters of Bayombong is located about 270 km north of Manila along Highway No. 5.

The Project area is bounded on the north by the Lamut River which separates it from Ifugao Province and on the east by the Magat River which traverses the province from south of Aritao to Bagabag. The Magat River separates the area from the Sierra Madre Range. The southern part of the Project is partially bounded by the Magat River and the Matuno River, and the lower portion of the Cordillera Mountains, while the western portion is bounded by the Cordillera Mountain Range.

The Maharlika Highway (National Highway No. 5), a first class road, traverses the area from Bayombong to Bagabag in the north. In addition, the area is serviced by all-weather access roads.

3.1.2 History

Before the arrival of Dominican missionaries in 1609, the Project area belonged to various native tribes. On May 28, 1672, Ibung, the first town in the area was founded by Father Juan Villaverde. Later, in 1767, Solano was established by a Spanish Dominican Missionary, Friar Alejandro Vidal. Native inhabitants of the region were the Gaddanges, a tribe whose ancestors originated from Cagayan and Isabela. Other native settlements were also established, those of the Ifugaos along the Lanog and Lamut rivers, and those of the Ilongots in the hills east of the Magat River.

Nueva Vizcaya Province was originally a part of the Cagayan Velley. In 1839, Governor Luis Lardizabal issued an order designating Nueva Vizcaya as a Politico-Militar province. The order was approved by a Royal Decree on April 10, 1841. However, actual civil government authority was not operative untill 1902 when the Philippine Commission was organized.

In 1856, a large portion of Nueva Vizcaya's northern territory was ceded to the newly established province of Isabela. Upon establishment in 1908 of the province of Ifugao, Nueva Vizcaya's northwest territory was ceded resulting in further reduction of area. The same was again reduced by a survey executed by the Bureau of Land in 1914 by the Administration Code of 1917, and finally by the passage of Republic Act. No. 6394 on September 10, 1971, when its sub-province, Quirino was given independent provincial status.

3.2 Physical Conditions

3.2.1 Topography

The Project area includes both hilly area in the Matuno River basin, and low flatland in the Magat sub-basin agricultural development area extending along the left bank of the Magat River, as shown in the attached location map.

The rugged mountains of the Matuno River basin range in elevation from 600 m - 2,700 m with comparatively good vegetation cover. The Matuno River first flows northward and then turns southward through the proposed dam site and the surrounding mountains, exiting near Manamtam at the southern edge of the Project area. The Matuno subsequently converges with the Santa Cruz and Santa Fe rivers at Santo Domingo to form the Magat River. The Magat River courses northeast ward from this point creating a broad floodplain across the alluvial lowland along the left banks to Bayombong and Solano after the Batu bridge, finally joining with the Lamut River.

The proposed agricultural development Project area is located on the alluvial lowland of the Magat River sub-basin, with an elevation range of 210 m - 320 m along the Magat River. Total area of the sub-basin is approximately 150 km^2. The area is predominantly agricultural land except for a few urban areas and sporadic low hills, while the western edge of the Project area is saddled by hills and mountains.

3.2.2 Meteorology and Hydrology

The Project area is located at a latitude of 16°30' North and longitude of 121° East with a typical monsoon climate. The area is seriously affected by the southwest monsoon between May and September, and the northeast monsoon from the Pacific between October and December. The weather of the Project area, except the unbalanced annual precipitation distribution, is suitable for agriculture.

The yearly average temperature is 26.1°C, with a maximum average of 29.9°C in April and a minimum average of 23.5°C in December. The yearly average humidity is as high as 84.5%. The annual average wind velocity is minimam with the maximum monthly average in November at 0.86 m/s and the minimum of 0.51 m/s in June. However, the maximum instantaneous wind velocity exceeds 60 m/s during the typhoon season.

The average annual pan-evaporation is 1,884 mm, with the maximum monthly average recorded in April at 205 mm and the minimum in December at 103 mm.

Average rainfall over the period of 1956 - 76 is 2,520 mm in the Matuno River basin at the proposed dam site, while that in the agricultural development area is as low as 1,480 mm. Monthly rainfall varies yearly, but 75% of the total annual rainfall falls between May and October.

The catchment area of the Matuno River is 593 km^2 on convergence with the Santa Fe River. According to the Bante Gauging station records (catchment area 558 km^2) downstream from the proposed dam site, the yearly average discharge observed over a 20-year period (1957 - 76) is 37.9 m^3/s. Monthly maximum average discharge is 60.8 m^3/s in October and minimum average discharge is 17.40 m^3/s in April.

The Magat River has a catchment area of 1,784 km^2 at the Batu bridge and a yearly average discharge of 68.7 m^3/s based on an average of 17 years from 1960 - 76. Monthly maximum average discharge is 110.6 m^3/s in September and minimum average discharge is 27.1 m^3/s in April.

The above information indicates that the Matuno River basin is a rich water resource which warrants maximum exploitation.

3.2.3 River and Flood Condition

(1) The Magat River which flows along the Project area, gathers flow from the Matuno, Santa Cruz and Santa Fe rivers. Passing the Batu bridge close to the southern edge of the Project area, the Magat River flows 35.2 km through the Project area down to its northern edge.

In this area partial banking, breakwater and a revetment have been constructed by The Ministry of Public Works and Highways (MPWH) along the trunk road and urban area. However, no river channel plan has been established. Therefore, this area is often affected by floods occurring at the unbanked sections or agricultural water intakes. In addition, direct discharge from the mountain side at the north edge of the Project area and insufficient drainage result in storage type floods.

Data on previous floods concerning flood area, water level, flood period and amount of damage is scarce. According to site interviews, rapid inuncation and depletion is typical which damages public facilities more than agricultural product or general property.

The Matuno River sub-basin has the richest vegetation cover sub-basins on the other hand are waste land having heavy deposits of sand and gravel from upstream. Although not quantitatively expressed, MPWH's 1980 Annual Report indicates that the Magat River bed is rising yearly resulting in larger scale floods. The effect of the back sand of the Magat reservoir in the downstream reaches will have to be studied whether it may affect the flooding in the Project area in a long range of coming years in relation with the above silting.

(2) After careful analysis of the field studies, damageless discharge at Batu bridge of the Magat river was analyzed at 2,000 m^3/s. On the other hand, the damage amount was estimated at 18 million Pesos based on the actual damage caused by Alying Typhoon, a flood discharge estimated at 3,600 m^3/sec.

3.2.4 Geology

Geologically, the Project area is composed of sedimentary and intrusive rock of post Cenozoic Tertiary formation, as shown in the geological map of APPENDIX I-II. The mountainous part of the Matuno River basin is made up of widely distributed conglomerate and sandstone of Miocenic Natbang formation. This formation has a cover of nonconformable limestone of the Macde formation in the lower basin area as well as near the mountain summits along both banks of the Matuno River.

The bedrock of the proposed dam site is conglomerate and the river bed is covered by deposits a maximum of 15 m thick. The fresh part of the rock is massive and hard. Although it has a slightly high permeability due to open cracks, the rock is judged suitable for the dam foundation.

As shown in the attached geological map, the geology of the Matuno river basin is mainly composed of Tertiary sedimentary rocks, such as sandstones, conglomerates, limestones, etc. with some intrusions. The dominant facies of the Natbang Formation in the Matuno river valley is conglomerate which contains gravels of andesite, porphyrite, chert limestone and slate, round or sub-round, a few millimeters up to 20 cm in diameter. The matrix is hard to moderately hard, fine to medium silty sandstone in some layers and grit composed of coarse angular particles in the others.

The Macde limestone is located in the heigher parts of the mountains in this river basin mostly in the level higher than EL.900 m overlying unconformably the above Natbang conglomerates.

As for the foundation of the "A", "B1" and "B2" damsites all the foundation rocks are composed of hard to moderately hard conglomerates. The river bed is normally covered with river deposit consisting of illsorted round gravels and cobbles with sand. Their gravel sources are the Natbang conglomerates and the Macde limestones. The thickness of those river deposits is normally in the range of 10 to 15 meters with a several maters weathered rock layer underneath. Those conglomerates are normally massive and hard enough to support the proposed dams safely although some parts where cracks previal requires sufficient treatment.

As for the dam foundation for B1 damsite, the conglomerates are generally hard and in good quality judged from the boring cores because the core recovery by boring is almost 100% except bore hole No. BB-8 which has very many cracks. Most of cores taken by boring are as long as 20 to 30 cm and the longest core is 60 cm. The weathered layer overlying the above fresh rock formation is generally thick in a range of 5 to 10 meters with many cracks, but it can be improved by consolidation grounting to have enough bearing capacity against the dam.

The alignment of surge tank-penstock-power house is extensively covered with thick talus deposits and slope-washes from the limestone ridge at the top of the slope. Some rare outcrops are only of andesite, hard but frequently jointed. The foundation of the penstock line is

hard but frequently jointed. The foundation of the penstock line is mostly composed of hard tuff and also the surge tank site is composed of the same fresh tuff as confirmed by boring No. BP-4 and BP-5. The power house site is composed of moderately hard andesite as boring BP-3 clarified. Those rock layers were also confirmed by seismic exploration as mentioned below.

The seismic exploration made for the surge tank-penstock-power house alignment revealed the existence of the following four layers:

Layer	Velocity Range (km/sec.)	Materials Interpreted
First Layer	0.3 - 0.5	Top soils
	0.6 - 0.7	Residual soils
Second Layer	0.8 - 1.0	Talus, Sand & Gravel or heavily weathered rocks
Third Layer	1.6 - 1.8	Weathered rocks, consolidated Talus or Sand and Gravel
Fourth Layer	2.4 - 2.6	Fresh pyroclastic rocks, tuff or weathered andesite
	3.0 - 3.4	Fresh rock formation, mainly andesite

Those fresh rock formations, although deep, assure the safe foundation for penstock line and power house without any trouble.

The geology along the proposed tunnel alignment was judged by ground reconnaissance and aerial photographs. It is presumed that the upper half of about 4 km in length would pass through the hard to moderately hard Natbang conglomerates. It suggests no difficulty for tunnel excavation, sometimes without steel supports. But the lower 2 km part beyond the major North-South fault will pass through soft tuff with many joints, suggesting heavy support requirement all through. The major fault part, probably several tens meters, will require most carefull works, such as sufficient draining facilities to be prepared before cross excavation.

The proposed reservoir area to be submerged is so thickly covered by natural jungle without so heavy cutting of trees that it is judged that no large scale land sliding may happen except some minor ones of overburden. At present some land slides of top soil layers are seen at several places on the steep rock cliffs but not the scale of endangering the dam and other structures.

As for the agricultural development area pyroclastic rock of the Eocenic Caraballo Group and intrusive diorite from the Oligene to Eocenic erase is distributed in hilly and flat areas. Formations are covered by Pleistocene to Holocenic terrace, talus and river deposits. Terrace deposits are very stable and most economically suitable for the structural foundation of the proposed Magat Diversion Dam while river deposits on the other hand, are planned for use in the Manamtam Dam. In both cases, some problems of permeability must be considered during the detail design stage of the Project.

The proposed canal route skirts the mountains of the Magat subbasin flowing along the slopes of isolated hills. The said route may be categorized into two areas, one composed of talus deposits and one of alluvial plain. Construction of the canals and canal structures will present no major problem. However, some quantity of limestone boulders and rock excavation at the foothills may happen within the Project area. Suitable drainage may be required during excavation of alluvial plain for canal construction.

3.2.5 Soil and Land Classification

(1) The left bank of the Magat River, Project area has 5 soil series; the Prenza, Bago, Maligaya and San Manuel series in the lowland area and the Guimbaloan series in the hill area.

Of these, the Bago, Maligaya and San Manuel series, which consist of alluvial deposits, generally form flat plain. The San Mannel series, which appears around Santo Domingo, has a fairly high permeability and is suitable for vegetable and corn farming. The Bago and Maligaya series have a low permeability and are widely

spread throughout the Project area. This soil is suitable for rice cultivation. The Prenza series, which consists of alluvial fan terrace deposits, is distributed at higher elevations around La Torre and Uddiawan. Soil reaction of the above 5 series is weakly acidic, while their cation exchange capacities and organic matter content are high. As the chemical characteristics of the soil are highly suited to rice production, high yeilds may be expected.

The Guimbaloan series, which covers the hill area, consists of tuff and has a high organic matter. At present, the area covered by this soil is used for pasture. The land froms a 5 - 10% slope interupted by gully erosion. This land could potentially be planned as orchard once irrigation systems, etc., have been completed.

The area covered by each soil series is shown below:

Soil Series	Area (ha)	Percentage (%)
Prenza Clay Loam	3,060	16
Bago Sandy Clay Loam	2,920	15
Maligaya Clay Loam	5,180	27
San Manuel Clay Loam, Sandy Loam	2,550	13
Guimbaloan	4,150	22
Others	1,440	7
Total	19,300	100

(2) Land Classification

Land is classified as follows in accordance with NIA standards based on USBR standards.

Land Class	Area (ha)	Land Class	Area (ha)
Arable		Non-arable	
1 R	9,625	Class 6	4,250
2 R	895	M - land	1,440
3 R	-	Right of way	605
Sub-total	10,520		
1 R (?)	1,360		
2 R (2)	135		
Sub-total	1,495		
2	795		
3	130		
Sub-total	925		
4 or	100		
4 P	-		
4 F	-		
Sub-total	100		
Total	13,040	Total	6,260
GRAND TOTAL			19,300

Characteristics of each classification are; 1R - areas highly suitable for irrigated rice with no soil, topography or drainage constraints (74% of flat area); 2R - areas scattering around hills, suitable for irrigated rice cultivation with little constaints of soil, topography and drainage.

Class 1R (2) and 2R (2) are areas which will be suitable for irrigated rice and diversified crops upon improvement, while class 2 and 3 are areas subject to flooding. 40R presents land suitable for orchard of which there is a potential 100 ha in the Project area.

3.2.6 Present Land Use

Of the total Project area (20,600 ha), 19,300 ha is lowland extending from the left bank of the Magat River and 1,300 ha is upland located at the west end.

Total arable land in the lowland area is 13,040 ha (67%) which includes 11,050 ha of paddy (57%), 1,890 ha of diversified crops including corn (10%) and 100 ha of orchard (0.5%). Non-arable land includes 4250 ha (21%), 1,440 ha of residential area (7%) and 605 ha of right of way (4%).

Irrigated paddy is 9,505 ha out of a total 11,050 ha of paddy. Due to the shortage of irrigable water however, most of the area is not perenially irrigated. Main diversified crop is corn without irrigation.

Arable land is divided into five (5) blocks according to present land use as follows:

Block 1

The areas of Bagabag, Sta. Lucia and Pieza which severely lack water are mainly composed of rainfed paddy and corn cropped areas.

Block 2

The areas of Bintawan and Villaverde lie at the foot of the mountain. Paddy is irrigated by local creeks but water supply is insufficient.

Block 3

The areas of Bayombong and Solano have the most productive irrigated paddy in the Project area served by the Colocol Communal Irrigation System.

Block 4

Santo Domingo and La Torre are paddy areas.

Block 5

The areas along the banks of the Magat, Lamut and Lanog rivers are suitable for diversified crops.

3.2.7 Present Water Use

Surface and groundwater in the Project area and vicinity is used for irrigation and domestic supply. In general, however, water supply is unreliable due to insufficient facilities. Present water resources for irrigation are surface water from the Magat, Matuno and Lanog rivers, Apad Creek, related tributaries which flow into the Project area from mountains as the west end and groundwater.

Althrough, surface water is supplied to 73 Communal Irrigation Systems (CIS), many do not receive timely or adequate supply. The reasons are as follows: unstable water intake by brush dam; drying up of tributaries in the mountain at west end during dry season; and, incomplete or deteriorated water distbitution facilities. Conditions related to lack of irrigation water supply are given in detail in 3.4.7.

Groundwater is used for pump irrigation systems in Bagabag and its vicinity. The area served by this method is 1,250 ha. However, recent rises in fuel costs make it difficult to maintain the system and the extent of actually irrigated area is accordingly limited.

In the case of surface water resources, the Lanog River supplies water for irrigation at its upper stream basin while at the same time the same receives inflow from Colocol CIS through Apad Creek. An intake gate, constructed mid-stream of the Lanog River, allows utilization of return flow. Although return flow utilization of return flow. Although return flow utilization has not been quantitatively surveyed, one such study carried out in Magaran CIS suggests that 20% can be utilized.

Irrigation water is also used for washing and general domestic use by the local populace. Colocol Canal is especially important to the residents, who often request a minimum canal depth of 1 m for washing purposes. Rivers, especially the Magat, are also used by the surrounding residents for washing. Accordingly a minimum river depth of 30 cm has been considered in the plan. The Borobbob spring supplies water to Bayombong and Solano while Magat River supplies small fish, although on an extremely limited scale.

The water quality of these resources is generally suitable for irrigation purpose. Among the water samples from the magat and Lancg rivers, a slightly high electric conductivity is found. However, even such contaminated water does not create any damage on crops as irrigation water.

3.3 Socio-economic Conditions

3.3.1 Administrative Jurisdiction

Nueva Vizcaya, in which the Project is located, is a member province of Region II, composed of 15 municipalities. Within these municipalities are 218 barangays distributed over the entire area. The Project service area contains 5 municipalities and 55 barangays as tabulated on the following page.

Municipality	Area (ha)	Total Barangay	Barangay in Project Area
Ambaguio	16,000	8	-
Aritao	40,415	15	-
Bagabag	26,000	16	15
Bambang	30,312	23	?
Bayombong	16,165	15	14
Diadi	10,510	10	-
Dupax del Norte	34,333	11	-
Dupax del Sur	37,886	10	-
Kasibu	36,000	28	-
Kayapa	48,290	30	-
Quezon	18,750	11	-
Sta. Fe	17,143	9	-
Solano	9,755	18	18
Villaverde	11,255	8	6
Alfonso Castaneda	37,515	6	-
Total	390,389	218	55

3.3.2 Population and Socio-Economic Condition

The population for the entire province in 1981 is estimated at 241,700 while that for the Project area's 5 municipalities is totaled approximately 94,500, or 39% of the province's population. The average annual population growth rate of 2.12% in the Project area between 1975 and 1980 was comperatively low, compared to the 2.86% growth rate for the province as a whole.

The following table shows the number of farm households and farm population in the Project service area, estimated on the basis of data and information collected from the Provincial Governor's Office and the Barangay survey undertaken by the Team.

Service Area	Household (a)	Population (b)	Family Size (b)/(a)
Bagabag	2,486	13,723	5.52
Bambang	405	2,072	5.12
Bayombong	2,173	9,954	4.58
Solano	2,979	16,178	5.43
Villaverde	1,312	7,566	5.77
Total	9,355	49,493	-
Average	-	-	5.29

In the Project area, the farm population is about 49,500, or 52.4% of the total population. The total number of farm households is estimated at about 9,350 or about 50.7% of the total households in the Project area. Available farm labour force data is presented in section 3.4.2.

The average family income of employed worker is ₱15,740/yr, while that of farming family is ₱19,050/yr. That of non-employed family is ₱11,680/yr. in 1981.

It is reported that in 1982 about 85% urban and 46% of rural families are provided with electricity. In urban areas, only 5% are serviced with domestic water while 75% use hand pumps or pitcher. In rural areas, 83% use hand pumps while the remaining use open wells.

To classify socio-economic development in rural areas, the degree of electrification is a convenient indicator of actural conditions. The proposed Project area was connected with the NPC transmission line network in 1981 laid parallel to the distribution lines to rural areas was impressive, witnessed by the fact that the rural area was electrified up to 46% in 1982. It is presumed the electrification rate in 1983 would have exceeded 50% in the rural area.

3.3.3 Relationship Between Urban and Rural Areas

In Nueva Vizcaya, as shown in the table hereunder, about 85% of the total population in 1980 lived in the rural area. A comparison of urban and rural population movement from 1975 - 80 reveals that the population ratio for urban areas decreased from 16.2% to 14.9% while on the other hand, that for rural areas increased from 83.8% to 85.1%.

Trends for movement of the labor force, both male and female, in 1980 are similar to those of the total population; (see APPENDIX I-V). Employed labor force trends also closely resembles general labor force; 14.4% for urban and 85.6% for rural areas. The ratio of the unemployed in the urban area however is 96.6%. It can therefore be assumed that the rural area absorbs unemployed labor in the form of agricultural labor.

Urban-Rural Population by Sex in Nueva Vizcaya

Residence and Sex	1975		1980	
	Number	Percent	Number	Percent
MALE	106,382	100.0	122,673	100.0
Urban	16,915	15.9	17,788	14.5
Rural	89,467	84.1	104,855	85.5
FEMALE	103,532	100.0	119,017	100.0
Urban	17,186	16.6	18,329	15.4
Rural	86,346	83.4	100,688	84.6
TOTAL	209,914	100.0	241,690	100.0
Urban	34,006	16.2	36,012	14.9
Rural	175,908	83.8	205,678	85.1

Source: Provincial Socio-Economic and Physical Profile Province of Nueva Vizcaya, 1982.

3.3.4 Public Facilities

Public markets in the province which are managed under the rotation schedule system, are distributed in each municipality except those located in mountainous areas. People who live in the latter depend on public markets of nearby municipalities. The public market of Bayombong serves an area as far south as Ambaguio and Quezon towns, while the Bagabag market serves residents as far north as Diadi.

Due to its location on the plain of the Magat River basin the Project area is a center of agricultural production, economic activity, education and administration. For this reason, the distribution of electrification and hospital facilities is more concentrated in this area. Elementary schools, health centers however, are spread throughout the province. The following table presents the major infrastructures in the province and Project municipalities.

Number of Facilities	Province	Bagabag	Bambang	Bayombong	Solano	Villaverde
Public Market	9	1	1	1	1	1
Power Distribution (kw)	450.01	11.82	71.89	138.23	172.97	0.57
Consumers	5,596	147	894	1,179	2,151	7
Telex Stations	2	-	-	1	1	-
Radio Stations	1	-	-	-	-	1
Public Telegraph Stations	7	1	1	1	1	-
Elementary Public Schools	215	11	25	17	21	14
Hospitals	9	-	3	-	3	-
Health Center and Clinics	77	6	9	10	11	4

3.3.5 Local Incentives

(1) Farmer's Incentive to Farming

As a result of discussions with self-governing bodies, local parties, CIS and meetings with area farmers, the following policies are considered indispensable to provide farmers' incentive:

i) Government subsidy for palay and other crops to increase farmers' income.

ii) Free education and seminars on improved agricultural technology.

iii) Free assistance from Government extension workers/technicians in the field fro improved farming practices.

iv) Financial assistance through loans and agricultural credit extension.

v) Subsidy for fertilizers and other farm inputs.

vi) Establishment of cooperatives/irrigators associations to assist farmers.

(2) Farmers' Expections

During the survey period, the Team interviewed local farmers to know their attitude towards the Project, the results are summarized below. In general farmers showed:

i) willingness to join new irrigator's association/farmers cooperatives,

ii) recognition of the importance of reliable irrigation supply for production improvement,

iii) desire to apply improved agricultural technology aimed at increasing crop production, and

iv) readiness to invest in provision of on-farm facilities for irrigation. (65% for equalized water distribution to the farm and 35% for increase of actural on-farm supply).

These findings have been taken into consideration by the Team while preparing this report and, where necessary, duly incorporated therein.

3.3.6 Farm Size and Land Tenancy

The farm management survey made in January 1983 shows the predominant farm area to be 1.0 - 2.5 ha and the average farm size to be 1.64 ha, which is at present slightly higher than the regional average farm size of 1.550 ha.

Around 26% of the tillers in the area own their land. Of the total number of farms, about 37% are share tenants, a relatively high percentage in camparison with 26% owner cultivators, 22% amortizing owners and 12% lessees. Althrough eventual conversion of share tenants to either lessees or amortizing owners is anticipated in view of the ongoing land reform program, this report has not taken into consideration any exchange or future consolidation of land which may result.

3.3.7 Transportation and Communication

Nueva Vizcaya has a secondary airport operated and maintained by the Bureau of Air Transportation. The main artery of transportation in the province is the National Highway Route No. 5 (Mahlika Highway). Via this route the distance between Bayombong and Metro Manila (270 km) requires about 5.5 hours. In addition to this national highway, a system of provincial, municipal and barangay roads criss-cross the Project area connecting the municipalities to rural areas. Different types of motor vehicles registered with the Bureau of Land Transportation serve the province. The average rate of motor vehicles to population is around 3:1,000.

Each Project municipality is provided with a Post Office headed by a Postmaster while Bayombong is the center of the Province's mail distribution. In addition, public telegraph stations serve the municipalities of Bayombong, Solano, Bagabag and Bambang. Solano and Bayombong are the only municipalities presently equipped with telephone services with operation and maintenance of the same being handled by the Bureau of Telecommunication.

3.3.8 Local Institution for Community Development

The rural and urban communities within the Project area are composed of several different native groups; the original Gaddanges, and later migrant groups of Ilocanos, Pangasinans and Tagalogs. Progress within the area was at times hampered by the unwillingness of people to participate in mutual endeavors. The local community is now served however, by several different government agencies and local institutions which participate in barangay assemblies. The following institutions form the nucleus of cooperative community activities:

i) Kabatang Barangay (Barangay Youth)

ii) Samahang Nayon and other Agricultural Cooperatives

iii) Communal Irrigation Association

iv) Barangay Councils

v) Municipal Development and other committees

vi) Regional offices of the Government such as NIA and NFA

vii) Government engineers and various other groups

Most of these groups are managed by local inhabitants, which is impressive when compared with the nation as a whole. In respect to the development of new water resources which is the main objective of the Project, the above groups and committees, recognizing the importance of the same, provide valuable assistance.

3.4 Present Agricultural Condition

3.4.1 Present Cropping Pattern

As shown in Fig. 6, major crops grown in the Project area are traditional and high yielding varieties (HYV) of paddy, and both white and yellow corn. Several kinds of vegetables and root crops are grown on a small scale mostly along the riverside. Some leafy vegetables, tomatoes, eggplant and other vegetables are however, grown in the double cropped areas, while farmers occassionally cultivate beans on the dikes of the paddy fields. Single rice cropping is prevalent, occupying about one half of the cultivated area. Cropping patterns of corn/corn and corn/vegetables are mainly practiced along the river.

Except for Bintawan-Villaverde, the north western section of the Project area, transplanting of both local and HYV wet season paddy covers a 3-month period starting from mid-August to Mid-November; harvesting of the same commences in November and ends in April.

HYV of dry season paddy which depend on local water flow are transplanted from early December to the second week of January in the western hill areas. In the other areas, dry season paddy is transplanted over a 3-month period from March to May. Corn planting in the dry season commences in early May and ends after 1.5 months. After harvesting wet season crops about 60% of the area cultivated is left fallow throughout the dry season.

Cropping intensity by block division varies from 109.5% in Block No.5 to 174.7% in Block No.3, while average cropping intensity throughout the Project area is about 135%. (See APPENDIX I-IV). It represents the ratio of the most developed area in the Nueva Vizcaya Province, namely, Bayonbong-Solano plain. But future improvement of irrigation facilities will make sure to increase the above cropping intensity further higher.

3.4.2 Present Labor Balance

1. Human Resources

The Project area, containing 13,040 ha of arable land in the lower portion, has an estimated 9,357 farm households with a total population of 49,503 persons. The average farm family size is thus 5.29 persons. The potential labor force of one farm family consists of approximately 0.64 persons from 15 - 19 years age group, 2.05 persons of 20 - 59 years age group, and 0.25 persons from 60 or more years age group, totaling 2.50 person/household. In this estimate the workable rates of the age groups are assumed to be 50%, 100% and 50% for 15 - 19 age, 20 - 50 age and above 60 age groups respectively. The average number of working days a year per farm is estimated at 240 days, in keeping with the World Bank estimates.

It is estimated that the said labor force is available in the Project area for about 5,407,900 man-days/yr with a 5% injury/illness ratio. According to the present cropping pattern and its intensity, the total labor requirement is estimated at about 221,000 man-days and 245,400 man-days during the peak months of April and October respectively. The balance of the labor force during the said months is thus approximately 223,500 or 50.3% in April, and 214,000 or 46.6% in October, providing a substancial surplus labour force potential. During the slack period from May to August, this surplus is even more noticeable with about 80 - 90% of the potential labor force being either under- or unemployed. Planning of this Project therefore took into full consideration the need to utilize the surplus labor.

2. Animal Resources

In the Project area, carabaos are generally utilized as draft animals. In 1982, an estimated 9,700 head were distributed throughout the Project area, 70% of which were utilized as draft animals, and 30% of which were non-utilized calves. Working days/yr of draft animals were estimated at 240 days. As well, an estimated 20% of all cultivation is mechanized employing 4-wheel and 2-wheel tractors.

The unused potential of carabaos and of farm machines is significant. in the case of carabaos without consideration of any farm mechanization, even during the peak months of September and October, the estimated surplus is 49% and 43.4% respectively as shown in APPENDIX I - IV.

3.4.3 Farming Practices

Conventional farming methods are still practiced in the Project area resulting in low crop yields. The Ministry of Agriculture has been promoting an improved paddy cultivation method, introducing a packaged program of HYV, fertilizer and agro-chemicals. However, about 60% of present paddy area cultivated in the wet season is still planted with local photosensitive varieties. Moreover, a bare minimum of agrochemicals and pesticides are used resulting in Tungro Virus damage especially to HYV.

Few farms report high corn yields as most farmers use convential methods of cultivation with rare application of fertilizer.

Pechay is cultivated intensively, although vegetables such as pulse, sweet potato, tomato and eggplant, and root crops are generally cultivated extensively. The market of Solano municipality contains the largest vegetable market in the area. At this market consumers are not concerned about the quality of produce. Therefore, there is little incentive for farmers to improve farming techniques aimed at production of quality produce. However, to increase productivity as well as to introduce various new varieties of produce in the area, new farming techniques are desired by the farmers.

Mango, coconut, caramansi (a kind of lemon), banana, etc. are cultivated in orchards, though only in rare instances do farmers achieve commercial production levels. The Philippine Coconut Committee has been managing a pilot farm for the production of the hybrid dwarf golden coconut (MAWA variety), although at present this type of coconut is planted only as a garden tree in the Project area. After deforestation of the hill areas for timber products coffee beans are gown on portions, but without shading trees.

On the basis of the above information, the present farming practices in the area are judged in need of substantial improvement.

3.4.4 Present Crop Yield and Production

The lowest average paddy yield for local varieties is found in Block No. 2, at only 1.4 t/ha. Highest yields are obtained in Block No. 3 and 5 at 2.96 t/ha. During the wet season HYV average from 1.8 - 2.7 t/ha, while during the dry season the same average about 3.5 t/ha. Both wet and dry season corn have average yields of about 0.9 t/ha.

Present average paddy production per year is 36,554 ton in the entire Project area, whereas that of corn is 1,844 ton. Production of each crop according to block area is presented below.

Unit: ton

Crop	Block					Total
	1	2	3	4	5	
Paddy	8,597	7,556	15,090	3,563	1,748	36,554
Local variety in wet season	2,492	2,412	4,601	1,093	713	11,311
HYV in wet season	2,850	2,936	2,430	986	-	9,202
HYV in dry season	3,255	2,208	8,059	1,484	1,035	16.041
Corn	548	153	-	-	1,143	1,844
Wet season	158	153	-	-	1,143	1,454
Dry season	390	-	-	-	-	390
Vegetable (sweet potato)	-	-	-	-	894	894
Orchard (pomelo)	375	374	187	-	936	1,872

Farmers of the area are interested in agricultural development and new cropping patterns aimed at introducing new crops into the area and increasing unit productivity.

3.4.5 Marketing and Prices

The marketing of farm outputs in and around the Project area is generally routed through four major channels:

i) National Food Authority (NFA)

ii) Area Marketing Cooperative (AMC)

iii) Middlemen, wholesalers

iv) Producer's direct retail

The National Food Authority buys products from farmers at a subsidized price on the basis of the national agricultural production policy. NFA also provides incentives to farmers by subsidizing the transportation of farm products to NFA buying stations. Buying activities are targeted at about 10% of the total market volume to maintain the subsided price.

Under present conditions in the Project area, NFA procurement ranged from 4 - 9% of the marketable surplus and this will increase in the future.

The Area Marketing Cooperative plays a role in marketing farm products through Samahang Nayon (farmers' associations). The Area Marketing Cocperative in the Project area also has a marketing system among the Cagayan Valley Development Cooperatives' farm members.

Other marketing routes are middlemen acting as wholesalers and direct producer retail. NFA reported that there are 3 mobile buying units and 1 permanent unit in Nueva Vizcaya. NFA, in addition, has established 274 retail and wholesale outlets for grain. The Area Marketing Cooperative has 2 buying units in the Project area.

Market price of the agricultural products in rural area has significantly large seasonal fluctuation mainly on account of inefficient marketing system and shortage of storage facilities. According to the socio-economical survey, the supporting and farm gate price in the Project area in 1981 are as tabulated below:

Unit: Pesos/kg

	Paddy	Corn	Mung Beans	Peanut	Onion
NFA Supporting Price	1.70	1.30	3.70	3.90	-
Farm Gate Price	1.21	1.31	7.09	4.21	5.73

A government price control policy at present does not exist, producer sale prices fluctuate frequently. As well, middlemen operate in the area on a year-round basis. Although accurate representation of the total situation is beyond the scope of the present study, farmers who borrow money from middlemen may recieve only half the average farm gate price for their produce as the rest of the profit must pay interest on the loan. Lock of more profitable specialized agricultural products restricts sale of produce to local markets rather than the lucrative Metro Manila area. In short, business of the Solano market is very local in flavor and not particularly active.

3.4.6 Farm Economy

On the basis of the Team's economy survey the present budget for a standard farm is estimated in the following table.

Unit: Peso/Year/Farm Family

	Urban	Rural
Agricultural income	12,030	7.009
Non-Agricultural income	8,760	2,920
Sub-total	20,790	9,929
Expenditures	19,127	9,631
Savings	1,663	298

In the urban area, as it is central to Bayombong and Solano including those irrigated areas serviced by Colocol CIS, annual income is high. As can be seen from the above Table, although slight, this area produces a surplus. However, it must be noted that such figures represent only the average farm household. Actual differences between the economic situation of each farm family area very great and the majority of farmers suffer an economic deficit.

3.4.7 Irrigation Condition

(1) General

Irrigation facilities in the Philippines are broadly classified into 3 major categories: National Irrigation System, Communal Irrigation System (CIS) and private (or small scale) pumping irrigation systems. Present systems in the Project area consist of communal irrigation and private pumping systems.

Generally, the CIS is a small-scale gravity irrigation system which utilizes water from small rivers and streams. The majority of intake structures are so called brush dams and canals are usually earthen. Recently, the Provincial Irrigation Office has been planning and constructing CIS with a modernized, concrete intake structure under

the guidance of Regional Irrigation Office. Operation of private pumps for irrigation on the other hand has been extremely limited due to the recent rise in fuel cost.

Said irrigation canals are operated and maintained by communal irrigators' associations which consist of the benefited farmers under the guidance of FSDC and the Provincial Irrigation Office.

(2) CIS and Water Right

There are 244 communal irrigation systems (CIS) serving 23,220 ha, of which 75 CIS covering about 9,000 ha are within the Project area, not including the Magat River right bank. The total number of registered water rights is 162, amounting to 19 m^3/s in the entire Province, of which 47, totaling 15.850 m^3/s are secured in the Project area. Out of 15.85 m^3/s of particular note is the Colocol CIS has a total 12 m^3/s. However, this CIS currently provides water to only 3,000 ha in the wet season, while present capacity of the main canal is at most 6 m^3/s. Accordingly, 12.0 m^3/s of water right for Colocol CIS is presumably registered to provide for large-scale improvement plans in the future. Present facilities have deteriorated, requiring immediate repairs in several locations. Such repairs, as they will have an immediate corresponding effect on production, are recommended as the first priority in Project implementation.

(3) CIS in Proposed Service Area

a) Inventory of Existing CIS

The following table shows the conditions of existing CIS which was complied by the Team in cooperation with the Provincial Irrigation Office (PIO) and the Nueva Vizcaya Governor's office.

Water Source	CIS (no)	Irrigated Area (ha)			Benefited Household (family)
		Potential (ha)	Wet (ha)	Dry (ha)	
Magat River (Colocol)	30	3,258	3,077	3,077	2,688
Lanog River	24	4,300	4,084	2,760	2,995
Lamut River/1	9	598	530	307	475
Apad Creek	9	946	764	583	619
Matuno River/2	3	571	569	569	400
Total	75	9,673	9,024	7,296	7,177
(Right Bank of Magat River)	(4)	(517)	(463)	(463)	-

/1 Consists of tributaries Nangalisan Creek, Ibung Creek and Maasin Creek.

/2 Including San Vicente CIS (27 ha) deriving its water source from Magat River.

Approximate alignment of the irrigation canals for each CIS is indicated in the topographical map, scale 1:10,000 in APPENDIX I-VII.

b) History

Colocol CIS, the largest system in the Province, was locally constructed in 1876 during the period of Spanish administration and has generally been well maintained as well as partially rehabilitated in 1932, 1948 and 1972. This type of old CIS is also present in the Apad Creek basin.

The Majority of CIS have been in existence for more than 50 years, new systems constructed after World War II totaling less than 20. This fact suggests that habitual water utilization rules are already well established within the community and farmers' groups, and as such, should be duly considered in planning the future introduction of the new water management system.

Colocol CIS have the most reliable water source supplied by the Magat River. However, part of the diversion weir is left as damaged by flood of the Magat River needing annual repair and improvement. Traditionally farmers utilizing said facilities in this region have worked together to repair the weir on a designated day in February.

c) Ongoing CIS

There is no national irrigation plan in the Project area at present, but several communal irrigation projects implemented by FSDC are in various stages of progress as presented on the following table.

Project	Irrigable Area (ha)	Water Source	Progress
Ganrib-Cabalitan	60	Lanog River	Under Construction
Sta. Cruz-Careb	450	- do -	- do -
Nangyatan	60	- do -	Ongoing
Lamut	500	Lamut River	Feasibility Study Completed

Since the water resources of the above projects are not sufficiently reliable, all the systems will be incorporated as an integrated new system under the proposed Project.

(4) Major Constraints on Existing CIS

a) Scarcity of Water Resources

In order to identify irrigation water shortages, NIA has carried out two types of surveys; an inventory survey of CIS carried out by PIO and a land use survey by PDD. Based on these surveys the Team re-surveyed the area in cooperation with NIA counterpart to identify present conditions.

In review, NIA inventory survey's estimations of water shortage areas are a little larger than actual situation for both wet and dry seasons. However, water resources for Colocol CIS will be sufficient when the Magat River water intake is improved and water management and existing irrigation facilities are improved. The same can be said for Sto. Domingo and Manamtam CIS.

Areas where water shortages occur during the wet as well as the dry season are extensive along the Ianog and Lamut rivers, and Anad Creek. Irrigation in the Sta. Lucia are is dependent on rainfall and groundwater, and requires urgent development of reliable water sources.

Based on the survey, the existing irrigated areas in the Project area can be tabled as follows:

	Area (ha)	Ratio of Irrigated area (%)
Whole Area/1	12,940	100
Irrigated Area/2		
Wet season	9,505	73
Dry season	4,209	33

/1 Excluding 100 ha of orchard

/2 Excluding existing area for upland cropping (1,890 ha) and rainfed area (1,545 ha)

Accordingly, water shortage is 27% in the wet season and 67% in the dry season. The major reasons for water shortage in this area are as follows:

- insufficient CIS water intake facilities from the Matuno and Magat Rivers,
- river water shortage (excluding matuno and Magat rivers),
- insufficient irrigation facilities at on-farm level, and
- generally insufficient and deteriorated water control facilities.

b) Existing Irrigation Facilities

The total length and density of main canals (with the Project, most of these will be downgraded to lateral or sub-lateral canals are 133 km and 17.1 m/ha as shown in the list below:

Water Source	Potential Area (ha)	Length of Main Canal (km)	Canal Density (m/ha)
Colocol CIS	3,040	65.41	21.5
Lanog River	2,417	25.15	10.4
Lamut River	1,060	19.33	18.2
Apad Creek	664	11.20	16.7
Matuno River	593	11.63	19.6
Total	7,774	132.72	Ave. 17.1

All the above canals are non-lined earthen canals with the exception of one portion along Bayombong municipality which is of stone masonry. Since the Colocol main canal has a larger slope and faster flow, the section between Bayombong and Solano in particular shows evidence of erosion and silting which requires canal lining.

The existing intake structures are brush or concrete type weirs with related structures. These however, have become obsolete with the exception of those rehabilitated by PIO. Deteriorated structures badly require rehabilitation and integration to realize improved water management.

Area residents, whether farmers or not, recognize the importance of irrigation canals and thus maintain them well, keeping them free from dirty water, waste, etc. However, more effort such as rehabilitation is a prerequisite to realize sufficient and equalized water distribution down to the terminal field.

c) On-Farm Facilities

A survey to identify the present on-farm density of irrigation canals was conducted over 586 ha of the Uddiawan area. The results shows about 20 m/ha of canal density which is the highest in the Project area together with the Colocol CIS area. The canal density at on-farm level for rainfed and other remaining areas is estimated at 0 at 10 m/ha respectively.

In order to materialize appropriate water management at farm level, about 66 m/ha of farm ditch is required, however, major difficulty in this respect will likely be land acquisition for new systems. Although tenant farmers are well aware of the importance of the on-farm ditches, they may object to reduction of their farm area resulting from construction of irrigation facilities.

3.4.8 Communal Irrigation System (CIS)

Farmers Irrigators' Associations are organized according to individual irrigation systems. These associations, in addition to the irrigation services, serve as the foundation for strengthening agrarian reform and promoting the cooperative development program. The same also serves as a focus for financial and technical assistance etc., from the government and private sectors. In addition, the associations facilitate loans, loan amortization and collection of irrigation fees.

Irrigation systems and associations served by the Colocol Canal are under the management of the Federal Farmers Irrigators' Association. This association is administered by a President and 2 Vice Presidents, each of whom is a representative of 3 municipalities, namely, Bayombong, Solano and Bagabag. The administration is further supported by a Secretary and 15 elected Board Directors. Several different committees are also established to solve problems that may arise and promote development of the system.

Aside from the Federal Colocol, the Project area is served by several individual irrigation systems each with its own Communal Irrigators' Association. Present conditions of operation and maintenance vary with

each system. Irrigation systems with a relatively stable irrigation water supply are well-operated while, those with insufficient water supply, have low operation standards and their facilities are conspicuously out-dated or even non-operational.

3.4.9 Drainage Condition

There are no man-made drainage facilities within the Project area at present. Existing lateral drainage utilizes the natural course of small creeks and streams. Such streams could be incorporated into the proposed drainage system with some construction and rehabilitation. This would improve paddy production especially during the rainy season. The present lateral drainage canal density, about 29 m/ha is considered sufficient.

The natural river which functions as the main drainage canal is subject to erosion and silting. With rehabilitation however, it may also be incorporated into the proposed system. Extreme meandering, erosion and silting mid-stream of the Lanog River results in poor drainage and flooding. The Apad Creek catchment area, approximately 22 km^2, drains into the Colocol main canal immediately upstream of Solano, and as no discharge control facilities are present, causes considerable flood damage to downstream areas. Improvement of these drainage routes is thus urgently needed.

The improvement of drainage in these areas as well as the improvement of irrigation in the Colocal water system will be given high priority in Stage I. Although the residents themselves are aware of the importance of drainage, investment in drainage systems by the agencies concerned has been delayed by budget limitations.

Studies of floods in Bayombong and Solano areas, revealed that they were not just the result of heavey rainfall or other natural conditions but involved human related factors as well. A systematic drainage plan based on scientific research is required to remedy this situation.

3.5 Agriculture Supporting Services

3.5.1 Government Activities

In the Project area, there are several different government agencies at the national as well as the local level which directly and indirectly serve farmers in the area. A given agency may function alone, in combination with other agencies or by establishing committees to oversee the progress of farm development, higher living standards, income generation, etc. In APPENDIX I-V major activities of various agencies are given in more detail. Agencies which serve working farmers are:

- National Irrigation Administration (NIA)
- Farm System Development Corporation (FSDC)
- Ministry of Agriculture (MA)
- National Food Authority (NFA)
- Ministry of Agrarian Reform (MAR)
- Ministry of Human Settlement (MHS)
- Ministry of Local Government and Community Development (MLGCD)
- Bureau of Fisheries and Aquatic Resources (BFAR)
- Bureau of Forest Development (BFD)
- Provincial/Municipal Government

These agencies all have local offices in Bayombong, a provincial seat thereby maintaining smooth and frequent contact between their offices.

3.5.2 Cooperatives

Organization and development of Samahang Nayon (SN) cooperatives, is one of the major goals of the Ministry of Agriculture. These cooperatives are composed of 25 - 200 farmers who reside within the geographical boundaries of the baranagay and work to improve living standards therein. As of December 1981, there are 113 resistered SN's in the province with a total membership of about 8,310.

The Area Marketing Cooperative was formed under Presidential Decree 175 on May 5, 1975. The said cooperative acts as the SN's marketing agency on a multi-municipal or provincial level. The Cooperative Rural Bank of Nueva Vizcaya is organized as a financing arm of the SN's.

In order to develop and strengthen local cooperatives, the Cagayan Valley Development Cooperative (CAVADECO) was organized by AMC's of Nueva Vizcaya, Isabela and Cagayan-Calinga Apayao on May 27, 1975. Other cooperatives in the area include 3 Credit Unions and 1 Consumer's Ccoperative.

The Nueva Vizcaya Seed Growers Association has 64 members, mostly superiority rice seed growers, with a cultivated area of about 135.5 ha. Of these 19 members having 36 ha located within Project municipalities. Since the organization of the Nueva Vizcaya Fishpond Operators' Association in 1978 the number of fishpond operators has increased to 103 as of June, 1982, and the total area utilized for fishpond operation is about 80 ha. Cooperatives in Nueva Vizcaya are independently managed and controlled by the members and are well organized in comparison with the rest of tye country.

3.5.3 Agricultural Credit Institutuions

Credit for the Project area is supplied by 5 Rural Banks, the Philippine National Bank, the Development Bank of the Philippines, and other private lending institutions such as the Samahang Nayon Cooperative Rural Bank and Cooperative Credit Unions. However, the Rural Banks and the Philippine National Bank supply most of the credit for the Masagana 99 and Masagana programs.

Farmers joining the Masagana 99 program are extended loans without collateral through a supervised farm credit scheme. The program consists of a technology package using recommended HYV and other farm inputs. Of the total credit given to any borrower, 60% is given in the form of farm inputs, while the remaining 40% is given in cash. The program, which was launched on May 21, 1973, completed phase XVII in May 1982.

The Masagana program was officially launched on December 15, 1981 as a continuation of Masagana Maisan and Masagana 77 with the objective of increasing corn yields and ultimately boosting the country's self-reliance with regards to food supply. The country is self-sufficient in its supply of white corn used for household consumption, but is deficient in yellow corn used for fodder.

Under the Masagana 99 program, the 5 Rural Banks and the Philippine National Bank provided an average of ₱1,430/ha to 34,041 farmers of the Project area and its vicinity until early 1983. The total amount extended to the Masagana 99 program was approximately ₱48 million. Under the Masagana program, about 2,212 farmers were granted an average of approximately ₱900/ha with a total of about ₱2 million.

Present banking facilities are more than sufficient to meet credit requirements of farmers in the area. However, some carefully examined due to the low repayment rate. Villaverde Rural Bank, the smallest creditor, reported a high repayment rate of 99% while Solano Rural Bank, the largest creditor, reported a very low repayment rate of less than 20%.

These facts shall be carefully taken into consideration in planning the collection method of water management and association fees. Also the fact that the loan repayment rate decreases when the loan amount becomes larger shall be noticed.

3.5.4 Post Harvest Facilities

The 5 Project municipalities have a total of 104 rice threshers, both hold-on and throw-in types, with a combined capacity of 4,542 cavans/ha or 1,816.8 t/day. These facilities are sufficient to thresh present yields estimated at 74,000 tons.

Processing facilities, both rice and corn mills, include the corntype, kiskisan-type, centrifugal-type, rubber roll-type and corn grinder, all owned by the private sector. Actual facilities in the area consist of 111 rice mills with a combined capacity of about 4.5/hr. With a 200-day milling season, these facilities are just adequate for the milling of present total production.

Sundrying is the usual practice for drying farm products as it is inexpensive and produces good quality. This method is not always possible during the rainy season however due to lack of sunlight. The National Food Authority has only one mechanical rice drier located in Bambang with a capacity of 2.5 t/hr, and therefore, it is necessary to increase these facilities to handle the demand.

Another post harvest facility in the area is warehouses. There are reportedly 40 warehouse units operated both by the NFA and the private sector in the Project municipalities with a combined capacity of 7,850 t. It is assumed that 50% of the total annual rice and corn production in the area needs warehousing, while these facilities could provide storage for only about 10% of production.

In addition, the NFA has established 274 retail and wholesale outlets for grains; Solano having the most while Villaverde has only 9 outlets. Farmers also sell their products to middlemen at lower prices. In order for the Area Marketing Cooperatives to promote business, 2 buying stations have been established in Bagabag and Solano. NFA has 1 permanent and 3 mobile buying stations which are handled by 2 farm leaders and rice grain classifiers in coordination with the municipal development officer.

Many of those post harvest facilities are concentrated in Solano municipality making this city the centre of expansion of economic development in general. However, no other agro-industrial facilities exist in the Project area.

3.5.5 Research Extension and Training

In Region II, there are several seed farms and experimental stations distributed in the region under the Bureau of Plant Industry (BPI) to experiment with and breed seeds. Of these stations, the most important in relation to the Project are the Ilagan Experiment Station at Izabera, and the Cagayan Valley Rice and Corn Experiment Station. The BPI's program of seed multiplication functions to produce breeder seed and foundation seed, to supervise the registered seed growers, and to facilitate distribution of certified seed to the farmers throughout the region.

One way of increasing family income and improving the quality of rural family and community life is through effective agricultural extension. The main bodies responsible for extension are the Bureau of Agricultural Extension, the Bureau of Plant Industry of the Ministry of Agriculture, and agricultural credit institutions. Other agencies, however, provide extension services through their own programs.

Masagana 99 is the major rice production program of the Ministry of Agriculture while the Masagana program involves the production of white corn for domestic consumption and yellow corn for fodder. Through these, and through credit programs supervised by credit institutions, the Ministry of Agriculture and different Banks are conducting farmer training programs using seminars or the Training and Visit System (T & V System).

There is presently a total of 143 extension workers in different government agencies in the province who work directly in the agriculture and fishery sectors. Extension worker staff development has been continuous. Rice technology specialists for example, are being sponsored annually by the National Food and Agriculture at Los Banos, under the Unified Rice Applied Research Training and Information Program.

Studies regarding the development of this area are considered to be necessary. These studies, inter alia, would include a study on cultivation and introduction of new cropping patterns, on development of livestock and fish culture industries, on development of hill agriculture, especially soil improvement, and on planting, cultivating and utilization of ipil-ipil.

3.6 Present Power Supply Condition and Future Demand

3.6.1 Administrative Organization

Administration for the electric power development and supply is under the control of the Ministry of Energy (MOE) under which the following three organizations are functioning.

1) National Power Corporation (NAPOCOR or NPC)

2) Manila Electric Company (MERALCO or MECO)

3) National Electrification Administration (NEA)

The NAPOCOR is the Government-owned corporation responsible for power development and supply through its transmission networks all over Philippines, except the power distribution in the Metro Manila area, which is managed by the MERALCO.

The MERALCO is a private company which has long supplied electric power in Metro Manila area with its oil-fired power plants, but in recent years the generating facilities have been transferred to NAPOCOR under the Government policy.

The NEA manages the rural electrification of small towns and villages isolated from the NAPOCOR transmission networks, financing the cooperative power supply mostly generated by small diesel generators. However, the price-hike of the diesel oil in 1974 and 1979 made the power generating cost much higher than before. Therefore when those cooperatives' power facilities are connected with the NAPOCOR transmission grid, the power rates are normally lowered and diesel generators are stopped as stand-by.

The organizations of NEA and NAPOCOR are shown in the attached Fig. 1 and 2.

3.6.2 Existing Power Supply Facilities

The existing power generating facilities (as of January 1983) total 3,511 MW as listed in the attached Table-14. All the locations of the existing power plants and transmission networks are shown in

the attached Fig. 3 including future extension plans. Oil-fired plants occupy 2,105 MW (60%), hydropower 856 MW (24.4%) and geothernal plants occupy 550 MW (15.6%). No coal-fired plant is existent at present except one 300 MW under construction at Batangas.

The first phase of Magat Hydropower Station, 360 MW (90 MW x 4) will be put into commission at the end of 1983. One large topic in hydropower sector is the completion of Kalayaaan pumped storage plant in 1982 the first one of that kindly in Philippines equipped with two units of 150 MW. This Kalayaan makes possible to stop some old oil-fired generators which have served for peak power supply. In addition the first nuclear power plant with 620 MW capacity under construction at Bataan will be completed in 1985.

3.6.3 Historical Power Supply and Demand

The electric energy generated and sold from 1955 to 1982 within the Luzon Grid under the control of NAPOCOR are shown in the attached Table 16.

As shown in those tables, the peak power demand has increased more than 10% per annum before 1972, but the growth rate has been lowered at 6% after 1973. The electric energy generation also has the same trend, namely the annual growth rate between 1973 and 1980 was down to 7.7% on an average. It further dropped between 4 and 5% after 1979 when the second oil price hike happened. The above growth retardation is attributable to the energy saving caused by higher tariff and the dull industrial consumption inevitably occurred due to the world economic recession.

The electric energy sold had the same tendency as the above. It is, however, noticed that the loss rate has been much reduced from 1981 at 7.1% compared with that of 15.7% in 1980. The much improvement of loss rate is mainly due to the abolition of several old oil-fired plants upon completion of 330 MW geothermal power plants after 1980. The abolished generators are five units of 25 MW in Rockwell plant in October 1982. At the end of 1983, it is scheduled to stop the operation

of three old units of 60 MW in Rockwell plant upon completion of the Magat hydropower first phase of 360 MW. This replacement will further contribute to improve the loss rate as well as the supply condition more dependable.

The peak power demand in 1982 reached the recorded highest of 2,364 MW, but the existing dependable power supply capacity of 3,216 MW has still the surplus of 852 MW. The NAPOCOR is making the best efforts to save diesel oil by stopping the oil-fired plants as much as possible as far as the geothermal and hydropower plants can substitute for them. It was clearly observed in the plant factors so that the geothermal plants had a plant factor as high as 73.3% in 1982, while that of oil-fired plants is averaged to be 46.0%. The lowest plant factor of 24.7% for the hydropower plants is due to the peak power operation as planned originally.

The annual load factor in Luzon Grid is stable in recent years and as high as 70% as shown in Table 16. This high load factor is attributable to the higher consumption of 24 hrs operated industries than the day-time industries. Also the domestic use of electricity for cooling of offices and houses and that for home-cooking in day-time make the power fluctuation not so intense. The power demand for cooling makes the yearly maximum peak demand being occurred in June and the minimum in January in a normal year.

The plant factor of Matuno hydropower project is selected to be 33.3% as same as the average plant factor in recent years after consultation with NAPOCOR. Even if the peak demand increases in future, the Kalayaan pumped storage power plant has a sufficient space to increase up to 1,800 MW. In addition to the Magat hydropower of 540 MW to be completed in 1984, the Luzon island has still much promising hydropower development potential, such as San Roque, Abulug, Agos, etc. having the capacity range of 140 MW to 390 MW. It is, therefore, not always necessary to cover the future peak demand only by Matuno power project.

The present power generation and consumption in 1982 by three major regions under the Luzon Grid are shown in the following table:

Region	Energy Generated (GWh)	Loss & Self Consumption (GWh)	Energy Sold (GWh)	Energy Consumed (GWh)	Surplus or Deficit (GWh)/2
Metro Manila	7,629.8	419.4	7,210.4	9,747.1	-2,536.7
Northern Luzon	2,842.6	267.0/1	2,575.6	2,682.9	- 107.3
Southern Luzon	3,892.5	597.2	3,295.3	651.3	+2,644.0
Total	14,364.9	1,283.6	13,081.3	13,081.3	0

Note: /1: Including the consumed energy for pumping of Kalayaan pumped storage plant.

/2: Negative figures mean the deficits which are filled up by transmission from other regions.

In the above table, it is clearly shown that the Metro Manila, the largest consuming center, consumes about 75% of the total, and deficit energy of 2,536.7 GWh is supplied from the Southern Luzon area. The Northern Luzon area consumes about 20% of the total having a little deficit of 107.3 GWh supplied from other regions. The Southern Luzon area consumes only 5% of the total and has much surplus supplying to the other regions.

Those three regions have distinct characteristics in the power generating mode also. The Southern Luzon generates the power mainly by geothermal power plants at Mak-Ban and Tiwi, 330 MW in total, while the Northern Luzon by mainly hydropower plants of Binga, Ambuklao, Angat, Pantabangan and Masiway, 505 MW in total. The Metro Manila area has most of major oil-fired plants.

The above energy supply and consumption proves that the deficit in Metro Manila area is compensated by the geothermal power from the Southern Luzon area as much as possible to save the operation of oil-fired plants in Metro Manila. The Northern Luzon area with many hydropower plants sends surplus power in rainy season but is compensated from Metro Manila or Southern Luzon area in dry season.

Particularly in a heavy droughty year the deficit in Northern Luzon increases, while in a rich water year much surplus is sent to Metro Manila.

The Northern Luzon area, however, will soon have the Magat hydropower first phase of 360 MW, which will generate 1,100 GWh of annual energy. Upon completion of this, the deficit in Northern Luzon will be fully solved and surplus of about 900 to 1,000 GWh can be supplied to Metro Manila. So that it is scheduled in the 10-year power development plan (1981-90) prepared by NAPOCOR that the three old units of 60 MW oil-fired generators in Rockwell plant will be stopped upon completion of Magat first phase. The three units are already 20 years old and generate only 482 GWh in 1982.

3.6.4 Demand Forecast and Development Program

The NAPOCOR has established the 10-year Power Development Plan (1981-90) taking into consideration the past historical trend and probable future power demand. The NAPOCOR's demand forecast is shown in the attached Table 18 and 19, which presumes that annual growth rate of peak demand (kW) between 1981 and 85 will be 7.3% and that between 1986 and 90 be 7.0%. It also presumes that the annual growth rate of energy consumption between 1981 and 85 will be 7.0% and that between 1986 and 90 be 6.9%. Those forecasted figures were deemed reasonable and practical at that time when sudden price-hike of oil and world-wide slump were unexpected. Although the demand increase became dull in the past few years due to the world economic recession, the forecasted figures seem realistic as a target of development plan because the recession would be recovered within several years and normally the actual implementation of the development program would be a little delayed.

Another important factor observed is the existence of much latent power demand in the rural areas. At present the NAPOCOR is paying much efforts to complete the main and secondary transmission networks all over Philippines including connections among the major islands, such as Luzon, Samar, Leite, Mindanao, etc. Upon completion of this network in

1980's almost all major cities and towns can be connected in the main transmission lines. But still numerous small villages and hamlets are isolated from this network due to shortage of distribution lines.

The fact that the power and energy consumption in Nueva Vizcaya Province has been rapidly jumped up by the extention of distribution lines to remote areas suggests much latent domestic demand still left under the surface. It was also proved in Mindanao as the consumption growth rate being 12 to 13% due to recent expansion of transmission lines. However there is no such a survey data showing how much latent demand exists in rural areas. Therefore, the next development plan shall include such rural demand to be realized after transmission networks are established based on the economic survey on unelectrified villages and those villages electrified by isolated diesel generators. Such future survey and development plan are worthwhile to be incorporated in the national power development policy.

CHAPTER IV

THE PROJECT

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THE PROJECT

4.1 Scope of the Project

4.1.1 Project Objectives

Based on field study results, Project area development potential and constraints thereto have been divided into the following categories, (i) agriculture, (ii) hydropower and (iii) flood control as discussed in detail below.

(1) Agriculture

i) The potential for agricultural development in the Project area, the only intensively consolidated agricultural area within Nueva Viscaya Province, is substantial.

ii) A large percentage of the Project area consists of paddy fields, 73% of which are serviced by existing CIS during the wet season, and 33% during the dry season. Water intake and distribution facilities of these systems are not only incomplete, but also require improved maintenance to increase effectiveness.

iii) The 75 existing CIS within the Project area have not been systematically planned, resulting in inefficient irrigation and drainage systems and a general lack of water management throughout the area.

iv) Inadequate drainage facilities within the Project area result in habitual inundation.

v) On-farm irrigation systems are almost non-existant.

vi) Presently, the average cropping intensity is approximately only 135% as a result of water shortage during the dry season.

vii) Modern technology has not yet been applied to rice cultivation in the Project area, while agro-chemicals and fertilizers are rarely used. The resultant lack of protection against Tungro

Virus adversely affects production, especially that of HYV paddy. Diversified crops have less commercial value due to extensive farming.

viii) Although agricultural support services are comparatively well-established and functioning effectively throughout the area, strengthening and improving of these existing systems is required.

ix) Except rice, specific agricultural products have not yet been designated within the Project area.

x) Transportation of agricultural produce is hapered by poor drainage in 30% of the total area.

xi) Cash compensation alone will be insufficient for the acquisition of land for the new system.

(2) Hydropower

i) The Government of the Philippines strongly promotes the development of indigenous energy resources, such as geothermal, coal, hydro and dendro power in an order of priority to save the heavy oil import.

ii) The Northern Luzon area where this Project is located has a little power shortage at present, but the same will be resolved by the commissioning of Magat hydropower station (first phase 360 MW) for the time being.

iii) Although the Project area still has much latent power demand due to lack of distribution lines in rural areas, such latent demand will come up to the surface in 1990's.

iv) The proposed Matuno dam and hydropower project has many advantages, such as good vegetation cover in the catchment area, least compensation problems, easy access to the dam, etc. However the considerably big amount of investment of US$370 million will be required for the project. Therefore the actual implementation is recommendable to be in 1990's considering the present financial situation.

(3) Flood Control

i) A river training plan for the Magat River which runs along the Project area has not been directly dealt with in the report as it is beyond the scope of the present Project.

ii) With completion of the Magat Dam downstream, the future effect of back sand will have to be studied together with the silting problems of the upstream reaches.

iii) The flood control capacity of the proposed Matuno dam is limited. The flood and silt control of the neighboring two rivers (St. Fe and St. Cruz) will have to be studied in future to plan a complete flood control of this Project area.

The development plan is designed to overcome the various constraints discussed above, and to draw forth the full potential of the area. The objectives for development of the agricultural sector are to ensure a reliable and consistent supply of irrigation water, to introduce modern agricultural technology thereby improving cropping intensity with subsequent increase in yield, and to improve the socio-economic condition of area residents. The main objective of hydropower development is to effectively utilize the water resources of the Matuno River, while that for flood control is to minimize flood damage in the Project area caused by the Magat River.

4.1.2 Basic Development Concept

The essential principle for the basic development concept is to formulate a realistic and effective plan. It may be reasonably assumed from objective observation of economic trends in the Philippines that the present situation of public finances must understandably limit the extent of national investment in new large-scale projects. Such limits are necessary to allow for periodic national expenditures on food and oil imports which may continue for the foreseeable future. It should further be noted that the World Bank, particularly in regards to NIA development policies, has recommended that new large-scale irrigation projects be postponed. If restraints on investments in large-scale

projects, out of concern for the burden they place on national finances, become too indiscriminate however, economic activity within the Philippines may be severely curtailed, affecting the general health of the Philippine economy and hindering development.

It has been customary in the Philippines to finance such large-scale projects as dam construction by foreign loans. In this connection, the Philippine government has been responsible for the local currency portion, which averages 30-50% of the total Project cost. Since 1982 however, the government has had a shortage in available domestic funds, with strict ceilings threfore being imposed on domestic currency expenditures in 1983.

In consideration of these conditions, it may be argued that a decision to commence a new project, if based only on its economic suitability, is not totally satisfactory.

The Team therefore formulated the Project to ensure that the scale of the same is always practically applicable to the real situation, and at the same time suited to the financial capacity of the government. Moreover, a system of organization to ensure the Project's actual realization and to foster the maturity and incentive of the individuals directly involved has been carefully considered in plan formulation. The proposed program for the preparatory stage of the Project's realization is discussed in Chapter VII, while the development plan with regards to realistic scale is discussed below.

(1) Agricultural Development Ojectives are to:

i) guarantee a stable water supply;

ii) establish a reliable irrigation supply by integration of existing irrigation systems without diminishing their present function;

iii) systematically improve the drainage system in correspondence with the establishment of the above irrigation system;

iv) extend and propagate dry season paddy through the expansion of double cropping, and introduce effective diversified crops;

v) develop effective farm level agricultural production activities;

vi) extend modern farming practices;

vii) strengthen existing agricultural support systems which will ensure efficient management after Project implementation; and

viii) promote hill area development.

(2) Hydropower Development Objectives are to:

i) effectively exploit the hydropower potential of the Matuno River by constructing a dam; it will also create the secondary effects on flood control and silt control.

ii) futher energize the Luzon Grid for distribution in Luzon; and,

iii) supplement the deficit irrigation water in droughty years, thus aiming at the comprehensive development.

(3) Flood Control Objectives are to:

i) reduce flood damage and thus support agricultural development and,

ii) stabilize livelihood and protect the cities of Bayombong and Solano by constructing embankments in appropriate locations along the Magat River.

4.1.3 Introduction of Stage Development

The present plan aims at the development of 3 specific sectors, namely, agriculture, hydropower and flood control. On the basis of the various development targets for each sector described above, a multi-purpose development plan has been adopted as suitable for present conditions in the Philippines. In addition, implementation of the plan is divided into 2 stages, the first stage forming the foundation for

the second. Such gradual implementation will keep initial investment down providing maximum return for minimum investment.

The objectives of stage development are: i) Stage I, to bring immediate benefit to the Project area, and ii) Stage II, to provide substantial enlargement of benefits. Stage II development will not nullify any of the functions of Stage I development. Such stage development would take the following form:

Stage I

A diversion dam will be constructed at Bayombong on the Magar River. This river will become the main source of irrigation water for the commencement of agricultural development. At strategic points along the same river, embankments will be constructed to reduce flood damage.

Stage II

A dam will be constructed on the Matuno River to develop hydropower, as well as to provide a stable irrigation source to the area.

4.2 Project Formulation

4.2.1 Optimum Scale of Development

(1) Agricultural Development Plan

Optimum scale of agricultural development was determined by evaluation of the following alternatives:

Alternative 1 To use water from the Matuno and Magat rivers, extending the irrigation area as far as technically possible.

Alternative 2 To use water from the above sources but to extend irrigation only as far as both technically and economically feasible.

Alternative 3 Same as alternative 2 but with an additional 1,000 ha of non-irrigated land in the western hill area for integrated rural agricultural development.

Upon evaluation of the above, alternative 3 was selected as the most appropriate scale for agricultural development. This alternative will be the most economically effective, facilitate modernization of agriculture, and have a widespread social impact. The projected land area for this proposed plan is 13,680 ha.

(2) Hydropower Development Plan

The object of the optimization sutdy is to find the most appropriate plan for the development of the Matuno River as a power source. Accordingly 4 sites (A, B_1, B_2 and C) were selected and compared for effectiveness. Of these, the C damsite was discarded due to inferior geology and restrictions in dam height. Thus the surveys and studies were concentrated in other three damistes. Economic comparison was made on three possible cases, namely, a high dam at site B_2, a high dam at site B_1, and a high dam at site A with an afterbay dam at site B_1, while various dam heights were considered for each case. The result was the selection of a high dam at B_1 with a height of 147 m as most appropriate.

(3) Flood Control Plan

Two possible approaches were considered for flood control, various possible scales of flooding being examined in each case; i) to include flood control capacity within the proposed Matuno Dam, or ii) to construct river embankments along the Magar River. Comparative analysis revealed that flood control capacity incorporated within the dam would be less economically feasible than exploitation of the dam for hydropower. For this reason and for the expected beneficial social impact, it was decided that a flood protection embankment at 2 areas would be planned along the left bank of the Magat River for a total length of 13.5 km. The construction cost of this plan is actually less than the justifiable expenditure. Although the Matuno dam will not have a specific flood control storage, a suitable gate operation will cut the flood peak of 10,300 m^3/sec into 6,800 m^3/sec.

4.2.2 Water Resources Development Plan

(1) Multi-purpose Development Plan

On the basis of the appropriate scale determined for each development objective in 4.2.1, an evaluation of different combinations of the objectives involving the Matuno and Magat rivers has been conducted to determine the most effective combination. As this study aims at a plan for water use and the proposed dam has no flood control capacity, evaluation has been based solely on those objectives concerning agriculture and hydropower development.

On the basis of B/C and B-C, irrigation and hydropower plans, as part of the optimum multi-purpose development plan, are porposed as follows:

Irrigation: Three diversion dams will be constructed for intake.

Upstream area: 1,090 ha Manamtam Diversion Dam on the Matuno River

Low flat land: 11,590 ha Magat Diversion Dam on the Magat River

Lowland area: 2,745 ha A diversion dam will be constructed on the Lanog River and return flow will be supplied to the area irrigated by the Magat diversion dam in addition to water supplied by the Lanog dam.

Water balance studies for the plan over the past 20 years however, indicate a shortage of water supply during the 1969 dry season and the 1975 rainy season.

Hydropower: Construction of a 147 m high dam on the Matuno River at site B_1, as recommended in 4.2.1, with a 6 km tunnel to divert water to Busilak barangay with tailrace released to the Magat River, appears to be the most feasible approach to hydropower generation. Peak generation is proposed for an 8-hour period. This can be adjusted however in the event of shortages in irrigation supply.

Other possible alternatives examined were as follows:

Proposal 1: Hydropower generation with a high dam at site A and an afterbay dam at site C, with all irrigation water supplied from a diversion dam to be constructed at Manamtam on the Matuno River.

Proposal 2: Hydropower generation with a high dam at site B_2. Irrigation water to be supplied directly from the tail-race of the power station to the main canal. Details are given in APPENDIX I-VI.

(2) Effectiveness of Multi-purpose Development

As explained in section 4.1.3, Stage I of the proposed development plan will, with minimal investment, have a substantial impact on agricultural development in the Project Area. Stage II, the establishment of a hydroelectric power supply from the year 1996, although it entails a larger capital investment, will result in a substantial enhancement of Project benefits. In addition to the advantage that any shortages in irrigation water supply which may occur in Stage I can be remedied in Stage II, the following reasons may be given for the expected effectiveness of the multi-purpose scheme.

i) Effect on the Magat Dam

Through improved cropping intensity brought about by implementation of the proposed plan, evapotranspiration will be increased at a rate of 44.9 MCM/yr. This would in turn result in reduction of annual benefit of power generated by the Magat Dam project by $0.15 million. This reduction will be offset however, by the storage effect of the proposed Matuno dam which will provide a 1% increase in the water supply available to the Magat Dam. Therefore the benefit reduction of Magat Project ($0.15 million) continues only for 5 years between Stage I and II.

ii) Maintenance Flow of Magat River

There is no clear stipulation in the Philippines at this time for maintenance flow of rivers. In the case of diversion dams, NIA's standard prescribed usable water flow was 90% of low water flow with a 5-year return period. The remaining 10% flow could thus presumably be adopted for river maintenance flow. For the Project however, the area inundated by the Magat reservoir will almost extend to the Project area boundary, and it is therefore considered that a maintenance flow on the Magat River for downstream irrigation need not be established. In addition to ensuring water supply to both the Project area and to all existing irrigated areas serviced by the Magat River, the proposed plan must also provide for additional maintenance of domestic water supply for washing, etc. (1.3 m^3/sec) and compensation for seepage loss (0.1 m^3/sec) caused by rise in the river water level by damming up. With the construction of the proposed Matuno dam, these problems will be also resolved.

iii) Sedimentation of Magat River

In October, 1982, the Magat dam, located 48.5 km downstream of the northern boundary of the Project area, was completed and water storage commenced. The Feasibility Report on the Magat Project estimates that sediment deposits will rise in the riverbed and hence the water level in the vicinity of Bagabag within the Project area will increase by 2-3 m over 50-year period. The same report assumes that the sediment production per hectare per year is 18 tons. The Magat Watershed Feasibility Study, on the other hand, reports an estimation of 35-40 t/ha per year. In the case of the Matuno River however, an annual accumulation of approximately 9 t/ha, based on field measurements, has been assumed. Construction of the Matuno Dam will help to mitigate the rise of the riverbed along the Magat River, and thus to effectively suppress flooding in future.

4.2.3 Agricultural Development Plan

(1) Adoption of Rural Agriculture Development Plan

The primary aim of the Project is to optimize effective land, water and labor resource utilization in Bayombong and the Solano sub-basin, and to maximize the area's agricultural development potential. The development plan, as aforementioned, must therefore be suited in scale to the social and economic situation. With this as a guideline, the most appropriate Project scale was selected after evaluation and comparison of the following plans:

Original Plan: to utilize water resources of the Matuno and Magat rivers for optimum economic effectiveness, including 12,680 ha to be irrigated.

Maximum Development Plan: maximum development of land resources focusing on the Matuno and Magat rivers as water sources. Lining of all main irrigation canals for more efficient water use. A total development area of 13,700 ha, with 555 ha on the left bank of the Lamut River and 465 ha on the right bank of the Magat River.

Integrated Rural Agriculture Development Plan: development of land and water resources with particular attention to utilization of local labor and increase of farm income. An additional 1,000 ha of the western hill area to be developed for cash crops, livestock raising, dendro forest, etc. Total development area of 13,680 ha.

After examination of the above, the Integrated Rural Agriculture Development Plan was selected as the most appropriate for the following reasons:

i) implementation of the same will increase the potential for development from single crop paddy farming to multi-crop farming.

ii) agricultural income will be increased while the rate of unemployed or underemployed and out-migration to Metro Manila will be decreased.

iii) with the introduction of multiple cropping, modernization of cultivation techniques will increase.

iv) animal husbandry and dendro forest will be promoted thereby reducing the flight of foreign capital while production of such crops as cashews will stimulate influx of foreign exchange thereby benefiting the national economy.

v) the Internal Rate of Return of this Integrated Plan is 18.9% the highest among other development plans.

The establishment of the said agricultural development plan will introduce integrated development methods into the NIA project as well.

(2) Irrigation Plan Formulation

A realistic irrigation plan should both preserve beneficial traditional irrigation practices and at the same time develop an economic, technically effecient system. The proposed plan was thus based on the opinions of various experts and those of the local farmers themselves, and is designed to incorporate existing irrigation systems wherever possible. Accordintly, the first step was a comprehensive field sutdy of present irrigation facilities.

According to field surveys, the existing CIS are judged to have the following deficiencies:

i) intake structures along the river, consisting of either temporary brush or stone dams, are washed out during yearly floods.

ii) as the intake facilities are deficient, water supply to the main canal is not reliable.

iii) in many sections irrigation canals have deteriorated with age and cross-sectional water flow areas are insufficient.

iv) excessively small CIS result in inefficient management and maintenance of facilities.

As the CIS have developed randomly in response to local needs, there is no organized overall irrigation system to efficiently coordinate operation. Limited water supply and usage of return flow results in further complexity of the irrigation water system.

Although benefited farmers in upstream canal area make relatively frequent efforts to maintain intake dams, they do not maintain the canal. For this reason, water shortages occur downstream and there is thus less incentive among beneficiaries in downstream areas to maintain the canal and related structures. This situation hastens the deterioration of irrigation facilities causing water shortages even during the wet season.

A new irrigation plan which would diminish the function of the existing CIS, no matter how modern or beneficial, would likely be opposed by the local farmers. A plan which on the other hand, increases and strengthens the functions of the existing CIS would likely receive the farmers' approval and active cooperation.

The latter approach has therefore been adopted. The present conditions of the existing CIS were surveyed as thoroughly as possible in the time allowed. In this way, a plan was drawn up whereby the water supply for each CIS would functionly continue with improvements. Furthermore, proposals for construction of new canals were kept to a minimum in determining the irrigation system, as such construction would decrease the area of cultivable land.

(3) Related Infrastructures

Improvement of drainage facilities, an increase in the percentage of roads, and the establishment of on-farm facilities are essential for the successful achievement of targeted yield. Drainage

facilities are necessary for timely removal of surplus water during inundation and for appropriate water management. Inspection roads are necessary for adequate operation and maintenance of facilities, and will moreover serve as farm and access roads to the local farmers and other residents. Finally, as the ultimate success of the Project is dependant on completion of the on-farm facilities, provision for establishment of the same has been included in the Project.

Additional programs such as construction of a model pilot farm, enlargement of the agricultural experimental center's functions, and establishment of a research center for hillside agriculture were also considered. As the main objective of the Project is to reinforce existing facilities however, the above were not included in the present plan.

(4) Integrated Approach to Hill Area Development

The development area is located in the southern part of the Project lowland, in the foot hills of the Cordillera mountains facing the Magat River. The area consists of about 1,300 ha presently used for pasture which varies in elevation from 300-420 m.

i) Hill Area Plan

a) Dendrological development plan

A program for ipil-ipil reforestation has been promoted in this area under the Magat Watershed Project by the Bureau of Forest Development, Ministry of Human Settlement and National Irrigation Administration. Ipil-ipil has high economic value as a source of fuel, charcoal, timber, animal feed, pulp, etc.

About 100 ha of the said area has been designated non-usable for other development purposes due to high elevation, steep gradient, varied undulation and excessive rock outcroppings. Calculations show that utilization of the same 100 ha of land for ipil-ipil would result in production of 400,000 bunches of firewood annually 5 years after the first planting.

b) Fruit-tree development plan

Approximately 114 ha of the Magsaysay hill area is devoted to fruit production forming the main fruit production area. The said area is thus the focus of the fruit-tree development plan, 400 ha of which have been designated for development.

From among various possibilities under the tree development plan the cashew has been selected for the following reasons:

- adaptability to variety of agro-climatological conditions and suitability to conditions in the Project area
- minimal cultivation of the cashew at present in the Philippines
- versatility; the cashew can be used for juice, vinegar, wine and hog feed
- high secondary processing potential including husking, roasting and oil extraction

Economic return on initial investment for cashew production will begin 5 years after the first planting and the yield will increase annually. If the plantations are well managed, approximate production of 1,500 t of raw nuts may be expected from 400 ha of land within 10 years of the first planting.

c) Animal husbandry development plan

The lower gently graded hills are currently used as cattle pasture. Present grazing practice is extensive with no particular facilities. The number of cattle are therefore limited. With the installation of the minimum necessary facilities however, 1.4 head of cattle may be grazed per hectare.

In the plan, 500 ha of land have been designated for development including provision of facilities as access roads, fences and water areas where water is derived from local streams and operation loss of the main irrigation canal. These facilities will provide grazing land for about 700 head of cattle and carabaos which will be used as sources of milk and meat.

4.2.4 Flood Control Plan

The flood control aspect of the Project was examined from two viewpoints; i) provision for flood control capacity in the reservoir of the proposed Matuno dam, and ii) construction of embankments along the Magat River to protect the area from annual flooding.

As mentioned in the Water Resource Development Plan, of the various dam functions, hydropower and irrigation are complementary. As the same discharge utilized for power generation can also be diverted for irrigation, no conflict will arise in the use of reservoir water in fulfilling these two functions. However, the relationship of power generation and flood control is competitive. To determine the priority, a comparison of the benefits of power generation as opposed to flood control were made by comparing a variety of cases of differing flood control capacity with a height fixed dam at site B_1.

In all cases, the loss in power generation benefits in relation to flood control benefits was greater. A surcharge depth of 10 m below the normal high water elevation provides a control volume of 33.6 MCM, and results in a loss of US$940,000 in power generation benefits annually, while the total annual benefit through flood control is US$910,000. From the viewpoint of the national economy then, it may be concluded that power geneeation is more profitable and therefore no provision has been made for flood control in the proposed dam.

The expectations on the local people with regards to flood mitigation however, are high. Accordingly, in Stage I, construction of a 13.5 km length of embankment along the left bank of the Magat River is proposed. The design flood is estimated at a probable 50-year return

period. Although the proposed Matuno dam will not have a specific storage for flood control, suitable gate operation will make possible to regulate the outflow from the design flood peak of 10,300 m^3/sec to 6,800 m^3/sec.

4.2.5 Hydropower Development Plan

The hydropower development was envisaged to utilize the available discharge and head of the Matuno river as much as possible. The location of dam, tunnel and power house is so selected as to supply the water after power generation to irrigation for a comprehensive project. The water discharged from the power house will be led to Magat river through a tailrace about two km upstream from the proposed Magat Diversion Dam.

As mentioned in 3.6, the present power generating facilities in Luzon Grid has an enough surplus to the demand of the major cities, mainly due to energy saving and economic slump after 1979. The Government had to convert the power source from the expensive oil imported to indigenous resources, such as geothermal, coal, hydro and dendropower. The NAPOCOR's 10-year Power Development Plan was thus established along with the above national policy.

The geothermal plant in Philippines has a high advantage of obtaining abundant steam from the shallow depth. Already in Mak-Ban and Tiwi, 10 units of 55 MW each were put into commission and also other promising sites are under investigation. However, the geothermal plants have some constraints, such as i) locations are limited, ii) environmental problem will become severe, and iii) unexpected change of steam supply might be occurred.

The fairly large coal reserves have been found at several places in Philippines. Therefore the coal-fired power plant is promising for its realization. The disadvantages of this type of power plants are - i) the caloric value of the coal is as low as about 4,700 kcal/kg suggesting the disposal problem of the ashes after use, ii) transportation and storage facilities are required and iii) air pollution problem. Those constraints would limit the total development size of coal-fired plants.

On the other hand, the hydropower development has the following disadvantages, namely, i) comparatively large initial investment, ii) complicated social problems for acquiring the required lands, especially for the reservoir area, and iii) fairly longer construction period of 5 to 6 years compared with 2 or 3 years for other thermal power plants. However, the hydropower has a wide range of advantages, such as no air and water pollution, flood control, silt control, effective water supply to other uses, inland fishery, recreation, etc. In addition, the hydropower does not require any fuel cost, which often tends to price fluctuation, therefore the energy cost will become very low after the facilities are amortized. It also assures the easiest operation with least outage than any other generating methods, resulting in most dependable power source with long life.

The Luzon island, blessed with rich rainfall, has numerous promising hydropower sites still left undeveloped. Those water potential is to be utilized as much as possible for any use without waste.

Although the power demand increase after 1979 becomes dull, it will be recovered within several years according to the world economic recovery. Also from the view point in a long run, the electric power and energy will be further required. The reasons for it are that the industrial self-sufficiency shall be required for Philippines sooner or later, because the present export of the primary goods may not earn sufficient foreign currency needed for import of finished commodities.

Not only the industrial demand but also the doemstic use of electric energy will be increased according to the increase of per capita income. The present power supply in Luzon covers only major cities, towns and their vicinities. Still much latent demand in rural areas are thirsty for power supply as proved by the increase in recent years in Nueva Vizcaya Power Supply Cooperative or high increasing rate in Mindanao having extension of transmission and distribution lines. However the financial capacity of the Philippines will limit the considerable expansion of distribution lines in rural areas after 1990.

It is very clear that the Matuno River Development Project will contribute much to the integrated regional development around Nueva Vizcaya Province creating social and economic incentive. However, the comparatively big amount of US$370 million required for the hydropower development suggests that the agricultural development shall be started with as the Stage I and that of hydropower be as the Stage II. Therefore it is recommended to implement the power development from 1991 following the Stage I.

4.3 Proposed Agricultural Development

4.3.1 Proposed Development Area

In the Project, the area to be selected for agricultural development can be classified into 4 different areas according to topography, vegetation and soil as well as present land utilization and irrigation systems. The 4 areas are as follows:

Division	Development Area (ha)
Magat River Left Bank Lowland	12,780
Western Hillside Area	1,300
Lamut River Left Bank Area	504
Magat River Right Bank Area	505

90% of the total arable land in the lowland area of the Magat River's left bank is paddy. In the proposed development plan, 12,680 ha have been allotted for the Project as irrigable area.

Most of the western hillside area is currently utilized for animal grazing as discussed in 4.2.3. In the Project, 1,000 ha of the area surveyed (1,300 ha) will be devoted to promotion of animal husbandry, establishment of cashew plantations and dendro-logical development with ipil-ipil.

The lower portion of the left bank area of the Lamut River is presently used as paddy and dry field. Most of the area however, is natural

pasture land. The soil is suited for paddy but the topography creates problems for reclamation of paddy field. If this area was selected for irrigated agricultural development, water could be supplied by the Lamut River after construction of an intake facility or of an inverted siphone across the Lamut River. This would bring water from the proposed mountain-side main canal, the source of which is the Magat River. Study results show however, that the development cost of either facility would exceed US$5,000/ha. The Lamut River left bank area was consequently eliminated as a potential development area.

The Magat River right bank area consists of the cultivated area of Paitan downstream from Batu bridge. Development in this area would mainly deal with irrigation. The most reliable irrigation water source would be the Matuno River. As discussed in APPENDIX I-I however, implementation of such a plan would cost an estimated US$6,000/ha. Consequently, this scheme was also eliminated from the plan.

4.3.2 Proposed Land Use Plan

The land use plan for the Project area was determined by dividing the area into blocks, 5 in the lowland area and 1 in the upland area, according to soil type, land classification and the irrigation development plan as shown in FIG. 7. The major objectives for land utilization within each block division are given below.

Block 1, located in Bagabag, Sta. Lucia and Pieza, is mostly suited for paddy and corn cultivation. Therefore 14% of the area has been designated as a wet paddy/dry corn crop rotation area and the remaining area as double paddy partly combined with mung beans.

Block 2, which is located in Bintawan and Villaverde, is paddy area.

Most of Block 3 is presently served by Colocol CIS. In this area farmers have attained a comparatively high level of stable agricultural production. This block, the most developed of the 6, can be utilized not only as a paddy production center, but also as a center for post harvest operations.

Block 4 is located in Manamtam, Sto. Domingo and La Torre areas and will be used for paddy.

Block 5, is located along the Magat River left bank, the Lamut River right bank and both banks of the Lanog River. The area has been designated as an upland irrigation area including paddy.

1,300 ha in the western hill area have been designated as Block 6, 1,000 ha of which will be used for a hillside development plan.

Land classification and proposed land use are tabulated in TABLE 2 and 3.

4.3.3 Proposed Cropping Pattern

(1) Proposed Cropping Pattern

With complete irrigation facilities, a major change in the cropping pattern will be effected. The proposed cropping pattern is depicted in FIG. 8.

The seasonal calendar for paddy in dry season commences in the mid-September and continues to the mid-November with land cultivation and puddling; transplanting begins in mid-October and ends in the second week of December while harvesting takes place from mid-January to the end of the first week in March. Harvesting of dry season paddy crops falls during the driest month.

To extend the wet season paddy area, the land cultivation and puddling are better to be commenced in May when natural rain water is available; transplanting from the last ten days of May to the end of June; and harvesting from late August to the end of October.

The proposed cropping pattern provides a 90-day fallow period between each cropping season. This period will allow farmers sufficient time to maintain irrigation systems and to post harvest operation. During this period, one third of the area will be planted with mung beans, the growth period of which is about 70 days. The mung bean is a promising leguminous crop, high in protein, the use of which will increase soil fertility by providing nitrogen and organic matters to the soil.