CHAPTER 4

CHAPTER 4. ROAD IMPROVEMENT PLAN

Section 1. Fundamental Approach to Road Improvement Plan

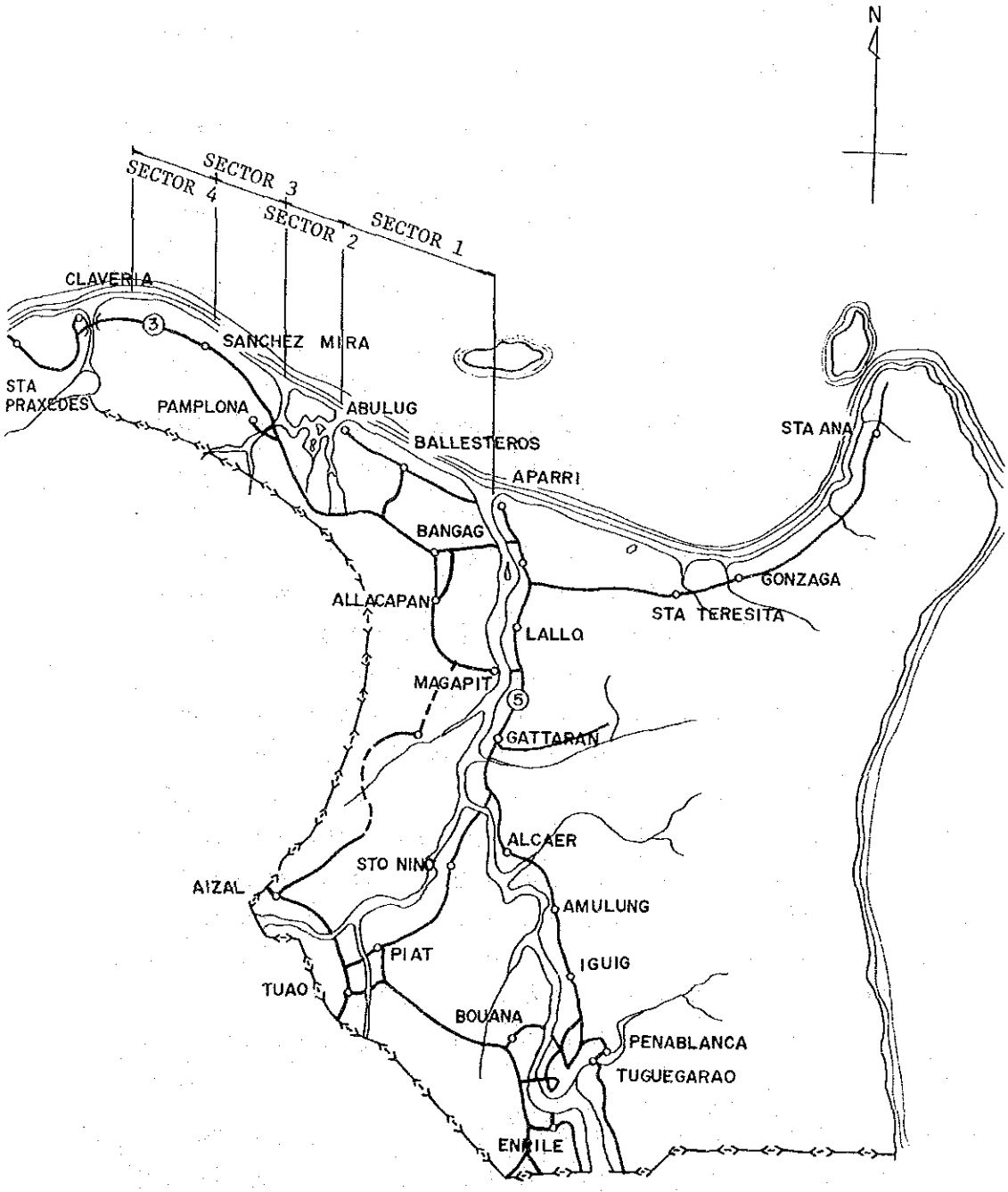
The present survey was conducted for the road improvement plan to be executed as apart of Aparri Iron Sand Deposit Development Project in order to transport iron sand from the said deposit to the proposed loading site at Centinela Point. The deposit lies in the northern coastal area of Luzon extending northward over a distance of about 55 km from Linao on the west bank of the mouth of the Cagayan river to Pata river. The survey covered the national highway and provincial roads and feeder roads which are directly required for transportation of iron sand as well as the borrow pits and gravel pits from which to collect the main materials and their transport roads.

For the purpose of the present survey for road improvement plan, the deposit area was divided in the same way as adopted by Japanese Steel Corporation in the survey in March 1976.

Table 4-1. Division of Aparri Iron Sand Deposit

SECTOR	LOCATION	EXTENSION	AREA	RESERVE IN TERMS OF REFINED ORE
1	Cagayan river Abulug river	19 km	4,000,000 m^2	2,572,000 t
2	Abulag river Pamolong river	10 km	2,000,000 m^2	1,299,000 t
3	Pamolong river Sanchez Mira river	14 km	2,500,000 m^2	1,419,000 t
4	Sanchez Mira river Pata river	11.5 km	6,400,000 m^2	4,760,000 t
TOTAL		54.5 km	14,900,000 m^2	10,050,000 t

Fig. 4-1 DIVISION OF IRON SAND DEPOSIT



1-1 Feeder Road

In order to transport iron sand from the deposit to the proposed loading site at Centinela Point, a number of feeder roads connected with the national highway or provincial roads must be available. While most of the roads planned to be used as such feeder roads are used for local residential road or agricultural purposes, there are few which permit the passage of large vehicles because of the inadequte condition along their route and their poor structural condition.

Between the coastal sand bar area and the national highway, there are weak ground zones, marshes rice paddy and many irrigation cannals flow through such zones. Although simple wooden bridges are constructed on most of these canals, they cannot withstand the heavy surface load imposed by iron sand trucks.

1-2 National Highway

The highway covered by the present survey is National Road Route 3 which is commonly called Manila North Road. It constitutes the highway network of northern Luzon together with National Road Route 5 which is also called Cagayan Valley Road. A section of this road, which is expected to be constructed along the northern coastline, is included in the Philippine Japan Highway Loan Project II (Second Phase PJHL Project; see Fig. 4-2) which now awaits the approval of the Japanese government. It is planned that as soon as the approval is given, the project will be implemented to complete the deisgn work in the initial year, and the construction work will be started from the Cagayan river towards the west for completion in the subsequent three years. Hence, the progress of this project was studied in specific relation to the time of starting mining operation in Aparri deposit as well as to the division of the deposit, and improvement of national roads was not included in the present Aparri deposit project (see Section 2 "Existing State and Future Improvement Plan of Highway Network of Northern Luzon").

PJHL-II was initially planned to be started from Bangag (see Fig. 4-3) because the Department of Public Highways was not informed of

Fig. 4-2 PAN PHILIPPINES HIGHWAY (PJHL)

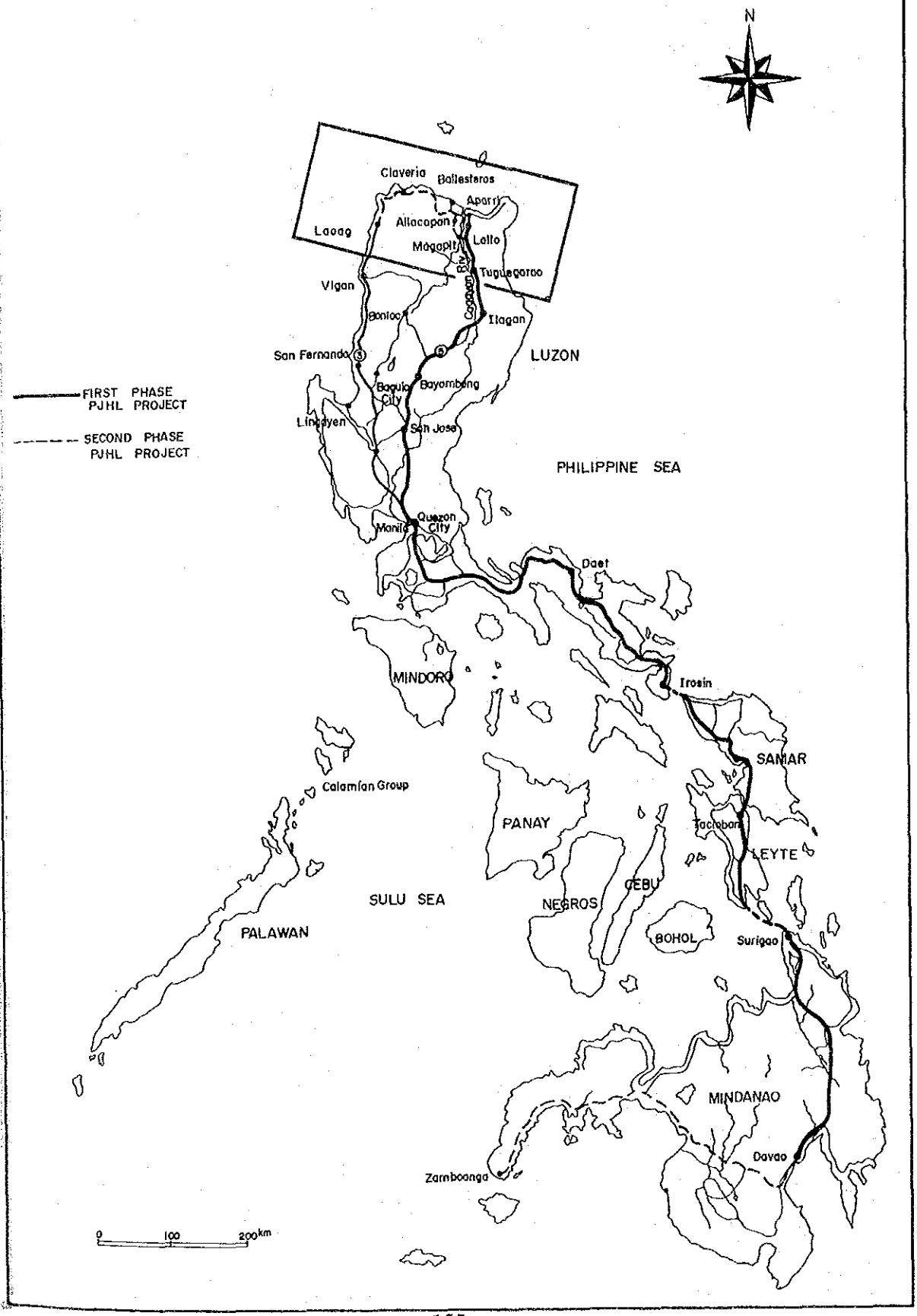
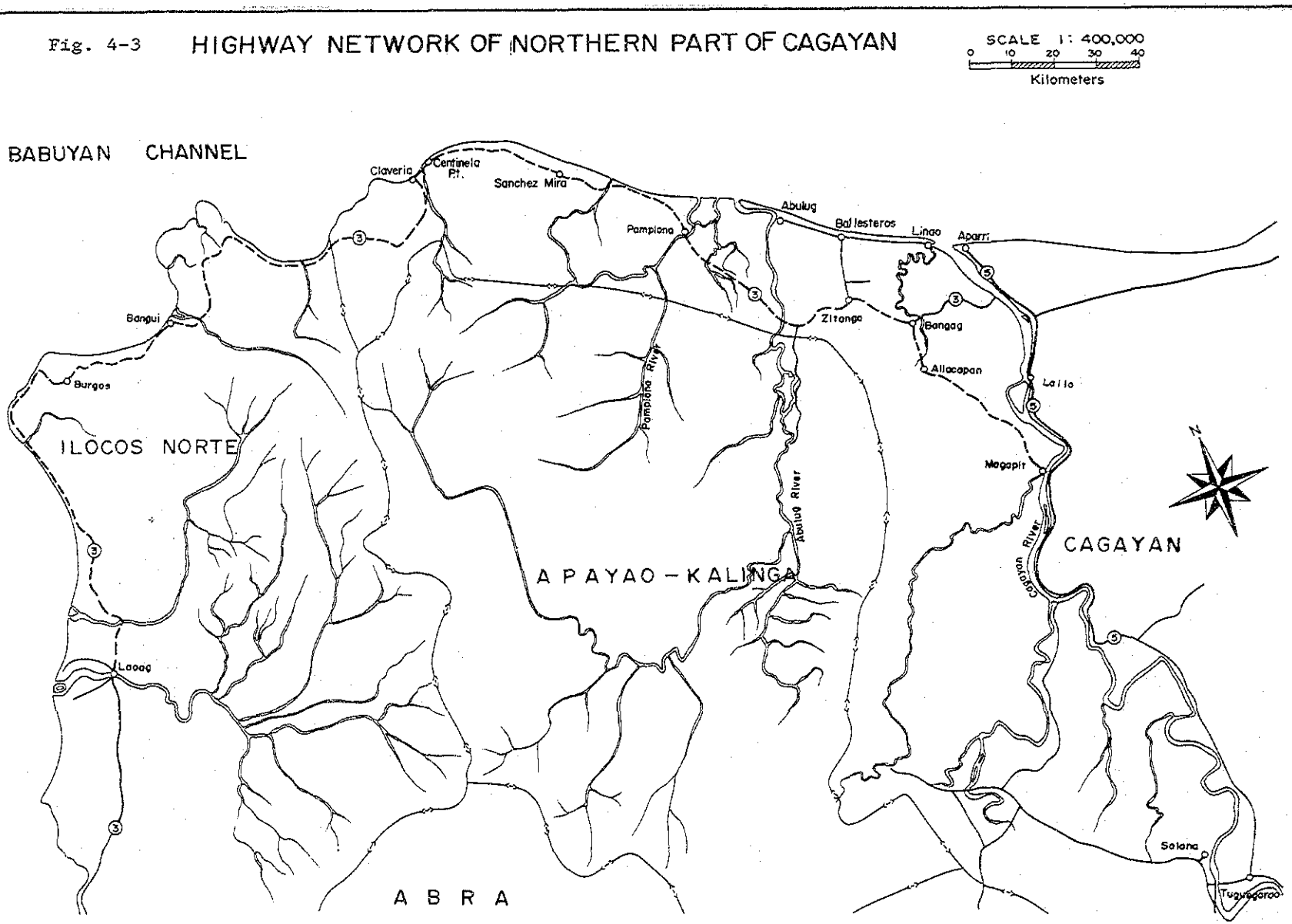


Fig. 4-3 HIGHWAY NETWORK OF NORTHERN PART OF CAGAYAN



the details of Aparri deposit project. It is apparent that once the exploitation of the deposit is started, there will be generated a very heavy traffic which is far heavier than the prevailing traffic. It is therefore hoped that PHJL-II will be implemented with priority also given to Sanchez Mira ~ Claveria section or to the improvement of smaller bridges to keep pace with the progress of Aparri deposit development.

1-3 Provincial Road

In the area covered by the present survey, sector I resorts to provicial roads of Cagayan for shipment of its iron sand. Of the three provincial roads running in this sector, mainly two will be used for transportation of iron sand. These are Abulug ~ Ballesteros ~ Liano road with which a number of feeder roads will be connected, and Zitanga ~ Ballesteros road which will connect the said road with National Road Route 3. These two roads are in a fairly good condition for local roads, but they pass through active commercial districts and the dwelling unit density is very high around Ballesteros. If iron sand is to be transported by these two roads, it must be preceeded by negotiations with the inhabitants along their route.

The other provincial road running in sector I connects Lucban and Abulug. Although a section of this road is being widened by the provincial government, its surface calls for improvement work and a new bridte must be built across the Guiddam river having a width of more than 55 m since the old bridge was washed away by flood discharge. Compared with the Zitanga ~ Ballesteros road, it is closer to Centinela Point and the dwelling unit density near Ballesteros is smaller. However, construction of a new 60 m long bridge cannot be economically justified when considered only from the viewpoint of Aparri deposit development project. In the present road improvement plan, therefore, this road was reviewed only for comparison and excluded from the estimate of total construction cost of recommended plans.

Under the Capital Improvement Program of Cagayan province, the former two roads are expected to be completed by 1980 before the mining operation starts in sector I following sectors IV and III. Hence, their improvement was not considered during the present survey.

Section 2. Existing State and Future Improvement Plan of Highway Network of Northern Luzon

2-1 Existing State of National Roads of Northern Luzon

There are two national roads leading to northern Luzon from Manila, i.e., National Road Route 3 (Manila North Road) and National Road Route 5 (Cagayan Valley Road). A strip of mountainous area dividing Luzon island from south to north lies between these two roads, and the Cagayan river flowe on the east of this area. Within Cagayan province, the two roads generally run in flatland areas.

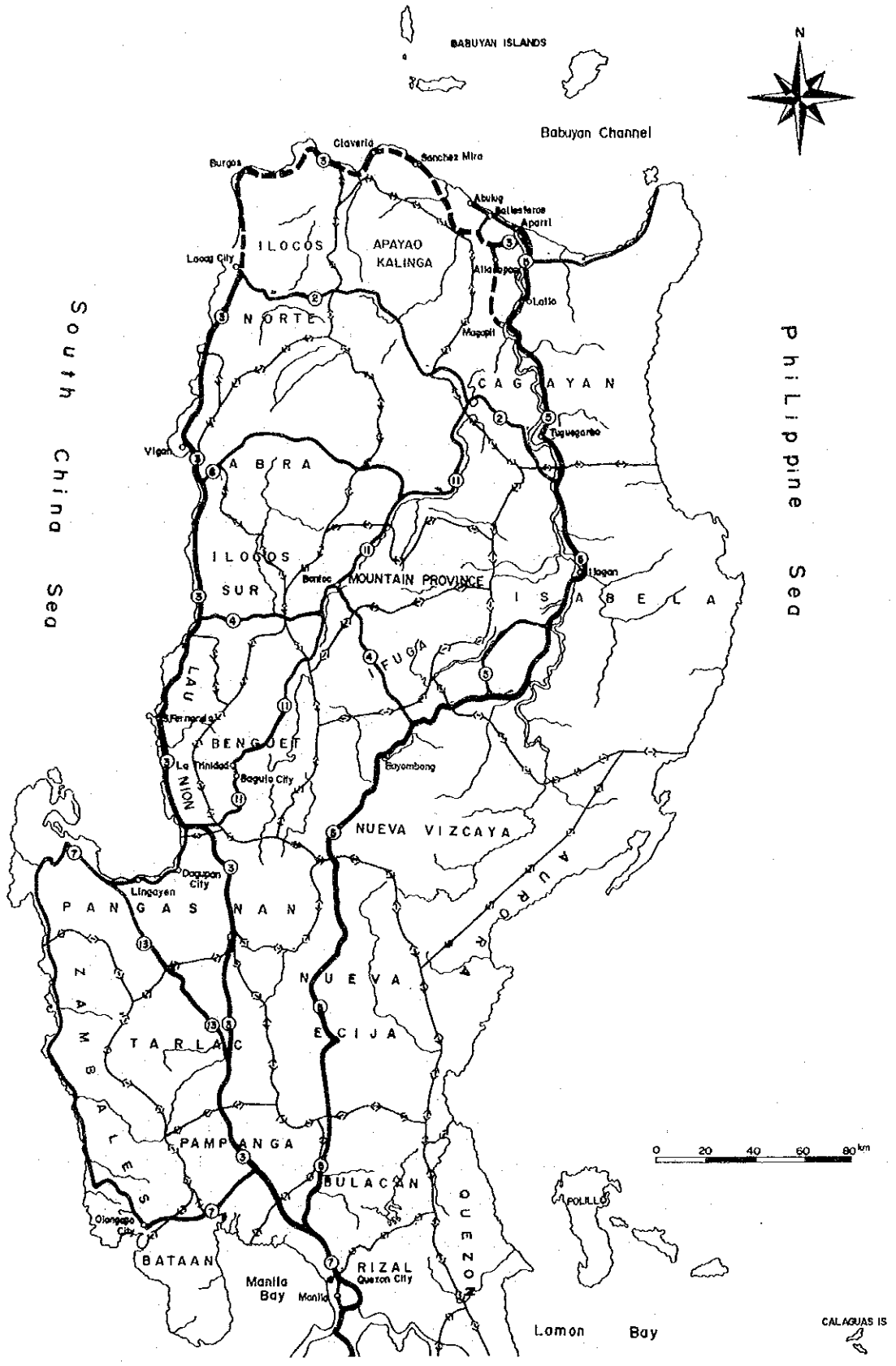
Starting from Manila, National Road Route 3 runs along the western and northern coasts of Luzon island, and joins National Road Route 5 after crossing the Cagayan river by ferry. It has a total extension of about 700 km.

National Road Route 5, which also starts from Manila, extends northward from the southern part of Isabela province approximately in parallel to the Cagayan river, and leads to Aparri. It has a total extension of about 600 km. It is an important arterial road constituting the northern-most section of PJHL-I which covers a distance of 1,481 km, extending southward from Aparri to Davao of Mindanao island via Samar island and Leite island.

There are a number of national roads routes 2, 4, 6, 11) which cross the mountainous area lying between route 3 and route 5, but they include many sections which still await improvement work (see Fig. 4-4).

The pavement work of National Road Route 3 has so far been completed between Manila and the point about 20 km to the north of Laoag city, but no improvement has yet been undertaken in northern sections along which mountainous terrain stretches as far as the shoreline and in those sections in Cagayan province which pass through rice paddy areas having an elevation of less than 5 m. Especially in the mountainous sections, there are many places where the passage of

Fig. 4-4 HIGHWAY NETWORK OF NORTHERN LUZON



pedestrians and vehicles often becomes impossible even in the dry season because landslide is caused once rain falls.

The main rivers crossed by National Road Route 3 in the survey area are the Claveria, the Pata, the Abulug and the Guiddam. Reconstruction of long and large bridges on these rivers has already been completed, but about half of smaller bridges with a length of less than 50 m are wooden bridges. If PJHL-II Project will be start, these bridges are replaced by new bridges using I-beam as main girder under PJHL-II.

At Cordinian junction where National Road Routes 3 and 5 join, the Cagayan river has a width of about 800 m but no bridge is constructed on it, so that the two roads are connected by ferry service. In the area extending downstream of Tuguegarao, the capital of Cagayan province, Magapit bridge now under construction is the only bridge on the Cagayan river. Now being built at Magapit where the width of the Cagayan is the smallest between Tuguegarao and Aparri, this bridge is the longest two-lane suspension bridge in the Philippines and is expected to be completed within this year.

A new road extending northward along the west bank of the Cagayan river from Magapit and joins National Road Route 3 at Bangag after passing Allacapan has recently be completed with the exception of few unpaved sections (see Fig. 4-5).

Improvement of National Road Route 5 has already been completed under PHJL-I except for the pavement of a very small section near Aparri.

Within the survey area, the maintenance of National Road Route 3 in undertaken by CWED (Cagayan Western Engineering District) of DPH (Department of Public Highways) at Tuguegarao. The geometric condition of this national road is generally satisfactory in horizontal, vertical and superelevation in few sections, and its surface is maintained in good condition as gravel road. As stated already, long bridges have newly been built on main river crossed by National Road Route 3, but about 20 of other smaller bridges are wooden bridges with a

maximum allowable surface load of about 10 tons (see Table 4-2).

Some sections of National Road Route 3 which pass through low-lying areas such as paddy field areas are prone to be inundated at time of flood because of the small height of road surface.

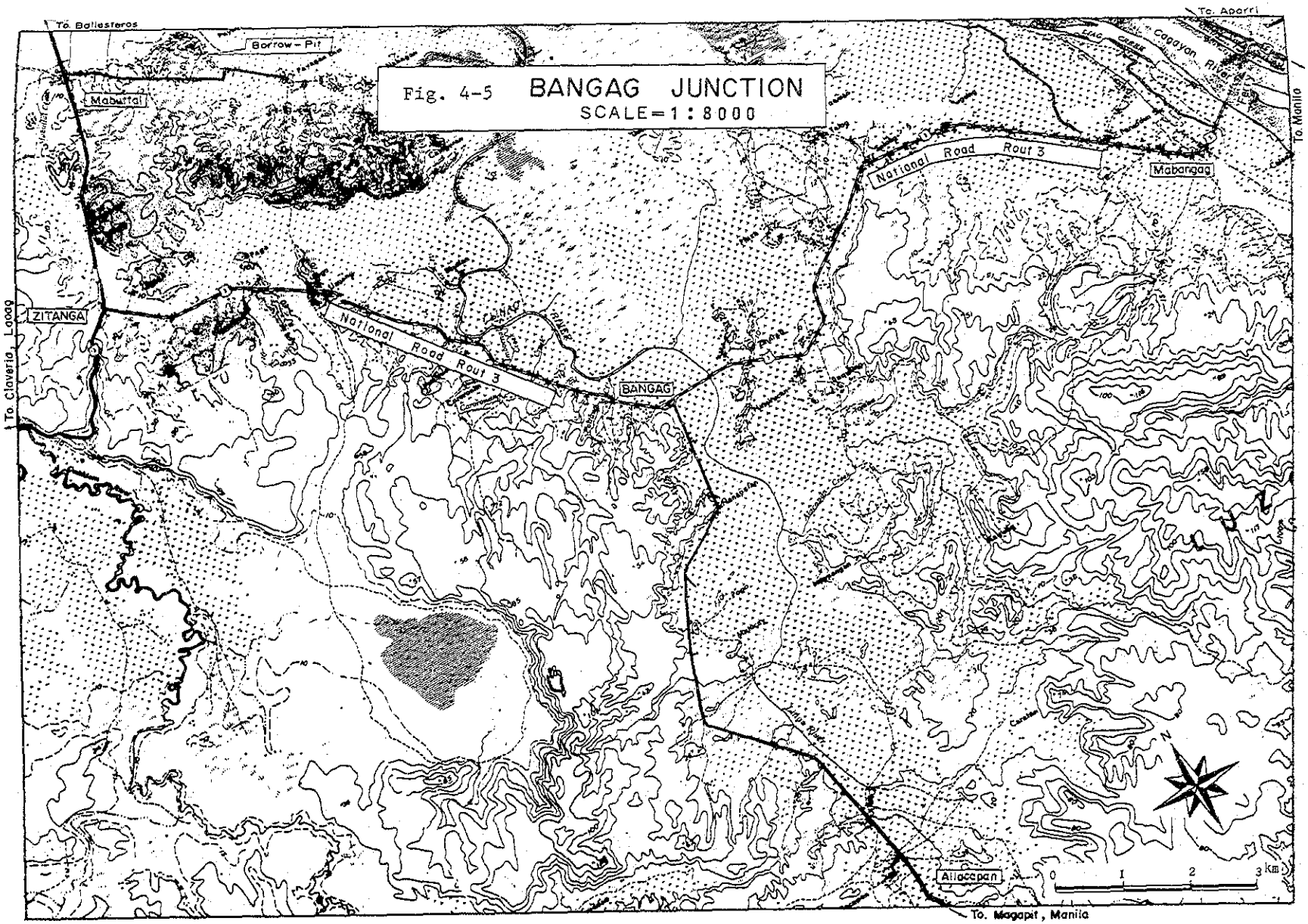


Fig. 4-5 BANGAG JUNCTION
SCALE=1:8000

Table 4-2. The List of Bridges of National Road Route 3 (I)

NAME OF BRIDGES	STATION	STRUCTURE	LENGTH	REMARKS
	km		m	
Claveria Br.	609,585	BX	155,00	Box Calvert
- do -	612,025	BX	3.00	
Culao Br.	614,192	BX	5.80	
- do -	615,131	BX	4.50	
Pata (1) Br.	617,672	Tb	8.30	Timber
Pata (2) Br.	618,872	RC	107,00	Reinforced Concrete Bridge
Nagtantayan Br.	621.313	RC	16.00	
Sanchez Mira Br.	631.593	I-Bm	54.87	I-Beam
Langagon Br.	631.602	RC	15.00	
- do -	633.603	RC	16.00	
Bangan (1) Br	636,246	RC	10.20	
Bangan (2) Br.	636,372	RC	10.20	
Bangan (3) Br.	636,482	RC	15.60	
Taguiporo Br.	636,834	Tb	7.00	
Cabalibaon Br.	637,194	I-Bm	21.34	
Pilig Br.	637,642	Tb	28.80	
Allasstan Br.	643,393	Tb	21.40	
Capago Br.	644,239	RC	31.00	
Pamplona Br	648,629	ST	449.80	Steel Trussed Bridge
Binalangan Br.	649,601	Tb	14.50	
Maragaragat Br.	652,033	Tb	11.65	
Bagu Br.	654,378	RC	15.24	
Dalayap Br.	654,720	Tb	11.40	

NAME OF BRIDGES	STATION	STRUCTURE	LENGTH	REMARKS
	km		m	
Stacruz (1) Br.	655,163	Tb	11.75	
Stacruz (2) Br.)	656,676	RC	15.45	
Calog Br.	664,117	RC	15.24	
Lucban Br.	668,048	ST	496.50	
Yagu Br.	670,640	By	24.10	Bailey
Guiddam Br.	674,095	ST	58.25	

2-2 Future Improvement Plan of Highway Network of Northern Luzon

1) Outline

The greater part of that section of National Road Route 3 which runs along the northern coast of Luzon island is not improved yet excepting the large bridges built on main rivers and few paved sections. The road covering a distance of about 210 km, including the said unimproved section of National Route No. 3, which links Manila and Magapit via Burgos located north of Laoag city about 488 km from Manila and Allacapan in Cagayan province is called Laoag ~ Allacapan road. The team was informed that this road is covered by the 6th Yen Credit Project for the Second Phase PJHL Project (PJHL-II). If PJHL-II is implemented smoothly, it will be completed in four years starting from the beginning of 1978 and completed in 1981 or 1982, one year of the above will be spent for the design works, and the subsequent three years for road construction works.

About 40 % of the said Laoag ~ Magapit road is already paved. Under the forthcoming PJHL-II, it is planned that 108 km of the remaining section will be paved by portland cement concrete and 37 km by bituminous concrete, and that road improvement work covering a total distance of 159.37 km including raising of road surface in sections liable to be inundated by flood water and construction of smaller bridges with a total length of 536.16 m will be implemented.

When iron sand transportation is started following the commencement of mining operation in the deposit, there will be generated a heavy traffic of large trucks which will be far larger than the present level of road traffic. In implementing PJHL-II, therefore, there may arise the need to determine the priority order of work sections in consideration of the progress of Aparri Iron Sand Deposit Development (AISDD) project.

The present surface condition of National Road Route 3 presents no problems for the traffic iron sand trucks. However, the road surface must be raised for a total distance of about 25 km in Sectors I, II and III. The cost required for this improvement work, including that for pavement, amounts to ₱820,000 per km.

2) PJHL Project Road

Construction of PJHL Project Road which crosses the Philippines islands from north to south covering a distance of about 2,100 km from Aparri in Luzon island to Davao in Mindanao island via Samar island and Leyte island was started in 1969 and is now nearly completed excepting few small sections.

Of the total construction cost required, The Japanese Government offered to credit $30 million for construction of 1,400 km section provided that the necessary construction equipment materials, and etc. would be procured from Japan.

The Government of the Philippines undertook to raise the remaining funds in other currencies and assume overall responsibility for the construction work which is expected to be completed in December 1977.

Following the completion of this road, the Government of the Philippines plans to construct Laoag ~ Allacapan road as Second Phase PJHL Project Road.

As for the relationship between AISDD project and PJHL-II project in terms of time and period of execution, the present survey presupposes the following time schedule.

Table 4-3 Work Schedule of AISDD Project and PJHL-II Project

Item \ Year	1977	1978	1979	1980	1981	1982 ~ 1987
PJHL-II Project		———	———	———	———	———
AISDD Project: Construction of Approach Road and Gravel Transport Road		———				
AISDD Project: Mining Operation in Sector IV			———	———	———	———
AISDD Project: Mining Operation in Sector III						———
AISDD Project: Mining Operation in Sector I						———
AISDD Project: Mining Operation in Sector II						———

Feeder road construction planned to be undertaken before commencement of mining operation in each sector, and first iron sand shipment scheduled for April 1979.

Improvement of National Road Route 3 is not planned under AISDD project as it is planned to be undertaken under PJHL-II project. If it is delayed for reasons assignable to PJHL-II project, Pata bridge #I must be rebuilt under AISDD project, and this will incur a construction cost of ₱170,000 ($23,300).

In case no approval is obtained for PJHL-II, then the reconstruction of wooden bridges which constitute part of the planned improvement work must be implemented under AISDD project. There are eight such bridges (total length: 114.8 m) and the total cost required for their rebuilding amounts to ₱2,296,000 ($314,520).

Background and Terms of Loans for PJHL Project

(Reference - 1)

Brief History of PJHL Project:

1. November 1966

The Philippine-Japan joint committee held it first meeting at which the Philippine side presented a memorandum requesting Japan's assistance in the following three projects.

a) Social Capital Improvement Project
b) Cagayan Railway Extension Project
c) Pan Philippines Highway Project

2. September 1967

At the second meeting of the joint committee, the Japanese side requested the Philippine side to clarify the priority order of the three projects. The discussion led to the final recommendation that top priority be given to the construction of Laoag ~ Zamboanga road having a total length of about 3,100 km.

3. October 1967

The Japanese government adopted the policy to provide loans for the construction of the said Laoag ~ Zamboanga road.

4. November 1967

At the request of The Government of the Philippines to conduct a survey for the said road construction project, the Japanese government carried out a technical and economic feasibility survey, whereby approval was given for the construction of Aparri ~ Davao section having a total extension of about 2,100 km.

The Philippine side requested for a loan of $60 million, to which Japanese side undertook to offer yen loan not exceeding ¥30 million.

5. February 21, 1969

Official loan agreement was concluded between the two governments, in which the said road construction project was referred to as Philippine Japan Highway Loan Project.

(Reference - 2)

1. Financing Institution

Japan Export-Import Bank and 13 Japanese foreign exchange banks (financing ratio - 80 : 20).

2. Recipient Body

The Republic of the Philippines.

3. Total Amount of Loan

An amount not exceeding 10,800 million yen ($30 million) to be advanced in instalments in accordance with the Implementation Program agreed upon between the governments of the Philippines and Japan.

4. Yen Loan Agreement and Contract

February 21, 1969	Yen Loan agreement was concluded.
February 21, 1969	First loan contract concluded with Japan Export-Import Bank, whereby ¥7,200 million was provided mainly for procurement of construction machinery and parts, machine tools, etc.
January 27, 1972	Advancement of total amount of yen credit stipulated in the loan contract was completed.
December 23, 1970	Second loan contract was concluded with Japan Export-Import Bank, whereby ¥3,600 million yen was provided mainly for procurement of bridge

construction materials, construction machinery and parts.

December 22, 1972 — Advancement of total amount of yen credit stipulated in the second loan contract was completed.

5. Term of Repayment and Interest Rate

19 years including a 5 year term of deferment ; 5.125% per annum.

6. Time Limit for Execution of Loan Contract

2 years after the day of conclusion of each loan contract.

In addition to the above yen loan provided by Japan Export-Import Bank and Japanese foreign exchange banks, a loan amounting to 3,800 million yen was provided on March 30, 1976 by Japan Overseas Economic Cooperation Fund for construction of the 33 km section in northern Samar and access road which constitute part of the unimproved road section in Samar island and Leyte island.

(Reference - 3)

The design criteria of Laoag ~ Allacapan road to be constructed under PJHL-II are as shown below.

BASIC DESIGN CRITERIA FOR PJHL-II HIGHWAY

1.	Average daily traffic volume :	400 ~ more than 2,000 vehicles/day
2.	Pavement loading:	10,000 LBS (ref. AASHO Standard Specifications of Highway Bridges, 1973, P-15)

3. Bridge loading : AASHO H-20

4. Design speed :
   on level terrain : 80 ~ 100 km/h
   on rolling terrain : 60 ~ 80 km/h
   on rugged terrain : 40 ~ 60 km/h

5. Maximum gradient :
   6%
   7% (on short tangents not more than one km. long)

6. Minimum radius of curvature:
   50 m (at design speed of 40 km/h)
   300 m (at design speed of 100 km/h)

7. Minimum sight distance :
   50 m (at design speed of 40 km/h)
   650 m (at design speed of 100 km/h)

8. Minimum length of vertical curve :

   $L = A - K$

   where L : Length of vertical curve
   A : Difference in longitudinal slope
   K : Constant varying by design speed

Design speed(km/h)	K
6	40
10	50
15	60
20	70
25	80
40	90
50	100

9. Number of traffic lanes : Two

10. Width of pavement : 6.70 m (2 lanes)

11. Type of pavement: Cement concrete pavement with a thickness of 23 cm, or asphalt concrete pavement with a total thickness of 50 cm

12. Width of road shoulder : 2.50 m ~ 3.00 m (1.50 m for largely cut sections)

13. Width of right of way:

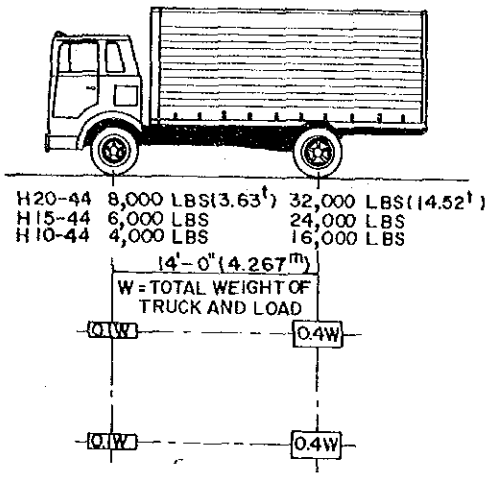
Rugged terrain	: 20 m
Level terrain	: 30 m
Public land in flat area	: 60 m

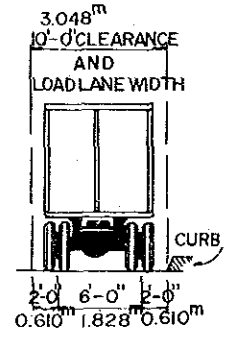
14. Minimum side of slope for cut and fill sections :

Height (m)	Type	Cut	Fill
0 ~ 1.2	Earth	4 : 1	4 : 1
1.0 ~ 2.0	Earth	2 : 1	2 : 1
More than 2.0	Earth	1 :1/2: 1	1 :1/2
1.1 ~ 2.0	Soft rock	1 :1/2: 1	1 :1/2
1.1 ~ 2.0	Hard rock	1/4: 1	2 : 1
More than 2.0	Hard rock	1/4: 1	2 : 1

Above data were obtained from Department of Public Highways.

Fig. 4-6 H Loadings





STANDARD H TRUCKS

In the design of timber floors and orthotropic steel decks (excluding transverse beams) for H20 loading, one axle load of 24,000 pounds or two axle loads of 16,000 pounds each, spaced 4 feet apart may be used, whichever prouduces the greater stress, instead of the 32,000 pound axle shown.

For slab design, the center line of wheels shall be assumed to be 1 foot from face of curb.

AASHO Standard Specifications for Highway Bridges 1973. P-15

Fig. 4-7 TYPICAL ROADWAY SECTION

PHILIPPINE – JAPAN FRIENDSHIP HIGHWAY

PHASE II

SCALE = 1 : 160

NOTE :

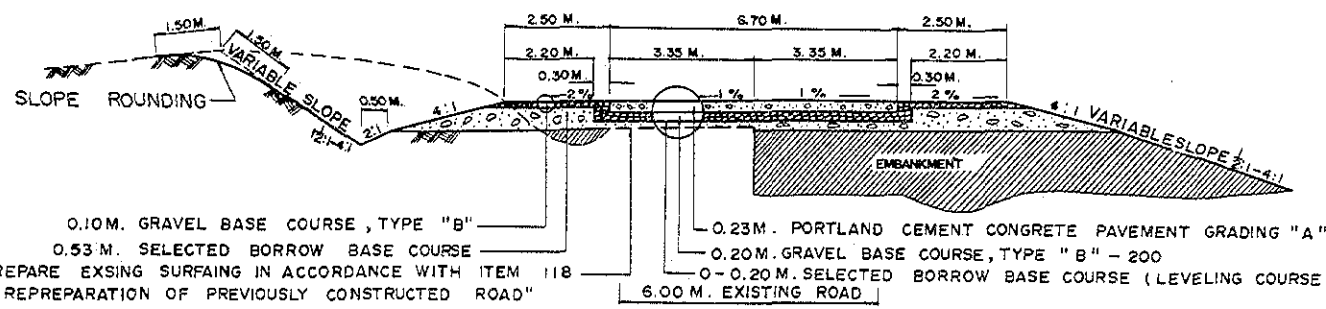
1. THE TOTAL THICKNESS OF THE EXISTING BASE & THE ADDITIONAL SELECTED BORROW BASE COURSE (LEVELING COURSE) SHALL IN NO CASE BE LESS THAN 0.20 M.
2. REPREPARATION OF PREVIOUSLY CONSTRUCTED ROAD SHALL BE CONSIDERED AS SUBSIDIARY WORK ONLY.

FORMULA FOR SUPERELEVATION

$$E = \frac{0.004V^2}{R}$$

WHERE

E = SUPERELEVATION IN M/M. WIDTH OF ROADWAY.
V = VELOCITY IN KILOMTER PER HOUR
R = RADIUS OF CURVATURE IN METERS
MAXIMUM E = 0.10 M. WIDTH OF ROADWAY



HALF SECTION WHERE EXISTING BASE COULD BE UTILIZED ⊣⊢ HALF SECTION WHERE EXISTING BASE COULD NOT BE UTILIZED

PORTLAND CEMENT CONCRETE PAVEMENT

Fig. 4-8 TYPICAL ROADWAY SECTION

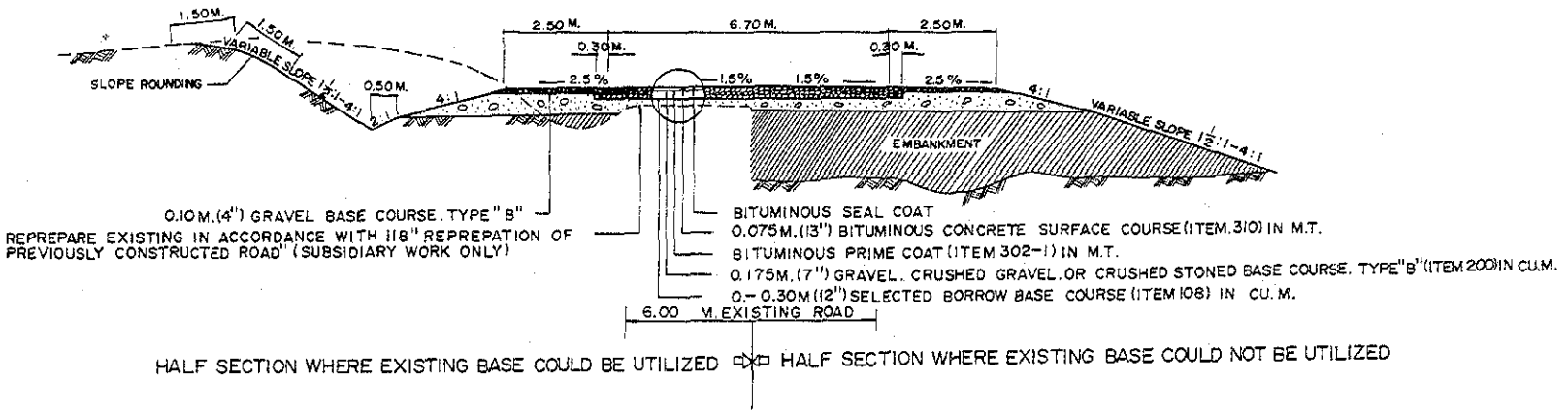
PHILIPPINE – JAPAN FRIENDSHIP HIGHWAY
PHASE II

SCALE = 1 : 160

FORMULA FOR SUPERELEVATION

$$E = \frac{0.004V^2}{R}$$

WHERE:
E = SUPERELEVATION IN M/M WIDTH OF ROADWAY
V = VELOCITY IN KILOMETER PER HOUR
R = RADIUS OF CURVATURE IN METERS
MAXIMUM E = 0.10 M/M WIDTH OF ROADWAY



ASPHALT PAVEMENT

2-3 Existing State of Provincial Roads in Northern Cagayan

All arterial roads in Cagayan province excepting National Road Routes 3 and 5, and Bangag ~ Magapit road are provincial roads and their improvement and maintenance services are carried out by Engineer's Office of Cagayan Province. There are four provincial roads which are related to the development of Aparri deposit, i.e., Zitanga ~ Ballesteros road, Abulug ~ Lino road, Pimpila ~ Abulug road, and Lucban ~ Abulug road. All these roads are gravel roads although they are partly paved by bituminous macadam in the central part of some residential districts. Nevertheless, they have a sufficiently large width and their surface is maintained in a fairly good condition. (see Fig. 4-9).

1) Zitanga ~ Ballesteros Road

This road starts from Zitanga where it branches off northwards from National Road Route 3 and leads to Ballesteros, the center of the area extending on the west bank of the Cagayan river. It has a total distance of 7 km. Light vehicles constitute the greater part of traffic which is heavy enough to make this road one of the most important provincial roads in northern Cagayan.

This road will be used for shipment of iron sand from sector I. As for the surface course condition, the greater part of the road is gravel road except that the about 1 km section running along the rolling area on the south of its route and the about 300 m section immediately before the town of Ballesteros are paved with bituminous macadam. The width is just as large as that of national roads. The road surface in maintained in good condition in the gravel road section. In the bituminous macadam paved sections, however, the surface roughness is not necessarily satisfactory and the pavement has a thickness of only about 3 cm. The surface course in these sections cannot therefore withstand the surface load imposed by frequent passage of heavy trucks.

In the 4 km section on the side of Ballesteros, the road surface is as low as rive paddy or has a height of only about 50 cm in

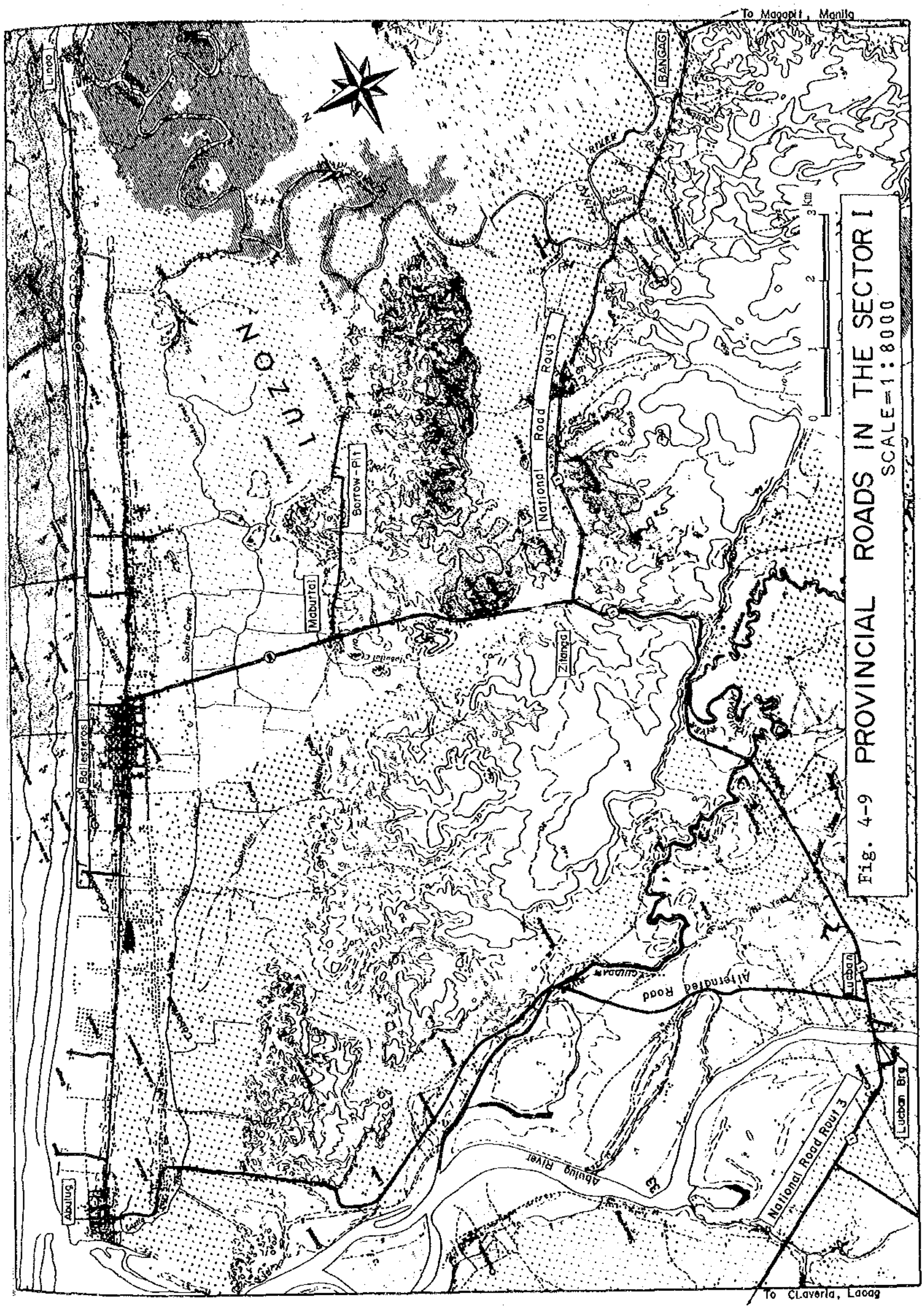


Fig. 4-9 PROVINCIAL ROADS IN THE SECTOR I
SCALE=1:8000

the highest parts. When a flood occurs, therefore, this section is inundated by flood water flowing across it from west to east, whereby the coastal rolling zone embracing Ballesteros becomes isolated.

There is a bridge on the southern and northern ends of this section. Zanja bridge on the northern end is a reinforced concrete bridge using T-beams and has a length of 12.0 m and a width of 6.8 m. In order to avert the destructive force of maximum flood level, its roadway surface is made 2 m higher than the road surface in the rice paddy section. Mabuttal bridge on the southern end is a wooden bridge with a length of 24.0 m and a width of 3.7 m. Passage of heavy trucks on this bridge is not possible because the maximum allowable load is only 1 ton. The wooden piles used as abutment have a length of 6.0 m and a top end diameter of about 15 cm.

2) Abulug ~ Ballesteros ~ Linao Road

This road runs east to west along the northern coast, covering a distance of about 19 km between the mouth of the Abulug river and Linao at the mouth of the Cagayan river, with Ballesteros located at the center of its route. Of the many towns and clusters found along its route, Ballesteros bears the highest population density and has many public facilities such as high schools, police station, public halls, and post offices. In addition, it is the center of business activities in this area and has a large traffic demand. Abulug ~ Ballesteros section of this road is paved by bituminous macadam along its entire route because it must meet the said high traffic demand of Ballesteros and also perform the function of a distribution route of the traffic on Zitanga ~ Ballesteros road. The average width of this section is 11.0 m.

In Ballesteros ~ Linao section a distance of only 3 km from Ballesteros is paved and the remaining 8 km to Liano is not,

and houses of farmers and fishermen are found sporadically along its route. The width is rather small in this section and averages 6.5 m. This section is made a short-cut to Aparri by the many small motor boats plying on the Cagayan river between Linao and Aparri. Demand for passenger and small cargo traffic is therefore high in this section.

3) Lucban ~ Abulug Road

For transportation of iron sand to National Road Route 3 from sector I which extends between Abulug and Linao, two routes can be conceived of. One is to connect Abulug ~ Ballesteros ~ Linao road with National Road Route 3 via Zitanga ~ Ballesteros road which has been explained in Item a), and the other is to make use of the capitoned road.

Lucban ~ Abulug road, having a total distance of 14.5 km, extends south to north and crosses the Guiddam river, a tributary of the Abulug river. The 2 km section from Lucban on National Road Route 3, which extends along an irrigation canal, is a gravel road on the levee of the canal and has an average width of 5.0 m. Since it was constructed for maintenance of the canal, the surface is well compacted. The following 3 km section which branches from the canal levee and leads to the Guiddam river has a width of 4.0 ~ 5.0 m and runs through rice paddy areas. Its surface is well compacted by vehicles and suggests that the traffic in this section is heavy. On the Guiddam river, there is no bridge and only wooden piers and some beams can be found on both banks because the 60 m long wooden bridge was washed away by flood discharge. The access road to this bridge has a width of 6.0 ~ 6.5 m and its subbase course is in good condition, but drain ditches are not sufficiently installed.

The first 5 km section from the Guiddam river is a new provincial road being improved from an agricultural road, and earthwork has been completed. It presents no problems in terms of geometric design, but the subbase course is not completed yet. If this

section is to be used for transportation of iron sand, the surface course work should be preceded by the levelling and compaction of the road surface. The remaining 4.8 km section has a high utilization ratio and its road surface is in good condition, but calls for the repair of three short-span wooden bridges.

4) Dana-Ili ~ Abulug Road

This is the only road that leads to the eastern end of sector II. It starts from a point between Pimpila and Curba on National Road Route 3 and extends to Dana-Ili on the left bank of the Abulug river, covering a distance of about 7.0 km. It has an average width of about 7.0 m which conforms to the construction standards of provincial roads. There is a timber yard at a distance of about 1 km to the north of Dana-Ili, from which timbers are transported by barges sailing down the Dana-Ili river (width : approx. 50 m) to the carrier anchored at offing.

Sector II embraces the Dana-Ili river and many other rivers and inlets of different sizes. If iron sand is to be transported from this sector by land, a number of new bridges including long ones must be constructed.

Dana-Ili ~ Abulug road is shown in the Maintenance Operation Map of C.W.E.D., but nothing is determined yet as to the budgetary appropriation or the year of execution. This road has two wooden bridges of about 10 m length on which traffic of timber trailers is observed. The roadway surface is considered to be maintained in good condition.

2-4 Future Improvement Plan of Provincial Roads of Northern Cagayan

Of a total budget of ₱62,660 thousand appropriated for Capital Improvement Programe (YE 76-A to YE 80) of Cagayan province, about 40 % or ₱24,910 thousand is earmarked for P.E.O. (Provincial Engineer's Office) which undertakes the implementation of provincial road improvement projects. The following table shows the provincial road

improvement projects which are related to the present survey.

Table 4-4. List of Provincial Road Improvement Projects in Survey Area

Project No.	Project Title	Total 5 yr Cost (₱1,000)	Financing Year
73102	Zitanga ~ Ballesteros Road	280	FY 77
73104	Zitanga ~ Ballesteros Road	3,320	FY79 ₱2,000 FY80 ₱1,320
73115	General Tinio Road Abulug	293	FY 80
73405	Mabuttal Bridge Bellesteros	367	FY 77
73412	Dana-Ili Bridge Abulug	367	FY 79

Table 4-4 indicates that the improvement of Zitanga ~ Ballesteros road is given the greatest importance in terms of budgetary appropriation. Specifically, three projects, Nos. 73102, 73104 and 73405, are all intended for the improvement of the said road, with No. 73102 planned for increasing the height of road surface, No. 73104 for pavement, and No. 73405 for rebuilding Mabuttal bridge. When Mabuttal bridge is rebuilt and the currently imposed limit on surface load is lifted, traffic of iron sand trucks on Zitanga ~ Ballesteros road becomes possible along its entire route.

Project No. 73412, Dana-Ili Bridge Abulug, is planned for the repair of the wooden bridge of Dana-Ili ~ Abulug road which leads to sector II.

As described in Section 2-3,3), improvement of Lucban ~ Abulug road consists mainly of the construction of a new bridge on the Guiddam river and the earthwork of its access roads. In the design of Guiddam bridge, the bridge length was taken at 61.60 m with account taken of the relationship between the river width and the location of abutment, and the design bridge height was set at 7.12 m at piers and 7.62 m at the center of bridge with consideration given to the maximum flood level of 4.5 m.

The foundation of abutment and piers is considered satisfactory, but it is necessary to conduct drilling to check its bearing capacity before the execution of construction work is started. (see Fig. 4-10)

In the 2.0 km section from National Road Route 3, guard rails must be installed on one side facing the irrigation canal to prevent the fall down of vehicles. Since this will reduce the present road width to 4.5 ~ 5.0 m, it is necessary to widen the road to the other side to secure a width of 7.0 m.

The 2,900 m long access section to Guiddam bridge passes through rice paddy, but only widenting was planned for this section because its ground condition is favourable. North of Guiddam bridge, the provincial government has already completed the earthwork which will be followed by the construction of subbase course and pavement work. As described already, this road the three bridges besides Guiddam bridge. One of these bridges must be rebuilt to a steel bridge of type 3 using I-beams and having a length of 20 m, and the other two to steel bridges of type 1 also using I-beams and having a length of 10 m.

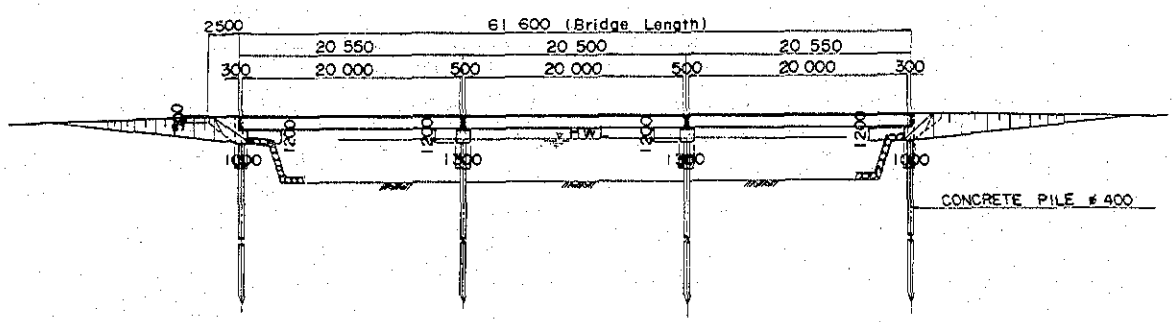
Mining operation in sectors from which iron sand is to be transported by the provincial roads covered by Capital Improvement Program of Cagayan Province is planned to be connected after completion of the program. Accordingly, improvement or repair of these provincial roads is not included in the present Aparri deposit development project, and only the improvement of feeder roads which are connected to these provincial roads and required for iron sand transportation is planned.

Fig. 4-10 GUIDDAM BRIDGE

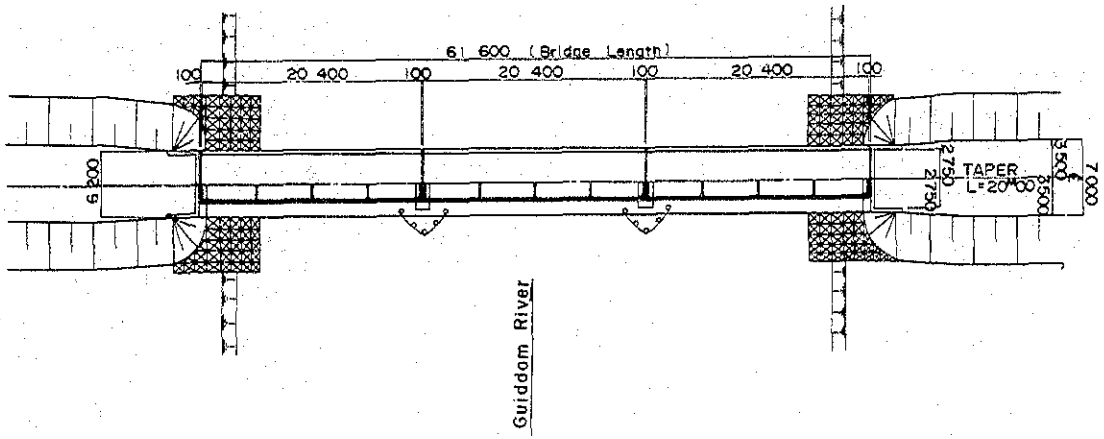
BRIDGE LENGTH 61.60M

SCALE=1:640

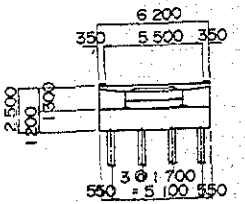
SIDE VIEW



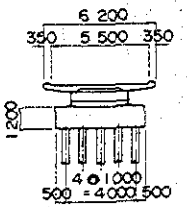
PLAN



CROSS SECTION
(ABUTMENT)



(PIER)



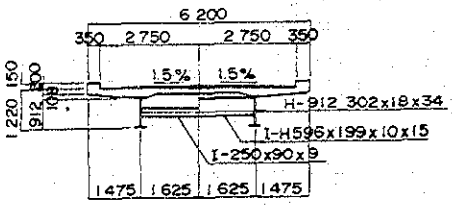


Table 4-5 DESIGN CRITERIA AND CONSTRUCTION STANDARDS (1)

F - FLAT
R - ROLLING
M - MOUNTAINOUS
PCCP - PORTLAND CEMENT CONCRETE PAVEMENT

	PROVINCIAL ROAD									MUNICIPAL ROAD								
Ave. No. of Veh./Day (A.D.T.)	Below 100			100 - 1000			Over 1000			Below 30			30 - 1000			Existing Concrete Pavement Regardless (ADT)		
Surface Type	Gravel			Asphalt or Concrete			PCCP			Gravel			Asphalt			PCCP		
Surface Width (M)	4.00			5 - 6			6.1-6.7			4.00			4 - 5			5 - 6.1		
Shoulder Width (M)	1.5			1.5 - 2			2-3			1.5			1.5 - 2.0			2.0		
Right of Way (R.C.W.) Per Exec. or Cir. 115	Not Less Than 15.00 M. to be Widened to 20.00 M.									Not Less Than 10.00 M.								
Terrain	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
Design Speed (KPH)	50	40	30	60	50	40	70	60	50	50	40	30	60	50	40	60	50	40
Maximum Gradient (%)	4	6	6	3	5	6	3	4	5	4	6	6	3	5	6	3	5	6
Minimum Radius of Horizontal Curve	350	250	150	300	250	200	250	200	150	200	150	100	200	150	100	200	150	100
Structure	Full Width			Surface and Shoulder						Full Width			Surface and Shoulder					

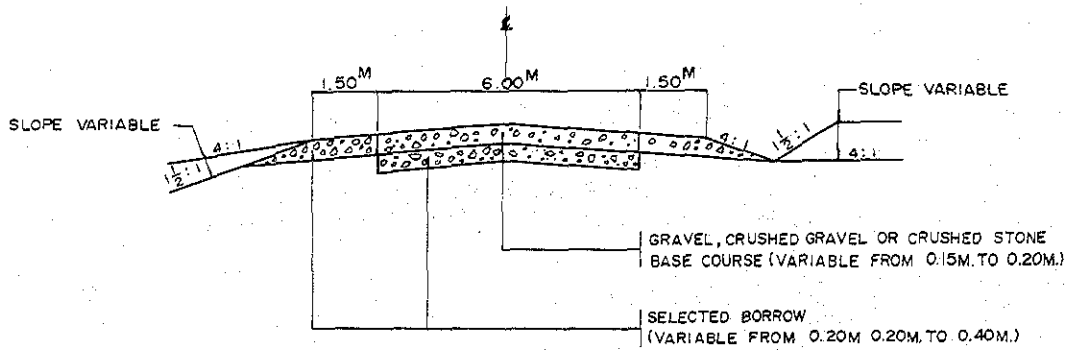
Table 4-6 ANNUAL AVERAGE DAILY TRAFFIC VOLUMES

DESIGN CONTROL	Under 100		100 - 400		400 - 1000		1000 - 2000		Over 2000	
	Mini-mum	Desi-rable	Mini-mum	Desi-rable	Mini-mum	Desi-rable	Mini-mum	Desi-rable	Mini-mum	Desi-rable
New Bridges										
Clear Roadway Width (Meters)	4.3	6.1	6.7	7.3	7.3	7.3	7.9	7.9	7.9	8.5
Design LL (A.A.S.H.O.)	H-10	H-15	H-15	-	H-15	-	H-20	-	H-20	-
Vertical Clearance if Any	-	-	-	-	-	-	4.3	-	4.3	-
Existing Bridges to Remain										
Clear Roadway Width (Meters)	-	-	4.0	-	5.5	-	6.1	6.7	6.7	7.3
Safe Load, Basic Posting (Tons)	-	-	6	-	10	-	15	-	15	-
Vertical Clearance	-	-	-	-	-	-	3.7	-	3.7	-

Fig. 4-11 CAGAYAN PROVINCIAL ROAD

TYPICAL ROADWAY SECTION
(FOR GRAVEL ROADS)

SCALE = 1 : 160

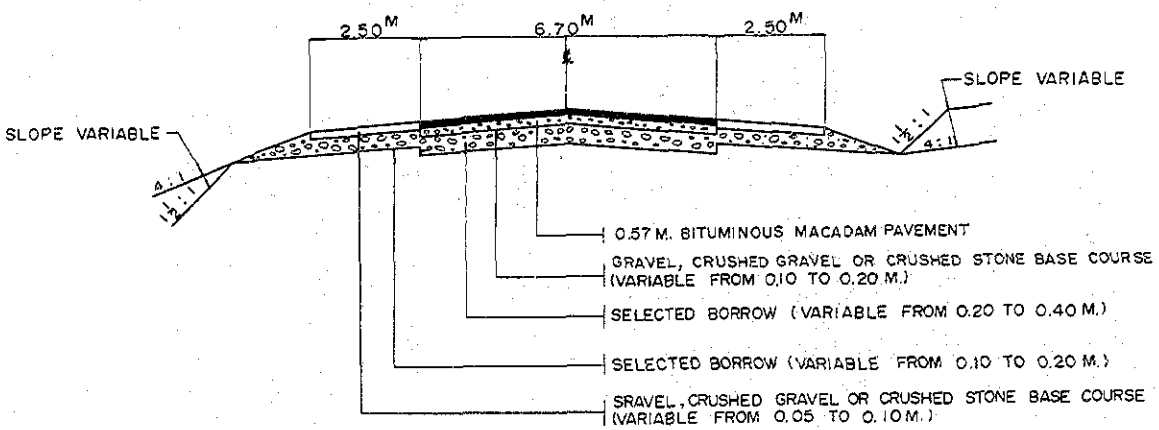


NOTE : THICKNESS OF BASES DEPENDS UPON SUBGRADE CLASSIFICATION. A MINIMUM OF 95° COMPACTON OF THE SUBGRADE IS DESIRED BEFORE ANY BASE IS PLACED ON TOP.

Fig. 4-12 CAGAYAN PROVINCIAL ROAD

TYPICAL ROADWAY SECTION
(FOR BITUMINOUS MACADAM ROADS)

SCALE=1:160



NOTE : THICKNESS OF BASES DEPENDS UPON SUBGRADE CLASSIFICATION. A MINIMUM OF 95° COMPACTION OF THE SUBGRADE IS DESIRED BEFORE ANY BASE IS PLACED ON TOP.

Section 3 Feeder Road

3-1 Existing State of Feeder Roads

Feeder roads connect arterial roads (national and provincial roads) with Aparri desposit area for transportation of iron sand. At present, they are used for local residential road or as agricultural roads.

Most of these roads pass through swamp or rice paddy areas and have small bridges built across small rivers or irrigation canals. They are not capable of withstanding the surface load imposed by the traffic of heavy trucks, and the bridges, mostly made of wood, are not maintained in satisfactory condition.

The great majority of them have a straight horizontal alignment, so that they join or intersect other roads at almost right angles. It is therefore necessary to increase their present width and improve their intersections to secure the necessary sight distance and turning radius required for the traffic of large vehicles. In addition, the population density along their routes is very high so that suitable safety measures should be planned particularly for the inhabitants living in the neighbourhood of National Road Route 3. (see Fig. 4-13).

In Abulug ~ Pamplona section in sector II, there are many rivers and creeks. If this section is to be connected with National Road Route 3 by land, it is necessary to construct at least two new bridges, one with a length of more than 150 m and the other about 50 m. However, since the iron sand reserve in this sector is smaller than that in other sectors, it is advisable to devise other suitable means of shipment than overland transportation which involves a high cost for bridge construction. (see fig. 4-14).

1) Tagat Road, Distance : 1.47 km (see Dwgs. 1/17 and 2/17 for plan and profile)

This road will be used exclusively for transportation of iron sand from National Road Route 3 to the jetty if Tagat is selected as the site of the new port for iron sand shipment.

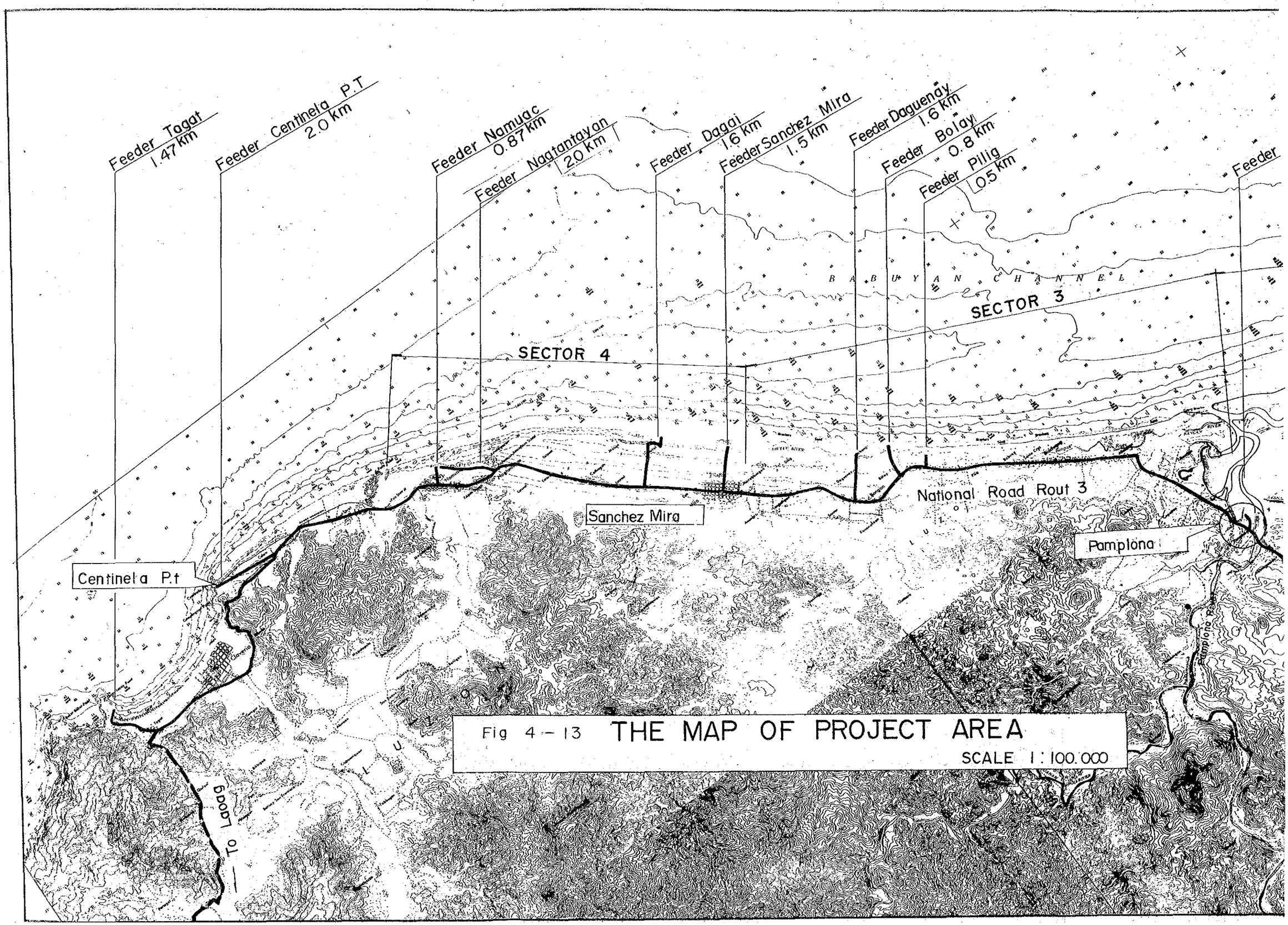
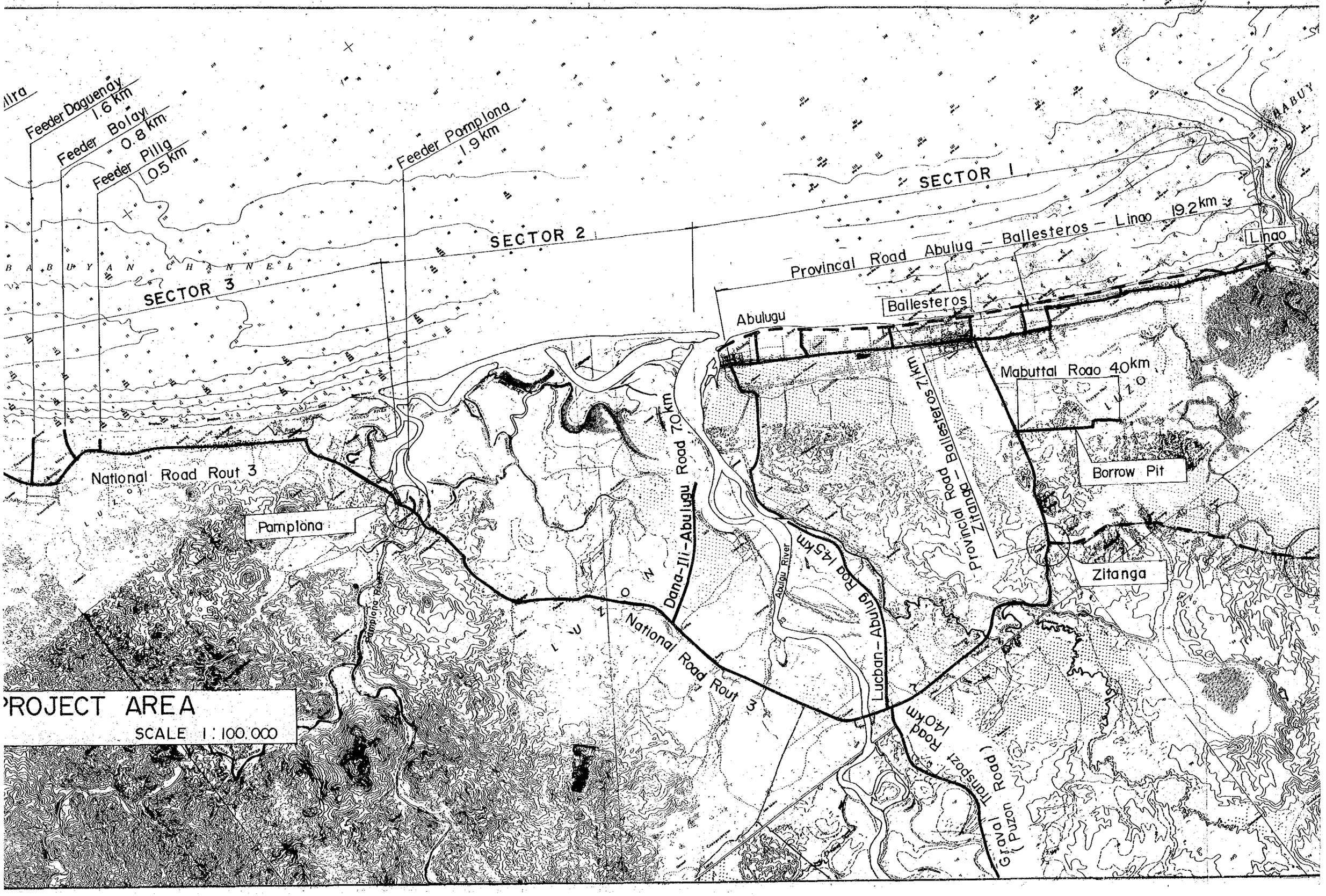
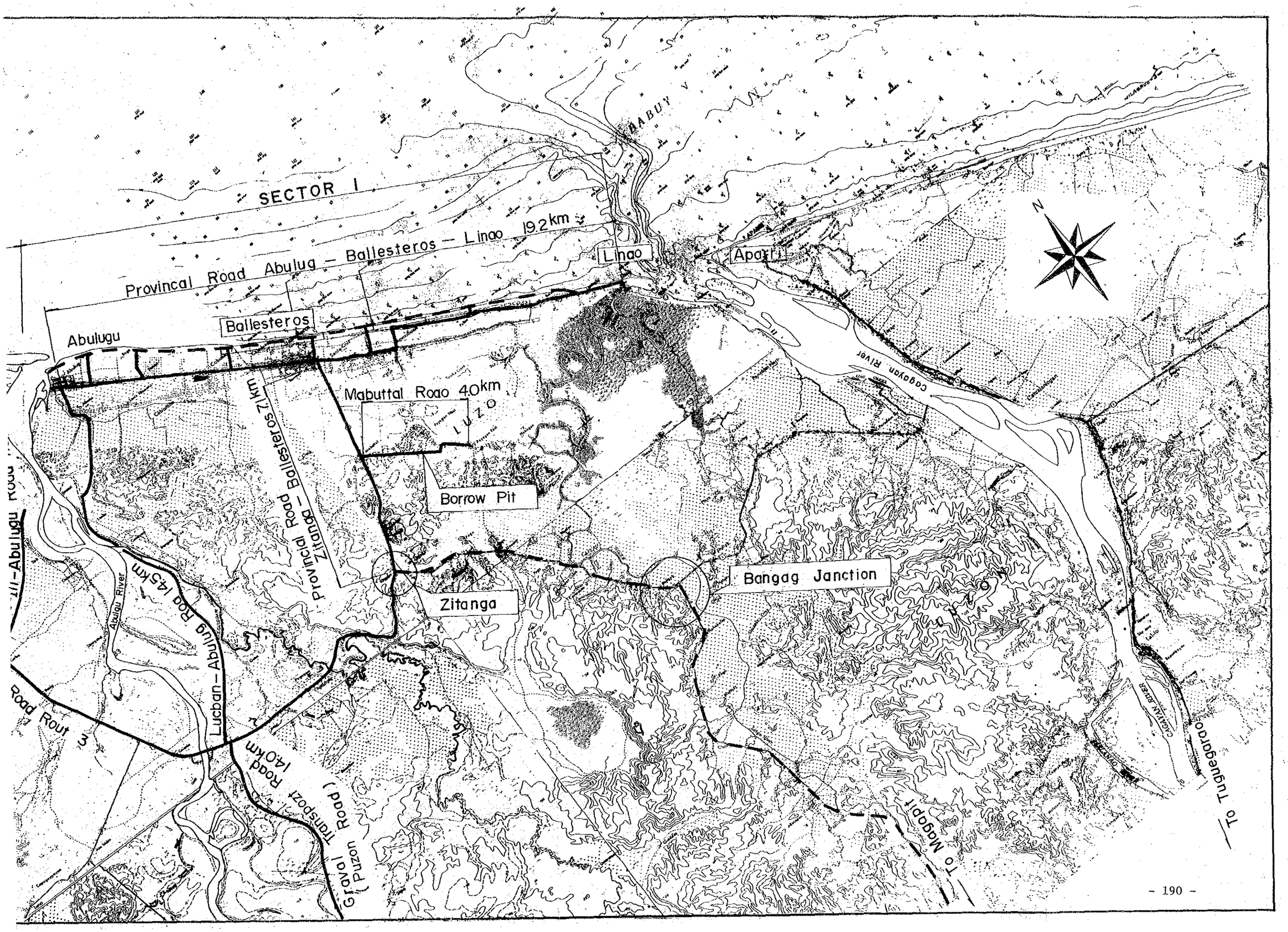


Fig 4 – 13 THE MAP OF PROJECT AREA

SCALE 1 : 100.000


Feeder Daguenay 1.6 Km
Feeder Bolay 0.8 Km
Feeder Pilig 1.05 Km
Feeder Pamplona 1.9 Km
SECTOR 1
SECTOR 2
SECTOR 3
BABUYAN CHANNEL
Provincal Road Abulug — Ballesteros — Linao 19.2km
Linao
Ballesteros
Abulugu
Mabuttal Roao 4.0km
Borrow Pit
Zitanga
Provincial Road Ballesteros — Zitanga 7.1km
Dana-Illi-Abulug Road 7.0 km
Abulug River
Abulug Road 14.5km
Lucban-Abulug Road 14.0km
Transpozi Road
Gravel Road (Puzon
National Road Rout 3
Pamplona
Pamplona Road
LUZON
PROJECT AREA
SCALE 1:100.000


SECTOR I
Provincal Road Abulug – Ballesteros – Linao 19.2 km
Linao
Apari
Ballesteros
Abulugu
Mabuttal Road 4.0km
Borrow Pit
Zitanga
Bangag Janction
Provincial Road Zitanga – Ballesteros
Road 14.5km
Abulugu River
Lucban – Abulug
Road Rout 3
Transpozi Road 4.0km
Gravel Road (Puzon
to Magopit
to Tuguegarao
N
LUZON

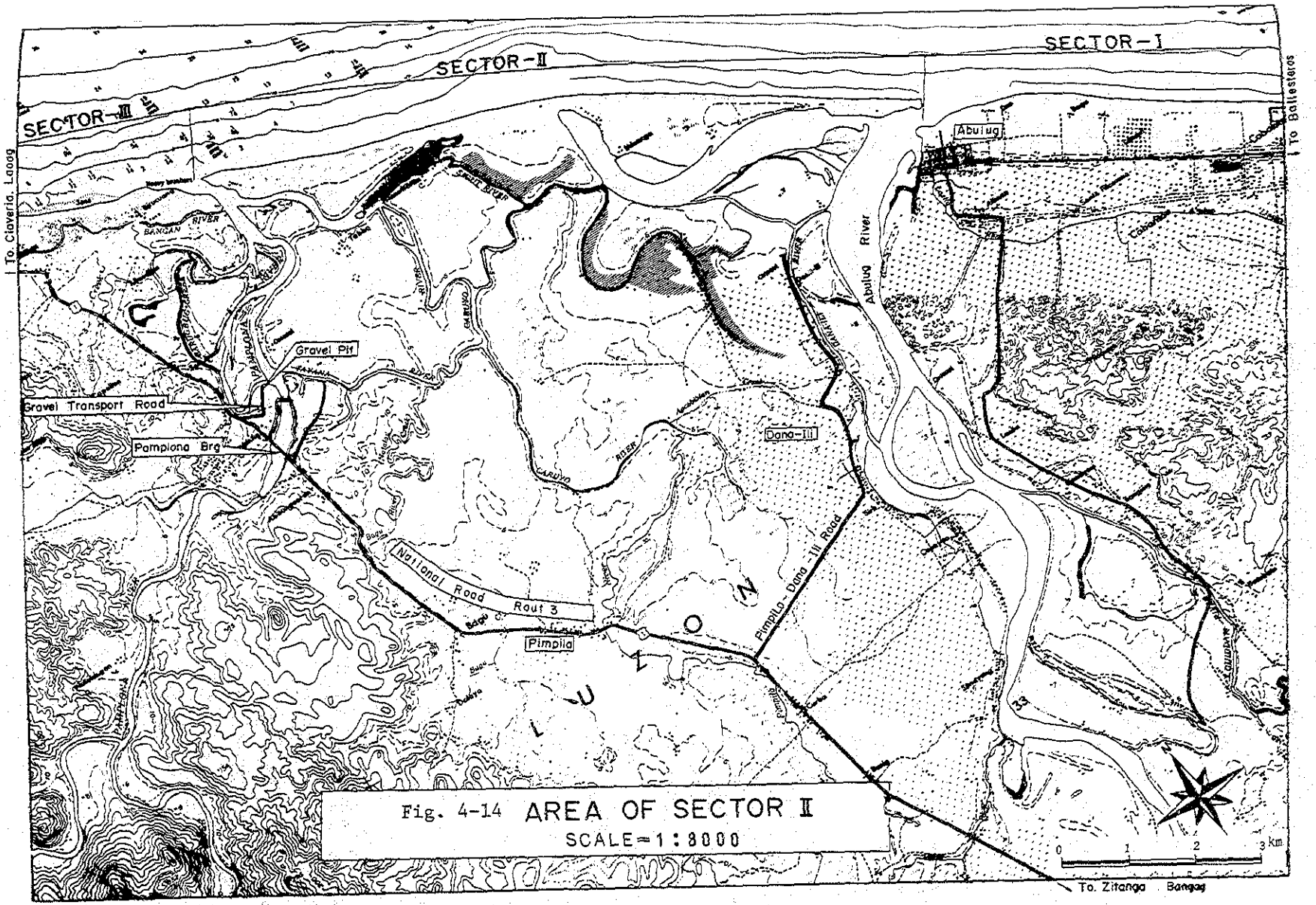


Fig. 4-14 AREA OF SECTOR II
SCALE=1:8000

It is paved along road entire length and therefore permits traffic of large vehicles. It has a width of 6.0 at the junction with the national road, and provides a good sight distance. There are neither headraces crossing this road nor structures which need to be taken into consideration in planning the iron sand transportation.

2) Centinela Road, Distance : 2.00 km (see Dwgs. 3/17 ~ 5/17 for plan and profile)

This road links National Road Route 3 and Centinela Point, the proposed site of the new port. It joins Route 3 at Culao where it has a width of only 3.3 m. In the narrowest section, the width is made as small as about 3.0 m by palm trees. In the 400 m section from Culao, the greater part of the road runs through palm forest and simple fences are built on both sides.

Access to and from the rational road is easy because of its large width, and calls for no improvement of the access section.

There are no rivers or headraces crossing the road, nor can be found any structures which need to be taken into consideration. The horizontal alignment presents no problems, but the width is small and averages 3.0 m along the entire route. The road surface is not paved and covered with sand.

3) Namuac Road, Distance : 0.87 km (see Dwg. 6/17 for plan and profile)

This road joins National Road Route 3 at the center of Namuac located midway between Claveria and Sanchez Mira. From the junction with the national road, it leads to the coastal sand dune area through a residential district and a low-lying rice paddy area. Its width, ranging from 3.0 to 4.0 m except in the residential district (6.0 m), is not large enough for the traffic of large vehicles.

At the junction with thenational road, it has a width of 6.0 m which is large enough for the access of large vehicles. However, the heavy dwelling unit density in the neighboring area demands that suitable measures be enforced to prevent traffic accidents after the iron sand transportation on this road is started.

There is a wooden bridge at a distance of 600 m from the national road. Passage of vehicles on this bridge is not possible because its floor slabs are rotten.

4) Nagtantayan Road, Distance : 2.00 km (see Dwgs. 7/17, 9/17 for plan and profile)

This road links the national road and sector IV at the same point as Numuac road so that it can be considered an alternative for Numuac road. Although construction of bridges or other structures is not required, this road has two disadvantages: it makes the distance between the deposit and the jetty 3.1 km longer than Numuac road, and passes through a residential district extending along its route for a distance of about 1.5 km. The width ranges from 4.0 to 5.0 m in wider places and from 3.0 to 4.0 m in narrow places, and the road surface is neither levelled nor covered with gravels.

5) Dagai Road, Distance : 1.60 km (see Dwgs. 10/17 and 11/17 for plan and profile)

In the 1.3 km section from the junction with the national road, this road has a width of 8 m of which 4.2 m is paved by bituminous macadam (random paving). Two irrigation canals cross this section, and the reinforced concrete slab bridges built on them allow the passage of heavy vehicles. In Dagai village, however, traffic of large vehicles is not possible becuase the road has many corners and a heavy cluster of houses is found along its route.

6) Sanchez Mira Road, Distance : 1.50 km (see Dwgs. 12/17 and 13/17 for plan and profile)

This road leads to the deposit area through the residential district in Sanchez Mira. It has a width of 7.5 m at the junction with the national road. In most of other parts, however, the width is as small as 3.0 m. Of the two bridges built between the national road and the deposit, the one near the national road permits the passage of small trucks, but the other close to the deposit does not.

7) Daguenay Road, Distance : 1.60 km (see Dwgs. 14/17 and 15/17 for plan and profile)

This road leads to Labeng block from Bangan. The width is 5.0 m at the junction with the national road and 3.5 m in other parts. It runs through paddy field area, and no houses are found along it. Between the national road and the deposit, there is a 30 m long wooden bridge which does not permit the passage of vehicles because of its small width and poor structure.

8) Bolay Road, Distance : 0.8 km (see Dwg. 16/17 for plan and profile)

This road connects with Bolay and the deposit area. The 400 m section branching off from the national road runs through rice paddy area where the ground condition is satisfactory, but it has a width of only 3.5 m. The 400 m section on the side of the deposit extends through a weak ground zone and is not capable of withstanding the surface load imposed by large vehicles. There is an irrigation canal flowing between the said weak ground zone and the coastal sand dune area, and a new bridge must be built on this canal.

9) Pilig Road, Distance : 0.5 km (see Dwg. 17/17 for plan and profile)

This road has an average width of 4.0 m. Although its horizontal alignment is generally satisfactory, it runs through a weak ground zone which has a length of 250 m. There is a wooden bridge between the national road and the deposit area, and it is not suited to the passage of vehicles because its

floor is composed of 12 square timbers (300 mm x 300 mm) simply tied and arranged to cross a stream and its substructure is in a poor condition.

10) Feeder Roads in Sector I : Abulug ~ Linao

There are about 20 feeder roads connecting sector I and the provincial road from Abulug to Linao. Since these roads are connected to sector I at varying intervals, they are not distributed equally to respective blocks. Further, Abulug ~ Linao road is not suited to iron sand transportation because it runs through residential districts.

The sandy beach of sector I is very well compacted. A running test conducted on the beach using a jeep recorded a highest speed of 80 km/h. The beach has an average width of more than 50 m and can be used for the traffic of iron sand trucks. It is therefore planned that this sandy beach will be used for iron sand transportation instead of the roads running in densely populated areas. (see Fig. 4-15).

Sector 2 | Sector 1

ABULUG

BALLESTEROS

CABALUAN

ABULUG RIVER

ALIMUNU

SANTA FILOMENA

CABARITAN

Abulug

F-1 740m

F-2 800m

F-3 600m

F-4

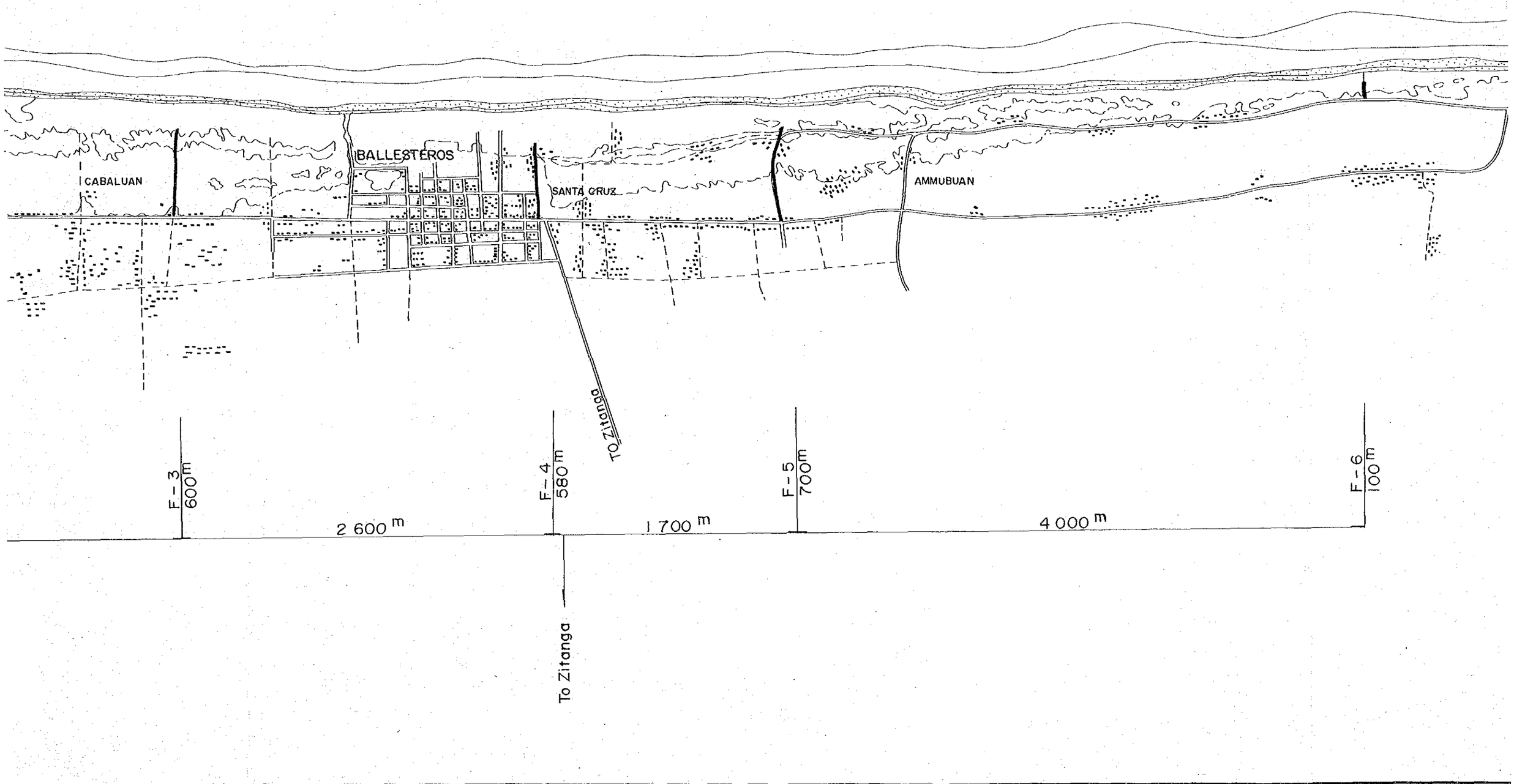
900 m

1 600 m

2 700 m

2 600 m

To Lucban


CABALUAN
BALLESTEROS
SANTA CRUZ
AMMUBUAN
To Zitanga
F-3
600m
F-4
580m
F-5
700m
F-6
100m
2 600 m
1 700 m
4 000 m
To Zitanga

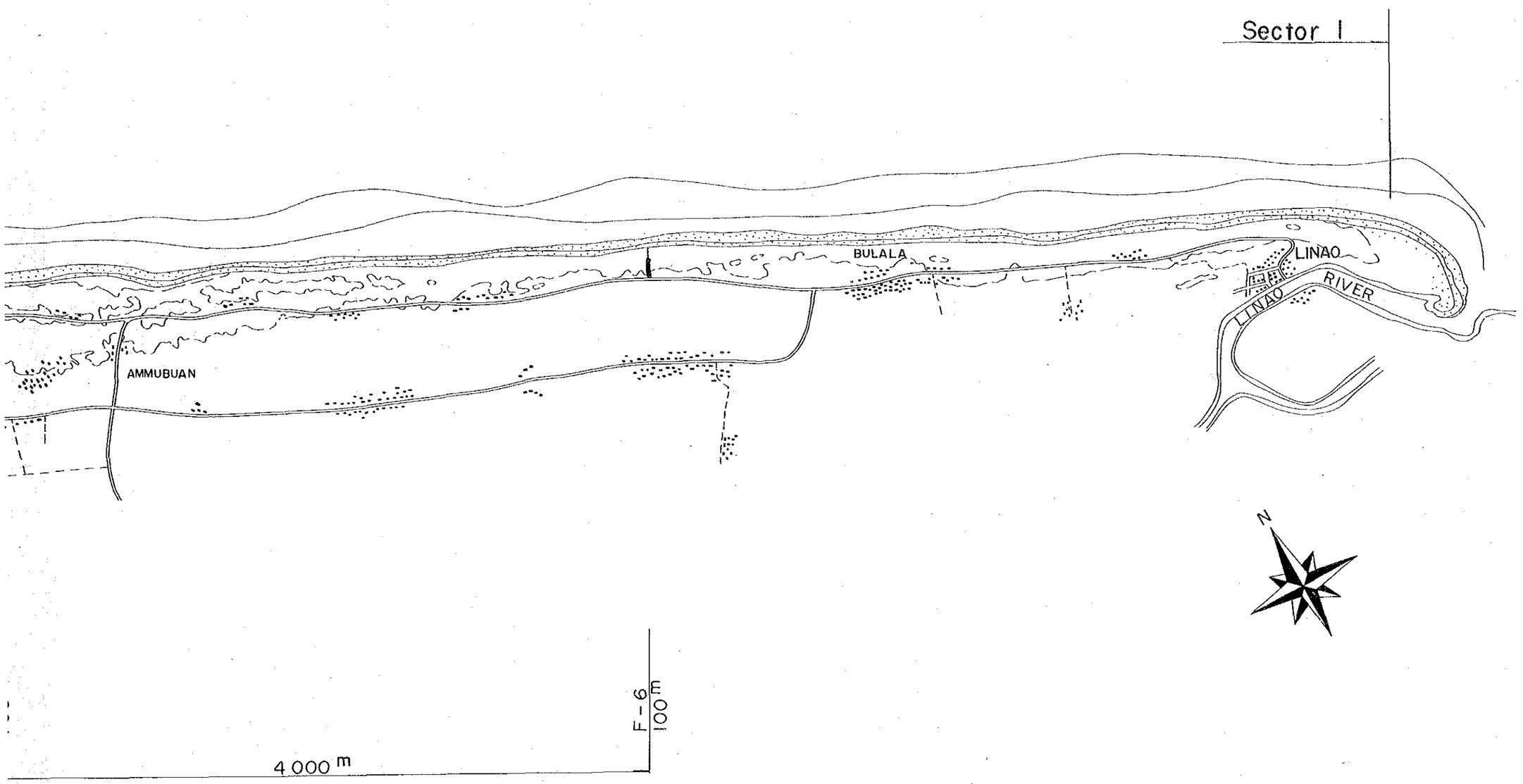


Fig 4-15 FEEDER OF SECTOR I

Scale 1 : 25 000

Table 4-7-a EXISTING STATE OF FEEDER ROADS

NAME OF ROAD	LENGTH	GEOMETRIC CONDITION	CONDITION		STRUCTURES	REMARKS
			ROAD SURFACE	ALONG THE ROUTE		
Provincial Road Zitanga - Ballesteros	7.0Km	W : 11.70m Sufficient. HA : Generally straight and Satisfactory. VA : 3.0Km low-lying section included.	Satisfactory and partly paved.	Passes through palm forest.	2 bridges, one each of RC and wooden bridge.	Improvement work planned to be executed by provincial government of Cagayan.
Provincial Road Abulug - Linao	19.2Km	W : 5.0 - 8.0m HA : Satisfactory. VA : Satisfactory.	Satisfactory and partly paved.	Passes through many residential districts.	None	
Tagat Road	14.7Km	W : Sufficient in 2/3(6.0m) deficient in 1/3(less than 3.0m) HA : Improvement of residential district required. VA : Satisfactory.	Satisfactory except in residential districts.	Improvement of residential required.	None	
Centinela P.T. Road	2.0Km	W : Average 3.0m narrow. HA : Satisfactory. VA : Improvement of undulation required.	Sandy and call for improvement.	Passes through plam forest.	None	

W : Width
HA : Horizontal Alignment
VA : Vertical Alignment

Table 4-7-b EXISTING STATE OF FEEDER ROADS

NAME OF ROAD	LENGTH	GEOMETRIC CONDITION	CONDITION		STRUCTURES	REMARKS
			ROAD SURFACE	ALONG THE ROUTE		
Namuac Road	0.87Km	W : 6.0m in part and 3.5 - 4.0m on the average. HA : Satisfactory. VA : Fill work required in low-lying section.	Sandy with clay.	Passes through residential districts in part.	One wooden bridge in poor condition.	
Nagtantayan Road	2.00Km	W : 3.0 - 4.0m HA : Unsatisfactory in two places. VA : Satisfactory.	Sandy with clay.	Passes through many residential districts.	None.	
Dagai Road	1.60Km	W : 6.5m (4.0m in paved section) HA : Unsatisfactory in one place. VA : Satisfactory.	Asphalt macadam penetrated pavement.	Passes through a chuster.	One RC slab bridge.	
Sanchez Mira Road	1.50Km	W : Narrow (3.0m) HA : Satisfactory. VA : Fill work required in port.	Sandy with gravels.	Passes through a residential districts.	Two wooden bridges.	
Daguenay Road	1.60Km	W : 5.0m HA : Satisfactory. VA : Fill work or structures required in low section.	Sandy with gravels, soft surface in part.	Passes through palm forest and paddy field area.	One wooden continuous foot bridge.	Weak ground.

Table 4-7-c EXISTING STATE OF FEEDER ROADS

NAME OF ROAD	LENGTH	GEOMETRIC CONDITION	CONDITION		STRUCTURES	REMARKS
			ROAD SURFACE	ALONG THE ROUTE		
Bolay Road	0.80Km	W : Narrow (3.5m) HA : Satisfactory. VA : Satisfactory.	Sandy with gravels, soft surface in part.	Passes through paddy field area.	Two wooden bridges.	
Pilig Road	0.50Km	W : 4.0m HA : Satisfactory. VA : Fill section in part.	Sandy with gravels.	Passes through paddy field area.	One wooden bridges.	
Pimpila - Dana-Ili Road	7.00Km	W : 5.0m HA : Satisfactory. VA : Satisfactory.	Gravel	Passes through paddy field area all the way and a cluster in part.	Two wooden bridges.	
Abulug - Lucban Road	14.5Km	W : Narrow in part. HA : Satisfactory. VA : Satisfactory.	Extremely poor with no surface paving, though satisfactory in part.	Passes through paddy field area and palm forest all the way and a cluster in part.	Four wooden bridges.	

3-2 Feeder Road Plan

The feeder road plan was formulated on the principle that the existing roads will be used without constructing new ones except in special sections, and in accordance with the planning policy described below.

1) Route Selection

Since none of the feeder roads were covered by a detailed surveying prior to the present survey, a present-state map was prepared on the scale of 1:3,500 by enlarging two topographic maps (scale : 1:50,000 and 1:25,000) with account taken of the findings of field survey. Assumptive elements were adopted in the preparation of this map, so that it is necessary to conduct a detailed surveying before working out the construction design. On the basis of the present-state map thus prepared, plans and profiles showing the alignment of feeder roads and locations of structures were prepared.

For sector I, however, the topographic map shown in Fig. 4-15 (scale : 1:25,000) was directly used for feeder road planning because all feeders in this sector are short and require no structures. Sector II was excluded from the feeder road planning because iron sand transportation by land was considered uneconomical due to the many rivers and creeks flowing in this sector.

2) Horizontal and Vertical Alignment, and Road Width

The horizontal and vertical alignment is so planned that it will run along the route of the existing road as far as practicable. The width is taken at a total of 7.0 m, 4.0 m for roadway and 1.5 m for shoulder on either side, in order to permit the passage of large vehicles on the earthwork section. For bridges, a width of 5.5 m is adopted. However, the approach section to the jetty at Centinela Point is planned to have a roadway width of 6.0 m and be paved by portland cement concrete.

3) Pavement

All feeder roads are planned to be improved to gravel roads excepting bridges and asphalt paved sections of existing roads. In order to withstand the surface load imposed by heavy trucks, the surface of feeder roads will be covered by gravels to be spread to have a roadway width of 4.0 m and a thickness of 20 cm over the subbase course which will have a thickness of 40 cm, and shoulders with a thickness of 60 cm will also be provided. (see Fig. 4-16)

4) Improvement of Feeder Roads in Weak Ground Zone

Earthwork of feeder roads consists mainly of widening of existing roads, and the gravel and sand transport volume is small except in sections where new roads must be constructed.

Many of the feeder roads in all sectors excluding sector I run through weak ground zones such as rice paddy area and marshy area. In these zones, careful attention must be paid to consolidation settlement of fills and to damage due to the traffic of heavy trucks. On the other hand, it is necessary to adopt the most economical and inexpensive method for construction of feeder roads because they will be used only during the relatively short mining period.

For improvement of weak ground, the following two methods are adopted with consideration given to the above conditions. However, actual implementation of the improvement work must be preceded by a detailed soil exploration of foundation because the soil exploration conducted during the present survey covered only the surface condition.

a) Improvement of Relatively Shallow Weak Ground (Depth - less than 1.5 m; symbol in plans - SG-1)

The existing road section in weak ground zones, constructed with fill material carried from other place, are not sufficiently compacted. It is planned that these sections will be removed to replace the weak ground in the fill section

with sandy soil of satisfactory quality.

Since all weak ground zones are relatively close to the Abulug river or the Pamplona river, sandy soil of required quality can be obtained with ease.

b) Improvement of Relatively Deep Weak Ground (Depth - more than 1.5 m; symbol in plans - SG-2)

If the weak ground has a large depth, it is not economical to replace the road foundation with sandy soil. When an arterial road crosses such a weak ground zone, construction of a continuous elevated bridge sometimes proves to be a suitable solution, but this is not economical in the case of the present project because the feeder roads will be used only for a limited period of time. Hence, it is planned that conduits will be placed side by side across the road in the section passing a weak ground zone, and that the fill volume will be reduced to alleviate its influence on consolidation settlement. It is also planned that if the conduits placed parallel to each other are subjected to differential settlement, they will be rearranged by grading which can be effected because all feeder roads will be improved to gravel roads.

5) Bridge

It is planned that the bridges to be constructed on the basis of the field survey of feeder roads will be classified into three standard types by length (type 1 - 10 m; type 2 - 15 m; type 3 - 20 m), and that the selection of type will be made according to the site condition. (see Fig. 4-17, 4-18, 4-19)

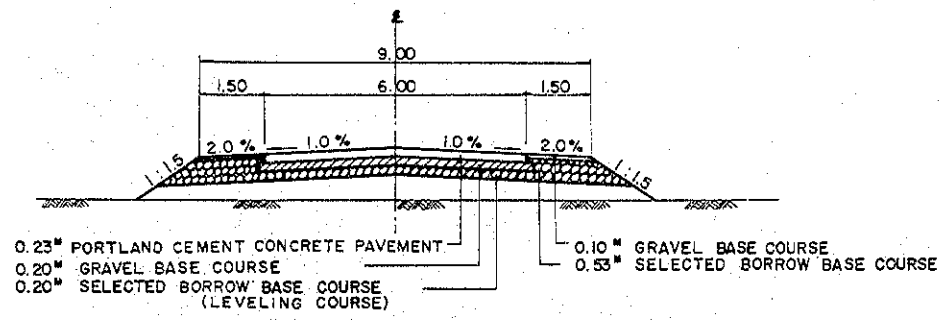
In respect of bridge structure, it is planned that all bridges will have a simple structure using simple I-beam as main girder and reinforced concrete floor slabs, and be capable of H-20 loading of AASHO in consideration of the traffic of iron sand trucks.

Fig. 4-16 TIPICAL CROSS SECTION

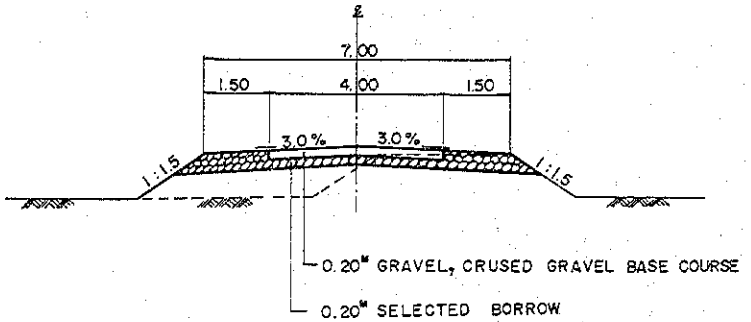
(FOR FEEDER ROADS)

SCALE=1:160

CENTINELA P.T. ROAD



FEEDER ROAD



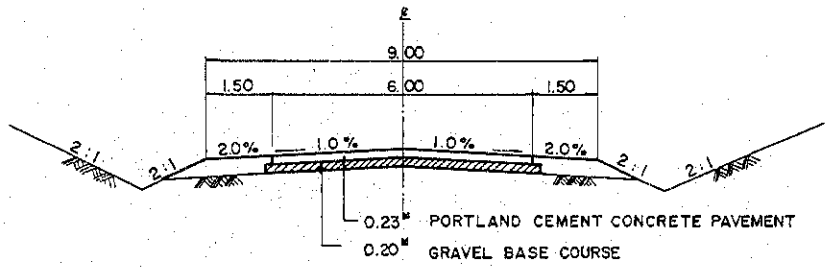


Fig. 4-17 BRIDGE TYPE - I SCALE = 1 : 160

BRIDGE LENGTH 10 M

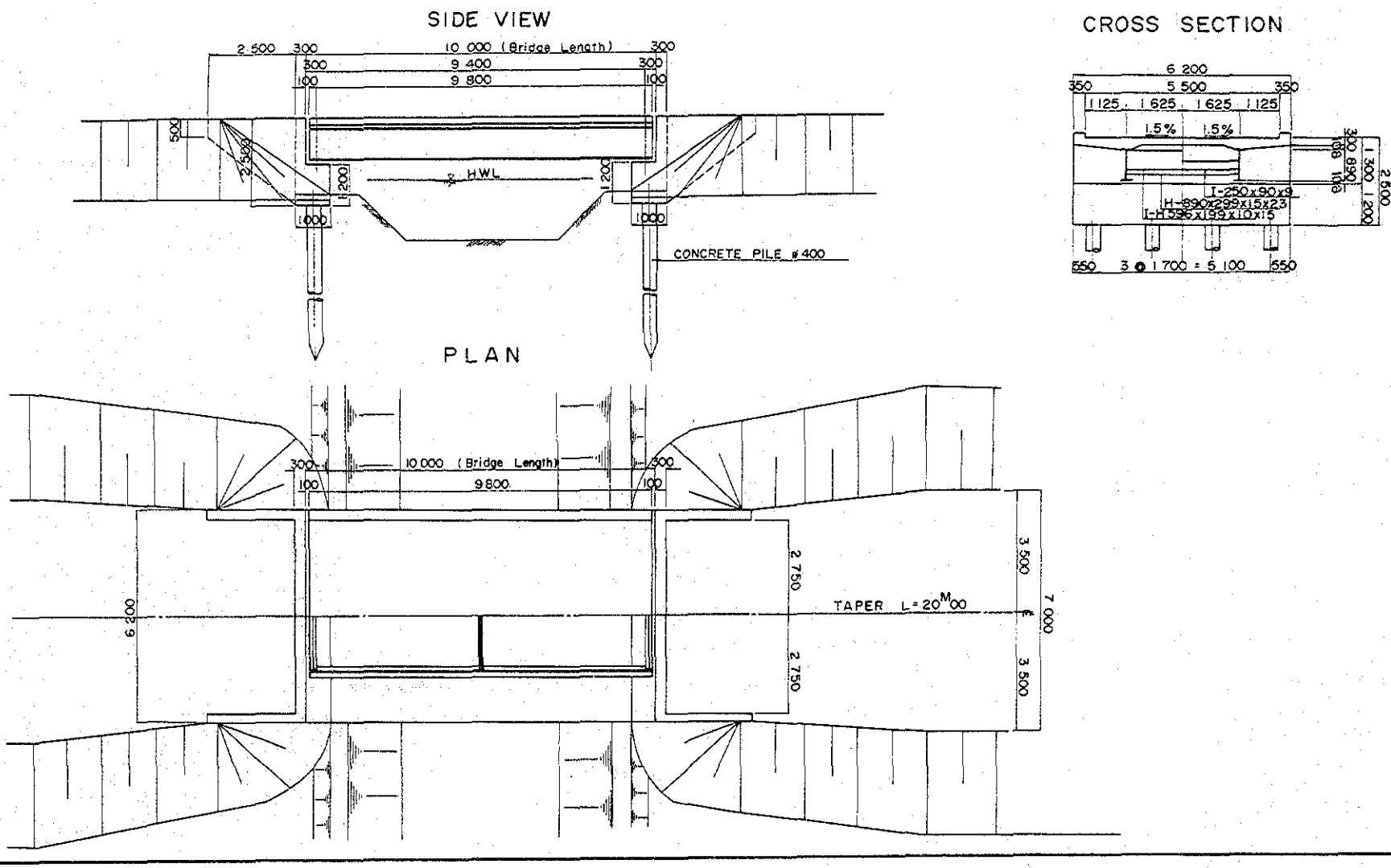
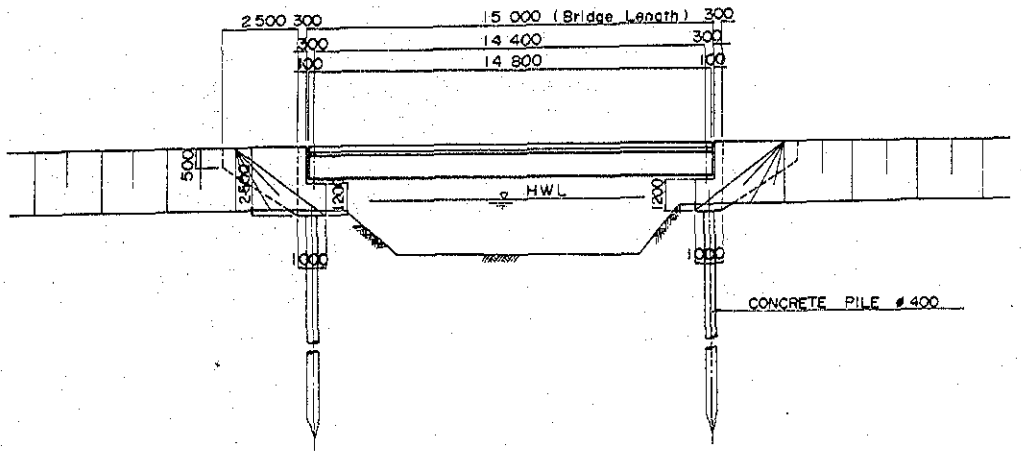


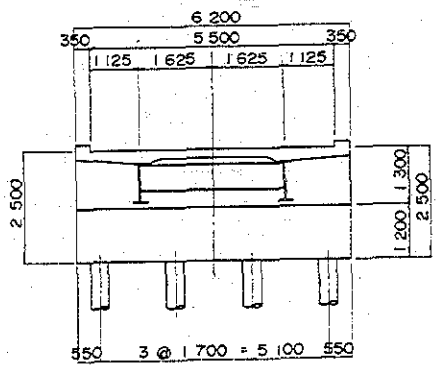
Fig. 4-18 BRIDGE TYPE - 2 SCALE = 1 : 160

BRIDGE LENGTH 15M

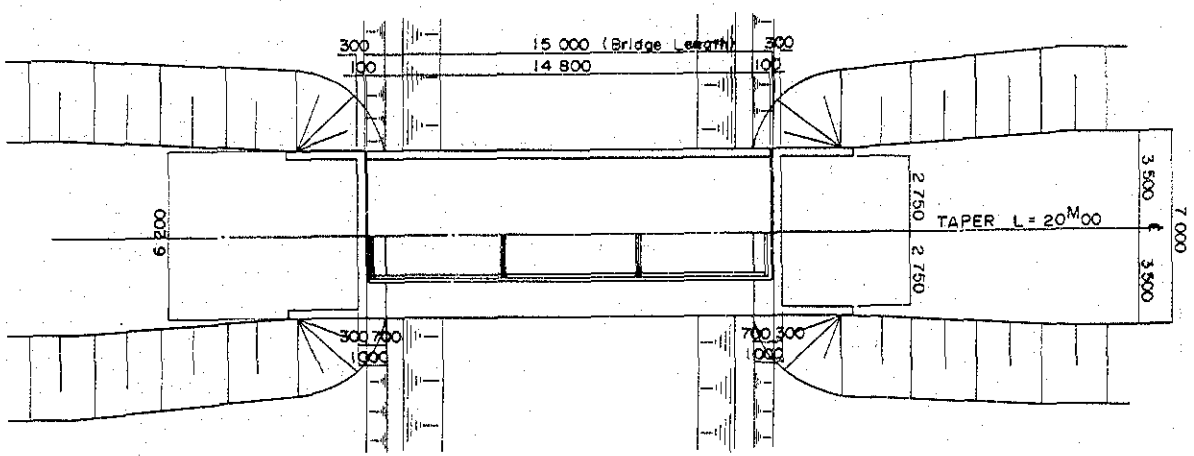
SIDE VIEW



CROSS SECTION (ABUTMENT)



PLAN



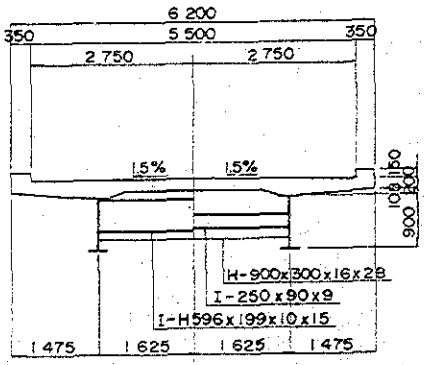
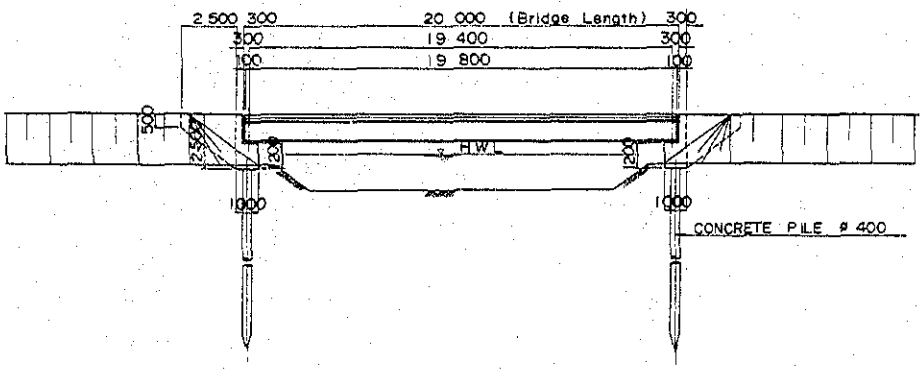


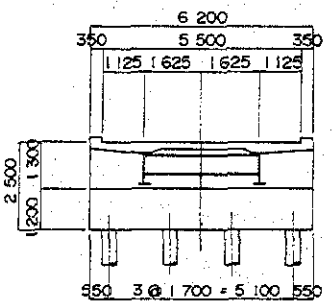
Fig. 4-19 BRIDGE TYPE – 3 SCALE = 1 : 320

BRIDGE LENGTH 20M

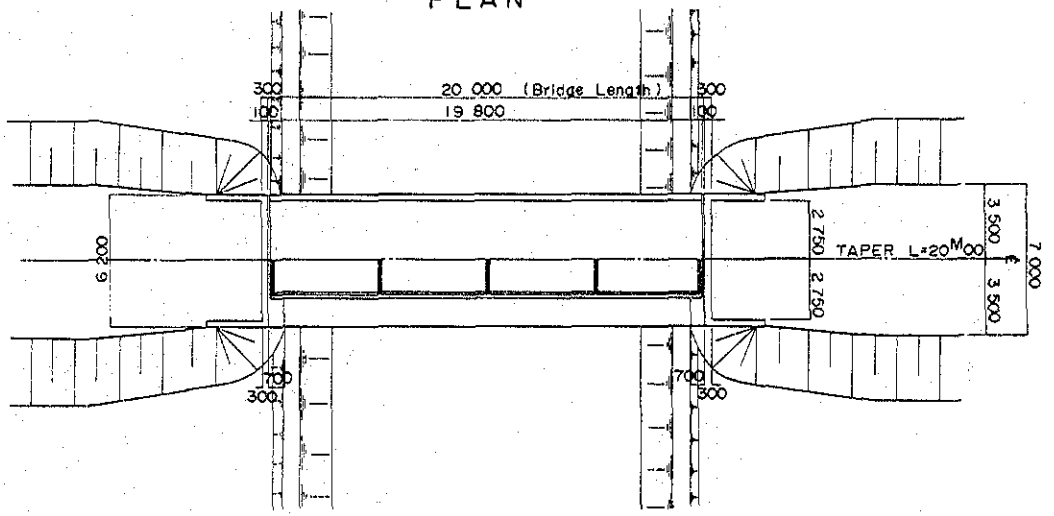
SIDE VIEW

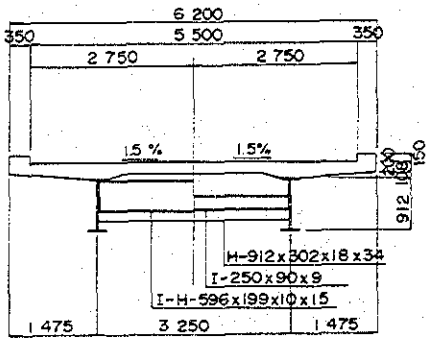


CROSS SECTION (ABUTMENT)



PLAN





6) Conduit Pipe

Since no Hume pipe manufacturing plant is existent near the project area, it is planned that corrugated metal pipes will be used in place of Hume pipes exceeding 60 mm in inside diameter. The pipes will be laid after excavating the ground to a depth 1.0 m and filling sandy soil of satisfactory quality, and will have an earth covering of more than 0.8 m.

7) Design Criteria and Construction Standards of Feeder Roads

Design speed	30 km/h
Roadway width	4.0 m
Shoulder width	1.5 m
Surface type	Gravel
Super elevation runoff	3.0 %
Maximum longitudinal slope	6.0 %
Minimum radius of curvature	50 m
Width of structures	5.5 m (= 0.75 m + 4.0 m + 0.75 m)
Design load of structures	ASSHO H-20 (in conformity to the standards for national roads)

8) Approach Section to Jetty (see Dwgs. 3/17 ~ 5/17 for plan and profile)

As described in Chapter 3 (New Port Construction Plan), Tagat and Centinela Point were proposed as the site of iron sand loading jetty, and the latter was selected after comparison of the two. For this reason, it is planned that the 2.0 km road leading to Centinela Point from the national road will be improved as the approach road.

Unlike the feeders connecting the national roads will respective sectors, the approach road will be used for a long time throughout the entire period of mining operation. Hence, it is planned that this road will be paved by cement concrete along its entire route and will have a width of 6.0 m for paved section and 1.5 m for shoulders. Construction of structures is not required because neither rivers nor canals cross this road.

9) Detailed Improvement Plan of Feeder Road

a) Namuac Road, Distance : 870 m (see Dwg. 6/17 for plan and profile)

The fill work will be carried out in accordance with the method described in Section 4.3.2 for improvement of weak ground SG-1. In addition, a 20 m long bridge of type 3 will be built on the river flowing across this road.

b) Nagtantayan Road, Distance : 2.0 km (see Dwgs. 7/17 ~ 9/17 for plan and profile)

This road will be improved to a gravel road because no surface improvement has been effected to any part of it. Further, guard rails will be installed in the 1,500 m long section between STA. 0 + 00 and STA. 15 + 00 which embrances a residential district. The guard rails will be installed on both sides of the road in such a way as will be able to secure a width of 5.5 m which is equivalent to the bridge width, and a footway with a width of 1.0 m will be provided outside the guard rail on both sides.

c) Dagai Road, Distance : 1,600 m (see Dwgs. 10/17 and 11/17 for plan and profile)

Although this road is paved by bituminos macadam between STA 0 + 00 and STA 14 + 00, the pavement has a width of only 4.20 m which is not large enough for smooth simultaneous traffic of upbound and downbound vehicles. It is therefore planned that 1.50 m of the 1.90 m width of the shoulder section on one side will be paved by selected borrow. At a distance of about 1,350 m from the national road, there is a T-intersection which can no longer be widened. The dwelling unit density in the neighborhood of this intersection, where a school is located, is very high. To avoid passing through this residential district, a new intersection will be created at STA 12 + 80 to provide a detour to the national road.

d) Sanchez Mira Road, Distance : 1,500 m (see Dwgs. 12/17 and 13/17 for plan and profile)

From its junction with the national road, this road runs through a residential district for a distance of 230 m. Guard rails will therefore be installed on both sides of the road in this section. The present road width in this section 7.5 m. The guard rails will be so installed as will be able to secure to roadway width of 5.5 m, and a footway with a width of 1.0 m will be provided outside the guard rail on either side.

The 160 m section between STA 3 + 00 and STA 4 + 60.00 and the 60 m section between STA 13 + 50.00 and STA 14 + 40.00 pass through rice paddy areas, but these sections will be improved only by spreading gravels in view of the present surface and subsurface condition.

From STA 4 + 80.00 to the terminal STA 15 + 00, the average width declines to 3.5 m. The 350 m section between STA 6 + 00 and STA 9 + 50.00 and the 210 section between STA 10 + 30.00 and STA 12 + 40.00 pass through rice paddy zones where the ground is weak. In these two sections, the road will be widened and improvement of weak ground SG-1 will be effected. The wooden bridges on two rivers (width : approx. 5 m) flowing across this road will be removed and new bridges of type 1 with a length of 10.0 m will be constructed.

e) Daguenay Road, Distance : 1,600 m (see Dwgs. 14/17 and 15/17 for plan and profile)

This road runs through a satisfactory sandy ground zone in the first 300 m section from its junction with the national road. However, the next 550 m section from STA 3 + 00 to STA 8 + 50.00 and the 400 m section from STA 12 + 00 to STA 16 + 00.00 are in rice paddy and marshy areas. The latter section passes through a weak ground zone which has

a depth of more than 1.5 m within 30 m between STA 12 + 00 and STA 12 + 30.00. The rice paddy zone has a low elevation and is often inundated by flood water in the wet season, so that plankings are laid continously for a distance of 300 m to permit the passage of pedestrians. It is therefore planned that a bridge of type 3 with a length of 20 m will be built on the river that flows through the said zone, and that 4 arched corrugated pipes with a span of 2.0 m and a height of 1.5 m will be installed in each 10 m in the weak ground zone in the approach section. However, this plan should be changed and fill work should be conducted if its execution is found to be possible by the soil exploration covering the foundation of abutment.

f) Bolay Road, Distance : 800 m (see Dwg. 16/17 for plan and profile)

The first 430 m section from the national road is in a rice paddy zone but needs only gravel pavement because the ground condition is satisfactory. However, the ground is weak in the next 345 m section from STA 4 + 30.00 to STA 7 + 75.00 so that the embankment of the existing road is in a poor condition. It is therefore planned that the subgrade soil above a depth of 1.5 m will be replaced with soil of satisfactory quality. The bridges on this road will be rebuilt to wooden beam bridges of type 1 and 2, using I-beams for type 2.

g) Pilig Road, Distance : 500 m (see Dwg. 17/17 for plan and profile)

Although this road has a length of only 500 m, it runs through a weak ground zone in the 230 m section between STA 1 + 00 and STA 3 + 30.00. Since the depth of this zone is small, it is planned that the existing road will be widened by the method for SG-1.

The existing bridge will be rebuilt to a type 2 bridge with a length of 15 m in consideration of the flow condition of the river in its upstream and downstream sections.

h) Feeders Roads in Sector I between Abulug and Linao

There are about 20 feeder roads which connect sector I with provincial road Abulug ~ Ballesteros ~ Linao which runs perallel to sector I and has a length of about 19 km. However, they are not suited to iron sand transportation because none are wide enough to permit the frequent traffic of upbound and downbound vehicles and the population density is very high in and around Abulug and Ballesteros. The sandy beach near the deposit area between Ballesteros and Liano is hard enough for vehicles to run at a considerably high speed, so that it is planned that this sandy beach and F-4 road (see Fig. 4-15) which links it with provincial road Zitanga ~ Ballesteros by the shortest distance will be used exclusively for shipment of iron sand. It is also lanned that other feeder roads linking the provincial road and sector I will be used for one-way traffic of iron sand trucks returning from the loading jetty in order to assure that the regional traffic around Ballesteros and local living environment will be subjected to the least possible disturbance. None of these feeder roads are paved but they will meet the above purpose if improved to gravel roads because the subgrade is composed of sandy soil of satisfactory quality.

Section 4. Transport Road from Gravel Pit and Borrow Pit

4-1 Gravel Transport Road

1) Abulug River Gravel Pit

Ascending southward about 14 km from the national road along the Abulug river into the Apayao-Kalinga province, one finds that aggregate for concrete of excellent quality is available in large quantities in the river bed of the Abulug (see Fig. 4-20). The provincial government gathers aggregate from this gravel pit.

The road leading to this pit, called Puzon Road, was originally constructed as a forest road. A toll of P1.0 ~ 2.0 per vehicle is charged on all cars passing on this road excluding official cars. Maintenance of this road is undertaken by the provincial government. Although it has an average width of 6.0 m, the surface is in a poor condition and rejects the passage of large vehicles in some sections when it rains. Considering the distance between the pit and the national road and the speed of trucks available in the project area, it will not be possible to make more than 4 return trips a day.

2) Pamplona Gravel Pit

There is a gravel pit at a distance of about 2 km to the north of Pamplona, from which the provincial government collects aggregates. Although the aggregates from this pit contain some weathered or soft gravels, the survey team was informed that they were used for superstructure and substructure of large bridges such as Pamplona bridge and proved to have a sufficient strength.

There is a road linking this pit and the national road. In about 800 m section of this road which runs through a palm forest from the pit, both the road surface and subgrade have a very high moisture ratio. When it rains,

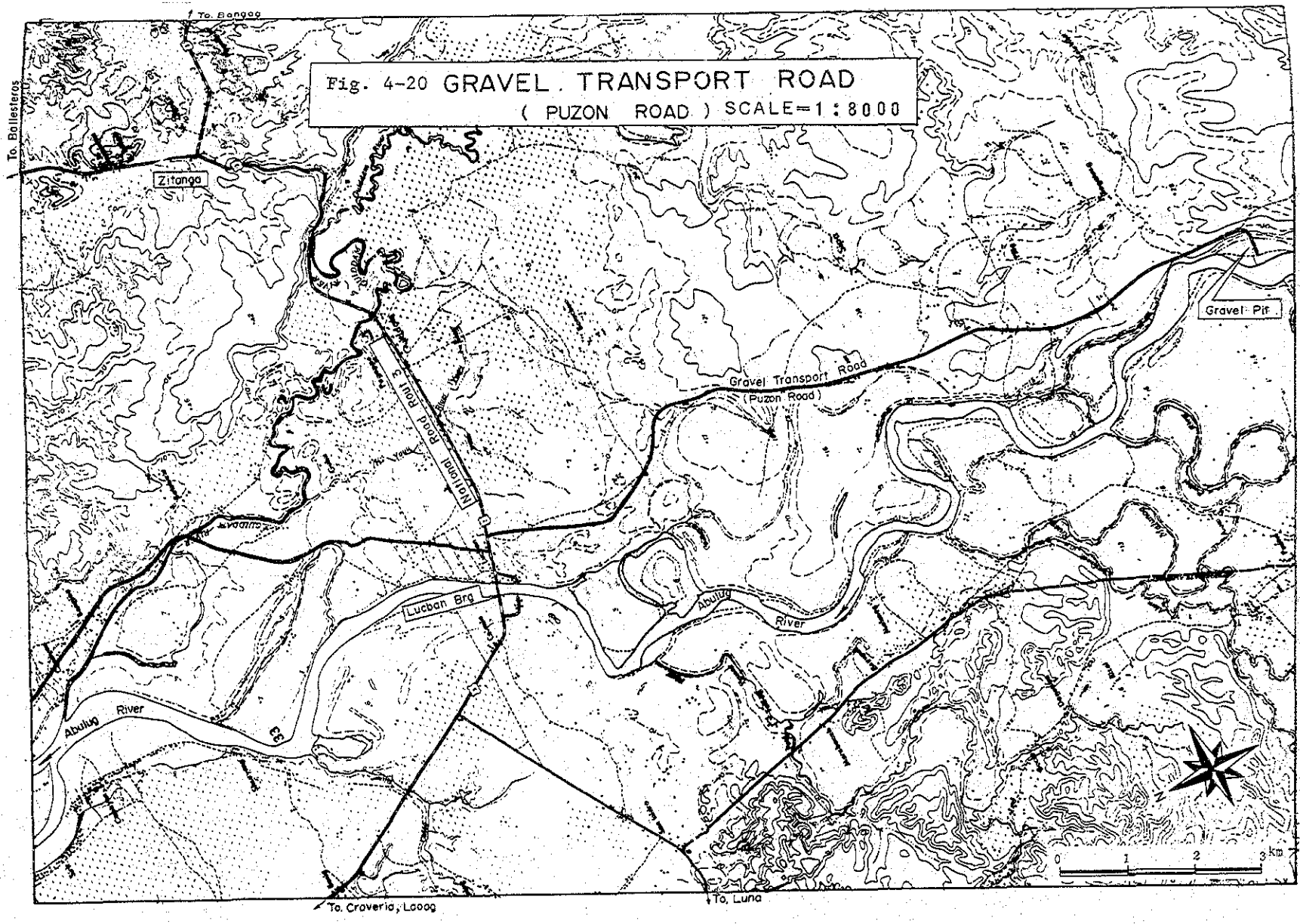


Fig. 4-20 GRAVEL TRANSPORT ROAD
(PUZON ROAD) SCALE=1:8000
To. Bongao
To. Ballesteros
Zitanga
National Road Poui 3
Gravel Transport Road
(Puzon Road)
Gravel Pit
Lucban Brg
Abulug River
Abulug River
To. Croveria, Laoag
To. Luna
0 1 2 3 km

it occasionally happens that a large vehicle gets stuch in the mud, making it impossible for other vehicles to pass.

For bulk transportation of gravels by this road, it is planned that culverts and unlined gutters will be provided.

4-2 Borrow Pit

Borrow pits are available in places along the national road, so that no particular difficulty is involved in gathering and transporting borrow. The small hillnear Mabuttal on provincial road Zitanga ~ Ballesteros is one of such borrow pits, and the fill material of provincial roads is collected therefrom. The landowner explained that he permits the collection of borrow against payment of ₱1.00 (=¥40) per m^3.

Small hills in the said area produce good fill material, but not rocks which can be crushed and used for subbase course and macadam pavement. According to an engineer of the provincial government, rocks for crushed stones can be obtained from hills along the 30 ~ 40 km upstream section of the Abulug river, but since the absence of a transport road and crusher plant makes it uneconomical to collect rocks from those hills, gravels of small diameter are used for asphalt macadam pavement work conducted in the neighborhood of Ballesteros. For this reason, use of crushed stones is not considered for road improvement under the present project.

Section 5 Feeder Road Construction Plan and Work Schedule

The feeder road improvement work will be carried out according to the priority order shown in Table 4-8 to keep pace with the progress of jetty construction and iron sand mining plan.

Top priority will be given to the feeder (approach) road at Centinela and to Pamplona gravel transport road because the former will be used as construction road for supplying the equipment and materials for jetty construction and the latter for transporting aggregate for concrete which is also required for jetty construction.

Feeder road construction and improvement work will be carried out according to the priority order of mining operation in the four sectors. Feeder road and improvement in a sector will be carried out according to the mining plan of the blocks in that sector, so that no definite priority order is shown in this report.

The priority order and construction period are shown in Table 4-9 for each feeder road.

Table 4-8 TOTAL LENGTH OF EACH FEEDER ROADS

Name of Feeder Road	Length of Feeder Road	Length of National Road	Provincial Road Zitang - Ballesteros	Provincial Road Abulug - Linao	Centinera P.T. Road	Total
	Km	Km	Km	Km	Km	Km
Centinera P.T. Road	2.00	-	-	-	-	2.00
Namac Road	0.87	5.40	-	-	2.00	8.27
Nagtantayan Road	2.00	7.20	-	-	2.00	11.20
Dagai Road	1.60	11.70	-	-	2.00	15.30
Sanchez Mira Road	1.50	13.90	-	-	2.00	17.40
Daguenay Road	1.60	18.10	-	-	2.00	21.70
Bolay Road	0.80	19.70	-	-	2.00	22.50
Pilig Road	0.50	20.50	-	-	2.00	23.00
F-1 Road	0.74	65.00	7.00	6.90	2.00	81.64
F-2 Road	0.80	65.00	7.00	5.30	2.00	80.10
F-3 Road	0.60	65.00	7.00	2.00	2.00	76.60
F-4 Road	0.58	65.00	7.00	-	2.00	74.58
F-5 Road	0.70	65.00	7.00	1.70	2.00	76.40
F-6 Road	0.10	65.00	7.00	5.70	2.00	79.80

Table 4-9 PRIORITY ORDER OF FEEDER ROADS CONSTRUCTION AND CONSTRUCTION PERIOD

Priority Order		Name of Road	Construction/Improvement Period	Remarks
1	Approach Road to Jetty	Centnela P.T. Road	60 days	
	Gravel Transport Road	Pamplona Road	60 days	
2	Feeder Road in Sector IV	Namuac Road	150 days	To be started with bridge construction.
		Dagai Road	90 days	
		Sanchez Mira Road	90 days	To be started with bridge construction.
3	Feeder Road in Sector III	Daguenay Road	150 days	To be started with bridge construction and weak ground improvement.
		Bolay Road	150 days	To be started with bridge construction.
		Pilig Road	120 days	To be started with bridge construction.
4	Feeder Road in Sector I	F-1 Road	5 days	
		F-2 Road	5 days	
		F-3 Road	5 days	
		F-4 Road	5 days	
		F-5 Road	5 days	
		F-6 Road	5 days	
5	Feeder Road in Sector II	——	——	

Section 6. Estimated Construction Cost

The total feeder road construction cost is estimated at ₱6,016,000 ($824,100). Breakdown of this total cost is shown in the following tables.

The unit cost employed in the estimation are based on the data provided by D.P.H. and O.P.E. and the results of field survey.

As described in Section 2-2 (Future Improvement Plan of Highway Network of Northern Luzon), improvement of National Road Route 3 is planned to be completed under PJHL-II project before the mining operaton is started in Aparri deposit. To provide for the case where the mining operation in Aparri deposit starts before completion of this improvement work and necessitates the improvement of Pata bridte I, an amount of ₱170,000 is separately appropriated (see Table 4-10).

The estimation is based on the commodity price as of March 1977, and price escalation due to inflation or other causes is disregarded.

Table 4-10-a FEEDER ROADS CONSTRUCTION COST

	Name of Road	Amount	Remarks
Approach Road to The Jetty	Centinela P.T. Road	₱1,069,150	
	Total	₱1,069,150	$146,500
Feeder Road in Sector IV	Namuac Road	₱ 721,429	
	Nagtantayan Road	——	Alternative Line
	Dagai Road	₱ 210,310	
	Sanchez Mila Road	₱1,074,631	
	Total	₱2,006,370	$274,800
Feeder Road in Sector III	Daguenay Road	₱ 976,201	
	Bolay Road	₱ 745,413	
	Pilig Road	₱ 451,230	
	Total	₱2,172,844	$297,600
Feeder Road in Sector II	Pimpila-Abulug Road	——	
	Total		

Table 4-10-b FEEDER ROADS CONSTRUCTION COST

	Name of Road	Amount	Remarks
Feeder Road in Sector I	F-1 Road	₱ 116,920	
	F-2 Road	₱ 126,400	
	F-3 Road	₱ 94,800	
	F-4 Road	₱ 91,640	
	F-5 Road	₱ 110,600	
	F-6 Road	₱ 15,800	
	Total	₱ 556,160	$ 76,200
Gravel Transport Road	Pamplona Road	₱ 211,500	
	Total	₱ 211,500	$ 29,000
	Grand Total	₱ 6,016,024	$824,100

Reference

Repair under AISDD Project	Pata #1 Bridge	P 170,000 ($ 23,300)	In case the implementation or work schedule of the PJHL Project is prolonged. In case the PJHL Project is not given the consent of Japanese government. Alternated with Zitang Ballesteros Road.
	Eight bridges included Pata #1 Bridge	P 2,296,000 ($ 314,520)	
Alternative Road	Abulug Lug ~ Lucban Road	P 4,399,050	

Table 4-11-a BREAKDOWN OF FEEDER ROADS CONSTRUCTION COST, SECTOR IV

Figures is brackets indicate volume of work.

Item / Unit Cost / Name of Road	Length	Gravel Pavement	Shoulder Pavement	Conduit Pipe	Embankment		Weak Ground Improvement		Cutting	Sub-Total	Remarks
					New	Widening	GS-1	GS-2		(A)	
		₱/Km 158,000	₱/Km 36,000	₱/m 50	₱/Km 197,500	₱/Km 72,000	₱/Km 375,000	₱/10m 107,451	₱/Km 136,800		
Namuac Road	Km 0.87	(0.85) 134,300	-	-	-	* (0.38) 9,029	(0.38) 142,500	-	-	₱ 285,829	Average hight of widened embankment : 0.33m 72,000P/Km/1.0H x 0.33 = 23,760 P/Km 0.38 x 23,760 = 9,029 P/Km
Nagtantayan Road	2.00	(2.0) 316,000	-	-	-	-	-	-	-	316,000	
Dagai Road	1.60	(0.32) 50,560	(1.25) 45,000	-	*(0.12) (0.20) 35,550	-	-	-	-	131,110	Average hight of new embankment : 0.30m 197,500P/Km/1.0mH x 0.30 = 59,250 P/Km 59,250 x 0.20 = ₱ 11,850 197,500 x 0.12 = ₱ 23,700
Sanchez Mira Road	1.50	(1.49) 235,420	-	-	-	*(0.56) 210,000	(0.56) 210,000	-	(0.08) 10,944	481,751	Average hight of widened embankment : 0.43 m
Total	3.97	(2.66) 420,280	(1.25) 45,000	-	(0.12) (0.20) 35,550	(0.94) 352,500	(0.94) 352,500		(0.08) 10,944	898,690	

* See "Remarks" for details.

Table 4-11-b BREAKDOWN OF FEEDER ROADS CONSTRUCTION COST, SECTOR IV

Figures is brackets indicate volume of work.

Item / Unit Cost / Name of Road	Bridges				Conduit Pipe	Guard Rail	Right of Way			Sub-Total	Total	Remarks
	Type-1	Type-2	Type-3	Others			Residential District	Palm Forest	Rice Paddy	(B)	(A)+(B)	
	₱/Bridge 164,000	₱/Bridge 246,000	₱/Bridge 328,000	₱/Bridge 1,232,000	₱/Section 1,800	₱/m 400	A 30 ₱/m² B200 ₱/m²	22 ₱/m²	20 ₱/m²			
Namuac Road	-	-	(1) 328,000	-	-	-	B(320) 64,000	(600) 13,200	(1,520) 30,400	₱ 435,600	₱ 721,429	829,228 ₱/Km
Nagtantayan Road	-	-	-	-	-	(2,080) 832,000	B(3,240) 648,000	(1,920) 42,240	-	1,522,240	1,838,240	919,120 ₱/Km
Dagai Road	-	-	-	-	-	-	A(1,600) 48,000	-	(1,560) 31,200	79,200	210,310	131,443 ₱/Km
Sanchez Mira Road	(2) 328,000	-	-	-	(2) 3,600	(460) 184,000	A(420) 12,600	(2,310) 46,200	(2,310) 46,200	1,074,631	716,420	716,420 ₱/Km
Total	(2) 328,000		(1) 328,000		(2) 3,600		A(2,020) B(320) 124,600	(1,440) 31,680	(5,390) 107,800	1,107,680	2,006,370	

Notes : Comparison was made between Naumuac Road and Nagtantayan Road which reach the same point in sector IV, and Namuac Road was selected as it incurs less cost and shorter in the length of the section which passes through residential district. The total shown in the above table does not therefore include the construction cost of Nagatantayan Road.

Table 4-12-a BREAKDOWN OF FEEDER ROADS CONSTRUCTION COST, SECTOR III

Figures is brackets indicate volume of work.

Item / Unit Cost / Name of Road	Length	Gravel Pavement	Shoulder Pavement	Conduit Pipe	Embankment		Weak Ground Improvement		Cutting	Sub-Total (A)	Remarks
					New	Widening	SG-1	SG-2			
		₱/Km 158,000	₱/Km 36,000	₱/m 50	₱/Km 197,500	₱/Km 72,000	₱/Km 375,000	₱/10m 107,451			
Daguenay Road	Km 1.60	(1.58) 249,640	-	-	-	(0.23) 16,560	(0.37) 138,750	1.0 107,451		₱ 512,401	Average height of widening embankment : 1.0 m
Bolay Road	0.80	(0.775) 122,450	-	-	-	*(0.705) 15,228	(0.345) 129,375			267,053	Average height of widening embankment : 0.3 m 72,000P/Km/1.0H x 0.30 = 21,600 P/Km 0.705 x 21,600 = P 15,228
Pilig Road	0.50	(0.485) 76,630	-	-	-	*(0.30) 12,960	(0.20) 75,000			164,590	Average height of windening embankment : 0.6 m 72,000P/Km/1.0H x 0.6 = 43,200P/Km 0.30 x 43,200 = P 12,960
Total	2.90	(2.84) 448,720				44,748	(0.915) 343,125	(1.0) 107,451		944,044	

* See "Remarks" for details

Table 4-12-b BREAKDOWN OF FEEDER ROADS CONSTRUCTION COST, SECTOR III

Figures is brackets indicate volume of work.

Item / Unit Cost / Name of Road	Bridges				Conduit Pipe	Guard Rail	Right of Way			Sub-Total	Total	Remarks
	Type-1	Type-2	Type-3	Others			Residential District	Palm Forest	Rice Paddy	(B)	(A)+(B)	
	₱/Bridge 164,000	₱/Bridge 246,000	₱/Bridge 328,000	₱/Bridge 1,232,000	₱/Section 1,800	₱/m 400	A 30₱/m² B 200₱/m²	₱/m² 22	₱/m² 20			
Daguenay Road	-	-	(1) 328,000	-	(1) 1,800	-	A (400) 12,000	(2,200) 48,400	(3,680) 73,600	P 463,800	P 976,201	610,125 P/Km
Bolay Road	(1) 164,000	(1) 246,000	-	-	(2) 3,600	-	-	(380) 8,360	(2,820) 56,400	478,360	745,413	931,766 P/Km
Pilig Road	-	(1) 246,000	-	-	-	-	-	(1,120) 24,640	(800) 16,000	286,640	451,230	902,460 P/Km
Total	(1) 164,000	(2) 492,000	(1) 328,000		(3) 5,400		A(400) 81,400	(3,700) 81,400	(7,300) 146,000	1,228,800	2,172,344	

Table 4-13-a BREAKDOWN OF FEEDER ROADS CONSTRUCTION COST, SECTOR I

Figures is brackets indicate volume of work

Item / Unit Cost / Name of Road	Length	Gravel Pavement	Shoulder Pavement	Conduit Pipe	Embankment		Weak Ground Improvement		Cutting	Sub-Total (A)	Remarks
					New	Widening	SG-1	SG-2			
		₱/Km 158,000	₱/Km 36,000	₱/m 50	₱/Km 197,500	₱/Km 72,000	₱/Km 375,000	₱/Km 107,451			
F-1 Road	Km 0.74	(0.74) 116,920								116,920	
F-2 Road	0.80	(0.80) 126,400								126,400	
F-3 Road	0.60	(0.60) 94,800								94,800	
F-4 Road	0.58	(0.58) 91,640								91,640	
F-5 Road	0.70	(0.70) 110,600								110,600	
F-6 Road	0.10	(0.10) 158,000								158,000	
Total	3.52	(3.52) 556,160								556,160	

Table 4-13-b BREAKDOWN OF FEEDER ROADS CONSTRUCTION COST, SECTOR I

Figures is brackets indicate volume of work.

Item / Unit Cost / Name of Road	Bridges				Conduit Pipe	Guard Rail	Right of Way			Sub-Total	Total	Remarks
	Type-1	Type-2	Type-3				Residential District	Palm Forest	Rice Paddy	(B)	(A) + (B)	
	₱/Bridge 164,000	₱/Bridge 246,000	₱/Bridge 328,000	₱/Bridge 1,232,000	₱/Section 1,800	₱/m 400	A 30 ₱/m² B 200 ₱/m²	₱/m² 22	₱/m² 20			
F-1 Road										-	116,920	
F-2 Road										-	126,400	
F-3 Road										-	94,800	
F-4 Road										-	91,640	
F-5 Road										-	110,600	
F-6 Road										-	15,800	
Total											556,160	

Table 4-14-a BREAKDOWN OF CONSTRUCTION COST OF APPROACH ROAD AND GRAVEL TRANSPORT ROAD

Figure is brackets indicate volume of work.

Item / Unit Cost / Name of Road	Length	Gravel Pavement	Portland Cement Concrete Pavement	Conduit Pipe	Embankment		Weak Ground Improvement		Cutting	Sub-Total	Remarks
					New	*Widening*	*SG-1*	*SG-2*		(A)	
		₱/Km 158,000	₱/Km 36,000	₱/m 50	₱/Km 197,500	₱/Km 72,000	₱/Km 375,000	₱/Km 107,451			
Centinela P.T.Road	Km 2.00	- -	(2.0) 709,510	-	-	-	-	-	(0.65) 88,920	₱ 798,430	
Pamptana Road	1.90	(0.90) 142,200	- -	(1,350) 67,500	-	-	-	-	- -	209,700	
Total	3.90	(0.90) 142,200	(2.0) 709,510	(1,350) 67,500					(0.65) 88,920	1,008,130	
(Reference Data)											
Abulug - Lucban Road	14.50	(9.94) 1,570,520			*(0.272) 94,010	*(4.9) 352,800				2,017,330	Average height of new embankment : 1.75m 197,500 P/Km/1.0 H x 1.75 = 345,625 P/Km 0.272 x 345,625 = P94,010 Average height of widened embankment : 1.0 m

* See "Remarks" for details

Table 4-14-b BREAKDOWN OF CONSTRUCTION COST OF APPROACH ROAD AND GRAVEL TRANSPORT ROAD

Figures is brackets indicate volume of work.

Item / Unit Cost / Name of Road	Bridges				Conduit Pipe	Guard Rail	Right of Way			Sub-Total	Total	Remarks
	Type-1	Type-2	Type-3				Residential District	Palm Forest	Rice Paddy	(B)	(A) + (B)	
	₱/Bridge 164,000	₱/Bridge 246,000	₱/Bridge 328,000	₱/Bridge 1,232,000	₱/Section 1,800	₱/m 400	A 30 ₱/m² B 200 ₱/m²	₱/m² 22	₱/m² 20			
Centinela P.T. Road												
Pamplona Road												

Calculation of Unit Cost

1) Gravel Pavement (per 1.0 km)

Pavement thickness	20 cm	Gravel transportation and spreading ₱40/m³
Subbase thickness	40 cm	Selected borrow transportation, spreading and compaction ₱4.5/m³

Quantity and Cost

Subbase course (selected borrow)

7.0 (W) x 0.4 (T) x 1,000.0 (L) = 2,800.0 m³

2,800.0 x 45 = 126,000 ₱/km

Surface course (gravel pavement)

4.0 (W) x 0.2 (T) x 1,000.0 (L) = 800.0 m³

800.0 x 40 = 32,000 ₱/km

Gravel pavement = Subbase course + Surface course

126,000 + 32,000 = 158,000 ₱/km

2) Cement Concrete Pavement (per 1.0 km)

Pavement thickness	23 cm	Placing of joint filler and other materials ₱55/m³
Subbase course	20 cm	Gravel subbase spreading and compaction ₱45/m³
Shoulder	63 cm	Selected borrow spreading and compaction ₱45/m³

Subgrade	20 cm	Selected borrow spreading and compaction ₱45/m³

Quantity and Cost

Concrete pavement

6.7 (W) x 0.23(T) x 1,000.0 (L) = 1,541.0 m³

1,541.0 x 55 = 84,755 ₱/km

Subbase course

6.7 x 0.2 x 1,000.0 = 1,340.0 m³

1,340.0 x 45 = 60.300 ₱/km

Shoulder

2.0 x 0.63 x 1,000.0 x 2 = 2,520.0 m³

2,520.0 x 45 = 113,400 ₱/km

Subgrade

(2.0 + 6.7 + 2.0) x 0.2 x 1,000.0 = 2,140.0 m³

21,400.0 x 45 = 96,300 ₱/km

Concrete pavement = Surface course + Subbase course + Shoulders + Subgrade

84,755 + 60,300 + 113,400 + 96,300 = 354,755 ₱/km

3) Shoulders in Asphalt Paved Section (per 1.0 km)

Shoulder thickness	Ave. 20 cm	Transportation, spreading and compaction of selected borrow ₱45/m³

Quantity and Cost

2.0 x 2 (W) x 0.2 (T) x 1,000.0 (L) = 800 m³/km

800.0 x 45 = 36,000 ₱/km

4) New Fill Work (per 1.0 km)

Cost of new fill work for national road (height : 2 m)
500,000 ₱/km

Width	9.7 m
Slope gradient	1 : 15
Sectional area	25.4 m^2

Feeder road

Width	7.0 m	
Slope gradient	1 : 15	20.0/25.4 = 0.79
Sectional area	20.0 m^2	

Feeder road construction cost (approx.)

500,000 x 0.79 = 359.000 ₱/km/2 m (height)

395,000 ÷ 2 = 197,500 ₱/km/1 m (height)

5) Widening of Fill (4.0 m)

Height	2.0 m
Slope gradient	1 : 15
Sectional area	8.0 m^2
Width increase	40 % of new fill

360,000 x 0.4 = 144,000 ₱/km/2.0 m (height)

144,000 x 1/2 = 72,000 ₱/km/1.0 m (height)

72,000 x 1/2 = 36,000 ₱/km/0.5 m (height)

6) *Weak Ground Improvement (ref. Section 3:3-2)*

Cost per km for a depth of less than 1.5 m (SG-1)

Subgrade soil replacement

15.0(W) x 1.5 (D) x 1,000 (L) = 7,500 m^3

Excavation, soil replacement, and soil disposal ₱50/m^3

7,500 x 50 = 375,000 ₱/km

Cost per 10.0 m for a depth of more than 1.5 m (SG-2)

Arched corrugated pipe Span 2.0 m, height 1.5 m, thickness 3.2 mm

¥28,580/m

Length and quantity of pipes 15 m x 4 pipes (per 10.0 m)

15.0 x 4 x 28,580 = ¥1,714,800

Cost in Peso (Cost ratio = 1 : 2)

¥1,714,800 x 2.0 = ¥3,429,600 ≒ ₱92,726

Foundation material

15.0 (L) x 10.0 (W) x 1.5 (T) = 225.0 m^3

Back filling material (Pipe sectional area)

20.0 x 10.0 - 2.51 x 13.0 x 4 = 69.5 m^3

2.51: Section of Pipe

225 + 69.5 = 294.5 m^3 294.5 x 50 = ₱14.725

Total cost of SG-2

92,726 + 14,725 = 107,451 ₱/10.0 m

7) Cut

Average cut depth 2.0 m (incl. spoil disposal)

Cost per km ₱190,000 (national road)

190,000 x 0.72 = 136,800 ₱/km

8) Bridge

Cost per 1 m of bridge length (width - 6.7 m) ₱20,000

Width of feeder road 5.5 m = 82 % of national road

20,000 x 0.82 = ₱16,400/m

Type-1 bridge with a length of 10.0 m

10.0 x 16,400 = ₱164,000

Type-2 bridge with a length of 15.0 m

15.0 x 16,400 = ₱246,000

Type-3 bridge with a length of 20.0 m

20.0 x 16,400 = ₱328,000

Guiddam bridge with a length of more than 50 m

Cost per 1 m of bridge length ₱20,000

61,60 x 20,000 = ₱1,232,000

9) Conduit Pipe

Reinforced concrete pipe made in the Philippines, 600 ϕ

₱520/m incl. laying cost

15.0 m (L) x 520 = ₱7,800

10) Right of Way

Per 1,000 m^2 in Residential District A

Cost of nipa houses per unit	₱200
Number of houses (Average)	100
Land area per house	10 m^2
Land cost per m^2	₱10

1,000 x 10 = ₱10,000

100 x 200 = ₱20,000

Total : ₱30,000/1,000 m^2

Per 1,000 m^2 in Residential District B

Cost of wooden houses per unit	₱5,000
Number of houses (Average)	20
Land area per house	50 m^2
Land cost per m^2	₱100

1,000 x 100 = ₱100,000

20 x 5,000 = ₱100,000

Total : ₱200,000/1,000 m^2

Per 100 m^2 of Palm Forest Area

Land cost	₱20/m^2
Number of palm trees per 100 m^2	20 (Average)
Cost of palm trees	₱10/tree

100 x 20 = ₱2,000

20 x 10 = ₱200

Total : ₱2,200/100 m^2

Paddy Field

₱20/m^2

11) Unit Construction Cost

Concrete pavement	₱500,000/km	National road
Concrete structure	₱700/m^3	National road
Reinforcement	₱600/t	National road (incl. processing and erection cost)
Retaining wall (H = less than 5.0 m)	₱150/m	National road, stone masonry
Gravel road maintenance	₱8,000/km	National road (incl. motor grader and wooden bridge maintenance)
Rent of trucks	₱150/hr	10 ~ 20 t trucks
Rent of bulldozers	₱800/hr	13 t capacity
Rent of power shovles	₱170/hr	2 cu. yd.
	₱250/hr	4 cu. yd.
Back hoe	₱180/hr	1/2 ~ 5.8 cu. yd.
Generator	₱6,400/month	50 ~ 74 kW
Air compressor	₱3,500/month	15 ~ 35 CFM ratings
Diesel pile hammer	₱38,700/month	
Portland cement	₱16/bag	