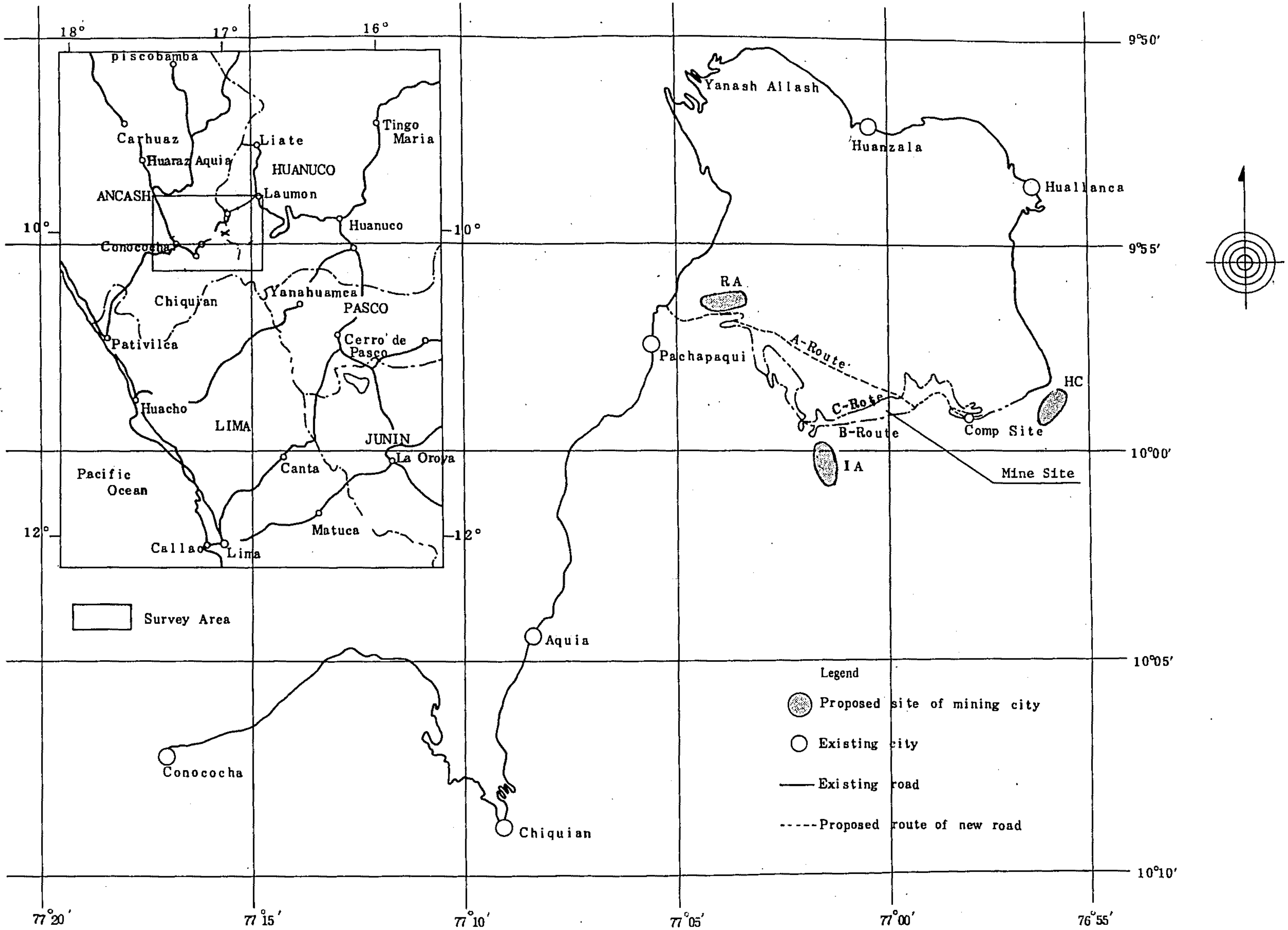
JAPAN INTERNATIONAL COOPERATION AGENCY

SURVEY FOR ROAD CONSTRUCTION AND CITY PLANNING FOR HILARION MINE DEVELOPMENT PROJECT

REPUBLIC OF PERU

March 1978

JAPAN INTERNATIONAL COOPERATION AGENCY



18°
17°
16°
piscobamba
Carhuaz
Huaraz
Aquia
Liate
Tingo Maria
HUANUCO
ANCASH
Laumon
Huanuco
10°
Conococha
Chiquian
Yanahuamca
PASCO
Pativilca
Cerro de Pasco
Huacho
LIMA
JUNIN
Pacific Ocean
Canta
La Oroya
12°
Matuca
Callao
Lima
Survey Area
9°50′
9°55′
10°00′
10°05′
10°10′
Yanash Allash
Huanzala
Huallanca
RA
Pachapaqui
A-Route
C-Rote
B-Route
HC
Comp Site
IA
Mine Site
Aquia
Conococha
Chiquian
Legend
Proposed site of mining city
Existing city
Existing road
Proposed route of new road
77°20′
77°15′
77°10′
77°05′
77°00′
76°55′

PREFACE

The Japanese government dicided to conduct a survey for road improvement and mining city planning necessary for the development of Hilarion mine and surrounding areas, and entrusted the Japan International Cooperation Agency with its execution.

The Agency dispatched an eight-member survey team headed by Mr. Shozo Tanifuji, president of Central Consultant Inc., to Peru for a period of 45 days from September 18 to November 1, 1977.

During its stay in Peru, the team was enabled to conduct the survey with the cooperation of the Peruvian authorities concerned. After its return to Japan, the team re-examined its of survey findings and has completed the survey for submission to the Peruvian Government.

The primary objective of the survey was to conduct a feasibility study in selecting the new road and the site of mining city for an early development of Hilarion mine and surrounding areas. Therefore, the team's activities involved studies on technical and economic feasibilities as well as analysis of development effect.

It is my sincere hope that this report, which contains the findings of the survey, will contribute to the development of Hilarion mine and surrounding areas and at the same time promote the friendly relations between Japan and Peru.

I wish to express my heartfelt thanks to the officials concerned of the Peruvian and Japanese Governments for extending their full cooperation in the work of the team.

Shinsaku Hogen

President
Japan International Cooperation Agency

March 1978

CENTRAL CONSULTANT INC.,

CABLE ADDRESS:
CENTRASULTAN TOKYO

TELEX: 02468236 CENTRA J

ISHIBASHI BLDG.,
SHIMOMEGURO 2-23-18,
MEGURO-KU, TOKYO, JAPAN.

PHONES:
TOKYO (491) 9001

LETTER OF TRANSMITTAL

Mr. Shinsaku Hogen
President
Japan International Cooperation Agency

Dear Sir,

Transmitted herewith is the "Report on Survey for Road Improvement and Mining City Planning for Hilarion Mine Development Project" compiled for the purpose of providing the basis for developing Hilarion mine which extends over two prefectures, Ancash and Huanuco, in the Republic of Peru.

The said survey was conducted by a survey team comprising eight experts from the Japan International Cooperation Agency and Central Consultant Inc., which was organized in September 1977 at the request of the Agency.

During its 45-day stay in Peru from September 18 to November 1, 1977, the team engaged in data collection, consultations with the pertinent Peruvian authorities, and field survey and surveying in the project area. After its return to Japan, the team exerted itself for fomulation of a plan for road improvement and mining city establishment on the basis of findings of the survey and data collected in Peru, and also conducted economic evaluation of the plan and other relevant works. The outcomes of strenuous effort expended by the team both in Peru and Japan are incorporated in this report.

It is my sincere hope that the presentation of this report will accelerate the development of Hilarion mine and neighbouring areas and also contribute towards economic development of both Japan and Peru.

I take this occasion to express my deep gratitude to the competent Peruvian authorities, Japanese Embassy in Lima and Compania Minera Hilarion S.A. for helpful cooperation in the field survey and data collection as well as to the Japan International Coopeation Agency for valuable assistance in the execution of the survey.

Shozo G. Tanifuji

Shozo Tanifuji

Leader
Japanese Survey Team for Road
Construction and City Planning
for
Hilarion Mine Development Project

March 1978

Fig. 1-1 Location Map

CONTENT

Chapter 1. Outline of the Project

1-1 Background of the Project

Hilarion Mine in the Republic of Peru is located in an area extending over two prefectures, Huanuco and Ancash, and its outcrops are found at elevation of 4,800 m. In Julay 1975, Mitsubishi Metal Mining Co., Ltd., Mitsubishi Corporation and Mitsubishi Peru S.A. established a Peruvian corporation named Compania Minera Hilarion S.A. and subsequently concluded an optional contract with Mr. Carbajal, the holder of mining right, for the purchase of the mine and exploration. Much hopes are anchored on the development of this mine as it es expected to provide Japan with a source of constant supply of mineral resources in which she is deficient and also open the way for the development of the central mountainous region of Peru.

In the exploration work so far conducted, which included geological survey, boring and pit excavation, the presence of mineral deposit was confirmed in some parts of the project area. The objective of the present preliminary survey, which was conducted by the Japanese survey team sent to Peru in September 1977, was to formulate an infrastructual improvement plan for the Hilarion Mine Development Project.

This report was prepared on the basis of the said preliminary survey and contains the plans for road improvement and new city development which are indispensable for project implementation. The plans presuppose that the mine operation will be initiated in 1983 for daily production of 800 tons by a total of 800 workers.

1-2 Purpose of the Survey

The survey was conducted to make technical and economic studies in order to assure that the development of the facilities required for the project, such as roads and a mining city, will not only promote the welfare of the local inhabitants but also contribute to the development of regional economy.

For this purpose, the survey covered the following activities.

(1) Road survey
   1) Improvement of the existing road section (approx. 140 km) between Conococha and the Camp Site.
   2) Planning of Huallanca bypass.
   3) Construction of new road section (approx. 20 km) between the camp site and Pachapaqui.

(2) Survey for mining city planning
   Planning of urban facilities which are required for the development of Hilarion mine.

(3) Preparation of topographic maps

   The Camp Site, described above, means the place where the existing road from Huallanca to the Hilarion mine ends and the exploration team for the mine has built their base camp.

1-3 Method of the Survey

The survey team, consisting of eight members including the leader, comprised five experts specialized in road engineering, two city planning experts, and one coordinator. During its 45-day stay in Peru (21 days for city planning experts), the team engaged in the following survey activities.

(1) Basic survey and data collection
   1) Census figures and economic data.
   2) Data related to mines and housing condition in mining areas.
   3) Data related to city planning.
   4) Data related to transportation and traffic.
   5) Data related to road construction.
   6) Data related to construction cost.
   7) Data related to the national development plan.
   8) Other data.

(2) Field survey and studies
   1) Studies of those sections of the existing road where improvement of alignment, drainage facilities, etc. is required.
   2) Disaster preventive studies for assumptive danger zones along the existing road.
   3) Studies for route determination of the new road with consideration given to the existing clusters as well as to the improvement and construction of the facilities such as roads which are necessary for project implementation.
   4) Brief studies on the durability of bridges and other structures.
   5) Survey for new mining city planning
      a) Survey of natural conditions in the selected city zones.
      b) Studies of the facilities available in similar mining cities.
      c) Studies on the fundamental conditions for urban development.

(3) Surveying
   1) Surveying of longitudinal grade in those sections of the existing road where the grade was considered to be too large during the field survey.
   2) Preparation of a 1/5,000 plan.
   3) Preliminary road construction design.
      For the purpose of the captioned design, a field reconnaissance was conducted using a 1/5,000 topographic map, with reference also made to the relevant data collected by the team.

(4) Rough design of the mining city
   A total of four optimum city zones, one for each proposed route of the new road, were selected by the method of alternative comparison, with account taken of the data of natural conditions of each zone.
   In mapping out the urban facilities plan, the minimum neighbourhood unit was obtained for each pattern of basic dwelling unit and consideration was given to the locations of related public facilities for preparation of the land use and general layout plans.

Chapter 2. Road Improvement Plan

2-1 Road Network

(a) Compared with the nation's average, the road density is fairly high in Ancash prefecture, but it is considerably low in Huanuco prefecture by reason of steep topography.

(b) The road under study (hereafter called the "project road") runs across the central part of Peru and links to Amazon corridor. It is the most important arterial road in Peru that leads from Lima capital region to the central forest land area of the country, but it is generally in an extremely deteriorated condition so that the development of forest resources is retarded.

As it crosses many steep passes of the Andes, its alignment is inevitably made very poor. Input of a huge cost will be required to improve the existing alignment.

(c) A close study of the project road on a road map will disclose the following facts.
- o It constitutes a part of National Highway No. 3 which runs through the country from sourth to north in parallel with National Highway No. 1 (Pan American Highway).
- o It runs on the route which directly links the eastern low-lying area and the northern inductrial area.
- o It constitutes a part of the route linking the eastern low-lying area and Lima in substitution for the road that runs through La Oroya.

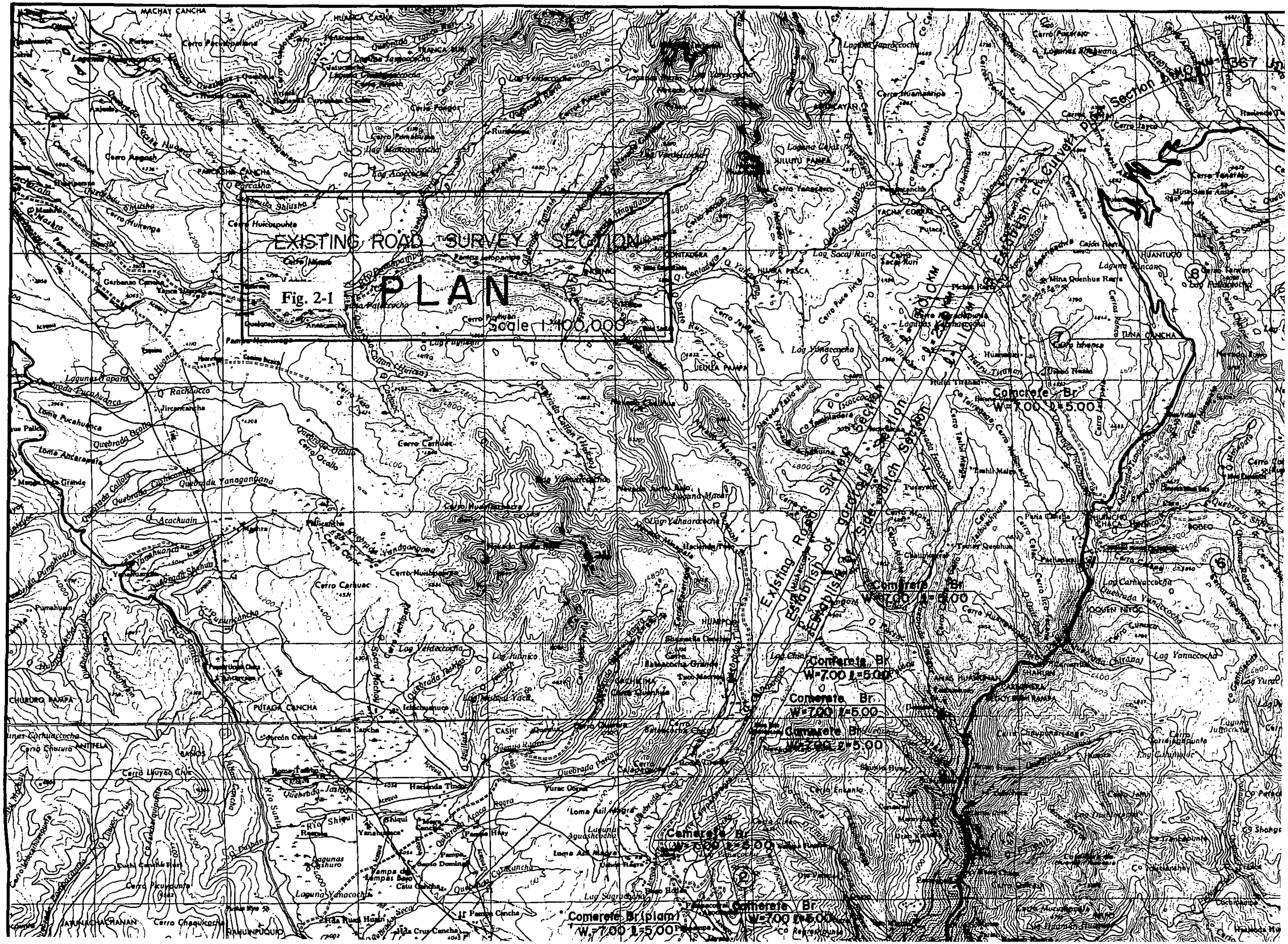
(d) The average daily traffic volume on the project road recorded in 1975 was 53 vehicles in Conococha ~ Chiquian section and 83 vehicles in Huallanca ~ La Union section. 17% of the traffic volume in the former section was accounted for by small vehicles and 83% by large ones. In the latter section, small vehicles accounted for 54% of the total traffic volume and large ones marked 46%.

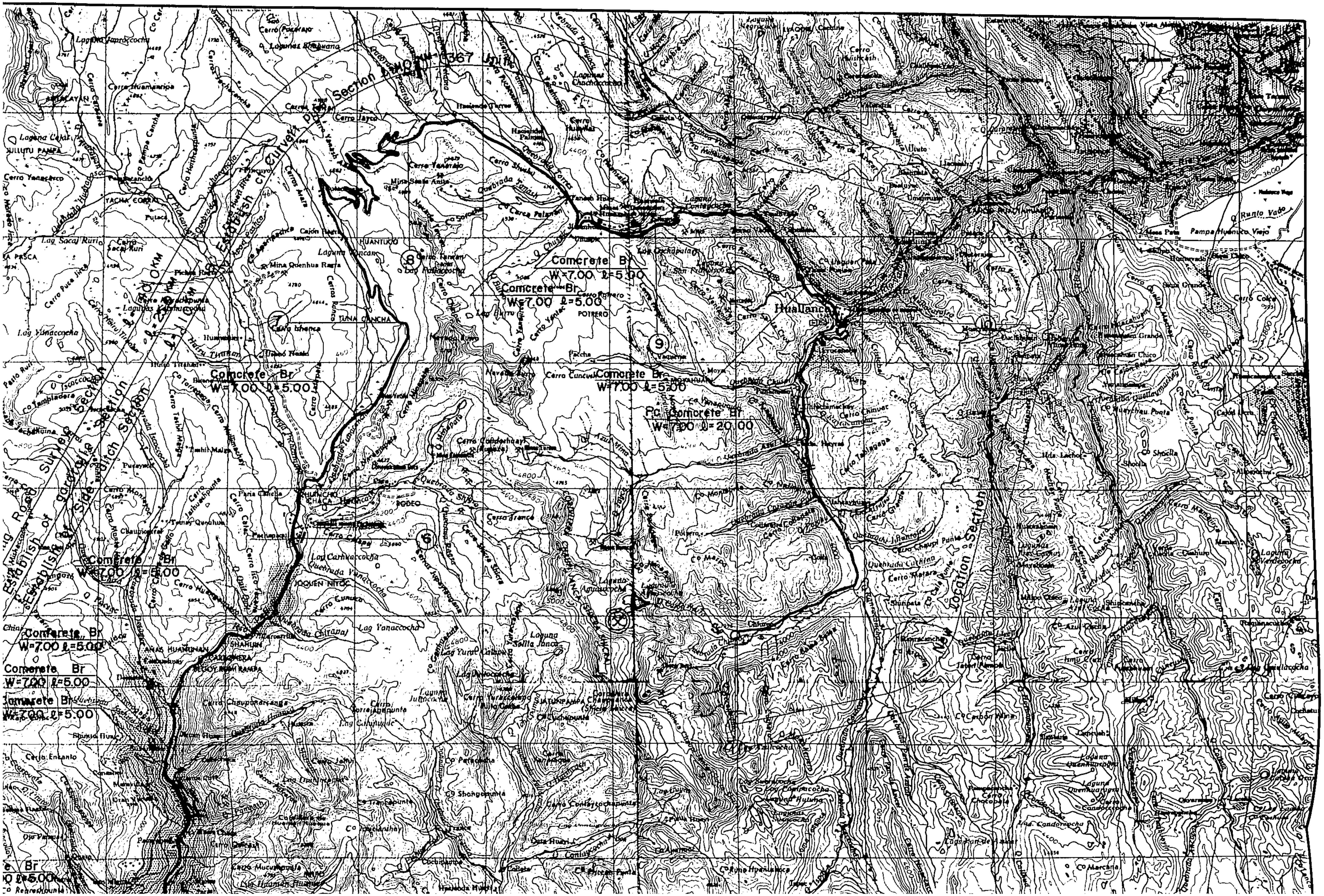
(e) The total number of motorcars registered in Ancash and Huanuco is 13,025 which accounts for 2.93% of the national total. The population of the two prefectures combined is 1,140 thousand or 8.42% of the national total. Thus, the ratio of registered motorcars to population is very low in the two prefectures.
The number of registered motorcars per 1,000 persons is 12.11 in Ancash and 10.23 in Huanuco against the country's average of 32.74.

2-2 Existing Road

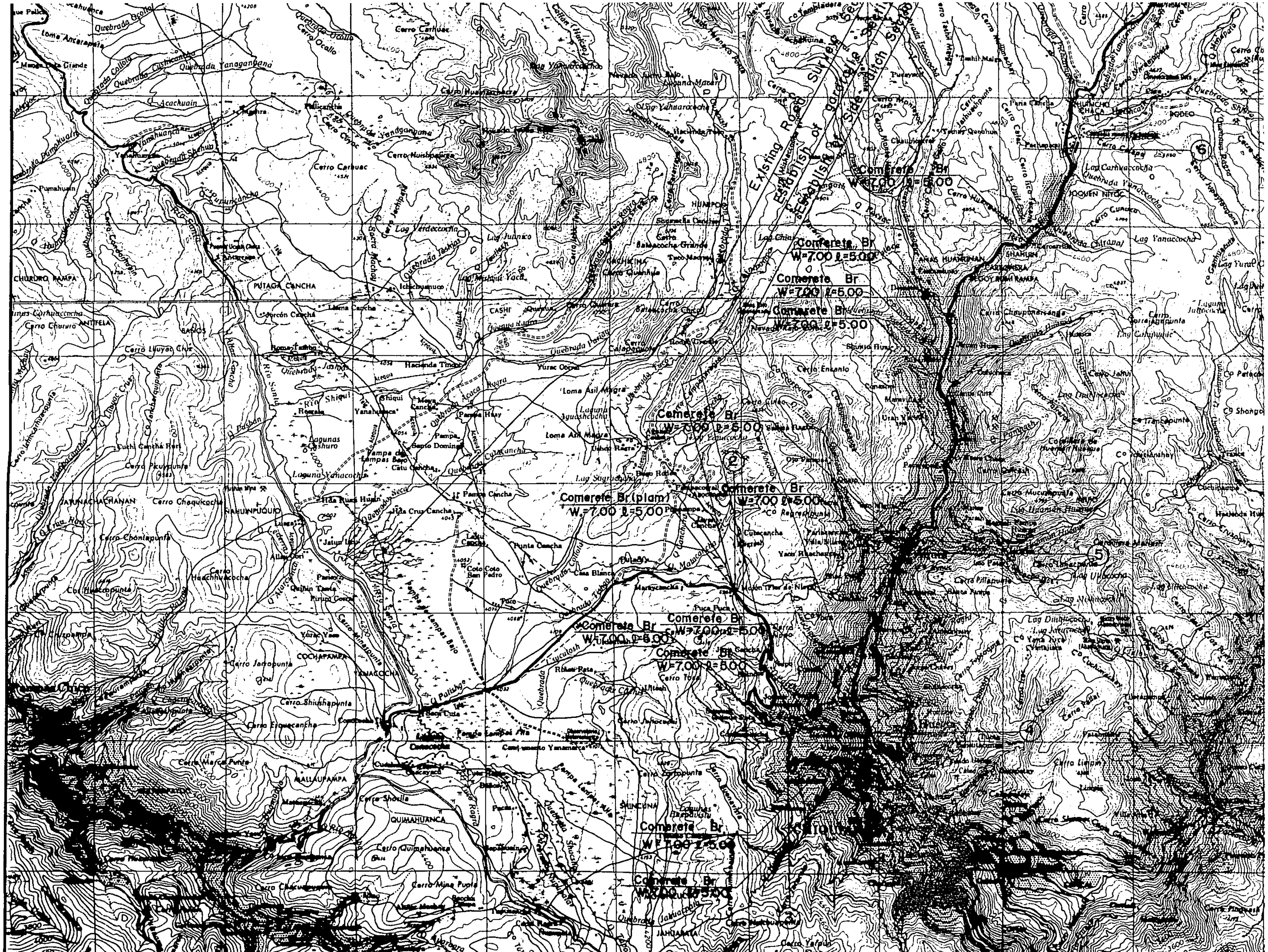
(1) Natural Condition along the Route

1) The survey area is embraced in Cordillera Blanca of the Andes and has an elevation of 3,000 ~ 4,800 m.
2) Topography is very steep because the whole area is within the West Andes Cordilleras which stretches in the NW — SE direction and was the centre of the orogenic movement and magmatism by which the Andes was formed from the latter part of Cretaceous towards the end of Tertiary.
3) Climate is generally mild but subject to a heavy diurnal variation. Snowfall and sleet are observed in the afternoon during winter at elevations of more than 4,000 m, and glacier is present at elevations of more than 5,000 m. Snowfall in the survey area is generally small. Snow on the road melts away quickly because of the high average temperature, so that there is no need to pay attention to freezing problem on the road surface. The wet season lasts from Decem-


EXISTING ROAD SURVEY SECTION
Fig. 2-1
PLAN
Scale 1:400,000
Existing Road Survey Section
Concrete Br
W=7.00 L=5.00
Comcrete Br (plan)
W=7.00 L=5.00
Quebrada Yanaganuana
Cerro Carhuac
Lag Verdeccocha
Lag Yanaccocha
PUTAGA CANCHA
CHURURO PAMPA
HUMPOG
Cerro Ocallo
Cerro Huicuspunta
Cerro Agoash
Lag Yunaccocha
Laguna Yapara
Loma Ancarapata
Loma Pucahuanca



Comcrete Br
W=7.00 ℓ=5.00
Comcrete Br
W=7.00 ℓ=5.00
Comcrete Br
W=7.00 ℓ=5.00
Comcrete Br
W=7.00 ℓ=5.00
Pc Comcrete Br
W=7.00 ℓ=20.00
Comcrete Br
W=7.00 ℓ=5.00
Comcrete Br
W=7.00 ℓ=5.00
Comcrete Br
W=7.00 ℓ=5.00
Comcrete Br
W=7.00 ℓ=5.00
Huallanca
Location Section
HUANTUCO
TUNA CANCHA
POTRERO
RODEO
JOQUEN NIYOC



Existing Road
Comerete Br
W=7.00 ℓ=5.00
Comerete Br (plam)
Quebrada Yanaganpana
Cerro Carhuac
Cerro Huishpaurca
Lag Verdeccocha
Lag Junnico
CHURURO PAMPA
PUTAGA CANCHA
Hacienda Tinco
Loma Asil Magra
Laguna Yanacocha
Rio Shiqui
Yanahuanca
Lagunas Cashuro
Pampa de Lampas Bajo
Cerro Chaquicocha
NAHUINPUQUIO
Cerro Chontapunta
Casa Blanca
COCHAPAMPA
Cerro Jarropunta
Cerro Shiushapunta
Cerro Eiquecancha
Cerro Marca Punta
MALLAUPAMPA
Cerro Shoilla
QUIMAHUANCA
Cerro Quimahuanca
Cerro Mina Punta
SHINCUNA
Cerro Zoropunta
CHURCHO
RODEO
Lag Carhuaccocha
Lag Yanaccocha
Cerro Jatun
Lag Ulicocha
Cerro Limpia
Cerro Yerbero
Cerro Pueblo Viejo

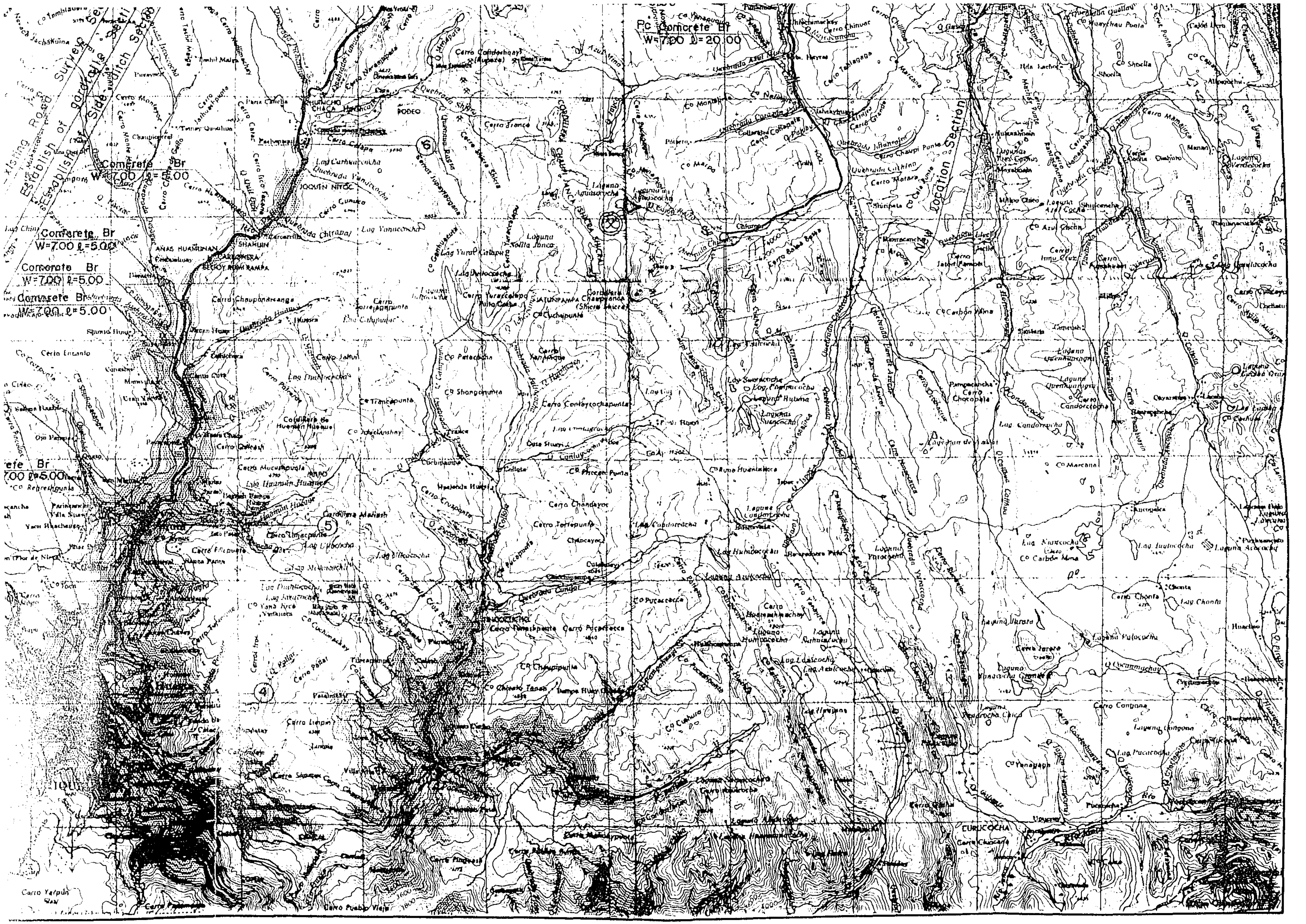
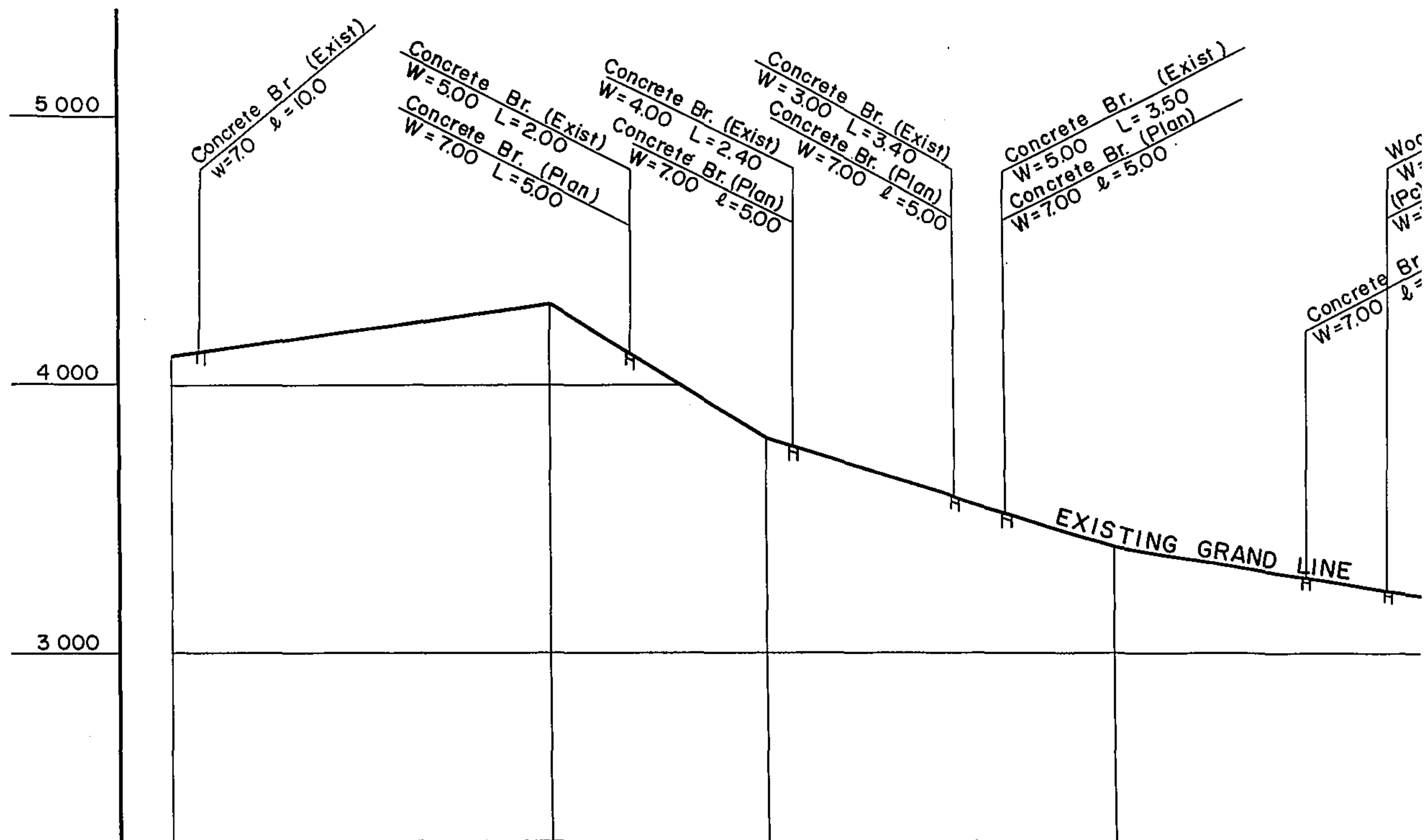
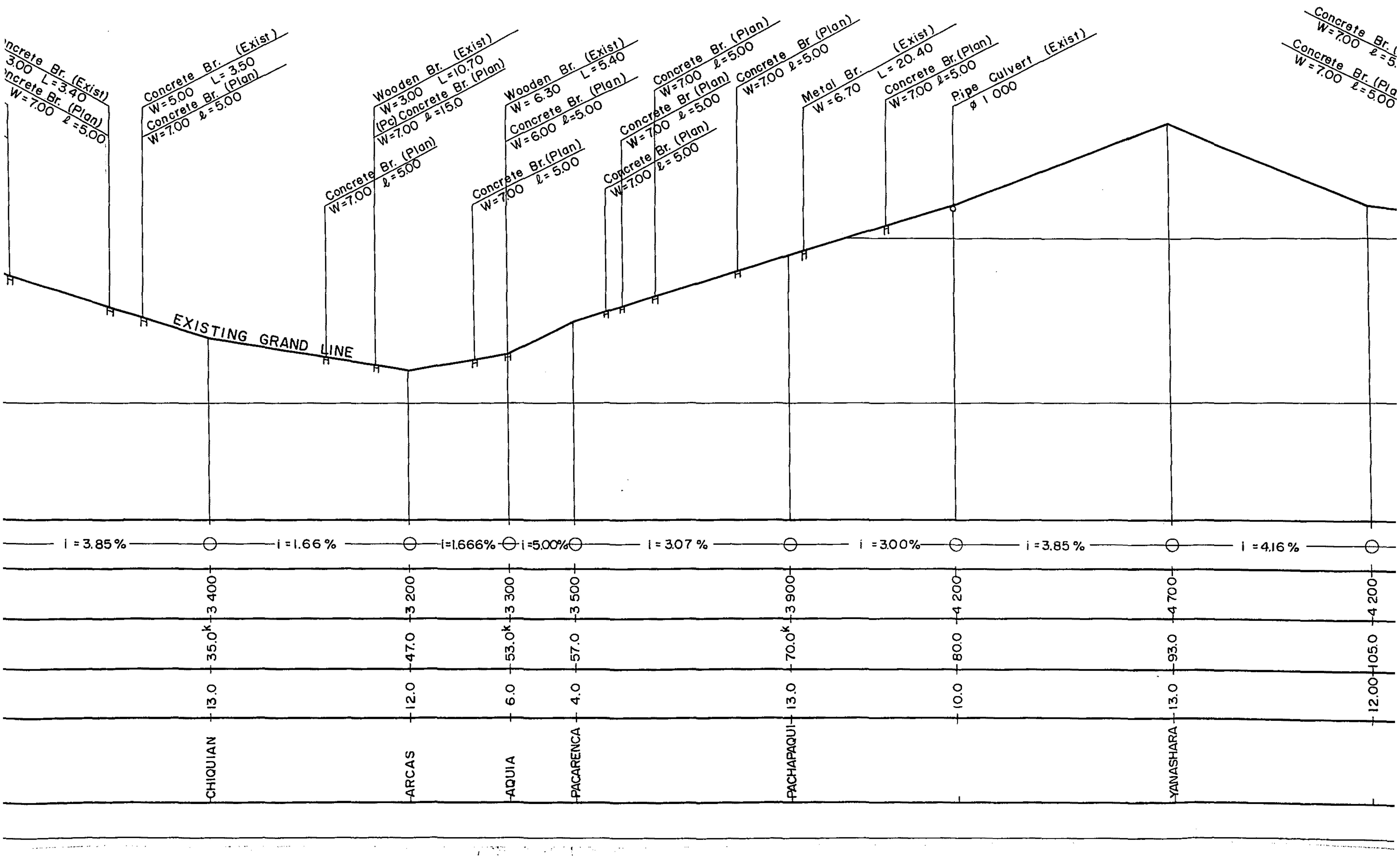

Pc Concrete Br
W=7.00 ℓ=20.00
Concrete Br
W=7.00 ℓ=5.00
Concrete Br
W=7.00 ℓ=5.00
Concrete Br
W=7.00 ℓ=5.00
Location Section
Cerro Chandayoc
Cerro Torrepunta
Quebrada Condor
Cerro Chonta
Lag Chonta
Cerro Congona
Cerro Marcana
CURUCOCHA
Cerro Yarpun

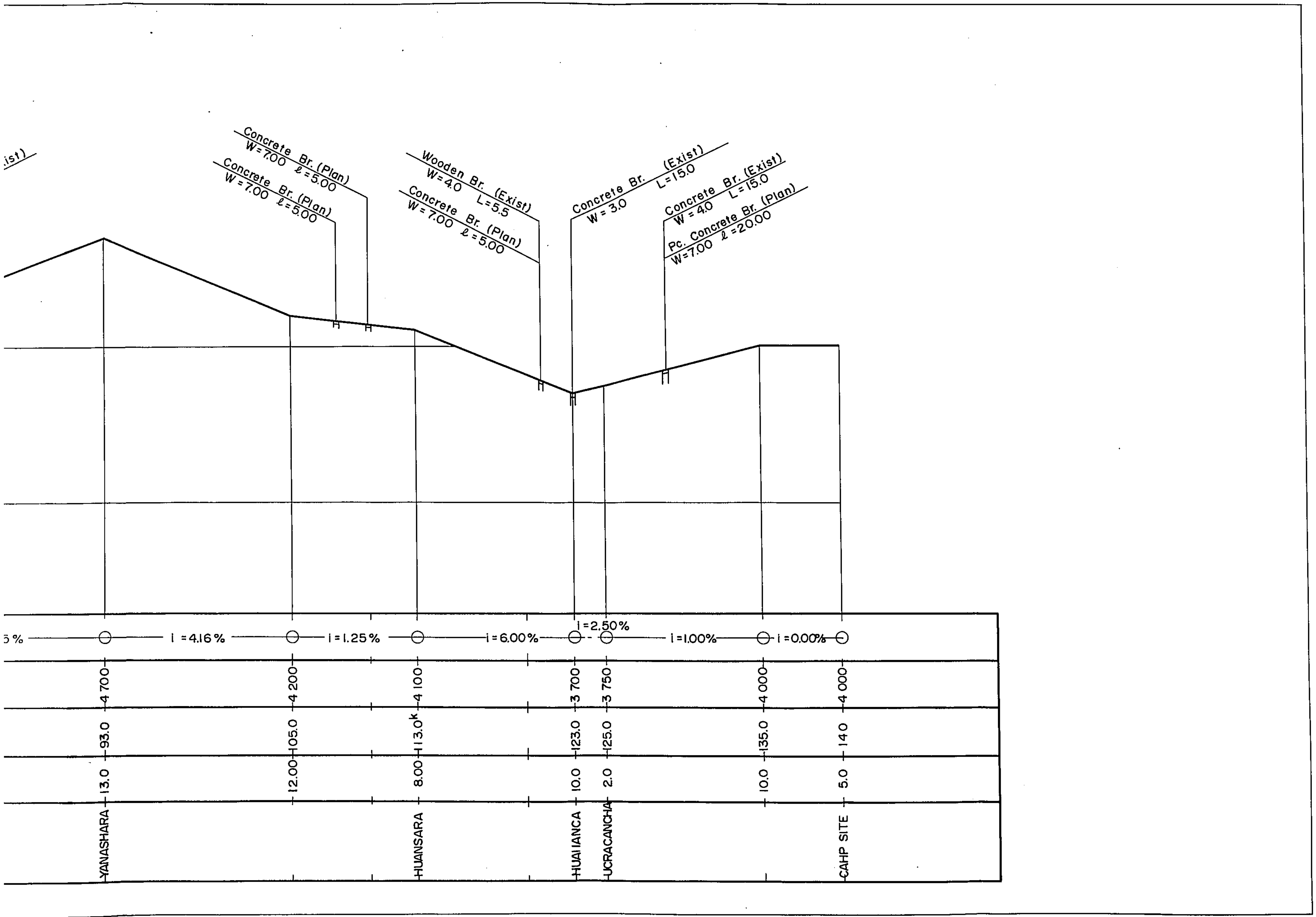
Fig. 2-2 EXISTING ROAD SURVEY



GRADE	○	i =1.33%	○	i =4.38 %	○	i = 3.85%	○	i =1.66 %
EXISTING GRAND HEIGHT	4 100		4 250		3 900		3 400	
ACCUMULATIVE DISTANCE	0		14.0		22.0		35.0^k	
DISTANCE	0		14.0		8.0		13.0	
ZONE	CONOCocha		MOJON		RAGRACocha		CHIQUIAN	

Fig. 2-2 EXISTING ROAD SURVEY SECTION PROFIL Scal H = 1 : 100 000 V = 1 : 2 000





xist)
Concrete Br. (Plan)
W=7.00 ℓ=5.00
Concrete Br. (Plan)
W=7.00 ℓ=5.00
Wooden Br. (Exist)
W=4.0 L=5.5
Concrete Br. (Plan)
W=7.00 ℓ=5.00
Concrete Br. (Exist)
W=3.0 L=15.0
Concrete Br. (Exist)
W=4.0 L=15.0
Pc. Concrete Br. (Plan)
W=7.00 ℓ=20.00
5%
i=4.16%
i=1.25%
i=6.00%
i=2.50%
i=1.00%
i=0.00%
4 700
4 200
4 100
3 700
3 750
4 000
4 000
93.0
105.0
113.0k
123.0
125.0
135.0
140
13.0
12.00
8.00
10.0
2.0
10.0
5.0
YANASHARA
HUANSARA
HUALIANCA
UCRACANCHA
CAHP SITE

ber to March, and the rainfall intensity is rather stabilized considering the large annual rainfall.

(2) Characteristics of Each Block (See Figs. 2-1 and 2-2)

1) Block ① ~ ② (L = 15 km)

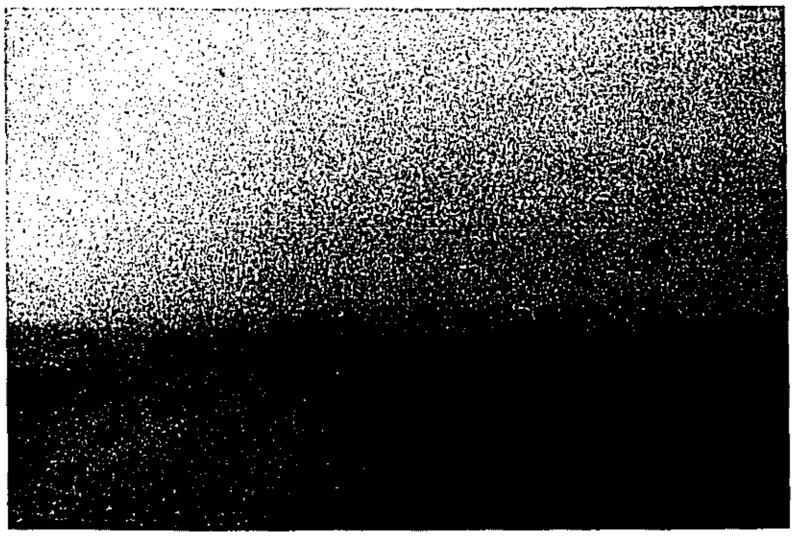


Photo 2-1

As seen in the above photo, this block runs through a vast plain. In the wet season when the water level rises, both sides of the road are occasionally submerged but not to the extent that the passage of vehicles becomes difficult.

The following are the characteristics of this block.

- It has a straight horizontal alignment for about 5 km and the radius of its horizontal curves is very large.
- As for longitudinal alignment, it has a constant up grade (i = 1.3%).
- It has a width of more than 10 m which is quite large for a two-lane road.
- The road surface is very stabilized because of the gravel subgrade.
- As the block runs through a plain, the cross-section covers the full road width, and virtually no cuts and embankments are observed.
- Water is pooled in disused gravel pits which are found from place to place along route.
- A concrete bridge of about 10 m span is built across Rio Santa.

2) Block ② ~ ③ (L = 9 km)

Photo 2-2

Topography becomes steeper as the extensive flat plain through which block ① ~ ② runs gradually changes into a grassland with a mild undulation. The road is not submerbed in this block.

- o The horizontal alignment depicts a gentle curve which conforms to the topography in this block.
- o The longitudinal alignment is generally easy, the average grade being about 4.3%.
- o The road width is 8.0 m which is large enough for a 2-lane road.
- o The road surface is stabilized because of the satisfactory ground condition.
- o In most sections, one side of the road is cut and the other side is composed of original ground.
- o The crossfall is about 1:0.5 as seen in the above photo.
- o The block is geologically composed of soil containing gravels. The slope is short in distance and presents no danger of stonefall.
- o A heavily superannuated concrete bridge with a width of 5.0 and a span of 2.0 m is built in one place.

3) Block ③ ~ ④ (L = 20 km)

Photo 2-3

The above photo shows an up-bound car stalling due to a flat tyre and a succeeding car also held up as it cannot pass the first car ahead. In this case, all down-bound cars are forced to wait for 30 ~ 60 minutes until the flat tyre is mended because they cannot pass by the first up-bound car.

- This block is most difficult for vehicles to pass in the whole road survey section as its steep topography presents hairpin curves in close succession.
- The horizontal alignment depicts a hairpin curve in almost all places. The average radius of curve is 15 m, the minimum being 8.5 m. The radius is small in Concococha side of Chiquian and relatively large in Aquia side of Chiquian.
- The longitudinal alignment is considerably steep, with a grade of more than 10% observed in some sections. Like the horizontal alignment, it is steep in Conococha side of Chiquian and relatively large in Aquia side of Chiquian.
- The average road width is 4.0 m which is not large enough for two facing vehicles to pass by each other. For this reason, passing places are provided but not in sufficient number.
- The road surface is in an extremely poor condition because the shoulders are not provided with suitable drainage facilities. When it rains, therefore, rainwater flows down the road surface in the longitudinal direction, boring many large holes which reduce the trafficability to a large extent.
- The valley side slope of the road having a crossfall of 1 : 1.0 ~ 0.8 seems to be stabilized, but no safety measures are taken for its shoulder, which is quite dangerous.
- The crossfall on the mountain side ranges from 1 : 0.3 to 1 : 0.5. Specifically, it is 1 : 0.3 in sections where cut rocks are exposed and 1 : 0.5 in sections consisting of soil containing gravels.
- As for structures, a wooden bridge is built at the end of a hairpin curve which is found near Aquia in Chiquian ~ Aquia section. This bridge has a concrete sub-

structure, but its superstructure consists of only flat planks laid on logs. It has a width of 3.0 and a span of 10.70 m.

4) Block ④ ~ ⑤(L = 9.0 km)

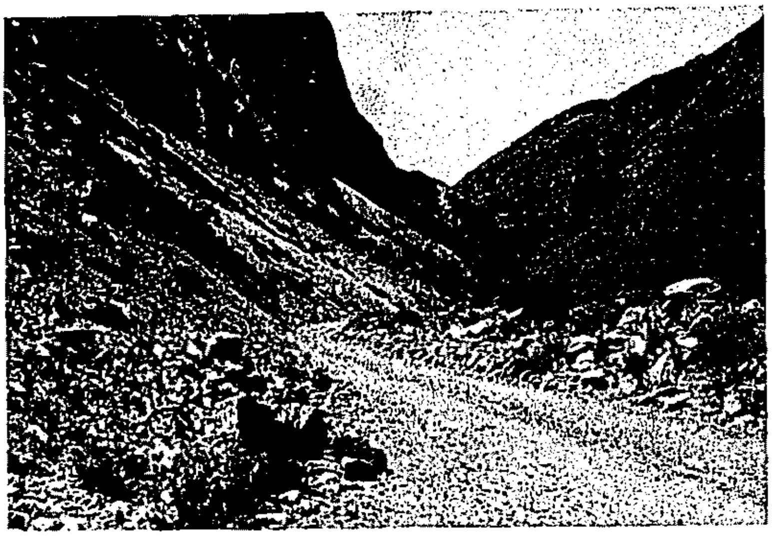


Photo 2-4

The above photo shows crushed stones accumulated on the mountain side to reduce the road width.

- Topography in this block is quite steep. As the road runs with mountains rising on the left and valleys on the right, it is probable that rockfall occurs frequently in some sections.
- The horizontal alignment is very smooth despite the steep topography.
- The road width ranges from 4.0 to 5.0 m, and turnouts are provided in a number of places.
- The subbase course is relatively stabilized, but the trafficability is poor because of crushed stones scattered on the surface course.

5) Block ⑤ ~ ⑥ (L = 17 km)

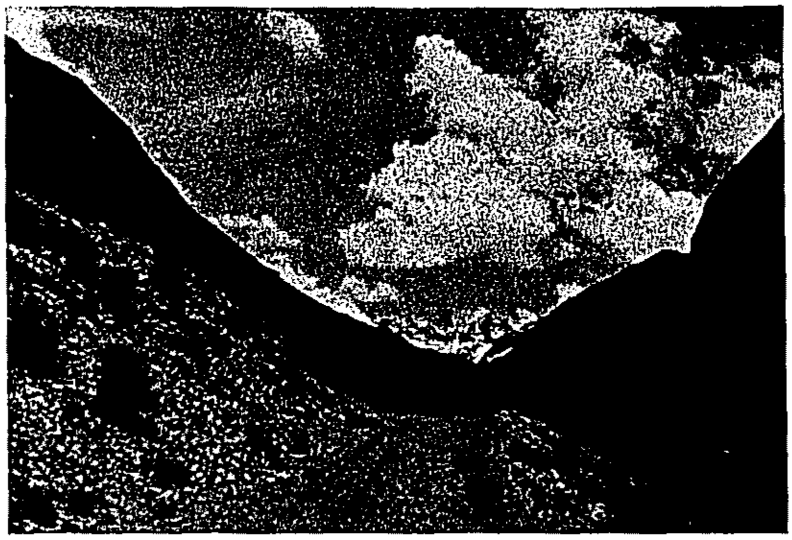


Photo 2-5

Topography in this block is similar to that in block ④ ~ ⑤.

- The alignment, both horizontal and longitudinal, is mild and presents no specific problems.
- The width is about 4.0 m in narrow section and about 5.0 m in wider sections, which is not large enough for large facing trucks to pass each other freely. In order for two large trucks to pass each other, one of them must stop to make way for the other.
- The road surface is in a very poor condition because the shoulders are not provided with drainage facilities. On rainy days, therefore, rainwater flows down the road in the longitudinal direction, making the rutting in the road surface deeper and deeper. Unlined side ditches are found in some sections.
- A wooden bridge is built near Aquia. It has a width of 6.30 m and a span of 5.40 m, and its superstructure consists of wooden logs and planks.

6) Block ⑥ ~ ⑦ (L = 10 km)

Photo 2-6

This block runs through a flat grassland area from Pachapaqui to the Yanash Allash Pass.

- The alignment, both horizontal and longitudinal, is mild, and the longitudinal grade averages about 3.0%.
- The width is 5.0 ~ 6.0 m which is large enough for a two-lane road.
- The road surface is in a satisfactory condition.
- There is no danger of rockfall because the road has practically no crossfall.
- A bridge is built at a point 1.0 km from Pachapaqui. It has a concrete substructure, a steel girder superstructure, a width of 6.0 m, and a span of 20.4 m. The bridge seems to be amply capable of withstanding H-20 (AASHO) wheel load.
- In addition, a pair of concrete pipe culverts are laid at the starting point of the hairpin curve of the Yanash Allash Pass with an overburden of about 4.0 m. The pipes have a diameter of 1,300 mm, and are considered to be rigid enough to withstand H-20 wheel load.

7) Block ⑦ ~ ⑧ (L = 25 km)

Photo 2-7

This block covers a distance of 25 km extending with the Yanash Allash Pass situated in between. The Pass has an elevation of 4,700 m, and a close succession of hairpin curves is found in both approach sections to the Pass.

- The horizontal alignment depicts a succession of hairpin curves with a relatively large radius.
- The longitudinal grade is about 4%. Since the largest grade is about 8%, the hairpin curves in this block are generally easy when compared with those near Chiquian.
- The width ranges from 5.0 to 5.5 m. The road surface becomes sloppy even by a slight rainfall or snowfall and causes tyres to skid. This is considered ascribable to the subsurface material and the lack of drainage structures.
- The crossfall is about 1 : 1.0 on both sides of the road.

8) Block ⑧~⑨ (L = 8 km)

Photo 2-8

The above photo shows the view of Yanash Allash Pass from Huanzala.

- This block runs from the ending point of the Yanash Allash Pass to Huanzala, with a river flowing 10 ~ 20 m below along its left side.
- The alignment, both horizontal and longitudinal, is very easy. The longitudinal grade is about 1.7%, and hardly exceeds 3% even in steep sections.
- The surface condition is satisfactory except in few sections. There is a small valley at a point about 1 km to Huanzala. Since water from this small valley flows across the road surface, this section is pitched with concrete slabs.

9) Block ⑨ ~ ⑩ (L = 10 km)

Photo 2-9

The photo shows one of the sections where the longitudinal grade is the largest in this block.

- This block covers the distance between Huanzala and Huallanca.
- The horizontal alignment is satisfactory, except that a hairpin curve with a minimum radius of 13.5 m is found in the neighbourhood of both Huanzala and Huallanca.
- The longitudinal grade ranges from 5 to 6% on the average.
- The width exceeds 7.0 m, but in one section where rocks are exposed, the road is only 4.0 m wide and slopes down sharply at an angle of nearly 90°. However, this section is very short and does not impede smooth flow of traffic.
- The surface condition is relatively good as unlined side ditches are provided at the pertinent places.
- A wooden bridge with a width of 4.0 m and a span of 5.5 m is built in this section. It has a concrete substructure.

10) Block ⑩ ~ ⑪ (L = 15 km)

Photo 2-10

The photo shows the typical view in this block where the road is constructed along Rio Chiuroc.

- o This block covers the distance from Huallanca and the camp site.
- o It is one of the branch roads of National Highway No. 3, and runs from Huallanca.
- o The width is as small as 3.0 ~ 3.5 m, so that even small vehicles are required to enter turnouts to pass each other.
- o The horizontal alignment depicts many curves with a small radius because the route conforms to natural topography. The longitudinal alignment is easy, showing no large differences in elevation between Huallanca and the camp site. The grade is about 1.00% along the whole route.
- o Consolidation of drainage structures has not yet been undertaken. In sections passing by small valleys, therefore, water flows across the road surface.
- o An arch bridge is built at the approximate centre of the block. It is built with concrete and stones, and has a width of 3.5 m and a span of 15 m, but it does not seem to be rigid enough to withstand the wheel load of or trucks.

(3) Road Improvement Plan (Basic Policy for Improvement)

Partial improvement and new road construction may be conceived of for improvement of the hairpin sections. Due to the steep topography surrounding the project road, however, planning of a new road construction will inevitably leads to the selection of a route which is not much divergent from that of the existing road. Partial improvement, if planned for changing the existing alignment, will also encounter great difficulties arising from the steep topography. Hence, it is necessary to effect local improvements within the limits of practical need for coping with the future traffic demand.

The problems to be solved for the project road are the lack of drainage structures, endangered road safety, and poor durability. The team noted that the absence of well consolidated drainage structures is degrading the road surface condition and reducing the running speed of vehicles as well. The team also noted that no protective measures are taken for shoulders. It is probable that traffic accidents will be averted to an appreciable extent if suitable safety measure are enforced including the installation of guard fences. The bridges on the existing road, which are small in number, are in need of some improvement or other because of their deterioration.

It is considered that the existing road can amply meet the future traffic demand if local improvements are effected in a rational manner without planning any large-scale improvement such as the construction of a bypass.

From this point of view, the items listed below are studied in the following pages for improvement of the existing road.

1) Bridges
2) Drainage structures
3) Safety measures
4) Locational relationship with existing towns and villages

1) Bridges

The following table shows particulars of the bridges built on the existing road.

Table 2-1 Existing Bridges

	Location	Structure		Width and Span	Need for Re-construction
		Superstructure	Substructure		
1	Conococha → 0.5K	Concrete	Concrete	W=6.0 L=10.0	No
2	Conococha → 17.0K	Concrete	Concrete	W=5.0 L= 2.0	Yes
3	Conococha → 23.0K	Concrete	Concrete	W=4.0 L= 2.4	Yes
4	Conococha → 29.0K	Concrete	Concrete	W=3.0 L= 3.4	Yes
5	Conococha → 31.0K	Concrete	Concrete	W=5.0 L= 3.0	Yes
6	Conococha → 45.0K	Wooden	Concrete	W=3.0 L=10.7	Yes
7	Conococha → 53.0K	Wooden	Concrete	W=6.3 L= 5.4	Yes
8	Conococha → 71.0K	Steel	Concrete	W=6.7 L=20.4	No
9	Conococha → 80.0K	Corrugated pipe		ϕ1,000 mm	No
10	Conococha → 121.0K	Wooden	Concrete	W=4.0 L= 5.5	Yes
11	Conococha → 123.0K	Concrete and stones	Concrete and stones	W=3.0 L=15.0	No
12	Conococha → 129.0K	Concrete and stones	Concrete and stones	W=4.0 L=15.0	Yes

Of a total of 12 bridges built on the existing road, two are considered to be rigid enough to withstand H-20 (AASHO) loading. One of them is the concrete bridge at a distance of 0.5 km from Conococha and the other is the steel bridge at the 71 km point. Other concrete bridges of shorter span and all wooden bridges must be rebuilt because of their superannuation.

In the present study, all new bridges are designed to be larger than the existing ones in both length and width, and their span is determined according to the presence of boulders and other factors. Further, the bridge type is standardized by adopting only three spans (5 m, 15 m and 20 m) in order to assure that the construction work can be executed with ease.

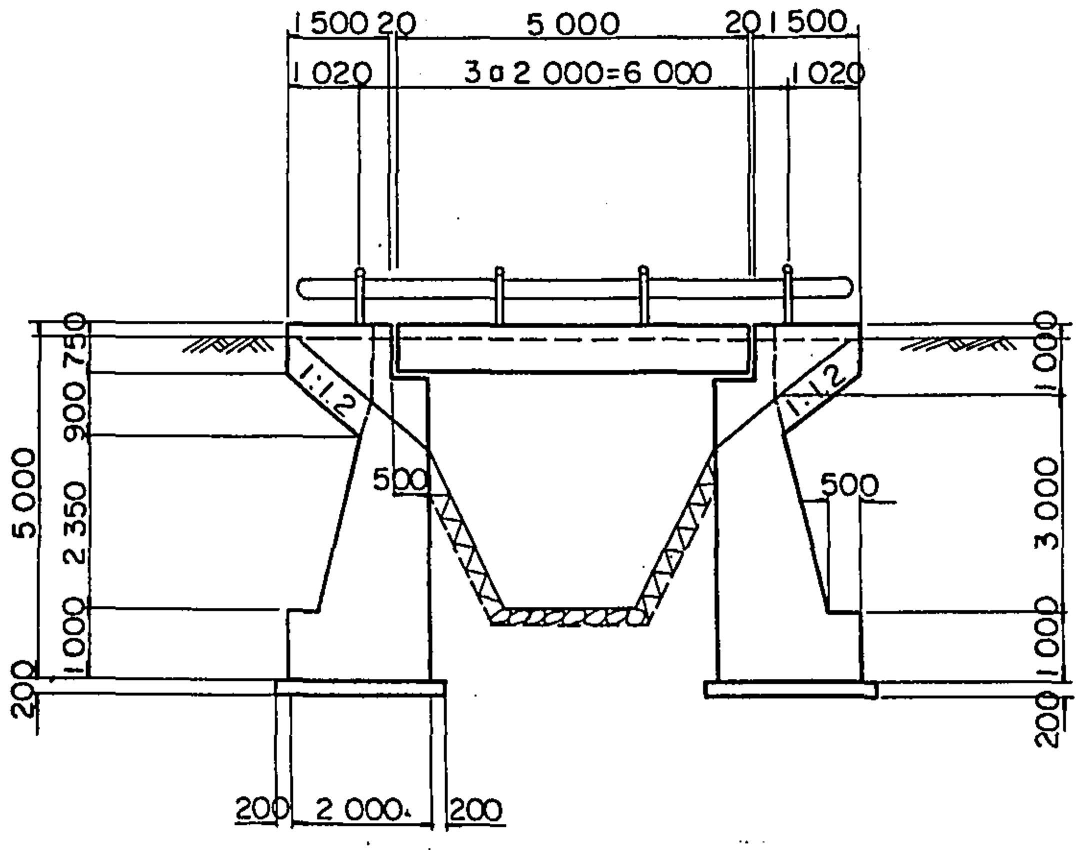


Fig. 2-3 Typical Section of Bridge (span 5 m)

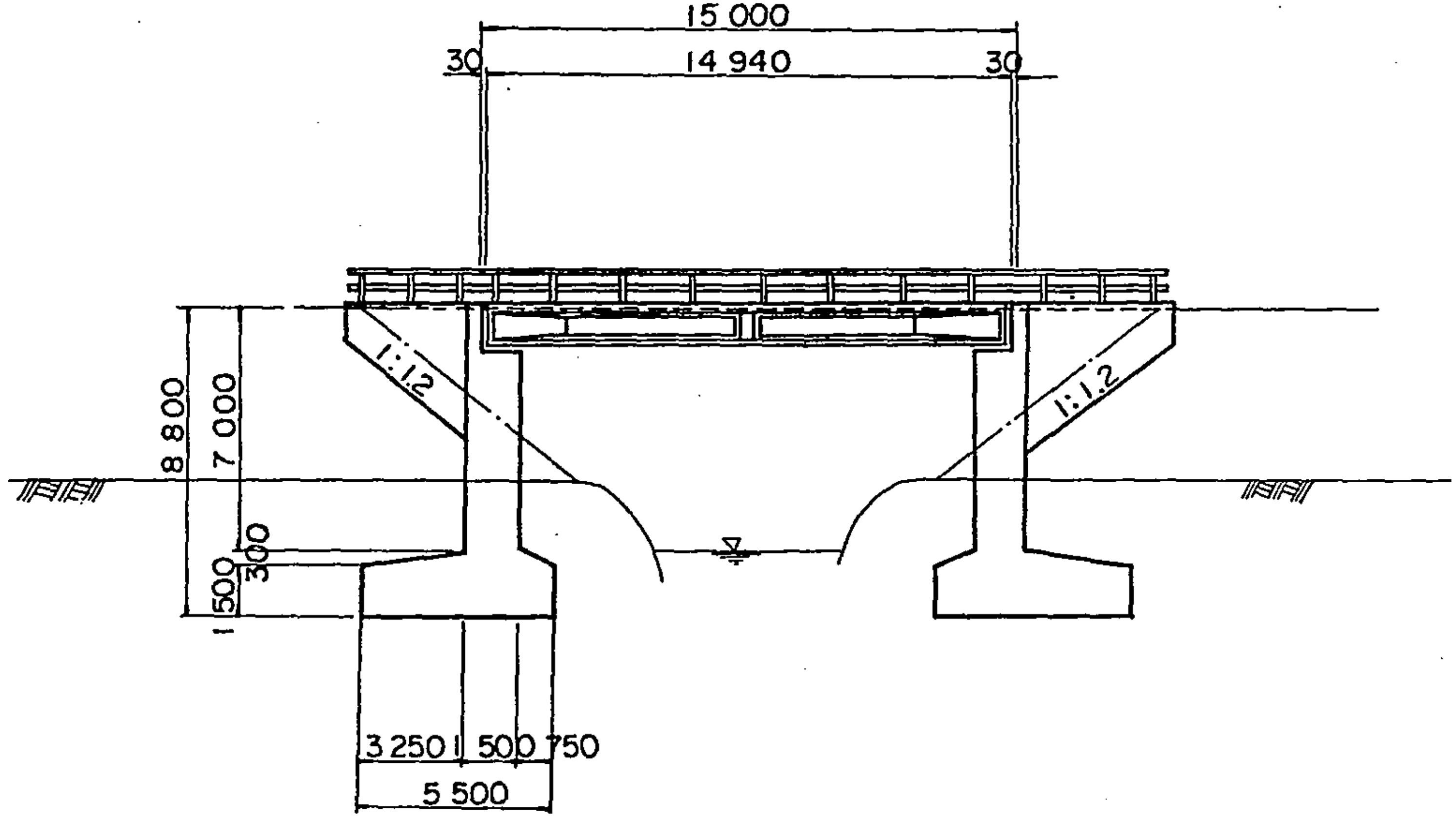


Fig. 2-4 Typical Section of Bridge (span 15 m)

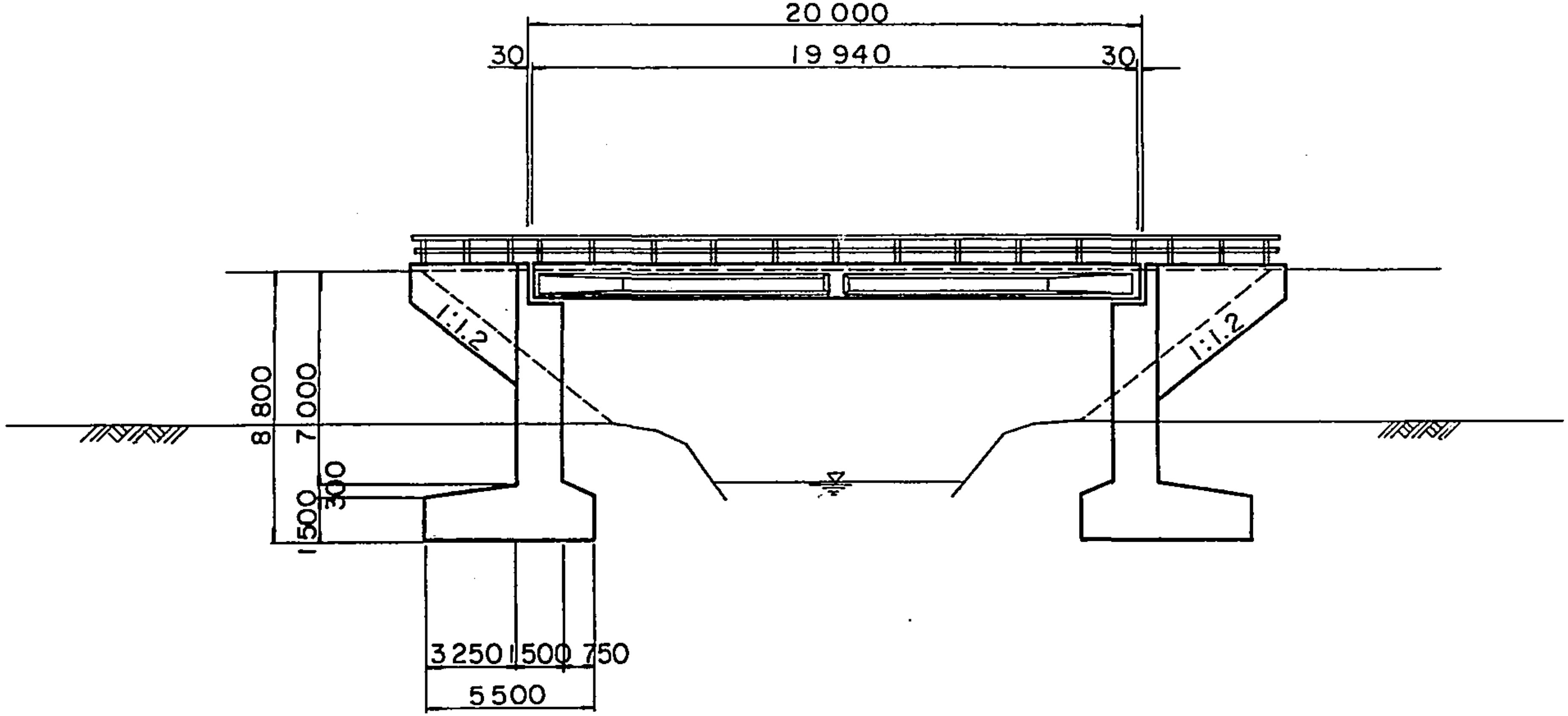


Fig. 2-5 Typical Section of Bridge (span 20 m)

2) Drainage structures

Since few and short sections of the existing road are provided with satisfactory side ditches, rainwater flows on the road surface along ruts and collects in depressions. In addition, no suitable protective measures being taken in areas small valleys, water from such valleys is allowed to flow freely across the road surface in some sections. The resultant deterioration of the surface condition is causing the decline of running speed of vehicles, reduction of traffic volume, and increase of maintenance cost. The situation calls urgently for improved drainage through the following measures.

1. Excavation of unlined shoulder side ditches in cut sections.
2. Building of a bridge of 5 m span over small valleys.
3. Installation of transverse pipe culverts for drainage from side ditch to valley.

a) Unlined side ditch

o Unlined side ditches should be so excavated as will have the typical section shown below.

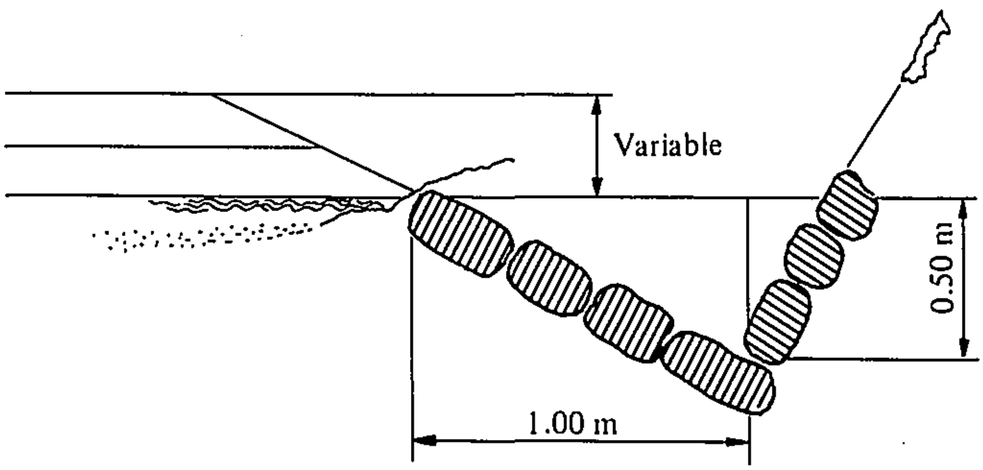


Fig. 2-6 Typical Section of Side Ditch

o The side ditch should be excavated on the mountain side of the existing road in its 120 km section leading to Huallanca, excluding the first block which runs from Conococha through the grassland area.

b) Drainage of small valleys

Although there are wooden bridges of 2 ~ 3 m span and concrete bridges built in a number of small valley areas, it is planned that 15 new bridge of 5 m span described in Section 2-(3)-1) (Bridges) will be constructed. The 5 m span is somewhat large, but it was selected in consideration of the valley size which ranges from 2 to 3 m and boulders.

The number of bridges to be built in each block is as shown below, and the location of each bridge is shown in Fig. 2-1.

Block ② ~ ③	2 places
Block ③ ~ ④	2 places
Block ④ ~ ⑤	2 places
Block ⑤ ~ ⑥	5 places
Block ⑥ ~ ⑦	1 place
Block ⑦ ~ ⑧	0 place
Block ⑧ ~ ⑨	2 places
Block ⑨ ~ ⑩	1 place
Total	15 places

c) *Installation of transverse pipe culvert*

The transverse pipe culverts are intended to discharge drain from the unlined side ditch into the valley across the road. They should be installed at adequate intervals so that storm drain will flow into each culvert when it rises to the specified level in the side ditch. Since the face of slope on cut is not protected and contains lots of gravels, it is likely that boulders and sand will fall down into the side ditch in large quantities, making it difficult to attain the design discharge. With this taken into account, the culverts are planned to be laid at intervals of 300 m and have a diameter of 600 mm. The typical section of the culvert is shown in Fig. 2-7.

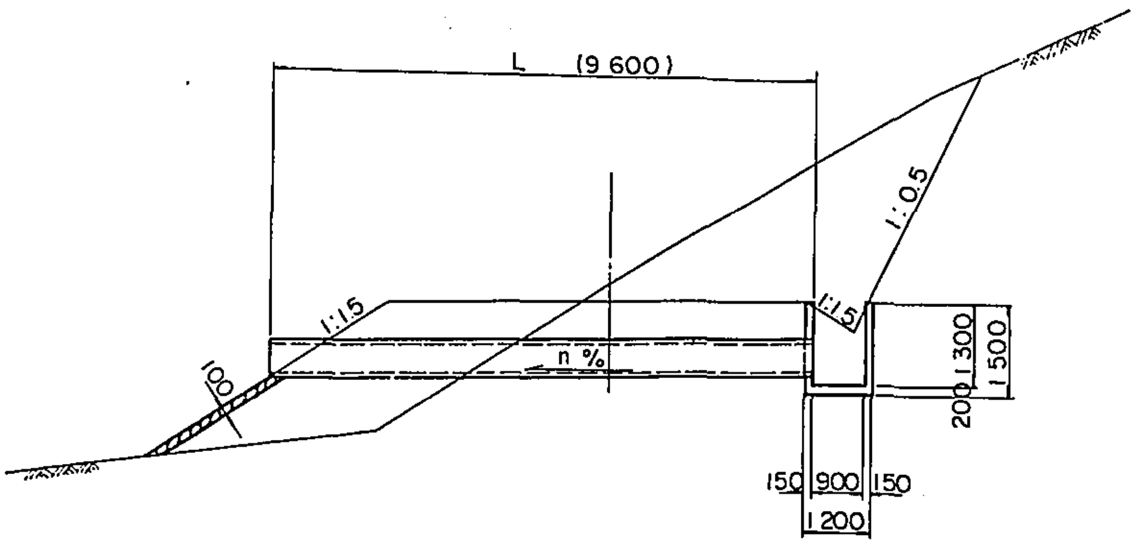


Fig. 2-7 Typical Section of Pipe Culvert

3) Safety measures

The survey disclosed that no adequate and sufficient safety measures are taken for the existing road. The following measures will have to be carried out to ensure the traffic safety on the existing road.

a) Installation of guard fences

Guard fences should be newly installed in sections where the road is narrow and the grade of the face of its valley-side slope is steep as well as in sections where the road has many curves with a small radius. Guard fences are an effective means of reducing traffic accidents as they assure greater traffic safety and produce sight line directional effect. In the case of the existing road, they should be installed in the 25 km hairpin sections which are in the neighbourhood of Chiquian.

b) Installation of curve mirrors

Since partial improvement of the hairpin curves in the neighbourhood of Chiquian involves extreme difficulty, it is necessary to improve the trafficability in such sections. At present, these curves are not causing any serious problems because the daily traffic volume is very small. It is evident, however, that with the increase of traffic volume in future, there will be an increasing number of vehicles that pass each other in the hairpin sections. The curve mirrors will be very useful in preventing traffic accidents in the hairpin sections as they will make it possible for the drivers to catch sight of facing vehicles.

They should be installed in 17 places in the hairpin sections in the neighbourhood of Chiquian.

c) Additional installation of passing places

Fifty percent of the existing road has only one lane and its passing places are provided at very long intervals, so that each vehicle must wait a long time in the passing place until the facing vehicle arrives. The traffic volume of up and down vehicles in Chiquian ~ Aquia section is about 100 vehicles/day at present. Assuming that the ratio of up traffic to down traffic is 6 : 4 and the running speed is 30 km/h, the headway turns out to be 900 m as calculated below.

$$l = \frac{30{,}000 \text{ m}}{\frac{100}{2}} \times \frac{6}{4} = 900 \text{ m}$$

As this means that each vehicle passes the facing vehicles every 900 m, smooth traffic can be assured only if passing places are provided at intervals of 900 m.

Needless to say, the interval must be reduced with the increase of traffic volume. For instance, the estimated traffic volume in 1990 is about 450 vehicles/day and the headway is 200 m (=30,000/450/2 x 6/4), so that the maximum allowable distance between passing places turns out to be 200 m. For tentative increase of passing places, it is planned that new passing places will be installed at intervals of 400 m as specified in the Peruvian Standards for Road Design. As for the size of the passing lane, a width of 7.0 m would suffice for large vehicles to pass each other, and a length of 25 m should be secured because semi-trailer tractors are expected to run on the road.

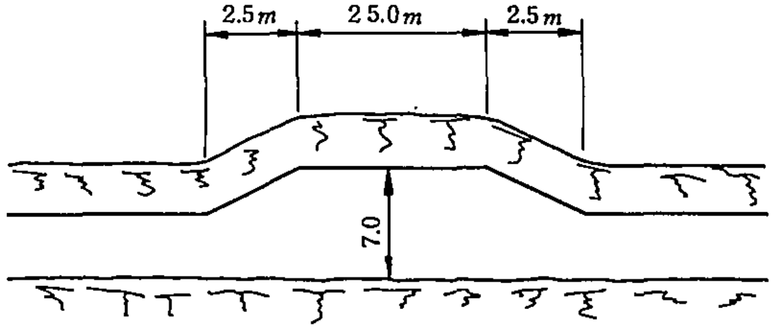


Fig. 2-8 Passing Place

d) Installation of traffic signs
When Hilarion mine is developed and produces an extensive economic spill-out effect, it is expected that vehicles running on National Highway No. 3 will tend to make long trips. For this reason, the following traffic sings should be installed at intervals of 5 km in order to improve the trafficability and prevent traffic accidents.

1. Guide sign (geographic name and direction)
2. Warning sign (natural conditions incl. dense fog)
3. Sign of geometric design (radius of curve, longitudinal grade, etc.)
4. Sign of road structure (warning against shoulder, etc.)

4) Locational relationship with existing towns
The existing road links six towns (Conococha, Chiquian, Aquia, Pachapaqui, Huanzala and Huallanca) which can be grouped into the two types shown below according to the pattern of their correlation with the existing road.

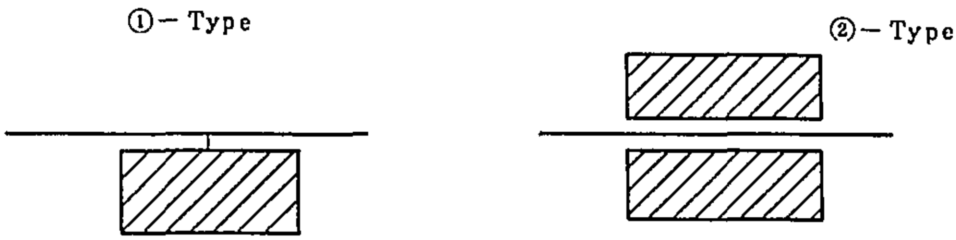


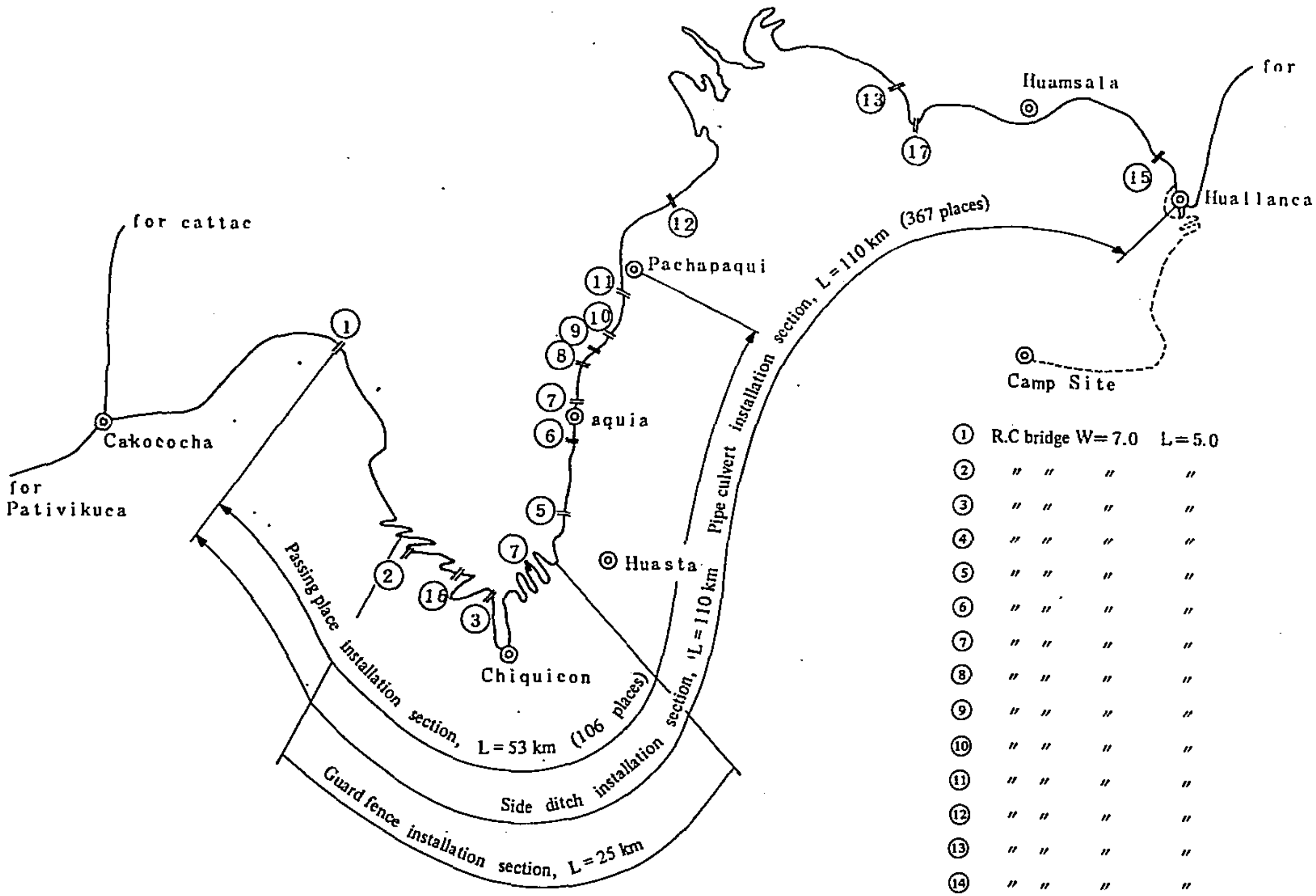
Fig. 2-9 Correlation of Towns with Existing Road

Four of the said six towns (Conococha, Chiquian, Pachapaqui and Huanzala) present type 1 correlation with the existing road, whereas the remaining two (Aquia and Huallanca) are in type 2 correlation with the existing road. In the case of type 1 correlation, it is expected that no difficulty will be encountered in coping with any increase of traffic volume. In the case of type 2 correlation, however, any increment of traffic volume is expected to invite traffic accidents and decline of traffic volume itself due to traffic congestion, and Huallanca is more liable to such traffic congestion than Aquia. In the section connected with Huallanca, the existing road has only one lane so that it is difficult to meet the future gowth of traffic demand and in addition, increased traffic volume is liable to invite frequent occurrence of traffic accidents because houses stand close together on the both sides of the road. For this reason, a hypass round Huallanca should be constructed so that National Highway No. 3 will not pass through the central part of Huallanca.

(4) Amount of Road Improvement Work

Table 2-2 Amount of Road Improvement Work

Kind of Structure	Unit	Conococha ~ Chiquian	Chiquian ~ Pachapaqui	Pachapaqui ~ Huallanca	Total
Guard fence	m	13,000	12,000	–	25,000
Side ditch	m	52,350	52,350	5,300	110,000
Pipe culvert	m	1,380	1,379	177	2,936
Bridge l = 15m	m^2	–	105	–	106
Bridge l = 5m	m^2	140	245	140	525
Passing place	place	36	70	–	106
Curve mirror	pce	9	8	–	17
Guide sign	pce	13	12	–	25



①	R.C bridge	W = 7.0	L = 5.0
②	〃 〃	〃	〃
③	〃 〃	〃	〃
④	〃 〃	〃	〃
⑤	〃 〃	〃	〃
⑥	〃 〃	〃	〃
⑦	〃 〃	〃	〃
⑧	〃 〃	〃	〃
⑨	〃 〃	〃	〃
⑩	〃 〃	〃	〃
⑪	〃 〃	〃	〃
⑫	〃 〃	〃	〃
⑬	〃 〃	〃	〃
⑭	〃 〃	〃	〃
⑮	〃 〃	〃	〃
⑯	〃 〃	〃	〃
⑰	〃 〃	〃	〃

Fig. 2-10 Existing Road Survey Section – Plan

2-3 New Road Construction Plan

(1) Natural Conditions

The survey area is situated in Cordillera Blanca of the Andes where glacial landform is developed and glacier-covered mountains rise to a height of more than 5,000 m.

Annual rainfall is nearly 1,200 mm, the greater part of which is concentrated in the wet season (December ~ March), and it hardly rains in the dry season.

Eucalyptus, cactus and shrubs grow on mountain slopes at elevations of less than 3,500 m, but vegetation becomes sparse at higher elevations. Grasses grow at an elevation of about 4,000 m, but vegetation ceases at elevations of more than 4,500 m. Hence, the area around the camp site (El. 4,100 m) is divided into grassland and bare land.

Geologically, the grassland is composed of soil or gravel-containing (40 ~ 60%) soil. The gravels are fist to head-sized and also include larger ones. The bare land consists of soft rocks and hard rocks.

Topography is extremely steep and the greater part of outcrop is found on the steep slope immediately below the end of glacier. In the area extending around the outcrop, weathered and crushed debris is distributed at an angle of repose. This area is featured by the uniform size of the crushed debris.

(2) Basic Policy for Design

As can be seen in the topographic map, the whole survey area is in a steep mountainous region featured by a compelxity of topgraphy. In the design of the new road, therefore, it was required to adopt the critical values specified in the Peruvian Standards for Road Design.

1) Classification of the new road

The new road section was classified as national highway as it is a bypass between two cities, Pachapaqui and Huallanca, which are on National Highway No. 3 that links Chiquian and La Union.

2) Geometric design

The design running speed was taken at V = 30 km/h in consideration of the existing conditions of the survey area. The critical values adopted for alignment are as follows.

Minimum radius of curve. . . . . .25 m
Maximum longitudinal grade. 10%

3) Typical section

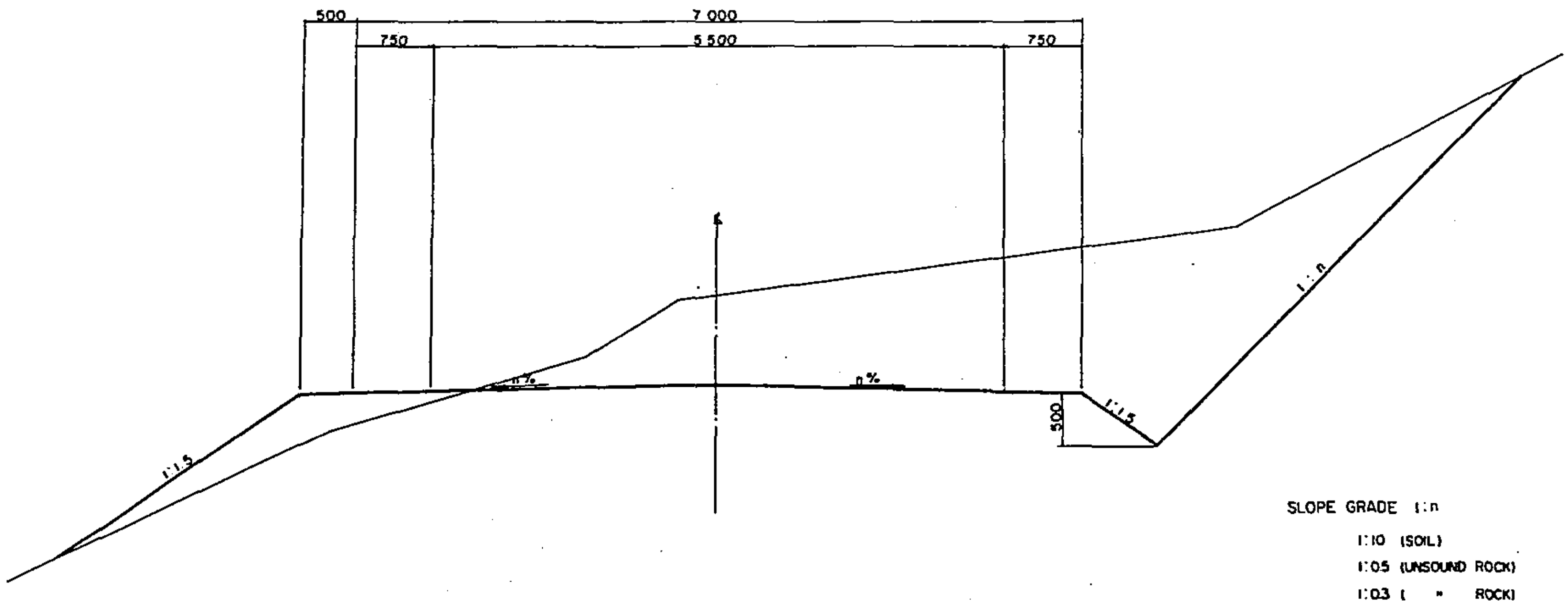


Fig. 2-11 Earthwork

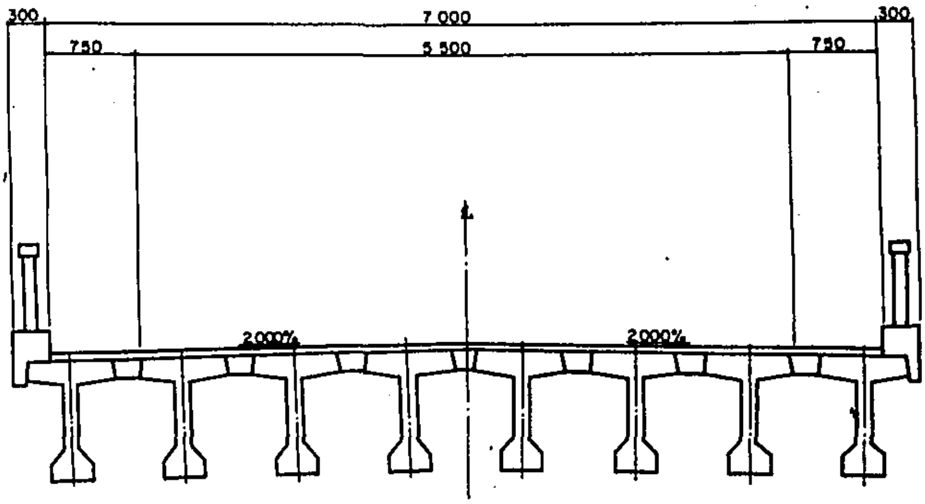


Fig. 2-12 Bridge

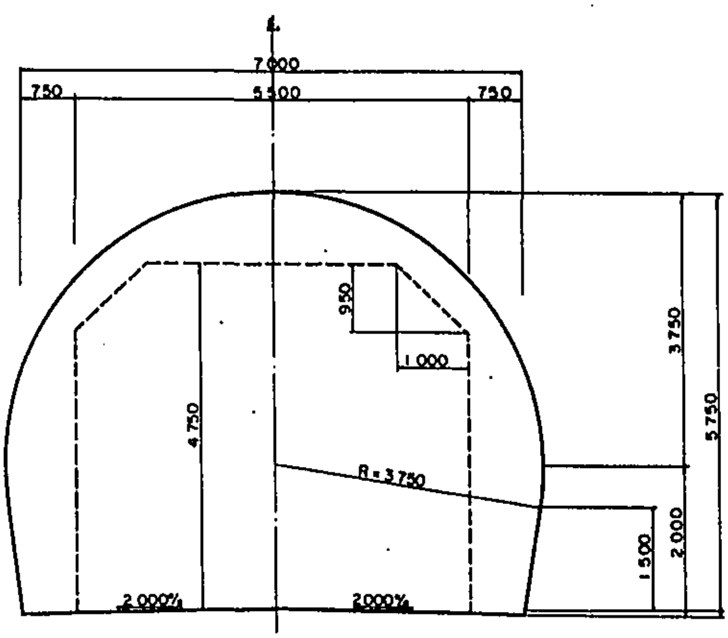


Fig. 2-13 Tunnel

(3) Route Selection

The following are the fundamental problems and control points which were encountered in the route selection.

1. Conformity to the Hilarion Mine Development Project.
2. Comparison with the existing section of National Highway No. 3 which passes the Yanash Allash Pass.
3. Ease of approach construction for tunnel driving under glacier.
4. Ease of construction work, and economic justifiability.
5. Conformity to the strike of vein.
6. Accessibility to the mining city.

For the purpose of studying these problems, comparison of alternative routes was made by selecting three elevations for Huallanca side tunnel entrance.

Fig. 2-14 is a rough sketch of the three routes.

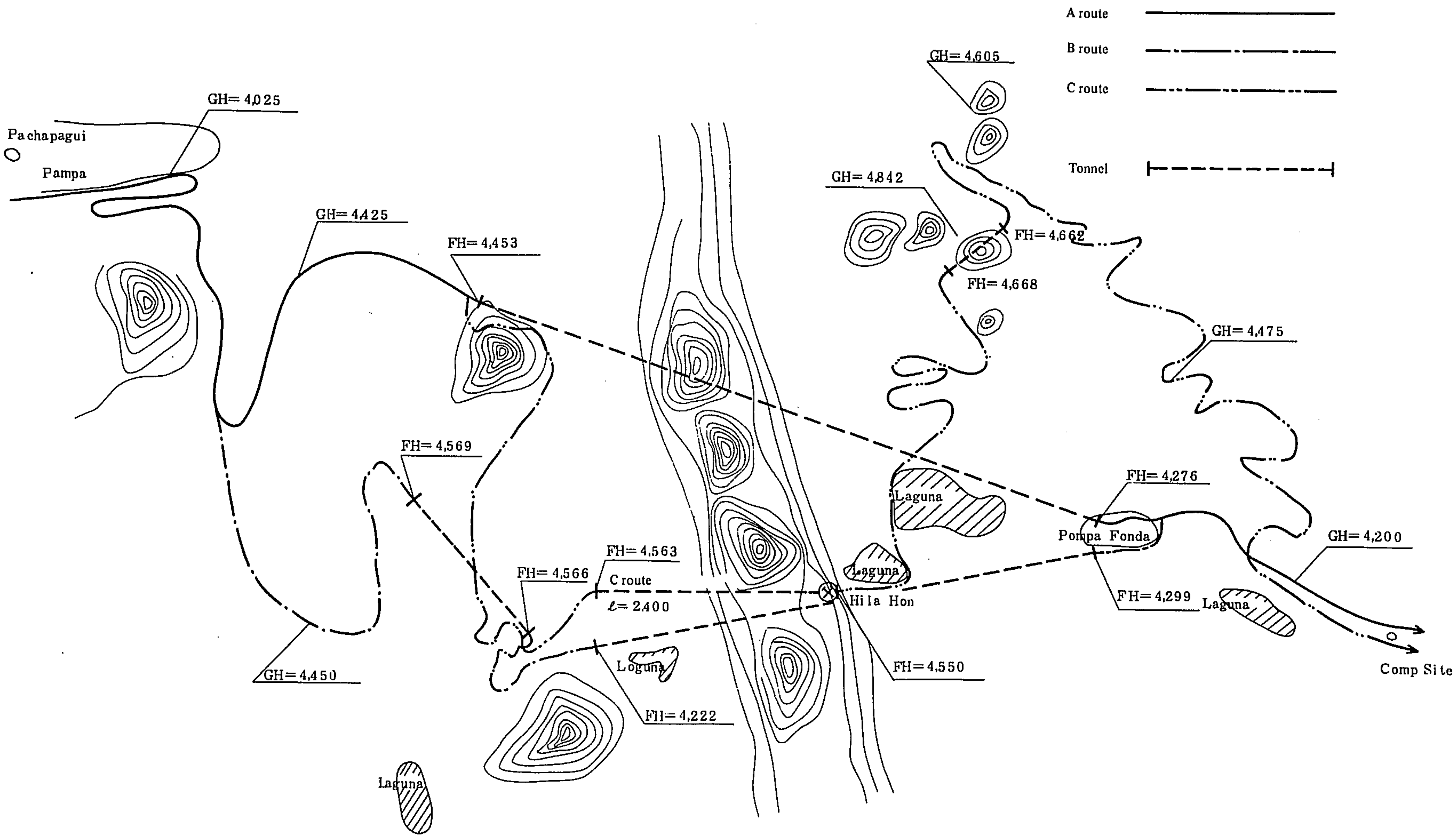


Fig. 2-14 Sketch of Alternative Routes

1) A-Route (L = 21.5 km)

i) Huallanca side section.

Distance	L = 5.8 km
Maximum elevation	H = 4,276 m

This section branches off from the existing road on Huallanca side at a distance of about 3 km from the camp site, and ascends in the direction of Shicra Shicra with an average grade of 6%.

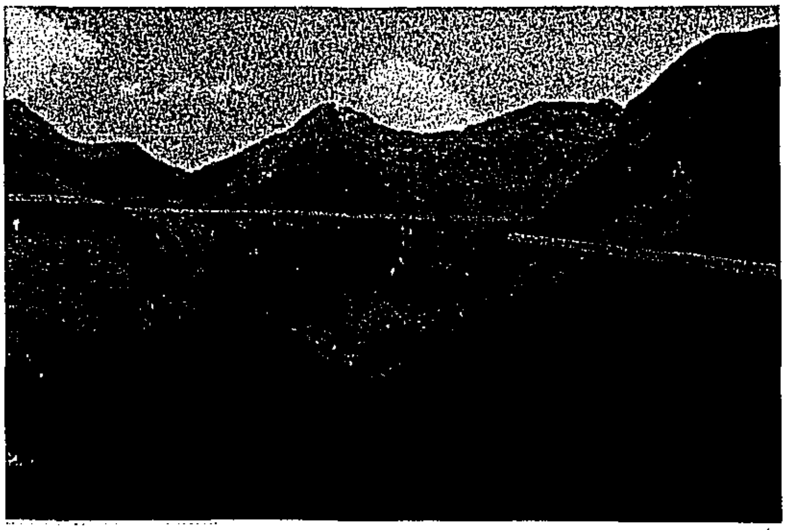


Photo 2-11

The above photo shows Pampa Fundo as viewed from Camp Site. The horizontal alignment of this section was planned along natural topography. It has no hairpin curves at all, and is better than any other routes. The first 5 km section was planned by taking advantage of a gentle slope, but the remaining 800 m section which leads to the tunnel entrance passes through an extremely steep rock-bound place shown in Photo 2-12. Two alternative plans, one for tunnel construction and the other for earthwork, were considered for this rocky section. Since the rock quality was quite satisfactory, the earthwork plan was adopted with account taken of the ease of execution and economy.

A mill (concentrator) can be built in a small flatland area (approx. 3 ha) extending around the entrance of the tunnel to be excavated through Shicra Shicra. Further, it is possible to select a suitable flat zone for mining city in Chinroc area extending around the camp site.

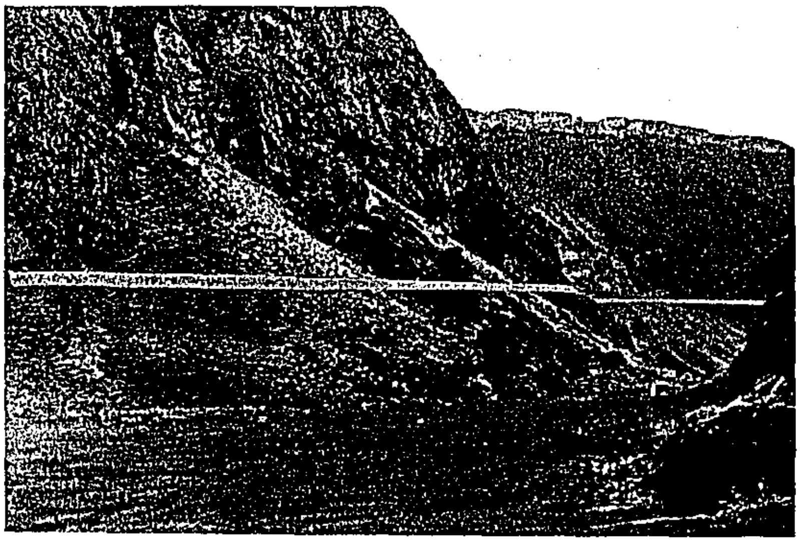


Photo 2-12

ii) Pachapaqui side section

Distance	L = 15.69 m
Maximum elevation	H = 4,353 m

A tunnel is planned to be driven through Shicra Shicra from the northern side of Pampa Fundo, and its entrance is planned to be the Pachapaqui side starting point of this section.

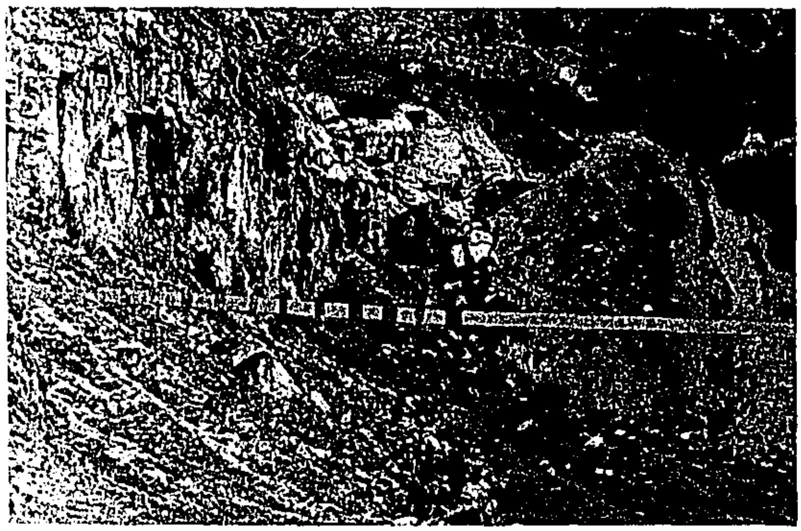


Photo 2-13

The tunnel will have a length of 5,000 m, an elevation of 4,276 m at the entrance and 4,352 m at the exit, and a longitudinal grade of 1.5%. It will pass a point 60 m to the north of laguna ad come out of the western slope of Cerreo Shicra Shicra (See Photo 2-14).

Photo 2-14

The route of this tunnel section deviates completely from the strike of vein estimated by Compania Minera Hilarion S.A.

To increase the distance for reduction of longitudinal grade between the tunnel exit and the flatland area of Rodeo, the route will then descend the slope which runs down from the ridge and is currently a place of reproduction of Puya Raimondy (Photo 2-15). A small channel flows through the central part of the flantland area. On reaching the flatland area, the road will take a mild downward course along the said channel until it joins National Highway No. 3 at its finishing point. The horizontal alignment of A-route is much better than that of Huallanca ~ Pachapaqui section of existing National Highway No. 3, and the longitudinal grade is about 4.5%.

As for the possibility of installing mining facilities, it is possible to construct the mill in the flatland area near the tunnel exit (Photo 2-15) and select a suitable zone for mining city in the flatland area of Q. Huishcash which is further close to Pachapaqui.

Photo 2-15

2) B-Route (L = 27.3 km)
   i) Huallanca side section

Distance	L = 6.0 km
Maximum elevation	H = 4,299 m

The route of this section is the same as A-route from its starting point to Pampa Fundo. On reaching Pampa Fundo, it shifts to the opposite side of the tunnel entrace on A-route through the southern slope (Photo 2-16) and ascends it to an elevation of 4,299 m.

Photo 2-16

For construction of mill (concentrator) and mining city, the same flatland areas as cited for A-route may be considered.

ii) Pachapaqui side section

Distance	L = 21.2 km
Maximum elevation	H = 4,579 m

As shown in Photo 2-17, the tunnel on B-route starts from the slope opposite to the tunnel entrance on A-route. It will pass below the southern side of Laguna and by the southern end of ore vein and reach the northern side of L. Solita Janca. The tunnel will have a length of 4.1 km and a longitudinal grade of 3%. From the exit of this tunnel, the route will take a 2.5 km upward course to cross a ridge with an elevation of 4,800 m (Photo 2-18). The ridge will be crossed by another tunnel with a length of 1.1 km (Photo 2-19). The route will pass by the highest point of B-route (H = 4,579 m) at the centre of the second tunnel, and then reach the valley of Q. Quenhua Ragra.

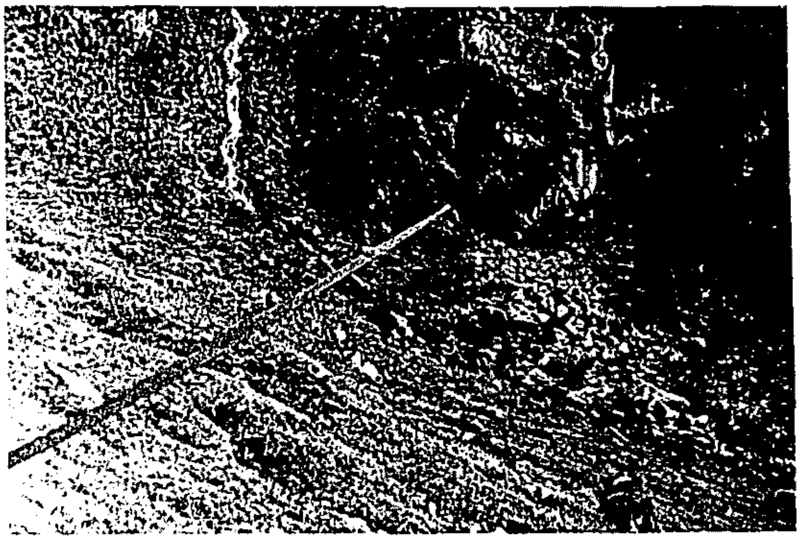


Photo 2-17

Photo 2-18

Photo 2-19

On the east side slope of the said valley, C-route is expected to pass and be joined by B-route. The average longitudinal grade of this section is planned to be 5.3%.

It will be possible to find a suitable zone for mining city construction in the neighbourhood of Q. Jaitocacha which is near the exit of the first tunnel

(L = 4.1 km). This area offers an excellent living environment because it is favoured with a mild undulation and luxuriance of trees of which any area along the other two routes is devoid. As for the mill (concentrator), it will be possible to build it on the mild slope extending immediately beneath the exit of the said tunnel.

3) C-Route (L = 39.8 km)

i) Huallanca side section

Distance	L = 15.5 km
Maximum elevation	H = 4,668 m

This section branches off from the existing road on the camp site side at a distance of about 1 km from the starting point of A-route. It meanders up the northern slope in front of the camp site and crosses Cerro Mina Punta (H = 4,800 m) by a tunnel with a length of 350 m. As shown in Photo 2-20, the tunnel must be drilled from a very steep rock-bound place and come out to an equally steep rock-bound place.

Photo 2-20

From the exit of this tunnel, the route takes a down course to L-Aguascocha where mining operation is being conducted, and then enters a second tunnel (H = 4,550 m) (Photo 2-21) after detouring round the said laguna.

In the design of the horizontal alignment of this section, a critical value specified in the Peruvian Standards for Road Design (R = 25 m) was adopted for four places. The longitudinal grade turned out to be 5.8% on the average. The sites of the mining city and mill (concentrator) are the same as cited for B-route.

Photo 2-21

ii) Pachapaqui side section

Distance L = 24.3 km

Maximum elevation H = 4,782 m

A tunnel will be driven from a place 300 m to the north of the test pit for exploration. It is planned that the tunnel will have a length of 2.4 km which is shorter than required for any of the other two routes, and will run approximately in parallel with B-route. It will have the mildest longitudinal grade in the tunnel (0.5%) of all tunnels.

From the exit of the said tunnel, the longitudinal grade will increase to cross the ridge of Cerro Yuraccalapu. While B-route is planned to cross this ridge by driving a tunnel, C-route will cross it by earthwork to be conducted on the slope (Photo 2-22).

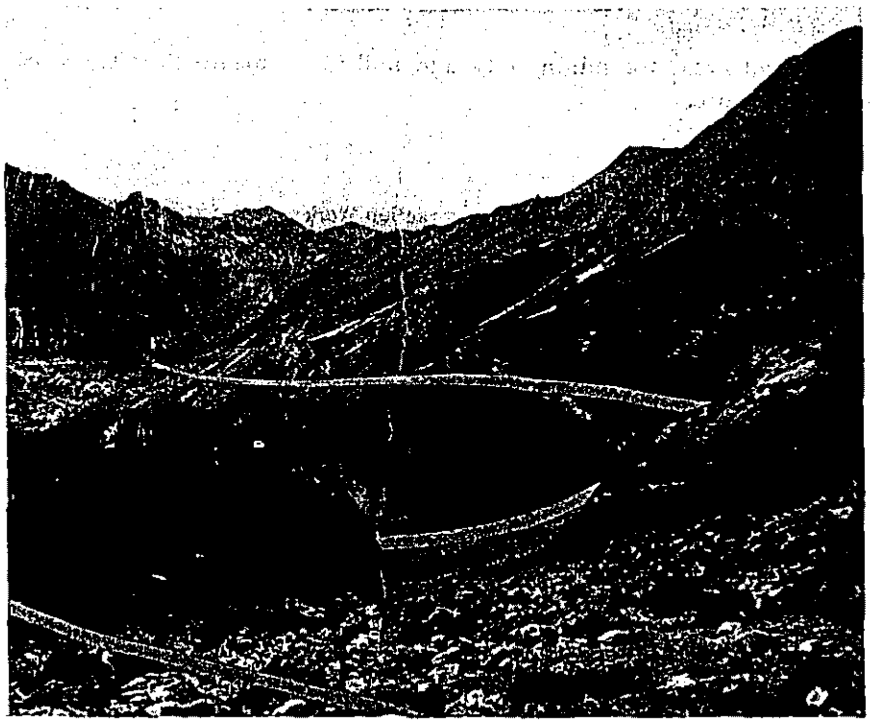


Photo 2-22

To descend from the summit of the ridge to the valley shown in Photo 2-23, the route will detour to the east side of Co. Shicra Shicra seen on the right side in the same photo, and go down the slope to Q. Quenhua Ragra and join B-route. It will then take a further downward course along the valley and join A-route.

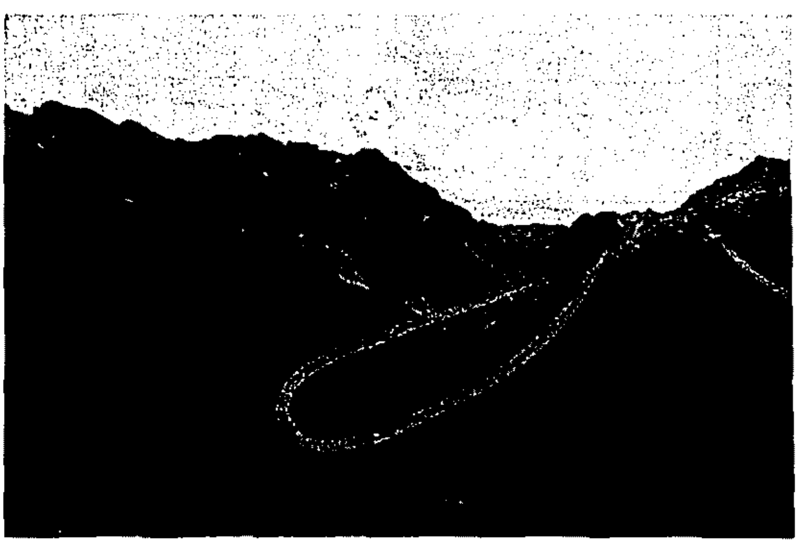


Photo 2-23

C-route was planned to pass many steep slopes in order to save the need for tunnel construction, so that it has a poorer horizontal alignment than the other two routes. The longitudinal grade is planned to be 5.8% on the average.

The flatland areas for mining city and mill (concentrator) are the same as cited for B-route.

(4) Amount of Construction Work

Table 2-3 Amount of Construction Work

Type of Work		Unit	Route		
			A-route	B-route	C-route
Earthwork	Cutting	M^3	1,265,555.0	1,489,555.0	2,346,172.0
	Coil	M^3	1,122,485.0	1,094,652.0	1,085,457.0
	Soft rock	M^3	97,850.0	267,060.0	771,380.0
	Hard rock	M^3	45,250.0	127,843.0	489,335.0
	Embankment (Haulage distance - less than 1 km)	M^3	19,409.0	31,919.0	45,785.0
	(Haulage distance - less than 0.05 km)	M^3	63,277.9	74,477.9	117,308.7
Pavement		M^2	165,044.0	196,476.5	284,625.0
Bridges and Culverts	Prestressed concrete bridge	M^2	560.0	560.0	560.0
	Corrugated pipe ϕ1.00 m	M	190.8	190.8	206.1
	Corrugated pipe ϕ0.60 m	M	931.2	1,113.6	1,632.0
	Stone masonry	M^3	2,416.7	3,371.2	5,227.5
Tunnel construction		M^3	195,333.0	197,186.0	101,833.0

2-4 Comparison of Alternative Routes

(1) Comparison of Alternative Routes

Table 2-4 Comparison of Alternative Routes

Route	Section	Distance	Maximum elevation	Average grade	Tunnel length	Curve with minimum radius	Characteristics	Relationship with related facilities
A-route	Huallanca side: Camp site ~ Tunnel entrance	L=5.8 km	H=4,276 m	6.0%	Nil	None	· Alignment is the best of all routes. · Distance is the shortest. · The existing road can be used as construction road. · Diverted traffic can be induced. · Design elevation is lower than the water level of Laguna.	· There are flatland areas in Pampa Fundo for dressing plant and near Camp Site for mining city planning.
A-route	Pachapaqui side: Tunnel entrance ~ Pachapaqui	L=15.69 km L=21.5 km	H=4,353 m	4.5%	L=5,000 m L=1,275 m	1 place	· Alignment is the best of all routes. · Distance is the shortest. · Diverted traffic can be induced. · Construction of the longest tunnel is planned. · Route is deviated from the ore vein.	· Dressing plant and mining city can be constructed at Rodeo of Pachapaqui. · Commuting distance is made long.
B-route	Huallanca side: Camp site ~ Tunnel entrance	L=6.0 km	H=4,299 m	6.0%	Nil	None	· Best alignment (same as A-route) · Design elevation is lower than the water level of Laguna.	· Same as A-route.
B-route	Pachapaqui side: Tunnel entrance ~ Pachapaqui	L=21.2 km L=27.3 km	H=4,579 m	5.3%	L=4,125 m L= 150 m L=1,050 m	2 places	· Route passes by the southern end of the ore vein. · Total tunnel length is the largest.	· Ichioparpa has sites for dressing plant mining city. · Excellent living environment is promised by mild undulation of land and luxurience of trees.
C-route	Huallanca side: Camp site ~ Tunnel entrance	L=15.5 km	H=4,668 m	5.8%	L= 350 m	4 places	· Alignment is unsatifactory. · Difference in design elevation is large. · Design distance is long. · Route is closer proximity to the mine shaft than the other two.	· Connection to the same place as reached by A- and B-routes is possible, but commuting distance becomes long.
C-route (cont'ed)	Pachapaqui side: Tunnel entrance ~ Pachapaqui	L=24.3 km L=39.8 km	H=4,782 m	5.8%	L=2,400 m	2 places	· Alignment is unsatisfactory. · Route passes the point with the highest desing elevation.	· Connection to the same place as reached by B-route is possible, but approach road road is made long.

(2) Construction Cost

Table 2-5 Estimated Construction Cost

Route	Distance (km)	Estimated Construction Cost	
		1000 Soles	1,000 yen
Concococha – Pachapaqui (Improvement of existing road)	70.0	98,298	324,383
*Pachapaqui – Huallanca (Improvement of existing road)	53.0	5,922	19,543
Huallanca – Camp Site (Bypass construction/improvement of existing road)	13.8	115,268	380,384
Sub-total	83.8	213,566	704,767
A-Route	21.5	595,205	1,964,177
B-Route	27.2	728,133	2,402,839
C-Route	40.7	1,028,115	3,392,780
Total for A-Route	105.3	808,771	2,668,944
Total for B-Route	111.0	941,699	3,017,606
Total for C-Route	124.5	1,241,681	4,097,547

* Construction cost for improvement of Pachapaqui ~ Huallanca section is not included in the total cost for the new route construction.

Judging from the cost comparison, A-route is most desirable. However, the final decision should be made only when all of the following data are made available.

- o Detailed execution plan of Hilarion Mine Development Project.
- o Estimate of financial aspect of the said project.
- o Possibility and conditions for raising the road construction fund.
- o Investment plan for road construction compatible with the said project.

Chapter 3. Mining City Planning

3-1 Outline of the Plan

(1) Design Period

15 years from the initiation of Hilarion mine operation.

(2) Design Population

The population of the mining city will be composed of the mine workers and their families, the employees of service industries required for their daily lives, and the families of such employees. The city has no built-up areas in its vicinities, and its location makes it practically impossible to expect that there will be any notable industrial location in its vicinities that can offer sizable employment opportunities. Hence, natural generation of such population that will live in the city and work in other areas is a matter of remote possibility, and disregarded for the mining city planning.

The changes in the city's population in the coming 15 years, as estimated from the conditions currently considered for the project implementation and from the data of population and economy of the project area, are shown in Tables 3-1 ~ 2 and Figs. 3-1 ~ 2. On the basis of these tables and figures, the design population is set at slightly more than 4,000.

(3) Design City Area

Assuming that the city will have a population density of about 150 persons/ha, its design area is set at about 33 ha including some allowance for possible future expansion.

(4) Facilities Required

1) Housing facilities

A housing plan compatible with the population estimate was prepared by marital status, and suitable dwelling unit types were selected for type-wise distribution of houses shown in Table 3-3.

2) Public facilities

Standards for public facilities consolidation were established with careful consideration given to the principal requirements of the Mining Law as well as to the welfare benefits to the surrounding areas that can be derived from the application of the standards.

3) Urban infrastructural facilities

It is planned that the fundamental urban facilities such as roads, waterworks and sewerage facilities, power faiclities, etc., which are indispensable for the citizens to enjoy healthy and cultural lives, will be constructed on a sufficient scale and level.

Table 3-1 Comprehensive Population Forecast
– Changes in the Number of Householders –

Unit : person

Operation Year	Mine Laborers			Service Population			Total			Number of Family Members of Married Householder
	Bacholor	Married	Total	Bacholor	Married	Total	Bacholor	Married	Total	
0	329	471	800	62	38	100	391	509	900	5.39
5	275	525	800	85	75	160	360	600	960	5.37
10	248	552	800	103	117	220	351	669	1,020	5.28
15	248	552	800	106	150	256	354	702	1,056	5.26

Table 3-2 Comprehensive Population Forecast
– Changes in Total Population –

Unit : person

Operation Year	Mine Laborers and Families			Service Population and Families			Total				Number of School Children
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Growth Rate in 5 Years	
0	1,630	1,270	2,900	147	85	232	1,777	1,355	3,132		775
5	1,734	1,410	3,144	262	177	439	1,996	1.587	3,583	0.144	902
10	1,780	1,461	3,241	375	270	645	2,155	1,731	3,886	0.085	962
15	1,789	1,458	3,247	457	342	799	2,246	1,800	4,046	0.041	981

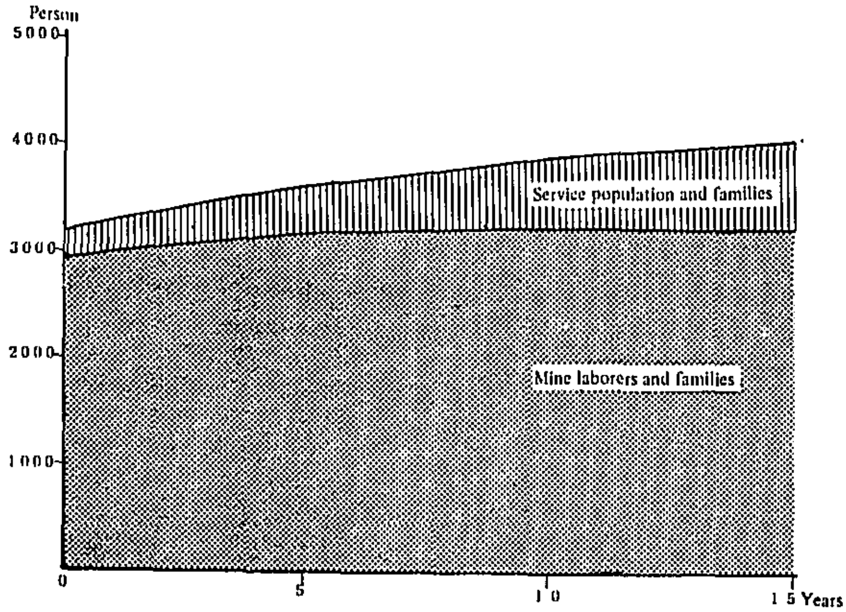


Fig. 3-1 Changes in Total Population of Mining City

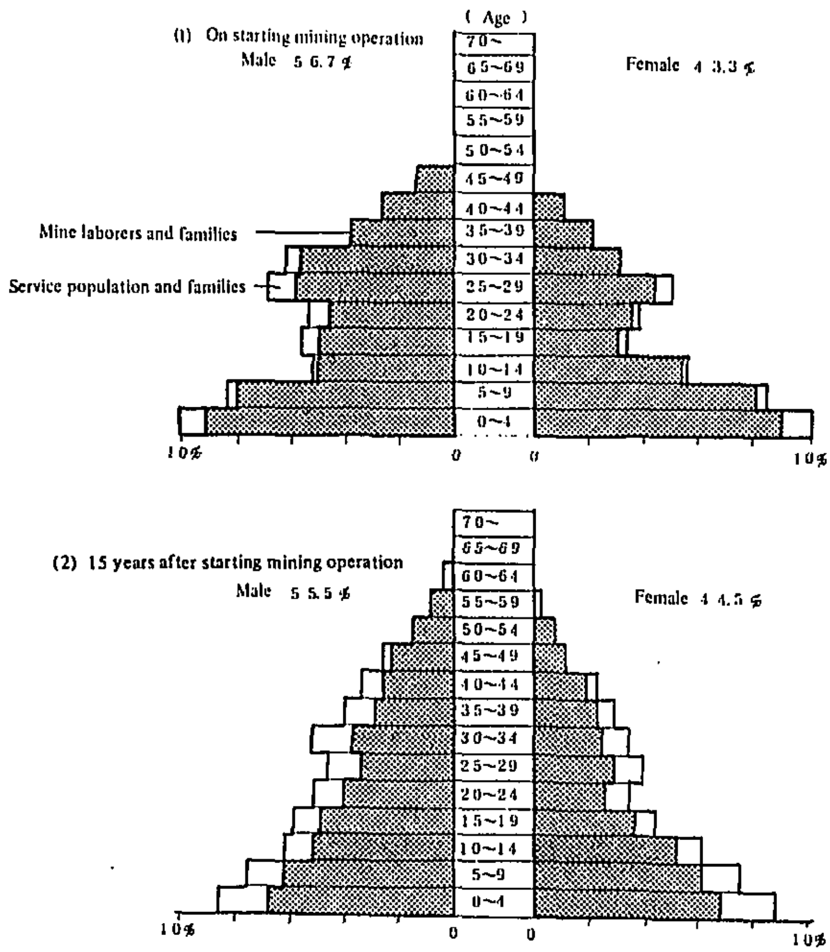


Fig. 3-2 Annual Population Composition of Mining City

Table 3-3 Dwelling Unit Distribution Plan by Type

	Mine Laborers		Clerical Staff		Engineers and Technical Staff	
Marital Status	Bachelor	Married	Bachelor	Married	Bachelor	Married
Number of Dwelling Units Planned	192	497	41	48	15	7
		2B.R. type 327 3B.R. type 170	56			55
Number of Dwelling Units to be Supplied	3 B.R. type: 2 dormitories 1 B.R. type: 2 dormitories *Accommodation: 192 persons*		20B.R. type: 3 dormitories Accommodation : 60 persons		4 household type: 14 buildings Accommodation : 56 households	

Table 3-4 Comprehensive Table of Facilities

Facilities			Statutory require-ments	Coverage: Mining city only	Coverage: Mining city and out-skirts	Time of construction: At time of city planning execution	Time of construction: On initiation of mining operation	Time of construction: After starting mining operation	Site area (m^2)	Total floor area (m^2)		Particulars and type of facilities
Housing facilities	Housing facilities for staffs	*Dwelling units for* married staffs	o	o			o		7,500	*5,190*		
		Dormitories for bachelors	o	o			o		2,900	*2,000*		
		Restaurants for bachelors	o	o			o		–	–		To be annexed to each dormitory and used as meeting hall, clubhouse, etc. as well.
	Housing facilities for laborers	Dwelling units for married staffs	o	o			o		65,600	45,900		
		Dormitories for bachelors					o		4,800	3,300		
		Restaurants for bachelors					o		500	350		
		Parking lots					o					1 car/5 dwelling units in residential district; suitable parking *area to be secured for central* facilities.
Administrative and *commercial* facilities	Administrative and management facilities	City hall	o		o		o			150		Branch office → Single community centre *building* for integrated administrative and management services.
		Police station			o		o			100	Incl. night duty room	Police box → (Single community centre building)
		Fire station		o		Δ			1,500	*100*		*Storehouse* → (Single community centre building)
		Post-cum-telephone office	o		o	Δ				100		
		Dormitory management office		o			o			50		
	Commercial *and service* facilities	Bank			o		o			100		
		Market place	o		o	o			2,000	500	20 m² (asphalt waterproofing) x 40 street stalls	Permanent market place and area for street stalls.
		Store			o				1,500		150 m² x 10 stores	Area for restaurants, service shops and maintenance shops.
Educational *and cultural* facilities	Educational facilities	Kindergarden	o	o		Δ			2,700	1,080	540 m² x 2	
		Primary and higher schools	o	o		Δ			10,500	2,750		

Facilities			Statutory requirements	Coverage: Mining city only	Coverage: Mining city and outskirts	Time of construction: At time of city planning execution	Time of construction: On initiation of mining operation	Time of construction: After starting mining operation	Site area (m^2)	Total floor area (m^2)		Particulars and type of facilities
Educational and cultural facilities	Cultural facilities	Church	o	o			o		2,500	500	Plot coverage incl. plaza – 20%	
		Public hall		o			o		2,000	700	$2 m^2 \times 300$ seats, $100 m^2$ for co-operative's hall	Multi-purpose hall serving as culture centre (Public hall, Library, Cinema house)
		Library		o			o			100	Lending library with *bookrooms*	
		Cinema house			o		o					
Medical and welfare facilities	Medical facilities	Hospital	o		o		o		3,000	1,200	$40 m^2 \times 30$ beds	
	Welfare facilities	Clubhouse	o	o			o		380	150		Meeting room, sport outfits storage, locker room and shower room
		Athletic facilities	o		o		o					1 each of large and small soccer courts, 2 tennis courts, and 2 basketball courts.
		Park		o			o					To be distributed suitably for balance land use.
		Green zone		o			o					
Infra-structural facilities	Transport facilities	Access road		o		o						
		Main road in residential district		o		△						
		Access road		o			o					
		Pedestrian's road		o			o					
		Parking lots		o			o					
	Public utilities	Water supply facilities	o	o		△						
		Sewage facilities	o	o			o					
		Rain water drainage facilities	o	o		△						
		Power transmission facilities	o	o		o						
		Waste disposal facilities	o	o			o					

Notes: The site area shown in the table is the minimum allowable area determined on the basis of the legal and general plot coverages. Final decision on the site area is to be adjusted according to the land requirement for infrastructural facilities and for balanced land use.

3-2 Selection of City Site

The three zones shown in Fig. 3-3, which were studied for determination of the city site, were selected by the following process.

Tentative selection of the three zones was made on the basis of the following analyses.

- o Preliminary paper location study and general topographic analysis of the new road which were conducted before the field reconnaissance.
- o Analysis of the preliminary study data of the three zones which were presented by compania Minera Hilarion S.A.

Then, the field reconnaissance was conducted to cast light on the following details and check the findings against the results of preliminary study.

- o Topography and geology.
- o Conditions for water utilization.
- o Socio-economic correlations with the clusters existing in the neighbouring areas.

The three zones thus selected have the characteristics described below.

o A-Zone (Huallanca Zone) – B- and C-Routes

Access to mine: This zone is situated on the east side of shed (adit side). If B-route is selected, therefore, it becomes most accessible to the adit. Further, if the city is located in the western half of this zone, it connects directly to the new road and alleviates the requirements for infrastructural facilities.

Topography: The zone opens to east and west, and its central part is a flatland area with an excellent insolation condition. In particular, the westernmost part of the zone enjoys an extremely high visible sky ratio and provides a free and unbostructed urban space because it forms an intersection of flatland areas extending in all directions. In addition, the high flatland ratio of the zone offers great flexibility in the site selection of mining facilities such as mill and slag disposal dam as well as in the physical planning of the city.

Development effect: Compared with the other two zones, A-zone is peculiar in that it is fairly close to Huallanca and La Union which have achieved the highest degree of accumulation among all neighbouring citites and also serves as an advance base of high priority programmes which will eventually be extended to the site from Huallanca under the National Development Plan.

o B-Zone (Ichicpampa Zone) – B- and C-Routes

Access to mine: This zone is on the west side of shed as C-zone is. A suitable city site is found near the tunnel exit, but the selection of this site presupposes the construction of a relatively long access road because it does not adjoins the new road. Thus, B-zone is not advantageous in terms of proximity to adit, requirements for infrastructural facilities and construction schedule.

Topography: The zone is composed of small flatland areas and mild slopes which are compatible with the planned scale of mine facilities and city. In the south-western part of the zone, there is a mild slope which promises great safety although it calls for voluminous earthwork to provide against earthquakes and sediment transportation during flood. It may as well be noted that the natural forest on the slope on the opposite side is the only forest in all the three zones, and it produces a refreshing and delightful impression in the desolteness of surrounding environment.

- C-Zone (Rodeo Zone) – All routes (A, B and C)

Access to mine:	No access road is required as this zone adjoins the new road even in case it is A, B or C route. Consequently, it provides the greater flexibility to route selection, but the distance from the adit is long as in B-zone.
Topography:	The same topographic features as seen in A-zone provide a high visible sky ratio in the central part, making it possible to secure an unobstructed urban space.
Development effect:	Pachapaqui is located close to C-zone, although the degree of accumulation in this town is still low. It can therefore be expected that the construction of public facilities in the mining city will produce direct spill-out effect on Pachapaqui.

For each of the above three zones, a detailed study was made to clarify the correlation with the mine facilities and each alternative route of the new road. As a result, the following sites were selected from among the site alternatives in each zone which are shown in Table 3-5.

A-Zone:	HCA and HCC sites	(hereafter called HA- and HC-sites)
B-Zone:	ICA site	(hereafter called IA-site)
C-Zone:	RCA site	(hereafter called RA-site)

Fig. 3-3 Base Map for City Site Selection

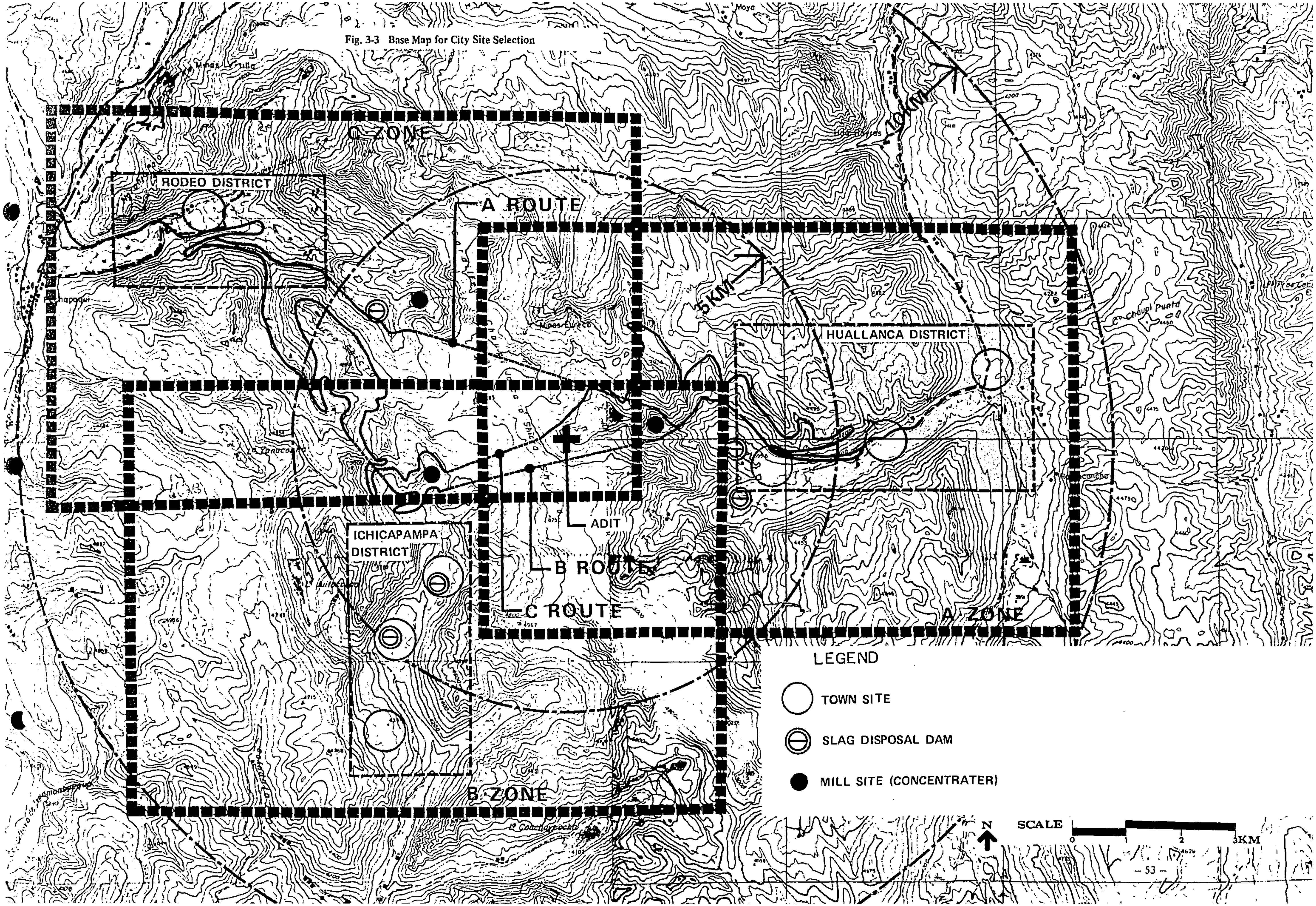


Table 3-5 Characteristics of Each Proposed Site

Item \ Zone / Site	HUALLANCA			ICHICPAMPA			RODEO
	HCA	HCB	HCC	ICA	ICB	ICC	RCA
Area (ha)	33.0	33.0	39.0	30.0	30.0	33.0	30.0
Land shape and difficulty in land use.	· Small plots of land are scattered like islands, making it difficult to plan housing area distribution.	· A narrow strip of land with a length of 1.5 ~ 2.0 km; distribution of housing areas is difficult.	· Two square-shaped areas can be secured so that land use can be planned with ease.	· Land use can be planned with ease because the site is a rectangular land with a large width.	· Similar to A-site in shape, but better than A-site in terms of acreage distribution for land use.	· Better in acreage distribution and shape than the other two sites.	· A triangular land with good acreage distribution which makes it easy to plan land use and housing area distribution.
Distance from adit.	C: 14 km A, B: 4 km	C: 16 km A, B: 6 km	C: 18 km A, B: 8 km	B: 16 km	B: 17 km	B: 18 km	A: 15 km, B: 21 km C: 24 km
Length of access road and difficulty in its construction.	· One road of about 1 km is required, but its construction involves difficulty.	· Not required.	· Not required.	· One road of 6 km length is required, and its construction involes difficulty.	· One road of 7 km length is required, but its construction involves difficulty.	· One road of 8 km length is required, but its construction involves difficulty.	· Directly adjoins the new road.
Amount of earthwork.	· Ordinary.	· A good deal of filling work is required due to the presence of many swamps.	· No so great as required for HCA and HCB.	· A large volume of embankment is required.	· Same as A-site.	· Grading (cutting) is required because the site is extends on a hill with a grade of 10 ~ 20%.	· Volume of embankment work is small because swamp area is small.
Characteristics of site.	· Complexity of topography is greater than in other sites. · There is a lake upstream of the site. · Site is within walking distance from the adit, and its suitability is implied by the boring conducted with a camp site established therein.	· Ground condition is poor due to the presence of many swamps. · There are oozing from the southern slope and debris flow.	· Good quality water is available in sufficient quantities. · Distance to Huallanca is the shortest of all sites. · Relative free from flood damage.	· Ground condition is very poor (muck from tunnel construction assumed to be used as fill material). · Site is geologically suited to slag disposal dam construction.	· Same as A-site.	· Ground condition is very satisfactory. · Trees grow in the neighbourhood. · Not influenced by the slag disposal dam.	· Ground condition is satisfactory and swampy area is small. Housing area distribution can be planned by taking advantage of the existing topography. Substantial spill-out effect can be expected because of the short distance to the existing clusters.

Zone	HUALLANCA			ICHICPAMPA			RODEO
Item / Site	HCA	HCB	HCC	ICA	ICB	ICC	RCA
Indeterminate factors.	· There will arise augmented need for river improvement and bridge construction.	· Supply of fill material.		· If A-site is selected as residential district, attention must be given to the rise of groundwater level and surface drainage.	· If B site is selected as residential district, A-site is to be used for slag disposal dam construction. In this case, however, safety of dam construction should be studied carefully.	· Possibility of land grading by surface grading or limited cutting work. · Possibility of cutting rocks in case cutting depth is large.	· A separate slag disposal dam site should be selected for I-sites, but the dam is to built within R-, B- and C-sites.
Insolation condition.	*Site is open to east* and west.	*Site opens to east* and west.	*Site opens to east* and west.	*Site opens to south* and north.	*Site opens to south* and north.	*Site is open to north* and south.	*Site is open to east* and west.

Note: A, B and C in the column of "Distance from adit" respectively represent the alternative routes of new road.

3-3 Construction Plan

For each of the city sites selected in the preceding section, concrete city planning was made in order to present the outline of the mining city and provide the basic data for its construction design, and the construction cost was estimated for preparation of a detailed investment plan.

A detailed study of the land use and facilities construction plan was made for RA-site which was selected for the following reasons.

- o It has high flexibility in conforming to any of the route alternatives of new road.
- o It stands midway between the best and the poorest in terms of locational conditions including natural condition.

Studies made for other sites, though conducted by the same process, were intended only to produce the outline of land use and detect any deviation that may be involved in the estimation of construction cost.

(1) Composition of Housing Area

For unmarried mine labourers who are expected to occupy the greater part of housing units, a prototype of neighbourhood unit consisting of a total of 100 dwelling units (36 units of 3 bedroom type and 64 units of 2 bedroom type) with two play lots and one each of small park zone and parking place was established. The central residential neighbourhood would consist of five of such units to be formed on the basis of the said prototype with adjustment made to the number of dwelling units. Fig. 3-4 is a schematic drawing of the prototype. Since the inhabitants of the neighbourhood unit are expected to move mostly on foot in their daily lives and behaviours, footpaths will be provided for access to each dwelling unit, and each footpath will be connected to the pedestrian way running through the neighhourhood and further to public facilities, bus stops, etc.

As for residential neighbourhood of bachelors and clerical and technical staffs, freer planning is permissible because of their small scale. In order to answer the purpose of relevant laws, it was planned that the residential area of bachelors would be severed from that of married persons by providing a suitable open place such as a road between them.

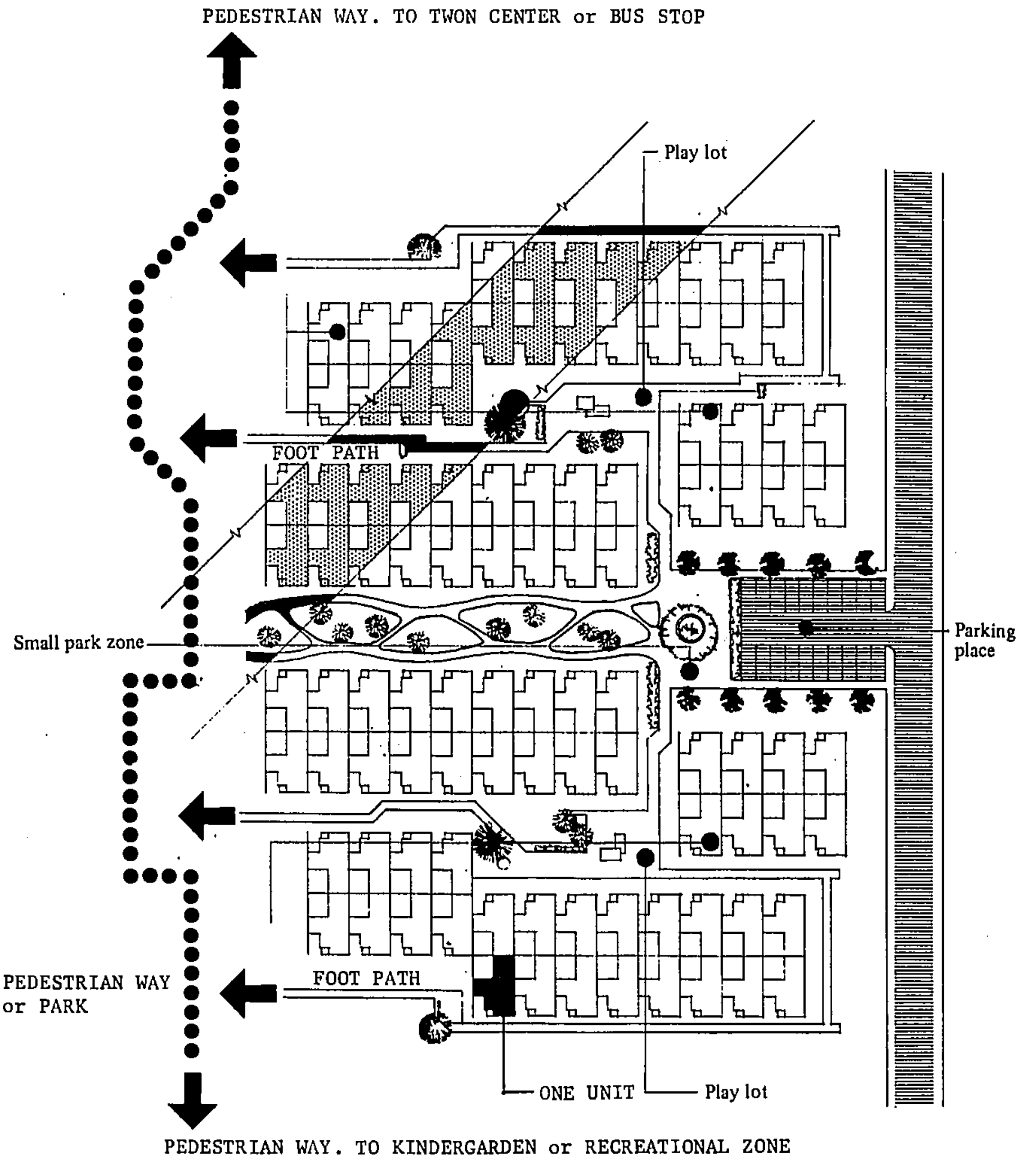


Fig. 3-4 Prototype of Neighbourhood Unit of Married Mine Labourers

(2) Land Use and General Layout Plan

The required land use conditions of RA-site were checked against the natural conditions of the site for comparison of land use alternatives, and the land use plan and general layout shown in Fig. 3-5 were selected as being most suitable. The physical plan was reviewed on the basis of the said plan and layout for preparation of the schematic land use plan and the general layout plan of RA-site which are shown in appendix. Similar studies were made for other sites and the resultant land use plans and general layout plans are also shown at the end of the report. Table 3-6 shows the acreage distribution in RA-site under the said land use plan.

Table 3-6 Land Use Area in RA-Site (m^2)

Item	A-Block	B-Block	C-Block	Total	Component Ratio (%)
Right of Way	18,880	6,660	–	25,540	7
Housing Area for Labourers and Staffs	145,920	39,060	–	184,980	52
Housing Area for Service Population	34,350	–	–	34,350	10
Area for Public Facilities Town Centre	32,670	–	–	32,670	9
Kindergarten	3,720	–	–	3,720	1
Park and Recreational Area	47,920	6,490	–	54,410	15
Area for Water Supply and Treatment Plants					
Water Purification and Distribution Plants	–	–	6,000	6,000	2
Sewage Treatment Plant	–	3,520	–	3,520	1
Unused Land	12,540	–	–	12,540	3
Total	296,000	55,730	6,000	357,730	100

(3) Infrastructural Facilities Plan

Studies were made on the construction of urban infrastructural facilities including roads, transport facilities, waterworks and sewage facilities, power supply facilities, etc. Figs. 3-6 ~ 10 are schematic plans prepared from the said studies for construction of various facilities.

(4) Housing Plan

The basic design of dwelling unit was prepared for each type discussed in Section 3-1 (Outline of the Plan). Figs. 3-11 ~ 12 show the design of most typical dwelling units.

LAND USE ALTERNATIVE LA – 3

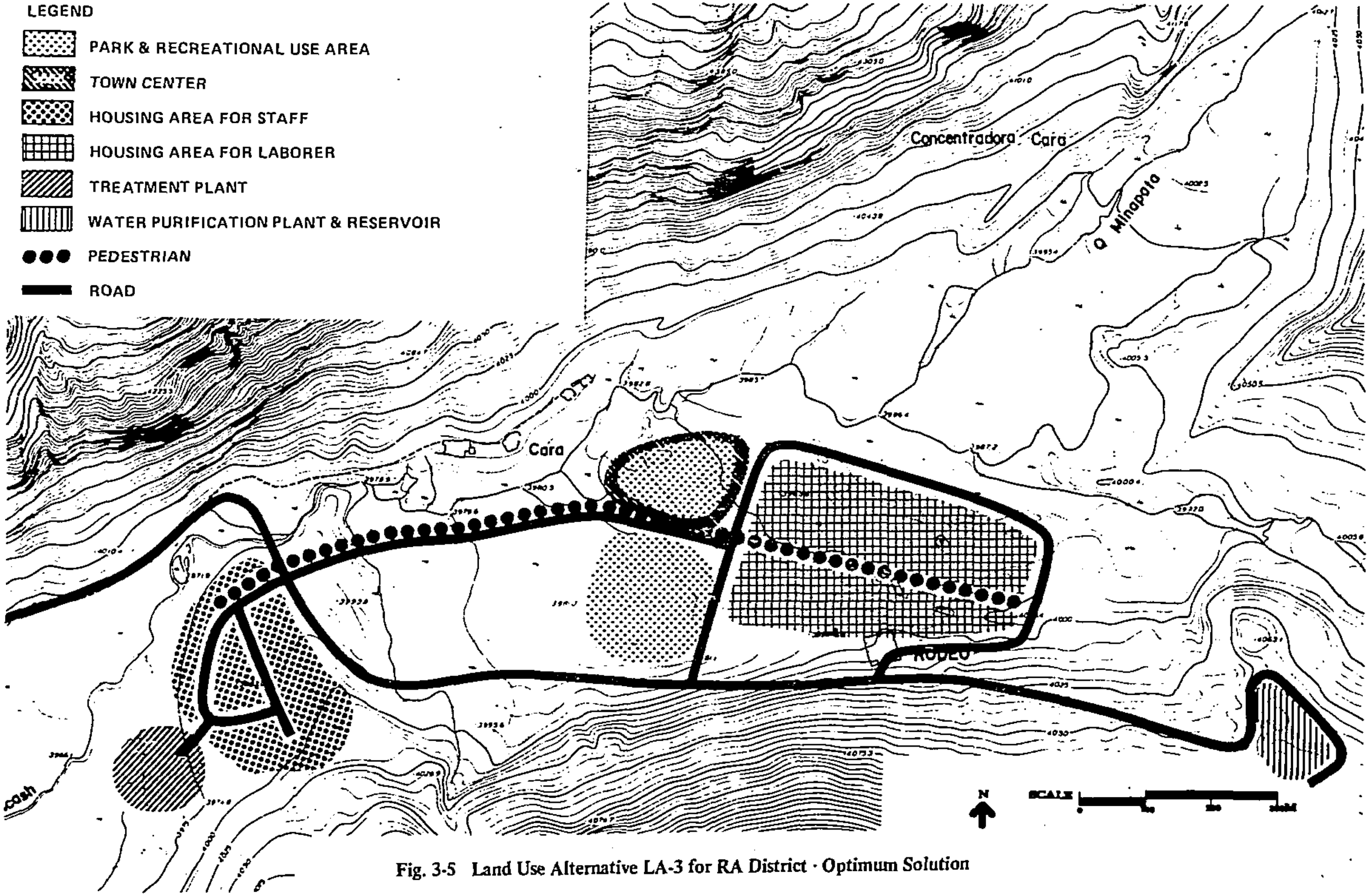


Fig. 3-5 Land Use Alternative LA-3 for RA District · Optimum Solution

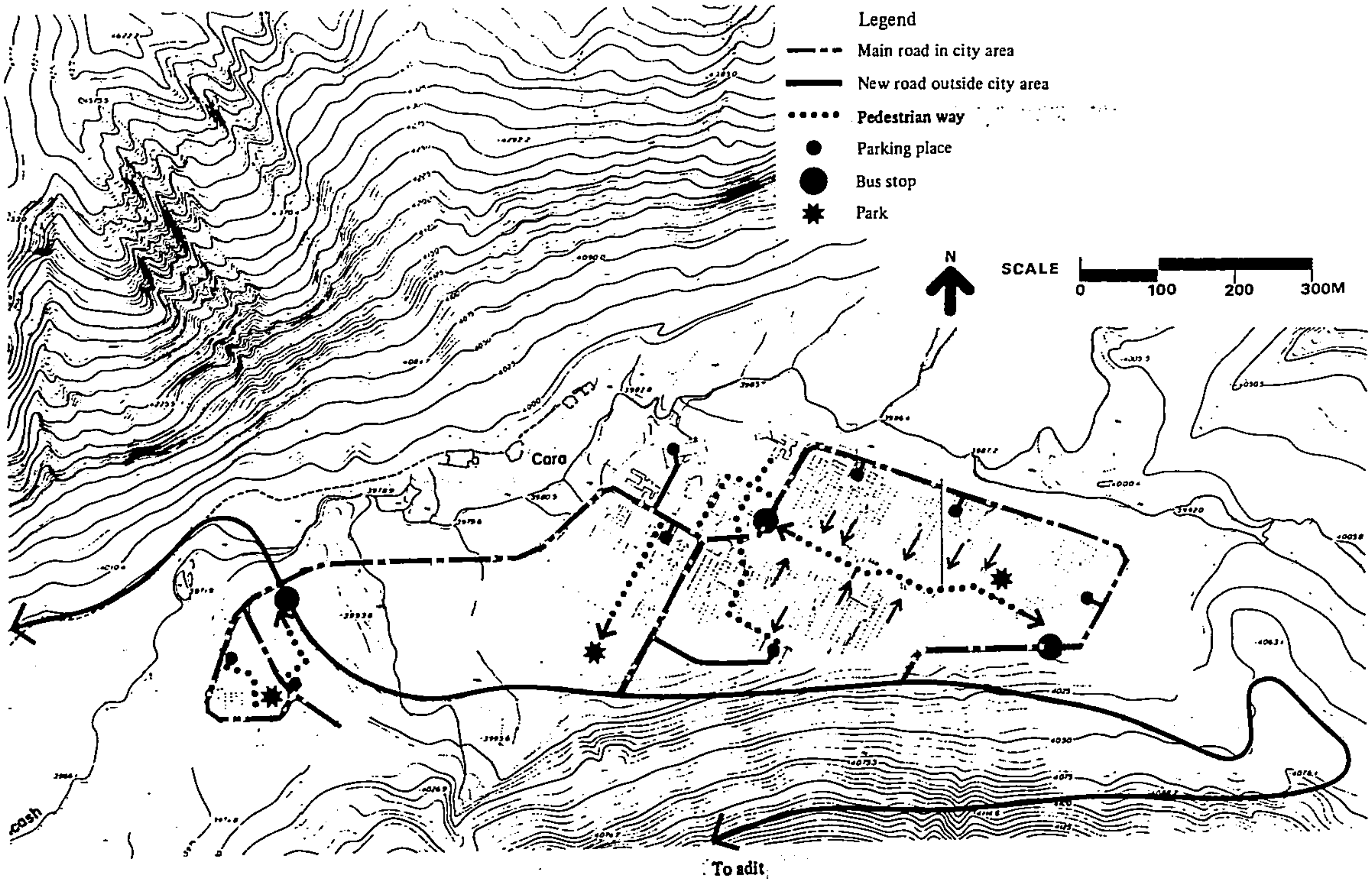


Fig. 3-6 Schematic Plan of Transport Facilities

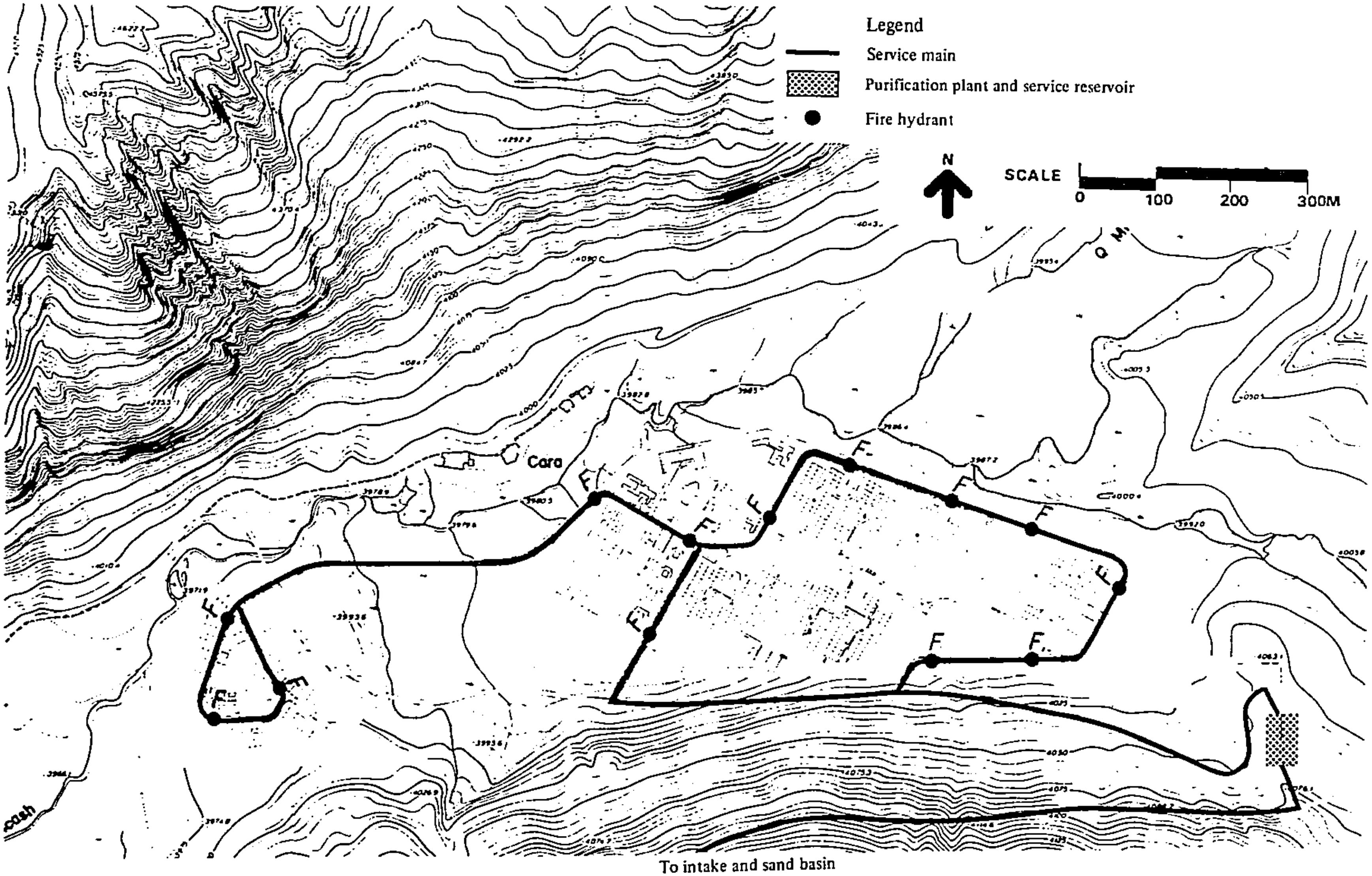


Fig. 3-7 Waterworks Plan

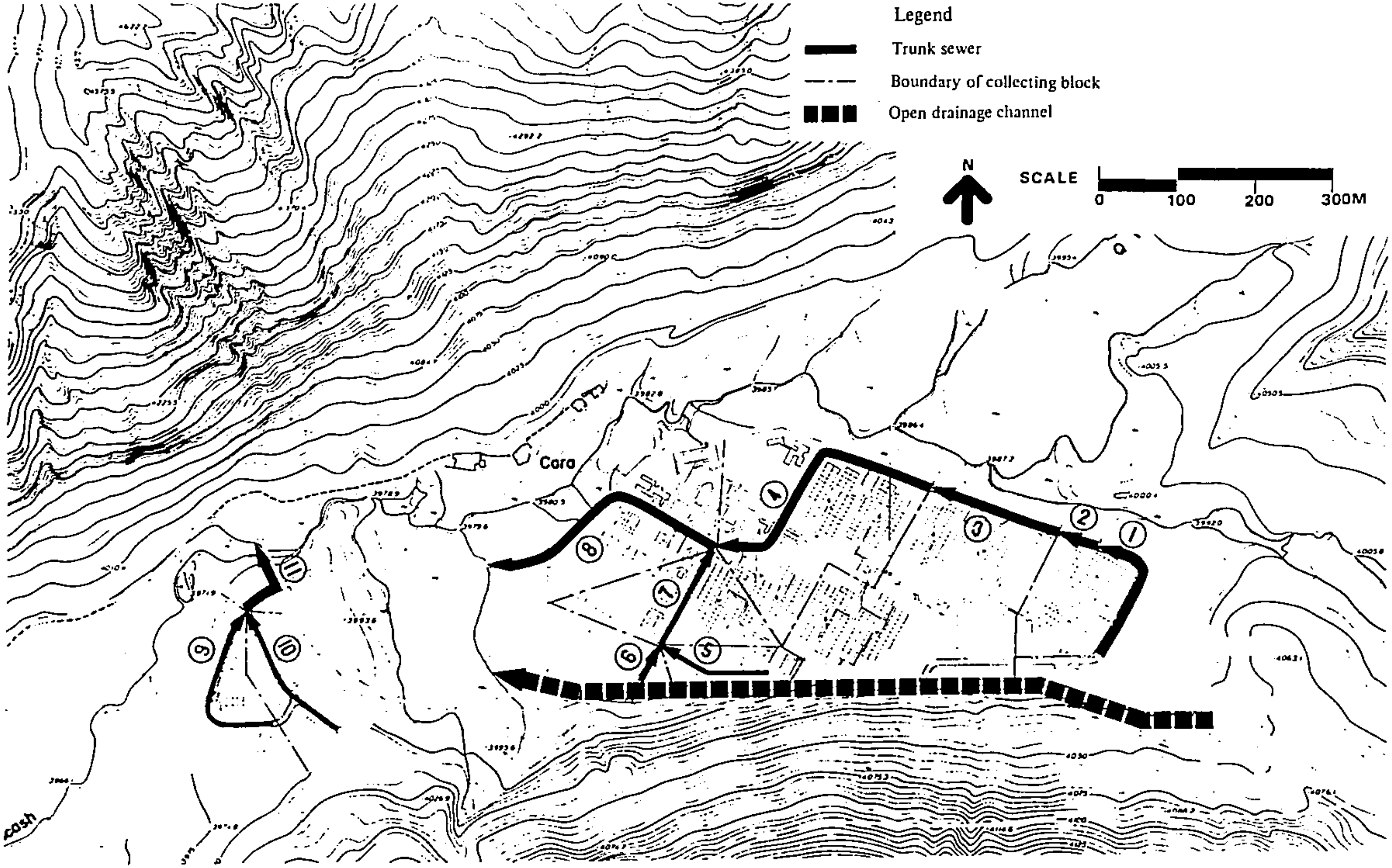


Fig. 3-8 Rain Water Drainage Plan (Main Drain Pipe)

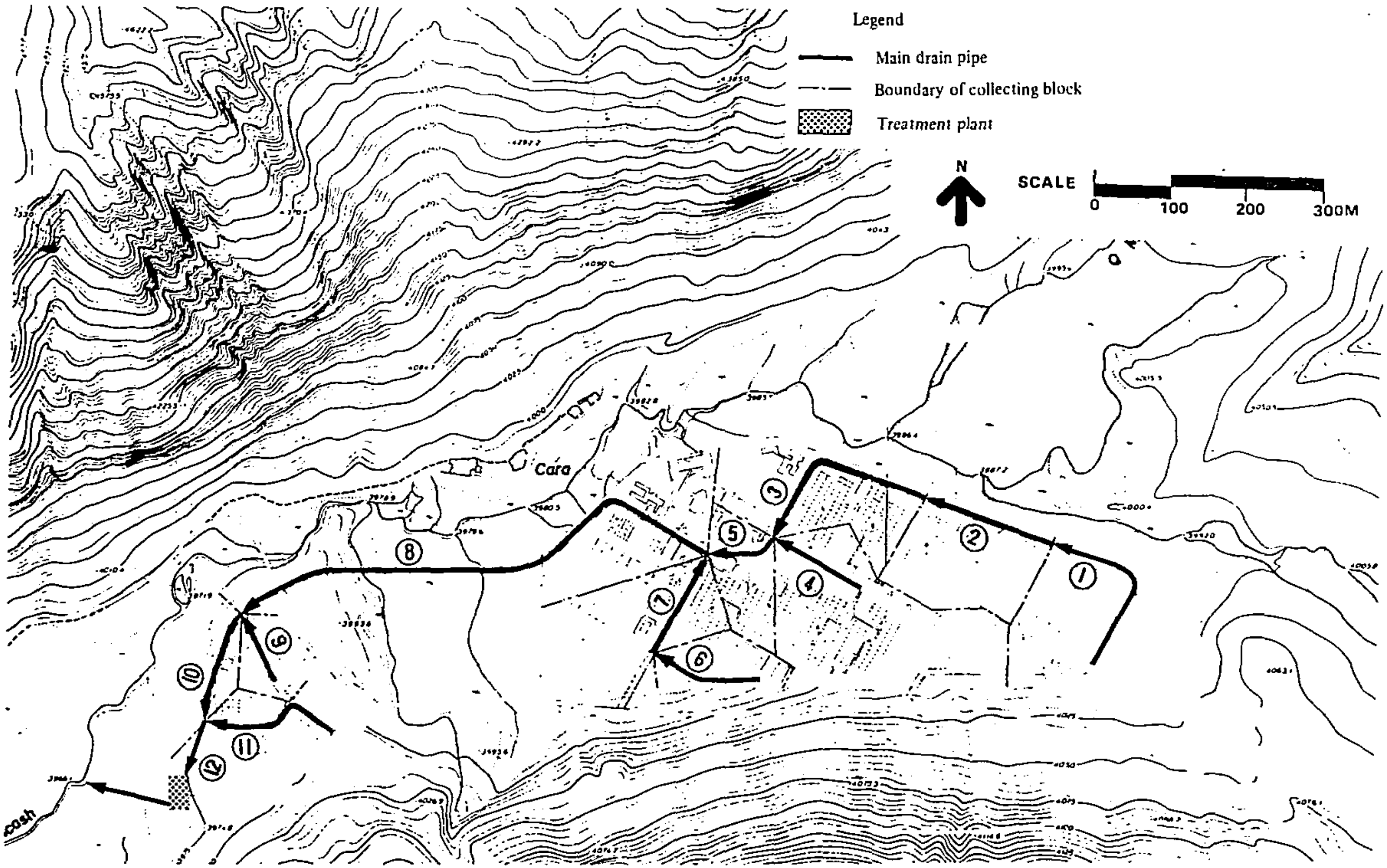


Fig. 3-9 Sewage Drainage Plan (Trunk Sewer)

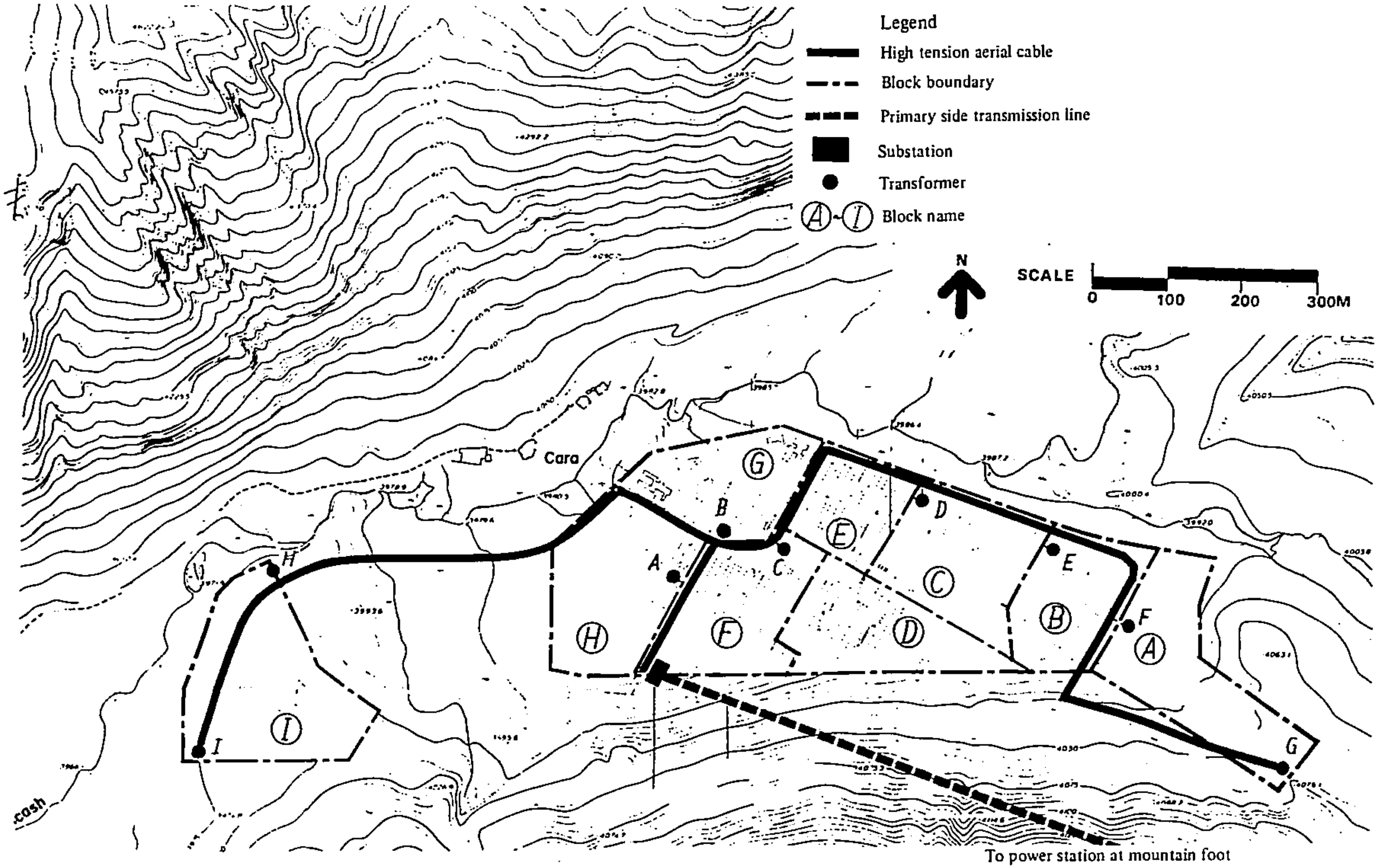


Fig. 3-10 Power Supply Plan

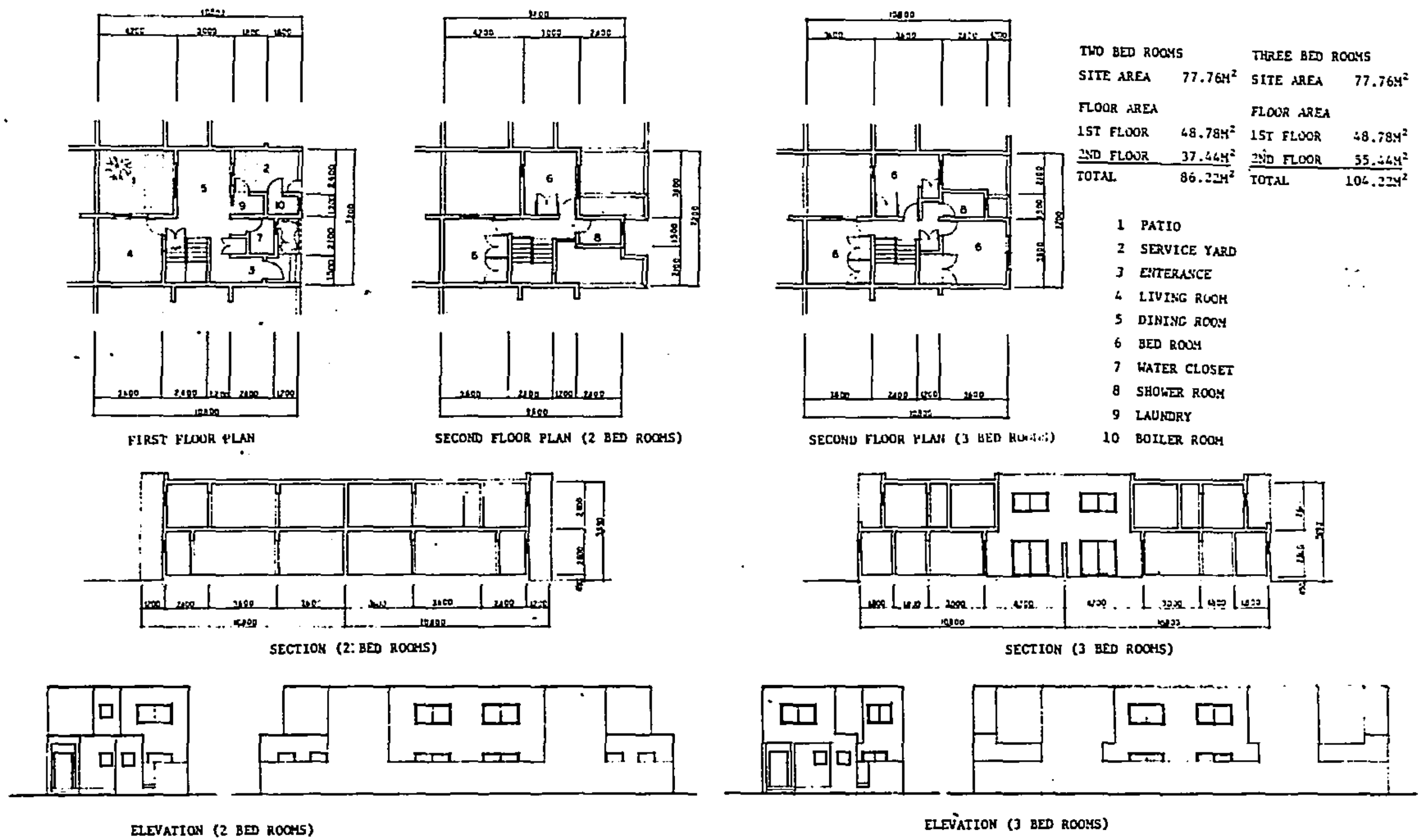


Fig. 3-11 Dwelling Unit for Married Mine Labourers (2 Bedroom Type and 3 Bedroom Type)

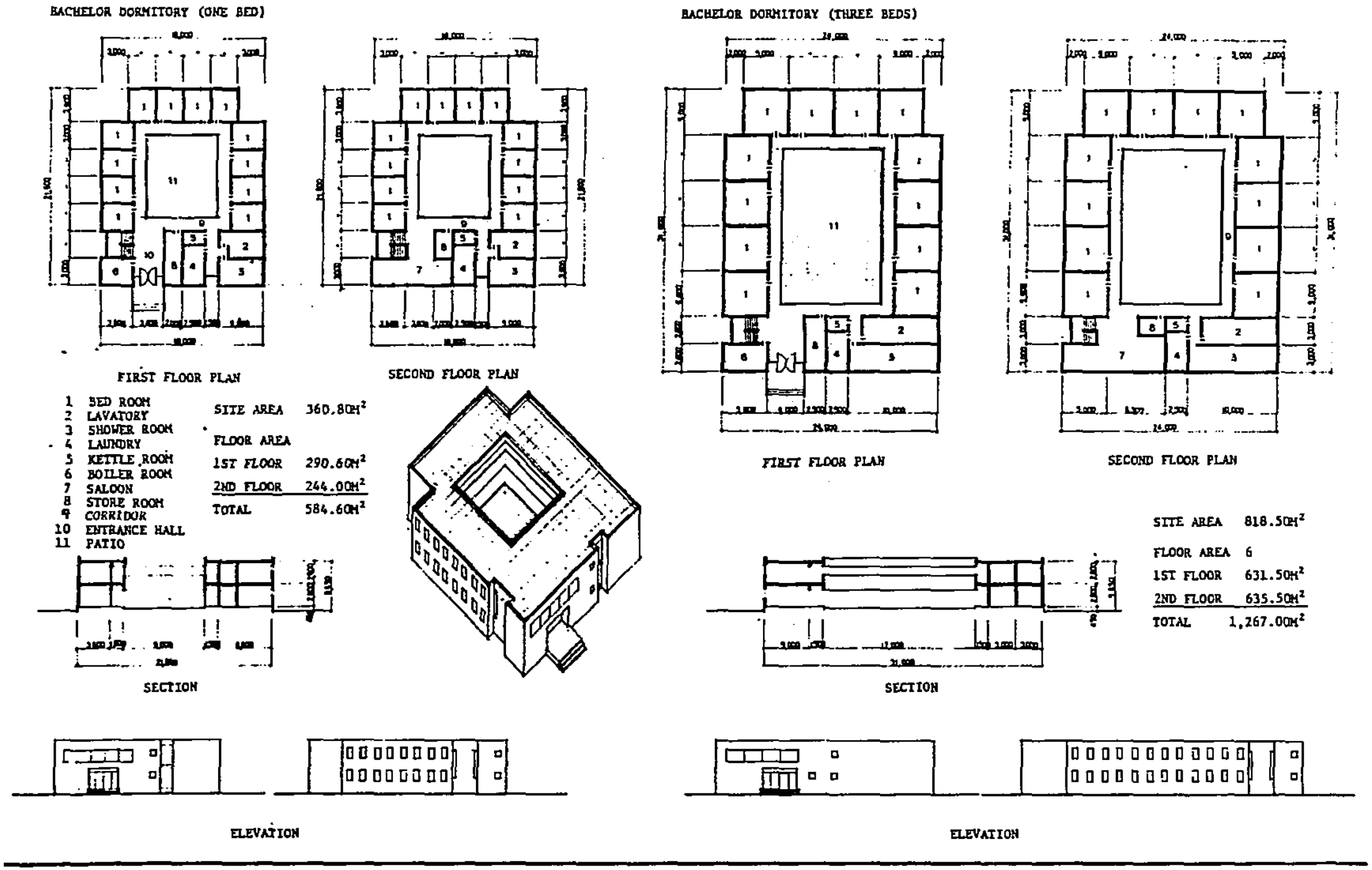


Fig. 3-12 Dwelling Unit for Unmarried Mine Labourers
(1 Bedroom Type, 3 Bedroom Type, Inner Court Type)

3-4 Cost Estimation

For each selected site of the mining city, the construction cost of urban facilities was divided into two portions; the common portion covering those facilities which are considered to incur the same cost in all sites and the variable portion covering the remaining facilities. The common portion was represented by that of RA-site, and the variable portion was calculated for each site. Table 3-6 shows the rough construction cost obtained by summing up the two portions for each site.

Table 3-6 Rough Construction Cost by Site

Item	RA-Site		IA-Site		HC-Site	
	(1,000 Soles)	(1,000 Yen)	(1,000 Soles)	(1,000 Yen)	(1,000 Soles)	(1,000 Yen)
Direct Construction Cost	795,000	2,655,000	888,000	2,966,000	745,000	2,488,000
Technical Fee[1]	79,500	265,500	88,800	296,600	74,500	248,800
Expenses [2]	119,300	398,300	133,200	444,900	111,800	373,200
Total	993,800	3,318,800	1,110,000	3,707,500	931,300	3,110,000

Notes: 1 10% of direct construction cost, covering the costs of survey, surveying, design and supervision.

2 15% of direct construction cost, including the common cost and contingencies.

3-5 Selection of Optimum Site

On the basis of comprehensive and unbiassed judgement of the characteristics of each site described in the foregoing pages, RA-site was selected as the city site that can be considered most suitable at present. The following are the main reasons for selecting RA-site.

- The site is situated in a flatland area which is open to east and west and excels in insolation condition. The central part of the site intersects the strip of flatland extending from north to south, and enjoys a very high visible sky ratio. Elevation of the site is lower than that of the other two. These conditions promise to provide excellent living environment.
- Grading can be conducted with ease and there is sufficient room for future expansion. In addition, the site is favourably conditioned for transport of large quantities of materials and equipment from Lima, so that cost reduction can be expected for such materials and equipment.
- HC-site is closer than the other sites to Huallanca which has the greatest population of all the neighbouring cities, but it does not produce the expected welfare benefit because of its proximity to Huanzara mine whose development was started before Hilarion mine. RA-site, on the other hand, almost adjoins Pachapaqui though the city has a small population. Considered from a practical point of view, therefore, it can be expected that the construction of the mining city in this site will produce a direct and sure development effect.
- Pachapaqui is situated on the extreme end of the chain of Pacific cities which extends into the Andes. Being adjacent to it, RA-site will serve as a base for extending the said chain and will consequently exhibit greater national development effect than the other sites.
- RA-site compares unfavourably with HC-site in terms of the construction cost and distance to mine facilities. It is to be noted, however, that the construction cost presented in this report is only a rough estimation based on the preliminary design and subject to changes. In the actual designing stage, it will be possible to reduce the cost

to that required for HC-site by conducting further detailed studies.

- Since the site is compatible with all the route alternatives of the new road, it exhibits satisfactory conformity to A-route which was selected as being most suitable.

Chapter 4. Effect of Rood Improvement and Mining City Construction

4-1 Spill-Out Effect on Wide Area Development

As described in Section 2-1 (Road Network), a close study of the project road on a road map discloses the following notable facts.

- o It constitutes part of National Highway No. 3 which runs through the country from north to south in parallel with National Highway No. 1 (Pan American Highway).
- o It runs on the route directly linking the eastern low-lying area and the northern industrial area.
- o It constitutes part of the route connecting the eastern low-lying area and Lima in substitution for the route via La Oroya.

Construction of this road is quite significant not just for mine development but for wide area development as well. Specifically, it secures a service route indispensable for mine operation and at the same time serves to accelerate the improvement of the entire network of important arterial roads of the country.

4-2 Effect on Regional Development

(1) Movement of local inhabitants and commodities is expected to become active and contribute to the expansion of living area and promotion of regional economy and welfare.

- o At present, roads are the only means of communication.
- o All routes linking the neighbouring origins of traffic such as Huallanca, Pachapaqui, Aquita, Chiquian and Huanzala will enjoy the benefit of the new road.

(2) Increased employment opportunities to be brought about the road construction and mine development will produce direct promotional effect on regional development.

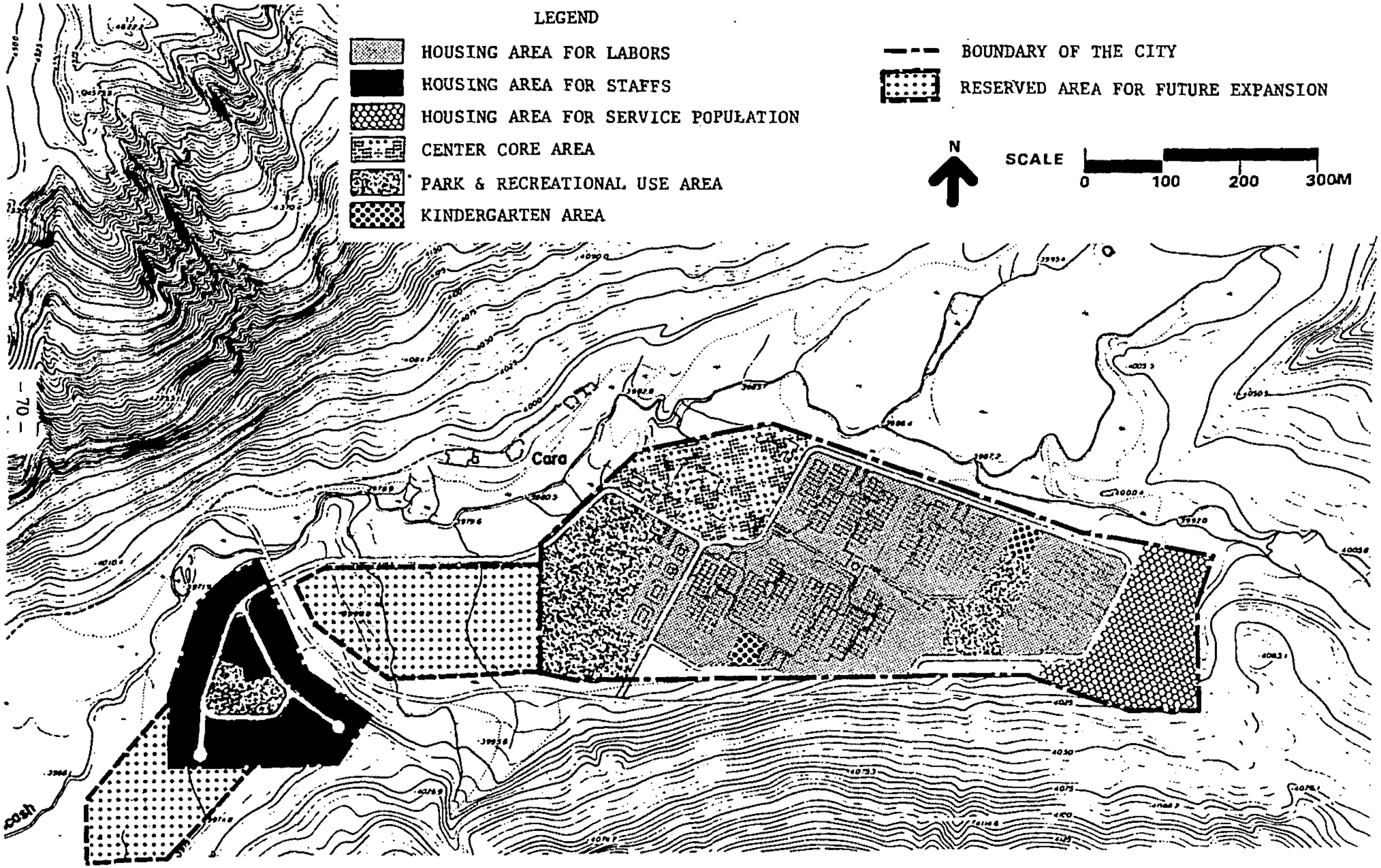
- o There are a large number of potentially jobless in the neighbouring areas.
- o There is high probability that the labourers excepting those with special skill and technical capabilities will be recruited from the surrounding areas.

(3) Operation of the many smaller mines in the surrounding areas will be stimulated, and this will produce a secondary development effect in such areas.

- o Not only the generation of induced traffic but also the operation of smaller mines will be made active.
- o The existing expansion plan of the concentrating plant operated by a private enterprise in Pachapaqui is indicative of the presence of the required development potentials.

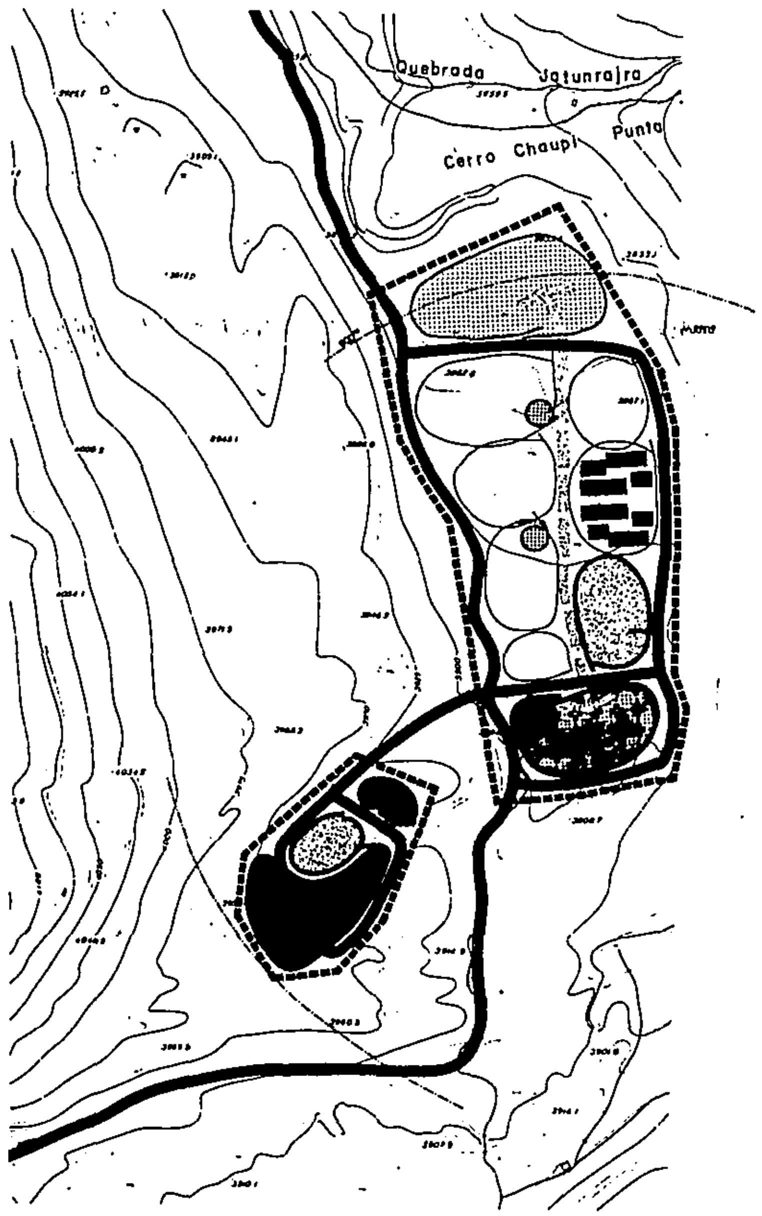
(4) Presence of mines similar and adjacent to Hilarion mine is reported. Development of Hilarion mine will provide easier access to the future development of mineral resources available at these mines, whether it is undertaken by a Peruvian or Japanese enterprise.

LAND USE PLAN FOR SITE ALTERNATIVE*RA



SCHEMATIC LAND USE PLAN FOR SITE ALTERNATIVE * IA , HC

IA DISTRICT



HC DISTRICT

LEGEND

- HOUSING AREA FOR LABORS
- HOUSING AREA FOR STAFFS
- HOUSING AREA FOR SERVICE POPULATION
- CENTER CORE AREA
- PARK & RECREATIONAL USE AREA
- KINDERGARTEN AREA
- BOUNDARY OF THE CITY

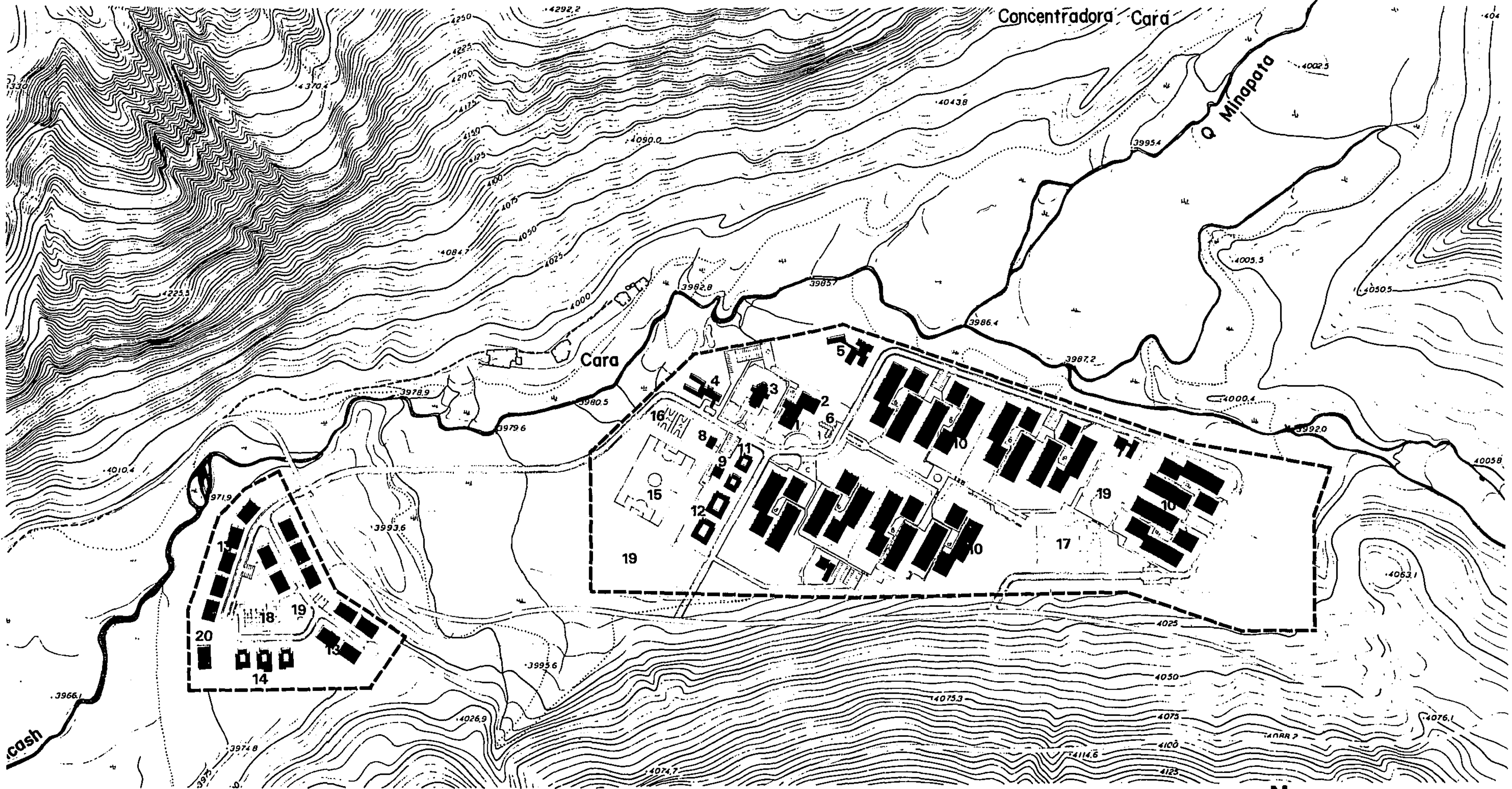
N

MAR 1978 SCALE 0 100 300M

CONSULTANTS;
CENTRAL CONSULTANT INC. JAPAN

CITY PLAN OF HILARION MINE

GENERAL LAYOUT PLAN FOR SITE ALTERNATIVE*RA



LEGEND
1 COMMUNITY CENTER
2 MARKET & CULTURE CENTER
3 CHURCH
4 HOSPITAL
5 SCHOOL
6 SERVICE SHOP
7 KINDERGARTEN
8 CLUB HOUSE
9 RESTAURANT
10 HOUSE FOR MARRIED LABORS
11 BACHELOR DORMITORY FOR LABORS
12 BACHELOR DORMITORY FOR LABORS (3 BED-ROOMS TYPE)
13 HOUSE FOR MARRIED STAFFS
14 BACHELOR DORMITORY FOR STAFFS
15 SOCCER COURT
16 BASKETBALL COURT
17 MINI-SOCCER COURT
18 TENNIS COURT
19 PARK
20 TREATMENT PLANT
21 WATER PURIFICATION PLANT & RESERVOIR

CITY PLAN OF HILARION MINE

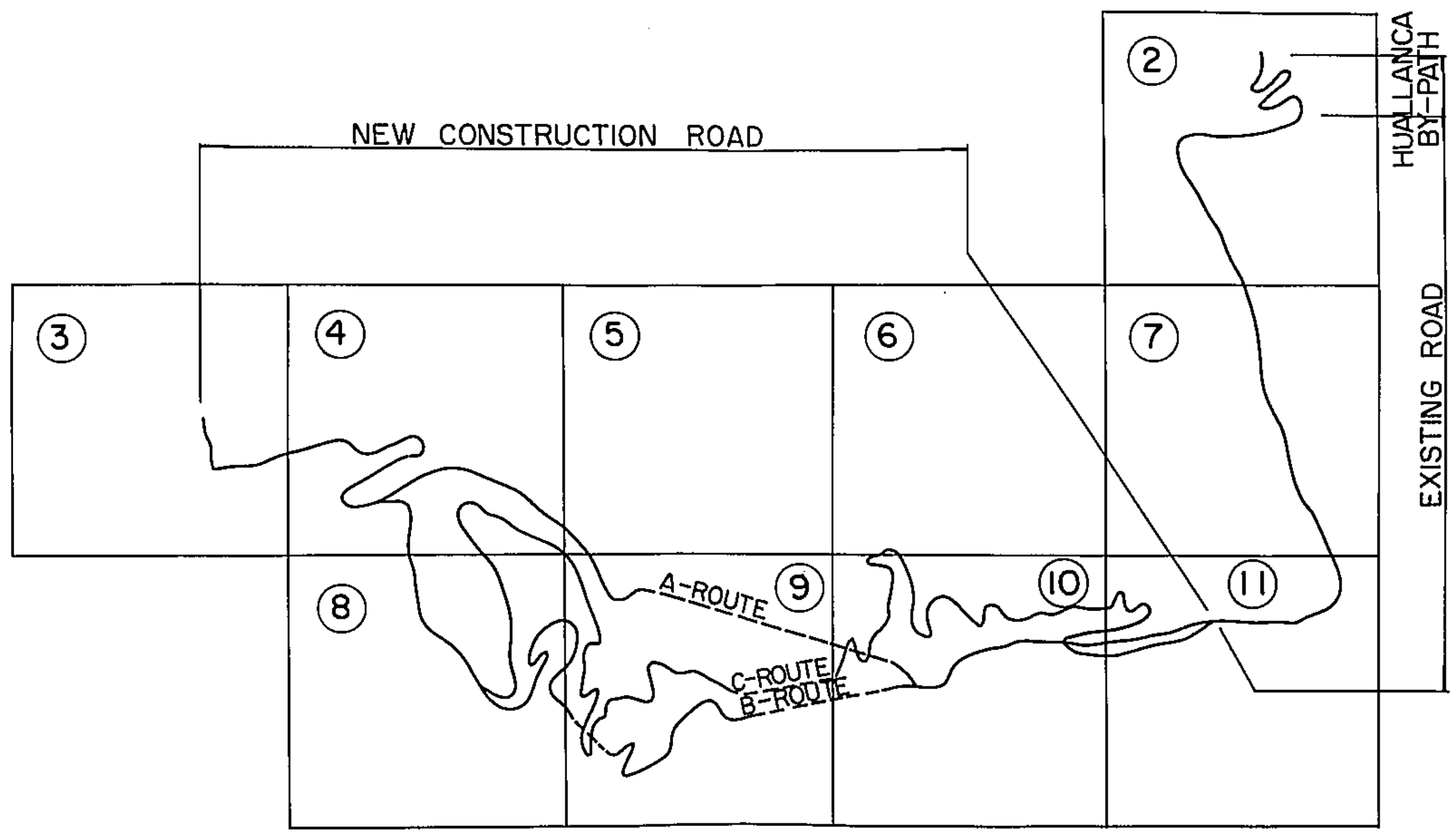
N

SCALE 0 50 100 200M

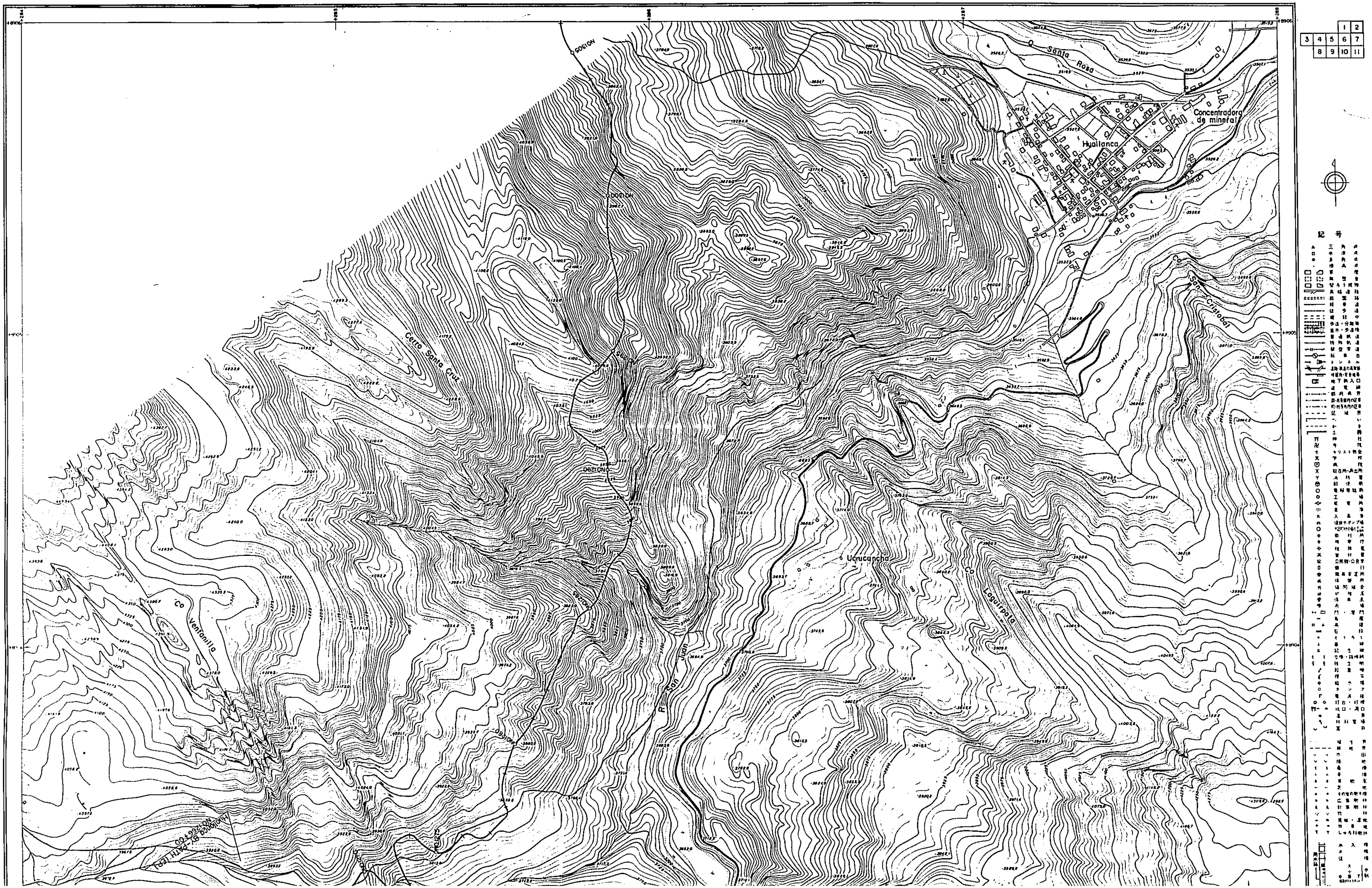
MAR 1978

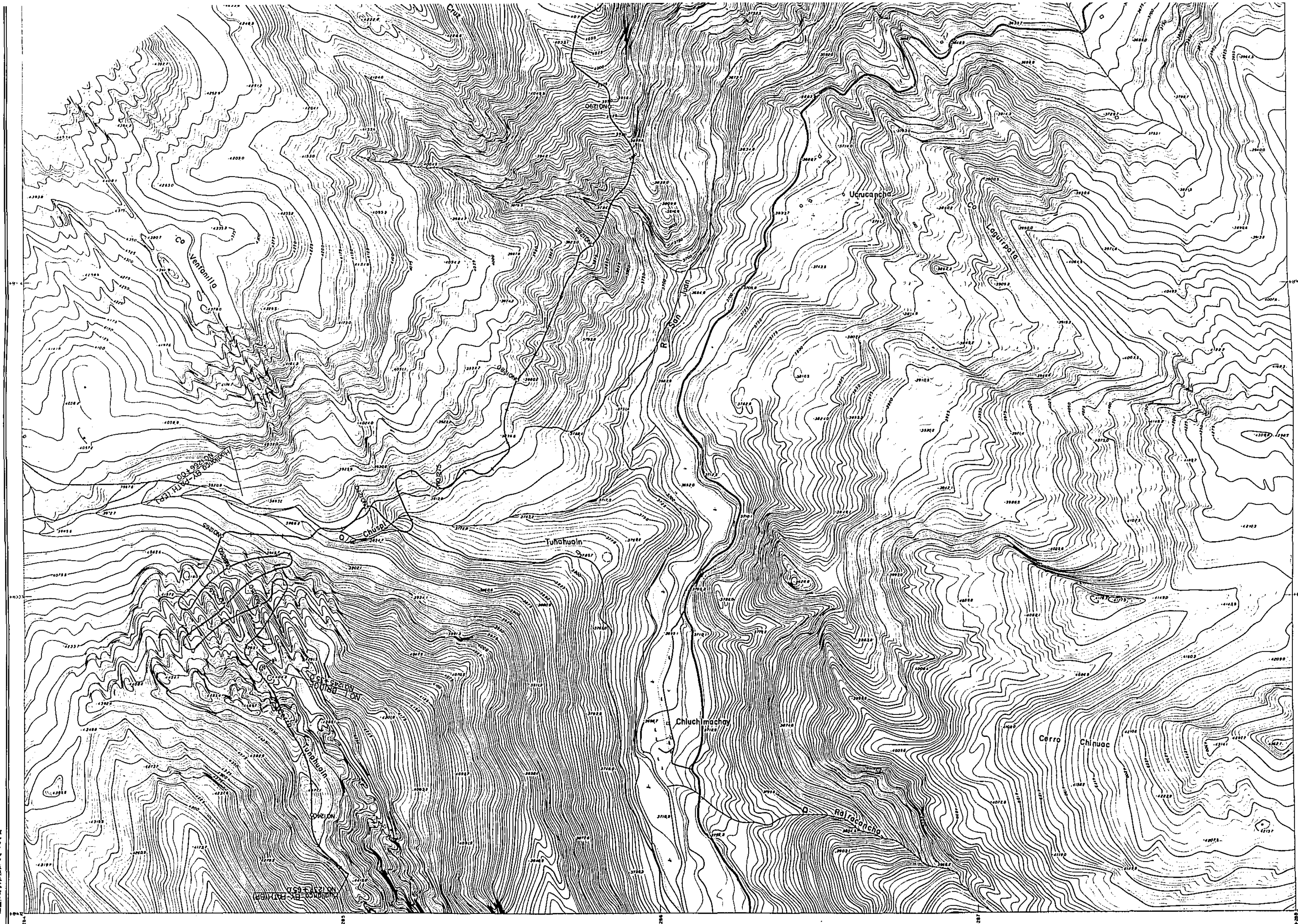
CONSULTANTS;
CENTRAL CONSULTANT INC. JAPAN

KEY PLAN


NEW CONSTRUCTION ROAD
HUALLANCA BY-PATH
EXISTING ROAD
A-ROUTE
C-ROUTE
B-ROUTE
2
3
4
5
6
7
8
9
10
11

ペルー共和国イラリオン鉱山周辺地形図2



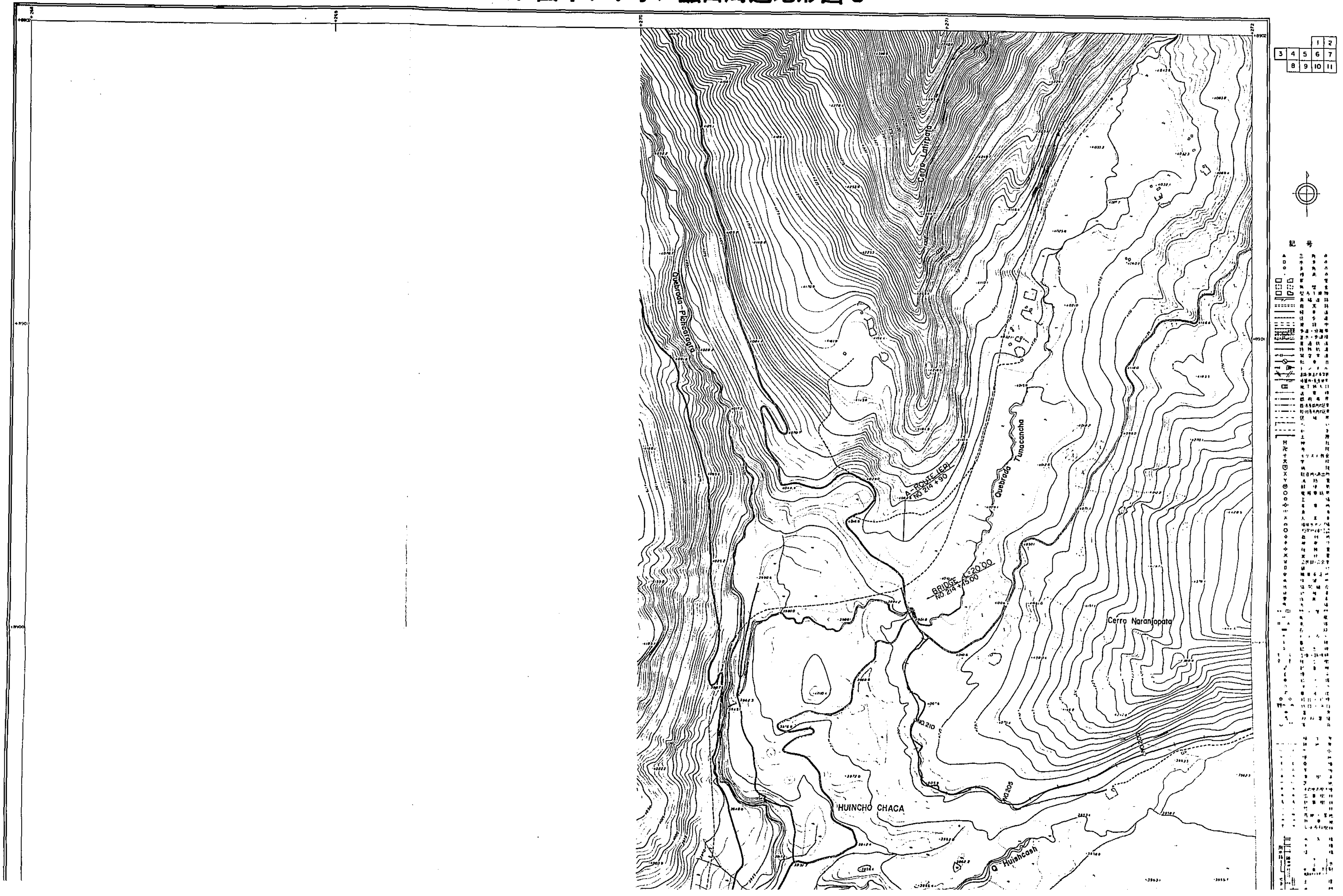


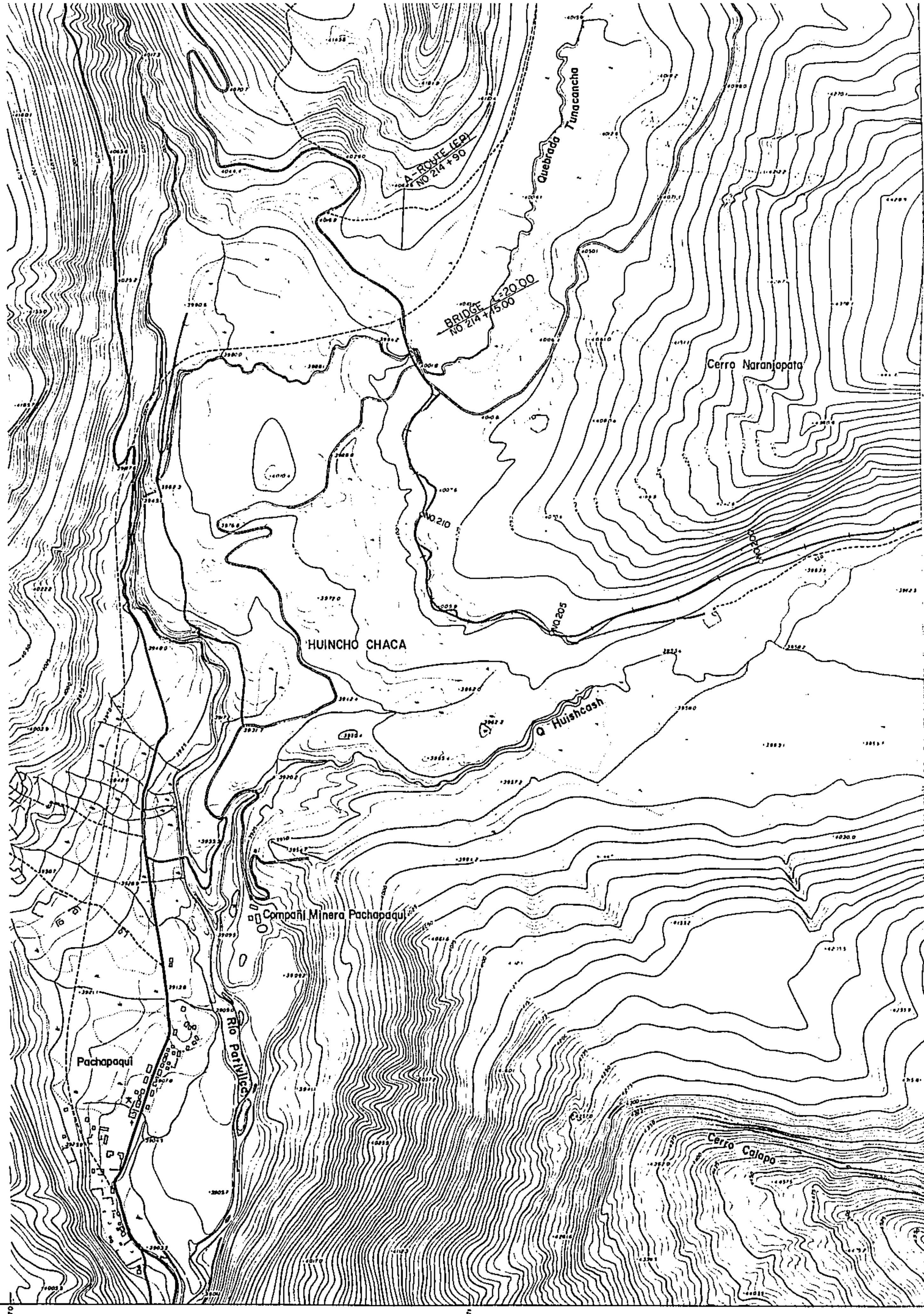
撮影 昭和37年6月　　等高線 5m間隔

1:5,000

国際協力事業団

ペルー共和国イラリオン鉱山周辺地形図 3





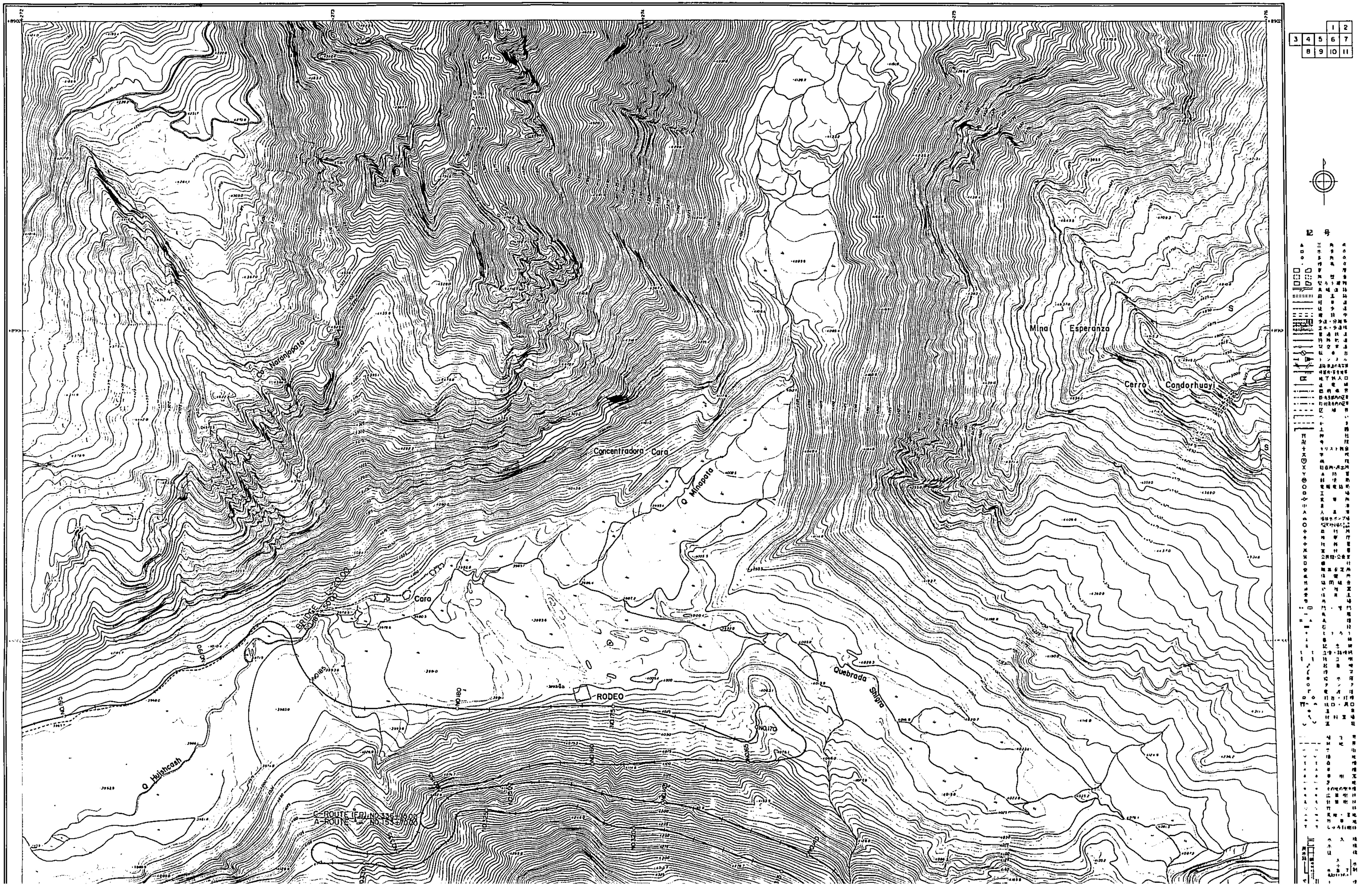
国際協力事業団

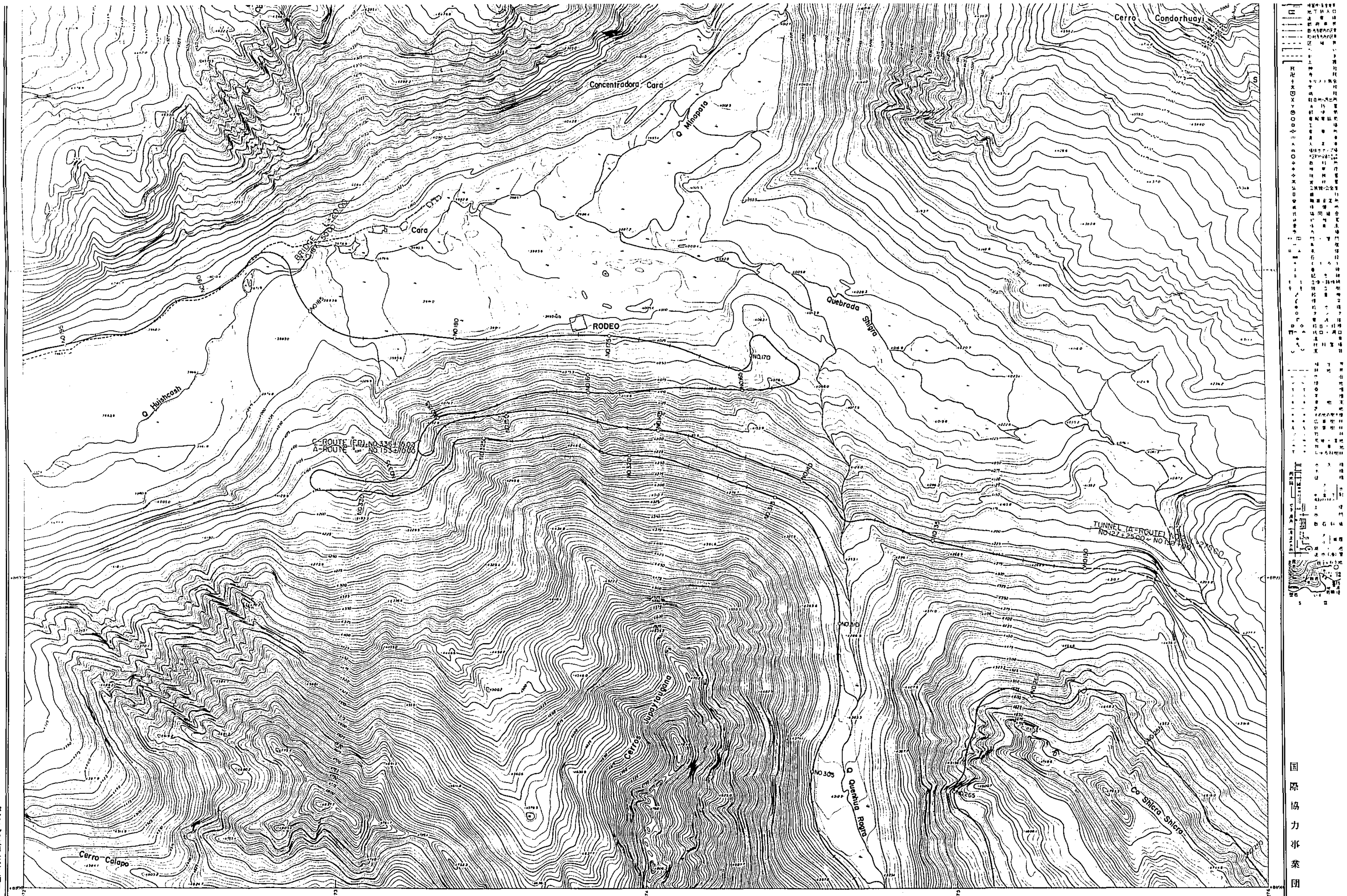
撮影 昭和37年6月
図化 昭和 年 月オートグラフA7, ステレオプロッターA8
等高線 5m間隔

1:5,000

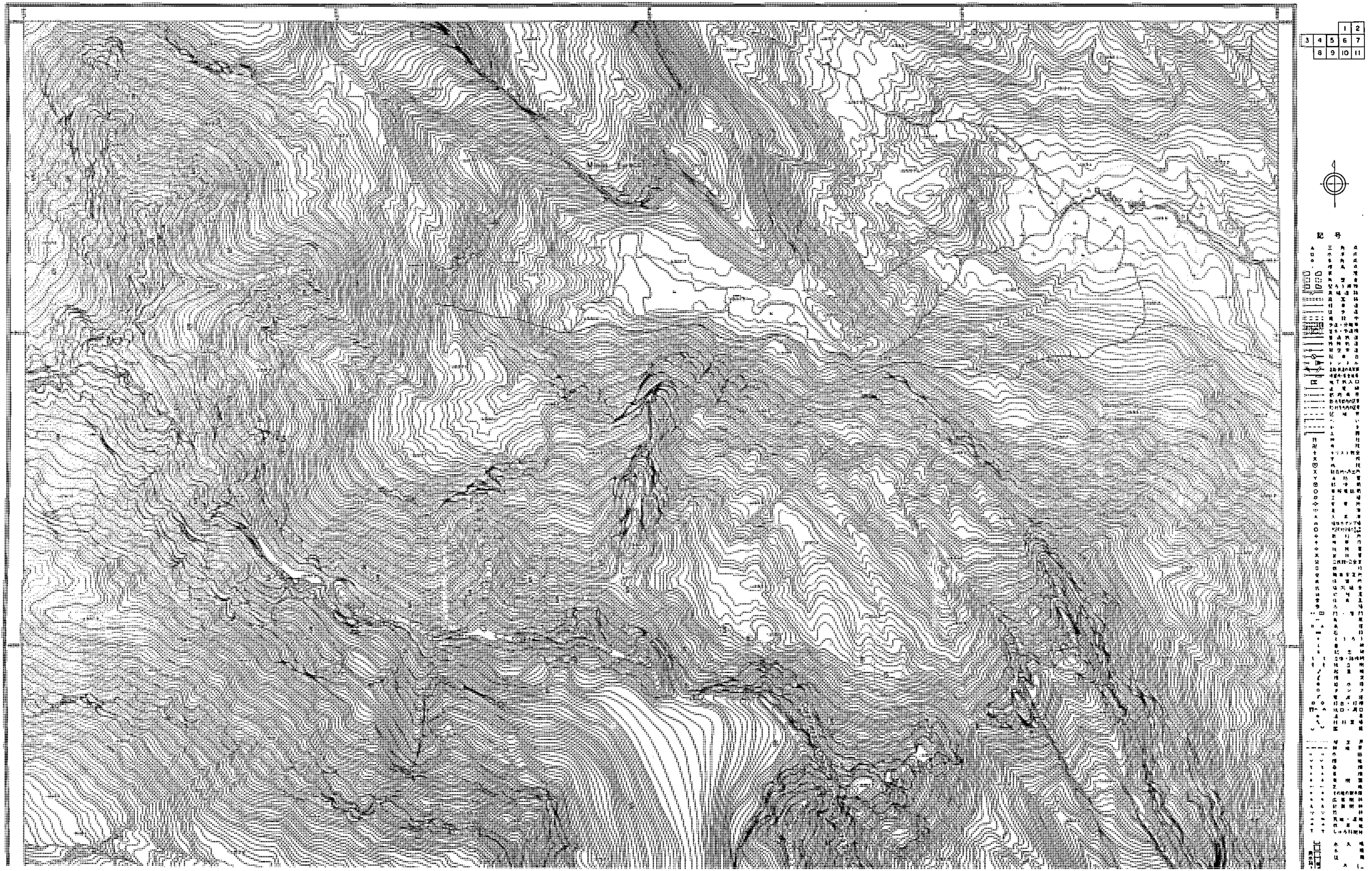
パシフィック航業株式会社調製

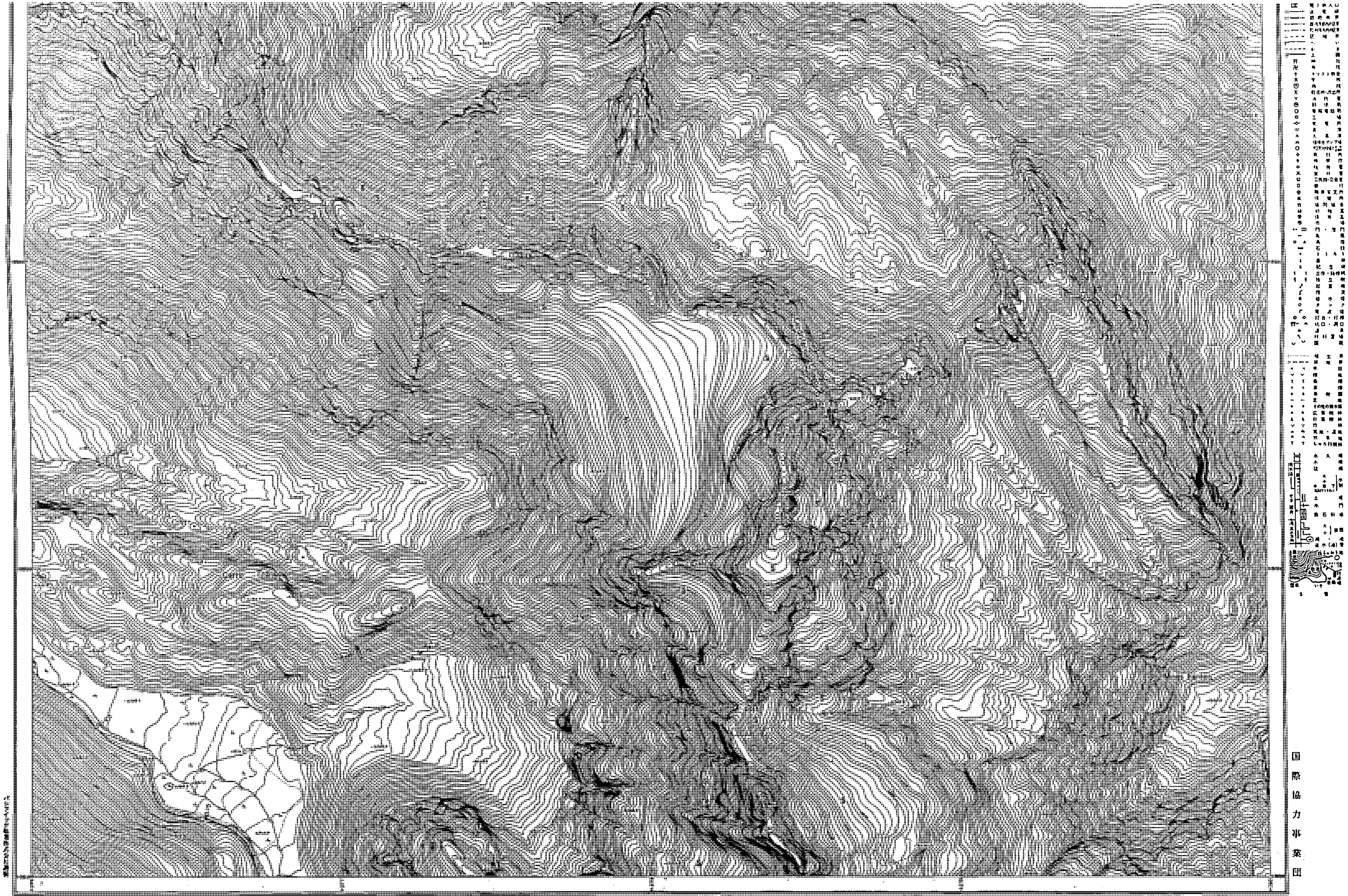
ペルー共和国イラリオン鉱山周辺地形図４




Cerro Condorhuayi
Concentradora Cara
Q. Minapata
Cara
BRIDGE
RODEO
Quebrada Shigra
Q. Huishcash
C-ROUTE (F.R.) NO.335+15.00
A-ROUTE NO.153+10.00
TUNNEL (A-ROUTE)
Cerros Jupaytaulgana
Q. Quenhua Ragra
Co Shicra Shicra
Cerro Calapo
NO.180
NO.175
NO.170
NO.165
NO.305
NO.265
国際協力事業団
1:5,000

ペルー共和国イラリオン鉱山周辺地形図５





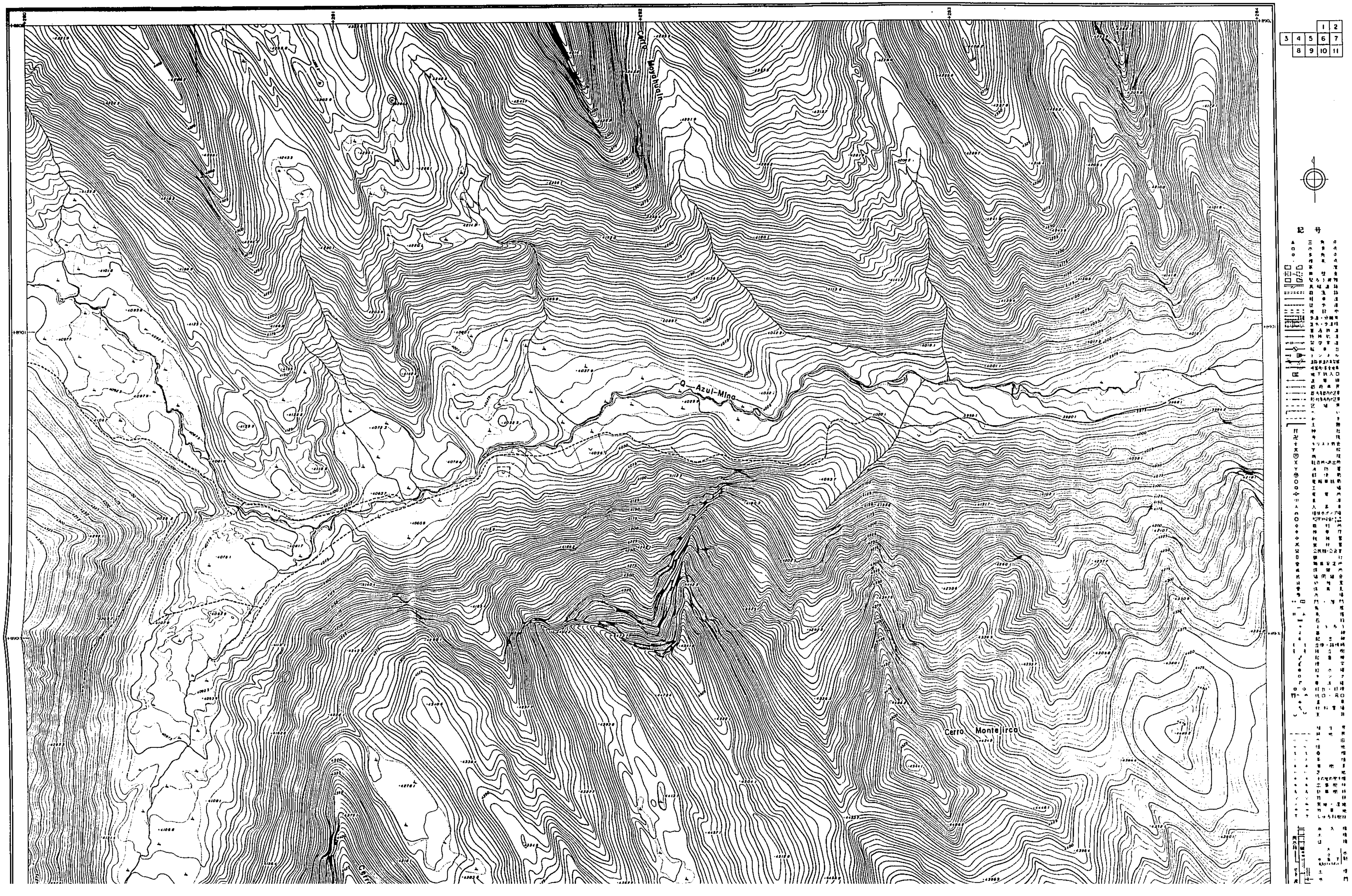
撮影 昭和37年6月　　等高線 5m間隔

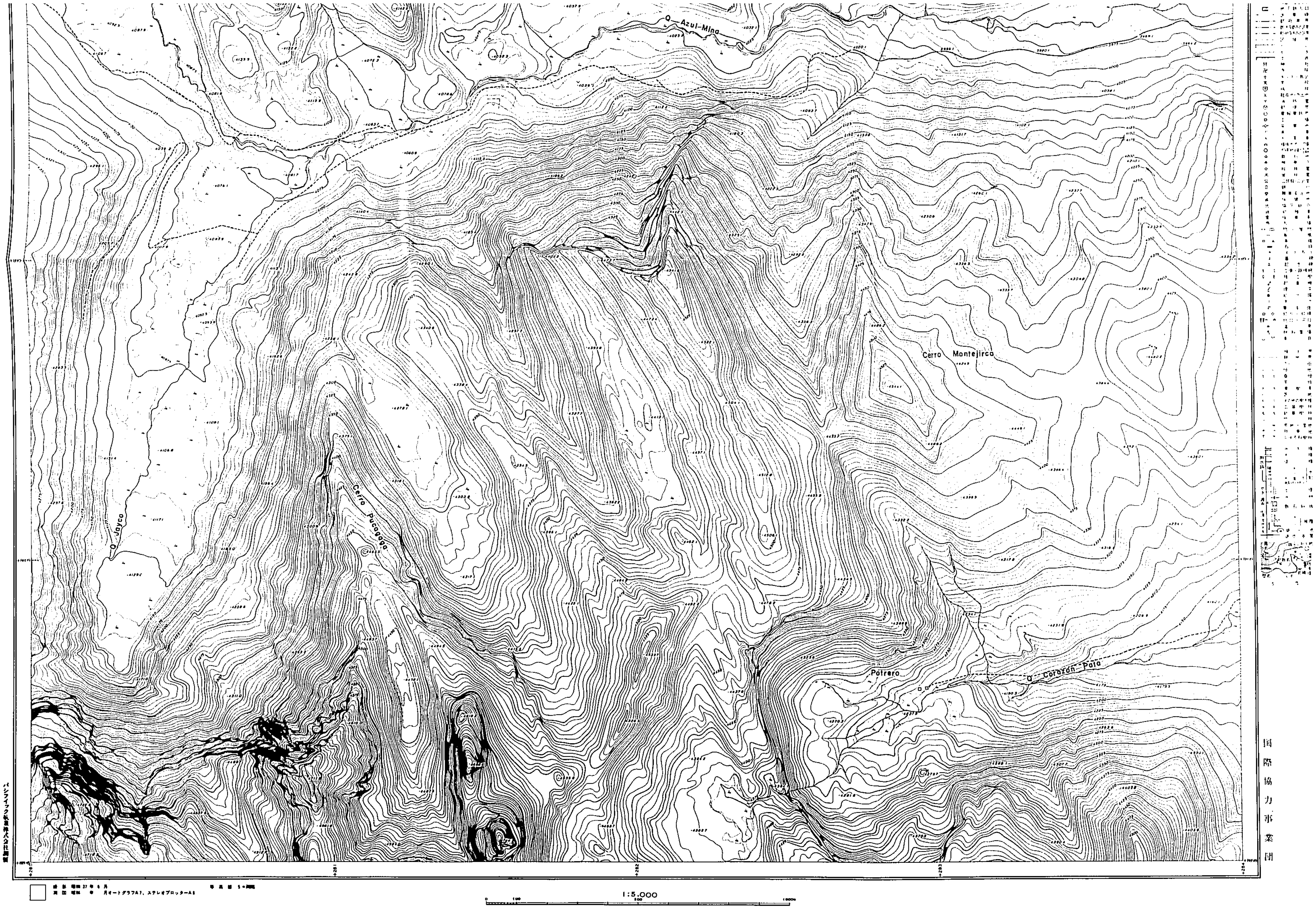
図化 昭和　年　月オートグラフA7, ステレオプロッターA8

1:5,000

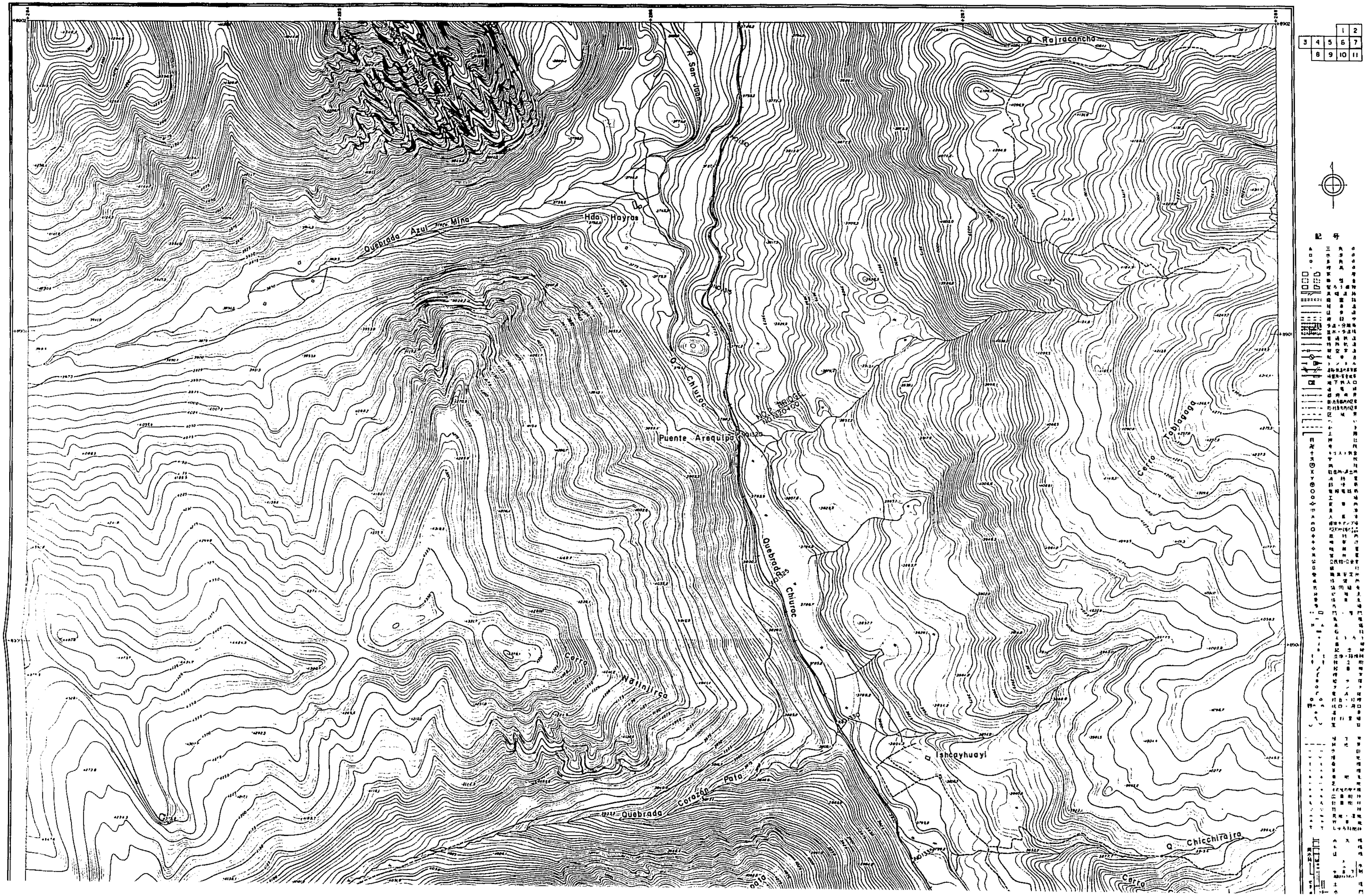
0　100　500　1000m

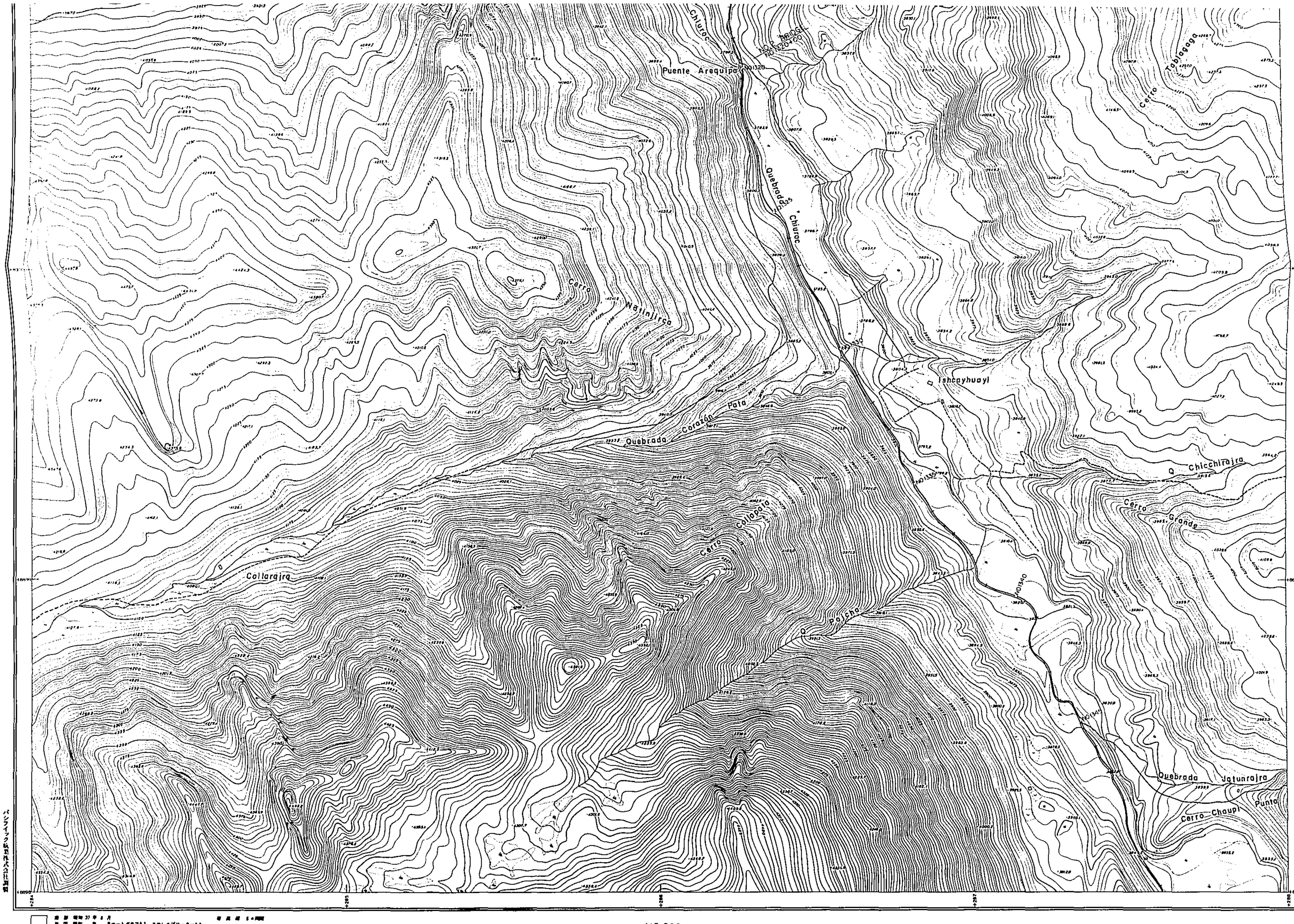
ペルー共和国イラリオン鉱山周辺地形図6




Q. Azul-Mina
Cerro Montejirca
Q. Jayco
Cerro Pucagaga
Potrero
Q. Corazon-Pata
1:5,000
国際協力事業団
パシフィック航業株式会社調製

ペルー共和国イラリオン鉱山周辺地形図7





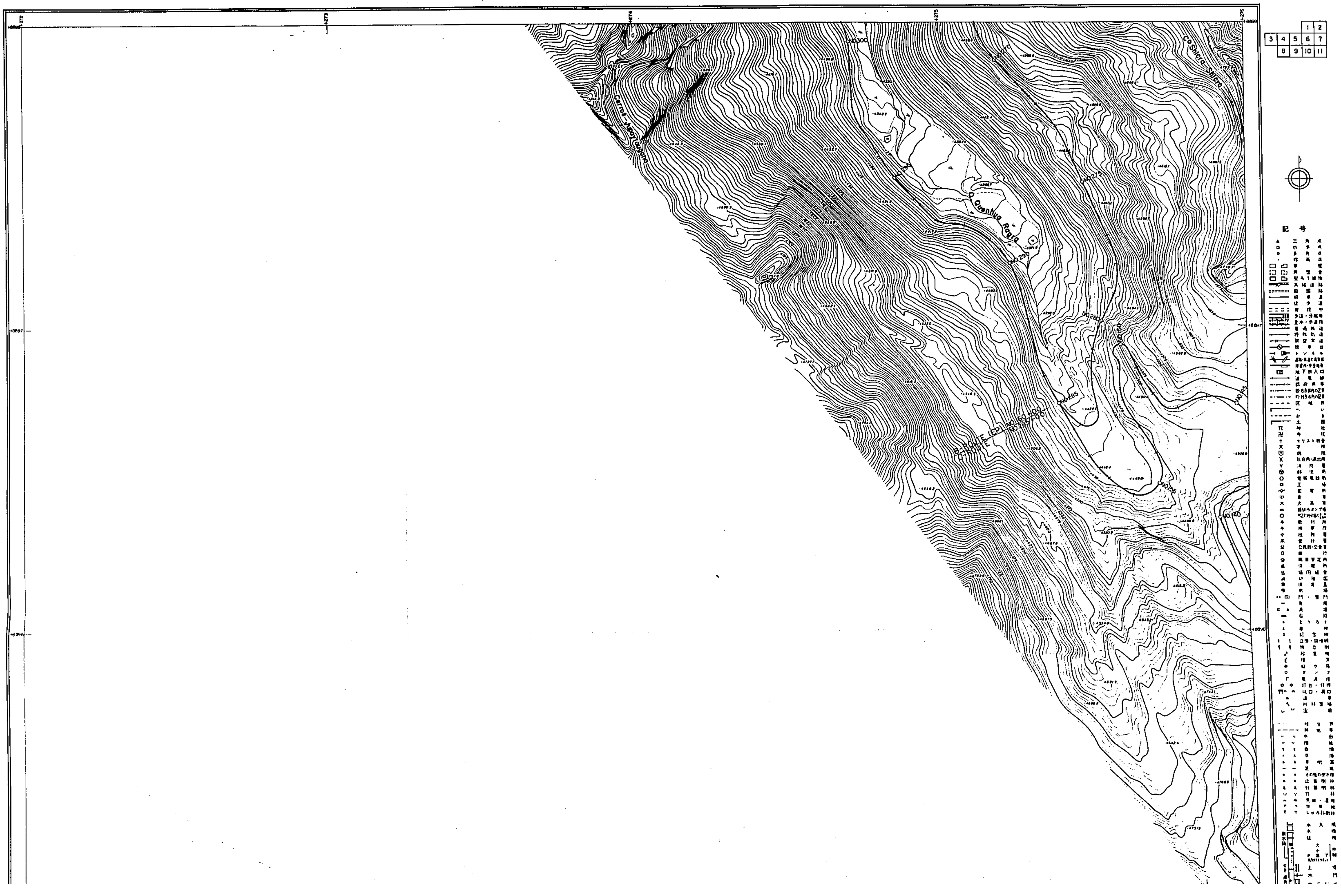
1:5,000

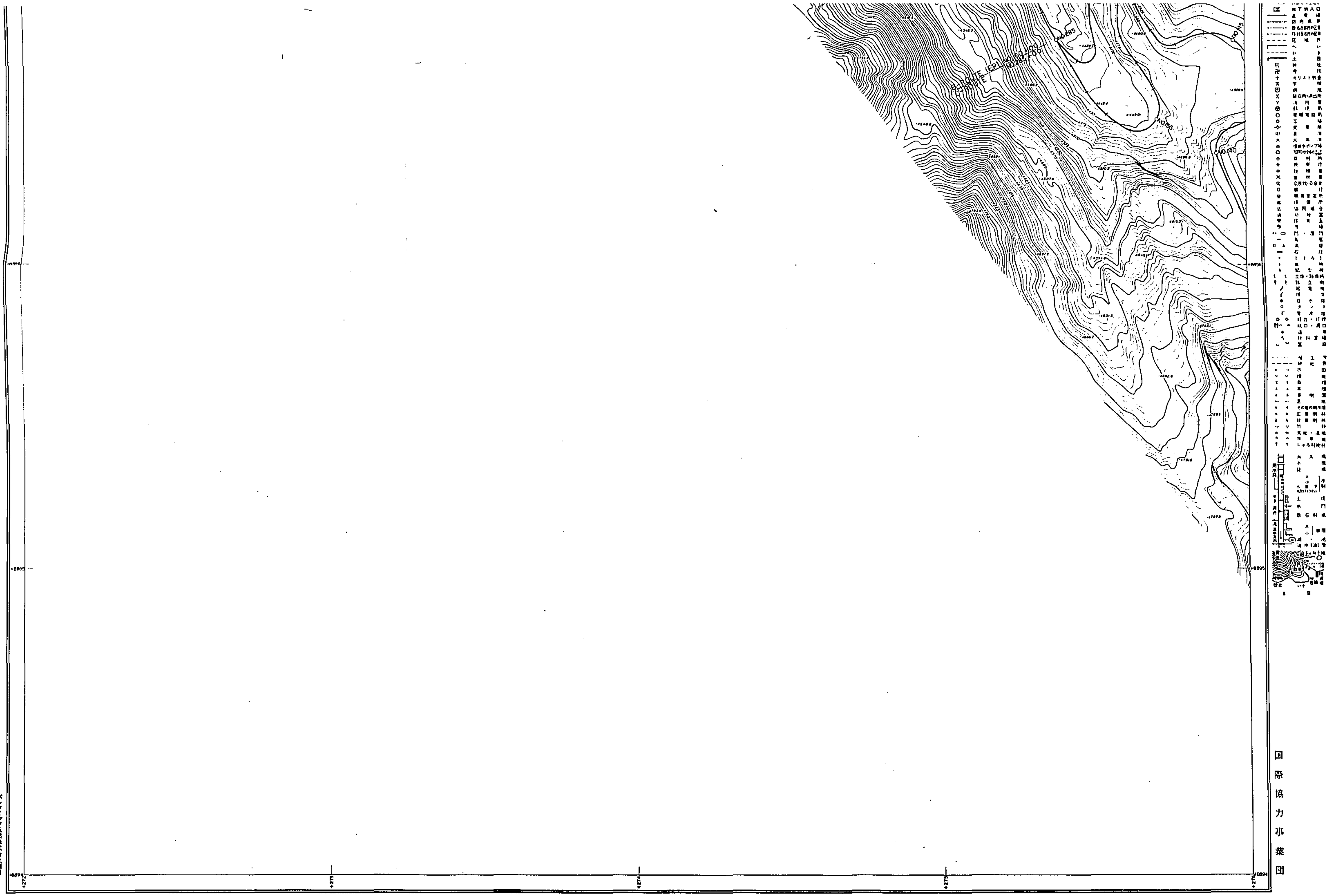
撮影 昭和37年8月
図化 昭和 年 月オートグラフA1, ステレオプロッターA8

国際協力事業団

パシフィック航業株式会社調製

ペルー共和国イラリオン鉱山周辺地形図 8

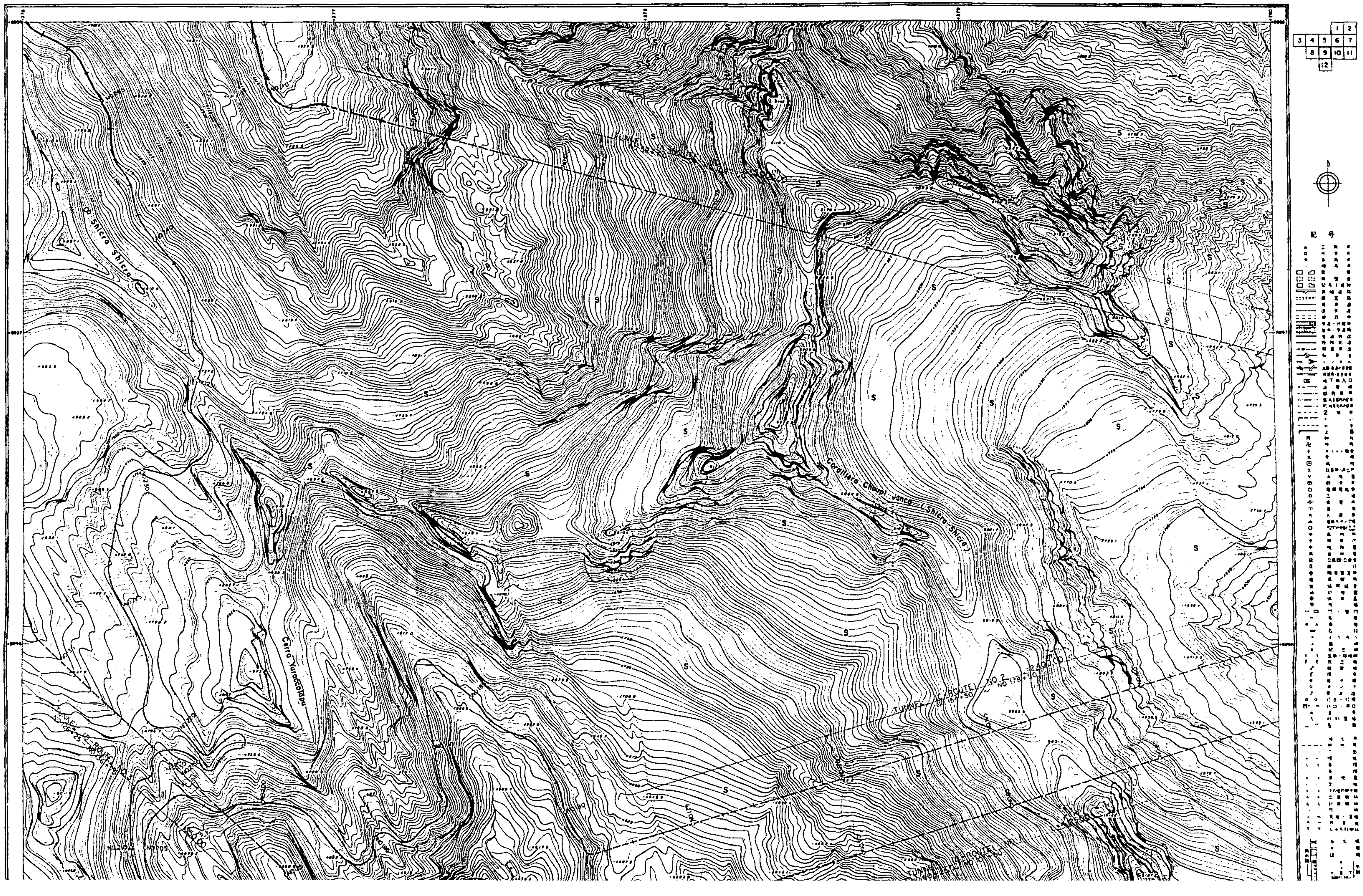


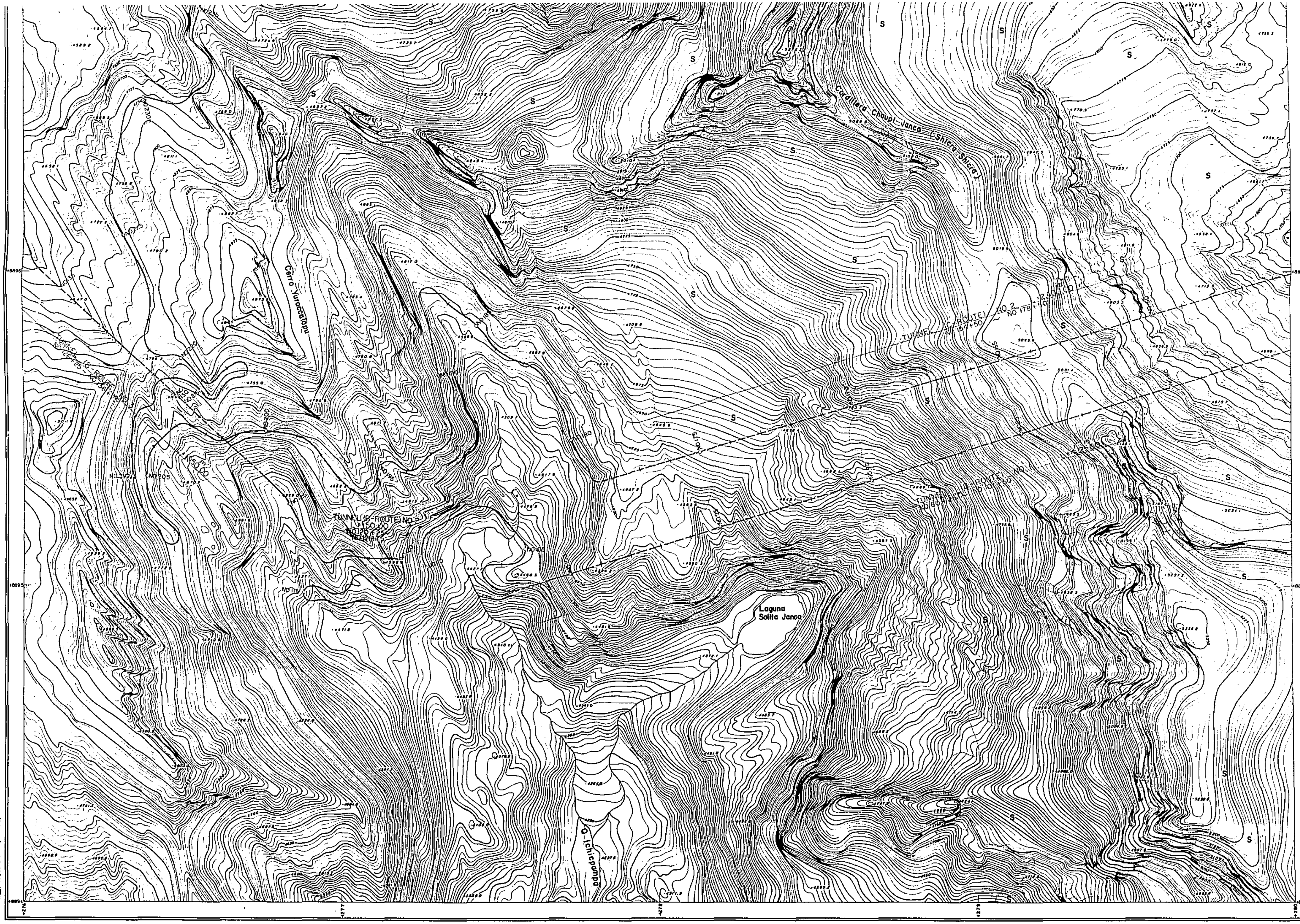


パシフィック航業株式会社

1:5,000

ペルー共和国イラリオン鉱山周辺地形図9

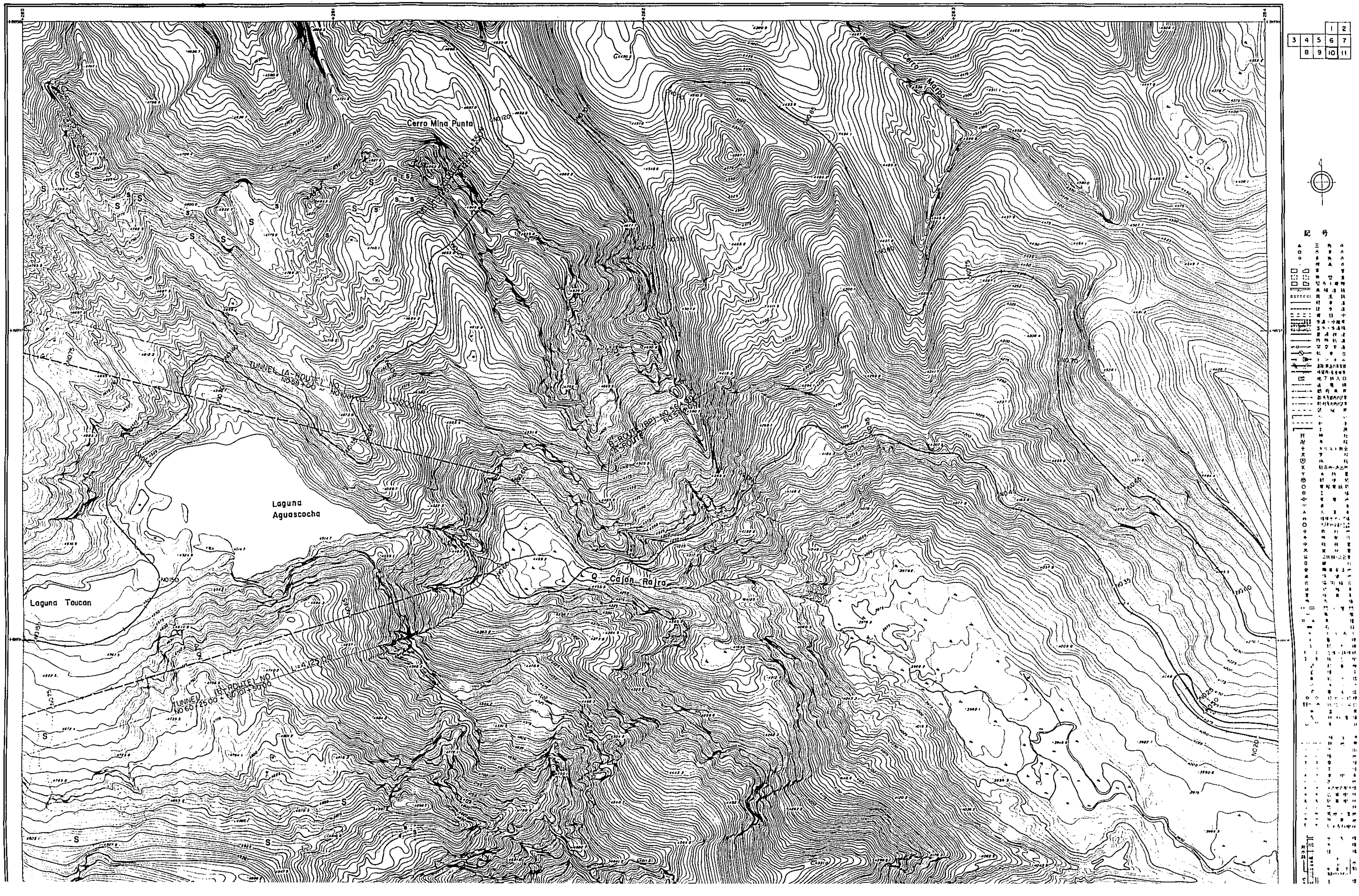


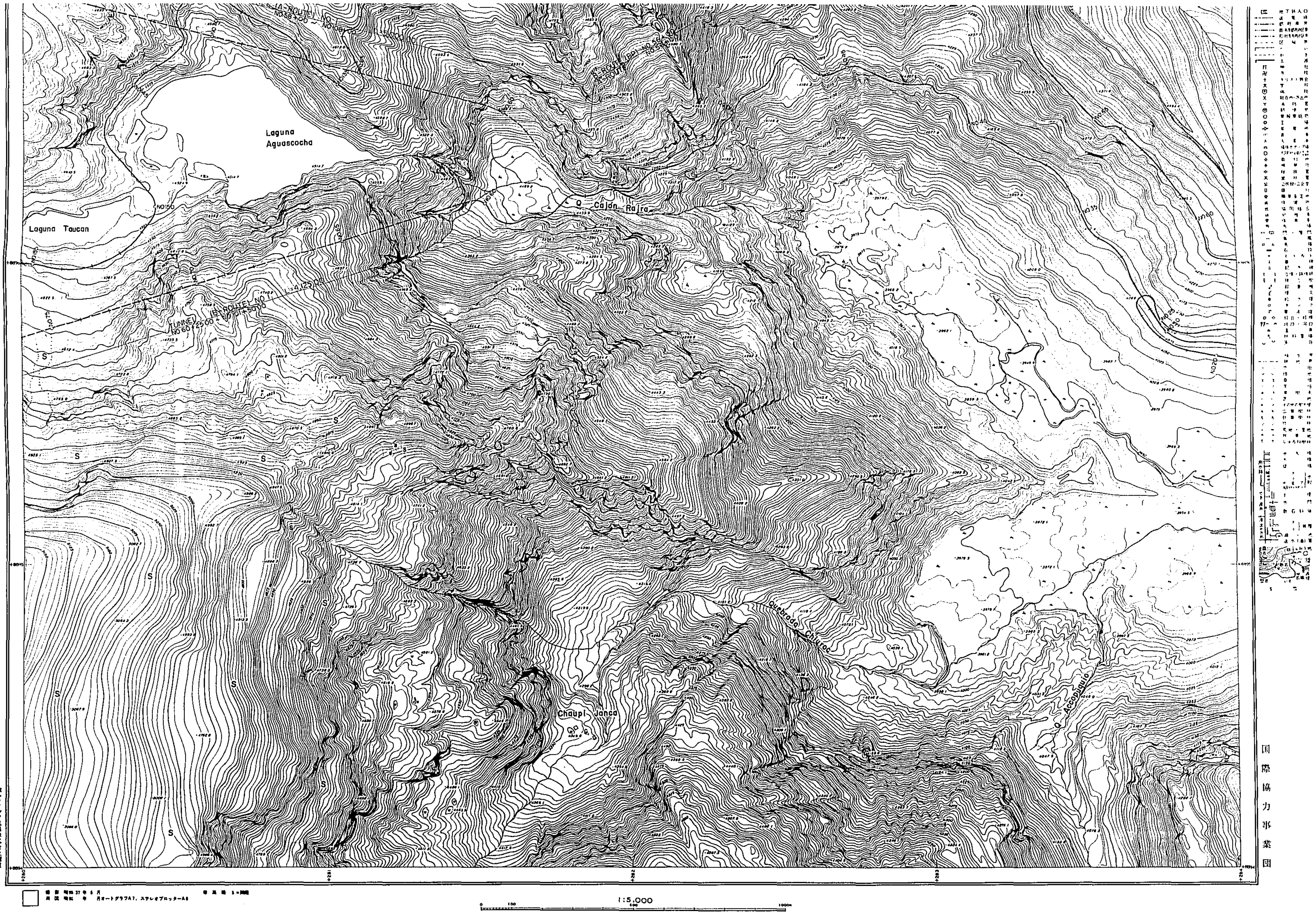


1:5,000

国際協力事業団

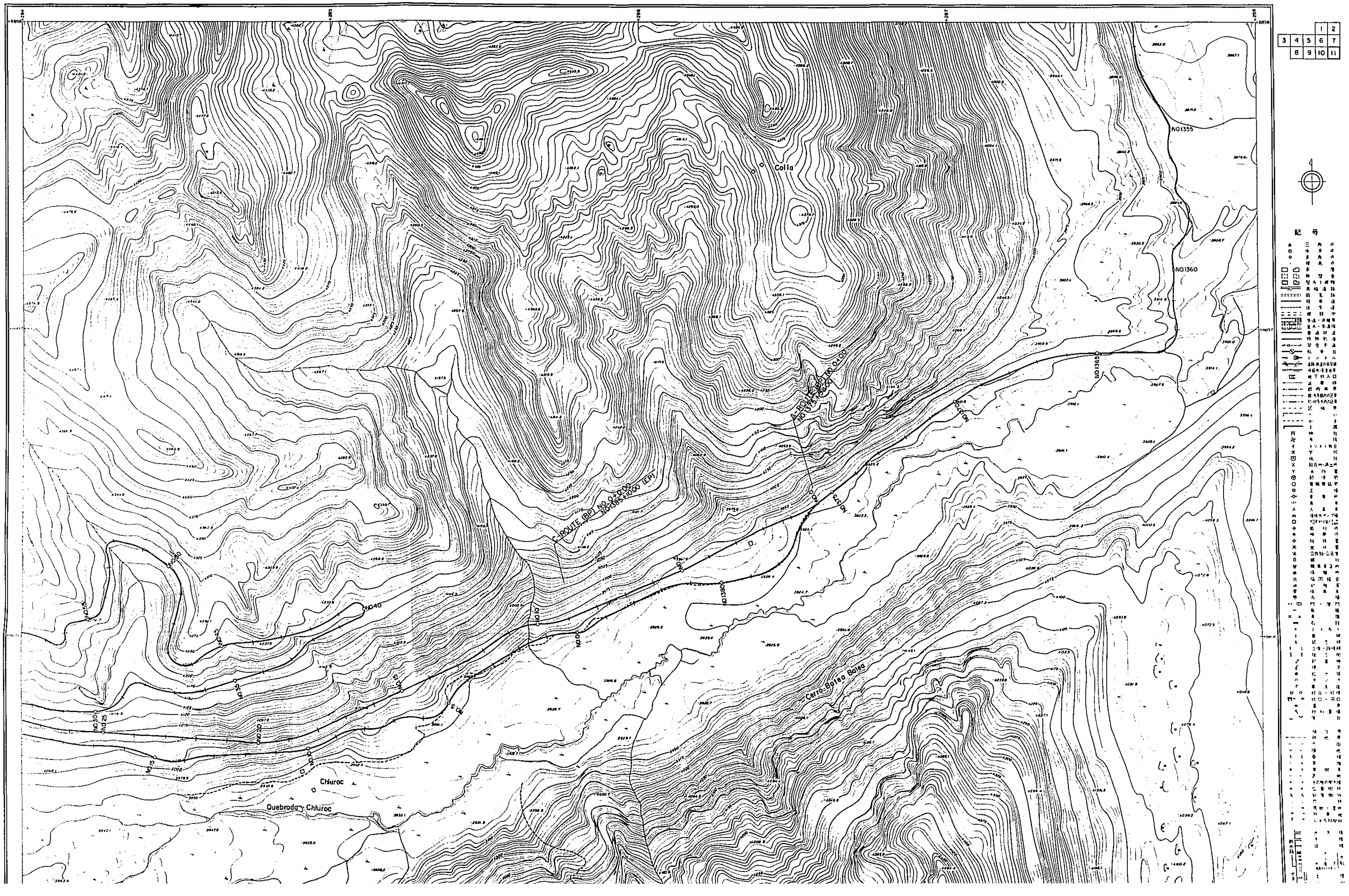
ペルー共和国イラリオン鉱山周辺地形図10

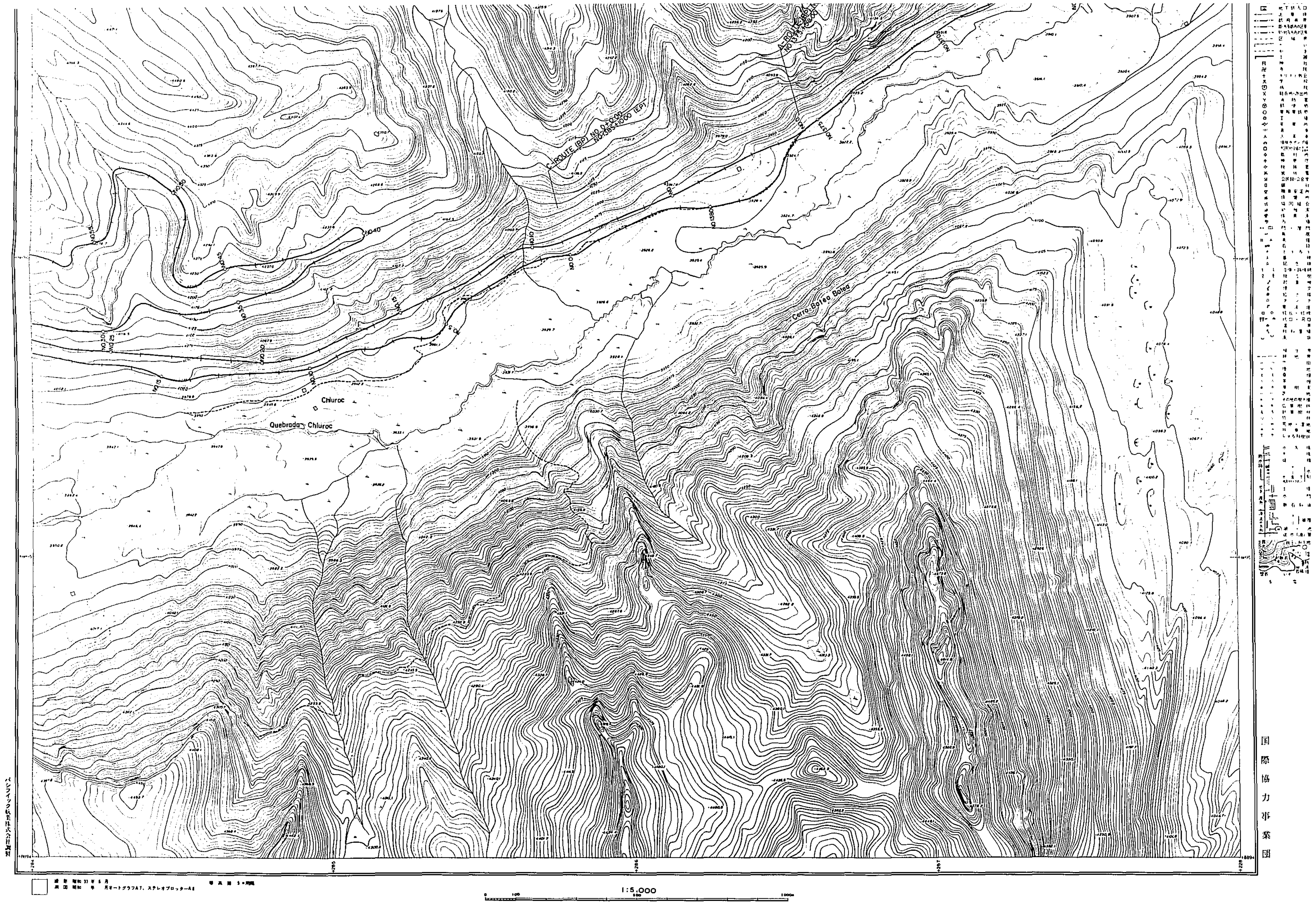



Laguna Aguascocha
Laguna Taucan
Q. Cajon Rajra
Quebrada Chiurac
Q. Acopiquio
Chaupi Janca
1:5,000

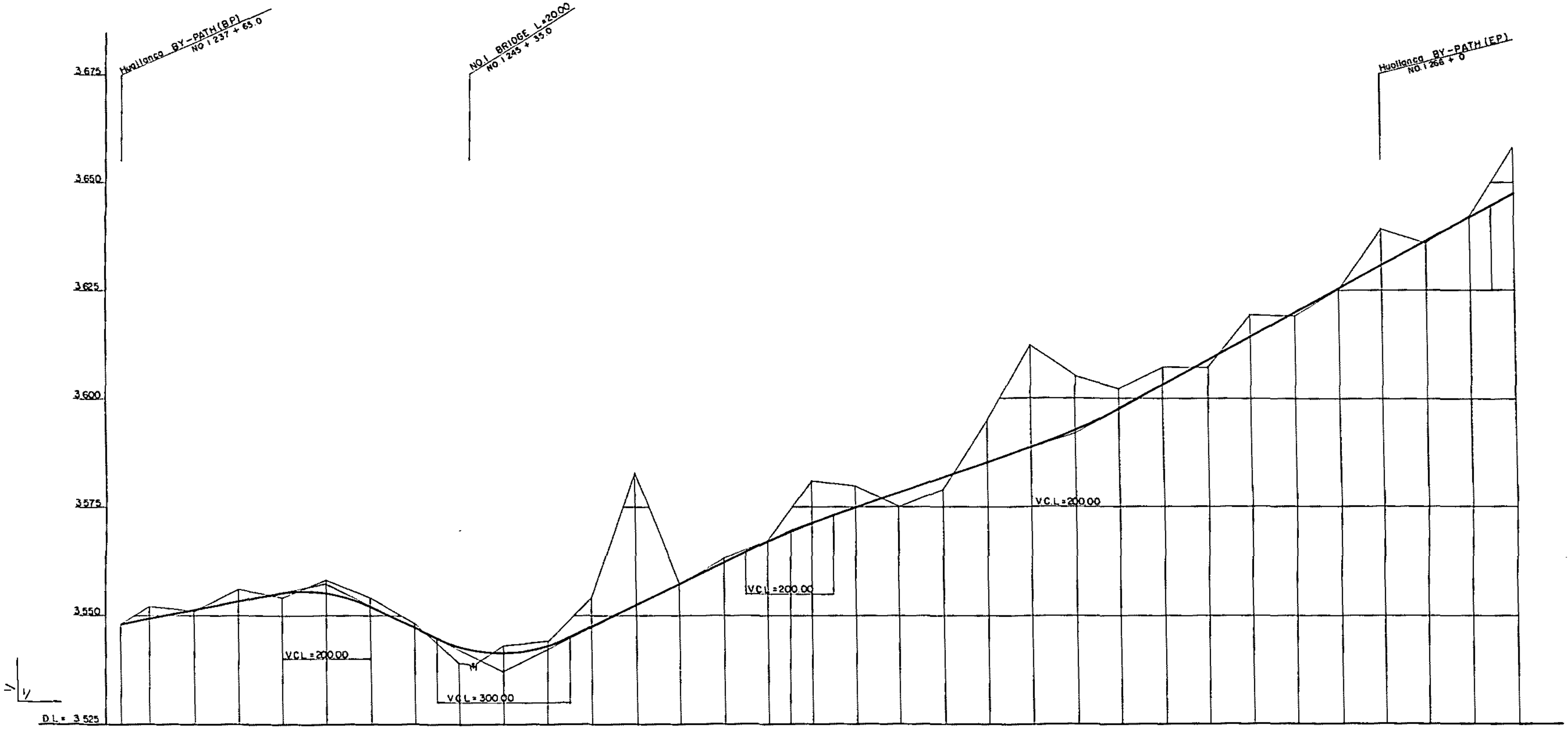
国際協力事業団

ペルー共和国イラリオン鉱山周辺地形図11




C-ROUTE (BP) NO.0+0.00
NO.13+1000 (EP)
Cerro Botea Botea
Chluroc
Quebrada Chluroc
国際協力事業団
パシフィック航業株式会社製
1:5,000
0
100
1000m

Huallanca BY-PATH NO. 1



1

GRADE: 3548.0 — I=2.000% L=435.00 — 3556.70 — I=5.000% L=400.00 — 3536.70 — I=5.000% L=650.00 — 3569.20 — I=3.608% L=650.00 — 3592.65 — I=5.500% L=1050.00

STATION	+65.00	NO.1238	NO.1239	NO.1240	NO.1241	NO.1242	NO.1243	NO.1244	NO.1245	NO.1246	NO.1247	NO.1248
EMBANKMENT HEIGHT	0.00		0.30		0.70				3.64			
CUTTING DEPTH	0.00	3.30		3.30		3.05	2.30	1.30		2.55	2.30	7.30
PROPOSED HEIGHT	3548.00	3548.70	3550.70	3552.70	3554.70	3554.95	3551.70	3546.70	3542.64	3540.45	3541.70	3546.70
GROUND HEIGHT	3548.0	3552.0	3551.0	3556.0	3554.0	3558.0	3554.0	3548.0	3539.0	3543.0	3544.0	3554.0
ACCUMULATED DISTANCE	123 765.0	123 800.0	123 900.0	124 000.0	124 100.0	124 200.0	124 300.0	124 400.0	124 500.0	124 600.0	124 700.0	124 800.0

STATION	NO.1249	NO.1250	NO.1251	NO.1252	NO.1253	NO.1254	NO.1255	NO.1256	NO.1257	NO.1258	NO.1259
EMBANKMENT HEIGHT							3.22	2.83			
CUTTING DEPTH	31.30	0.30	1.30	0.39	10.09	5.39			9.57	22.96	11.88
PROPOSED HEIGHT	3551.70	3556.70	3561.70	3566.61	3570.91	3574.61	3578.22	3581.83	3585.43	3589.04	3593.12
GROUND HEIGHT	3583.0	3557.0	3563.0	3567.0	3581.0	3580.0	3575.0	3579.0	3595.0	3612.0	3605.0
ACCUMULATED DISTANCE	124 900.0	125 000.0	125 100.0	125 200.0	125 300.0	125 400.0	125 500.0	125 600.0	125 700.0	125 800.0	125 900.0

STATION	NO.1260	NO.1261	NO.1262	NO.1263	NO.1264	NO.1265	NO.1266	NO.1267	NO.1268	NO.1269
EMBANKMENT HEIGHT			2.15		1.15	0.65		0.65	0.15	
CUTTING DEPTH	3.85	3.35		4.35			7.85			10.44
PROPOSED HEIGHT	3598.15	3603.65	3609.15	3614.65	3620.15	3625.65	3631.15	3636.65	3642.15	3647.56
GROUND HEIGHT	3602.0	3607.0	3607.0	3619.0	3619.0	3625	3639.0	3636.0	3642.0	3658.0
ACCUMULATED DISTANCE	126 000.0	126 100.0	126 200.0	126 300.0	126 400.0	126 500.0	126 600.0	126 700.0	126 800.0	126 900.0

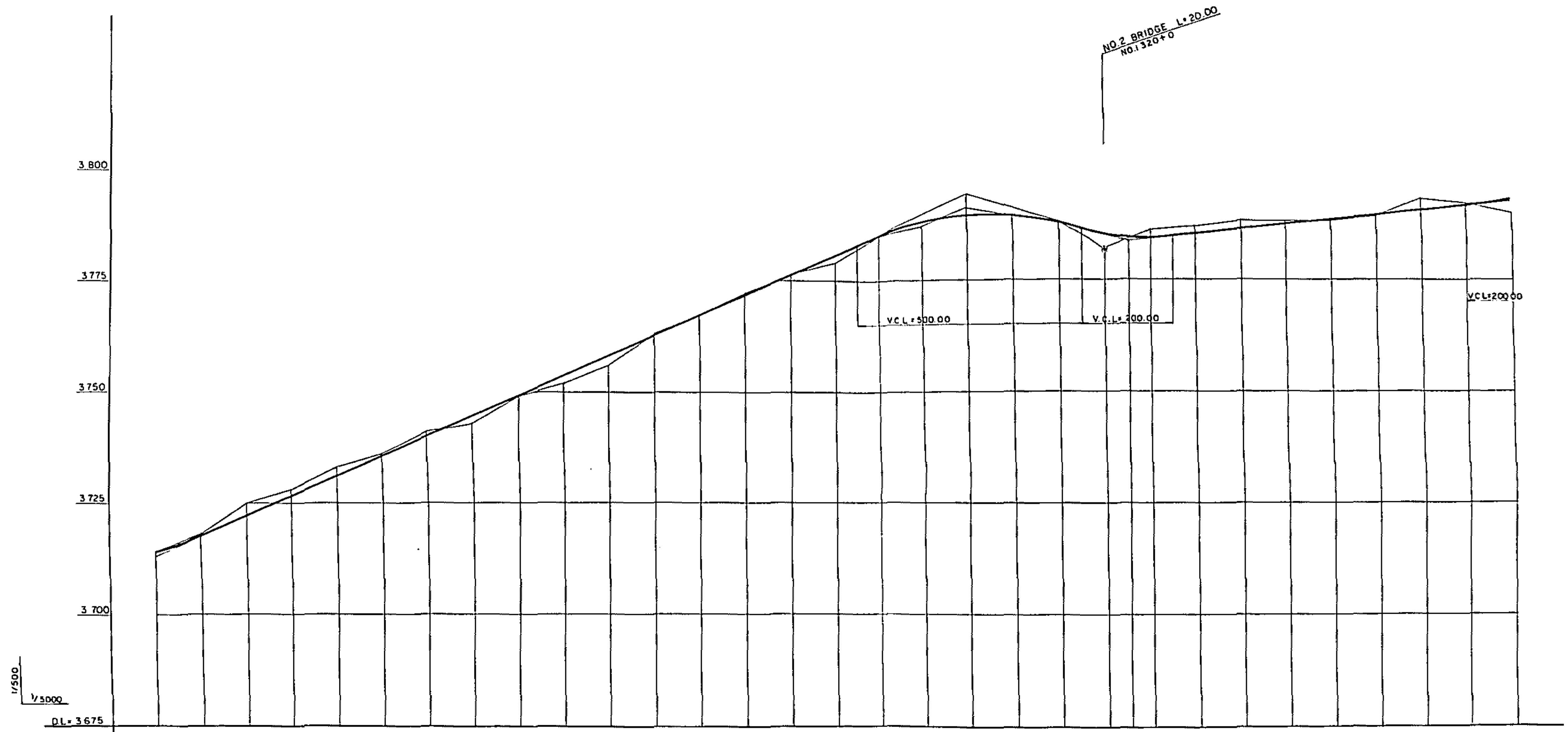
EXISTING ROAD NO. 1

GRADE	3650.40				i=4.000% L=750.00				3680.40				i=3.000% L=1000.00			
EMBANKMENT HEIGHT										1.40	0.40	2.40		4.40	4.40	
CUTTING DEPTH	10.44	0.69	3.60	5.60	1.60	1.60	0.60	4.60	1.85				1.60			4.60
PROPOSED HEIGHT	3647.56	3652.31	3656.40	3660.40	3664.40	3668.40	3672.40	3676.40	3680.15	3683.40	3686.40	3689.40	3692.40	3695.40	3698.40	3701.40
GROUND HEIGHT	3658.0	3653.0	3660.0	3666.0	3666.0	3670.0	3673.0	3681.0	3682.0	3682.0	3686.0	3687.0	3694.0	3691.0	3694.0	3706.0
ACCUMULATED DISTANCE	126900.0	127000.0	127100.0	127200.0	127300.0	127400.0	127500.0	127600.0	127700.0	127800.0	127900.0	128000.0	128100.0	128200.0	128300.0	128400.0
STATION	NO.1269	NO.1270	NO.1271	NO.1272	NO.1273	NO.1274	NO.1275	NO.1276	NO.1277	NO.1278	NO.1279	NO.1280	NO.1281	NO.1282	NO.1283	NO.1284

GRADE			3710.40							i=0.250% L=1200.00					3713.40
EMBANKMENT HEIGHT											2.40				0.46
CUTTING DEPTH	2.60	0.40	6.29	5.35	5.10	4.95	1.60	1.35	1.10	0.85		1.35	1.10	0.85	
PROPOSED HEIGHT	3704.40	3707.40	3709.71	3710.65	3710.90	3771.15	3711.40	3711.65	3711.90	3712.15	3712.40	3712.65	3712.90	3713.15	3714.46
GROUND HEIGHT	3707.0	3708.0	3716.0	3716.0	3716.0	3716.0	3713.0	3713.0	3713.0	3713.0	3710.0	3714.0	3714.0	3714.0	3714.0
ACCUMULATED DISTANCE	128500.0	128600.0	128700.0	128800.0	128900.0	129000.0	129100.0	129200.0	129300.0	129400.0	129500.0	129600.0	129700.0	129800.0	129900.0
STATION	NO.1285	NO.1286	NO.1287	NO.1288	NO.1289	NO.1290	NO.1291	NO.1292	NO.1293	NO.1294	NO.1295	NO.1296	NO.1297	NO.1298	NO.1299

2

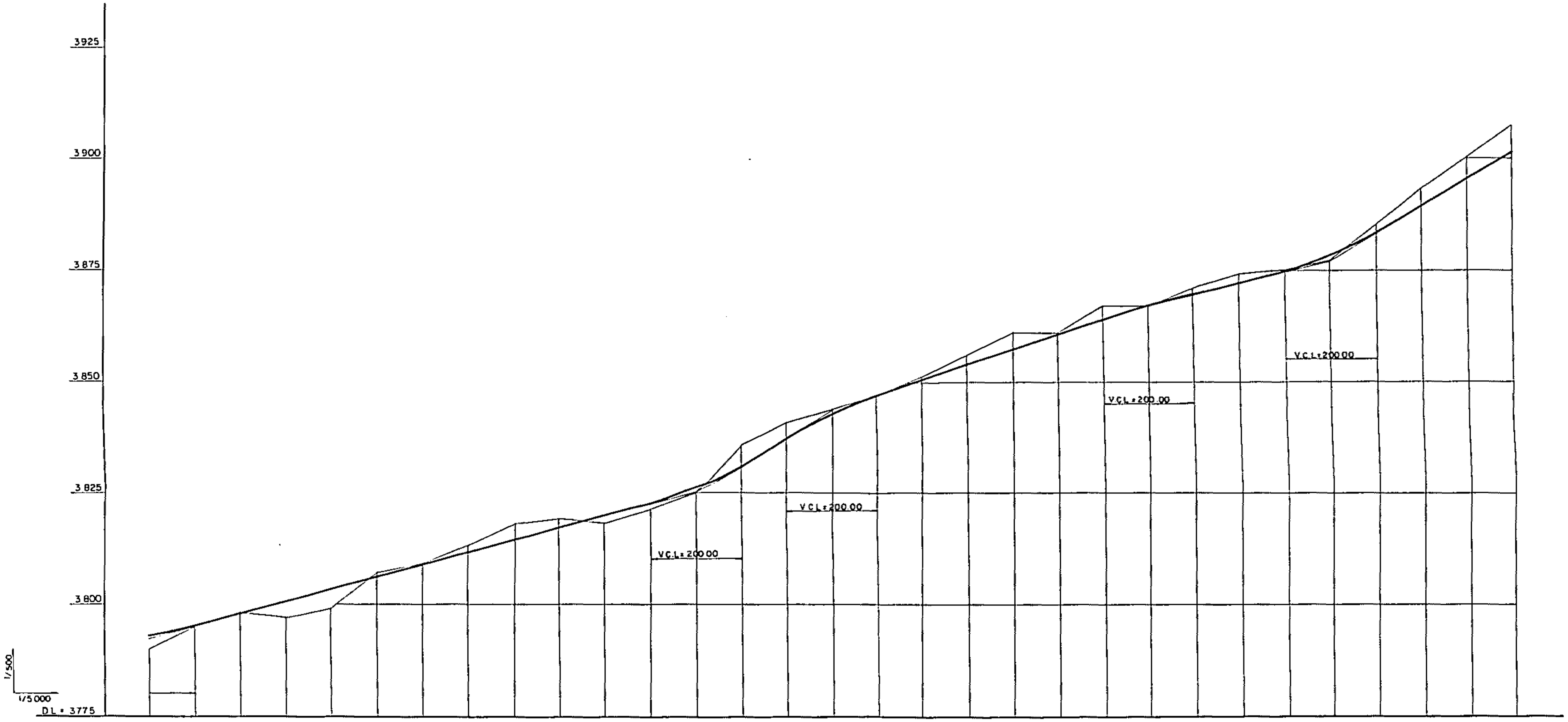
EXISTING ROAD NO. 2



STATION	ACCUMULATED DISTANCE	GROUND HEIGHT	PROPOSED HEIGHT	CUTTING DEPTH	EMBANKMENT HEIGHT	GRADE
NO.1299	129900.0	3714.0	3714.46		0.46	3713.40
NO.1300	130000.0	3718.0	3717.90	0.10		
NO.1301	130100.0	3725.0	3722.40	2.60		
NO.1302	130200.0	3728.0	3726.90	1.10		
NO.1303	130300.0	3733.0	3731.40	1.60		
NO.1304	130400.0	3736.0	3735.90	0.10		
NO.1305	130500.0	3741.0	3740.40	0.60		
NO.1306	130600.0	3743.0	3744.90		1.90	
NO.1307	130700.0	3749.0	3749.40		0.40	
NO.1308	130800.0	3752.0	3753.90		1.90	i = 4.500 % L = 1800.00
NO.1309	130900.0	3756.0	3758.40		2.40	
NO.1310	131000.0	3763.0	3762.90	0.10		
NO.1311	131100.0	3767.0	3767.40		0.40	
NO.1312	131200.0	3772.0	3771.90	0.10		
NO.1313	131300.0	3776.0	3776.40		0.40	
NO.1314	131400.0	3779.0	3780.90		1.90	
NO.1315	131500.0	3785.0	3785.21		0.21	
NO.1316	131600.0	3787.0	3788.21		1.21	
NO.1317	131700.0	3791.0	3789.71	1.29		3794.40
NO.1318	131800.0	3789.0	3789.71		0.71	i = 3.000 % L = 350.00
NO.1319	131900.0	3788.0	3788.21		0.21	
NO.1320	132000.0	3782.0	3785.65		3.65	3783.90
NO.1321	132100.0	3786.0	3784.65	1.35		
NO.1322	132200.0	3787.0	3785.40		2.40	
NO.1323	132300.0	3788.0	3786.40	1.60		
NO.1324	132400.0	3788.0	3787.40		1.40	i = 1.000 % L = 850.00
NO.1325	132500.0	3788.0	3788.40		0.40	
NO.1326	132600.0	3782.0	3789.40		0.40	
NO.1327	132700.0	3793.0	3790.40	2.60		
NO.1328	132800.0	3792.0	3791.40		0.60	
NO.1329	132900.0	3790.0	3797.08		7.08	3792.40

3

EXISTING ROAD NO. 3



4

	NO.1329	NO.1330	NO.1331	NO.1332	NO.1333	NO.1334	NO.1335	NO.1336	NO.1337	NO.1338	NO.1339	NO.1340	NO.1341	NO.1342	NO.1343	NO.1344
GRADE	3792.40							i=2.700% L=1200.00					3824.80	i=6.500% L=300.00		3844.30
EMBANKMENT HEIGHT	7.08	0.10	1.80	3.50	4.20						1.40	1.10	0.75			
CUTTING DEPTH						1.10	0.40	1.70	4.00	2.30				4.70	3.20	0.45
PROPOSED HEIGHT	3797.08	3795.10	3797.80	3800.50	3803.20	3805.90	3808.60	3811.30	3814.00	3816.70	3819.40	3822.10	3825.75	3831.30	3837.80	3843.55
GROUND HEIGHT	3790.0	3795.0	3798.0	3797.0	3799.0	3807.0	3809.0	3813.0	3818.0	3819.0	3818.0	3821.0	3825.0	3836.0	3841.0	3844.0
ACCUMULATED DISTANCE	132900.0	133000.0	133100.0	133200.0	133300.0	133400.0	133500.0	133600.0	133700.0	133800.0	133900.0	134000.0	134100.0	134200.0	134300.0	134400.0
STATION	NO.1329	NO.1330	NO.1331	NO.1332	NO.1333	NO.1334	NO.1335	NO.1336	NO.1337	NO.1338	NO.1339	NO.1340	NO.1341	NO.1342	NO.1343	NO.1344

	NO.1345	NO.1346	NO.1347	NO.1348	NO.1349	NO.1350	NO.1351	NO.1352	NO.1353	NO.1354	NO.1355	NO.1356	NO.1357	NO.1358	NO.1359
GRADE			i=3.500% L=700.00				3868.80	i=2.500% L=400.00			3878.80		i=6.000% L=600.00		
EMBANKMENT HEIGHT	0.80	0.30			0.80		1.55	0.30		1.50	2.68				
CUTTING DEPTH			1.20	2.70		1.70			0.20			0.20	2.20	3.20	4.20
PROPOSED HEIGHT	3847.80	3851.30	3854.80	3858.30	3861.80	3865.30	3868.55	3871.30	3873.80	3876.30	3879.68	3884.80	3890.80	3896.80	3902.80
GROUND HEIGHT	3847.0	3851.0	3856.0	3861.0	3861.0	3867.0	3867.0	3871.0	3874.0	3875.0	3877.0	3885.0	3893.0	3900.0	3907.0
ACCUMULATED DISTANCE	134500.0	134600.0	134700.0	134800.0	134900.0	135000000	135100.0	135200.0	135300.0	135400.0	135500.0	135600.0	135700.0	135800.0	135900.0
STATION	NO.1345	NO.1346	NO.1347	NO.1348	NO.1349	NO.1350	NO.1351	NO.1352	NO.1353	NO.1354	NO.1355	NO.1356	NO.1357	NO.1358	NO.1359

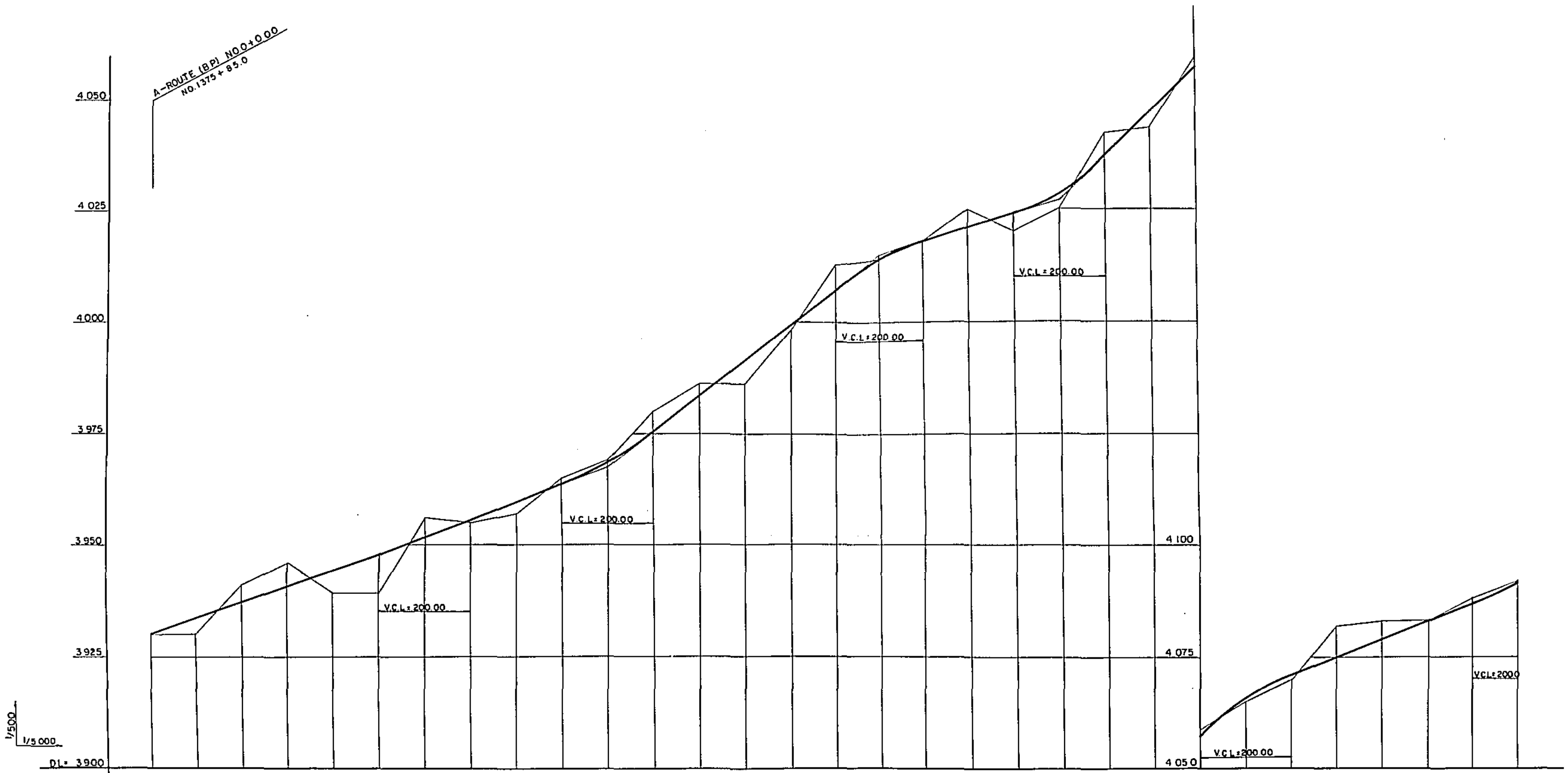
EXISTING ROAD NO. 4

5

	NO.1359	NO.1360	NO.1361	NO.1362	NO.1363	NO.1364	NO.1365	NO.1366	NO.1367	NO.1368	NO.1369	NO.1370	NO.1371	NO.1372
GRADE			3914.80			i=3.000% L=600.00			3932.80					
EMBANKMENT HEIGHT			0.05		6.80	6.80		3.20				0.05	0.80	
CUTTING DEPTH	4.20	2.20		4.20			2.20		6.01	7.45	5.70			0.45
PROPOSED HEIGHT	3902.80	3908.80	3914.05	3917.80	3920.80	3923.80	3926.80	3929.80	3931.99	3932.55	3932.30	3932.05	3931.80	3931.55
GROUND HEIGHT	3907.0	3911.0	3914.0	3922.0	3914.0	3917.0	3929.0	3933.0	3938.0	3940.0	3938.0	3932.0	3931.0	3932.0
ACCUMULATED DISTANCE	135900.0	136000.0	136100.0	136200.0	136300.0	136400.0	136500.0	136600.0	136700.0	136800.0	136900.0	137000.0	137100.0	137200.0
STATION	NO.1359	NO.1360	NO.1361	NO.1362	NO.1363	NO.1364	NO.1365	NO.1366	NO.1367	NO.1368	NO.1369	NO.1370	NO.1371	NO.1372

	NO.1373	NO.1374	NO.1375	NO.1376	NO.1377	NO.1378	NO.1379	NO.1380	NO.1381	NO.1382	NO.1383	NO.1384	NO.1385 +10.0
GRADE			i=0.250% L=1600.00								3928.80	i=5.762% L=210.00	3943.00
EMBANKMENT HEIGHT	3.30	2.05		4.55	3.30	2.05	0.80	0.55	2.30			0.56	0.32
CUTTING DEPTH			0.20							2.95	2.45		
PROPOSED HEIGHT	3931.30	3931.05	3930.80	3930.55	3930.30	3930.05	3929.80	3929.55	3929.30	3929.05	3930.55	3935.56	3942.32 3943.00
GROUND HEIGHT	3928.0	3929.0	3931.0	3926.0	3927.0	3928.0	3929.0	3929.0	3927.0	3932.0	3933.0	3935.0	3942.0 3943.0
ACCUMULATED DISTANCE	137300.0	137400.0	137500.0	137600.0	137700.0	137800.0	137900.0	138000.0	138100.0	138200.0	138300.0	138400.0	138500.0 138510.0
STATION	NO.1373	NO.1374	NO.1375	NO.1376	NO.1377	NO.1378	NO.1379	NO.1380	NO.1381	NO.1382	NO.1383	NO.1384	NO.1385 +10.0

A - ROUTE NO. 1

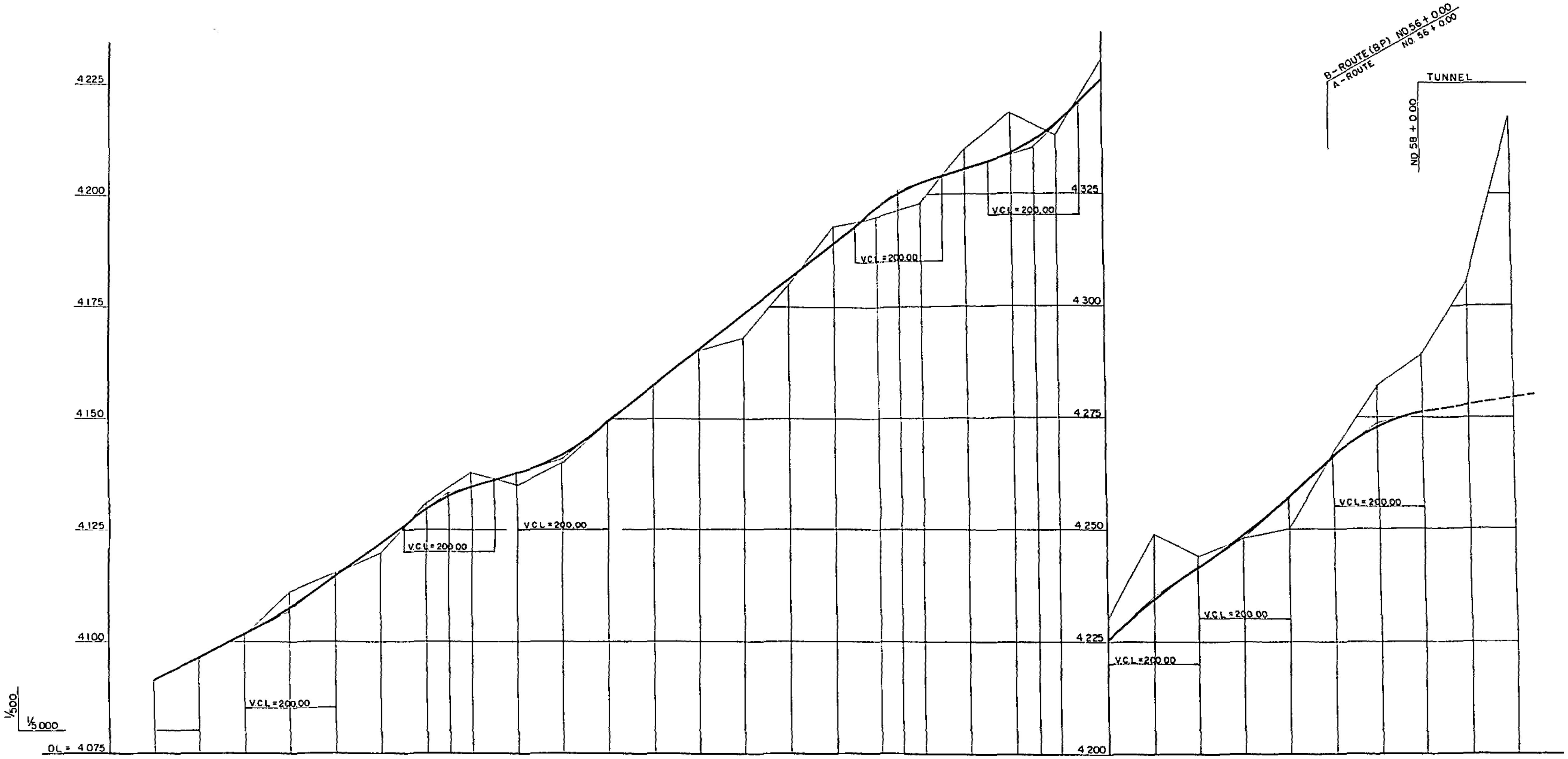


6

STATION	ACCUMULATED DISTANCE	GROUND HEIGHT	PROPOSED HEIGHT	CUTTING DEPTH	EMBANKMENT HEIGHT	GRADE
NO.0	0.0	3930.0	3930.00	0	0	3930.00
NO.1	100.0	3930.0	3933.50		3.50	I= 3.500 % L= 600.00
NO.2	200.0	3942.0	3937.00	5.00		
NO.3	300.0	3946.0	3940.50	5.50		
NO.4	400.0	3939.0	3944.00		5.00	
NO.5	500.0	3939.0	3947.50		6.50	
NO.6	600.0	3956.0	3951.13	4.87		3951.00
NO.7	700.0	3955.0	3955.00	0	0	I= 4.000 % L= 400.00
NO.8	800.0	3957.0	3959.00		2.00	
NO.9	900.0	3965.0	3963.00	2.00		
NO.10	1000.0	3969.0	3968.00	1.00		3967.00
NO.11	1100.0	3980.0	3975.00	5.00		I= 8.000 % L= 600.00
NO.12	1200.0	3986.0	3983.00	3.00		
NO.13	1300.0	3986.0	3991.00		5.00	
NO.14	1400.0	3998.0	3999.00		1.00	
NO.15	1500.0	4013.0	4007.00	6.00		
NO.16	1600.0	4014.0	4013.75	0.25		4015.00
NO.17	1700.0	4018.0	4018.00	0	0	I= 3.000% L= 400.00
NO.18	1800.0	4025.0	4021.00	4.00		
NO.19	1900.0	4020.0	4024.00		4.00	
NO.20	2000.0	4025.0	4028.75		3.75	4027.00
NO.21	2100.0	4042.0	4037.00	5.00		I= 10.000 % L= 400.00
NO.22	2200.0	4043.0	4047.00		4.00	
NO.23	2300.0	4059.0	4057.00	2.00		
NO.24	2400.0	4065.0	4065.50		0.50	4067.00
NO.25	2500.0	4070.0	4071.00		1.00	I= 4.000 % L= 600.00
NO.26	2600.0	4082.0	4075.00	7.00		
NO.27	2700.0	4083.0	4079.00	4.00		
NO.28	2800.0	4083.0	4083.00	0	0	
NO.29	2900.0	4088.0	4087.00	1.00		
NO.30	3000.0	4092.0	4091.50	0.50		4091.00

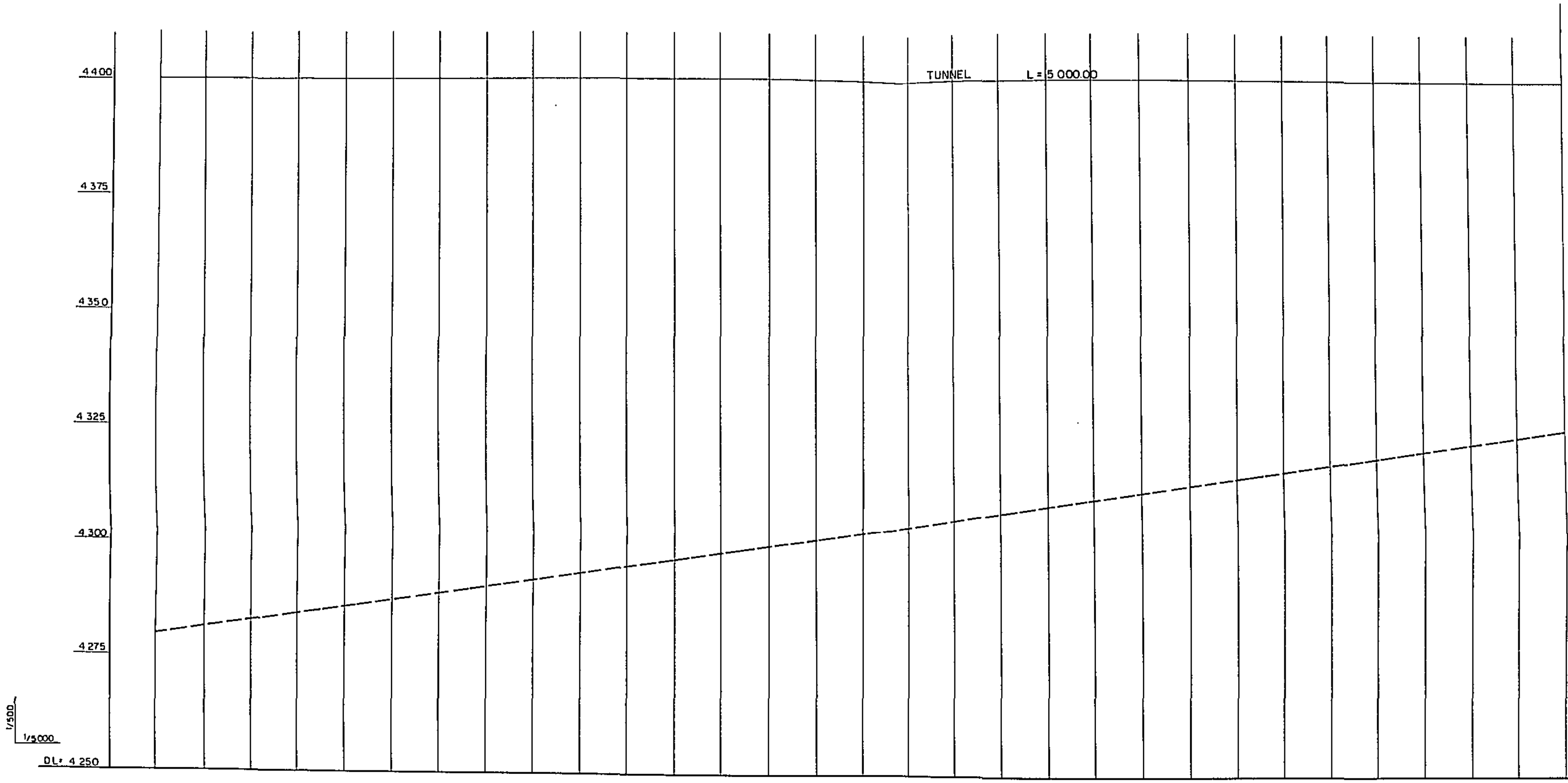
A-ROUTE NO. 2

7



GRADE	4 091.00	i=6.000% L=300.00		4 109.00		i=7.000 % L=350.00	4 133.50	i=3.000% L=250.00		4 141.00			i=8.000 % L=760.00				4 201.00		i=3.000% L=300.00	4 210.00		i=10.000% L=250.00	4 235.00	i=6.500% L=200.00	4 248.00	i=9.000% L=300.00		4 275.00		i=1.500 % L=5 250.00	
EMBANKMENT HEIGHT	0.50	1.00	0		1.00	3.00			3.00	2.25	0	0	0	5.00	1.00		1.69	4.19		9.06	2.44			2.50	0.63	2.00					
CUTTING DEPTH			0	1.75			1.25	3.25			0	0	0			4.00			4.50			5.00	14.87				1.00				
PROPOSED HEIGHT	4 091.50	4 097.00	4 103.00	4 109.25	4 116.00	4 123.00	4 129.75	4 134.75	4 138.00	4 142.25	4 149.00	4 157.00	4 165.00	4 173.00	4 181.00	4 189.00	4 196.69	4 202.19	4 205.50	4208.94	4 215.44	4 225.00	4 234.13	4 241.50	4 248.63	4 257.00	4 266.00	4 273.125	4 276.50	4 278.00	4 279.50
GROUND HEIGHT	4 091.0	4 096.0	4 103.0	4 111.0	4 115.0	4 120.0	4 131.0	4 138.0	4 135.0	4 140.0	4 149.0	4 157.0	4 165.0	4 168.0	4 180.0	4 193.0	4 195.0	4 198.0	4 210.0	4 218.0	4 213.0	4 230.0	4 249.0	4 244.0	4 248.0	4 250.0	4 267.0	4 282.0	4 289.0	4 305.0	4 342.0
ACCUMULATED DISTANCE	3 000.0	3 100.0	3 200.0	3 300.0	3 400.0	3 500.0	3 600.0	3 700.0	3 800.0	3 900.0	4 000.0	4 100.0	4 200.0	4 300.0	4 400.0	4 500.0	4 600.0	4 700.0	4 800.0	4 900.0	5 000.0	5 100.0	5 200.0	5 300.0	5 400.0	5 500.0	5 600.0	5 700.0	5 800.0	5 900.0	6 000.0
STATION	NO. 30	NO. 31	NO. 32	NO. 33	NO. 34	NO. 35	NO. 36	NO. 37	NO. 38	NO. 39	NO. 40	NO. 41	NO. 42	NO. 43	NO. 44	NO. 45	NO. 46	NO. 47	NO. 48	NO. 49	NO. 50	NO. 51	NO. 52	NO. 53	NO. 54	NO. 55	NO. 56	NO. 57	NO. 58	NO. 59	NO. 60

A-ROUTE NO. 3

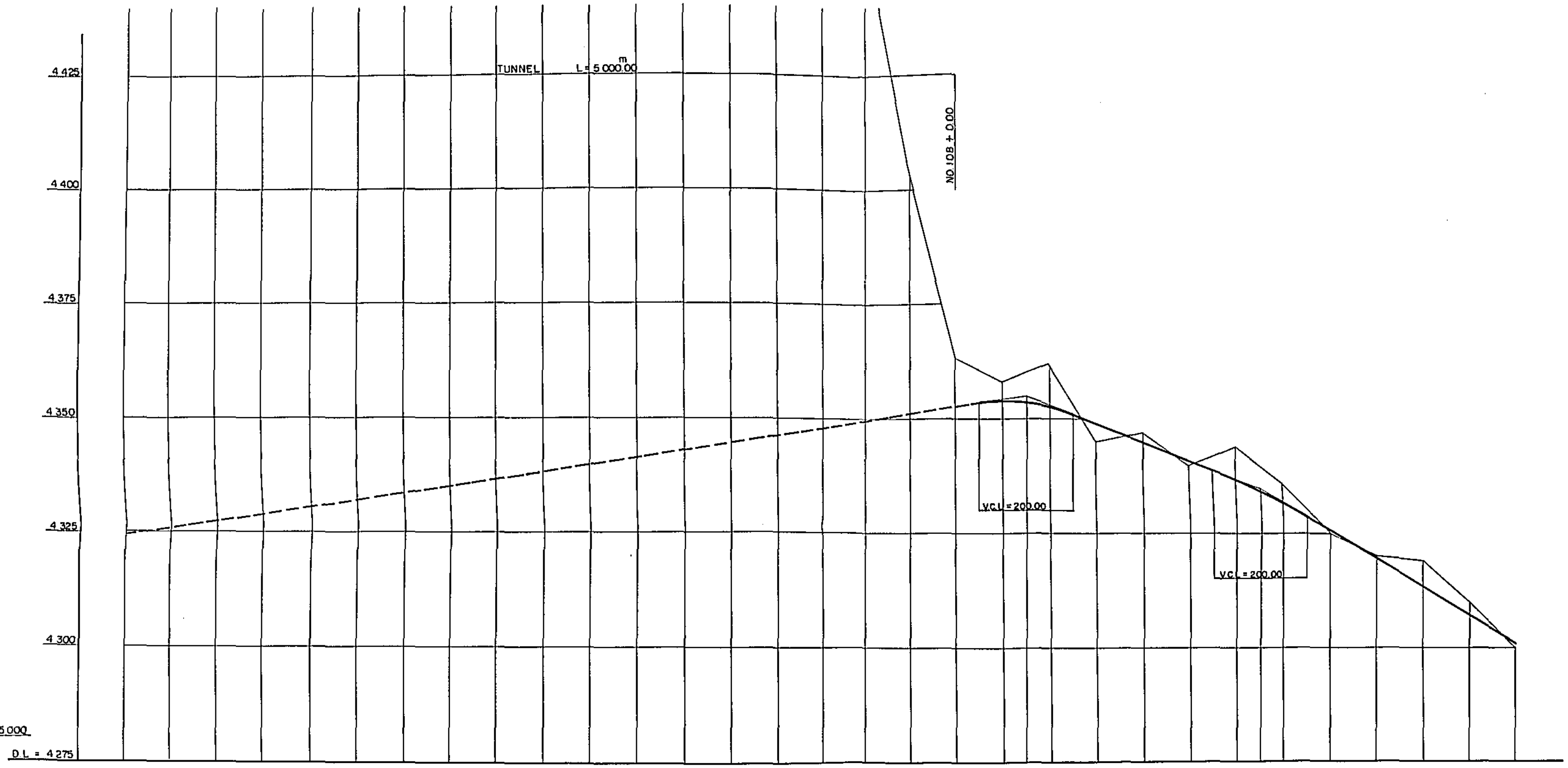


STATION	NO. 60	NO. 61	NO. 62	NO. 63	NO. 64	NO. 65	NO. 66	NO. 67	NO. 68	NO. 69	NO. 70
GRADE											
EMBANKMENT HEIGHT											
CUTTING DEPTH											
PROPOSED HEIGHT	4279.50	4281.00	4282.50	4284.00	4285.00	4287.00	4288.50	4290.00	4291.50	4293.00	4294.50
GROUND HEIGHT	4342.0	4403.0	4455.0	4530.0	4577.0	4623.0	4646.0	4594.0	4564.0	4534.0	4532.0
ACCUMULATED DISTANCE	6000.0	6100.0	6200.0	6300.0	6400.0	6500.0	6600.0	6700.0	6800.0	6900.0	7000.0

STATION	NO. 71	NO. 72	NO. 73	NO. 74	NO. 75	NO. 76	NO. 77	NO. 78	NO. 79	NO. 80
GRADE								i = 1.500% L = 5 250.00		
EMBANKMENT HEIGHT										
CUTTING DEPTH										
PROPOSED HEIGHT	4296.00	4297.50	4299.00	4300.50	4302.00	4303.50	4305.00	4306.50	4308.00	4309.50
GROUND HEIGHT	4550.0	4597.0	4632.0	4690.0	4691.0	4690.0	4756.0	4810.0	4847.0	4891.0
ACCUMULATED DISTANCE	7100.0	7200.0	7300.0	7400.0	7500.0	7600.0	7700.0	7800.0	7900.0	8000.0

STATION	NO. 81	NO. 82	NO. 83	NO. 84	NO. 85	NO. 86	NO. 87	NO. 88	NO. 89	NO. 90
GRADE										
EMBANKMENT HEIGHT										
CUTTING DEPTH										
PROPOSED HEIGHT	4311.00	4312.50	4314.00	4315.50	4317.00	4318.50	4320.00	4321.50	4323.00	4324.50
GROUND HEIGHT	4940.0	5010.0	4935.0	4941.0	4965.0	4973.0	4987.0	5005.0	5022.0	5055.0
ACCUMULATED DISTANCE	8100.0	8200.0	8300.0	8400.0	8500.0	8600.0	8700.0	8800.0	8900.0	9000.0

A-ROUTE NO. 4

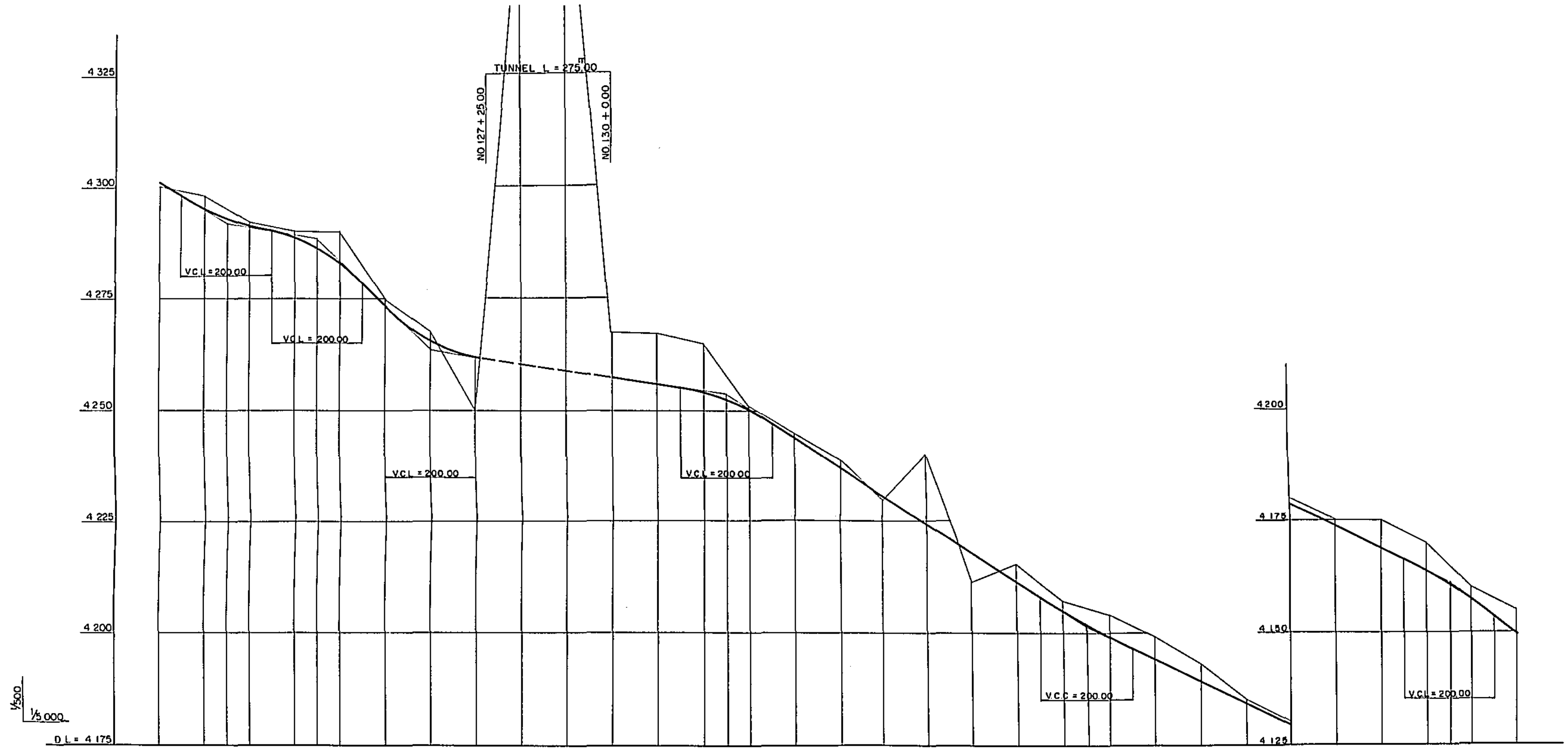


9

GRADE: i = 1.500 % L = 5 250.00; (4 353.75); i = 3.900 % L = 500.00; (4 334.25); i = 6.000 % L = 700.00

STATION	ACCUMULATED DISTANCE	GROUND HEIGHT	PROPOSED HEIGHT	CUTTING DEPTH	EMBANKMENT HEIGHT
NO. 90	9 000.0	5 055.0	4 324.50		
NO. 91	9 100.0	5 083.0	4 326.00		
NO. 92	9 200.0	5 155.0	4 327.50		
NO. 93	9 300.0	5 080.0	4 329.00		
NO. 94	9 400.0	5 025.0	4 330.50		
NO. 95	9 500.0	4 970.0	4 332.00		
NO. 96	9 600.0	4 889.0	4 335.00		
NO. 97	9 700.0	4 845.0	4 335.00		
NO. 98	9 800.0	4 816.0	4 336.50		
NO. 99	9 900.0	4 765.0	4 338.00		
NO. 100	10000.0	4 716.0	4 339.50		
NO. 101	10 100.0	4 680.0	4 341.00		
NO. 102	10 200.0	4 655.0	4 342.50		
NO. 103	10 300.0	4 629.0	4 344.00		
NO. 104	10 400.0	4 565.0	4 345.50		
NO. 105	10 500.0	4 494.0	4 347.00		
NO. 106	10 600.0	4 454.0	4 348.50		
NO. 107	10 700.0	4 404.0	4 350.00		
NO. 108	10 800.0	4 368.0	4 351.50		
NO. 109	10 900.00	4 358.0	4 352.66		
NO. 110	11 000.0	4 362.0	4 351.46	10.54	
NO. 111	11 100.0	4 345.0	4 347.90		2.90
NO. 112	11 200.0	4 347.0	4 344.00	3.00	
NO. 113	11 300.0	4 340.0	4 340.10		0.10
NO. 114	11 400.0	4 344.0	4 336.07	7.93	
NO. 115	11 500.0	4 336.0	4 331.12	4.88	
NO. 116	11 600.0	4 325.0	4 325.25		0.25
NO. 117	11 700.0	4 320.0	4 319.25	0.75	
NO. 118	11 800.0	4 319.0	4 313.25	5.75	
NO. 119	11 900.0	4 310.0	4 307.25	2.75	
NO. 120	12000.0	4 300.0	4 301.3		0.13

A – ROUTE NO. 5



10

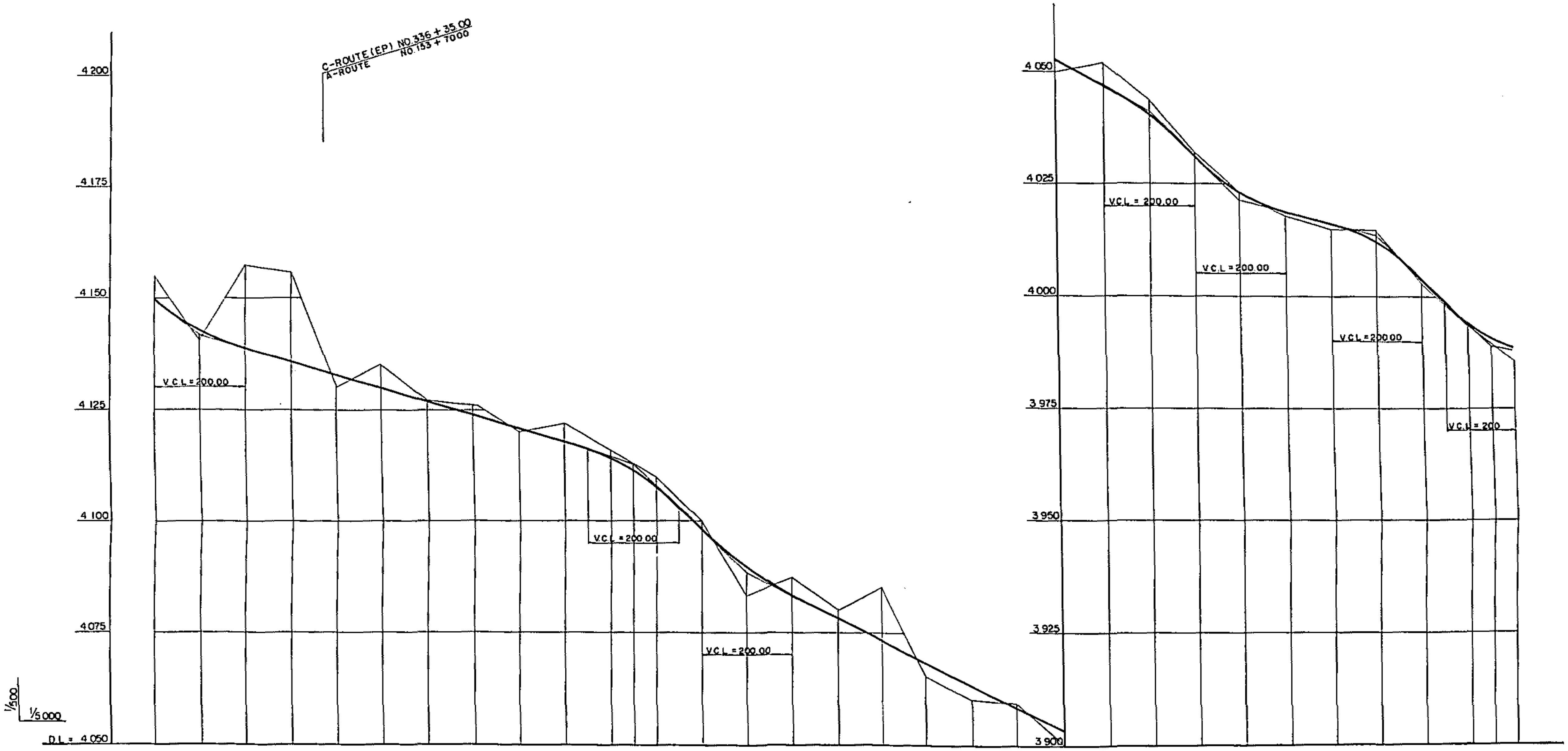
GRADE: 4 292.25 — I=2.000% L=200.00 — 4 288.25 — I=1.000% L=250.00 — 4 263.00 — I = 1.500 % L = 650.00 — 4 253.25 — I = 6.500 % L = 800.00 — 4 201.25 — I = 5.000 % L = 800.00 — 4 161.25

STATION	NO. 120	NO. 121	NO. 122	NO. 123	NO. 124	NO. 125	NO. 126	NO. 127	NO. 128	NO. 129	NO. 130
EMBANKMENT HEIGHT	0.13	2.50						11.50			
CUTTING DEPTH			0.50	1.25	7.25	2.25	2.87				10.00
PROPOSED HEIGHT	4 301.3	4 295.50	4 291.50	4 288.75	4 282.75	4 272.75	4 265.13	4 261.50	4 260.00	4 258.50	4 257.00
GROUND HEIGHT	4 300.0	4 298.0	4 292.0	4 290.0	4 290.0	4 275.0	4 268.0	4 250.0	4 345.0	4 295.0	4 267.0
ACCUMULATED DISTANCE	12 000.0	12 100.0	12 200.0	12 300.0	12 400.0	12 500.0	12 600.0	12 700.0	12 800.0	12 900.0	13 000.0

STATION	NO. 131	NO. 132	NO. 133	NO. 134	NO. 135	NO. 136	NO. 137	NO. 138	NO. 139	NO. 140
EMBANKMENT HEIGHT						0.50		6.50		
CUTTING DEPTH	11.50	11.31	1.32	1.50	1.00		16.00		4.00	2.41
PROPOSED HEIGHT	4 255.50	4 253.69	4 249.68	4 243.50	4 237.00	4 230.50	4 224.00	4 217.50	4 211.0	4 204.59
GROUND HEIGHT	4 267.0	4 265.0	4 251.0	4 245.0	4 238.0	4 230.0	4 240.0	4 211.0	4 215.0	4 207.0
ACCUMULATED DISTANCE	13 100.0	13 200.0	13 300.0	13 400.0	13 500.0	13 600.0	13 700.0	13 800.0	13 900.0	14 000.0

STATION	NO. 141	NO. 142	NO. 143	NO. 144	NO. 145	NO. 146	NO. 147	NO. 148	NO. 149	NO. 150
EMBANKMENT HEIGHT										
CUTTING DEPTH	5.16	5.25	4.25	1.25	1.25	1.25	6.25	6.43	2.88	5.60
PROPOSED HEIGHT	4 198.84	4 193.75	4 188.75	4 183.75	4 178.75	4 173.75	4 168.75	4 163.57	4 157.12	4 149.40
GROUND HEIGHT	4 204.0	4 199.0	4 193.0	4 185.0	4 180.0	4 175.0	4 175.0	4 170.0	4 160.0	4 155.0
ACCUMULATED DISTANCE	14 100.0	14 200.0	14 300.0	14 400.0	14 500.0	14 600.0	14 700.0	14 800.0	14 900.0	15 000.0

A-ROUTE NO. 6



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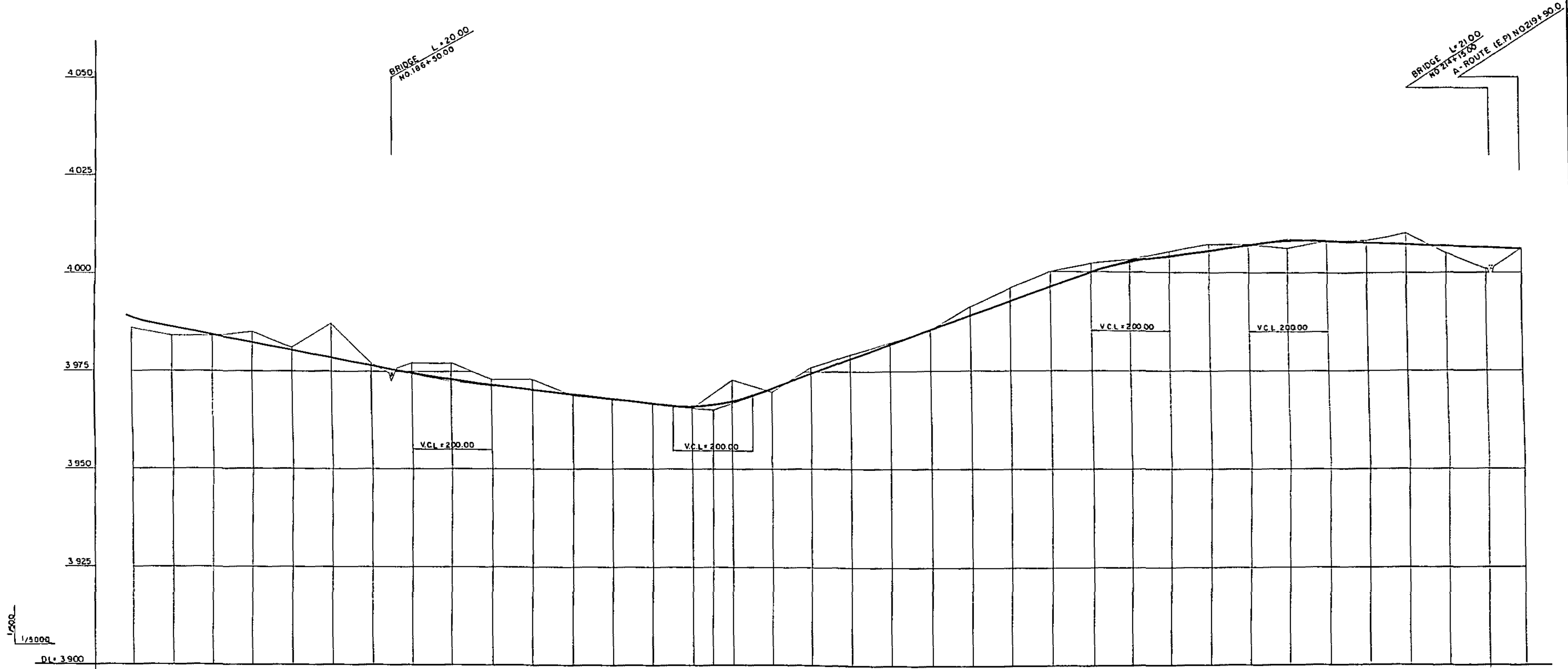
	NO. 150	NO. 151	NO. 152	NO. 153	NO. 154	NO. 155	NO. 156	NO. 157	NO. 158	NO. 159	NO. 160	NO. 161	NO. 162	NO. 163	NO. 164	NO. 165
GRADE		4 141.50					i = 3.000 % L = 950.00					4 113.00	i = 10.000 % L = 250.00	4 088.00		
EMBANKMENT HEIGHT		2.73			2.50									6.22		
CUTTING DEPTH	5.60		18.50	19.50		5.50	0.50	2.50	2.50	4.50	1.94	3.44	2.00		4.14	2.28
PROPOSED HEIGHT	4 149.40	4 142.73	4 138.50	4 135.50	4 132.50	4 129.50	4 126.50	4 123.50	4 120.50	4 117.50	4 114.06	4 107.56	4 098.00	4 089.22	4 082.86	4 077.72
GROUND HEIGHT	4 155.0	4 140.0	4 157.0	4 155.0	4 130.0	4 135.0	4 127.0	4 126.0	4 123.0	4 122.0	4 116.0	4 110.0	4 100.0	4 083.0	4 087.0	4 080.0
ACCUMULATED DISTANCE	15 000.0	15 100.0	15 200.0	15 300.0	15 400.0	15 500.0	15 600.0	15 700.0	15 800.0	15 900.0	16 000.0	16 100.0	16 200.0	16 300.0	16 400.0	16 500.0
STATION	NO. 150	NO. 151	NO. 152	NO. 153	NO. 154	NO. 155	NO. 156	NO. 157	NO. 158	NO. 159	NO. 160	NO. 161	NO. 162	NO. 163	NO. 164	NO. 165

	NO. 166	NO. 167	NO. 168	NO. 169	NO. 170	NO. 171	NO. 172	NO. 173	NO. 174	NO. 175	NO. 176	NO. 177	NO. 178	NO. 179	NO. 180
GRADE			i = 5.139 % L = 900.00				4 041.75	i = 10.000 % L = 200.00	4 021.75	i = 2.500 % L = 300.00		4 014.25	i = 10.000 % L = 250.00	3 989.25	
EMBANKMENT HEIGHT		2.44	2.31						0.63	1.25	1.75		1.25	0.75	2.75
CUTTING DEPTH	12.42			1.83	2.03	5.11	3.46	0.25				2.62			
PROPOSED HEIGHT	4 072.58	4 067.44	4 062.31	4 057.17	4 052.03	4 046.89	4 040.54	4 031.75	4 023.63	4 019.25	4 016.75	4 012.38	4 004.25	3 994.75	3 988.75
GROUND HEIGHT	4 085.0	4 065.0	4 060.0	4 059.0	4 050.0	4 052.0	4 044.0	4 032.0	4 023.0	4 018.0	4 015.0	4 015.0	4 003.0	3 994.0	3 986.0
ACCUMULATED DISTANCE	16 600.0	16 700.0	16 800.0	16 900.0	17 000.0	17 100.0	17 200.0	17 300.0	17 400.0	17 500.0	17 600.0	17 700.0	17 800.0	17 900.0	18 000.0
STATION	NO. 166	NO. 167	NO. 168	NO. 169	NO. 170	NO. 171	NO. 172	NO. 173	NO. 174	NO. 175	NO. 176	NO. 177	NO. 178	NO. 179	NO. 180



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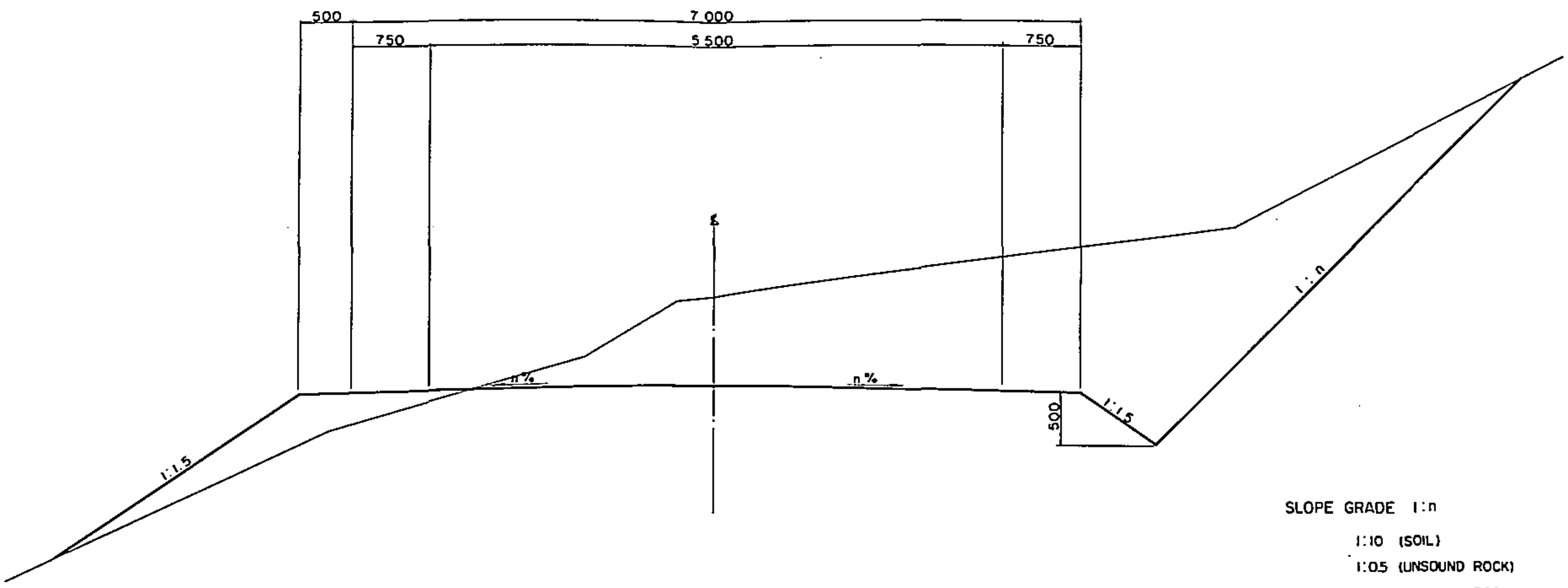
STATION	NO 180	NO.181	NO.182	NO.183	NO.184	NO.185	NO.186	NO.187	NO.188	NO.189	NO.190	NO 191
GRADE					I=2.000 % L=850.00				3972.25			I=1.000 % L=650.00
EMBANKMENT HEIGHT	2.75	2.25	0.25					2.25				0.25
CUTTING DEPTH				2.75	0.75	8.75	0.75		4.50	1.50	2.75	
PROPOSED HEIGHT	3988.75	3986.25	3984.25	3982.25	3980.25	3978.25	3976.25	3974.25	3972.50	3971.25	3970.25	3969.25
GROUND HEIGHT	3986.0	3984.0	3984.0	3985.0	3981.0	3987.0	3977.0	3977.0	3977.0	3975.0	3973.0	3969.0
ACCUMULATED DISTANCE	18000.0	18100.0	18200.0	18300.0	18400.0	18500.0	18600.0	18700.0	18800.0	18900.0	19000.0	19100.0

STATION	NO.192	NO.193	NO.194	NO.195	NO.196	NO.197	NO.198	NO.199	NO.200	NO.201	NO.202	NO.203
GRADE			3965.75						I=3.500 % L=1050.0			
EMBANKMENT HEIGHT	0.25	0.25	0.53		1.00				0			
CUTTING DEPTH				5.22		1.50	1.00	0.50	0	2.50	4.00	4.50
PROPOSED HEIGHT	3968.25	3967.25	3966.53	3967.78	3971.00	3974.50	3978.00	3981.50	3985.00	3988.50	3992.00	3995.50
GROUND HEIGHT	3968.0	3967.0	3966.0	3973.0	3970.0	3976.0	3979.0	3982.0	3985.0	3991.0	3996.0	4000.0
ACCUMULATED DISTANCE	19200.0	19300.0	19400.0	19500.0	19600.0	19700.0	19800.0	19900.0	20000.0	20100.0	20200.0	20300.0

STATION	NO 204	NO.205	NO.206	NO.207	NO.208	NO.209	NO.210	NO.211	NO.212	NO.213	NO.214	+90.00
GRADE		4002.50		I=1.500 % L=400.000		4008.50		I=0.424 % L=590.00				4006.00
EMBANKMENT HEIGHT					0	2.23	0.08			1.80	5.38	0
CUTTING DEPTH	3.00	1.00	1.00	1.50	0			0.35	2.77			0
PROPOSED HEIGHT	3999.00	4002.0	4004.00	4065.50	4007.00	4008.23	4008.08	4007.65	4007.23	4006.80	4006.38	4006.0
GROUND HEIGHT	4002.0	4003.0	4005.0	4007.0	4007.0	4006.0	4008.0	4008.0	4010.0	4005.0	4001.0	4006.0
ACCUMULATED DISTANCE	20400.0	20500.0	20600.0	20700.0	20800.0	20900.0	21000.0	21100.0	21200.0	21300.0	21400.0	21490.0

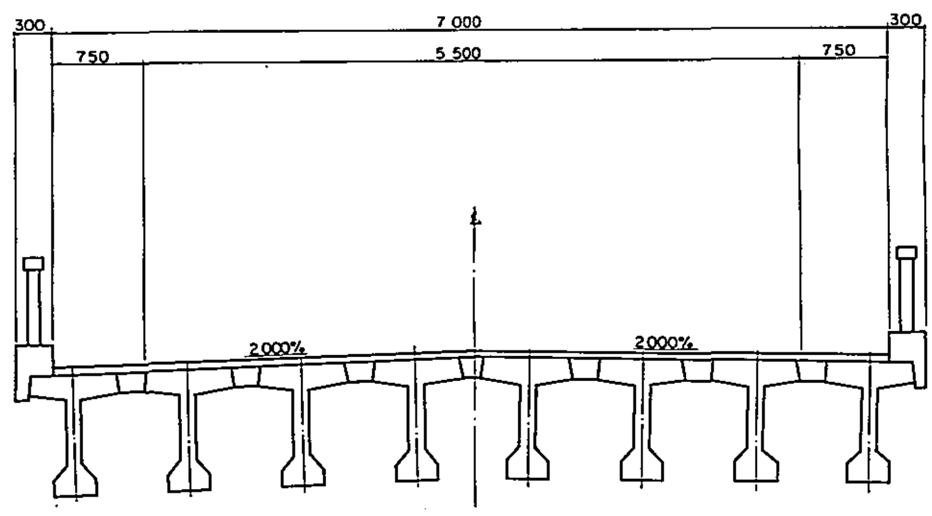
TYPICAL CROSS SECTION S=1:30

SMBANKMENT & CUT SECTION

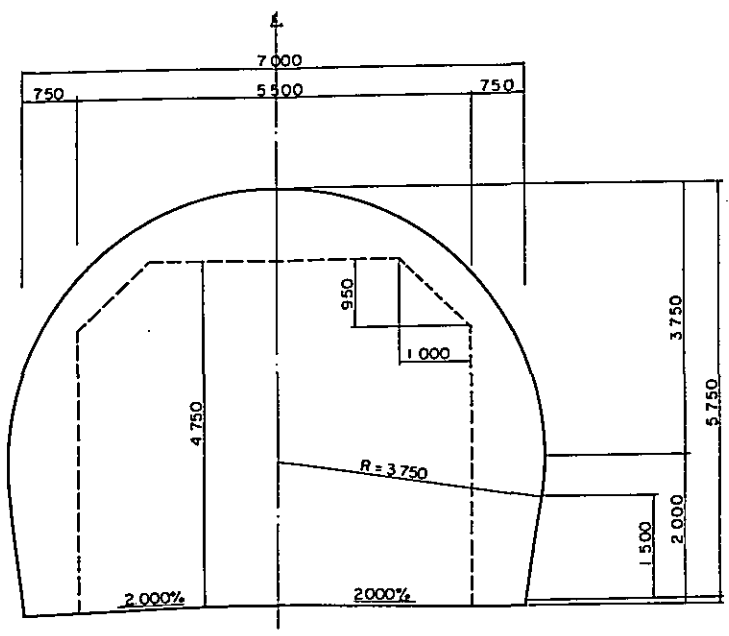


SLOPE GRADE 1:n
1:10 (SOIL)
1:05 (UNSOUND ROCK)
1:03 (" ROCK)

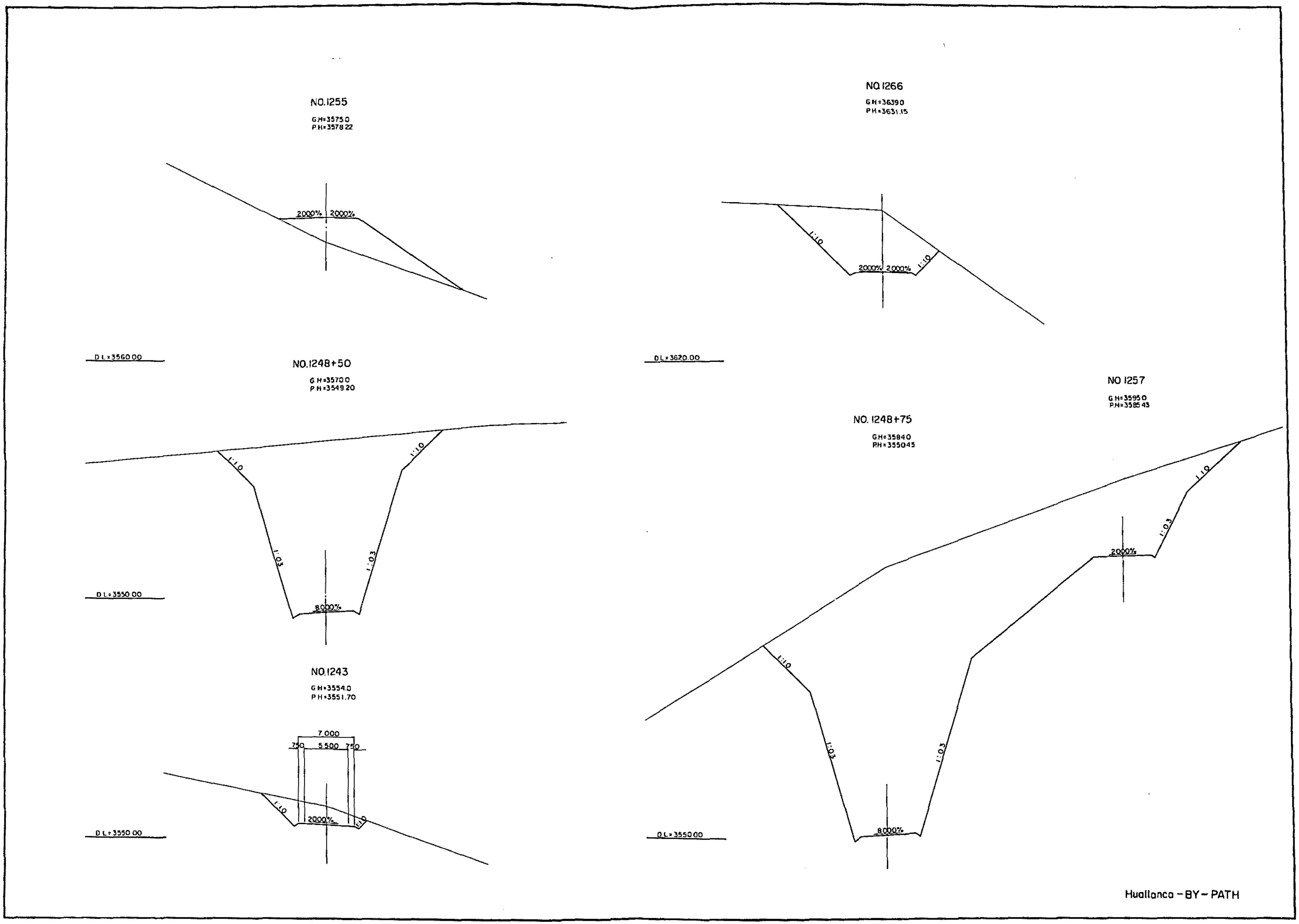
BRIDGE SECTION



TUNNEL SECTION

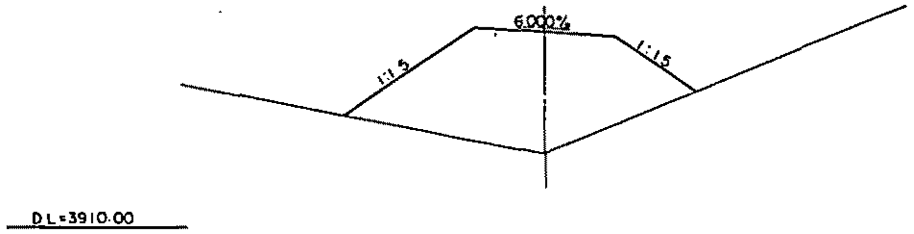


14


NO.1255
G.H=3575.0
P.H=3578.22
2000% 2000%
D.L=3560.00
NO.1266
G.H=3639.0
P.H=3631.15
1:1.0
2000% 2000%
1:1.0
D.L=3620.00
NO.1248+50
G.H=3570.0
P.H=3549.20
1:1.0
1:1.0
1:0.3
1:0.3
8000%
D.L=3550.00
NO 1257
G.H=3595.0
P.H=3585.43
NO. 1248+75
G.H=3584.0
P.H=3550.45
1:1.0
1:0.3
2000%
1:1.0
1:0.3
1:0.3
8000%
D.L=3550.00
NO.1243
G.H=3554.0
P.H=3551.70
7.000
750 5.500 750
1:1.0
2000%
1:1.0
D.L=3550.00
Huallanca - BY - PATH

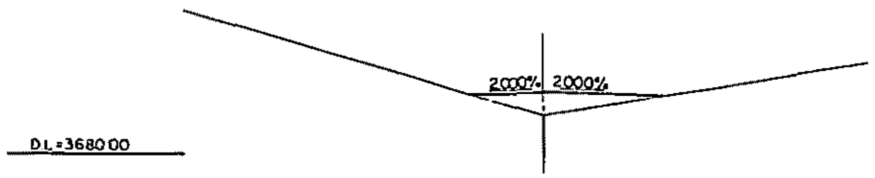
NO.1363

GH=3914.0
P.H=2920.80



NO.1278

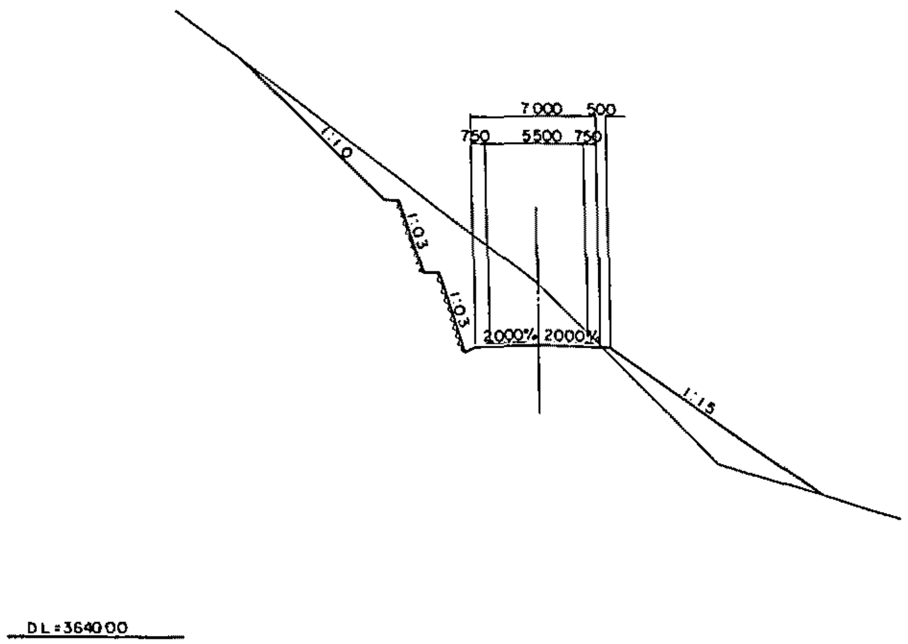
GH=3682.0
P.H=3683.40



15

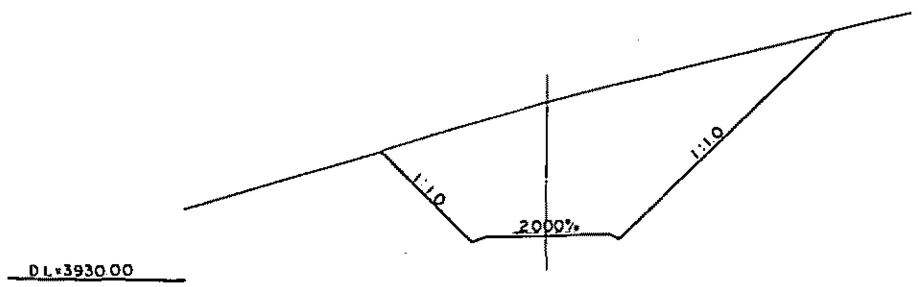
NO.1271

GH=3660.0
P.H=3656.40

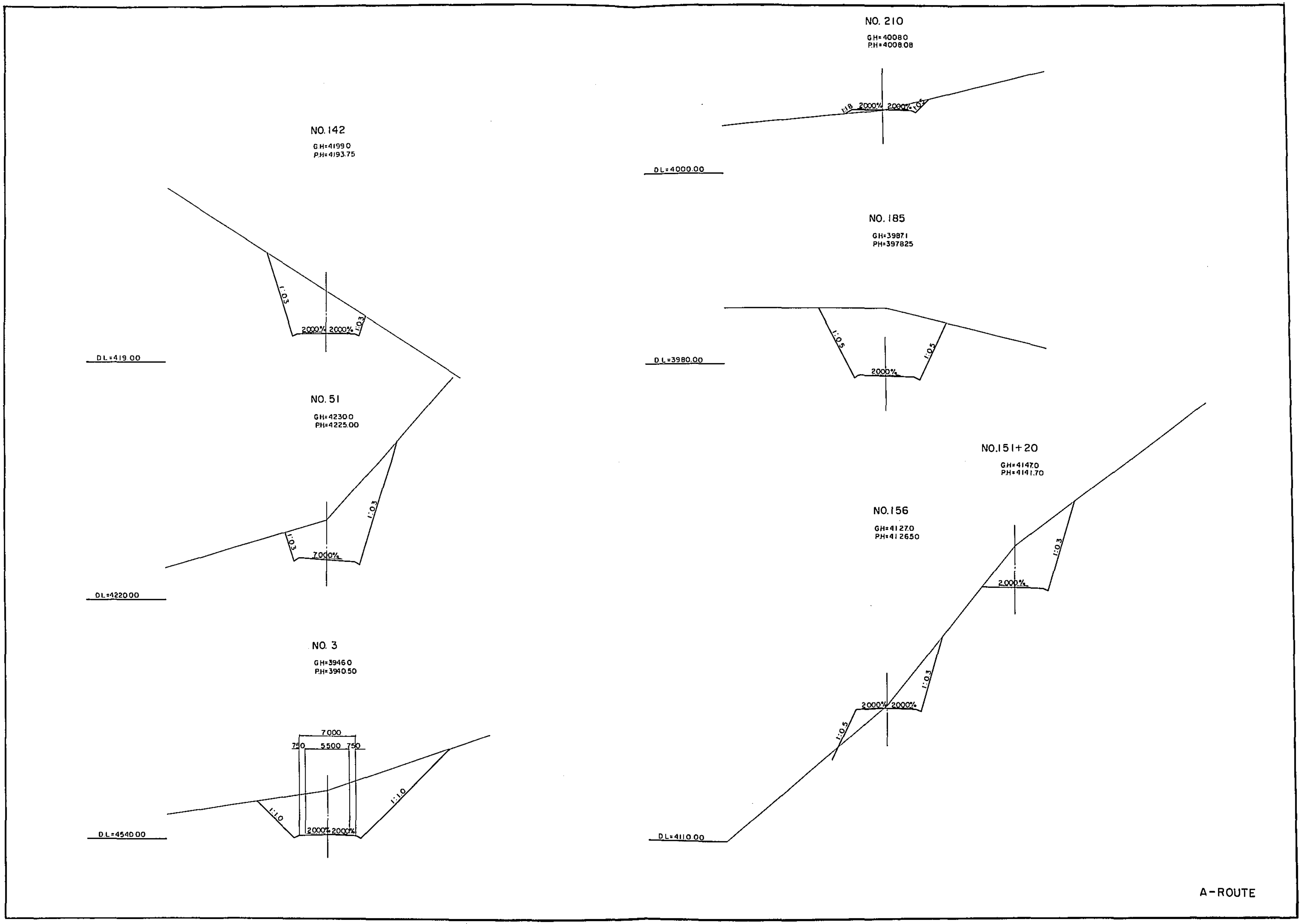


NO. 1368

GH=3940.0
PH=3932.55

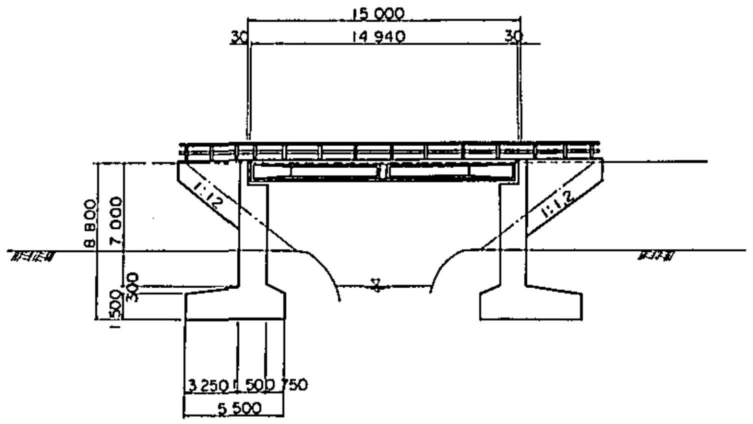


EXISTING ROAD

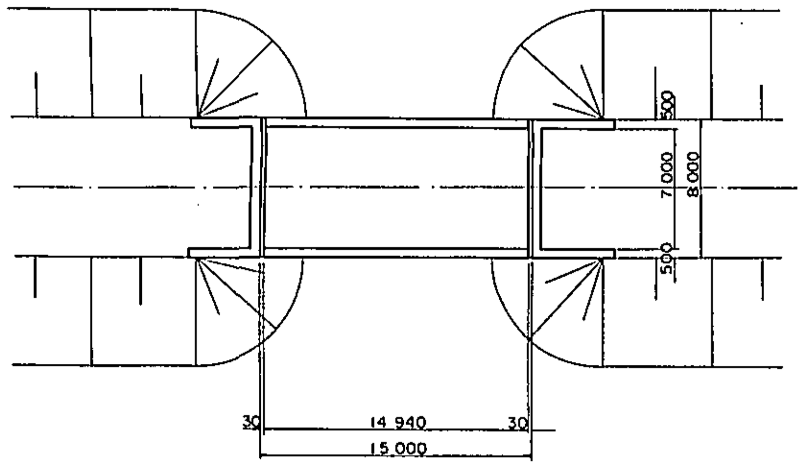

NO. 210
GH=40080
P.H=4008.08
1:18
2000%
2000%
D.L=4000.00
NO. 142
GH=41990
P.H=4193.75
1:03
2000%
2000%
1:03
D.L=419.00
NO. 51
GH=42300
P.H=4225.00
1:03
1:03
7.000%
D.L=4220.00
NO. 3
GH=39460
P.H=3940.50
7.000
750
5500
750
1:1.0
1:1.0
2000%
2000%
D.L=4540.00
NO. 185
GH=39871
PH=397825
1:0.5
1:0.5
2000%
D.L=3980.00
NO.151+20
GH=41470
P.H=4141.70
1:0.3
2.000%
NO.156
GH=41270
P.H=412650
1:0.3
2000%
2000%
1:0.5
D.L=4110.00
A-ROUTE

17

SIDE ELEVATION

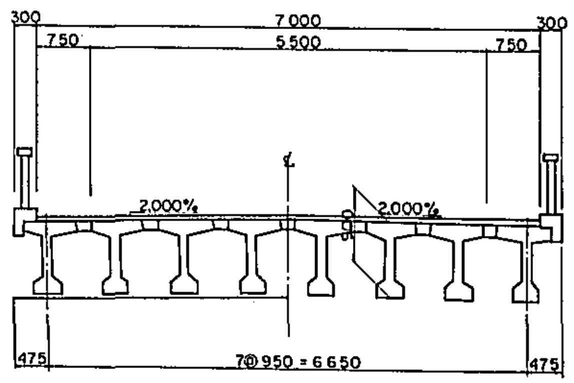


PLAN



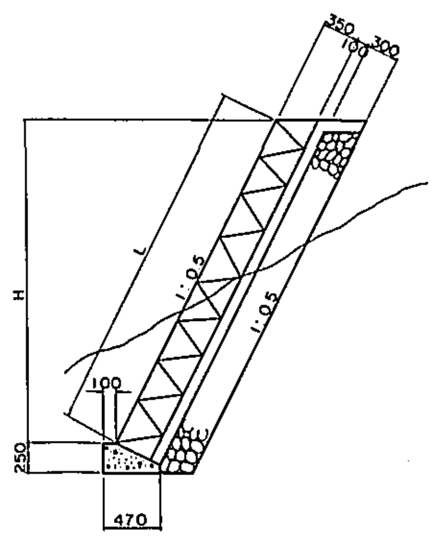
TYPICAL CROSS SECTION

END CENTER

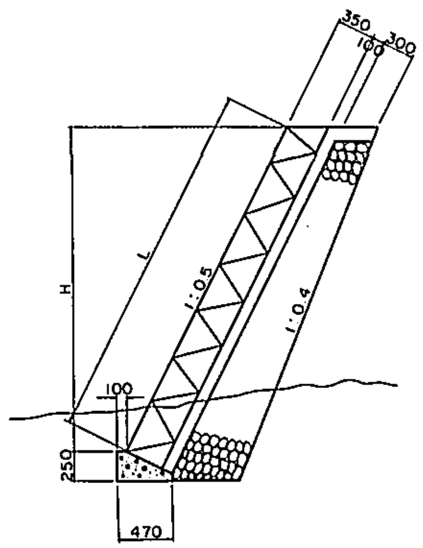


BLOCK MASONRY S=1:30

CUT TYPE



BANK TYPE



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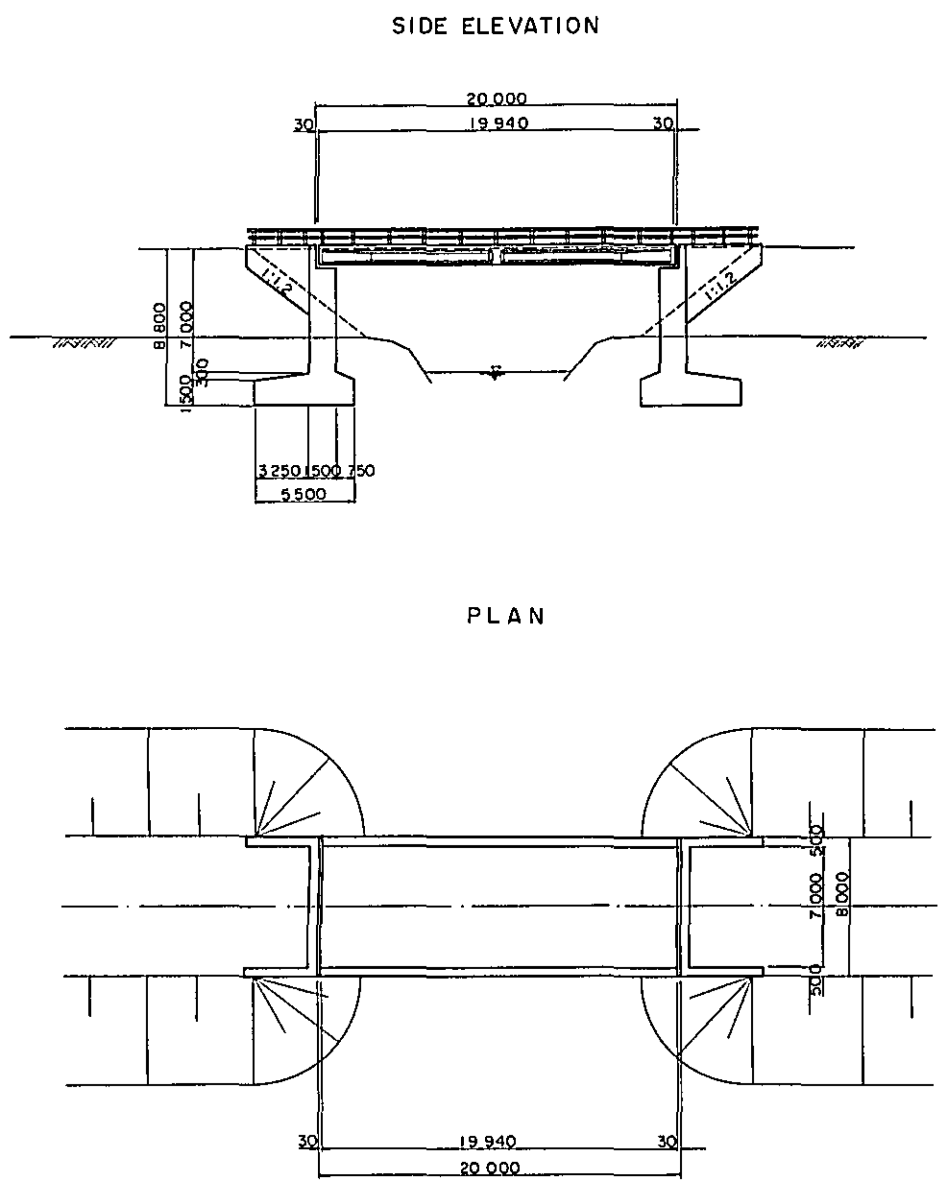
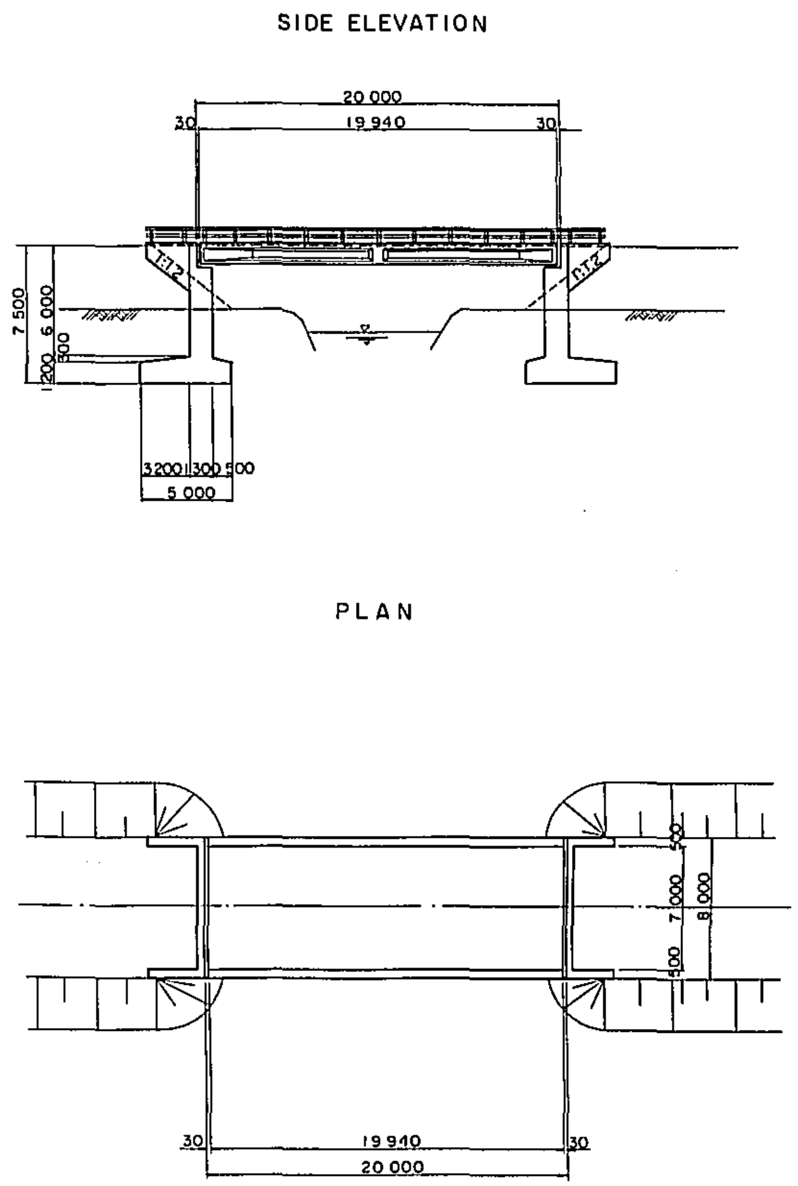
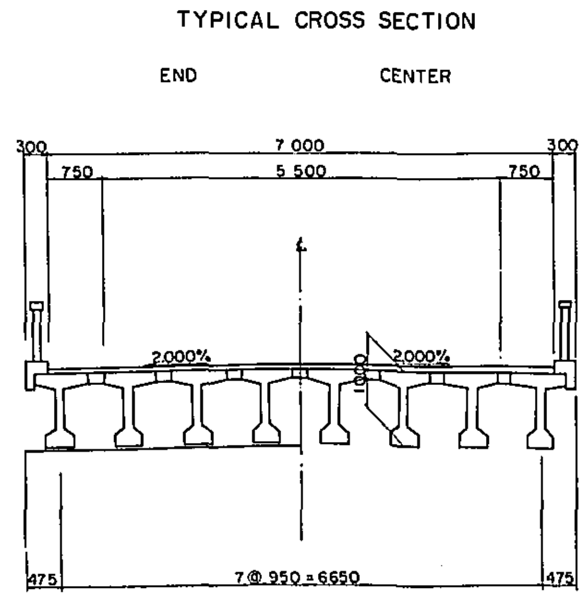
GENERAL VIEW OF PRESTRESSED CONCRETE BRIDGE S=1:200

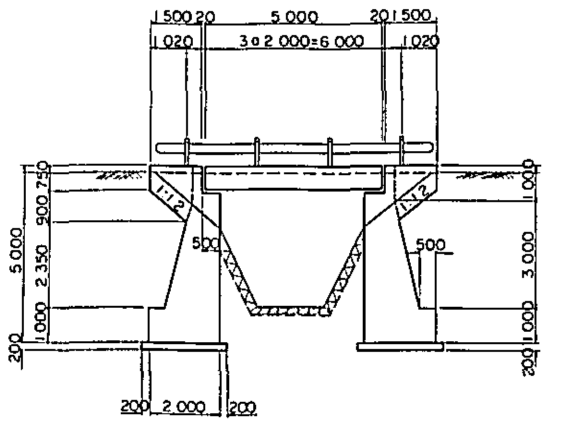




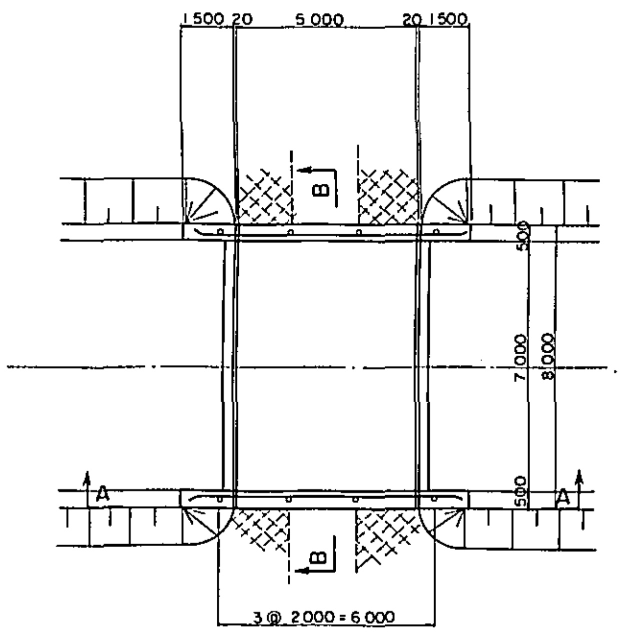


GENERAL VIEW OF CONCRETE SLAB BRIDGE S=1:100

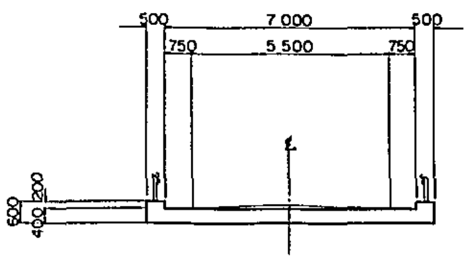
SECTION A-A



PLAN



SECTION B-B

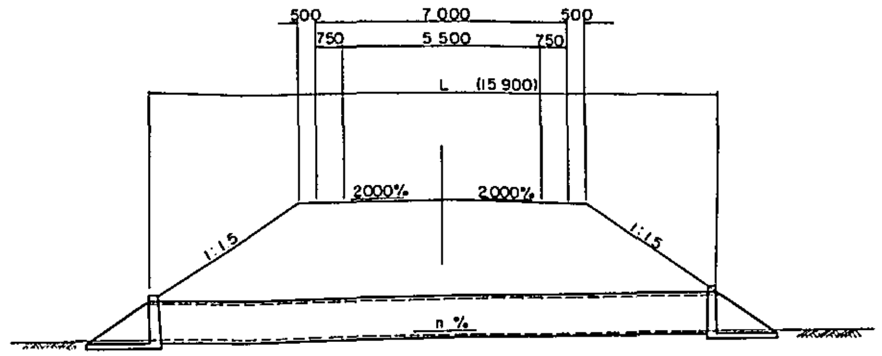


MATERIAL LIST

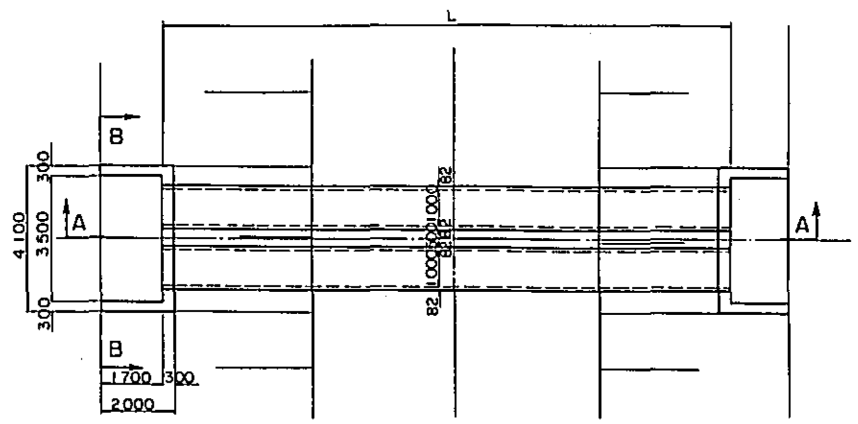
KIND	ITEM	MATERIAL
UPPER		
CONCRETE	M^3	17.0
FORM	M^2	48.0
REINFOR-CEMENT	TON	1.7
LOWER		
CONCRETE	M^3	91.6
FORM	M^2	197.6

GENERAL VIEW OF CONCRETE PIPE S=1:100

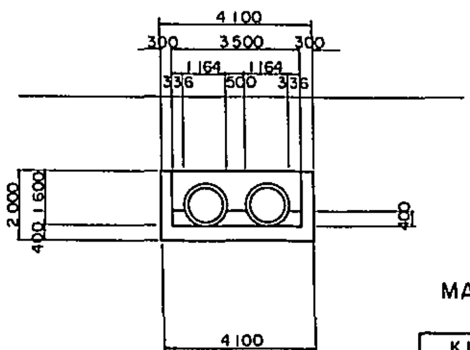
SECTION A-A



PLAN



SECTION B-B

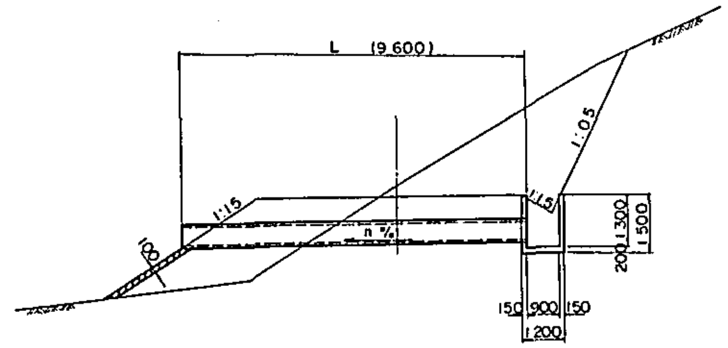


MATERIAL LIST

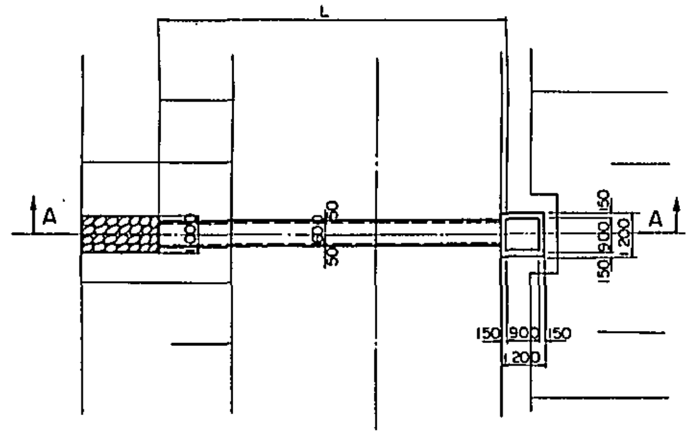
KIND	ITEM	MATERIAL
CONCRETE PIPE		
φ1.00	M	31.8
BASE CONCRETE	M^3	22.0
BASE FORM	M^2	12.2
IN & OUTLET		
CONCRETE	M^3	12.1
FORM	M^2	30.9

GENERAL VIEW OF CORRUGATED PIPE S=1:100

SECTION A-A



PLAN



MATERIAL LIST

KIND	ITEM	MATERIAL
CORRUGATED PIPE		
φ0.60	M	9.6
GRAVEL	M^3	0.3
CATCHBASIN		
CONCRETE	M^3	1.1
FORM	M^2	11.1