

4.5.4 Estimation of Approximate Construction Costs of Projects

The objective of the present study of the Project is the formulation of a master plan for a hydroelectric power development project in the upstream Rio Atrato. Accordingly, the study level is preliminary. Meanwhile, there is also the objective of selecting a project site which should be developed at an early date from among the group of hydroelectric projects on the upstream Rio Atrato, and proceeding with investigations to a feasibility study.

Therefore, in order to study the economics of each of the project sites, approximate calculations were made for construction costs. The estimations were made, however, under the following preconditions.

- 1) For design of the projects, 1/25,000 topographical maps roughly prepared this time using aerial photographs or radar imagery were referred to. For areas of major structures of El Siete No. 1, No. 2, El Once and El Lloro Projects, 1/10,000 topographical maps were employed. Regarding the four project sites of El Siete No. 1, El Siete No. 2, El Once and El Lloro for which it was possible to use aerial photographs it may be said that planning could be done with some degree of accuracy. But for the two sites of El Dieciocho No. 1 and El Dieciocho No. 2 for which radar imagery had to be relied on, the accuracies were inferior compared with the former four sites.
- 2) In estimation of work quantities, approximate quantities were estimated using 1/25,000 topographical maps. However, with respect to work quantities of major structures, rough designing was done using 1/10,000 topographical maps and estimates were made for the individual work items of El Siete No. 1, No. 2, El Once and El Lloro Projects.
- 3) Regarding unit prices for construction costs, the actual unit prices in Colombia in 1980 were referred to and unit prices of 1981 level were estimated. As for machinery and equipment, the purchase prices were determined at 1981 levels.
- 4) Interest during construction was calculated by the approximate formula of $0.4 \times (\text{interest rate}) \times (\text{construction period})$ with the average interest rate for domestic and foreign currency as 8%.

- 5) As the engineering cost and administrative cost, 10% of the direct construction cost was adopted.
- 6) The contingency cost was calculated as 10% of civil works cost and 5% of machinery and equipment purchasing and installation costs.
- 7) Compensation was considered for the houses and cultivated land to be submerged by the reservoir, and roads to be relocated, and was estimated referring to actual unit price in Colombia.

The results are as shown in Table 4-5-15.

Table 4-5-15 Construction Cost of the Upstream Rio Atrato Project

Description	Unit: 10 ³ US\$						
	EL SIETE NO. 1 (150 MW)	EL SIETE NO. 2 (124 MW)	EL ONCE (176 MW)	EL DIECIOCHO NO. 1 (252 MW)	EL DIECIOCHO NO. 2 (261 MW)	EL LLORO (147 MW)	Total (1,120 MW)
Civil Works	81,102	64,836	212,460	207,317	170,219	137,619	
Dam	20,912	3,698	145,515	89,599	23,393	85,463	
Intake	654	807	3,557	2,321	765	14,070	
Sedimentation Basin	—	992	—	—	—	—	
Headrace Tunnel	10,691	23,309	12,151	55,774	16,136	—	
Surge Tank	1,539	2,310	—	7,069	9,102	—	
Penstock Line	31,163	18,248	20,109	15,456	18,760	—	
Powerhouse	9,623	9,154	15,821	20,567	24,972	—	
Tailrace Tunnel	—	—	—	20,567	52,852	25,678	
Outlet	2,110	3,497	12,176	12,915	1,085	1,678	
Switchyard	1,000	775	1,085	1,570	1,630	500	
Construction Road	3,410	2,046	2,046	2,046	5,706	10,230	
Electrical & Mech. Equipment	18,000	20,000	31,800	37,300	40,900	53,200	
Equipment & Camp for Construction	300	300	600	600	600	600	
Total Direct Cost	99,402	85,136	244,860	245,217	211,719	191,419	
Engineering Fee & Administration Cost	9,940	8,514	24,486	24,522	21,172	19,142	
Compensation	6,783	1,523	11,760	11,330	221	9,697	
Contingency	10,712	8,517	26,521	26,242	21,266	19,366	
Total Indirect Cost	27,435	18,554	62,767	62,094	42,659	48,205	
Sub-total	126,837	103,690	307,627	307,311	254,378	239,624	
Interest during Construction	12,163	10,310	39,373	39,689	32,622	23,376	
Total Construction Cost	139,000	114,000	347,000	347,000	287,000	263,000	1,497,000

4.5.5 Evaluation of Economic Effect of Each Project

The construction cost per kW and the construction cost per kWh were determined for each project based on the annual energy production estimated in 4.5.2 and the approximate construction cost estimated in 4.5.4, while further, generating cost was obtained with annual expense factor as 12%, and the results are as shown below.

Table 4-5-16 Economic Effect for Each Project

Project	Max. power output (MW)	Annual energy production (GWH)	Construction cost (Million US\$)	Con-struction cost per kW (US\$/kW)	Con-struction cost per kWh (US\$/kWh)	Gener-ating cost (US\$/kWh)
1. El Siete No. 1	160	735	139	869	0.189	0.023
2. El Siete No. 2	124	608	114	919	0.188	0.023
Sub-total (1 + 2)	284	1,343	253	891	0.188	0.023
3. El Once	176	753	347	1,972	0.461	0.055
4. El Dieciocho No. 1	252	1,091	347	1,377	0.318	0.038
5. El Dieciocho No. 2	261	1,115	287	1,100	0.257	0.031
Sub-total (4 + 5)	513	2,206	634	1,236	0.287	0.034
6. El Lloro	147	592	263	1,789	0.444	0.053
Total	1,120	4,894	1,497	1,337	0.306	0.037

As seen from the figures in the preceding table, El Siete No. 1 and No. 2 (total output 284 MW) will have a construction cost per kW of US\$891/kW, the cheapest at the upstream Rio Atrato, while the generating cost will also be the cheapest at US\$0.023/kWh (COL\$1.15/kWh).

These projects as ones to be implemented in 1988 and after will not be inferior compared with the other projects prepared by Colombia (see 4.2.3).

As stated in 4.2.1(7), the actual electricity rate is COL\$0.84/kWh (US\$0.0168/kWh) on the average. However, this rates are being raised at an average of 2%/month (27% annually), and it may be assumed that a time will come when other project sites including those in the Upstream Rio Atrato Basin will be profitable.

Meanwhile, the construction cost per kW of the El Dieciocho No. 1 and No. 2 projects (total output 513 MW) will be US\$1.236, while the generating cost will be US\$0.034/kWh (COL\$1.7/kWh). These projects are higher in generating costs than El Siete No. 1 and No. 2 Projects, but the time when they will be profitable will come in the near future.

The generating costs of the El Once and El Lloro projects are US\$0.055/kWh and US\$0.053/kWh, respectively, to pose problems about their economic effectivities, and these projects should be held pending for the time being.

CHAPTER 5 **METHOD OF PROCEEDING WITH FURTHER INVESTIGATION
WORKS AND FEASIBILITY STUDY**

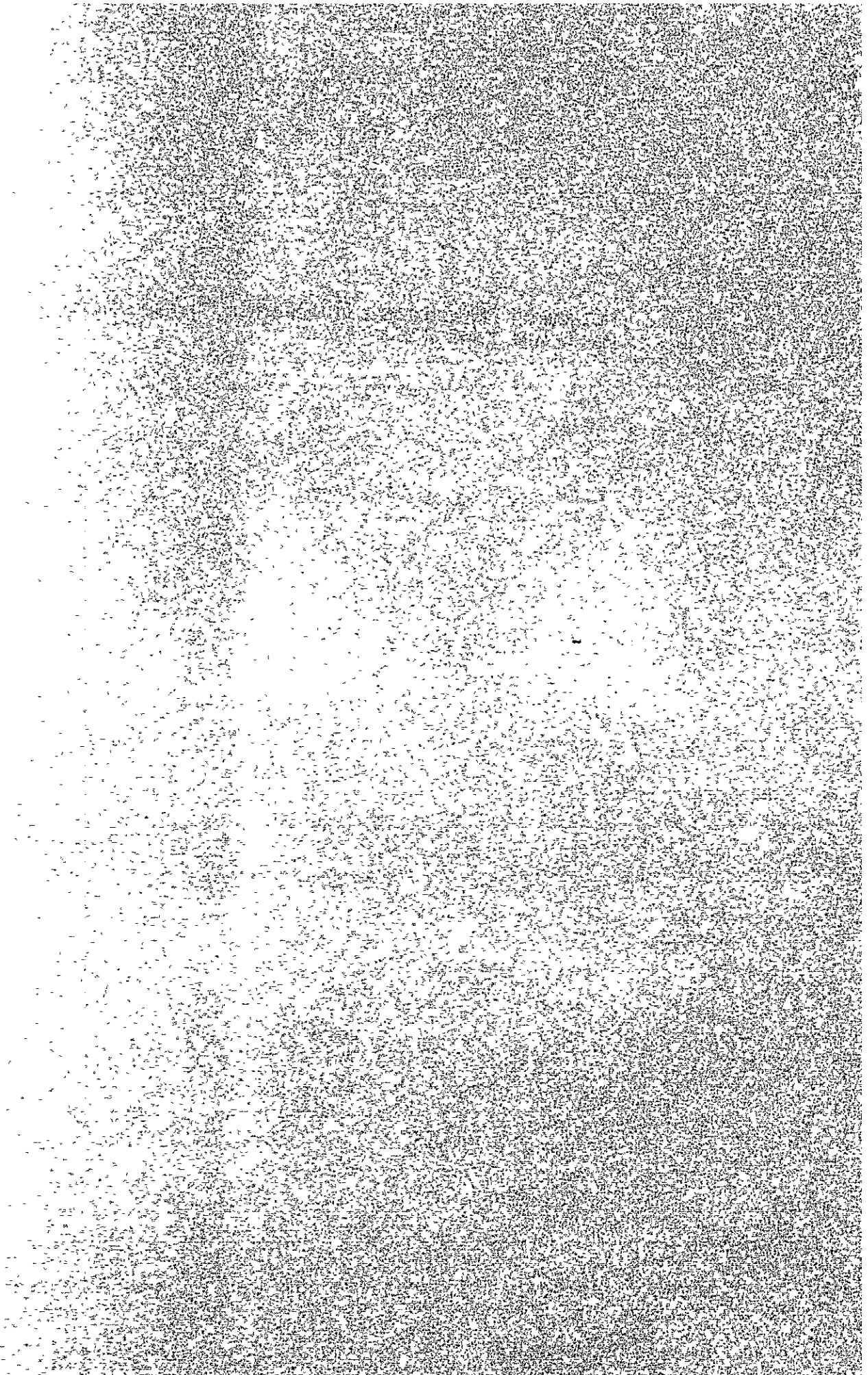


TABLE LIST

- | | |
|-------------|---|
| Table 5-1-1 | List of Field Investigation Works of El Siete No.1 and No.2 Project |
| Table 5-1-2 | List of Proposed Subsurface Investigation Works of El Siete No.1 and No.2 Project |
| Table 5-1-3 | List of Observation for Concrete Sand and Aggregate Sieve Analyses Test |

5. Method of Proceeding with Further Investigation Works and Feasibility Study

In the study for the master plan on Rio Atrato electric power development just carried out, the start of the study was made from a incomplete condition of topographical maps and hydrological data, and the adequate data for use in a master plan study had to be graded up in Tokyo as worth data for this study.

For example, 1/25,000 topographical maps were prepared carrying out simple mapping utilizing aerial photographs. These maps are capable of covering only the El Siete No. 1 and No. 2 projects, the El Once project, and the El Lloro project, while for the El Dieciocho No. 1 and No. 2 projects the topographical maps were prepared based on radar imagery and taking into account data of simple surveying carried out in the field. These topographical maps cannot be used for a feasibility study because of low accuracy.

Meanwhile, regarding geological investigations, the condition was one which the detailed investigations had not been made at all. Therefore, in order to raise the El Siete No. 1 and No. 2 Projects to the feasibility study level, the investigation works described below must be carried out prior to the study.

5.1 Topographical Surveying

In order to proceed hereafter with the feasibility study on the power generation project at the upstream part of the Rio Atrato, it is necessary for various topographical maps to be prepared at an early date. For this purpose, it is necessary for complete aerial photography works in the project area to be carried out as soon as possible.

The items of topographical maps to be prepared are 1/25,000 aerial photographic survey maps, 1/5,000 aerial photographic survey maps and 1/2,000 surveyed topographical maps.

Details of topographical surveying and the estimated quantities at the project sites are described below.

(1) Aerial Photography

In order to carry out the aerial photographic surveying and the photogeological interpretation, it will be necessary for aerial photography works covering the entire catchment areas of the project sites to be carried out. Prior to taking aerial photographs, the necessary signals and new bench mark must be installed on the ground, while it will be needed for leveling to be done from the existing bench mark (El Siete bench mark) to the location indicated in Drawing-13. These bench marks must be made possible to be identifiable in aerial photographs.

(2) Leveling

Leveling is to be performed from the existing bench mark to the project sites and bench marks installed for surveying of topographical maps.

(3) Aerial Photographical Map, Scale: 1/25,000

For planning of the project and studying the layout of structures, 1/25,000 scale aerial photographical maps are to be prepared using aerial photographs and the results of ground surveying. The necessary control points are to be provided in the project area for mapping works.

(4) Aerial Photographical Map, Scale: 1/5,000

For calculation of storage capacity at the reservoir, scale 1/5,000 aerial photographical maps of the reservoir areas are to be prepared.

(5) Topographical Map, Scale: 1/2,000

For design of major structures, scale: 1/2,000 topographical maps of the damsite, penstock, powerhouse and substation areas are to be prepared.

The work quantities of the above topographical surveys for the El Siete No. 1 and No. 2 projects are as shown in Table 5-1-1.

Table 5-1-1 List of Field Investigation Works of
El Siete No. 1 and No. 2 Project

Works	Unit	El Siete No.1	El Siete No.2	Total	Remarks
Aerial Photographing	km ²	-	-	450	
Leveling	km	-	-	40	Bench Mark 12 sites points
1/25,000 Aerial Photographical Map	km ²	41	28	69	
1/5,000 Aerial Photographical Map	km ²	1.0	-	1.0	
1/2,000 Topographical Map	km ²	3.7	1.5	5.2	

5.2 Geological Survey Works

The geological survey works necessary for the El Siete No. 1 and No. 2 projects to be raised to the levels of feasibility studies are as described below.

(1) Geological Survey and Photogeological Interpretation

- ° Preparation of detailed geological maps of sites of dams, penstocks and powerhouses using topographical maps (scale: 1/2,000) made by ICEL.
- ° Geological interpretations of aerial photographs (scale: 1/25,000) and preparation of geological maps using aerial photographical maps (scale: 1/5,000, 1/25,000) made by ICEL in relation to reservoirs, headrace tunnels and tailraces.

(2) Subsurface Investigations

° Boring Works

The work quantities of boring for geological survey works are shown in Table 5-1-2. The locations of boring are shown in Drawing-14. Furthermore, permeability tests are to be performed in all of the borehole at the damsites.

° Adits

The work quantities of adits are as shown in Table 5-1-2 and the locations in Drawing-14.

° Observation of suspension sand. concrete aggregate sieve analysis test.

The work quantities are as shown in Table 5-1-3 and the locations in Drawing-15.

Table 5-1-2 List of Proposed Subsurface Investigation Works of El Siete No. 1 and No.2 Project

Project	Site	Work	No.	Elevation (m)	Length (m)	Direction	Remarks	
El Siete No. 1	Dam	Drill hole	AD-1	1,470.0	30.0	90°	Right Bank *	
			AD-2	1,435.0	30.0	90°	ditto *	
			AD-3	1,415.0	30.0	90°	River bed *	
			AD-4	1,470.0	30.0	90°	Left Bank *	
			AD-5	1,460.0	30.0	90°	Right Bank *	
			AD-6	1,430.0	30.0	90°	ditto *	
	Total: 6 holes 180 m							
			Adit	AA-1	1,435.0	40.0	N20°E, 0°	Right Bank
				AA-2	1,435.0	30.0	S20°W, 0°	Left Bank
	Total: 2 adits 70 m							
	Penstock		Drill hole	AP-1	1,420.0	20.0	90°	
				AP-2	1,310.0	20.0	90°	
AP-3				1,220.0	20.0	90°		
AP-4				1,120.0	20.0	90°		
Power House		Drill hole	AH-1	995.0	30.0	90°		
Total: 5 holes 110 m								
El Siete No. 2	Intake Dam	Drill hole	BD-1	1,000.0	20.0	90°	Right Bank	
			BD-2	980.0	20.0	90°	River bed *	
			BD-3	1,000.0	20.0	90°		
	Penstock	Drill hole	BP-1	880.0	20.0	90°		
			BP-2	810.0	20.0	90°		
			BP-3	760.0	20.0	90°		
	Power House		Drill hole	BH-1	730.0	30.0	90°	
Total: 7 holes 150 m								

Note: * Permeability test

Table 5-1-3 List of Observation for Concrete Sand and Aggregate Sieve Analyses Test

No. of Hole	Hole Depth	Total Depth	Observation area
10	10 m	100 m	60,000 m ²

Note: The dimension of vertical hole is 2 m x 2 m in a regular square, and about 10 m of depth. The necessary concrete quantities for El Siete No.1 and No.2 Project are 420,000 m³. (250,000 m³ for El Siete No.1 Project and 170,000 m³ for El Siete No.2 Project)

5.3 Method of Proceeding with Feasibility Study

With regard to the manner of proceeding with a feasibility study, there is described in "Inception Report on Feasibility Study for Atrato River Hydroelectric Power Development Project" submitted to ICEL by JICA in August 1981 before starting on the present First Study (master plan formulation) and agreed upon by the two parties.

Here, it was decided to revise the abovementioned Inception Report giving consideration to the results of studies of the master plan.

The parts to be revised and the reasons for revision are as follows:

- (1) Adopted scale for topographical maps -
- ° Area of the project : 1/25,000
 - ° Tunnel routes and El Lloro Reservoir : 1/10,000
 - ° Reservoirs of El Siete, El Once and El Dieciocho : 1/5,000
 - ° Structures such as dams, spillways, surge tanks, penstocks and powerhouses : 1/2,000

- (2) Field investigation works for a feasibility study are to be carried out limited to the El Siete No. 1 and No. 2 projects.
- (3) It was assumed that if geological survey works are limited to the El Siete No. 1 and No. 2 projects, the items of investigation listed below could be omitted.

° Geophysical prospecting:

There is no firm in Colombia with the capability of performing geophysical prospecting, and instead, the number of drill holes is to be increased for clarifying the geological conditions.

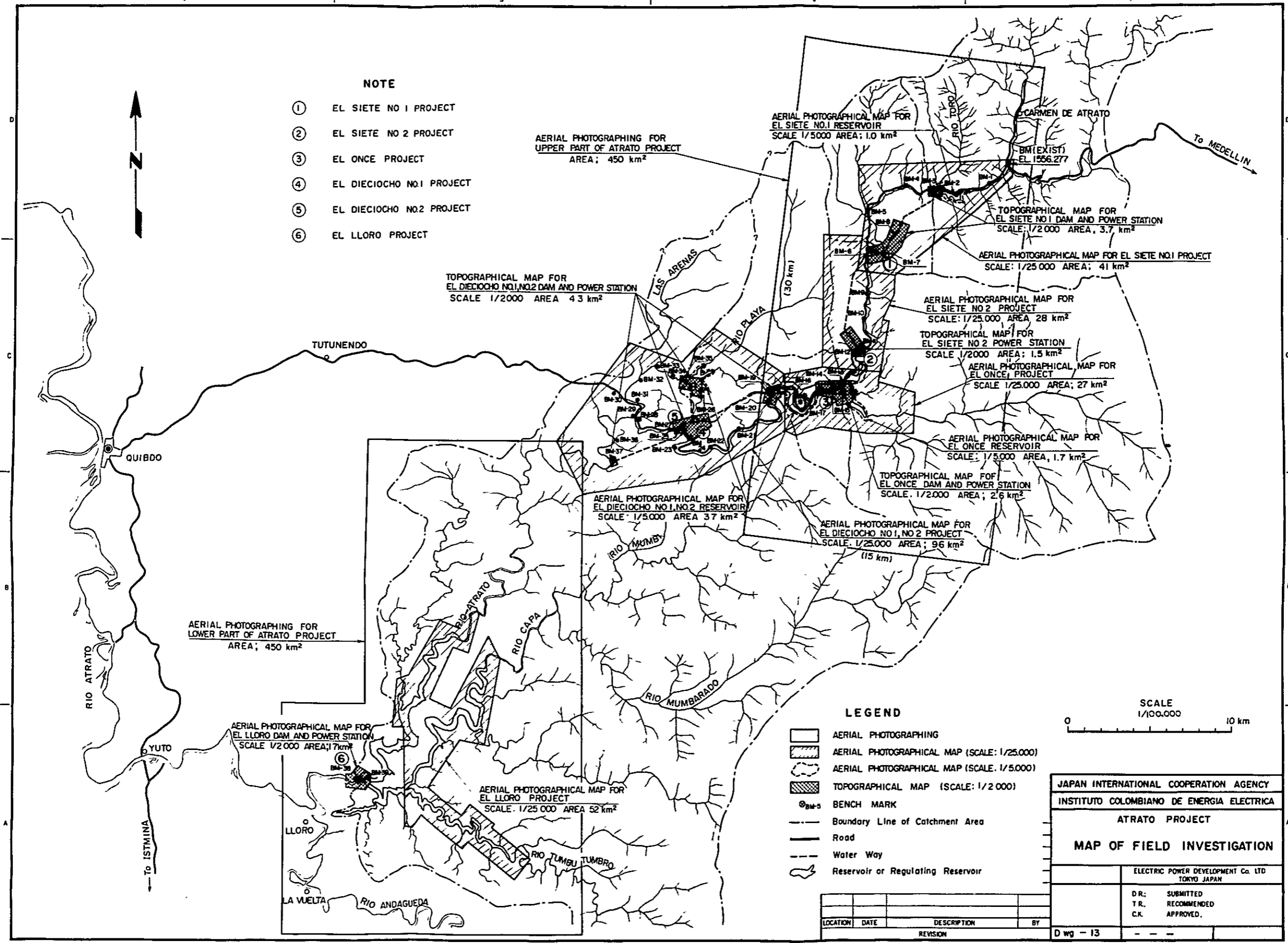
° Permeability test:

The damsites of both El Siete No. 1 and No. 2 have relatively small quantities of river deposits and permeability tests of river deposit are not necessary, but the Permeability test for dam foundation rocks are to be carried out in boring hole of each dam site.

- (4) Changing of number of sites for installation of gaging stations.

Since the feasibility study is to be limited to the El Siete No. 1 and No. 2 projects, new gaging stations are to be provided at the El Siete No. 2 Damsite and Rio Playa bridge. Also, precipitation observation stations are to be installed together with the runoff gaging stations.

The Inception Report of August 1981 should be revised considering the above points.



- NOTE**
- ① EL SIETE NO 1 PROJECT
 - ② EL SIETE NO 2 PROJECT
 - ③ EL ONCE PROJECT
 - ④ EL DIECIOCHO NO.1 PROJECT
 - ⑤ EL DIECIOCHO NO.2 PROJECT
 - ⑥ EL LLORO PROJECT

AERIAL PHOTOGRAPHING FOR UPPER PART OF ATRATO PROJECT
AREA; 450 km²

AERIAL PHOTOGRAPHICAL MAP FOR EL SIETE NO.1 RESERVOIR
SCALE 1/5000 AREA; 1.0 km²

TOPOGRAPHICAL MAP FOR EL SIETE NO.1 DAM AND POWER STATION
SCALE: 1/2000 AREA; 3.7 km²

AERIAL PHOTOGRAPHICAL MAP FOR EL SIETE NO.1 PROJECT
SCALE: 1/25 000 AREA; 41 km²

AERIAL PHOTOGRAPHICAL MAP FOR EL SIETE NO 2 PROJECT
SCALE: 1/25,000 AREA; 28 km²

TOPOGRAPHICAL MAP FOR EL SIETE NO 2 POWER STATION
SCALE 1/2000 AREA; 1.5 km²

AERIAL PHOTOGRAPHICAL MAP FOR EL ONCE PROJECT
SCALE 1/25,000 AREA; 27 km²

AERIAL PHOTOGRAPHICAL MAP FOR EL ONCE RESERVOIR
SCALE: 1/5,000 AREA; 1.7 km²

TOPOGRAPHICAL MAP FOR EL ONCE DAM AND POWER STATION
SCALE: 1/2,000 AREA; 2.6 km²

AERIAL PHOTOGRAPHICAL MAP FOR EL DIECIOCHO NO.1, NO.2 RESERVOIR
SCALE: 1/5,000 AREA 37 km²

AERIAL PHOTOGRAPHICAL MAP FOR EL DIECIOCHO NO.1, NO.2 PROJECT
SCALE: 1/25,000 AREA; 96 km²
(15 km)

AERIAL PHOTOGRAPHING FOR LOWER PART OF ATRATO PROJECT
AREA; 450 km²

AERIAL PHOTOGRAPHICAL MAP FOR EL LLORO DAM AND POWER STATION
SCALE 1/2 000 AREA; 7 km²

AERIAL PHOTOGRAPHICAL MAP FOR EL LLORO PROJECT
SCALE: 1/25 000 AREA 52 km²

LEGEND

- AERIAL PHOTOGRAPHING
- AERIAL PHOTOGRAPHICAL MAP (SCALE: 1/25,000)
- AERIAL PHOTOGRAPHICAL MAP (SCALE: 1/5,000)
- TOPOGRAPHICAL MAP (SCALE: 1/2 000)
- BENCH MARK
- Boundary Line of Catchment Area
- Road
- Water Way
- Reservoir or Regulating Reservoir

SCALE
1/100,000
0 10 km

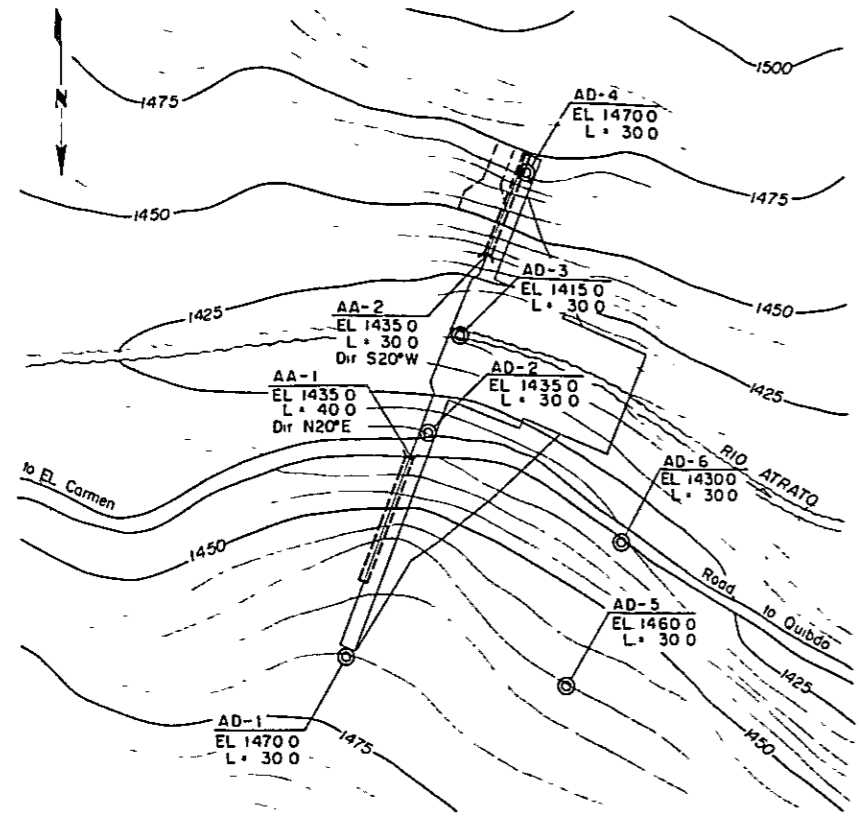
JAPAN INTERNATIONAL COOPERATION AGENCY
INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA
ATRATO PROJECT
MAP OF FIELD INVESTIGATION
ELECTRIC POWER DEVELOPMENT Co. LTD
TOKYO JAPAN

LOCATION	DATE	DESCRIPTION	BY
		REVISION	

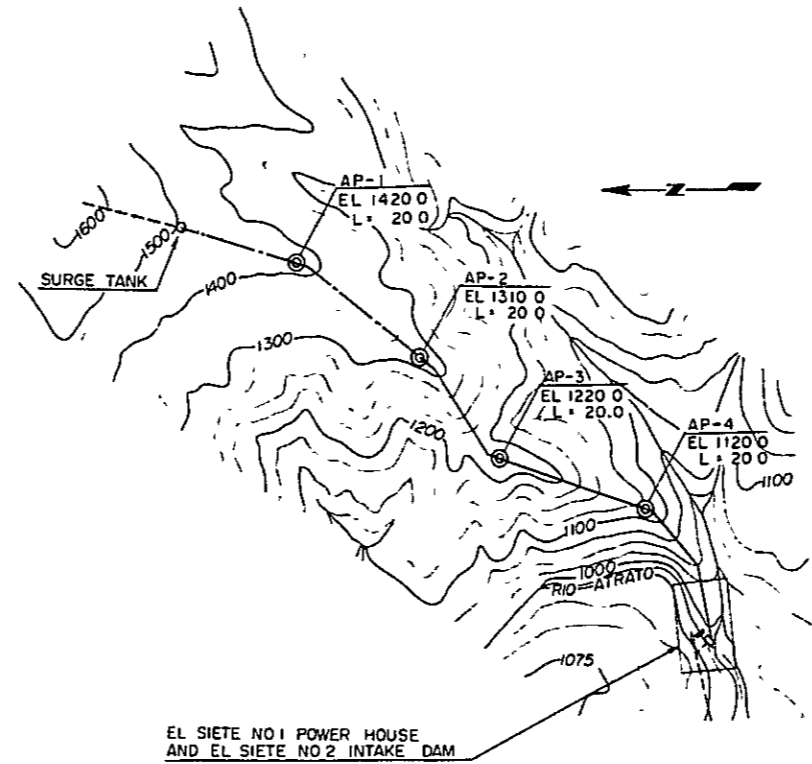
D.R. SUBMITTED
T.R. RECOMMENDED
C.K. APPROVED.

Dwg - 13
SHEET NO OF

EL SIETE NO. 1 DAM



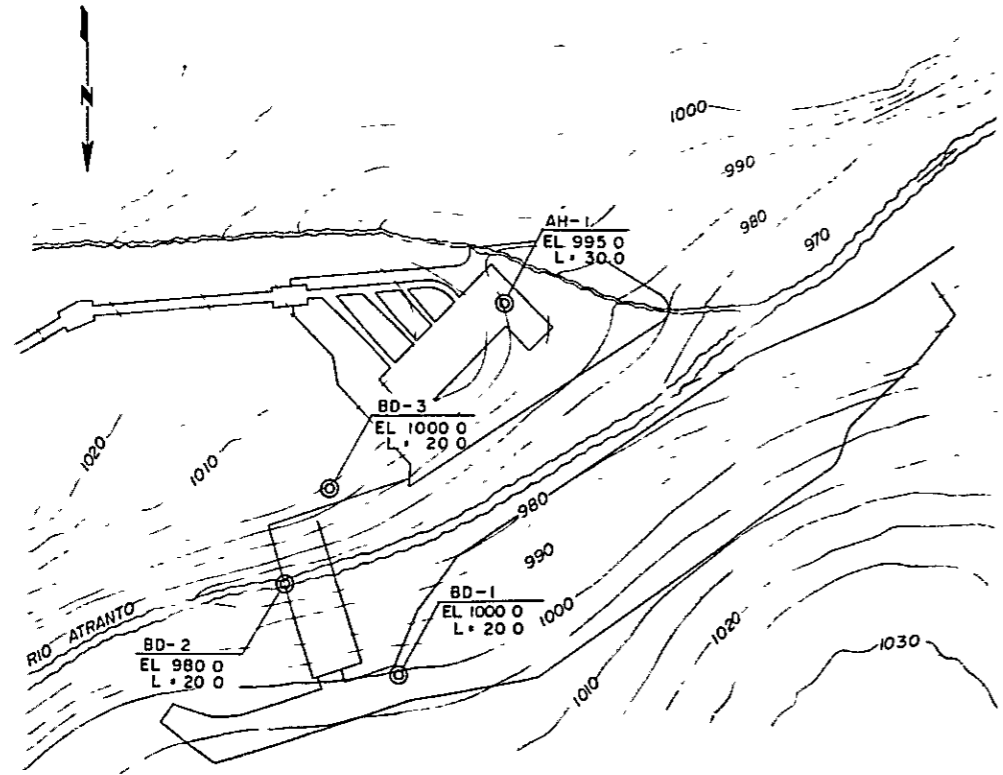
EL SIETE NO. 1 PENSTOCK



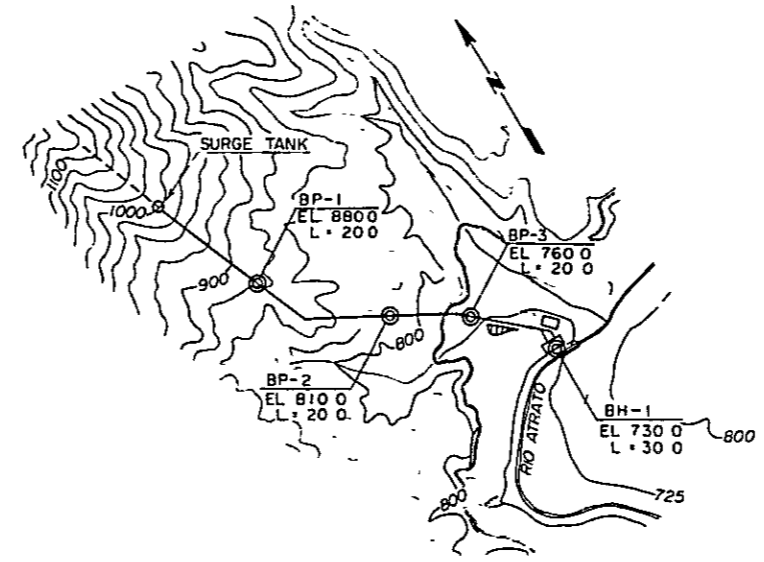
LEGEND

- Drill hole
- AD - Name of Hole
EL - Elevation (m)
L - Length of Hole (m)
- Adit
- AA - Name of Adite
EL - Elevation (m)
L - Length of Adite (m)
Dir - Direction

EL SIETE NO 1 POWER HOUSE AND EL SIETE NO.2 INTAKE DAM



EL SIETE NO 2 PENSTOCK AND POWER HOUSE



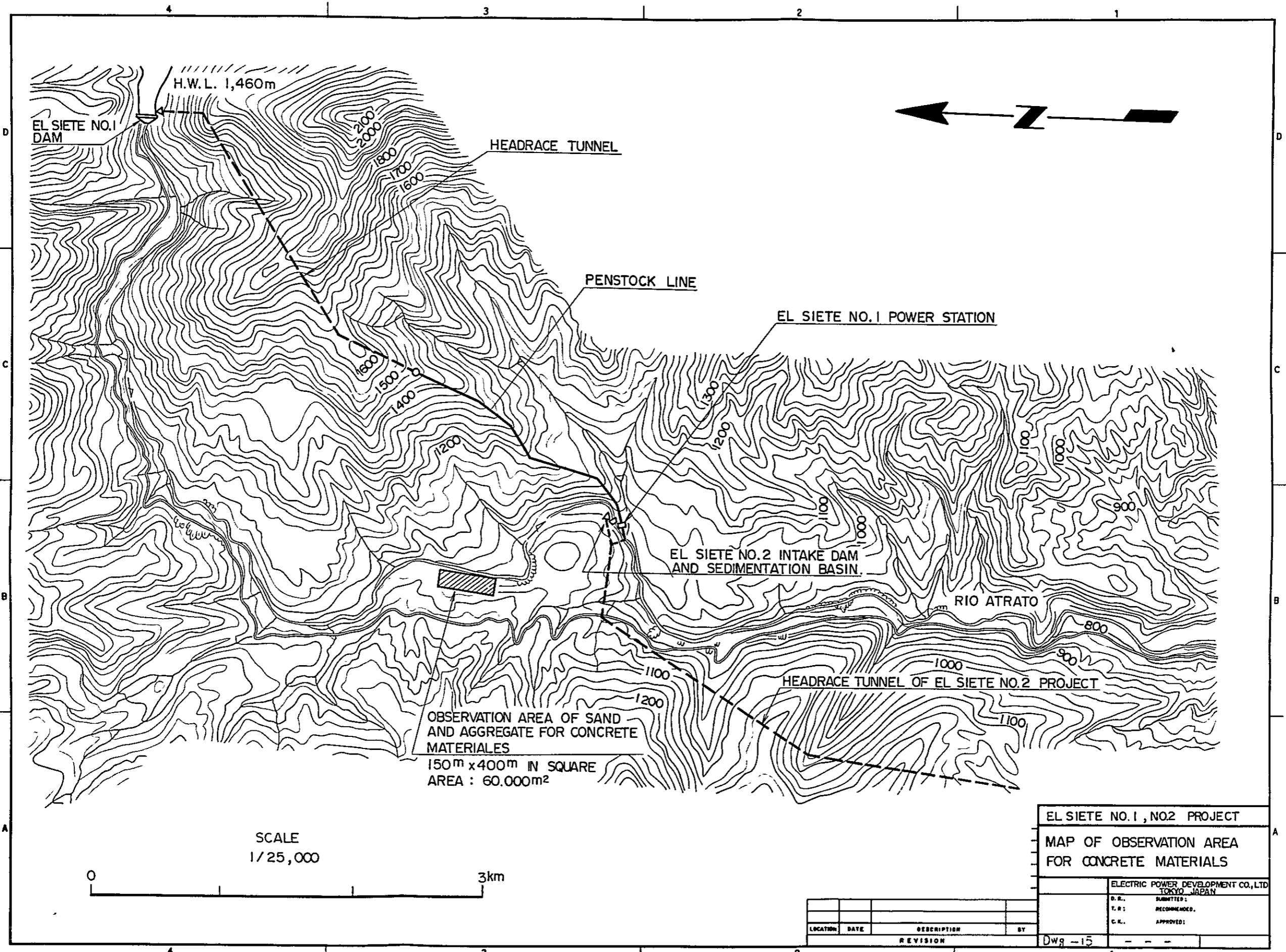
- 0 100 m
- "EL SIETE NO 1 DAM" and "EL SIETE NO 1 POWER HOUSE AND EL SIETE NO 2 INTAKE DAM"
- 0 1000 m
- "EL SIETE NO 1 PENSTOCK" and "EL SIETE NO 2 PENSTOCK AND POWER HOUSE"

JAPAN INTERNATIONAL COOPERATION AGENCY	
INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA	
ATRATO RIVER PROJECT	
LOCATION OF PROPOSED SUBSURFACE INVESTIGATION WORKS OF EL SIETE NO1 AND NO 2 PROJECT	
ELECTRIC POWER DEVELOPMENT Co LTD TOKYO JAPAN	
DR	SUBMITTED
TR	RECOMMENDED
CK	APPROVED

LOCATION	DATE	DESCRIPTION	BY
		REVISION	

Dwg - 14

1 SHEET NO OF



SCALE
1/25,000

0 3km

OBSERVATION AREA OF SAND
AND AGGREGATE FOR CONCRETE
MATERIALES
150m x 400m IN SQUARE
AREA : 60.000m²

LOCATION	DATE	DESCRIPTION	BY
REVISION			

EL SIETE NO.1 , NO2 PROJECT	
MAP OF OBSERVATION AREA FOR CONCRETE MATERIALS	
ELECTRIC POWER DEVELOPMENT CO., LTD TOKYO, JAPAN	
D.R.	SUBMITTED:
T.R.	RECOMMENDED:
C.K.	APPROVED:
Dwg - 15	- - -

1 SHEET NO. OF

APPENDIX

APPENDIX-I Photomicrograph and Petrographic Description of Rock

APPENDIX-II Rating Curve

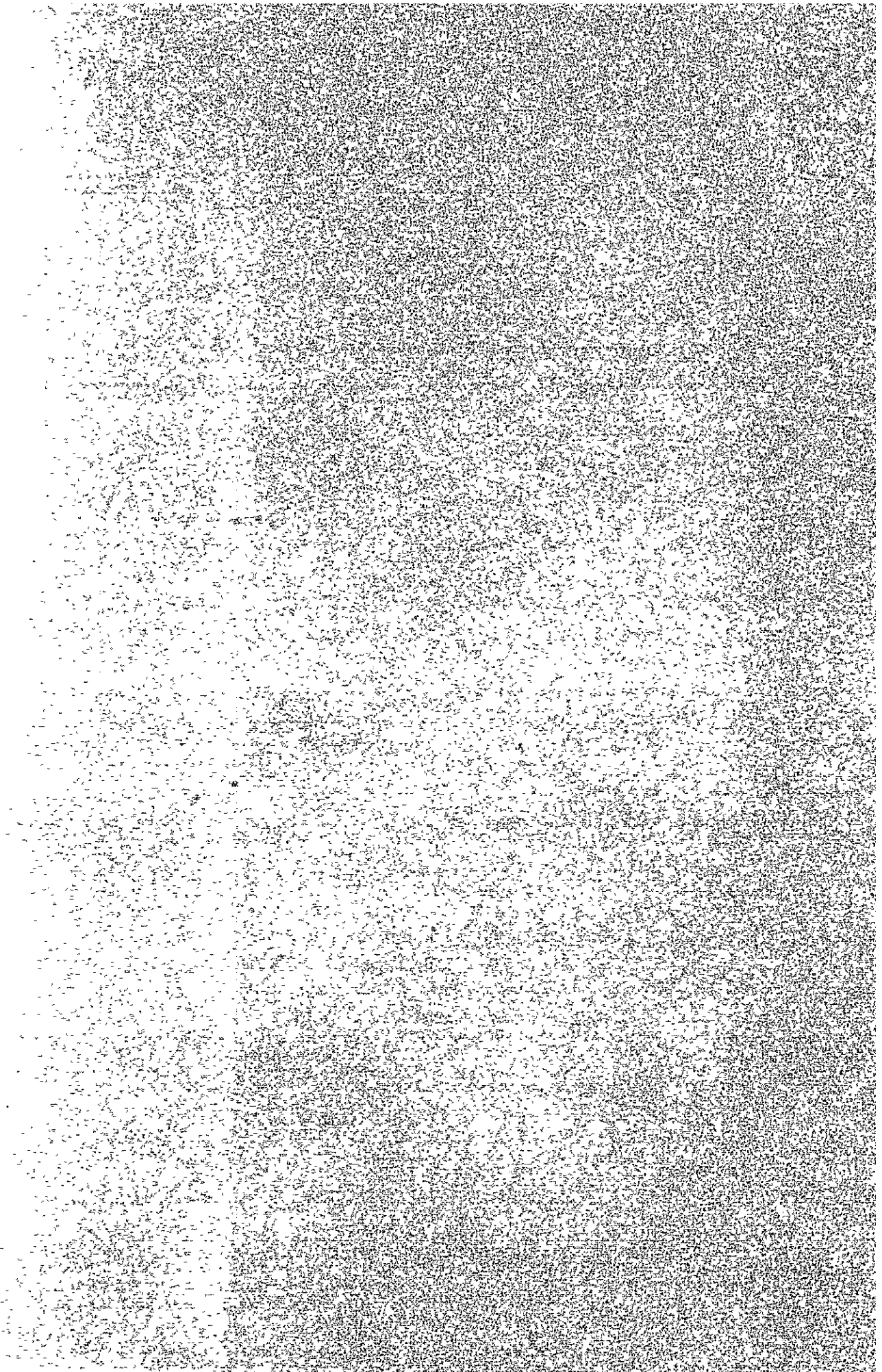


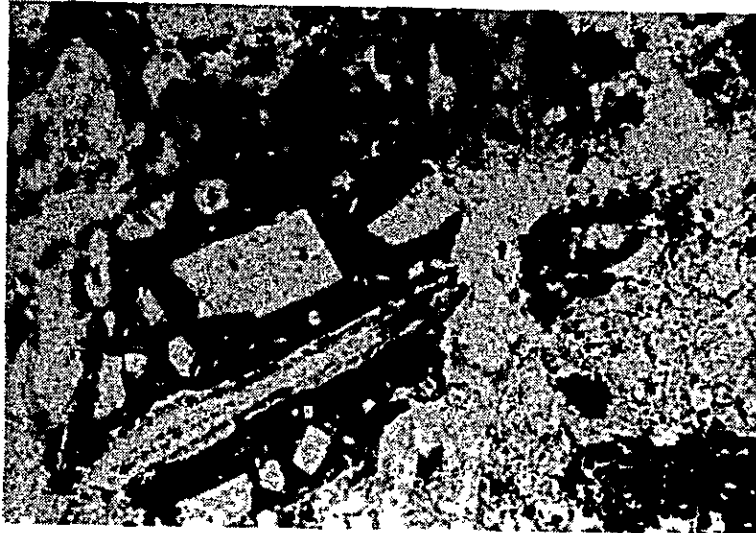
FIGURE LIST

- Fig. A-2-1 RATING CURVE AT PUENTE DE SANCHEZ GAGING STATION
Fig. A-2-2 RATING CURVE AT LOS ARAYANEZ GAGING STATION

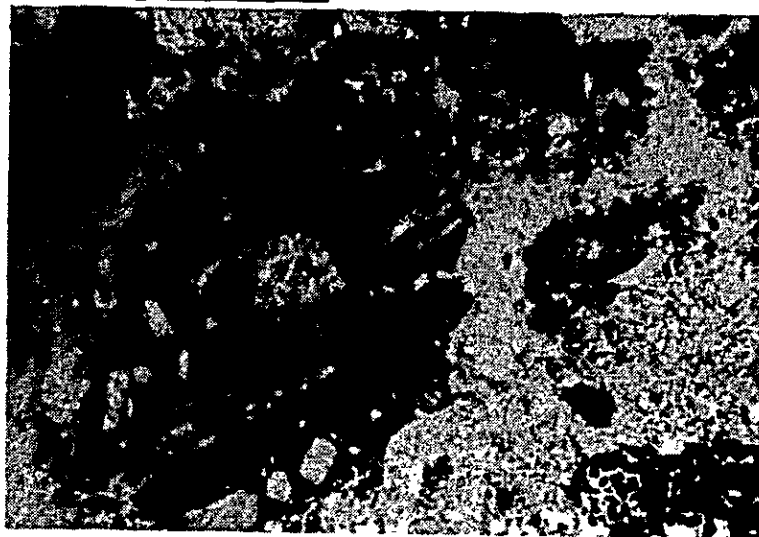
Photomicrograph and Petrographic Description of Rock (Plate 1 of 5)

Locality: El Siete No. 1 Project, Damsite

Rock name: Deep reddish green altered basaltic tuff



0 0.5mm (open nicols)



(crossed nicols)

Petrographic description:

Hydrothermally altered basaltic tuff (the so-called "schalstein"). Plagioclases were replaced by albite and sericite along cleavage planes. Augite crystals also suffer chloritization along cleavage or crystal margin. Tuffaceous texture shown by the presence of basaltic bombs is clearly observed. Extremely low double refraction of chloritic mineral indicate no swelling character.

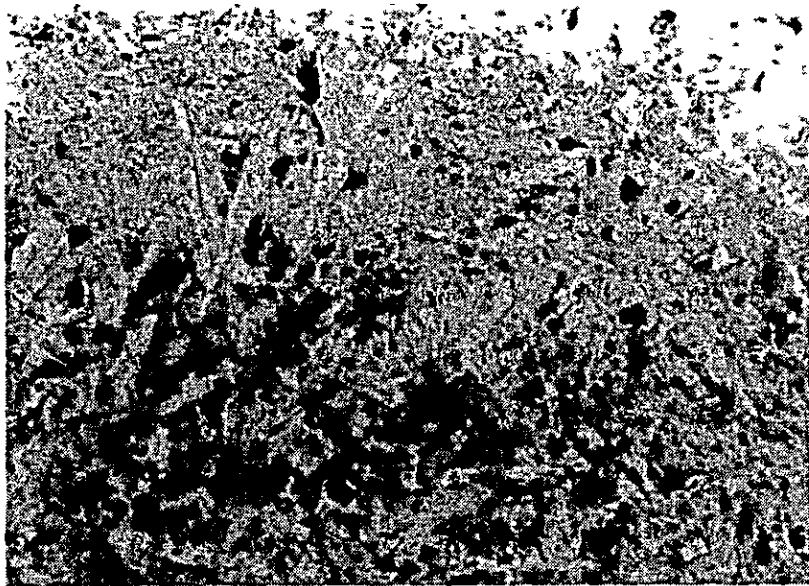
Rock forming minerals;

Plagioclase > Augite >> Chlorite > Magnetite > Hematite, Leucoxene

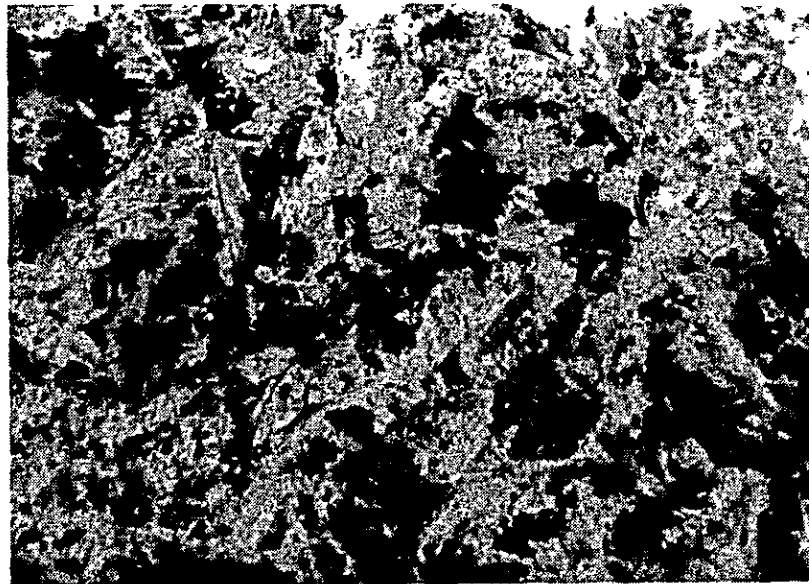
Photomicrograph and Petrographic Description of Rock (Plate 2 of 5)

Locality: El Siete No. 2 Project, near the Headrace Tunnel Route

Rock name: Dark green diabase (dolerite)



0.5mm (open nicols)



(crossed nicols)

Petrographic description:

Originally augite dolerite but has been hydrothermally altered. "Metadiabase" is commonly used for this type of rock. Most of augite crystals have been replaced by pale green actinolite and chlorite and plagioclase was albitized. Ophitic texture is clearly observed and no deformation texture is present. No swelling chlorite is observed.

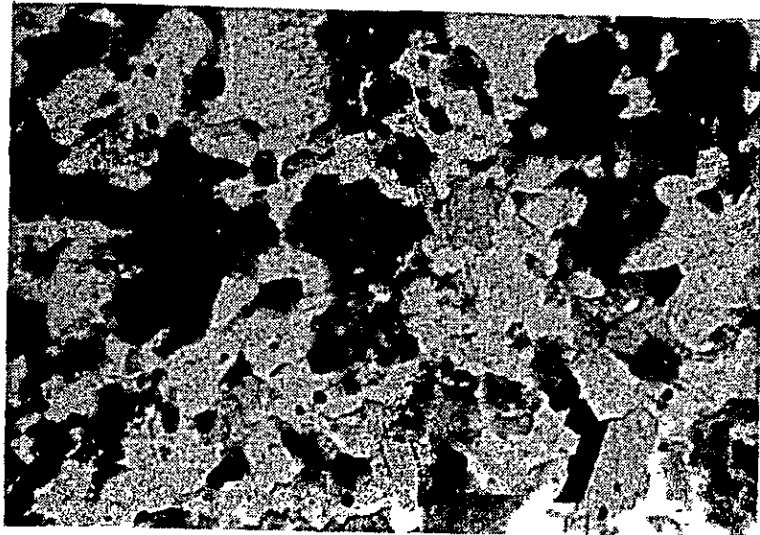
Rock forming minerals;

Actinolite > Plagioclase > Augite >> Chlorite > Leucoxene

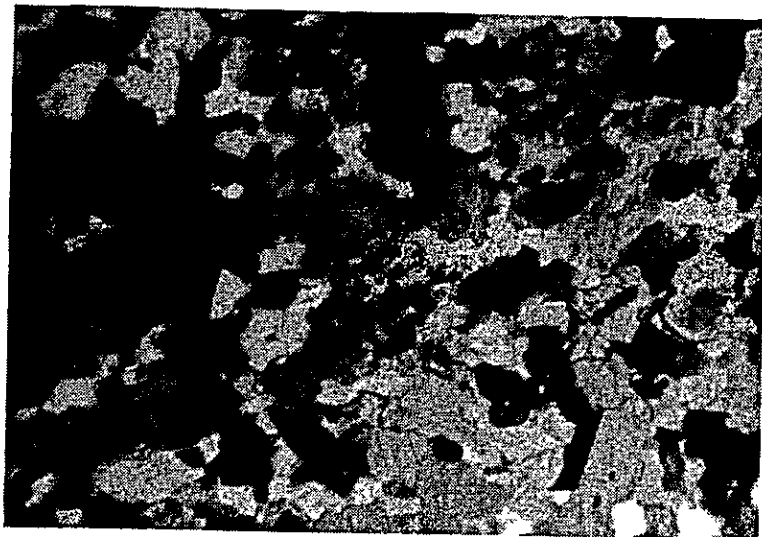
Photomicrograph and Petrographic Description of Rock (Plate 3 of 5)

Locality: El Once Project, near the Damsite

Rock name: Dark green medium-grained amphibolite



0 0.5mm (open nicols)



(crossed nicols)

Petrographic description:

Fresh granular amphibolite chiefly composed of grass green hornblende and plagioclase. Plagioclases have suffered weak albitization along their cleavage planes.

Metamorphic rock originated from basaltic rock. Commonly found as xenolith within acid plutonic mass.

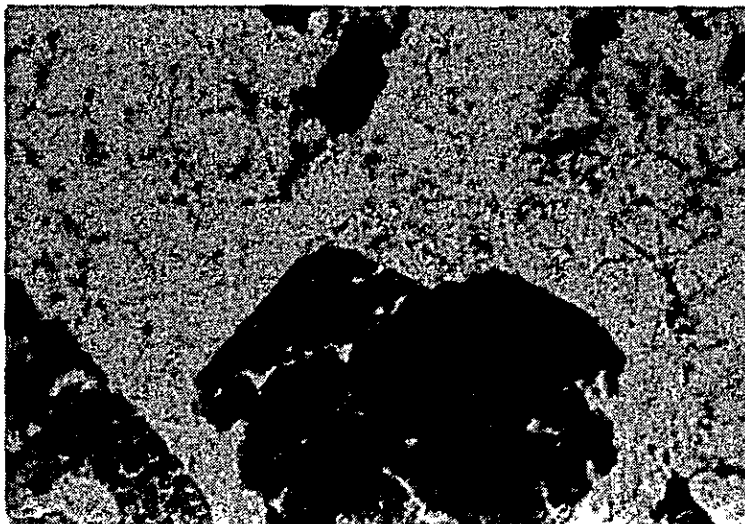
Rock forming minerals;

Plagioclase > Hornblende > Quartz > Magnetite

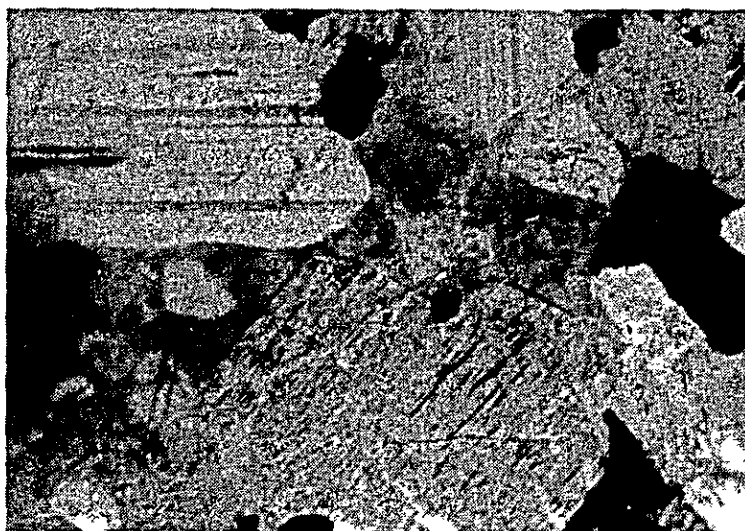
Photomicrograph and Petrographic Description of Rock (Plate 4 of 5)

Locality: El Diechiocho No. 1 Project, near the Damsite

Rock name: Coarse-grained Granodiorite



0 5mm (open nicols)



(crossed nicols)

Petrographic description:

Typical hornblende-biotite granodiorite. Plagioclase having weak zonal texture has been altered partly by albite and sericite. Color of hornblende is brownish green. Brown biotite was chloritized along cleavage planes.

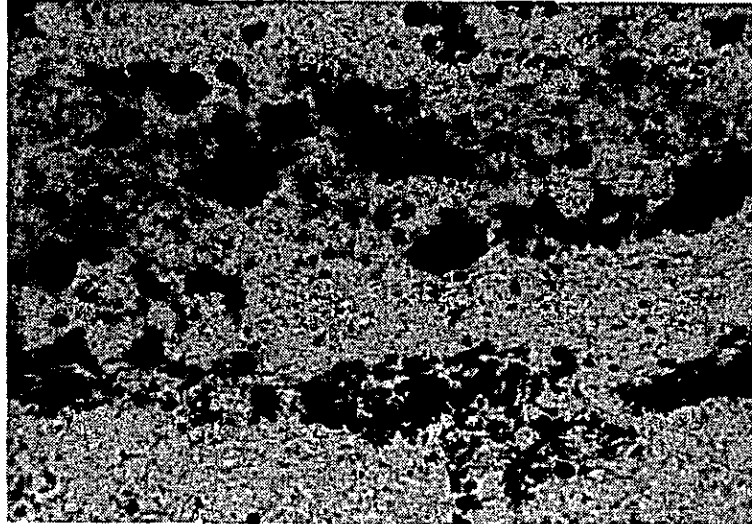
Rock forming minerals;

Plagioclase > Hornblende > Quartz > Biotite > K-feldspar > Magnetite > Zircon

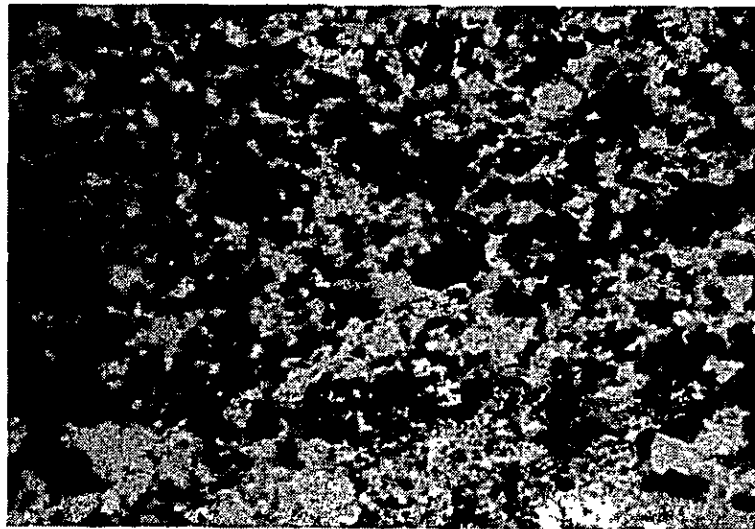
Photomicrograph and Petrographic Description of Rock (Plate 5 of 5)

Locality: El Dieciocho No. 2 Project, near the Power Station Site

Rock name: Greyish light green Kyanite-Muscovite Schist



0 0.5mm (open nicols)



(crossed nicols)

Petrographic description:

Siliceous schist or gneiss in which muscovite and kyanite(?) were formed. Composition of plagioclase is near albite.

Rock forming minerals;

Quartz >> Plagioclase > Muscovite > Kyanite(?), Magnetite > Zircon

Fig. A 2-1 RATING CURVE
AT PUENTE DE SANCHEZ GAGING STATION

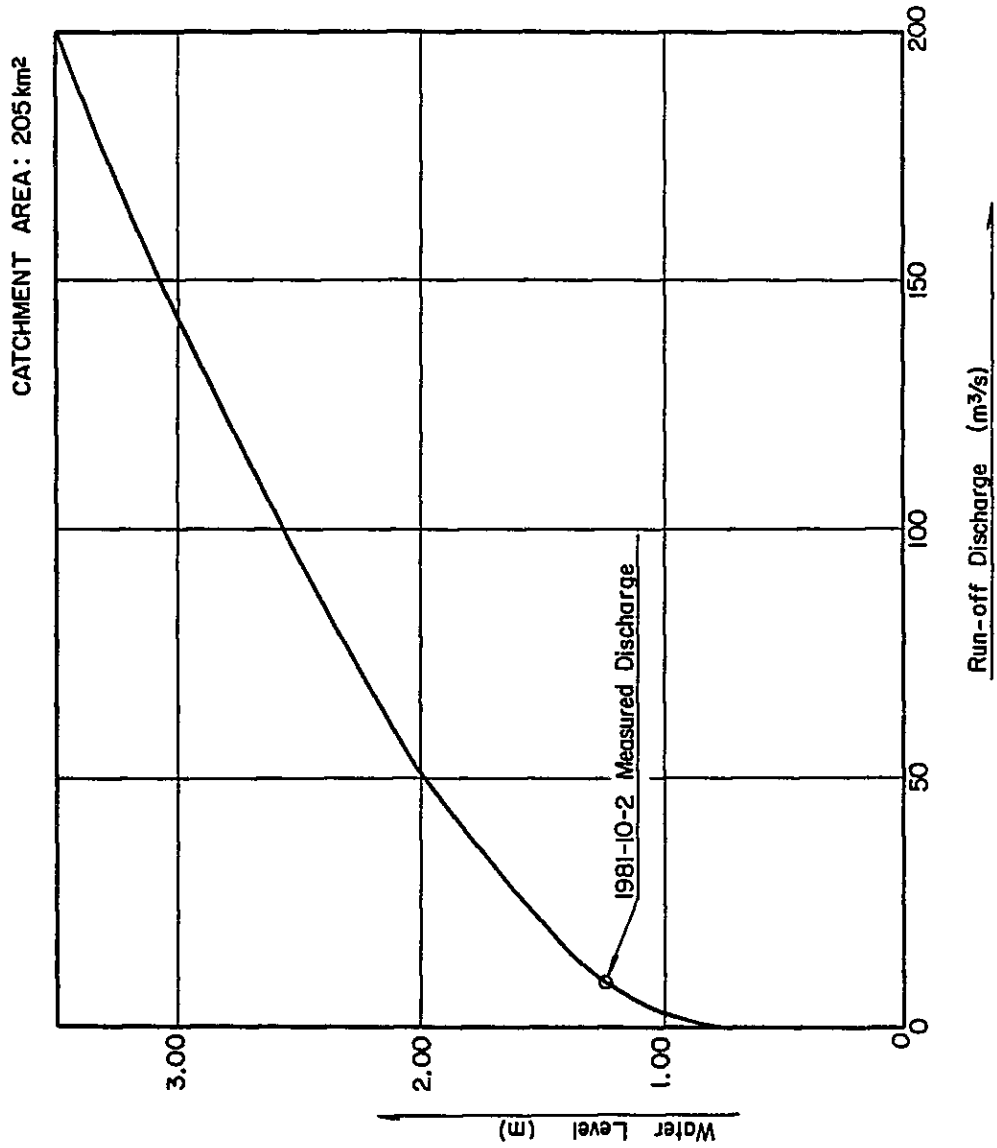
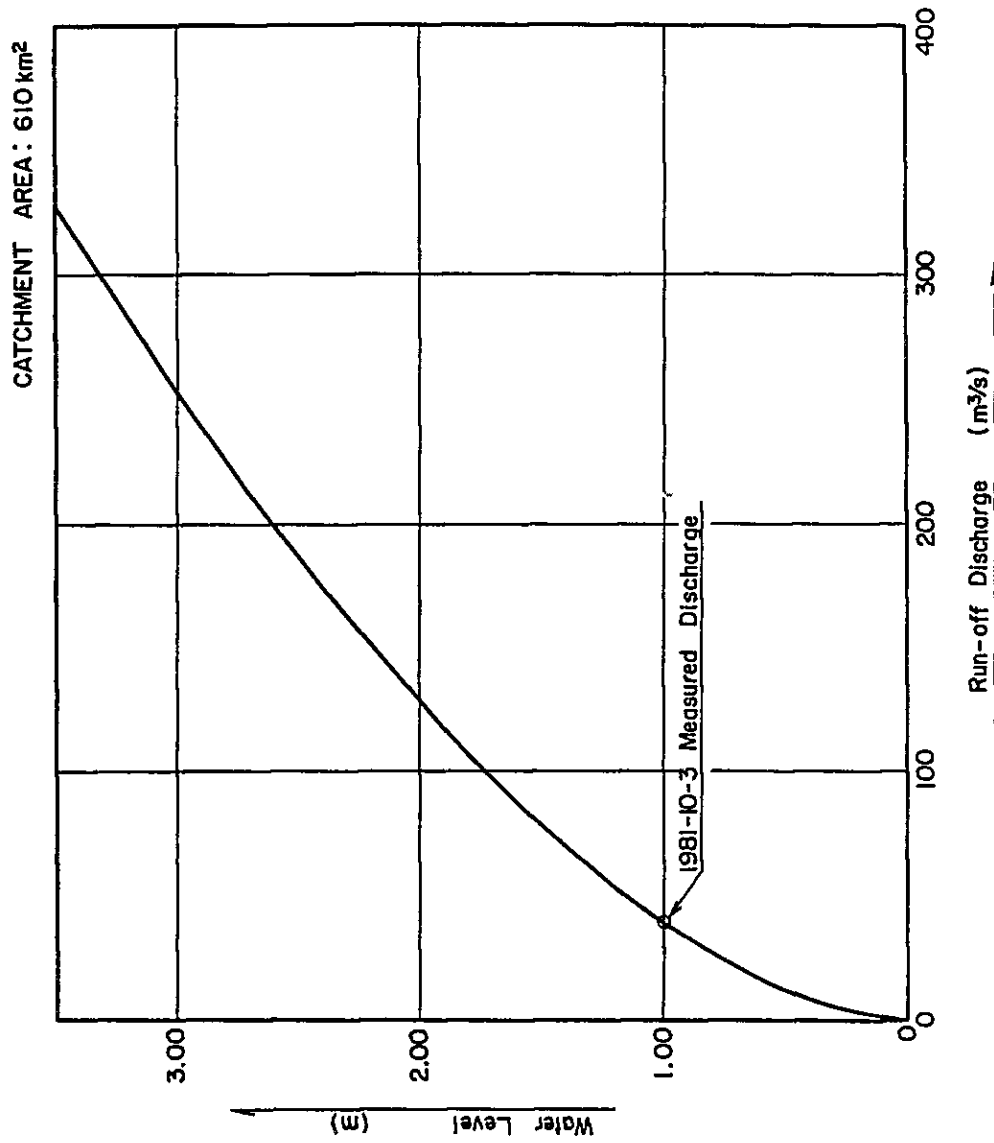


Fig. A 2-2 RATING CURVE
AT LOS ARRAYANEZ GAGING STATION



JICA