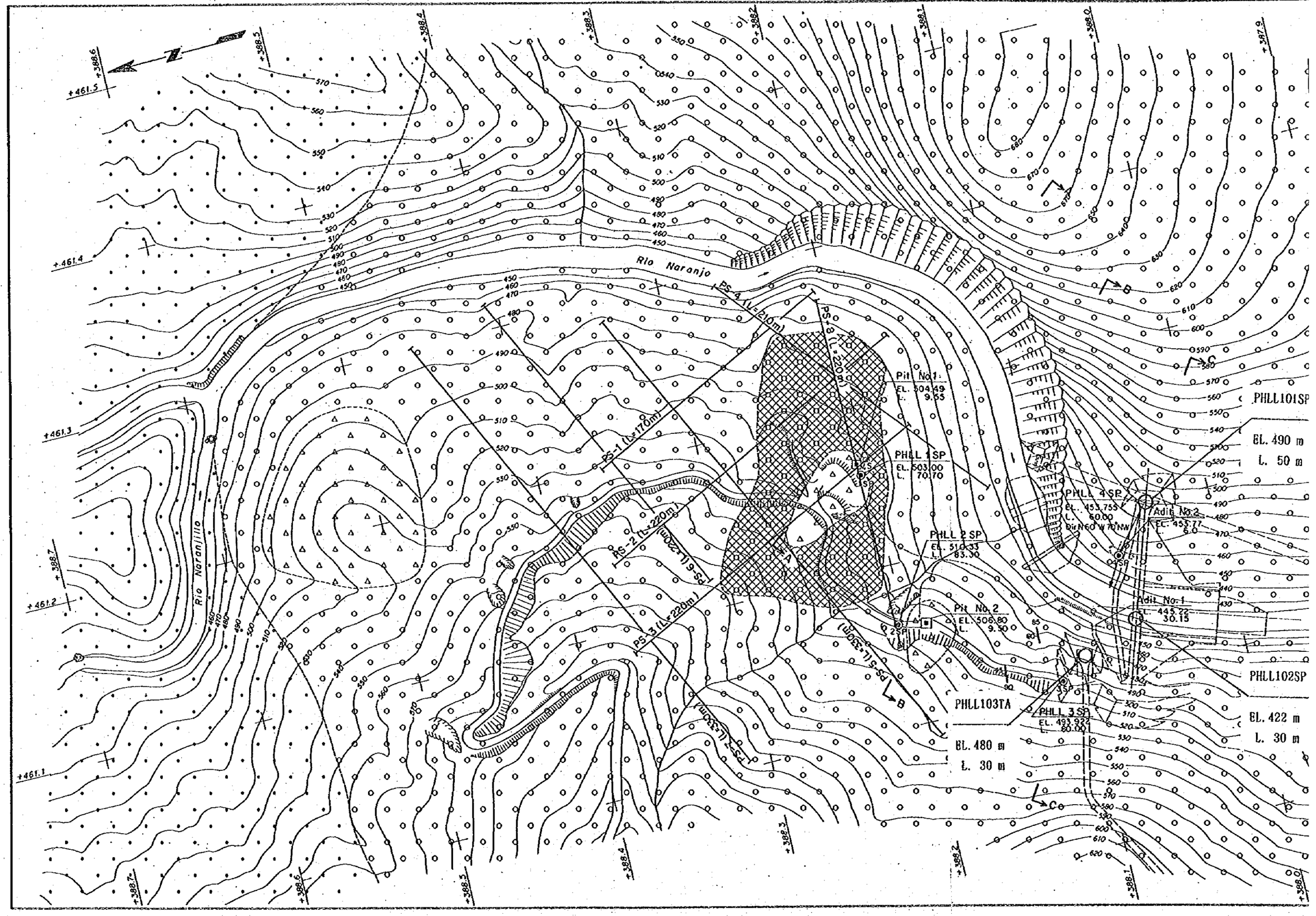
15.4 Environmental Study and Compensation

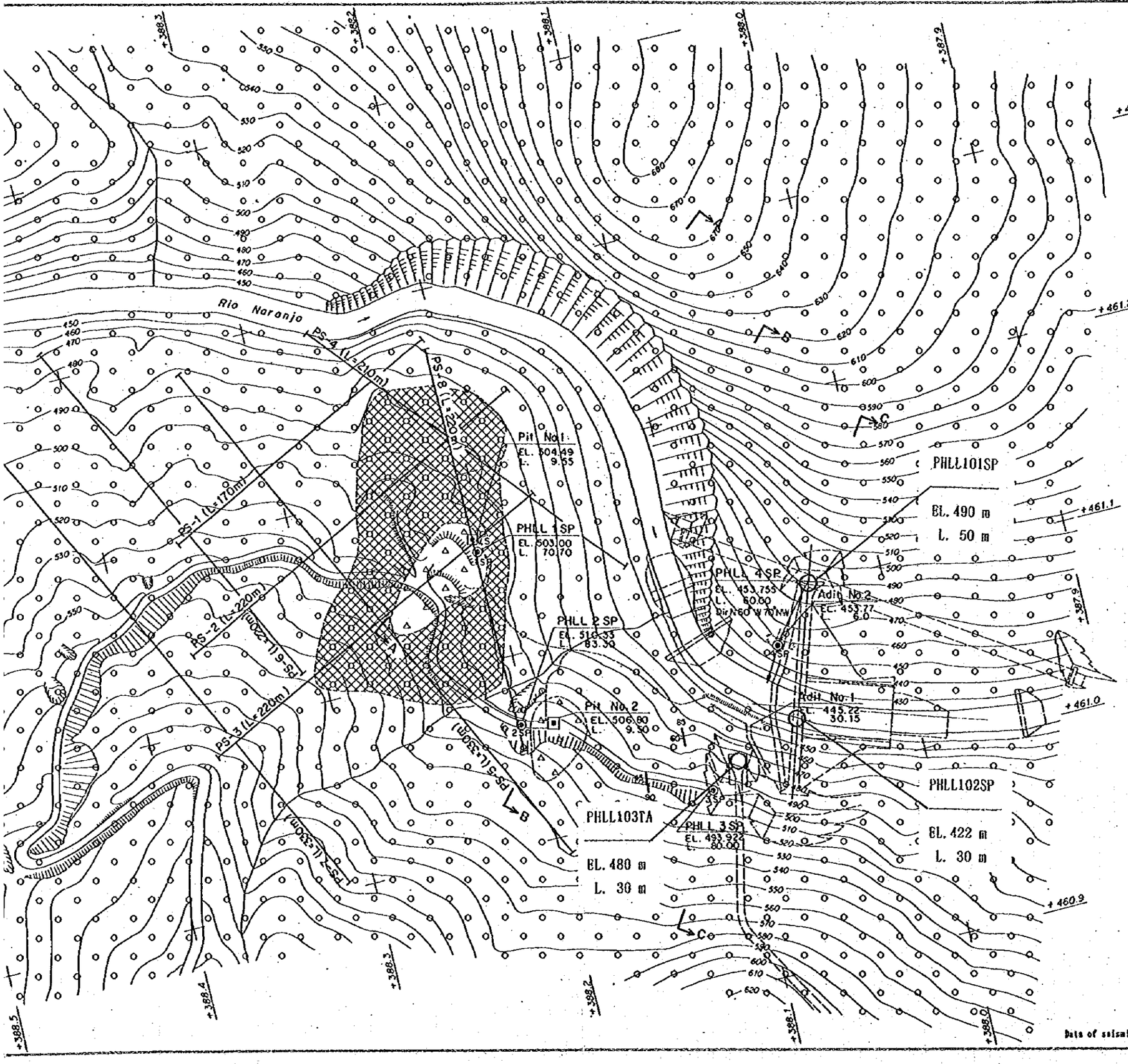
15.4.1 Impact on Social Environment

An increase in the number of tourists is especially expected at the downstream area of this Project. Therefore, the study is carried out regarding immigration to mainly Quepos and employment opportunities. The study is also carried out regarding items such as the future water use plan of which the impact on the social environment is large since the water flow is divided into the Paquita River.

15.4.2 Public Health Study

Studies and surveys are conducted regarding harmful insects and plants that mediate disease, and the health of the local residents. The result is reflected in the power development project to prevent public health problems in the local community.


Rio Naranjo
Rio Naranjillo
PS-4 (L=210m)
PS-1 (L=170m)
PS-2 (L=220m)
PS-3 (L=220m)
PS-5 (L=330m)
PS-6 (L=330m)
Pit No.1
EL. 504.49
L. 9.55
PHLL 1 SP
EL. 503.00
L. 70.70
PHLL 2 SP
EL. 510.33
L. 83.30
PHLL 4 SP
EL. 453.755
L. 60.00
Dir. N60°W 70°NW
Adit No.2
EL. 455.17
L. 6.0
Pit No.2
EL. 506.80
L. 9.50
Adit No.1
EL. 445.22
L. 30.15
PHLL103TA
EL. 480 m
L. 30 m
PHLL 3 SP
EL. 493.922
L. 80.00
PHLL101SP
EL. 490 m
L. 50 m
PHLL102SP
EL. 422 m
L. 30 m
A
B
C
+461.5
+461.4
+461.3
+461.2
+461.1
+388.6
+388.5
+388.4
+388.3
+388.2
+388.1
+388.0
+387.9
+388.7



LEGEND

- Talus Deposits
- Conglomerate (Strongly Weathered)
- Conglomerate
- Sandstone
- Geologic Boundary
- Strike and dip of Bedding
- Adit
- Test Pit
- Drillhole
- Seismic Prospecting Traverse
- Geologic Section

Further Investigations

PHLL101SP
EL. 490 m
L. 50 m

Core drilling with in-hole measurements and tests

0 100m

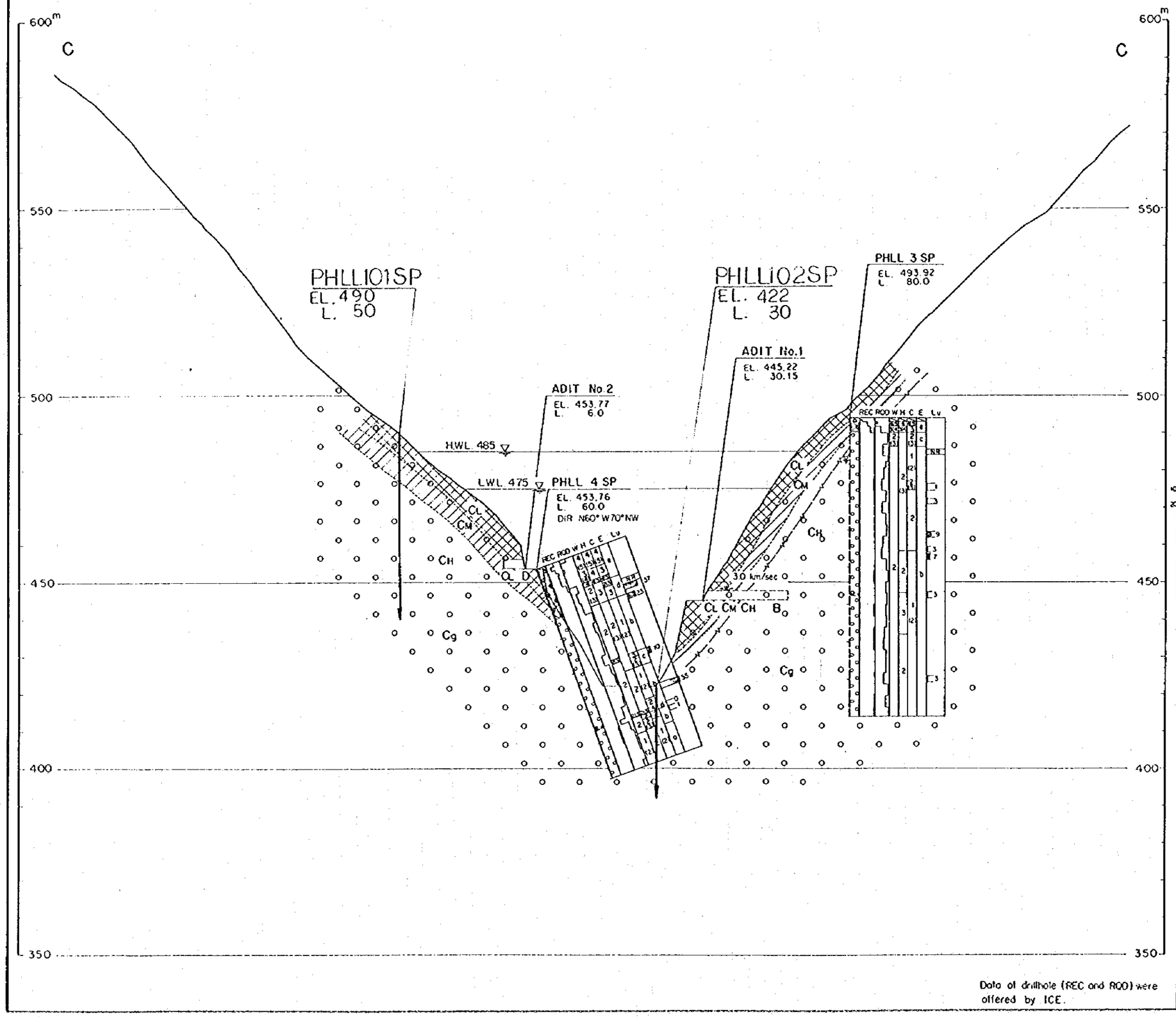
Data of seismic prospecting were offered by ICE.

REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

FURTHER INVESTIGATIONS AT DAMSITE AND POWER INTAKE SITE

Fig. 15 - 1 | Date:



LEGEND

- Conglomerate
- Geologic boundary
- Boundary of rock mass classification
- Ground water level
- Adit No. / EL. / L. (EL.: Elevation (m), L.: Length (m))

(Rock Mass Classification)

- CH — Somewhat cracky but not loosened rocks
- CM — Somewhat cracky and slighty loosened rocks
- CL — Cracky and loosened rocks due to weathering and/or creeping
- D — Soft or brittle rocks due to weathering or shearing

(Drillhole Log)

- PHLL / EL. / L. / DIR.
- Hole number
- Elevation of hole head (m)
- Length drilled (m)
- Direction and dip of inclined hole
- Result of Lugeon test
- Lu Value assumed from P-Q Curve
- Lu Value (L/min/m/under injection pressure = 10 kgf/cm²)
- Test section
- Core evaluation
- Rock classification (W: Weathering, H: Hardness, C: Interval of cracks)
- ROD (Rock Quality Designation)
- REC : Core Recovery
- Geologic log
- Depth (m)
- Cracky cores
- Core Evaluation (See core classification and Evaluation)

Further Investigations

PHLL101SP

Core drilling with in-hole measurements and tests

0 — 50m

Data of drillhole (REC and ROD) were offered by ICE.

REPUBLIC OF COSTA RICA

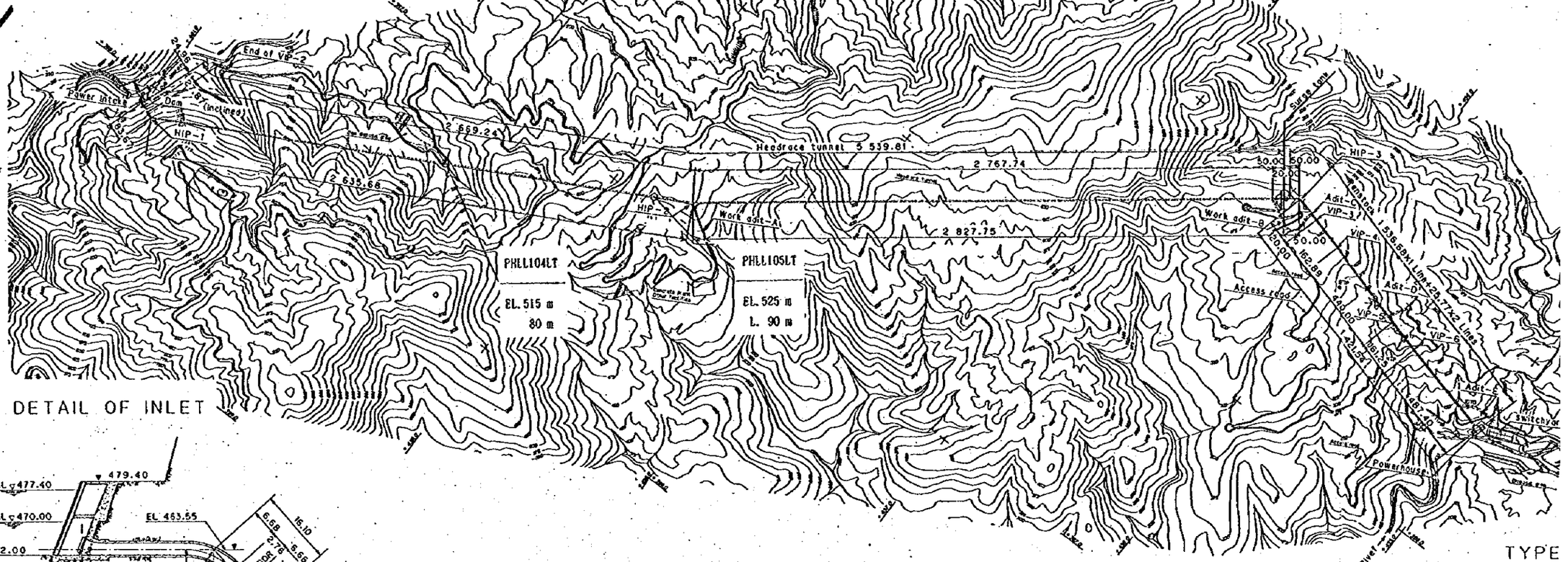
LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

FURTHER INVESTIGATIONS

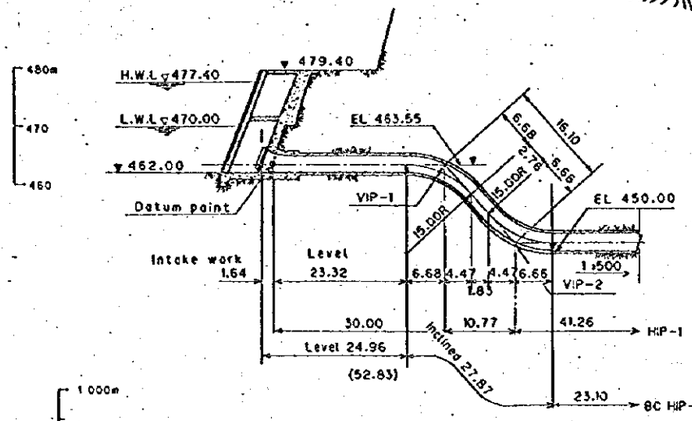
AT DAMSITE

Fig. 15 - 2 | Date :

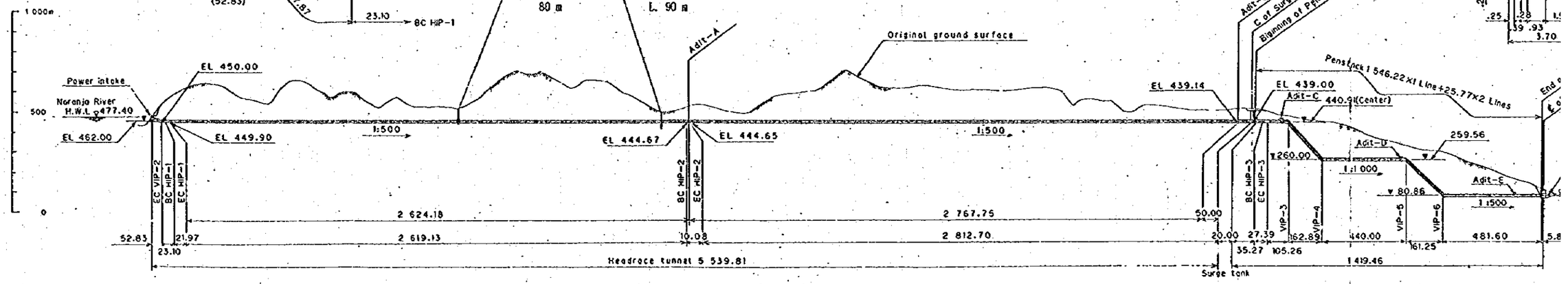
PLAN

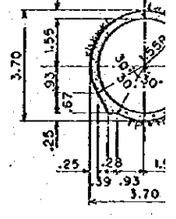


DETAIL OF INLET



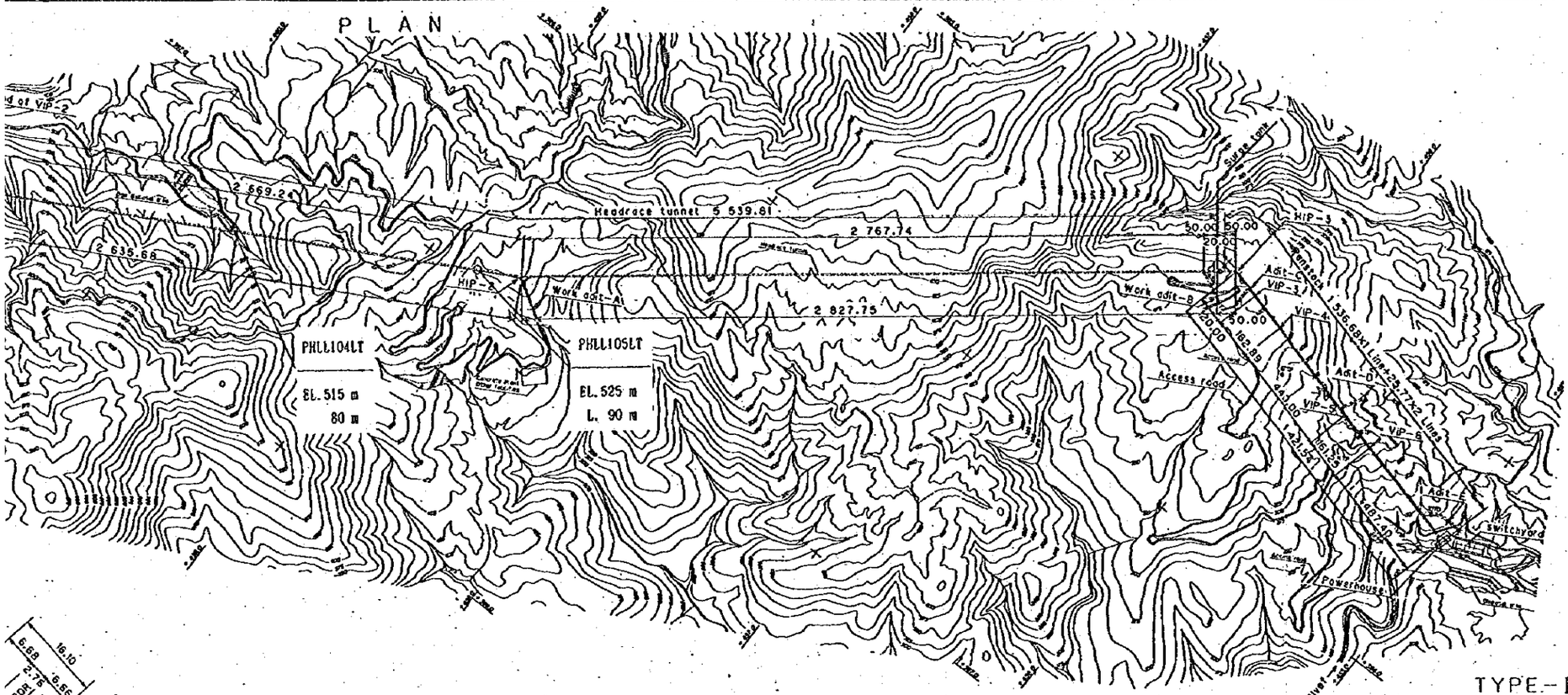
PROFILE





TYPE

PLAN



IP	Coordinate		Distance	Note
	X	Y		
Intake	388 101.00	461 014.80		Datum point
HIP-1	388 120.00	460 935.00	82.03	
HIP-2	386 860.00	458 620.00	2 635.68	
Surge tank	385 112.09	456 397.17	2 827.75	C of S.T
HIP-3	385 075.00	456 350.00	60.00	

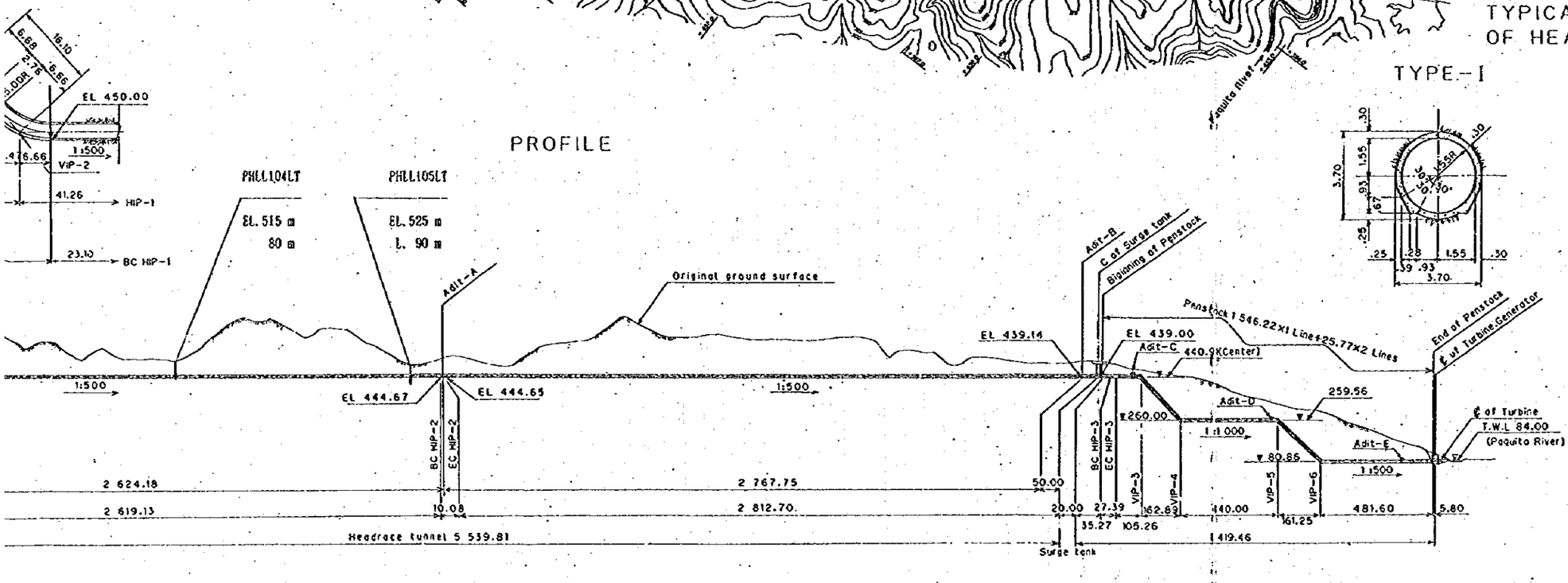
IP	IA	R	TL	CL
VIP-1	48°00'00"	15.00	6.68	12.57
VIP-2	47°53'07"	15.00	6.66	12.54
HIP-1	41°57'03"	30.00	11.50	21.97
HIP-2	9°37'16"	60.00	5.05	10.08
HIP-3	52°19'01"	30.00	14.74	27.39

LEGEND

PHLL
EL. m
L. m

Core drilling with in-hole measurements and tests

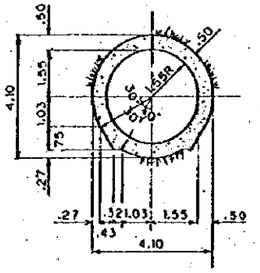
PROFILE

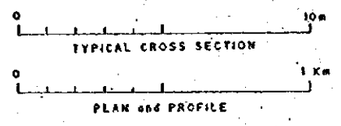


TYPICAL CROSS SECTION OF HEADRACE TUNNEL

TYPE-I

TYPE-II





REPUBLIC OF COSTA RICA

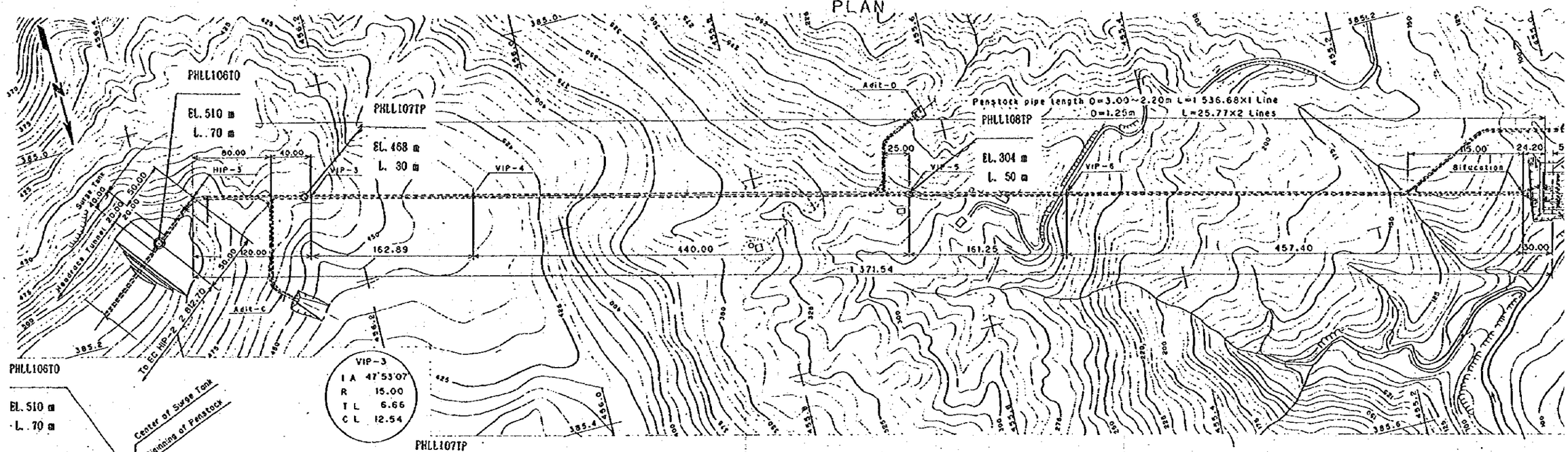
LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

FURTHER INVESTIGATIONS

ALONG HEADRACE TUNNEL ROUTE

Fig. 15 - 3

PLAN



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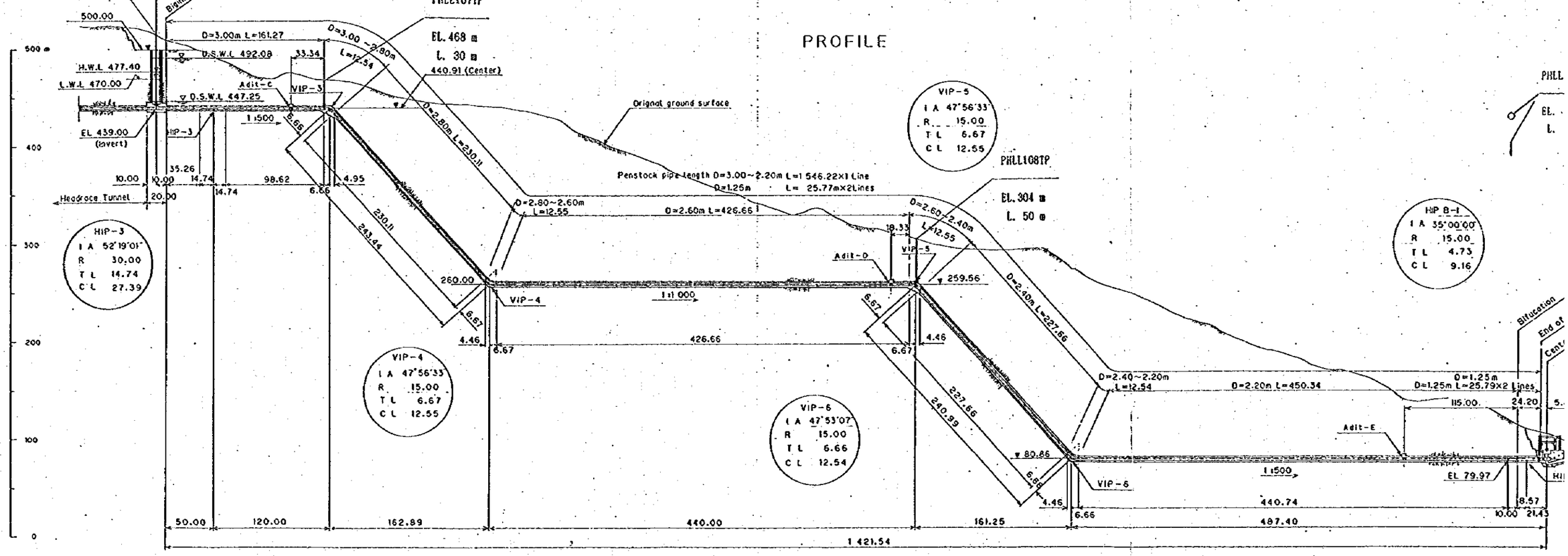
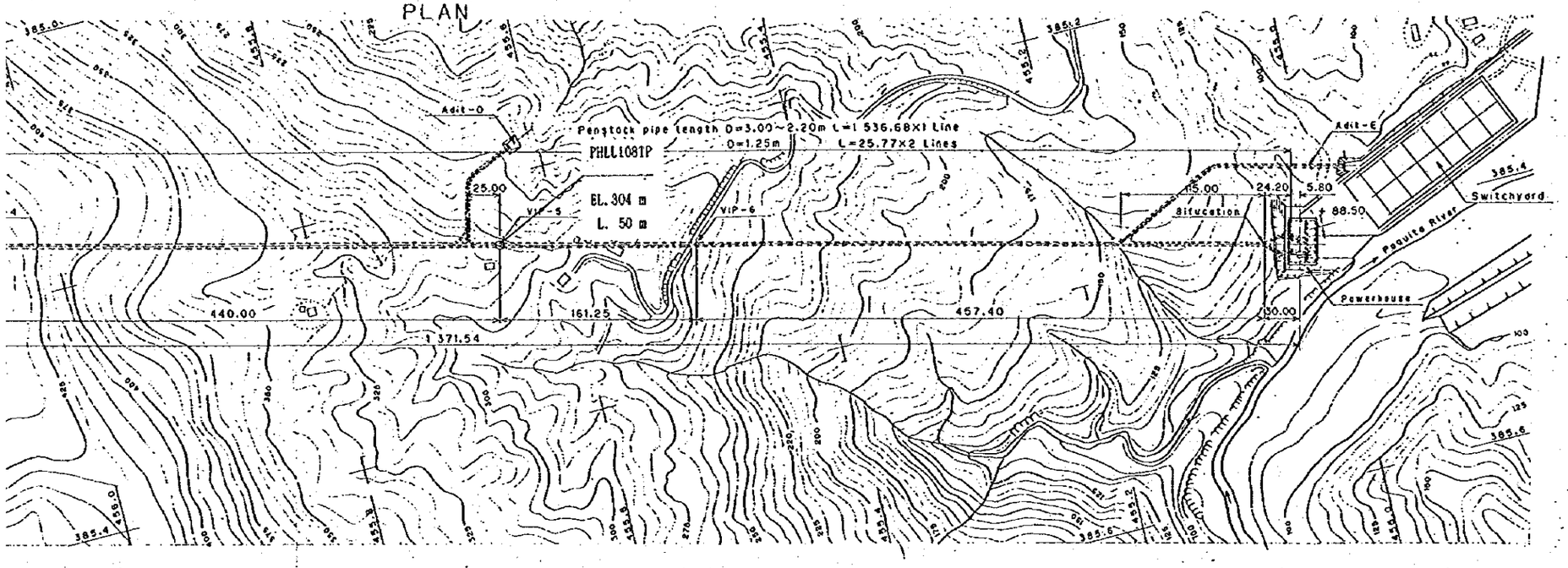


PLAN



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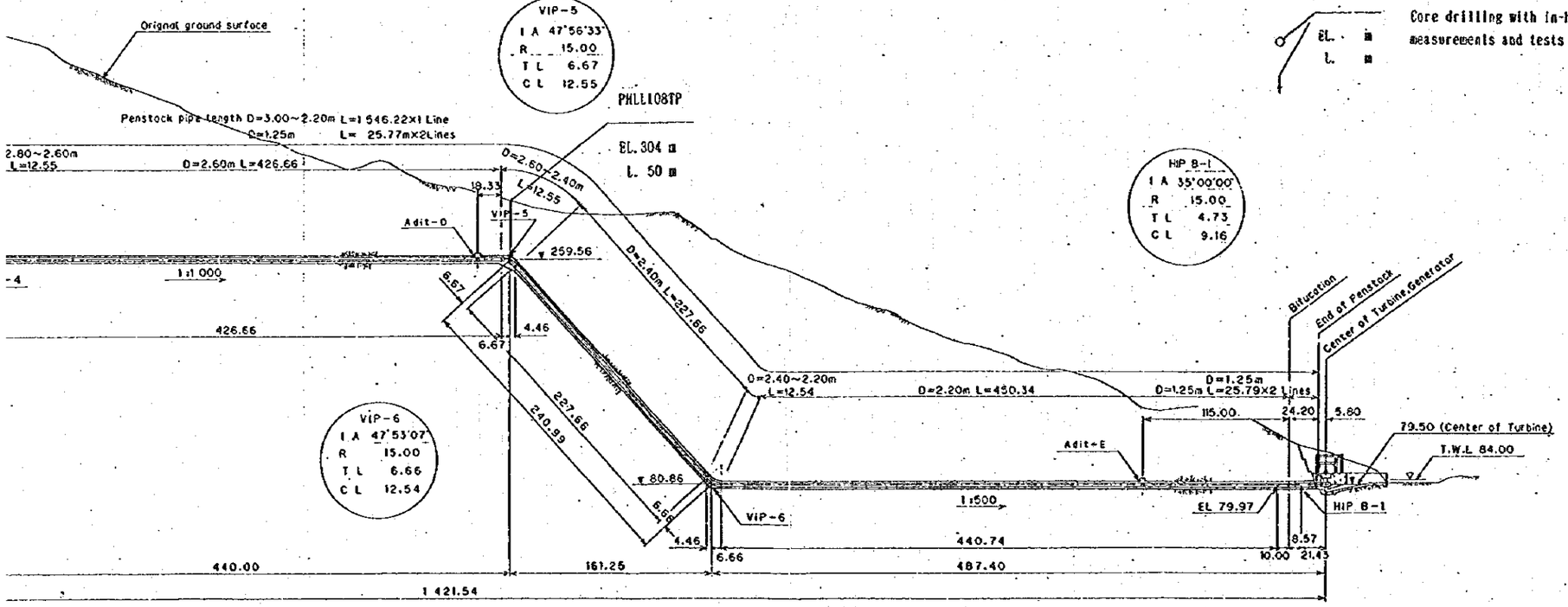


LEGEND

PHLL

EL. m

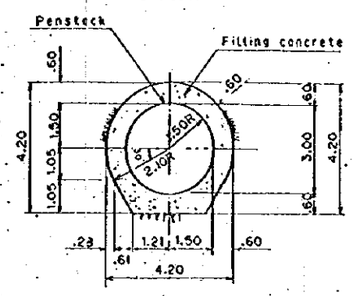
L. m

Core drilling with in-hole measurements and tests

TYPICAL CROSS SECTION

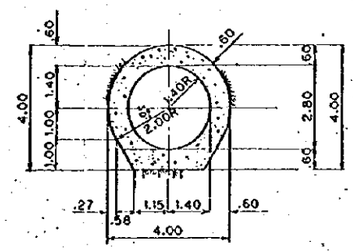
TYPE-I

D=3.00 m



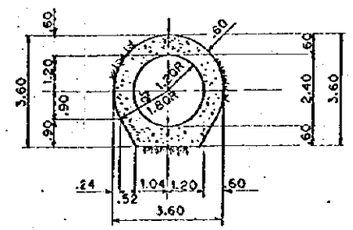
TYPE-II

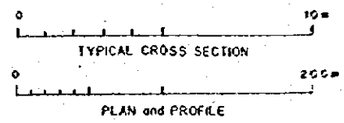
D=2.80~2.60 m



TYPE-III

D=2.40~2.20 m



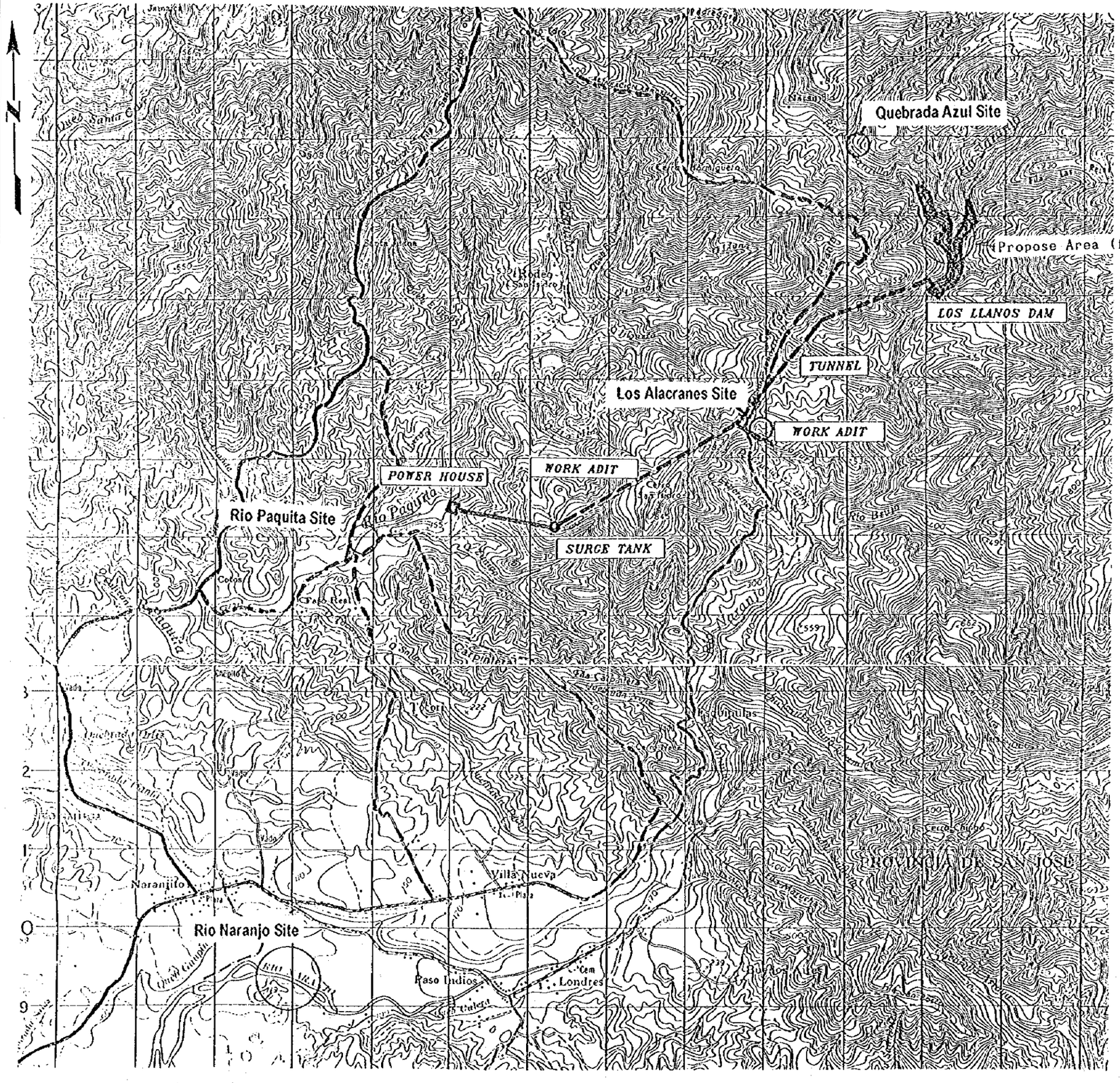


REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

FURTHER INVESTIGATIONS AT SURGETANK SITE AND PENSTOCK ROUTE

Fig. 15 - 4



REPUBLIC OF COSTA RICA

LOS LLANOS HYDROELECTRIC POWER DEVELOPMENT PROJECT

Location Map of Riverbed Deposits Sites and Rock Quarry Sites

Fig. 15 - 5 | Date :

Table 15-1 Geologic/geotechnic Investigation Planning (1/4)

Site/Route	Investigation Methods	General Specifications	Remarks
1. Down-stream damsite	Detailed geologic mapping	• To provide detailed engineering geologic maps to use detailed topographic maps. • To cover the damsite and its vicinities	Detailed topographic map: 1/1000 or more in scale.
	Core drilling and in-hole measurements/tests	• Drillhole PHLL101SP (with all coring) - Location: Aprx. EL 490m on the left bank of the down-stream site. - Length: 50m or more - Water level measurements: During drilling at the full section. - Lugeon tests: Covering the full section.	A unit length of Lugeon test: 5m or less.
		• Drillhole PHLL102SP (with all coring) - Location: Aprx. EL 422m on the riverbed of the down-stream site. - Length: 30m or more - Water level measurements: During drilling at the full section. - Lugeon tests: Covering the full section.	
		• Drillhole PHLL103TA (with all coring) - Location: Aprx. EL 480m on the intake site of the down-stream damsite. - Length: 30m or more - Water level measurements: During drilling at the full section. - Deformation tests: Two (2) points or more around the hole bottom.	

Table 15-1 Geologic/geotechnic Investigation Planning (2/4)

Site/Route	Investigation Methods	General Specifications	Remarks
2. Headrace tunnel route	Detailed geologic mapping	- To provide detailed engineering geologic maps to use topographic maps in scale 1/5,000. - To cover the headrace tunnel route. - Special items to be made sure: To confirm aerophoto lineaments and regional joint patterns.	
	Core drilling and in-hole measurements/tests	● Drillhole PHLL104LT (with all coring) - Location: Aprx. EL.515m, a spot about 1500m down-stream side from the intake, on the bottom of a ravine. - Length: 80m or more - Water level measurements: During drilling at the full section. - Lugeon tests: Covering the full section. - Deformation tests: Two (2) points or more around the hole bottom.	A unit length of Lugeon test: 5m or less.
		● Drillhole PHLL105LT (with all coring) - location: Aprx. EL 525m, a spot about 2500m down-stream side from the intake, on the bottom of a ravine. - Length: 90m or more - Water level measurements: During drilling at the full section. - Lugeon tests: Covering the full section. - Deformation tests: Two (2) points or more around the hole bottom.	

Table 15-1 Geologic/geotechnic Investigation Planning (3/4)

Site/Route	Investigation Methods	General Specifications	Remarks
3. Penstock route and power station site	Detailed geologic mapping	● To provide detailed engineering geologic maps to use topographic maps 1/5,000 and/or 1/1,000 in scale. ● To cover the surgetank site, penstock route and powerstation site and their vicinities. ● Special items to be made sure; To confirm on aero photo lineament crossing the penstock route and the boundary of the conglomerate and marlstone around the powerstation site.	
	Core drilling and in-hole measurements/tests	● Drillhole PHLL106TO (with all coring) - Location: Aprx. EL 510m, at the surge tank site. - Length: 70m or more - Water level measurements: During drilling at the full section. - Lugeon tests: Covering the lower 1/3 section. - Deformation tests: Two (2) points or more around the hole bottom.	A unit length of Lugeon test: 5m or less
		● Drillhole PHLL107TP (with all coring) - Location: Aprx. EL 468m on the penstock route. - Length: 30m or more - Water level measurements: During drilling at the full section. - Lugeon tests: Covering the lower half section. - Deformation tests: Two (2) points or more around the hole bottom.	

Table 15-1 Geologic/geotechnic Investigation Planning (4/4)

Site/Route	Investigation Methods	General Specifications	Remarks
(3. Penstock route and power station site)	(Core drilling and in-hole measurements/tests)	● Drillhole PHLL108TP (with all coring) - Location: Aprx. EL 304m on the penstock route. - Length: 50m or more - Water level measurements: During drilling at the full section. - Lugeon tests: Covering the lower half section. - Deformation tests: Two (2) points or more around the hole bottom.	A unit length of Lugeon test: 5m or less.
4. Quarry site for concrete aggregates	Detailed geological mapping	● To provide detailed engineering geologic maps to use topographic maps 1/1,000 in scale. - To cover an area around the conjunction of Rio Naranjo and Rio Naranjillo, about 700m up-stream from the down-stream damsite. - Special items to be made sure; To confirm and trace "Layers of sandstone".	
	Core drilling	● Two (2) drillholes with all coring. ● Location: Each hole should be decided by the said geological mapping. ● Length: 20m or more (each hole).	
	Laboratory tests	● All necessary laboratory tests for concrete aggregates to use drilled cores.	

INDEX.