APPENDIX

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## APPENDIX - 1

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# List of Drawings

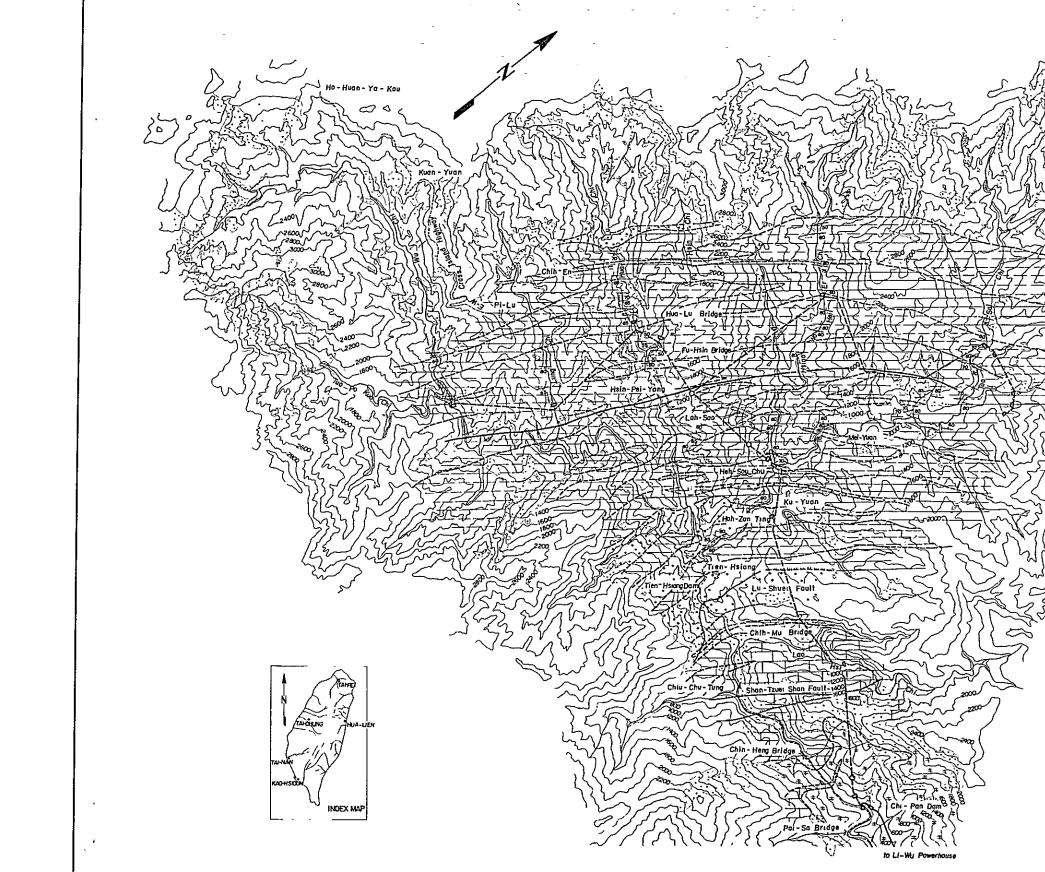
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DWG. No.2	Elevation of main terrace in Li-Wu Chi
DWG. No.3	Relation map of Taiwan Earthquake
DWG. No.4	Geological map of Tuo-Po-Kuo dam site, plan and section
DWG. No.5	Geological map of Lung-Chi dam site, plan and section
DWG. No.6	Geological map of Hua-Lu dam site, plan and section
DWG. No.7	Geological map of Fu-Hsin dam site, plan and section
DWG. No.8	Geological map of Hsiao-Wa-Hei-Er and Hsi-Hsiao-Wa- Hei-Er dam site, plan and section
DWG. No.9	Geological map of Tao-Sai dam site, plan and section
DWG. No.10	Geological map of Ku-Pei-Yang dam site, plan and section
DWG. No.11	Geological map of Man-Tou Shan dam site, plan and section
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DWG. No.20	Geological map of Tien-Hsiang dam site, plan and section
DWG. No. 21	Geological map in the vicinity of Tien-Hsiang
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DWG. No. 25	Transmission line, proposed route
DWG. No.26	Transmission line, tangent towers
DWG. No.27	Telecommunication system diagram

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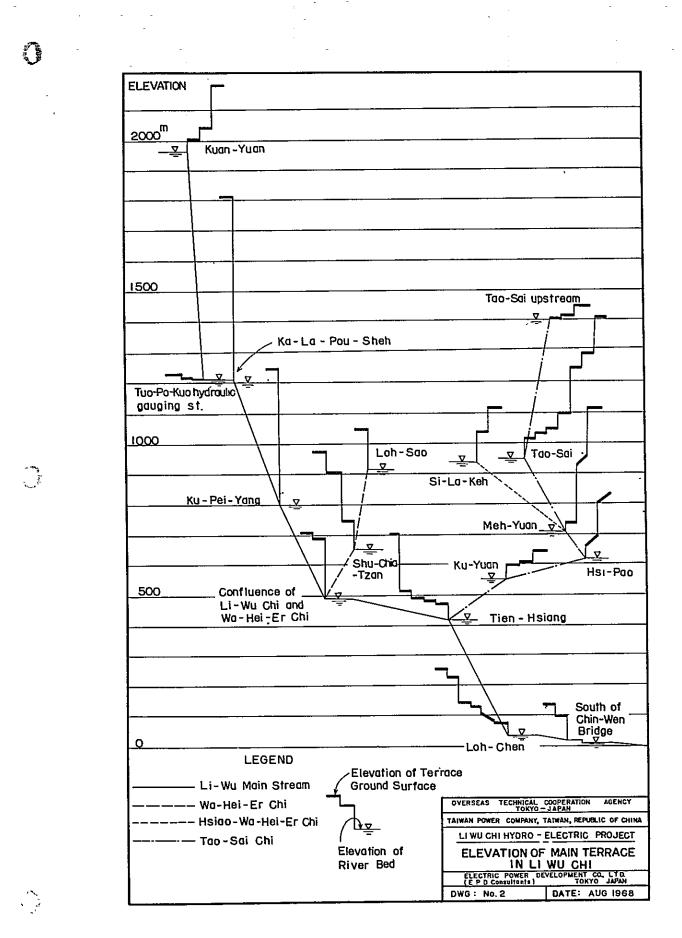
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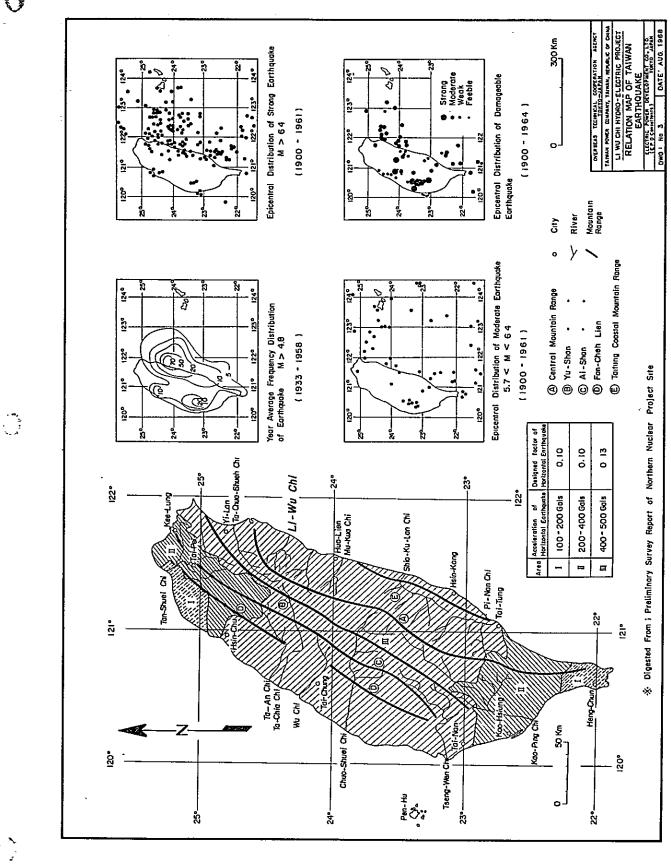
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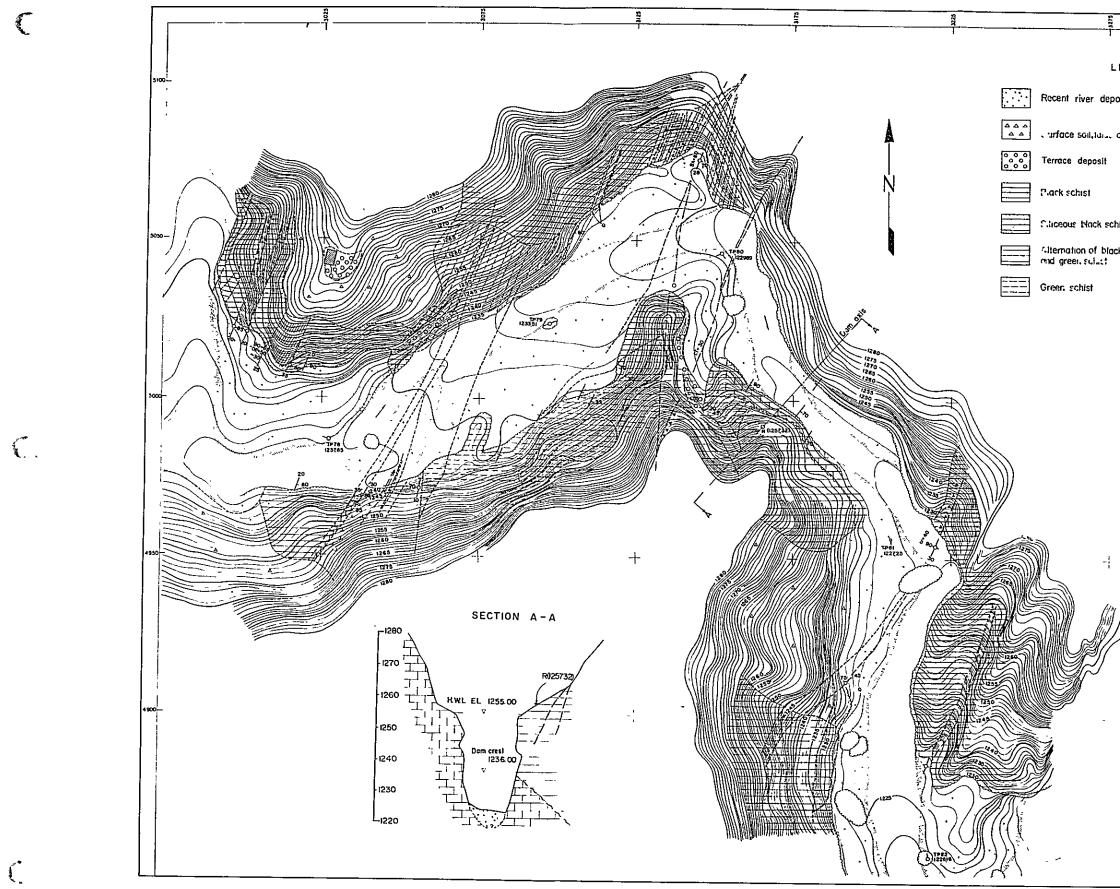
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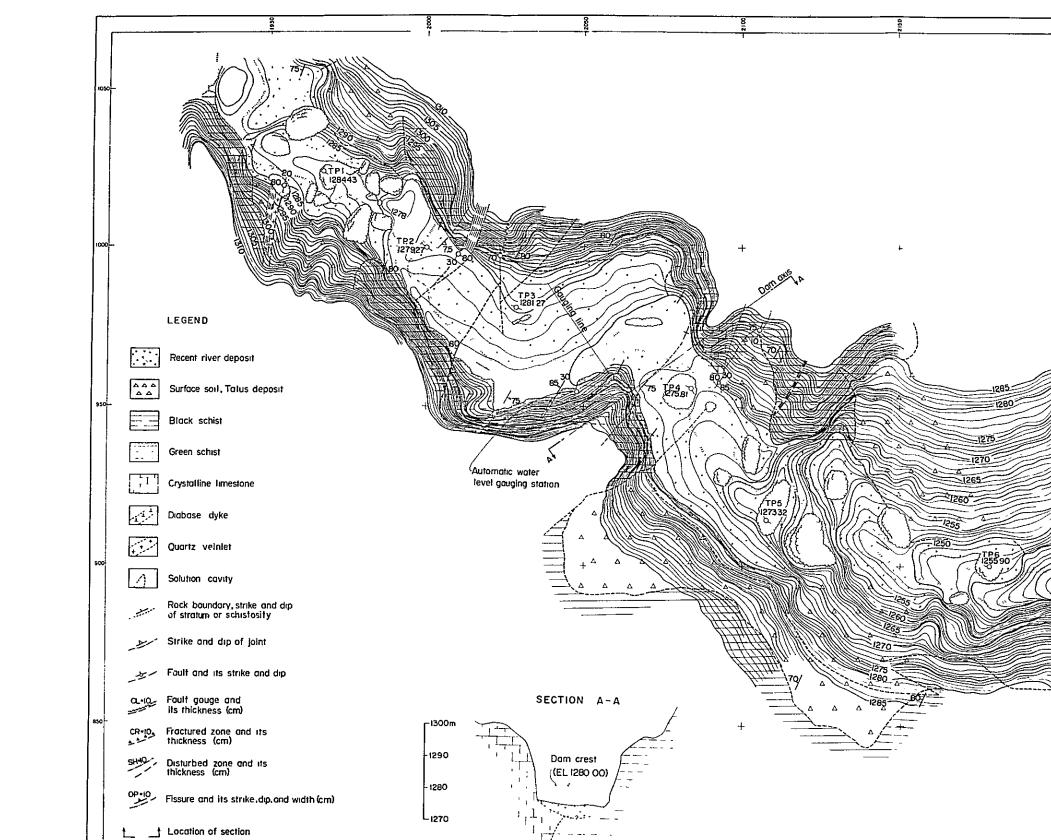




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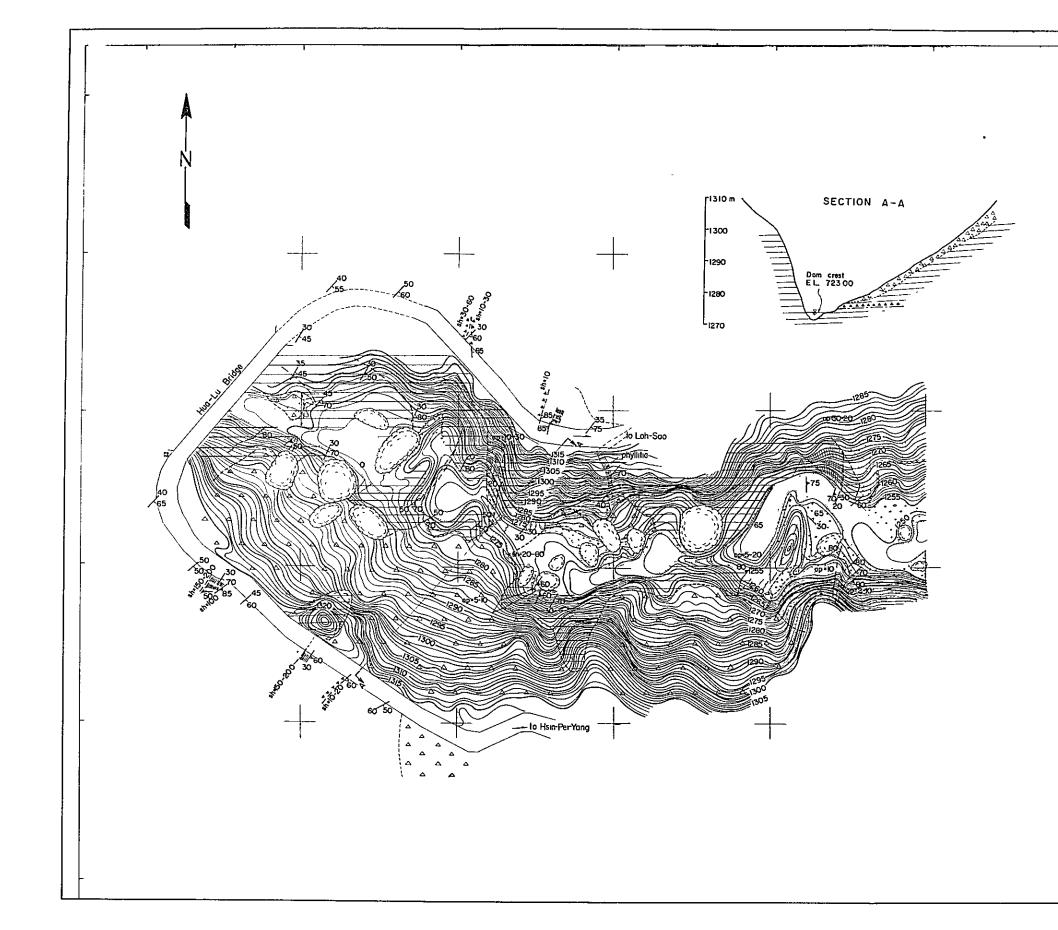
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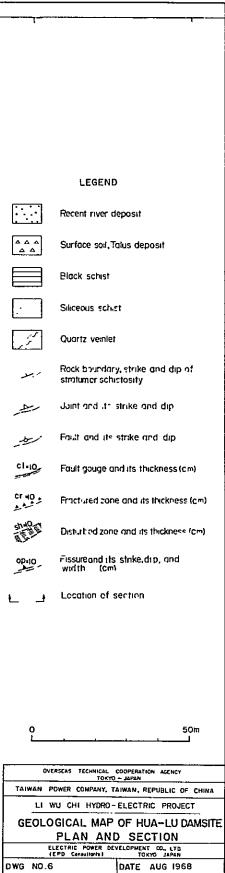
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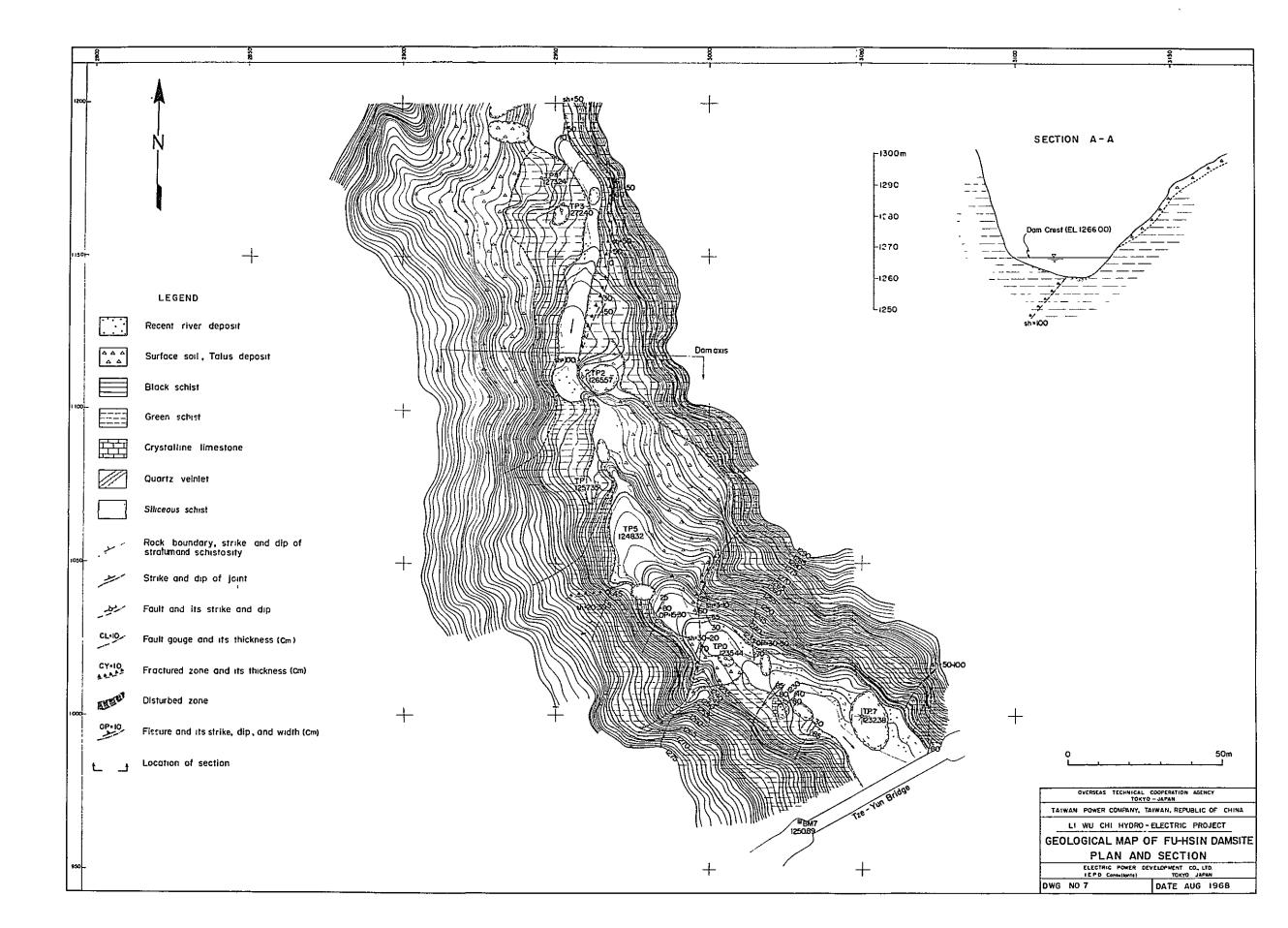


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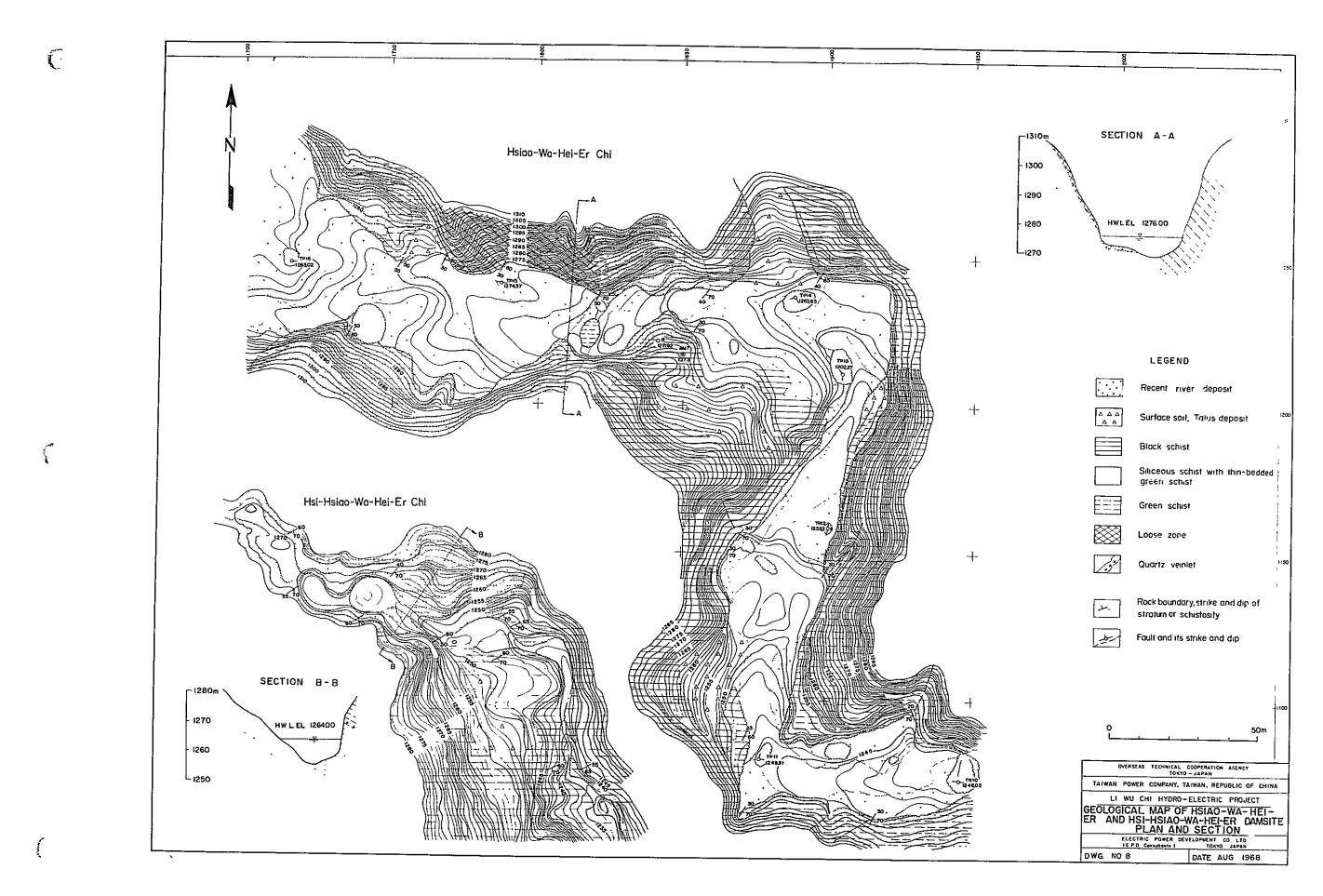


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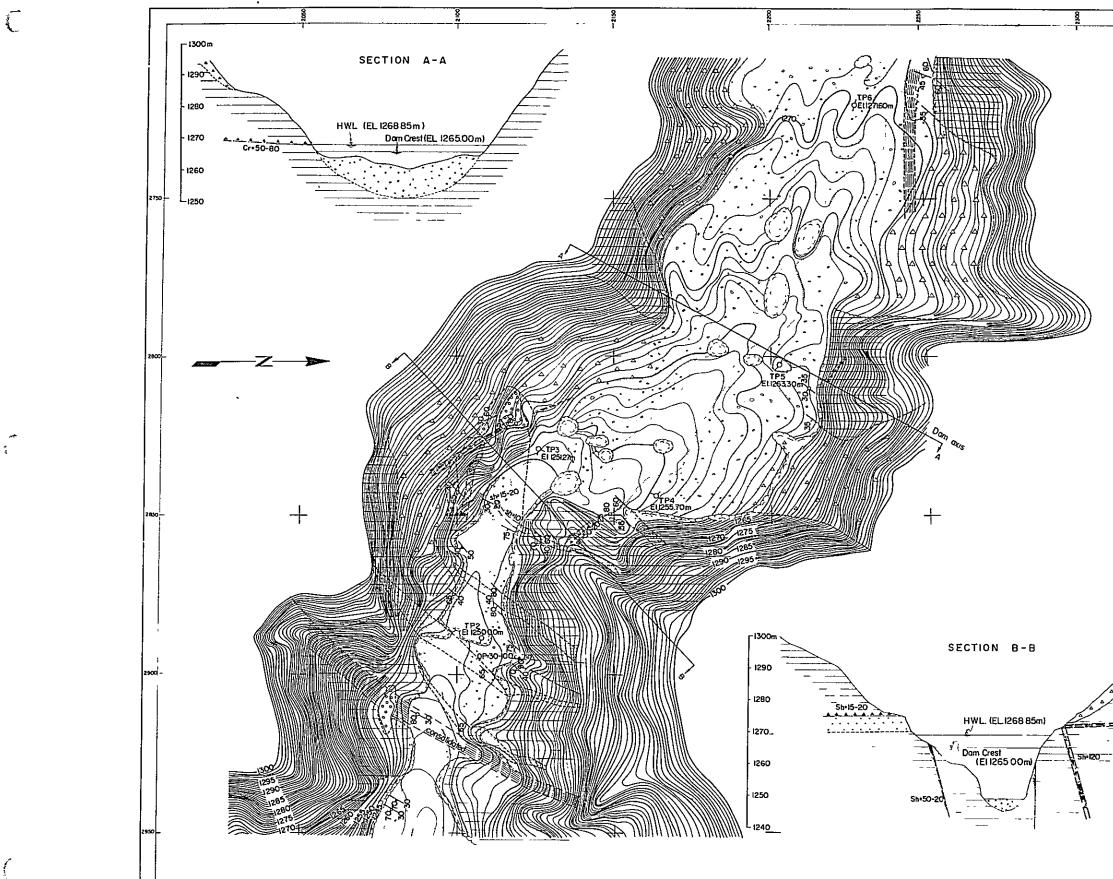
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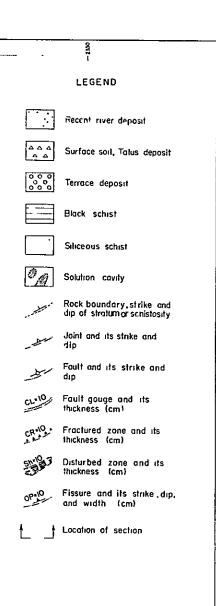
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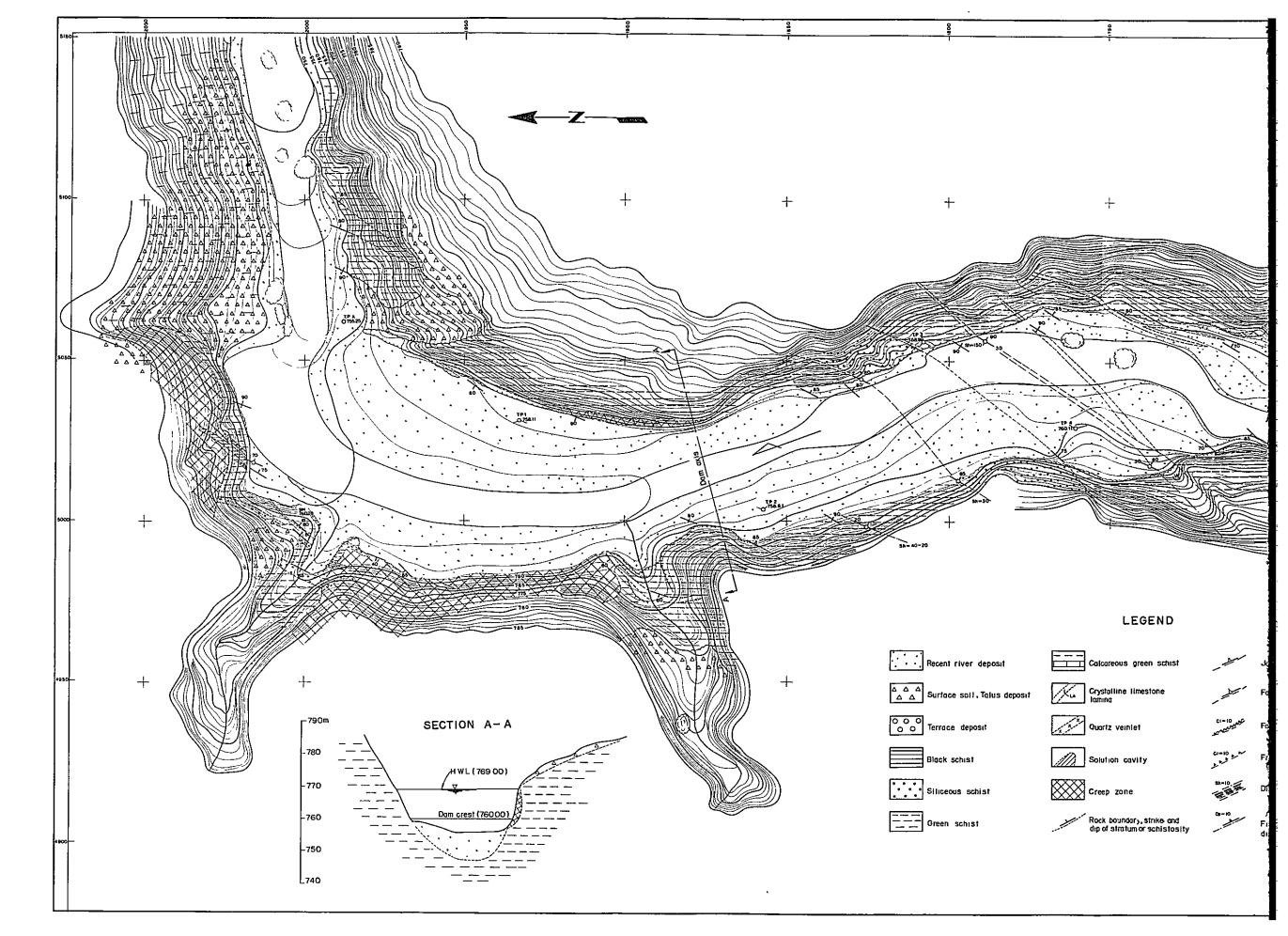


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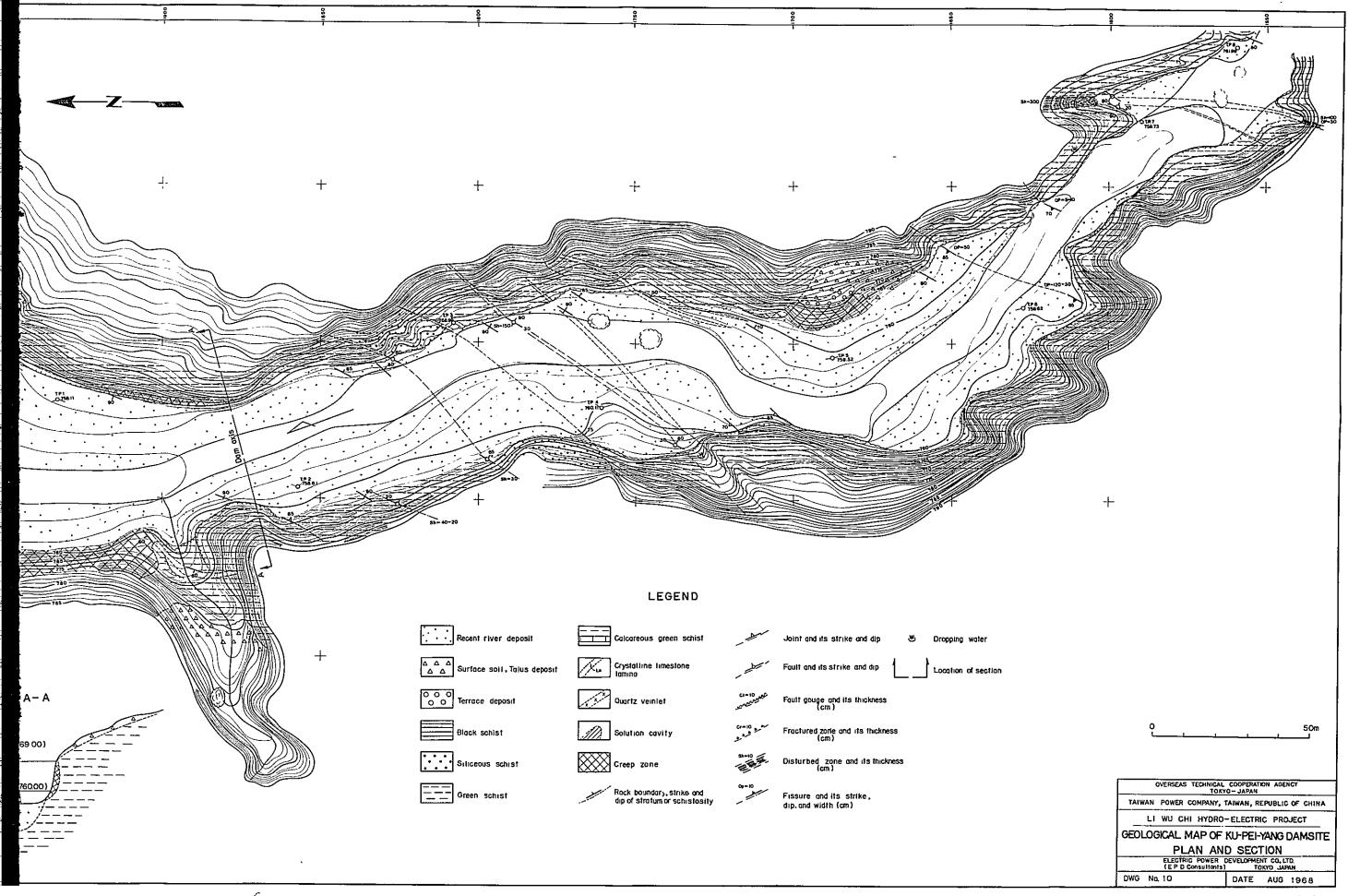
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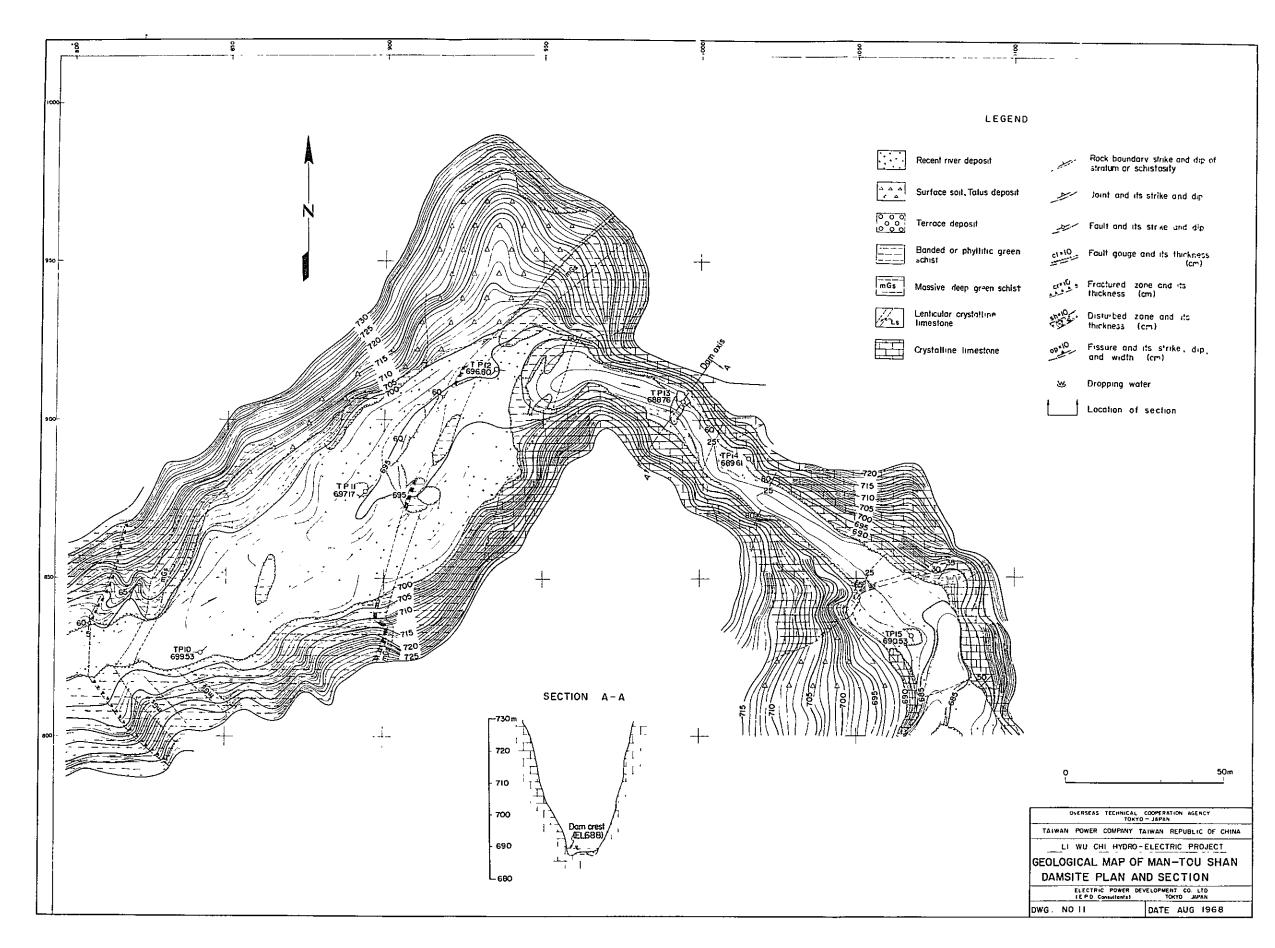


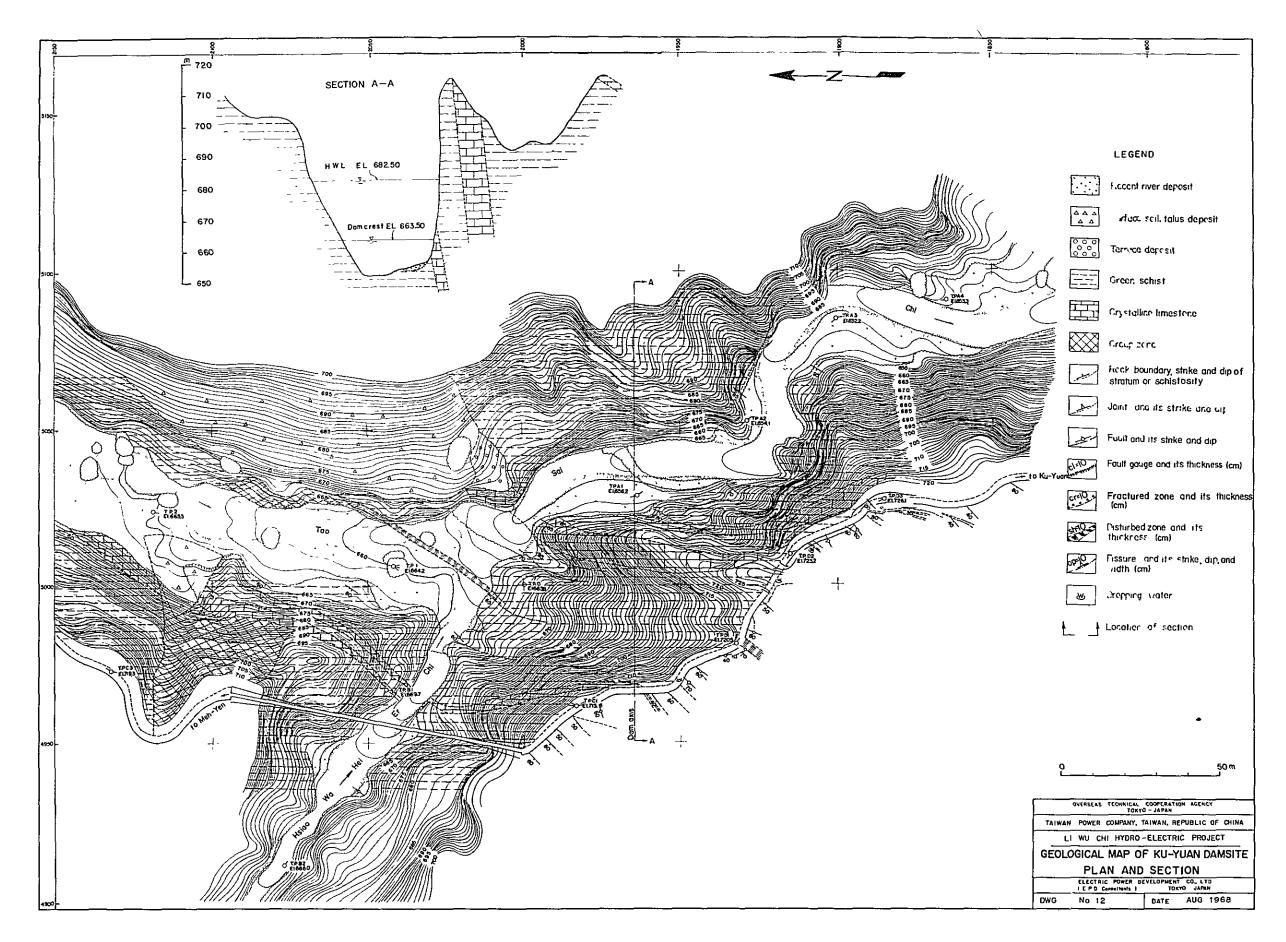
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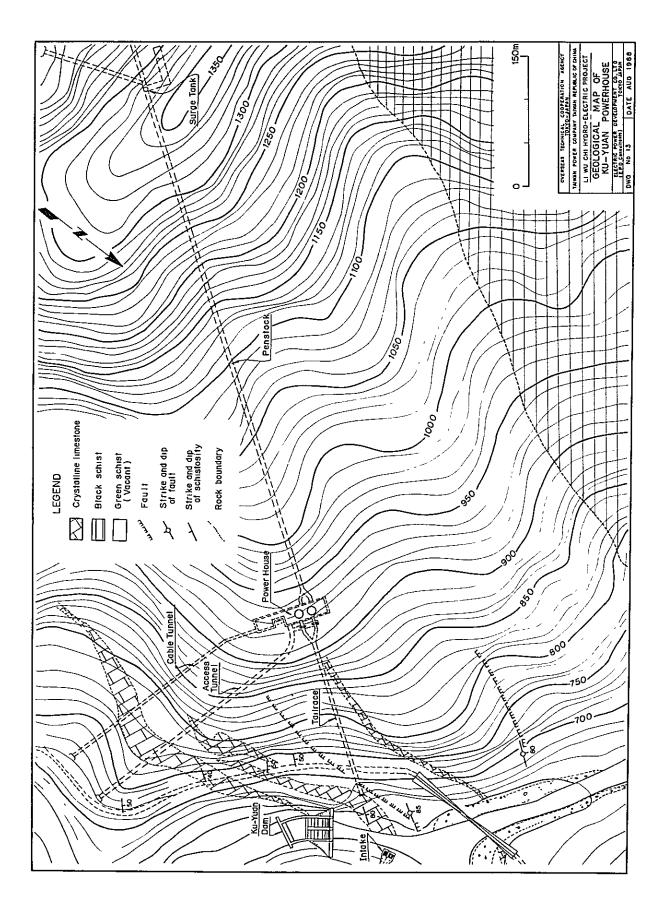


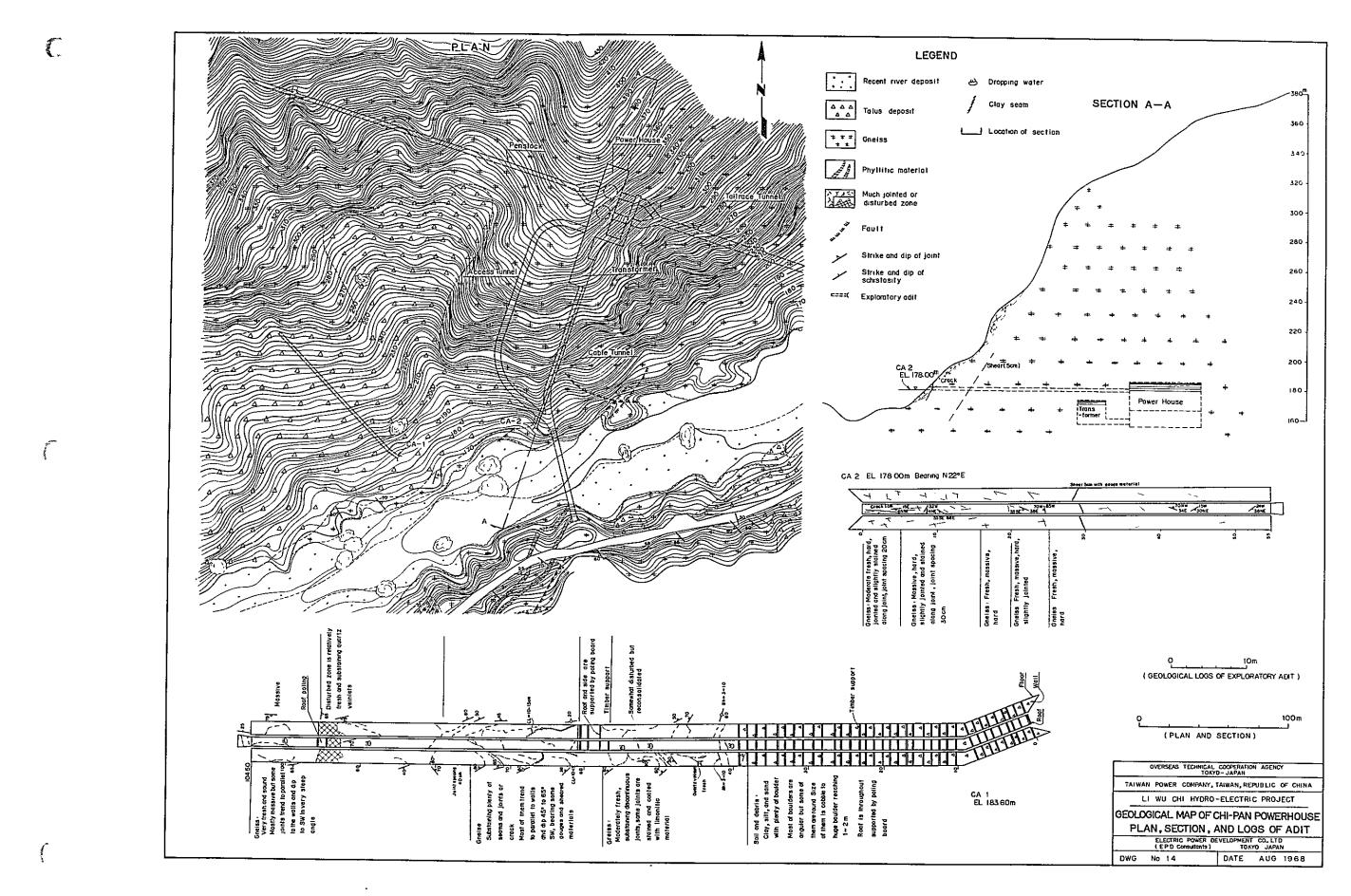
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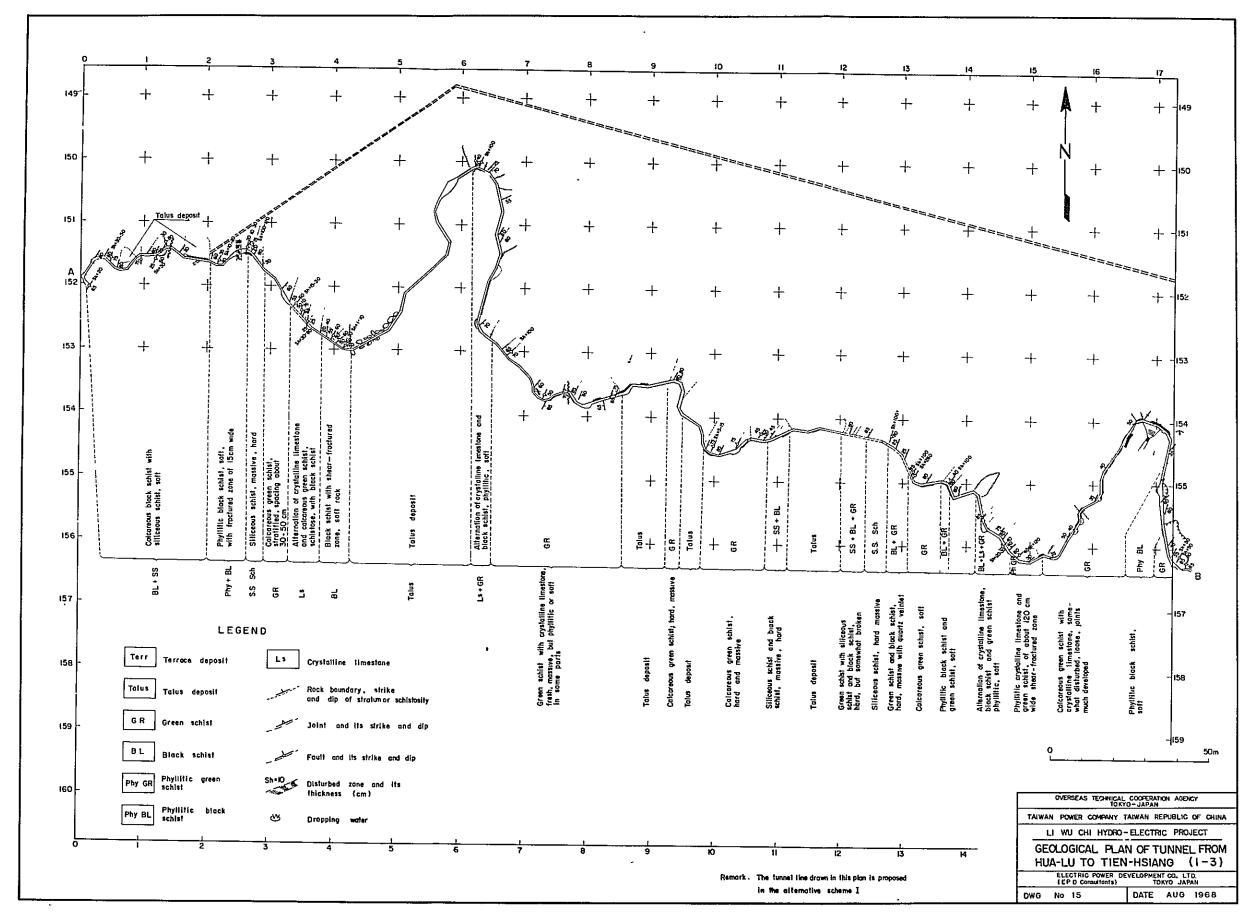
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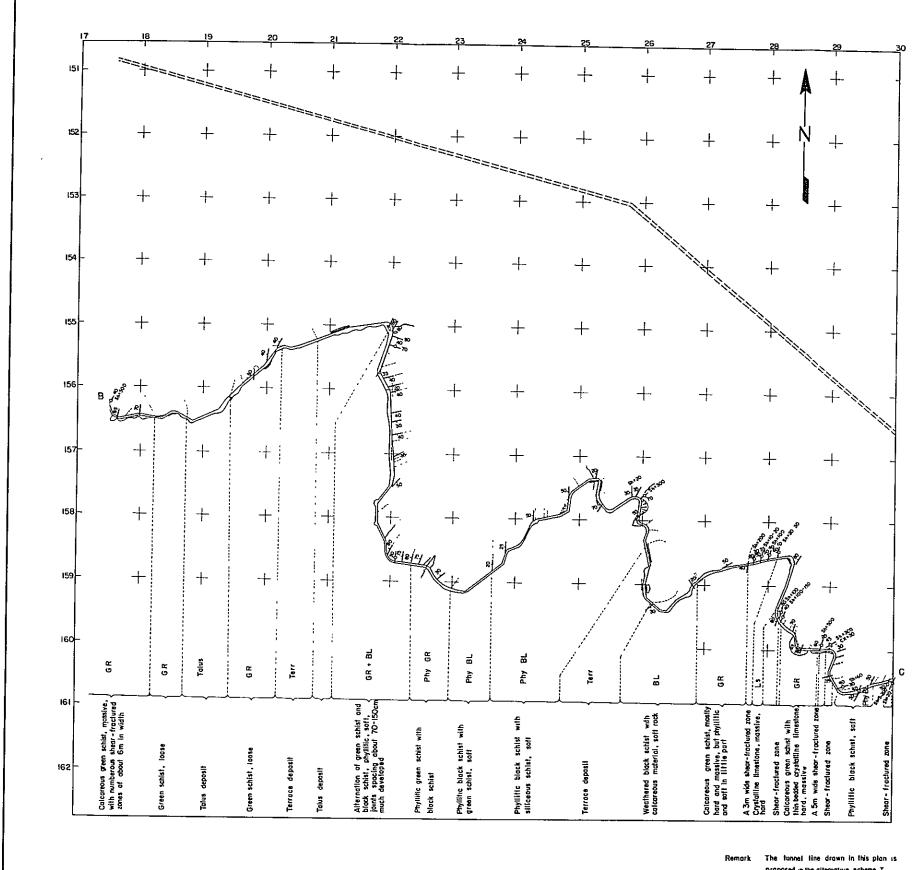
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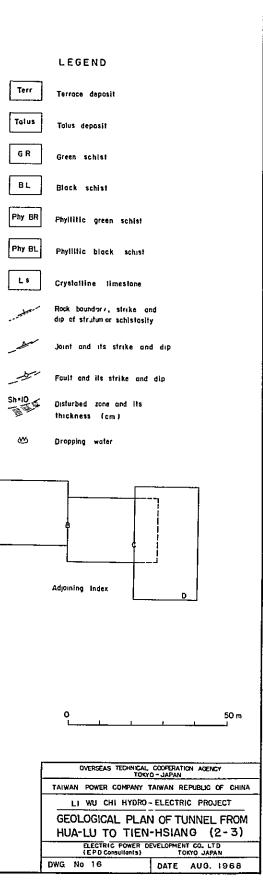
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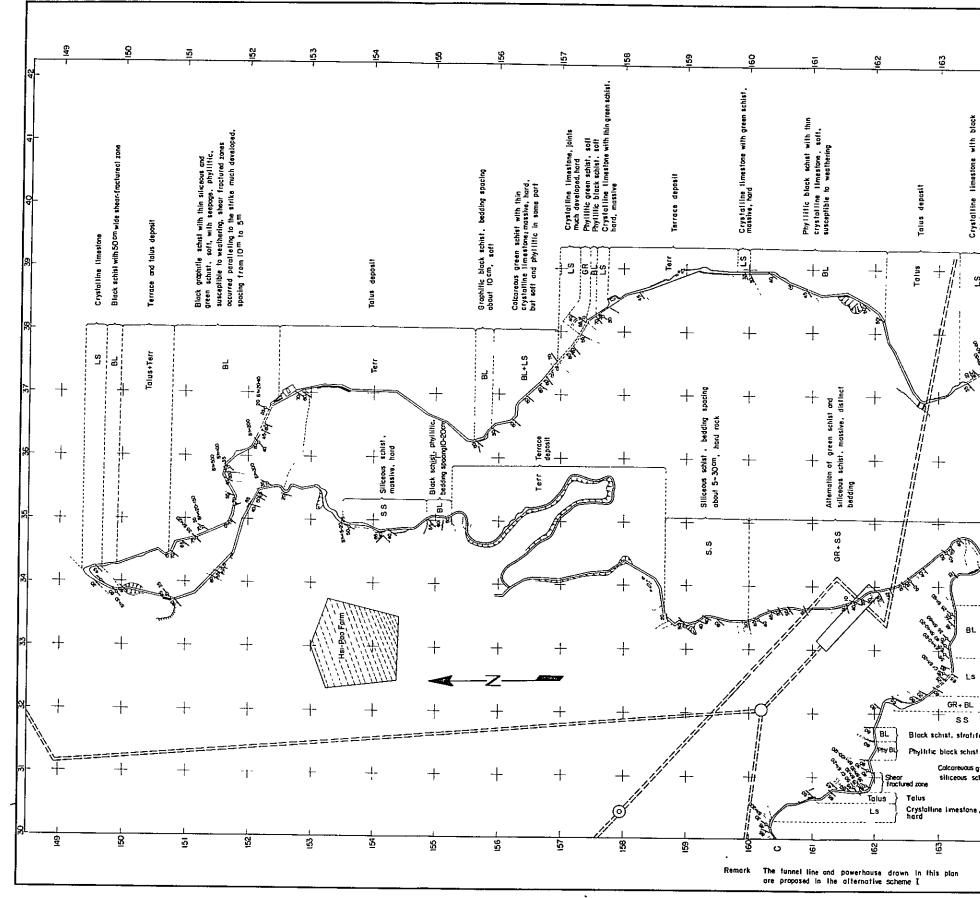
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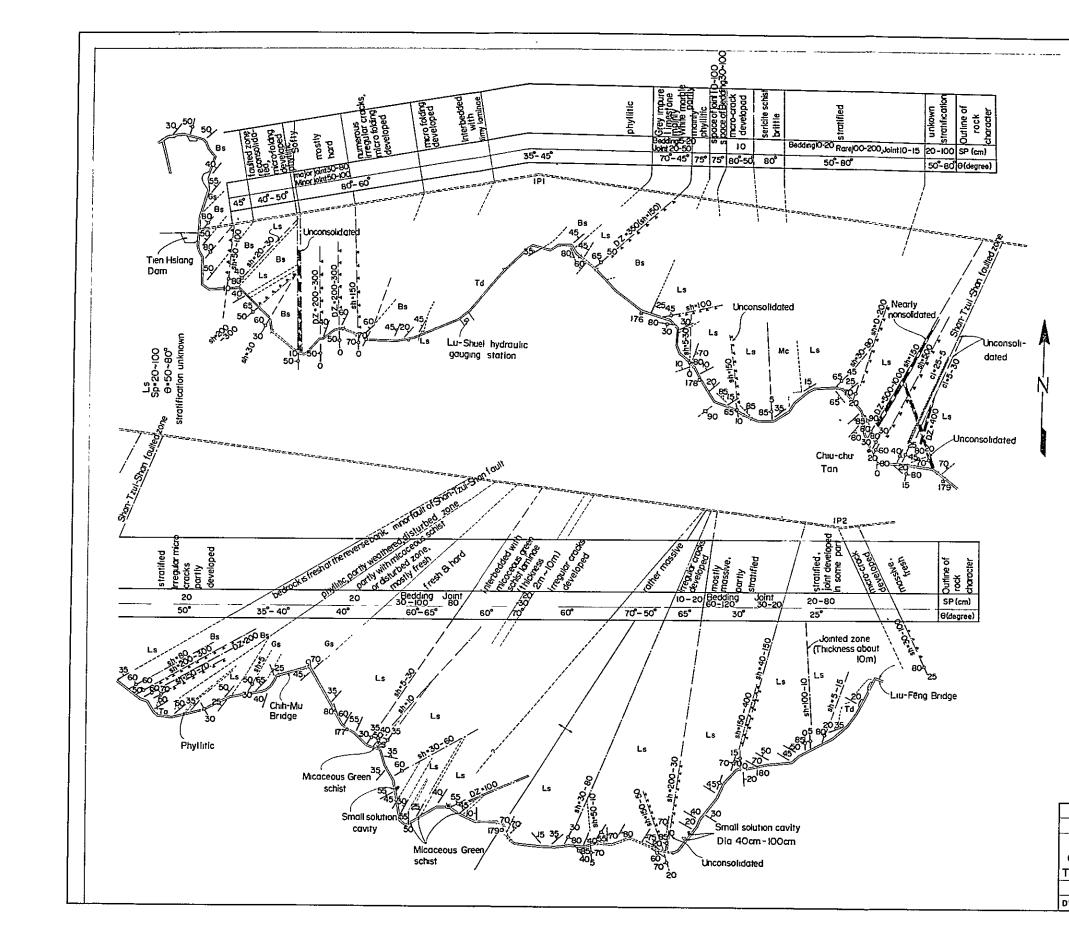
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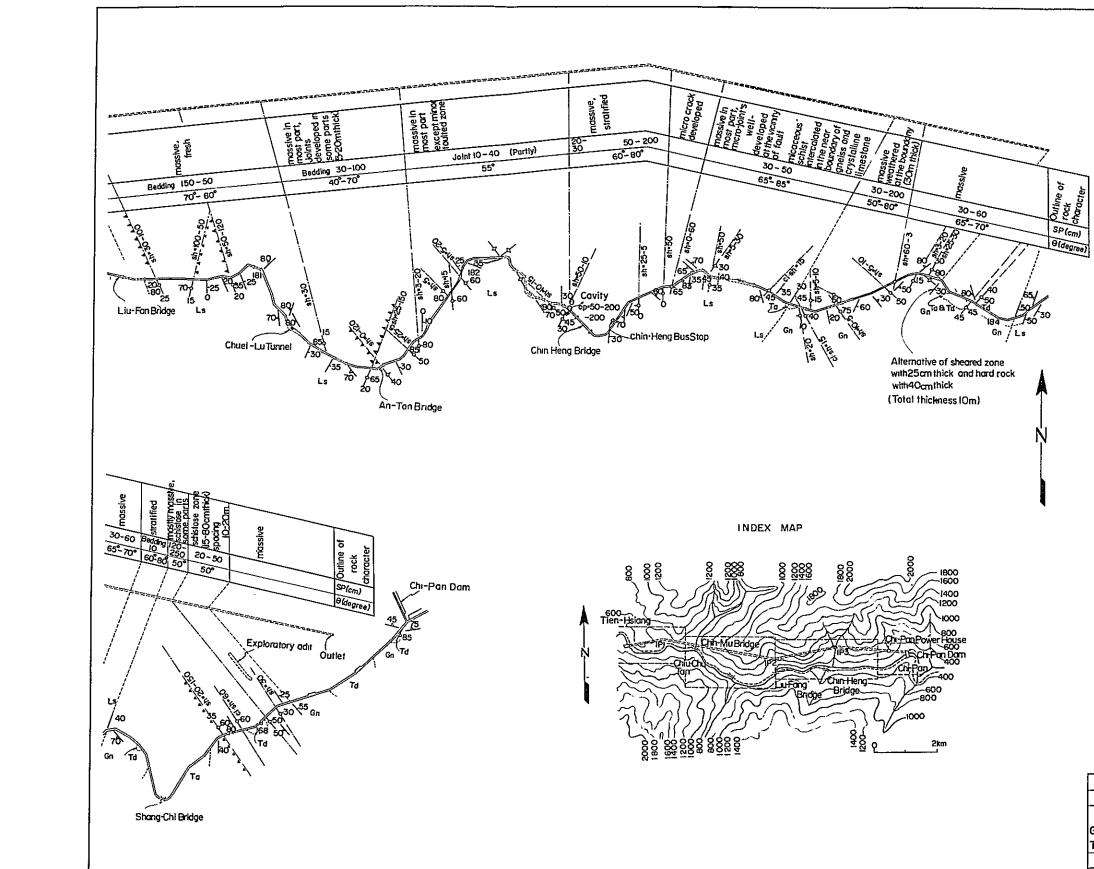


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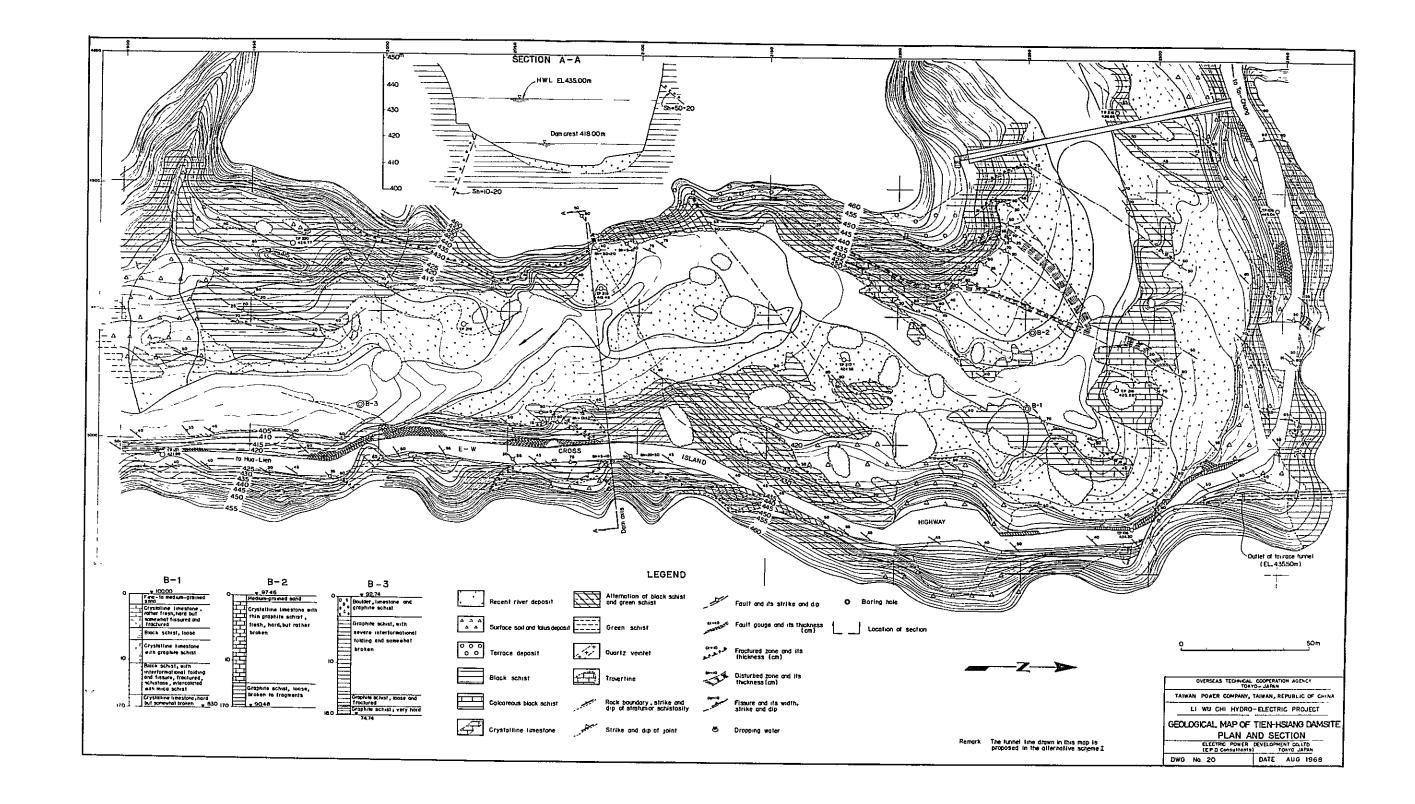
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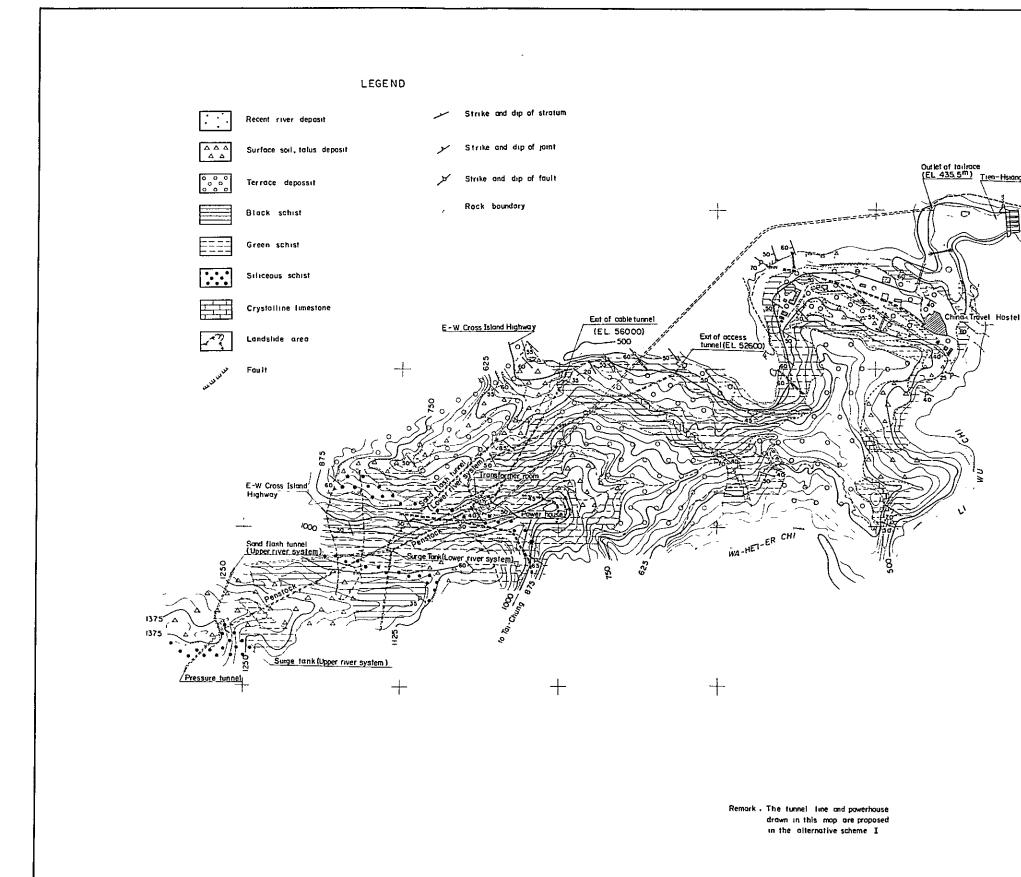


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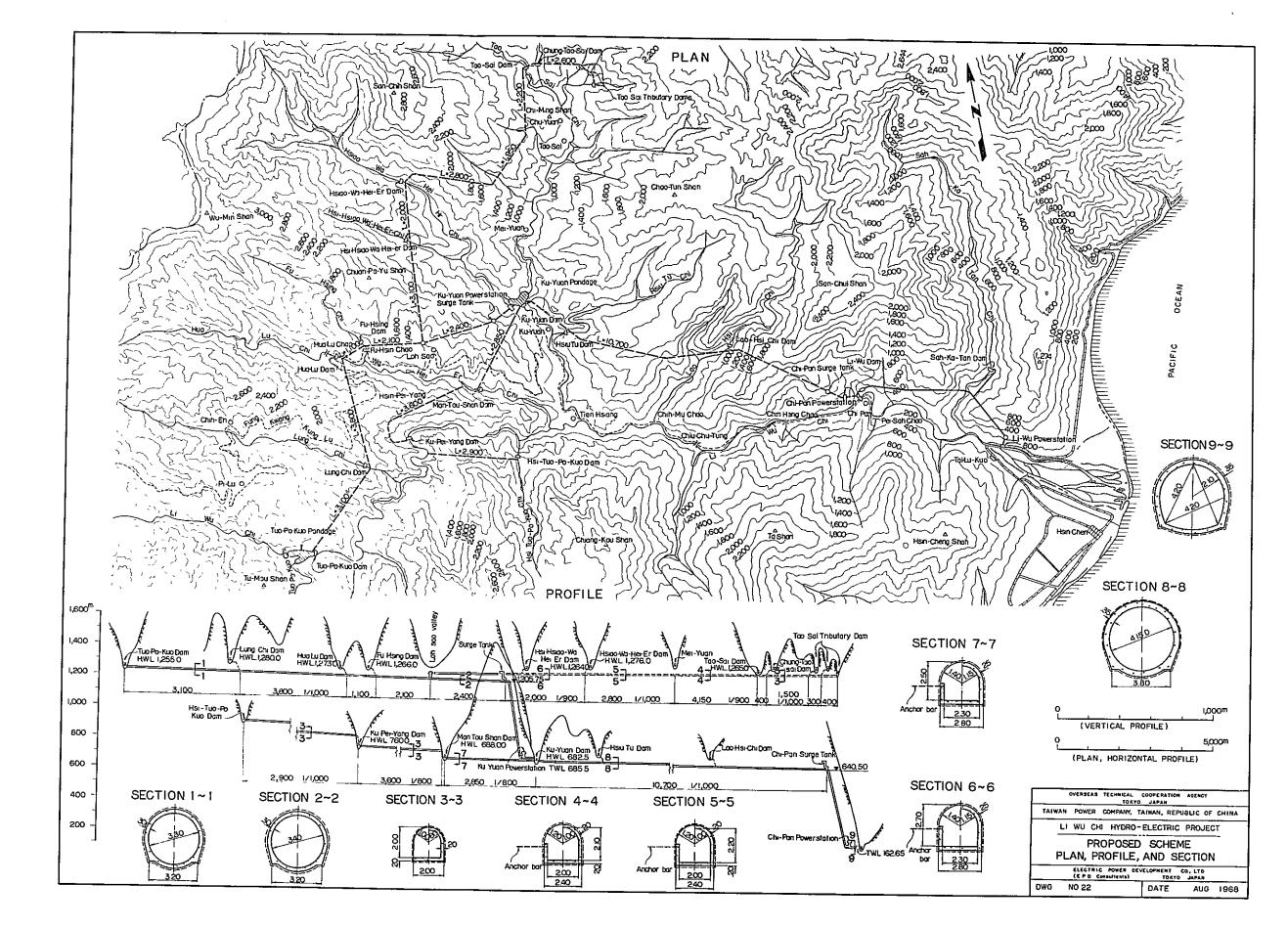


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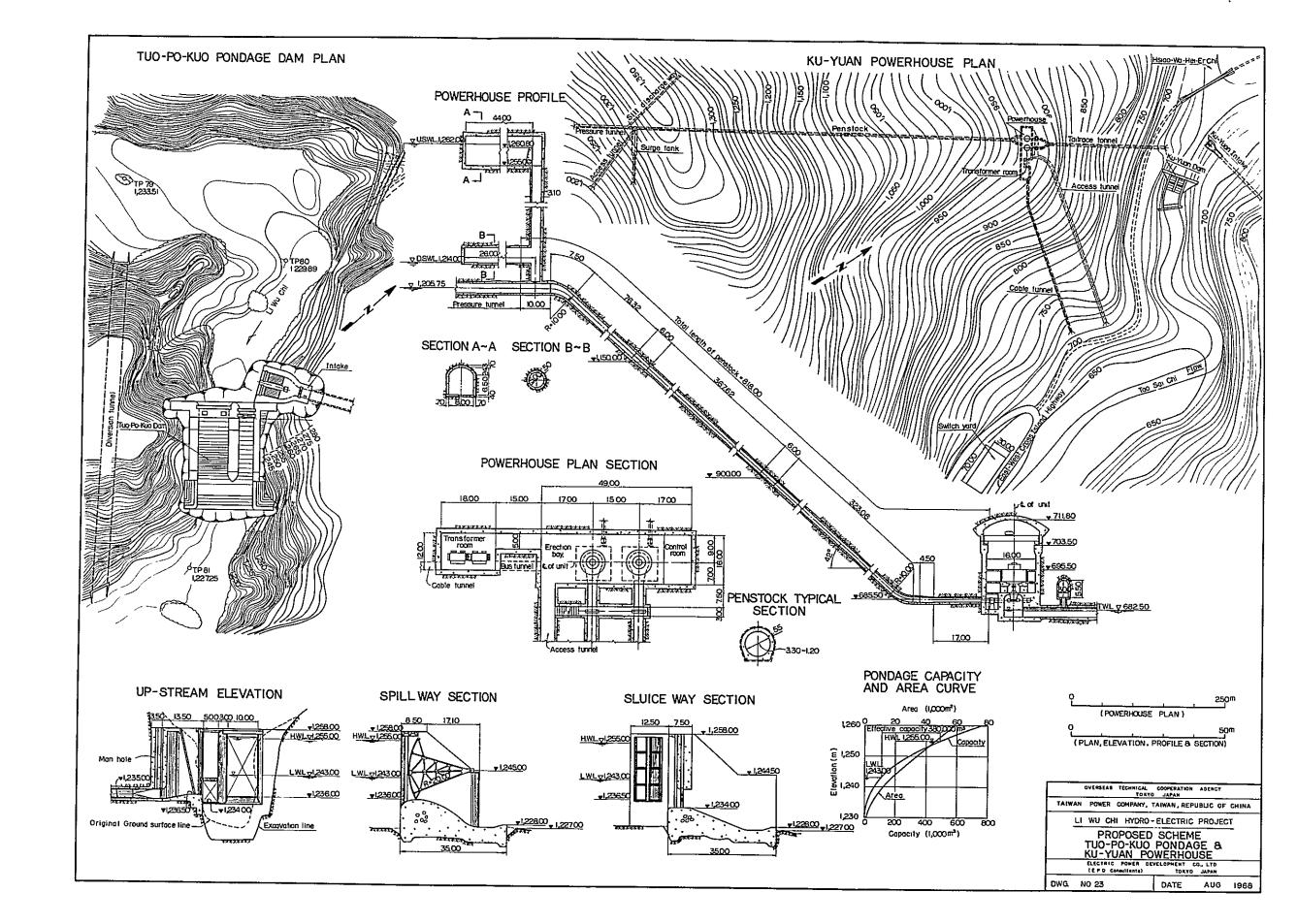
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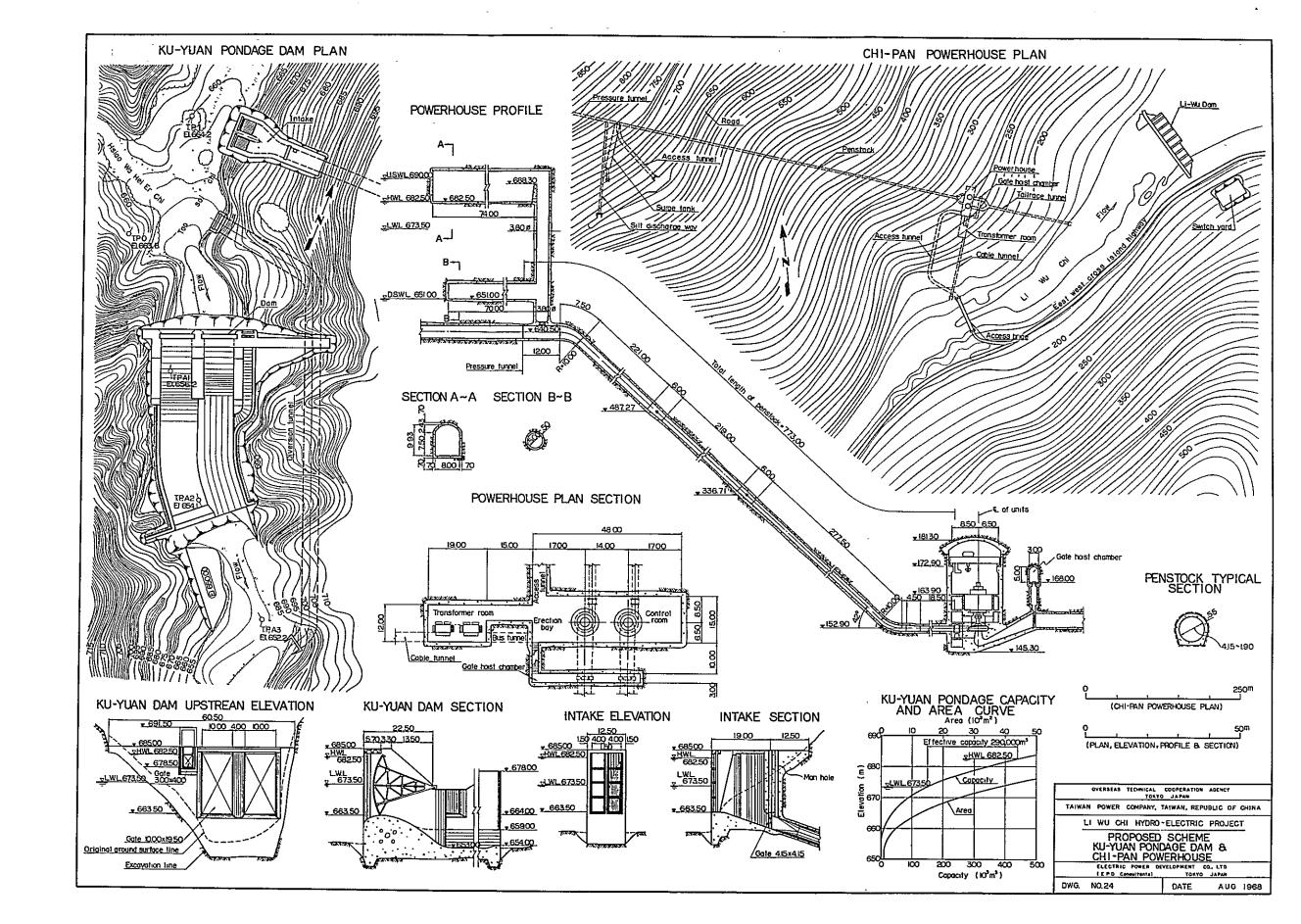
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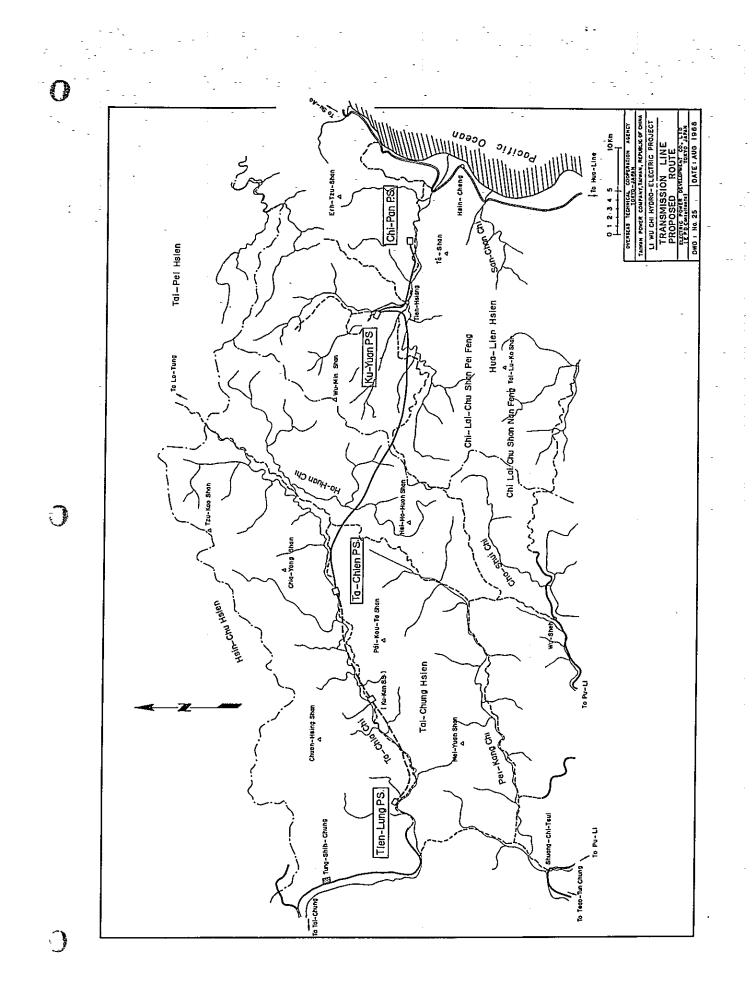


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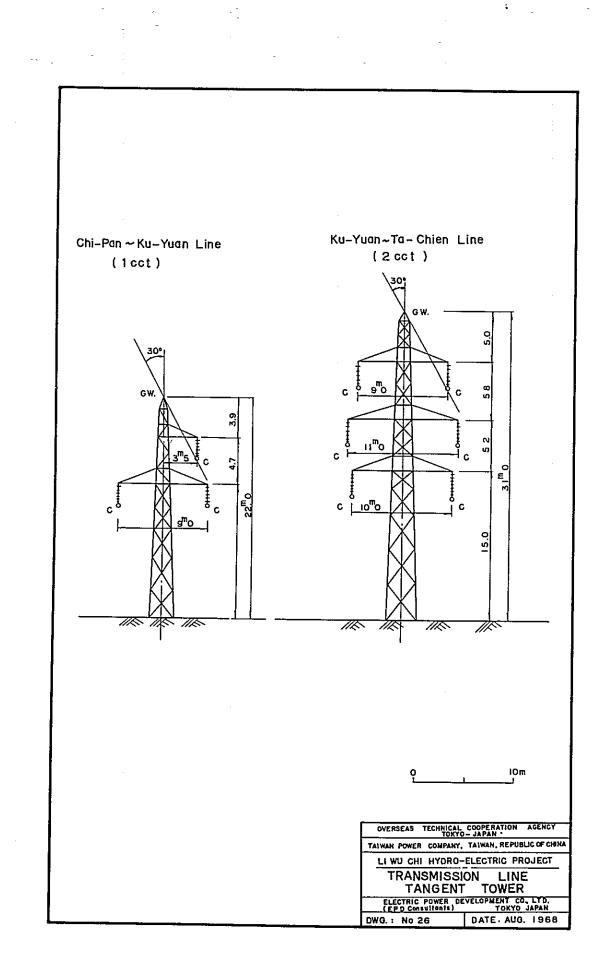
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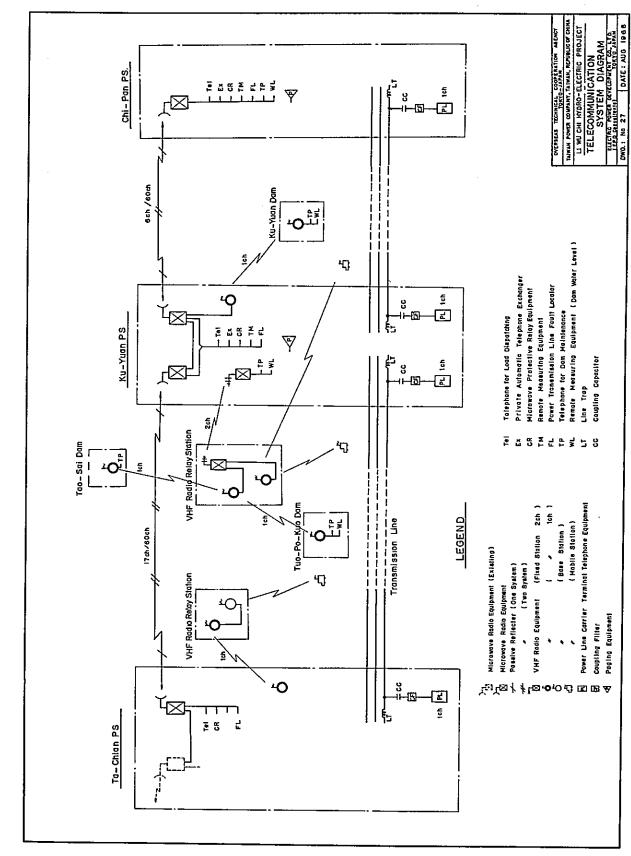
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APPENDIX - 2

EVALUATION OF HYDROELECTRIC POWER

Evaluation of a hydroelectric power normally follows the procedures given below.(1) A thermal power plant, which will be assumed to be the major part of power supply in the future, is selected as an alternative thermal power plant.

(2) First, the fixed and variable costs equalized throughout the serviceable years of such a selected standard thermal power plant are calculated, and the related transmission costs are added to them and also adjustment of the difference between the characteristics of hydro and thermal power plants are made to obtain the capacity cost and energy cost of hydro power at the receiving primary sub-station.

Annual Capacity	Annual Fixed Cost of + Annual Cost of Alternative Thermal + Transmission
Cost(kWh Cost)	Net Peaking Capability x (1 - kW Trans- of Alternative Thermal x mission Loss Rate)
· -	x kW Adjustment Factor
Energy Cost	Annual Variable Cost of Alternative Thermal Power Plant
(kWh Cost)	Net Energy Production x (1 - kW Trans- of Alternative Thermal x mission Loss Rate)

(3) The maximum output and energy which the said hydroelectric station can effectively supply in the system are then converted into the respective cost expressed at the high voltage side of the primary sub-station. These are called effective peaking capability and available energy respectively.

(4) The benefit of the said hydro power can be regarded as the sum of the capacity benefit which is calculated from multiplying the effective peaking by capacity cost and the energy benefit which is calculated from multiplying available energy by energy cost.

Among the above evaluation procedures, those which have close relations with the supply and demand of power are the following two:

(1) The method of adjustment subject to the difference in character between the hydro and thermal power plants, namely, outage rate, maintenance, influence of dry and wet seasons, capability of quick response to variance of demand, etc.

(2) Calculation method of effective peaking capability and available energy.

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The following describes the practical method and the relation to supply and demand conditions of the above two points.

### (1) Effective Peaking Capability

The effective peaking capability can be defined as the output which is effective in supply and demand of power on the driest day under maximum load. It can be calculated as described as follows.

The output required to be produced continuously during peaking hours by the said hydro power in view of the supply and demand conditions on the day of maximum load on the basis of available energy on the driest run-off day is the effective peaking capability.

#### (i) Available Flow on Driest Day

Either day of average run-off calculated from the run-off of the driest day of daily average run-off calculated from the minimum 10-day-runoff recorded in the past is chosen as the driest day. The reserve capacity which is necessary to maintain the constant supply reliability of the whole power system will depend upon the selection of the driest day.

The increase or decrease in the reserve capacity in this case does not mean the increase or decrease in the total supply capability including hydro and thermal powers. But it rather means the variation in the available supply capacity of hydro power which can be used as reserve capacity.

In this Study, however, in compliance with the Taipower Standard, the daily average value of the run-off of the driest 10 days has been chosen as the basic run-off in calculating the effective peaking capability.

However, in evaluation of supply capacity of hydro power in comparison to that of thermal power, it is needless to say that the kW value of effective output calculated on the basis of a poorer inflow condition is more valuable than that calculated on a better condition, and this adjustment in the kW cost is taken into consideration in evaluation of the hydro power as the kW adjustment factor. In other words, the kW adjustment factor becomes greater under severer conditions for the standard level of

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water in the dry day, and it is smaller under milder conditions.

The actual calculation method and the figures of the kW adjustment factor are mentioned in the following section.

(ii) Necessary Peak Operation Hours of Hydro Power Station

Peak operation hours will be governed by the shape of the load duration curve of the day of the maximum load and the portion supplied by the said hydro power in the load duration curve.

The smaller the ratio of amount of peak hydro power to the total supply, the shorter will be the necessary peak operation hours, and on the contrary, the greater the ratio of peak hydro power, the longer should be the hours of peak operation. If the peak of the load duration curve is made sharp, the necessary peak operation hours are shorter, but if the peak is flatt, the necessary peaking hours must be longer.

The daily load curve is generally subject to seasonal fluctuation depending upon the natural conditions such as the time of sunrise and sunset, temperature, etc., and in the longer range, it is also in accordance with yearly variation depending upon the change in the industrial structure and in the mode of living in consequence of economic development. Therefore, it is advisable to determine the necessary peak operation hours to be used in the evaluation of hydro power from a long-range stand point taking into consideration change in status of hydro power subsequent to increase in power demand in the future and to changes in power sources and the variation of the load curve coresponding to economic development of the country. Judging from the natural conditions in Taiwan, so far as the future shape of the daily load curve of the Taipower System is concerned, twelve months of the year can be divided into the following three groups.

(a) Winter Type:

The four months of October, November, December and January belong to this type, and the load curve is the lighting peak type as the industrial demand of the day-time overlaps the lighting demand in the evening due to relatively early sunset in this season. For this reason, the peaking hours are relatively short and it is thought that this trend will continue for a considerably long time in the future.

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#### (b) Summer Type:

The four months of June, July, August and September belong to this type, and the load curve will become the daytime peak type in the near future because of the increased demand for air-conditioning due to the increase in building demand on account of high temperatures in the daytime, although the industrial use of the daytime will not overlap the lighting demand in the evening because of late sunset. ()

However, the lighting peak will remain for the time being and the peaking hours will gradually become longer.

(c) Spring Type:

The four months of February, March, April and May belong to this type. The load curve comes in between the winter and summer types as sunset time is not early and yet daytime temperature is not so hot.

Although it will be a lighting peak type for the time being, it will shift to the daytime peak type following the summer type and before the winter type. For this reason, the peak duration is short at the moment, but will gradually becomes longer.

It is assumed that a considerable length of time can be spared in this season for the maintenance of thermal plants, as the maximum monthly peak load is smallest of the year in this season.

Considering the seasonal characteristics of the above load curves and the estimated load curves for August and December, 1967 as well as the data of load duration curves in Japan and also the position of the Li-Wu Chi Hydroelectric Development Project in the load curve after commencement of its operation and in the future, the hours of operation upon which the calculation of the effective output is based in this study is determined as follows:

Winter: October, November, December and January - 5 hoursSummer: June, July, August and September - 7 hoursSpring: February, March, April and May - 6 hours

 Monthly Effective Peaking Capability and Annual Overall Effective Peaking Capability

As a rule, when the ratio of thermal power becomes larger in the

power supply system, it becomes impossible to carry out scheduled inspections and repairs of thermal plants in the wet season and in the low demand season only, and the repairs of the thermal plants will be required to be performed throughout the year. Only in case the ratio of thermal power is small, scheduled inspections and repairs can be limited to a certain period, for instance, in the wet season only. The peaking capability of hydro power in the maximum load day and moreover in the driest day of the month in which the maximum operation of the thermal power station is required can be evaluated as the effective peaking capability of the said hydro power, because the development of the particular hydroelectric power station makes it possible to reduce the construction cost of a thermal power plant equivalent to the above peaking capability of the hydroelectric power station.

Moreover even if the above peaking capability might increase in other months, it only leads to an increase in the possible amount of repair of thermal plant during that month, in other words, it only increase the reserve capacity for the month, and it is not necessary that a supply capacity is directly related to a reduction of thermal capacity. Therefore, the maximum output that can supply demand effectively in the month of maximum thermal plant operation is regarded as the effective output of the said hydroelectric station.

Surface Surface

> However, in case the ratio of thermal power supply becomes so large that scheduled repair and inspection of the thermal plants should be performed every month through the year, it is necessary to evaluate the mean value for twelve months of the peaking capability of the hydroelectric power station that can effectively cover the supply on the maximum load and the direst day of each month as the effective peaking capability of the said hydroelectric power station. Because, by developing hydro power, the repairable amount of thermal power increases equivalent to the above peaking capacity of the hydro power. The amount of the thermal facilities that can be reduced due to the increase in repairable amount of thermal power can be expressed as follows:

If  $H_i$  represents the peaking capability hydroelectric plant can supply effectively in the month of i, M (month) represents the number of days of repair and inspection of the thermal plant and  $rarchine{T}$  represents the number of the thermal plant to be reduced by the development of the hydroelectric power,  $\Sigma_{l}^{12}H_{i}$ , the increase in the repairable amount of thermal power plant due to the increase in the supply capacity of hydroelectric power is equal to  $\Delta T.(12 - M)$ , that is, the decrease in the repairable amount due to the decrease of the thermal power  $\Delta T$ .

 $\Sigma H_i = \Delta T (12 - M)$ 

Therefore, the reduced amount of the thermal power plant,  $\triangle T$ , is:

$$\Delta T = \frac{\Sigma H_i}{12 - M} = \frac{12}{12 - M} \cdot \frac{\Sigma H_i}{12}$$

In the above equation,  $\frac{\sum H_i}{12}$  is the effective peaking capability of the hydroelectric power, and  $\frac{12}{12 - M}$  is the kW adjustment factor due to the difference of repair and inspection between hydro and thermal power.

(2) Available Energy

The available energy production can be calculated as follows: Available Energy Production = Possible Energy x

> (1 - Outage Ratio) x (1 - Surplus Ratio)

### (3) kW adjustment Factor

The kW adjustment factor means the adjustment items in the evaluation of hydroelectric power arising from the difference in characteristic between hydro and thermal power, and consists of the following items:

(i) Because of the lower outage rate, the reliability of hydroelectric power station is higher than that of thermal power plant, which is an advantage of hydroelectric power station.

(ii) Repair and inspection of a thermal power plant is longer and more frequent than that of a hydroelectric power station, so this makes the average annual supply capacity of the thermal power plant smaller than that of the hydroelectric power station, which is also an advantage of hydro power.

(iii) The output of a hydroelectric power station can be stepped-up or stepped-down faster than a thermal power plant, and this makes the hydro-

electric power station operate more effectively corresponding with quick changes in demand. This is also an advantage of hydro power.

(iv) Depending upon the standard level of inflow which is the basis of calculation of the effective peaking capability of hydroelectric power, the effective output varies, and so does the reliability of the effective output. Therefore, this should be calculated into the kW adjustment factor.

The above items of adjustment change in the values depending upon the variation in supply and demand condition and the different supply reliability required in the supply system, and this leads to a wide variation of the kW adjustment factor itself.

(i) The kW adjustment factor determined by the differences in the outage rate and upon the standard level of inflow can be calculated as a ratio of the required amount between the hydro power supply capacity and thermal power supply capacity in order to make the supply reliability of the power system equal.

In this study, the value of the driest-10-day period in the past more than 10-year period is used as the standard level of inflow, so any period drier than this is hardly conceivable. Also, the outage rate of a hydroelectric power station is much smaller than that of a thermal power plant. Therefore, as this adjustment factor, a reserve supply capacity has been calculated in order to maintain the reliability of which one day of supply shortage may take place in every 10 years, if the entire system is composed of the thermal power, and in consideration of the above, the kW adjustment factor is set at 1. 20.

(ii) The kW adjustment factor determined by the difference of speed of output variation between hydro and thermal power is rated at 1.00 in this study, since the advantage of hydro power does not demonstrate the effect unless the ratio of hydro power supply to thermal is less than 10% in the total system capability.

(iii) The kW adjustment factor determined by the difference in repair and inspection between the hydro and thermal power plants can be calculated as an advantage of hydro power in view of the average annual sypply capacity. In this study, the repair and inspection period of thermal plant is assumed to be one month a year, and the kW adjustment factor is rated at 1.09 or

The combined kW adjustment factor of all of the above can be calculated as follows: 0)

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 $1.20 \times 1.00 \times 1.09 = 1.31$ 

 $(\frac{12}{12-1}).$ 

Thus, the kW adjustment factor is rated at 1.30.

# APPENDIX - 3

## List of Run-off Record

- <b>*</b> -	N	Name of gaging station	Period
	1.	Lu-Shuei	1957 - 1967-
	2	Tao-Sai	1964 - 1967
	3.	Hsi-La-Keh	1965 - 1967
	4.	Fu-Hsing	1964 - 1967
· ·	5	Hua-Lu	1964 - 1967
	6.	Chih-En	1965 - 1967
	7.	Tuo-Po-Kuo	1965 - 1967
-	8.	Ku-Yuan	1965 - 1967
	9.	Man-Tou-Shan	1965 - 1967

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SEPT	00000000000000000000000000000000000000	64.59 2.15 5.30
AUG .	44044444444444444444444444444444444444	64.71 2.09 8.00
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. JUNE	ма44 604 милии и мили и милии и мили и ми	96.58 3.22
MAY		50.27
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00.1	00000000000000000000000000000000000000		1.65 6.45 0.99	00000000000000000000000000000000000000	-	0.42
SEPT	000000000000000000000000000000000000000	23.33	0,78 1,46 0,47	00000000000000000000000000000000000000	10	0,56
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יוור	00000000000000000000000000000000000000	10.08	0.33 0.41 0.29	00000000000000000000000000000000000000	72	1, 99 B. 75
JUNE	0000-00000000000000000000000000000	19.32	0,64 1.57 0.36	C0000000000000000000000000000000000000	21.74	0.72
MAY	00000000000000000000000000000000000000	9.24	0.36	00000000000000000000000000000000000000	1.01	0, 34
APR	00000000000000000000000000000000000000	9.81	0.33 0.41 0.29	00000000000000000000000000000000000000	1010	0.35
MAR	00000000000000000000000000000000000000	1 +1	0.44 0.61. 0.35	CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	12.54	0.59
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		5.7				000000000000000000000000000000000	26-5 0.8
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JUNE	00040-2020-2020-2020-2020-2020-2020-202	68.87			,		17.96
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AFK		9.06	$\sim$	t in	0,16	NNNNNNNNNNN+04mm44444mmmmmmNNNN0	10.70 0.36
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	00000000000000000000000000000000000000	n n	6.1	0.42	0.20	00000000000000000000000000000000000000	8-88 0.32 1.10
		7.66	2	0.28	0, 22	00000000000000000000000000000000000000	0.33
	-0064846860-00460460-00466666	TOTAL	MEAN	MAX	MIN	ーンきょうかっきの ひょうちょうかい ひゅうちょうろう ひゅう しょうしょう うろう ひょうちょう ひょうちょう ひょうちょう ひょう ちょう ひょう ちょう ひょう ちょう ひょう ちょう ひょう ちょう ひょう ちょう しょう しょう しょう しょう しょう しょう しょう しょう しょう し	TOTAL MEAN MAX.
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00.1	иликоничинаний водите 4-100000-100000000000000000000000000000	152.82 4.93 33.50 2.00	00000000000000000000000000000000000000	21.23 0.68 0.80
SEPT	* • • • • • • • • • • • • • • • • • • •	59,95 2,00 8,05 0,95	00000000000000000000000000000000000000	29.63 0.99 1.56
VUG	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	71-07 2.49 12.14 0.64	1-0-8-004-000000000000000000000000000000	139.46 4.50 20.00
INLY .	00-000000000000000000000000000000000000	23.76 0.77 0.65	мила-2000000000000000000000000000000000000	232.10 7.49 39,00
JUNE	00004-00004r00mm000400C00000000	640		43.33 1,44 2,40
MAY .	000000000000000000000000000000000000000	21.18 0.68 0.84	00000000000000000000000000000000000000	21.30 0.69
APR	CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	22-03 0.73 0.54	00000000000000000000000000000000000000	0.50
MAR		38.71 1.25 9.50		19.91 0.64 0.88
EFB :		41.33 1.43 2.6/	CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	15 39 0.62
JAN	00000000000000000000000000000000000000	39.86 1.29 0.75	CC00CC0CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	20.13 0.65 0.71
DATE		TOTAL MEAN MAX. MIN	100日19らてもど100日499~22~22~2~2~2~2~2~2~2~2~11-1~1~~~2~2~2~~~~~~~~	TOTAL MEAN MAX
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DEC	104444	******	*******	00000000000000000000000000000000000000	14444	14.55	0.47		
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001				000000000000000000000000000000000000000	The Prop Prop Prop	26.65	0.86		144.22
SEPT	00001-1	~~~~~~	0~0~0~1000		-mmNO	42.71	3.50	000000000000000000000000000000000000000	30.20
AUG				00000000		21.85	0,80	C0000000000000000000000000000000000000	
חורא		-0000-7-7-0		-cooooo 04444444	000000	• <b>•</b> ;	2,29 2,20 0,86		31.65
JUNE	DONNN	PO@P-44	04001-41-	10000000000000000000000000000000000000	04100		2. 14 18. 80 1. 05	44000000000044410040000000000000000000	55.11
MAY		00000	ວິເກເກເກເກາ- ເວັ້ນ	00000000 20000000 20000000000000000000	0000	21.90	0.71		34.12
APR	000000	000000		00000000	- ounina	1.41	0, 52 0, 52	00000000000000000000000000000000000000	24.66
MAR	տանան	ատաշտո	ະເດຍດແດແດແດງດ	00000000000000000000000000000000000000			0.54	N	30.70
FEB .	ເບັນເປັນເປັນ		4044444	00000000000000000000000000000000000000	0000	0	0.38	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	20.19
- NAL	000000		0000000		4400 4400	2	0.50	00000000000000000000000000000000000000	6.21

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TOTAL MEAN MAX.

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DEC		· • • • •	2000000000000000000000000000000000000	
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0CT	00000000000000000000000000000000000000	4400	C00C00C0000000000000000000000000000000	13.40 0.43 0.54
SEPT	00000000000000000000000000000000000000	19.50 0.65 0.65	00000000000000000000000000000000000000	23.85 0.80 2.72
AUG	44000000000000000000000000000000000000	0,00,0	COCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	14.05 0.45 0.54
	20000000000000000000000000000000000000	126.41 4.08 33,40 0,56		
JUNE	00000000000000000000000000000000000000	25.31 0.84 0.34 0.34		142.45 4.75 20.40
MAY	444444444-0000000000000000000000000000	12.92 0.42 0.75 0.34	44555555555555555555555555555555555555	10.71 0.35 0.53
APR	00000000000000000000000000000000000000	11.19 0.37 0.38 0.34	CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	10.30 0.34 0.4/
MAR.	CC000000000000000000000000000000000000	14 76 0.48 0.77 0.77	00000000000000000000000000000000000000	11.43 0.37 0.76
FFR	00000000000000000000000000000000000000	11.55 0.63 0.34		6.88 0.25 0.36
NAL	00000000000000000000000000000000000000	12.95 0.42 0.32	60000000000000000000000000000000000000	8.47 0.27 0.55
DATE	-NW4N92200000000000000000000000000000000000	TOTAL <sup>†</sup> MEAN MAX. MIN,		TDTAL MEAN MAX.
YEAR			60000000000000000000000000000000000000	

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6. Chih-En gauging station drainage area: 18.6 k

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SEPT	00000000000000000000000000000000000000	12.10	15	łr	, 62 °
AUG	00000000000000000000000000000000000000	15.11	17	22.0	.620
	00000000000000000000000000000000000000	L4.85	4 0	1.08	-0.34
JUNE	00444444440000000000000000000000000000		ŝ		0, 52
MAY	000000000000000000000000000000000000000	13.83	0.45		0.21
APR	00000000000000000000000000000000000000	10.261	0.34	0.72	0.29
MAR	-0000000000000000000000000000000000000	13.701	0.44		0.251
FEB	00000000000000000000000000000000000000	7.78	0.281	0.72	
JAN	20200000000000000000000000000000000000	6.80	0.22	29	0,18
DATE		님	MEAN	MAX.	MIN
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	DEC	00000000000000000000000000000000000000	62.02 2:50 2:50	00000000000000000000000000000000000000	61.01 1.97 2:08
	NON	иииииииииииииииииииииииииииииииииииии	89.80 2.99 4.70	иния-колоничиний - станалики состании - станалики состании - станалики состании - станалики состании - состан	65.47 2.18 2.70
	001	ашемииииииииииииииииииииииииииииииииииии	73.21 -2.36 -3.90	44440000000000000000000000000000000000	3.11
	ŞEPT		153.73 5.72 7.76 3.90		171.87 5.73 14.94
- 196/	AUG	00000000000000000000000000000000000000	542.71 17.51 46.80 9.00	00000000000000000000000000000000000000	122.63 2.96 6.95
ы 1965	JULY	20000000000000000000000000000000000000	1086, 75 35, 06 272, 67 4, 90	00000000000000000000000000000000000000	216.20 6.97 16.60
ion: 1,130	JUNE	・ 、 、 、 、 、 、 、 、 、 、 、 、 、	269.70 0.99 20.20 3.65		1307.92 43.60 143.00
elevation:	MAY	444040444444600000000000000044044444 002040000000000	186.90 6.03 7.9.50		160 - 18 5. 17 10, 20
IN 2.C11	APR .		84 69 2.82 5,90 2,16		10.91 3.70 5.75
ramage area:	MAR	<i><i><i>VNNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VNN</i>-<i>VN</i></i></i>	111.41 3.59 7.20 2.33		11118 3.59 6.20
BID	FEB		73.21 2.61 4.90 2.16	20000000000000000000000000000000000000	60.48 2.69 2.93
4	JAN	CC20440404640606666666600000000000000000	119.47 3.85 5:36 2.33	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	60.66 1.96 2.13
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 00.T	44474444444444444444444444444444444444	544.66		117.00	
SEPT	Loon2444444wwwwwwwwwwwageo000000000000000000000000000000000000	146.04	4.8	9.50	) (T
AUG	ຆຌຌຌຌຆຑຑຑຑຬຑຑຑຑຑຬຑຌຌຎຌຌຌຌຑຑຑຑຑຬຬຬຬຬ ຬຎຎຬຬຬຌຬຬຬຬຬຬຬຬຬຬ	137.70		4	
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MAY .	00000000000000000000000000000000000000	وًا و	5.99	00.25	1.73.
APR		147.13	4,90	Ч	3.18
MAR	ຉຒຉຓຌຌ <i>ຉ</i> ຑໞຎຎຌຎຬຑຉຬຬຏຎຨຌຬຎຎຌຌຬຏ ຺຺຺຺຺຺຺຺຺຺຺຺຺຺຺຺຺຺຺	N	5.56	14.30	1.87
FED		<b>ה</b>  י	3.00	Z. 40	2,18
JAN	ľ	99.21	2.34	3,63	2.03
DATE	ーとの484567000000000000000000000000000000000000	TATA	<b>U</b>   •	WAX	_
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DEC	44444444400000000000000000000000000000	- 119.63	20.6		3.24	00000000000000000000000000000000000000	15	2.42	1	-
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00.1	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	185.52	5	7.02		-0	148.80	10	ιř	
SEPT		239.68	5	9	ł		223-30	<b>N</b>	16.23	
AUG	00000000000000000000000000000000000000	50.949	20.9		169'2		117.95	108.E	10	
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- JUNE	ຆຆຆຆຌຌຆຑຩ຺ຨຑຌຌຌຑຌຌຑຉຌຬຬຬຨຉຬຌຩຩຩຩ ຌຌຌຌຩຩຌຩຘຆຌຌຬຬຬຎຎຎຌຬຬຬຬຬຬ ຉຬຑຎຑຎຎຑຑຎຎຬຬຬຎຎຎຎຌຬຬຬຬຎ ຬຬຎຎຑຎຎຑຎຎຎຬຬຬຎຎຎຎຎຎຎ	180.25	1	10,25		00000000000000000000000000000000000000	0	30,99	0	
	44000000000000000000000000000000000000	120.35	8	7.20	2,90	₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩	136.90	-	m	1
믭	амаа44маииииииииииииииииииииии 44446546666666666	100.45	•	ŋ	Ð	00000000000000000000000000000000000000	114.53	Ø	. 1	Þ
Ē.	www.anon44444444444.www.c.www.www. 222220000000000000000000000000	125.03	60.5			ຑຑຑຠຎຎຎຎຎຎຎຎຎຎຎຎຎຎຎຎຎຎຎຎຎຎຎຎຎຎ ຠຎຠຎຎຎຎຎຎຎຎ	127.14	-	N	2.78
비	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	98.90	3.53	-	1	00000000000000000000000000000000000000		3,06	Ô	
31	44604000000000000000000000000000000000	134.35	4.33	6]	3.60	₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩	97.44	3.14	3.64	7 7 8 1
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NON		1141.03	. <b>m</b>	207 46	
00.1	ณฑฑฑฑฑฑ4444444444444444444444444444444	479.60	15.47	70.50	
SEPT	►900004444444444444444444440€₽►9000 ₩454406000000000000000000000000000000000	155.40		9.10	
AUG	๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛	137.60	4.44	13.10	
JULY	๗๗๗๗๗๚๚๗๗๚ ๗๗๚๚๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛๛	153, 90		11.40	
JUNE	20210000000000000000000000000000000000	289.61	9.65	18.75	
МАУ	00000000000000000000000000000000000000	142.50	4.60	8.75	
APR	ຆຆຆຆຆຆຆຆຆຉຉຑ֏ຌໞຌໞຎຎຎຎໞຩຎຑຌຌຌຌຌຒ ຌຬຬຬຘຌຨຬຬຬຬຎຎຩຩຩຬຌຉຉຉຉຌຨຌຌຌຌຏຌຬ ຎຒຎຬຬຎຎຎຎຎຌຘຌຌຓຓຬຬຬຬຬຬຬຬຬຬຬຬ	135.87	4.53	8.55	
MAR	aqqınınıqqqqqqquuququququququququq Qongqtgggccgggcggggggggggggggggggggggggggg	133-80	4.32	8.40	
FEB	₩₩₩44₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩₩ 44444460000004€00000₩₩₩₩₩₩₩₩₩₩ 444444400000000	93.05	3, 32	7.85	•
JAN	00000000000000000000000000000000000000	81.75	2.64	3.05	
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:	001		44.31	1.83	1.27	
	SEPT	00000000000000000000000000000000000000	<b>m</b> :	3,28	ŝ	
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	JULY .	00000000000000000000000000000000000000	635.36	5 - 1	9	имимиличини и и и и и и и и и и и и и и и и и
1	5		96.22	615	ת	11111111111111111111111111111111111111
	5			3.02		
aav	5	000000000000000000000000000000000000	27.76 0.93		-1	1.01-0000000000000000000000000000000000
MAR			5	2012-		
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(2)	Yearly maximum discharge of Lu-Shuei					
<b>(</b> 3) <sup></sup>	Typhoon data in Taiwan		-			
	Heavy rainfall at each observation station in recent year of Li-Wu Chi					
(5)	Monthly water temperature at Lu-Shuei	drainage area				
(6)	Air temperature at Lu-Shuei					
(7)	Air temperature at Loh-Sao	ι,				
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(9)	Relative humidity at Lu-Shuei	- , 1				
(10)	" at Loh-Sao	• • • •				
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(12)	Monthly evaporation at Lu-Shuei					
(13)	" at Loh-Sao	•				
(14)	" at Chu-Wei					
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(16)	" rainy day at Chi-Pan	1952-1967	s			
(17)	" rainfall at Lu-Shuei	1957-1967	1			
(18)	" rainy day at Lu-Shuei	1957-1967				
(19)	" rainfall at Chu-Wei	1963-1967				
20)	" rainy day at Chu-Wei	1965-1967				
21)	" rainfall at Loh-Sao	1965-1967				
22)	" rainy day at Loh-Sao	1965-1967				
23)	" rainfall at Ho-Huan-Ya-Kou	1958-1967				
24)	" rainy day at Ho-Huan-Ya-Kou	1958-1967				
25)	" rainfall at Tuo-Po-Kuo	1965-1967				
26)	" rainy day at Tuo-Po-Kuo	1965-1967				
27)	" rainfall at Ku-Pei-Yang	1965-1967				
28)	" rainfall at Chih-En	1963-1967				
29)	Maximum rainfall in year, day and hour at Chi-Pan					
30)	Maximum rainfall in year, day and hour at Lu-Shuei					
31)	Maximum rainfall in year, day and hour at Ho-Huan-Ya-Kou					
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- (35)	Daily rainf	all at Ho-Huan-Ya	a-Kou	1964-1967
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(53)	Monthly wind direction and wind speed in Hua-Lien and Tai-Chung			
(54)	Vearly route of typhoon in Trivian			

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(54) Yearly route of typhoon in Taiwan

III . Hydrological Data

(1) Run-off Records

	•
Gaging station	Period
(a) Chi-Pan intake	1955.1 - 1959.12
(b) Chi-Pan upstream	1955.8 - 1960.4
(c) Lu-Shuei	1956.2 - 1967.12
(d) Tien-Hsien	1964.2 - "
(e) Ku-Yuan	1964.9 - "
(f) Tao-Sai	n _ n
(g) Hsi-La-Keh	1967.9 - "
(h) Fu-Hsing	1964.3 - "
(i) Hua-Lu	11 · _ 11
(j) Man-Tou-Shan	1964.9 - <sup>11</sup>
(k) Chih-En	1964.3 - "
(l) Tuo-Po-Kuo	1964.9 - "

(2) Discharge duration curve at Lu-Shuei station

(3) Stage-discharge curve of river flow gaging station

(4) Gradient of river and Manning's "n" at gaging station

(5) Stage-discharge curve of Tien-Hsiang station

(6) Hydrograph (time-discharge) of maximum flood at Lu-Shuei station

- (7) Records of flood discharge at Lu-Shuei station with date (monthly maximum discharge)
- (8) Report on Li-Wu Chi hydro electric development alternative schemes
- (9) Data of sedimentation (Lu-Shuei Tien-Hsiang stations)

IV Data for Cost Estimations

- Unit cost of construction materials (cement, reinforcing bar, steel pipe, formed steel, timber (plate, bar) copper plate, dynamite, detonater, light oil, glycerine, gasoline, market cost of aggregates at (Li-Wu Chi)
- (2) Wage of laborer

(Laborer, foreman, carpenter, mechanic, electric, truck driver, heavy construction equipment operator, welder, special laborer of tunnelings)

(3) Custom duty

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### V. Load Forecast and System Characteristics

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- (1) Long-Term Load Forecast Report, March 1967
- (2) Investigation Report on Taipower System Load Characteristics Winter 1966
- (3) Primary substation service consumption
- (4) Primary and secondary line losses rate
- (5) Line loss rate of peak load
- (6) Typical load curve
- (7) Regional demand for power flow investigation

## VI. Supply Capacity

(1) Hydro plant

Max. output, max. discharge max effective head. no. of water turbine, effective storage capacity, effective depth, water level, turbine performance curves of Wu-Sheh and Ta-Chien power plant, the ratio of uncontrolled flow to inflow (Ta-Chia River only) 10-day average output of run-off-river station with and without pondage. capacity curve and power constant, for pondage station (Tien-Lun, Ku-Kuan, Wu-Lai, Kuei-Shan, Lung-Chien, Li-Wu, Lower Ta-Chien, Wan-Ta). Reservoir type station (Wu-Sheh and Ta-Chien)

10-day average output

Capacity curve and power constant

Station service power

Utility factor

Pondage plant inflow (1962-1963)

(2) Thermal plant

Max. output, net output, kind of fuel (kcal/kg, kcal/1)

Station service power

Fuel consumption rate

Fuel cost

Periodical outage for maintenance (no.of days, interval)

Dependable capability

Time required to increase load

Over-load capability

Forced outage rate



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VII. Li-Wu Chi Project

(1) Taipower planning standard May, 1968

(2) Organization chart of typical hydro station (Ku-Kuan)

(C) System diagram in 1976

(4) Organization chart of line maintenance station

(5) Typical diagram of existing substation

(6) Hydro plant maintenance handbook

(7) Construction general

Meteorological conditions

temperature, humidity, wind, rainfall,

lightning, typhoon, intensity of earthquake, salthazard

Existing distribution system (power for construction)

Materials for transmission and transformation project

domestic materials

import materials, import duty

price

Cost estimate for Lower Ta-Chien transmission project transportation cost.

## VIII. Reference Book and Data

- (1) The Electric Utility Law (promulgated by the National Government on December 10, 1967)
- (2) Ten-year Power Development Program (1965-1974)
- (3) Cost of Alternative thermal, Ta-Lin two 300 Mw oil-fired
- (4) Plant, December 1967.

(5) Ku-Kuan Hydro Project. Construction Report Volume I, II, Taiwan Power Company September, 1963.

- (6) Hydrological Studies of Flood in Taiwan, May 1965
- (7) Construction Cost of Lower Ta-Chien Hydroelectric Project
- (8) Copy of LiteratureT.L. Hsu 1954

On the Geomorphic Features and the Recent Uplifting Movement of Coastal Range, Eastern Taiwan, Bùll. Geol Sur. Taiwan.  $\overline{i} p_{\hat{h}}$ 

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- (9) Actual system load data
  - 1) Daily load curve of the third Wednesday
  - 2) Daily load curve of max. peak day
  - 3) Daily peak kw
    - For each month 1966-1967 and April, August and December 1963-1965

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- (10) Hydro supply capability
   Daily flow data at typical gaging station of Ta-Chien,
   Ta-Chia River and Lu-Shuei, Li-Wu Chi
- (11) Review Report on Hydroelectric Development Project of Li-Wu Chi
- (12) Report on Hydroelectric peaking planning of Li-Wu Chi
- (13) Correlative calculating data between Lu-Shuei gaging station and other gaging stations.
- (14) Average daily discharge of other gaging stations, that calculated from correlation.

