THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT

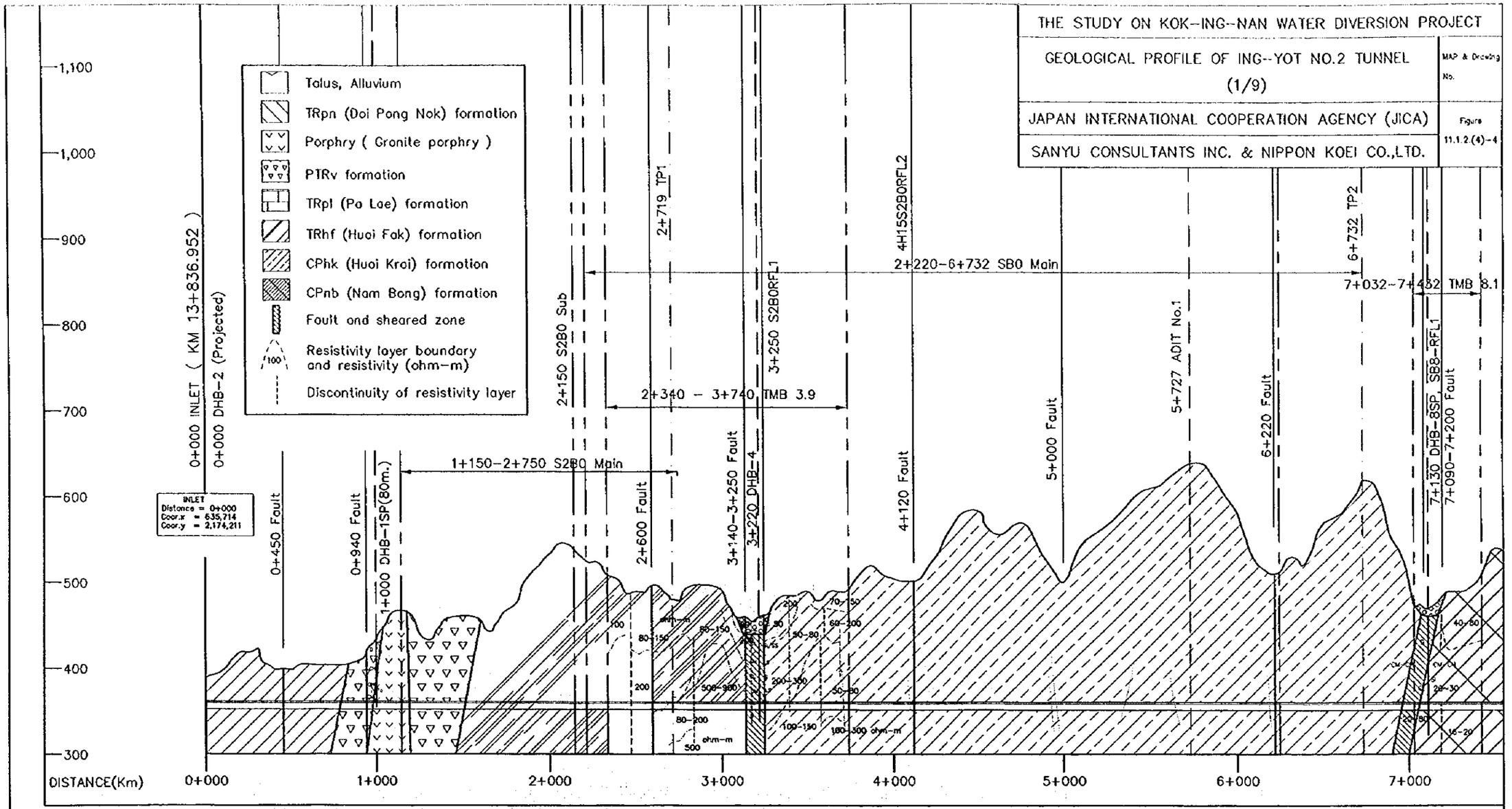
GEOLOGICAL PROFILE OF ING-YOT NO.2 TUNNEL (1/9)

MAP & Drawing No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.

Figure 11.1.2(4)-4



Geological condition	Rock facies, weathering	Reddish brown-reddish purple shale sandstone, tuff alternation. Easily break along bedding plane. Weathered. TRpn formation	Greenish gray, tuff, lapilly tuff, hard, intruded with porphyrite. PTRv formation	Greenish-grayish-brown shale, interbedded with sandstone and tuffaceous sandstone, TRhf formation	Fault	Dark gray to gray slate interbedded with thin layer of metasandstone, some limestone, calcareous shale, quartzite, quartz vein Foliated texture, fresh, medium hard, break along latent crack along bedding and slaty cleavage 3,140m.-3,250m. fault (very intensely fractured, altered and moderately-highly weathered). CPhk formation	Brownish gray to dark gray slate interbedded with sandstone CPhk formation	Fault sheared zone, very intensely fractured altered to clay thrust
	strike & (α = classing angle from strike)	16W (73) 47W (71) 14W (71)	36W (85)	36W (58)		36W (58)	74W (16)
	Dip & (apparent dip)	63(62)S 43(42)S 38(36)S	40S	45(40)S		60(58)S	58(24)S
Overburden	(m.)	32 56 37 57 105 71 94 81 138 184 147 126 135 118 137 94 124 131 158 141 223 208 138 240 278 222 149 159 209 259 192 112 129 17					
Resistivity (ohm-m)	TEM, TDEM	200 80-200 500-900 200-300 100-150 50-80					20-80 16-20
	Borehole logging						
Seismic (Km/sec)	Refraction Vpr						
	Reflection Vpr						
	Borehole logging						
Drilling	RQD	60-80		0-20			0
	qu (kg/cm²)						
Rock mass classification (CRIEPI Japan)		D D-CL D D-CL CL D CM-CH CM-CH CM-CH CM-CH					
Permeability, groundwater discharge		groundwater discharge		3+140-3+250 (groundwater discharge from fault zone and interbedded limestone)			
Grade of ground (Tunnel type)		E2 E1 D2 D1 C2 C1 C2 C1 D2 E1 E2 E1 D2 C1 C2 D1 D2 D1 C2 D1 C2 D1 C2 D1 C2 C1 C2 D1 D2 E1 D2 E1 D2 C1 C2 C1 C2 D2 E1 92					
RMR system (rate - rock mass class)		13-IV 22-IV 13-V 22-IV 22 13-V 56-III 56-III 56-III 39-IV 56-III 39-IV 56-III 58-III 39-IV 14-V 43-III 54-III 43-III 54-III 43-III 54-III 43-III 54-III 21-IV					
Notice for tunnel geology & counter measure		Shallow overburden and highly to moderately weathered, soft and intensely fractured shale. Forepiling method.	Lapilly tuff and porphyrite are rather TRpn formation.	Detail survey is required to confirm distribution and rock facies of the TRhf formation.	Pay attention to water discharge and collapse of fault zone.	It is necessary to cover quickly excavated rock surface by shotcrete to prevent looseness of rock along bedding and slaty cleavage and small fault.	Pay attention to collapse of fault (6+950-7+500)

THE STUDY ON KOK--ING--NAN WATER DIVERSION PROJECT

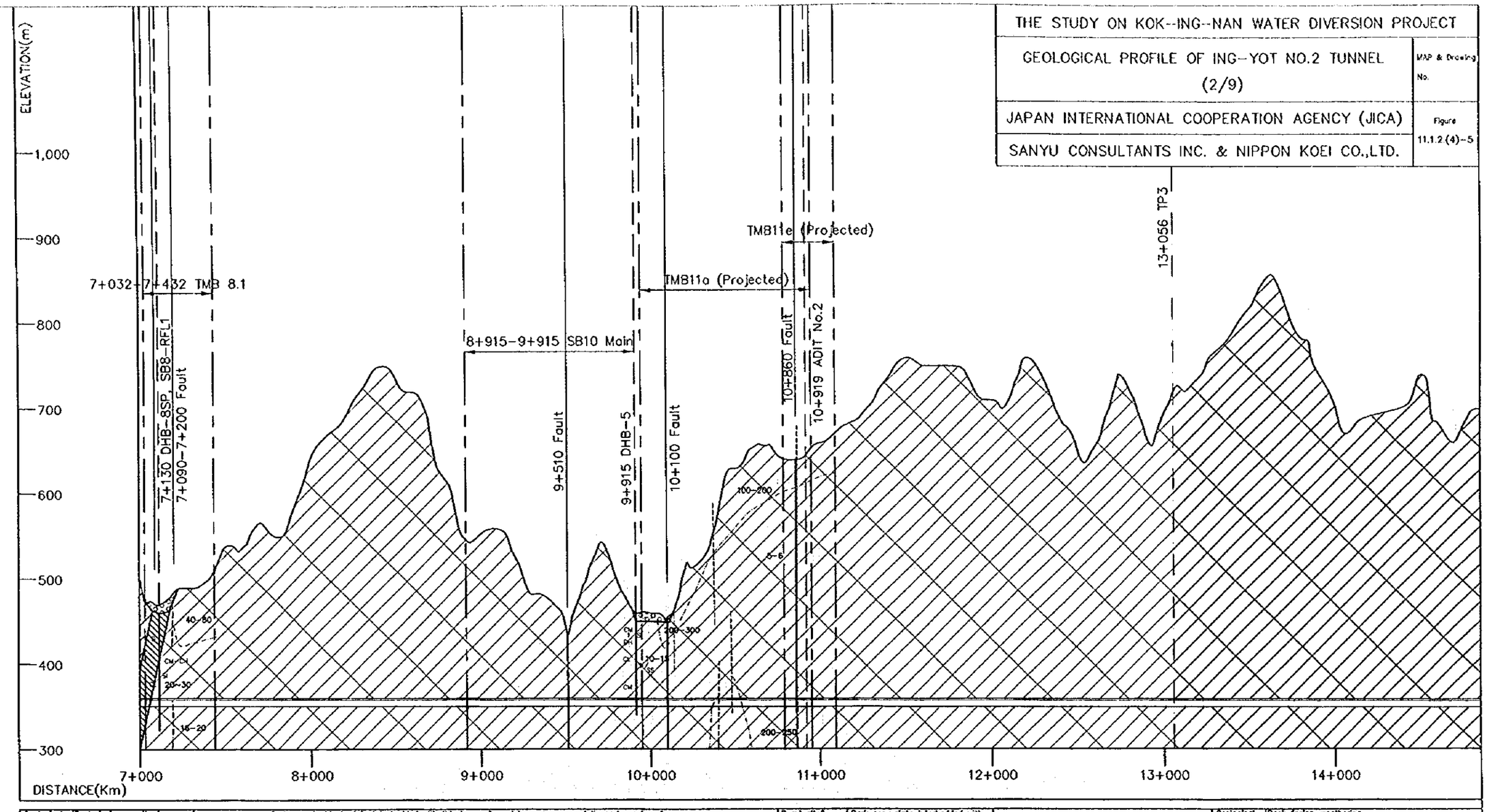
GEOLOGICAL PROFILE OF ING--YOT NO.2 TUNNEL (2/9)

MAP & Drawing No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.

Figure 11.1.2 (4)-5



Geological condition	Rock facies, weathering	Dark gray to black slate interbedded with thin layer of sandstone, some quartzite and quartz vein. Fresh, medium hard (slate), hard (sandstone), foliated slate structure, breakable along bedding plane sometimes slicken side found out along bedding plane, slightly metamorphosed and foliated. CPnb formation	Porphyrite! High resistivity by TEM	Dark gray slate interbedded with sandstone CPnb formation		Geological condition	Rock facies, weathering
	strike & (α= crossing angle from strike)	88E 66E 64E (34) (62) (64)			66W (4)		strike & (α = crossing angle from strike)
	Dip & (apparent dip.)	33(20)S, 58(51)S, 80(78)s			42(4)S		Dip & (apparent dip.)
Overburden	(m.)	179 189 280 339 185 197 122 74 183 101 153 296 322 390 350 398 277 380 296 361				Overburden	(m.)
Resistivity	TEM, TDEM	10-15 100-200 200-250				Resistivity	TEM, TDEM
(ohm-m)	Borehole logging					(ohm-m)	Borehole logging
Seismic	Refraction Vpr					Seismic	Refraction Vpr
(Km/sec)	Reflection Vpr					(Km/sec)	Reflection Vpr
	Borehole logging						Borehole logging
Drilling	RQD	20-100				Drilling	RQD
	qu (kg/cm²)						qu (kg/cm²)
Rock mass classification (CRIEPI, Japan)		CM-CH | CH-B | CM-CH | CL-CM | D | CL-CM | CM-CH | CL-CM | D | CL-CM | CM-CH | CL-CM | CM-CH | CM | D | CM-CH | D | CM-CH-B | CM-CH | CM-CH-B				Rock mass classification (CRIEPI, Japan)	
Permeability groundwater discharge						Permeability groundwater discharge	
Tunnel type		D1 D2 D1 C2 C1 C2 D1 D2 D1 D2 D1 D2 C1 C2 C1 C2 D2 C1 C2 D1 C2 C1 C2 D2 C1 D1 C2 C1 C2 D2				Tunnel type	
Tunnel method						Tunnel method	
Notice for tunnel geology & counter Measure		Pay attention to impact for Phu Sang waterfall spring by tunnel excavation therefors necessary to investigate and observe groundwater level and quartz.				Notice for tunnel geology & counter Measure	

THE STUDY ON KOK--ING--NAN WATER DIVERSION PROJECT

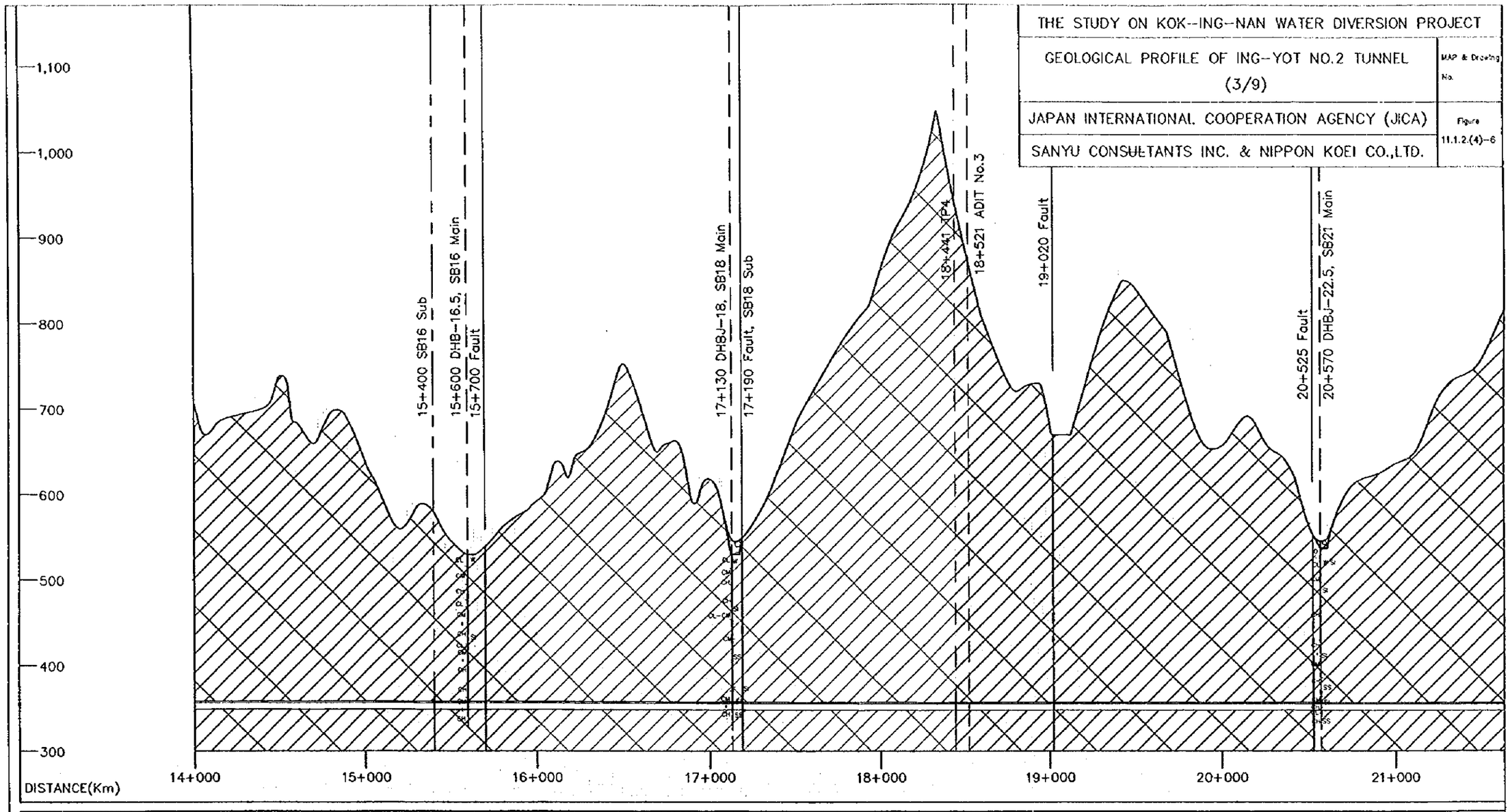
GEOLOGICAL PROFILE OF ING--YOT NO.2 TUNNEL (3/9)

MAP & Drawing No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

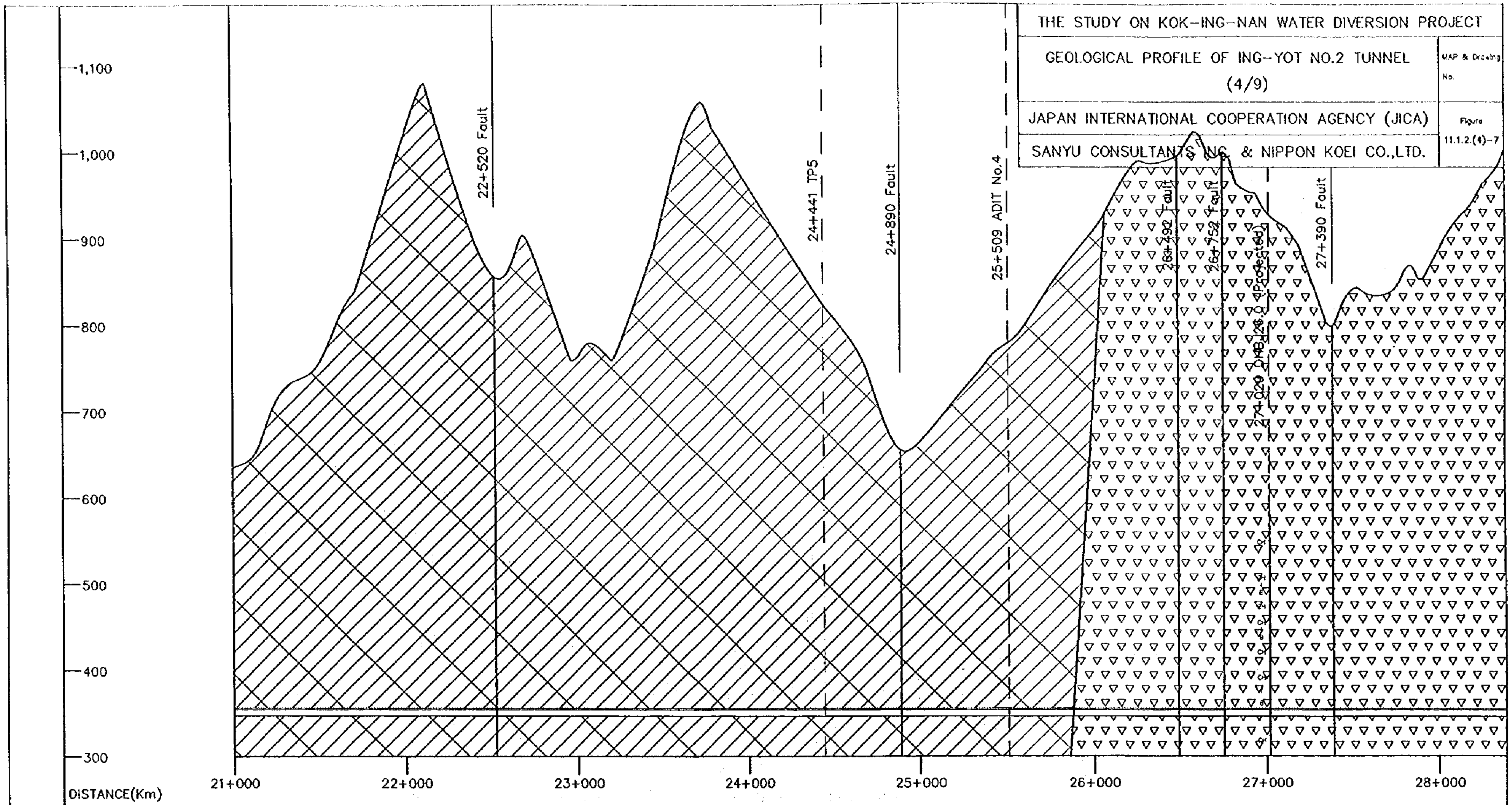
SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.

Figure 11.1.2.(4)-6



Geological condition	Rock facies, weathering	Dark gray-black slate interbedded with thin sandstone layer some quartzite and quartz vein. Foliated (slaty) texture. Consists mainly of muscovite and quartz. Parallel alignment of fine-grained muscovite, chlorite and clay minerals marks strong foliation (slaty cleavage) in the rock. Sandstone consists mainly of quartz, fine-very fine grain, shows clastic (semi-schistose)texture. Fresh, hard to moderately hard, broken with ordinary to light hammer blow along latent slaty cleavage (bedding).CPnb formation
	strike & (α = clossing angle from strike)	15W (6) / 41W (19) / 4E (4)
	Dip & (apparent dip.)	20-30 50(7)SW / 20-40 35(13)SW / 20-40 48(4)
Overburden	(m.)	301 201 230 171 232 391 232 259 187 364 501 687 363 312 493 295 334 188 266 388
Resistivity	TEM, TDEM	
(ohm-m)	Borehole logging	40-230
Seismic	Refraction Vpr	
(Km/sec)	Reflection Vpr	10-30 / 80-20
	Borehole logging	4.0-4.9 / 30-4.7 / 4.7-5.3
Drilling	RQD	5-20 / 20-80 / 70-100
	qu (kg/cm²)	124-405 / 287-269 / 101-406
Rock mass classification (CRIEPI, Japan)		CM-CH / CM-CH-B / CM-CH-B / CM - CH - B / CM - CH - B / CM - CH - B / CM-CH / CM-CH / CM-CH
Permeability groundwater discharge		
Tunnel type		C1 C2 D1 D2 E1 D2 C2 C1 D1 C2 C1 C2 D1 D2 C1 D2 C1 D1 C2 C1 C2 D1 C2 D1 D2 D1 C2 C1 C2 D1 C2 D1 D2 E1 D2 D1 C2 D1 C2
Tunnel method		
Notice for tunnel geology & counter measure		Rock facies observed on drilling information are almost stable although contain remarkable bedding and slaty cleavage. But it is necessary to confirm location and rock feature of fault interpreted by topographic feature along main valley (15+600, 17+150, 19+020, 20+550, 24+890) / It is necessary to investigate in more detail for supposed fault along main v

THE STUDY ON KOK–ING–NAN WATER DIVERSION PROJECT	
GEOLOGICAL PROFILE OF ING–YOT NO.2 TUNNEL (4/9)	MAP & Drawing No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure 11.1.2 (4)–7
SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.	



Geological condition	Rock facies, weathering	Dark gray–block slate interbedded with thin sandstone layer. Foliate texture, consists of quartz muscovite, CPnb formation / Grayish green tuff, fine grain, contain lapilly. Some Dacite interbedded. Tuff, Dacite. Tuff consists of quartz, plagioclase, volcanic lithic fragment, hard, massive, rock blocks are separated b[y] firm hammer blow along latent cleavage. PTRv formation
	strike & (α = closing angle from strike)	36E (92) / 1E (57) / 17 (73)
	Dip & (apparent dip.)	57(57)NW / 31(26)NW / 44(43)NW
Overburden	(m.)	388 / 723 / 497 / 403 / 700 / 469 / 300 / 422 / 633 / 572 / 444 / 530
Resistivity (ohm–m)	TEM, TDEM	
	Borehole logging	1.5~5.0 (Tuff) 10<(Dacite)
Seismic (Km/sec)	Refraction Vpr	
	Reflection Vpr	
	Borehole logging	5.0–6.3
Drilling	RQD	70–100
	qu (kg/cm²)	531–1098
Rock mass classification (CRIEPI, Japan)		CM / CM–CH / CM / CM–CH–B / CL–CM / CM–CH–B / CM / CM–CH / CM / CM–CH–B / CM–CH–B / CL / CM–CH–B / CH – B / CL–CM / CH–B / CM / CH–B / CM / CH – B
Permeability groundwater discharge		
Tunnel type		D1 / C2 / D1 / C2 / D1 / C2 / C1 / B / C1 / C2 / D1 / C2 / C1 / C2 / C1 / B / C1 / C2 / D1 / D2 / D1 / C2 / C1 / C2 / D1 / C2 / D1 / C2 / D1 / C2 / D1 / D2 / D1 / C1 / D1 / C2 / D1 / C2
Tunnel method		C1 / B
Notice for tunnel geology & counter Measure		DHBJ26.0 artesian groundwater flow out 92 l/min (depth 25[...] water pressure at drill hole 1.5 kg/cm² Pay attention for water discharge from cracks of the tuffac[...]

THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT

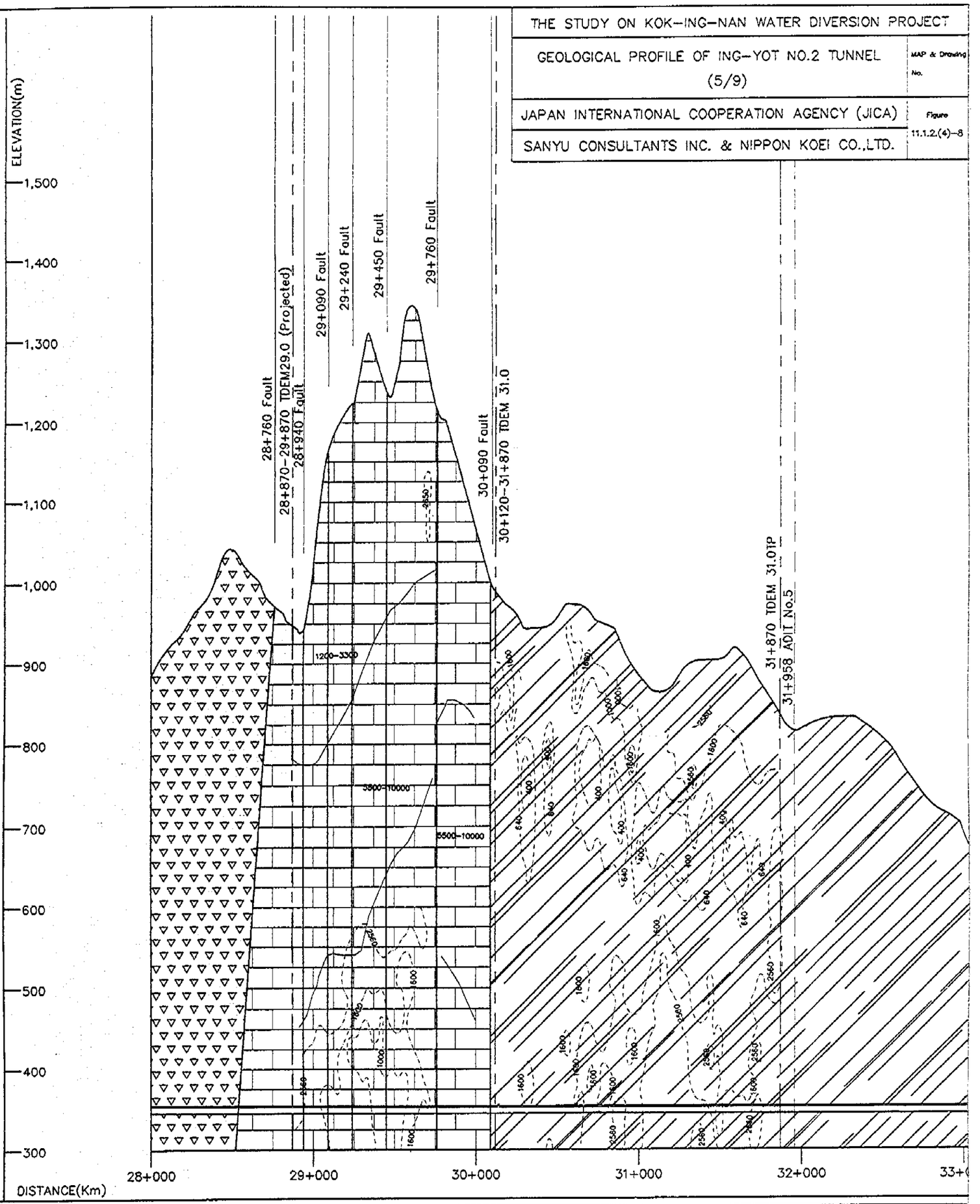
GEOLOGICAL PROFILE OF ING-YOT NO.2 TUNNEL (5/9)

MAP & Drawing No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.

Figure 11.1.2.(4)-8



Geological condition	Rock facies, weathering	Tuff, Dacite. PTRv formation	Limestone gray~grayish black, dense, hard TRpl formation	Light gray to dark gray, Tuff, tuffaceous sandstone interbedded with thin shale layer, partly intensely silicified, hard, fresh, massive without fault sheared zone. TRvf formation DHBJ-33.0 depth from 101.5m to 169.5m sheared and subjected to intense alteration
	strike & (α = clossing angle from strike)	Limestone N73W, 30N, N54E 26SE, N44E, 38NW		
	Dip & (apparent dip.)			
Overburden (m)		680	534 704 847 957 642 590 616 510 564 461 378	
Resistivity (ohm-m)	TEM, TDEM	>2650 2000 1000~1600 600 400 2000	1000~1600 2000 1600~2000 2560< 1600~2560 2000	
	Borehole logging			
Seismic (Km/sec)	Refraction Vpr			
	Reflection Vpr			
	Borehole logging			
Drilling	ROD			4.7~5.5
	qu (kg/cm²)			20~100 650~1150
Rock mass classification (CRIEP, Japan)		CH - B / CL-CM / CL / CH-B / CH / CM / CL / CH-B / CL-CM / CH-B / CH-B / CH-B / CL / CL-CM / CH - B		
Permeability groundwater discharge				
Tunnel type		C2 D1 C2 D1 C2 D1 D2 C1 D2 E1 D2 C2 E1 C2 D1 C2 D1 D2 D1 D1 C2 D1 D2 C2 D1 C2 D1 C2 D1 D2 C1 C2 D2 C2 C1 C2 D1 C2 D1 C2		
Tunnel method				
Notice for tunnel geology & counter Measure			It is necessary to pay attention to water discharge from clastic cave in limestone (TRpl) formation considering forecast drilling and to confirm boundary between limestone and underlain formation.	It is neccessary to confirm distribution of low resistivity zone obeerved by TDEM3.0 N suppoeed to indicate some fault and highly

THE STUDY ON KOK–ING–NAN WATER DIVERSION PROJECT

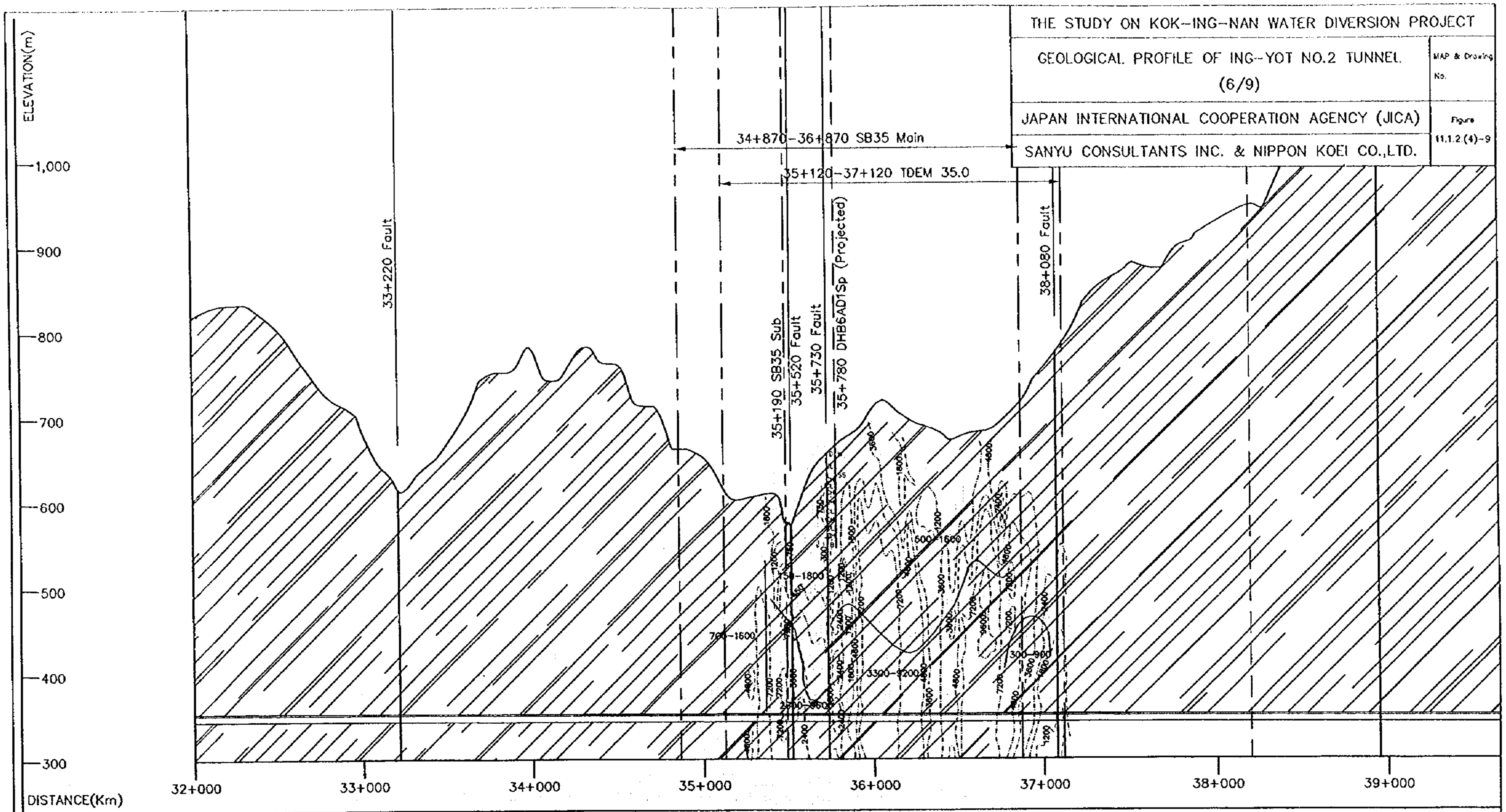
GEOLOGICAL PROFILE OF ING–YOT NO.2 TUNNEL (6/9)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.

MAP & Drawing No.

Figure 11.1.2 (4)-9



Geological condition	Rock facies, weathering	TRhf (Huai Fak) formation. / Dark gray sandstone, sandy tuff, fine to medium grained interbedded thin layer of shale very frequently, fresh, hard, massive, up to 100m Fe–Oxide stained along cracks. Faults along Yuan river are interpreted by topographical feature and relatively low resistivity zone is interpreted by TDEM, and which will be not so fractured at tunnel level considering with borehole data and TDEM resistivity. / Sandstone, sandy tuff, fine to medium grained interbedded with thin layer of shale. Fresh, hard massive. TRhf formation
	strike & (α = closing angle from strike)	5E (28); 41E (63); 65W (43); 32E (54); 20 (40); 17E (73); 27W (29)
	Dip & (apparent dip.)	30(15)E; 18(18)N; 10(7)N; 18(15)W; 17(12)W; 5–20; 47(46)W; 40(22)S
Overburden	(m.)	376; 262; 339; 428; 390; 428; 363; 249; 221; 314; 366; 321; 423; 523; 730
Resistivity (ohm–m)	TEM, TDEM	
	Borehole logging	4800; 5600–7200; 2400–1500; 7200; 3600–7200; [illegible]; 7200; [illegible]
Seismic (Km/sec)	Refraction Vpr	
	Reflection Vpr	
	Borehole logging	
Drilling	RQD	80–100
	qu (kg/cm²)	
Rock mass classification (CRIEPI, Japan)		CL–CM; CH – B; CL CM; CH – B; CH – B; CH – B; CH – B; CL–CM; CL CM; CH – B; CL–CM; CH – B; CH – B; CL CM; CH – B
Permeability groundwater discharge		
Tunnel type		C1; C2; D1; C2; D1; C2; C1; C2; D1; D2; E1; D2; D1; C2; C1; B; C1; C2; D1; D2; D1; D2; D1; C2; C1; C2; C1; C2; D1; D2; D1; C2; C1; B; C1; B; C1; C2; D1; D2; D1
Tunnel method		
Notice for tunnel geology & counter Measure		It is neccessary to confirm distribution of low resistivity zone observed by TDEM3.0 No42–No52+ which supposed to indicate some fault and highly altered zone. / Rock facies observed on drilling information from DHB6Ad1Sp are almost stable. But it is necessary to confirm location and rock feature of fault along Yuan river which interpreted by topographical feature and TDEM low resistivity zone.

THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT

GEOLOGICAL PROFILE OF ING-YOT NO.2 TUNNEL (7/9)

MAP & Drawing No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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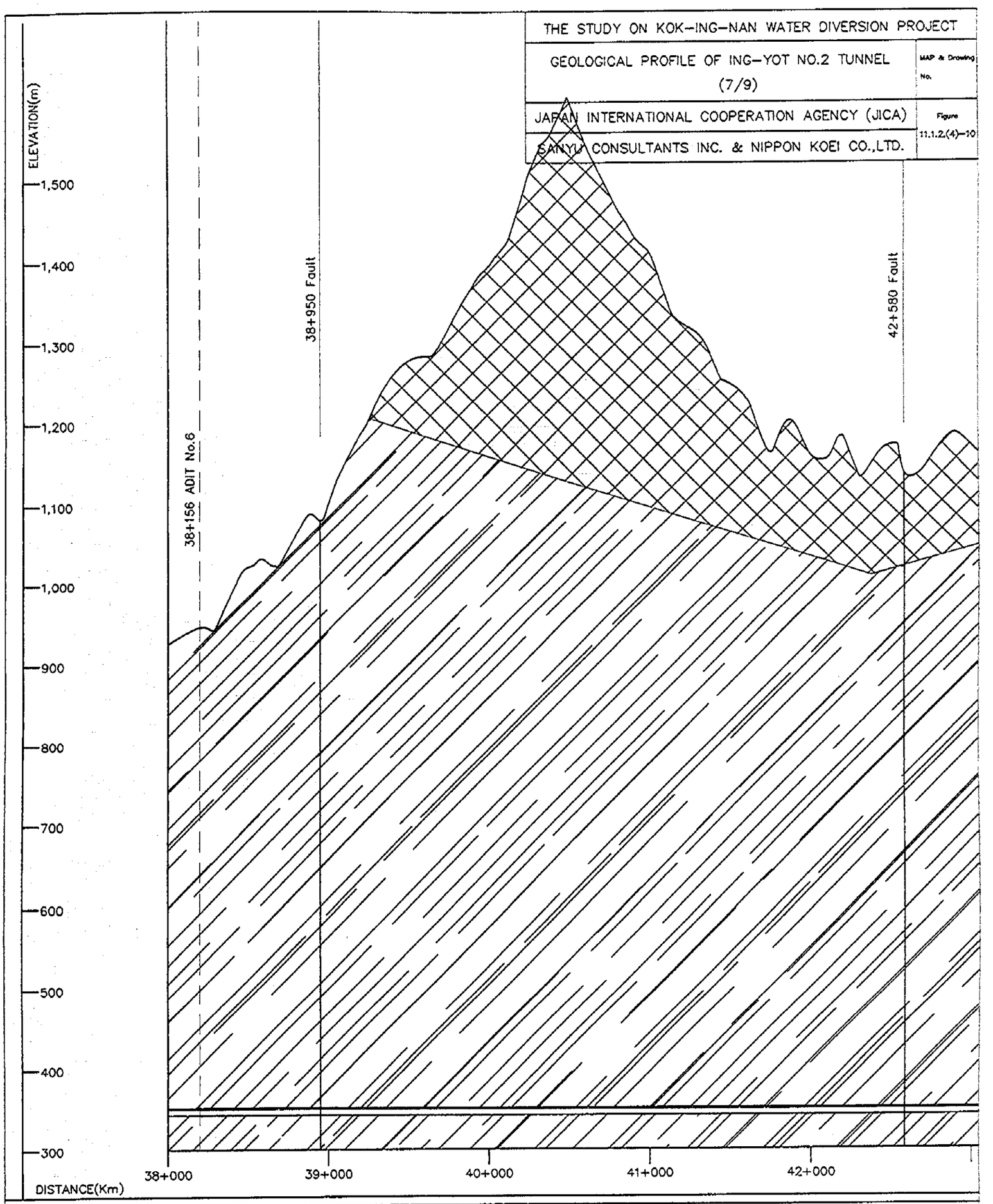
Figure 11.1.2.(4)-10



Geological condition	Rock facies, weathering	Sandstone, sandy tuff, fine to medium grained interbedded with thin layer of shale, Fresh, hard massive, TRht formation	Top of mountains is underlain by ms5-3 formation which consists of tuff, shale, sandstone refering to published geological map, but exact distribution and rock facies have not been confirmed yet.
	strike & (α = classing angle from strike)	17E (73)	27W (29)
	Dip & (apparent dip.)	47(48)W	49(22)S
Overburden	(m)	523 730 1041 1236 983 811	
Resistivity (ohm-m)	TEM, TDEM		
	Borehole logging		
Seismic (Km/sec)	Refraction Vpr		
	Reflection Vpr		
	Borehole logging		
Drilling	RQD		
	qu (kg/cm²)		
Rock mass classification (CRIEPI, Japan)		CH - B | CL-CM | CH - B | CH - B | CL-CM | CH - B	
Permeability groundwater discharge			
Tunnel type		C1 B C1 B C1 C2 D1 D2 D1 C2 C1 C2 C1 B C1 C2 C1 C2 C1 C2 C1 C2 C1 C2 D1 C2 D1	
Tunnel method			
Notice for tunnel geology & counter measure		There are no any detailed geological informations under high mountain area from 39+000 to 45+000 therefore more detail investigation is required considering field reconnaissance, depper drilling, TDEM etc.	

THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT

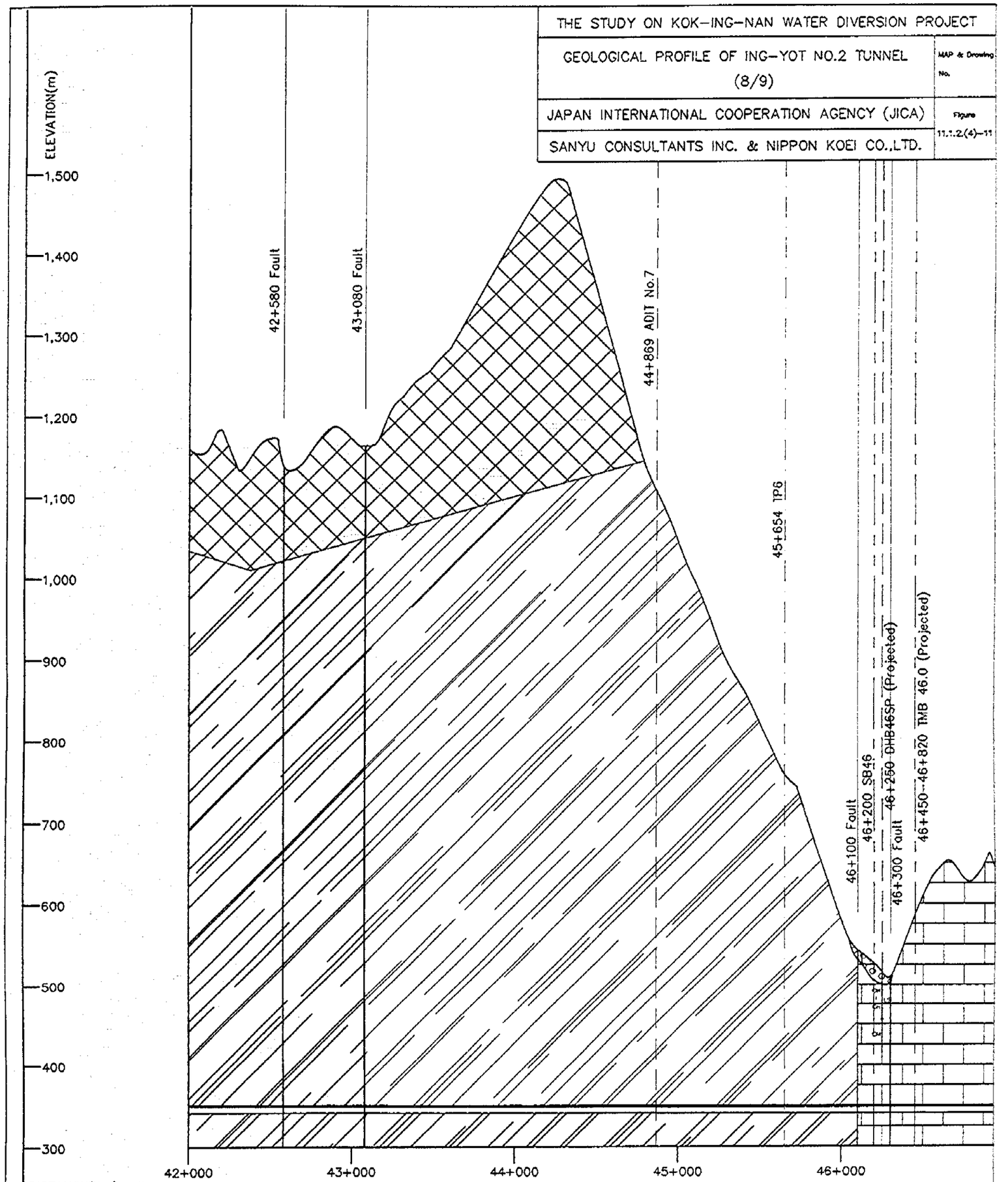
GEOLOGICAL PROFILE OF ING-YOT NO.2 TUNNEL (8/9)

MAP & Drawing No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.

Figure 11.1.2.(4)-11



Geological condition	Rock facies, weathering	Sandstone, sandy tuff interbedded with shale TRhf formation	Limestone dark gray to gray, fresh hard to hard, interbedded with thin sh Separated along silken side formed layer by soft-medium hammer blo
	strike & (α= crossing angle from strike)		SE (59)
	Dip & (apparent dip.)		37(33)W
Overburden	(m.)	812 933 1143 754 407 159	302
Resistivity	TEM, TDEM		1000<
(ohm-m)	Borehole logging		
Seismic	Refraction Vpr		
(KM/sec)	Reflection Vpr		
	Borehole logging		
Drilling	RQD		
	qu (kg/cm²)		
Rock mass classification (CRIEPI. Japan)		CH - B | CL-CM | CH - B | CL-CM | CH - B | CH - B | CH-CL CM-CH | CM CH | CH CM | CM-CH	
Permeability groundwater discharge		C2 C1 C2 C1 C2 D1 C2 D1 D2 D1 C2 D1 D2 D1 C2 C1 C2 C1 B C1 C2 C1 C2 D1 D2 D1 C2 C1 C2 D1	
Tunnel type			
Tunnel method			
Notice for tunnel geology & counter Measure			It is necessary to pay attention to groundwater discharge from clastic cave found in Limestone formation considering forecast drilling.

THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT

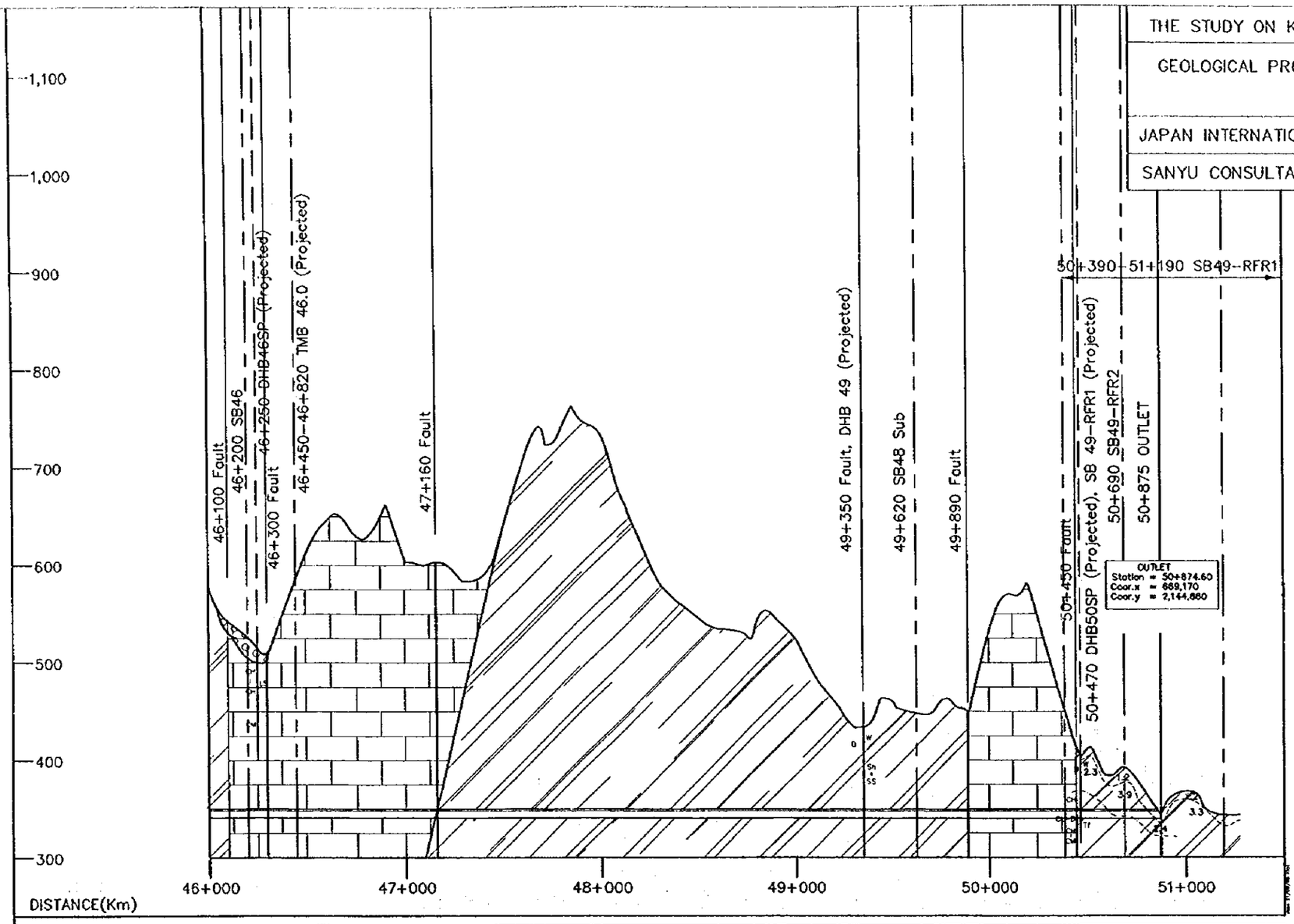
GEOLOGICAL PROFILE OF ING-YOT NO.2 TUNNEL (9/9)

MAP & Drawing No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

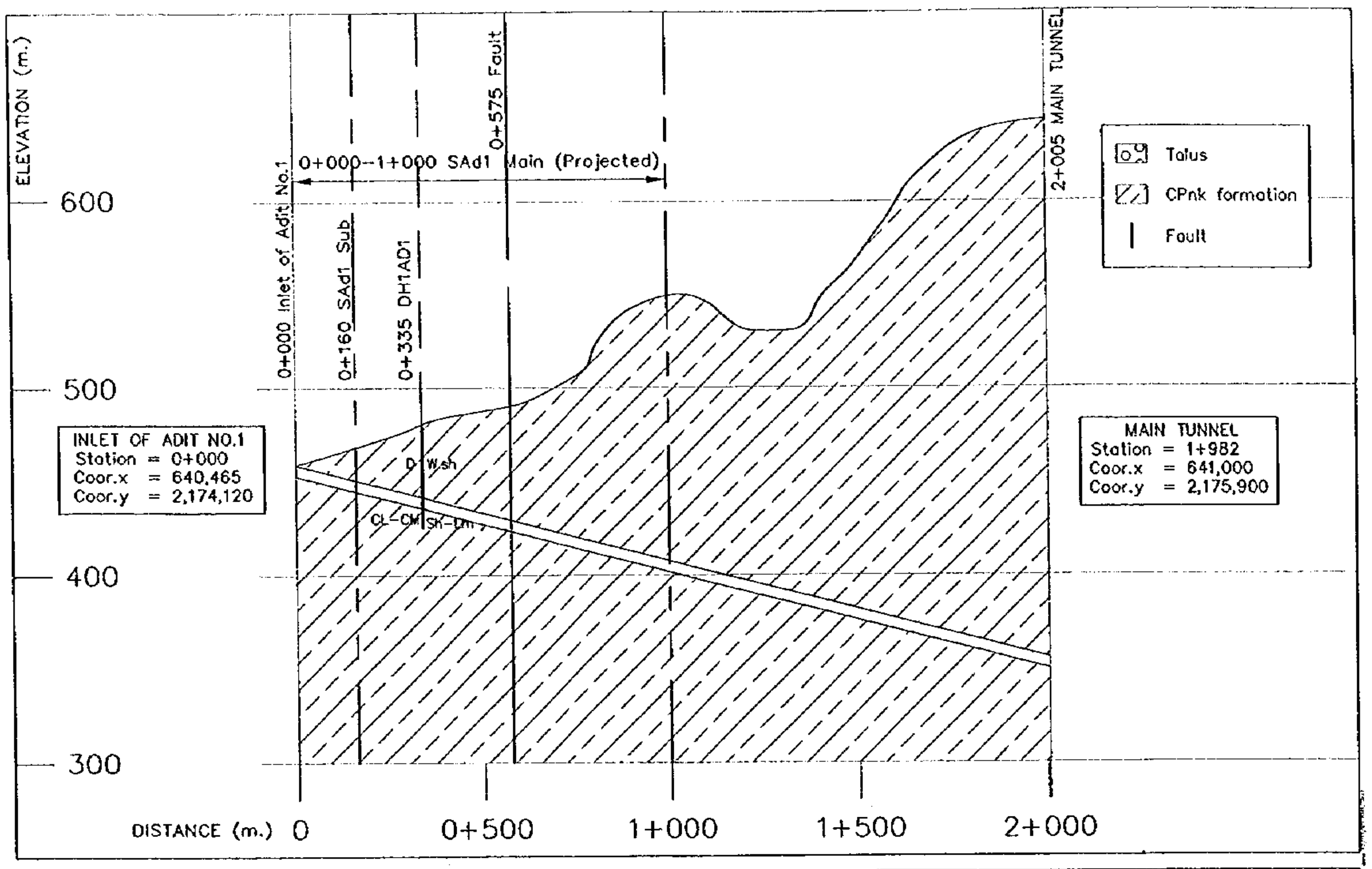
SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.

Figure 11.1.2.(4)-12



Geological condition	Rock facies, weathering	Limestone dark gray to gray, fresh, medium hard to hard, interbedded with thin shale layer. Seperated along silken side formed in shale layer by soft-medium hammer blow	Sandy tuff and tuffaceous sandstone interbedded with shale and tuffaceous shale dark gray, fresh-slightly weathered, hard along fault sheared zone very intensely fractured and soft, TRhf formation	Limestone, dark gray hard, fresh	Sandy tuff, shale TRhf	Highly weathered sandy tuff, tuffaceous shale alternation, reddish brown, clay soft
	strike & (α = clossing angle from strike)	6E (59) 12W (41)	7E (60)	6E (59)	23 (76)	
	Dip & (apparent dip.)	37(33)W 46(34)N	58(54)W	45(41)W	50-60	47(46)W
Overburden (m.)		159 302 251	253 412 233 173 84 98 99 288		56	34
Resistivity (ohm-m)	TEM, TDEM	1000<				
	Borehole logging					
Seismic (Km/sec)	Refraction Vp					3.9 ~ 2.4
	Reflection Vp					
	Borehole logging					
Drilling	RQD				50-60	
	qu (kg/cm)					
Rock mass classification (CRIEPI, Japan)		CM-CH CM-CH B CM	CH - B CH - B	CM-CH CM-CH		D
Permeability groundwater discharge						
Tunnel type		C2 D1 D2 E1 E2 E1 E2 D2 D1 C2 D1 D2 E1 D2 D1 C2 C1 C2 C1 C2 C1 C2 D1 D2 E1 E2 E1 D2 E1 E2 D1 C2 D1 D2 E1 E2 E1 C2				
Tunnel method						
Notice for tunnel geology & counter measure		It is necessary to pay attention to groundwater discharge from clastic cave found in Limestone formation considering forecast drilling.		Pay attention groundwater discharge from clastic cave found in Limestone.		Shallow overburden and highly weathered soft geology.

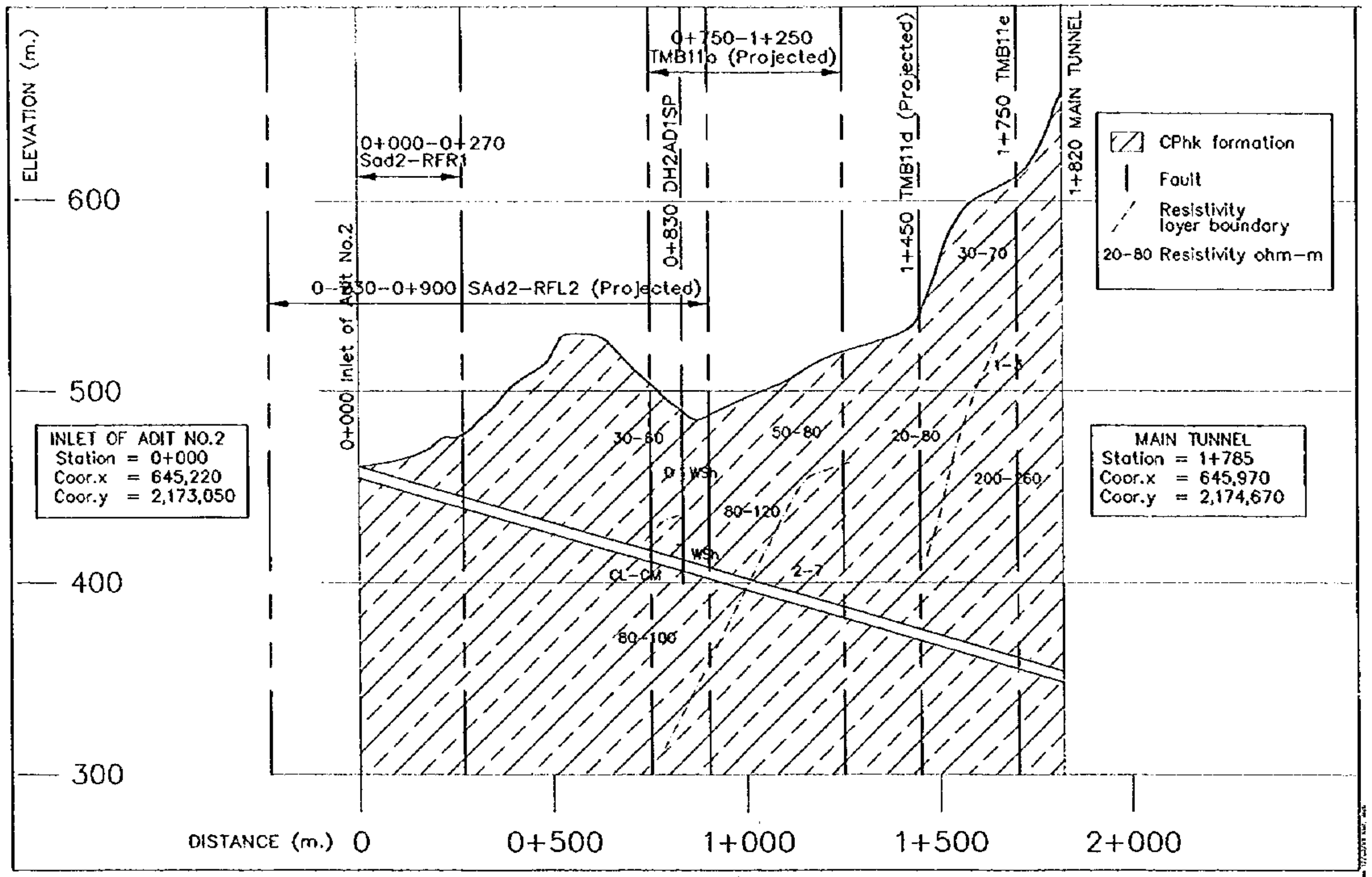
Geological Profile of Adit No.1



Geological condition	Rock facies, weathering	Slate, gray-dark gray, interbedded with thin layer of sandstone, calcareous shale, quartzite, fresh, hard, moderately to intensely fractured. DH1AD-1 (GL-43.1 m. highly weathered shale, yellowish brown, 43.1~65 m. calcareous shale). CPhk (Huai Krai) formation
	strike & (α = clossing angle from strike)	
	Dip & (apparent dip.)	40~60
Overburden (m.)		38 76 141 141 273
Resistivity (ohm-m)	TEM, TDEM	
	Borehole logging	
Seismic (Km/sec)	Refraction Vpr	
	Reflection Vpr	
	Borehole logging	
Drilling	RQD	50~70
	qu (kg/cm²)	
Rock mass classification (CRIEPI. Japan)		D | CL CM | D | CL-CM | CH-CM
Permeability, groundwater discharge		
Tunnel type		E2 | E1 | E2 | E1 | D2 | D1 | C2 | D1 | C2 | C1 | C2
Tunnel method		
Notice for tunnel geology & counter Measure		Highly weathered and intensely fractured zone.

THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
GEOLOGICAL PROFILE OF ING-YOT NO.2 TUNNEL ADIT NO. 1	MAP & Drawing No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure 11.1.2. (4)-13
SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.	

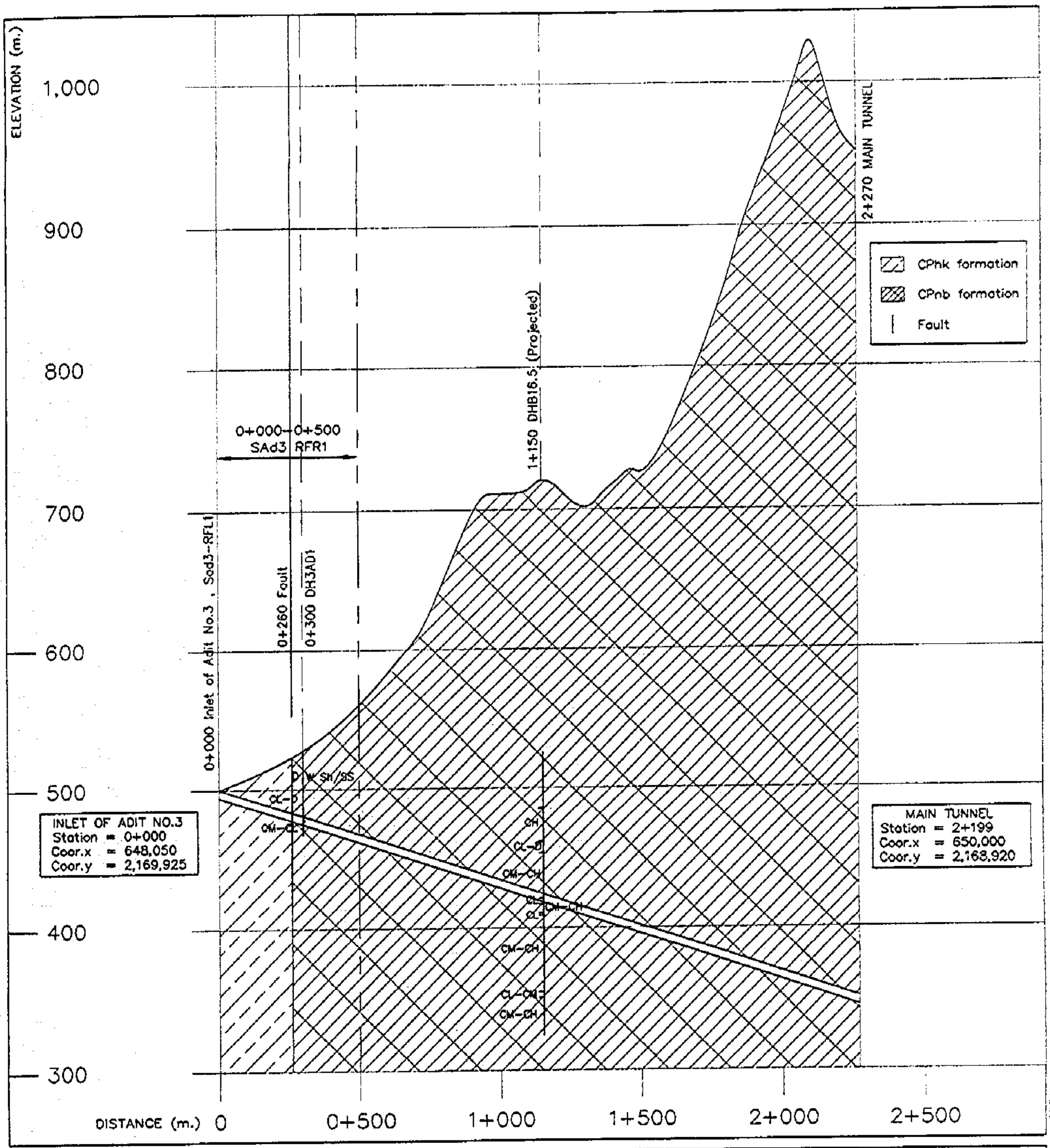
Geological Profile of Adit No.2



Geological condition	Rock facies, weathering	Shale, Tuff, gray to dark gray, medium hard in fresh rock highly to moderately weathered, intensely fractured. CPhk (Huai Krai formation) Highly weathered and altered to reddish brown clay and white tuffaceous clay.
	strike & (α= clossing angle from strike)	
	Dip & (apparent dip.)	
Overburden (m.)		31 / 94 / 74 / 133 / 249
Resistivity (ohm-m)	TEM, TDEM	80–120 / 2–7 / 4–7
	Borehole logging	
Seismic (Km/sec)	Refraction Vpr	
	Reflection Vpr	
	Borehole logging	
Drilling	RQD	0–20
	qu (kg/cm²)	
Rock mass classification (CRIEPI. Japan)		D / CL–(CM) / CM–CH
Permeability groundwater discharge		
Tunnel type		E2 / E1 / D2 / D1 / C2 / C1 / C2 / D / D2 / E1
Tunnel method		
Notice for tunnel geology & counter Measure		Soft and intensely fractured rock. / Pay attention water–discharge from fractured rock and impact to Phu Sang Water Fall Spring

THE STUDY ON KOK–ING–NAN WATER DIVERSION PROJECT	
GEOLOGICAL PROFILE OF ING–YOT NO. 2 TUNNEL, ADIT NO. 2	MAP & Drawing No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure 11.1.2. (4)-14
SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.	

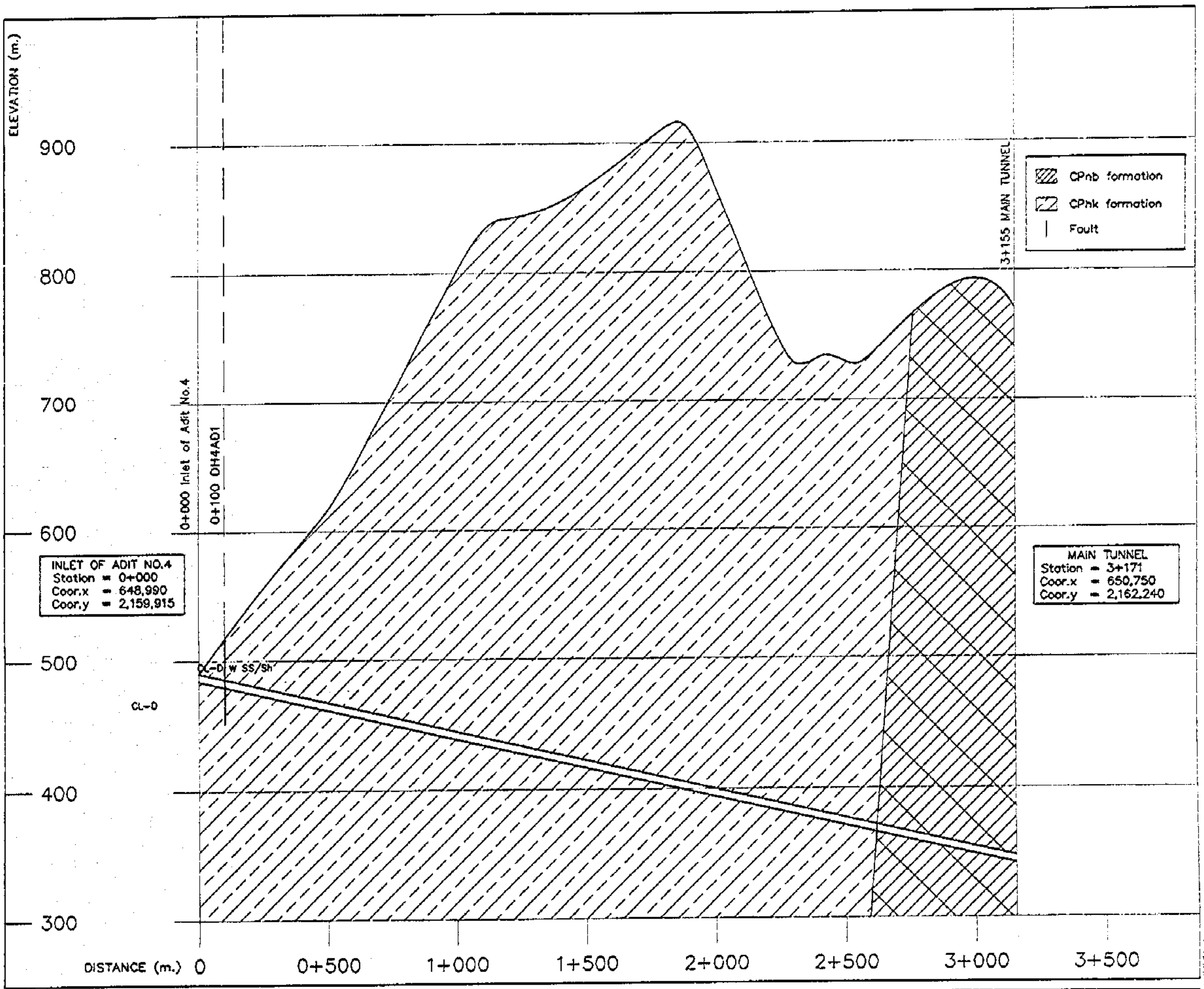
Geological Profile of Adit No.3



Item	Sub-item	Values (along distance, left to right)
Geological condition	Rock facies, weathering	Highly weathered shale CPhk form / Slate interbedded with thin layer of sandstone frequently light gray to dark gray. Slightly to highly weathered intensely fractured. CPnb (Nam Bong) formation
	strike & (α = clossing angle from strike)	14E (87) / 41W (23) / 13E (76)
	Dip & (apparent dip.)	20–30 / 52W(52) / 20–40,35W(15) / 70W(67)
Overburden	(m.)	46 / 145 / 289 / 413
Resistivity (ohm–m)	TEM, TDEM	
	Borehole logging	15–20
Seismic (Km/sec)	Refraction Vpr	
	Reflection Vpr	
	Borehole logging	4500
Drilling	RQD	
	qu (kg/cm)	
Rock mass classification (CRIEPI, Japan)		D / CL D / CL–CM / CM–CH / CM–CH
Permeability groundwater discharge		
Tunnel type		E2 / E1 / D2 / D1 / C2 / C1 / B
Tunnel method		
Notice for tunnel geology & counter Measure		Highly weathered and intensely fractured zone.

THE STUDY ON KOK–ING–NAN WATER DIVERSION PROJECT	
GEOLOGICAL PROFILE OF ING–YOT NO.2 TUNNEL, ADIT NO.3	MAP & Drawing No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure 11.1.2. (4)-15
SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.	

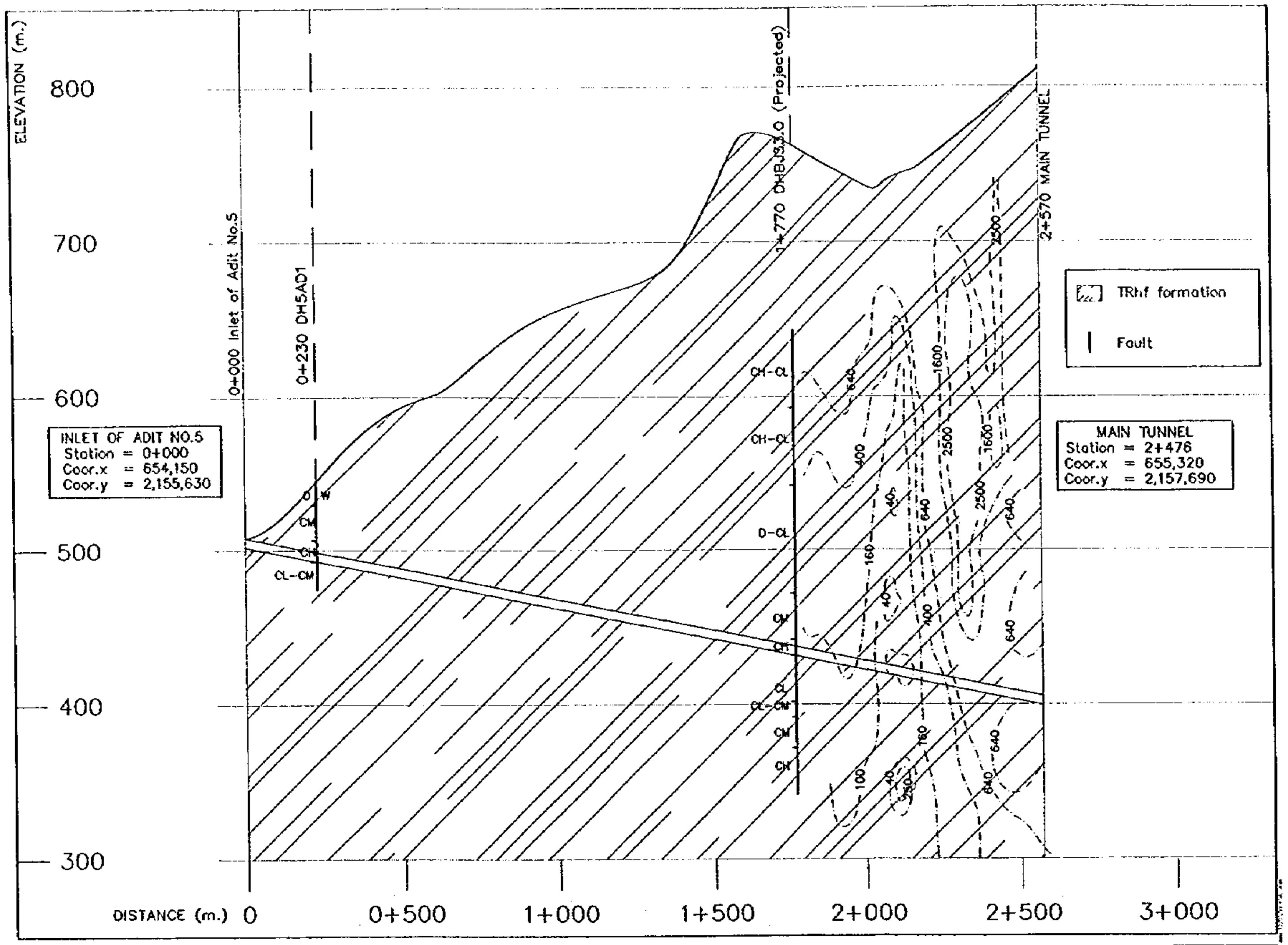
Geological Profile of Adit No.4



Geological condition	Rock facies, weathering	Sandstone interbedded with shale, light gray to dark gray, near by inlet highly weathered intensely fractured, soft to hard, silicified. CPhk (Huoi Krai) formation / Slate interbedded with thin sandstone layer frequently, hard, foliated slaty.
	strike & (α = closing angle from strike)	
	Dip & (apparent dip.)	
Overburden	(m.)	52 / 128 / 241 / 400 / 511 / 341 / 438
Resistivity (ohm-m)	TEM, TDEM	
	Borehole logging	
Seismic (Km/sec)	Refraction Vpr	
	Reflection Vpr	
	Borehole logging	
Drilling	RQD	0-10
	qu (kg/cm²)	
Rock mass classification (CRIEPI, Japan)		CL-D / CL-CM / CM-CH / CM-CH / CM-CH-B
Permeability, groundwater discharge		
Tunnel type		E2 / E1 / D2 / D1 / C2 / C1 / B / C1 / E2 / C1 / C2
Tunnel method		
Notice for tunnel geology & counter Measure		Intensely fractured rock.

THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
GEOLOGICAL PROFILE OF ING-YOT NO.2 TUNNEL ADIT NO.4	MAP & Drawing No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure II.1.2.(4)-16
SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.	

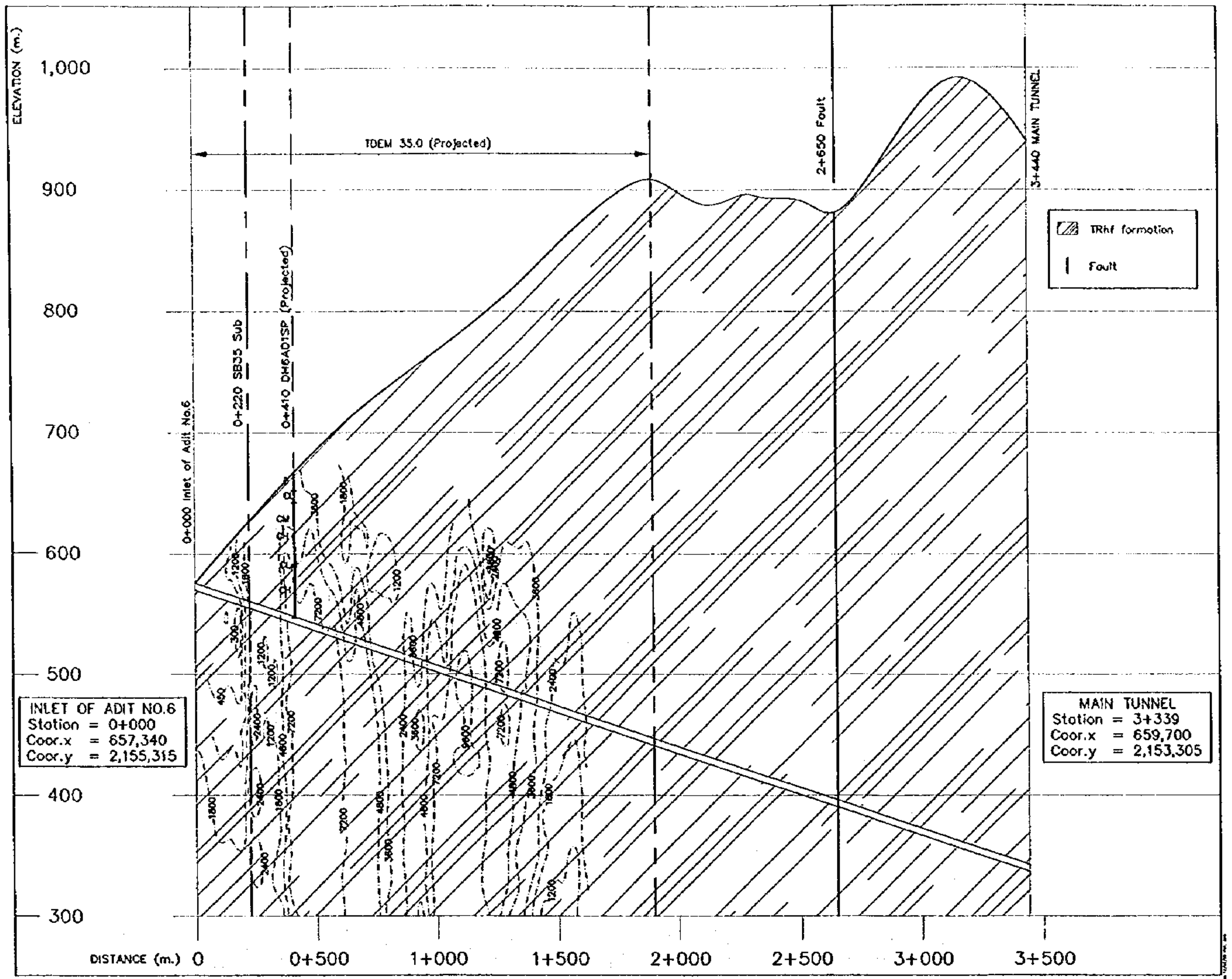
Geological Profile of Adit No.5



Geological condition	Rock facies, weathering	Sandstone highly weathered Tuff, sandstone / Sandstone slightly-moderately weathered intensely-moderately fractured / Sandstone, Tuff(sandy) interbedded with shale. Light green to greenish gray, hard to very hard, fresh, slightly fractured. TRhf formation / Fault zone, intensely altered, intensely fractured, soft to medium hard. (1+970–2+270)
	strike & (α = clossing angle from strike)	1E (46) / 6E (41) / 24E (22)
	Dip & (opparent dip.)	30–45 / 70E(63) / 30E(21) / 38E(16)
Overburden	(m.)	46 / 114 / 185 / 247 / 326 / 306
Resistivity (ohm–m)	TEM, TDEM	100–160 / 160–400 / 40 / 100–160 / 40–160 / 160–400 / 400–640 / 640–1600 / 640>
	Borehole logging	
Seismic (Km/sec)	Refraction Vpr	
	Reflection Vpr	
	Borehole logging	
Drilling	RQD	
	qu (kg/cm²)	
Rock mass classification (CRIEPI. Japan)		D / CM–CH / CM–CH–B / CL~CM / CL~D / CL~CM / CM–CH–(B)
Permeability, groundwater discharge		
Tunnel type		E2 / E1 / D2 / D1 / C2 / C1 / B / C1 / C2 / D1 / D2 / E1 / D2 / D1 / C2 / D1
Tunnel method		
Notice for tunnel geology & counter Measure		To confirm rock condition of low resistivity zone observed by TDEM.

THE STUDY ON KOK–ING–NAN WATER DIVERSION PROJECT	
GEOLOGICAL PROFILE OF ING–YOT NO.2 TUNNEL, ADIT NO.5	MAP & Drawing No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure 11.1.2. (4)-17
SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.	

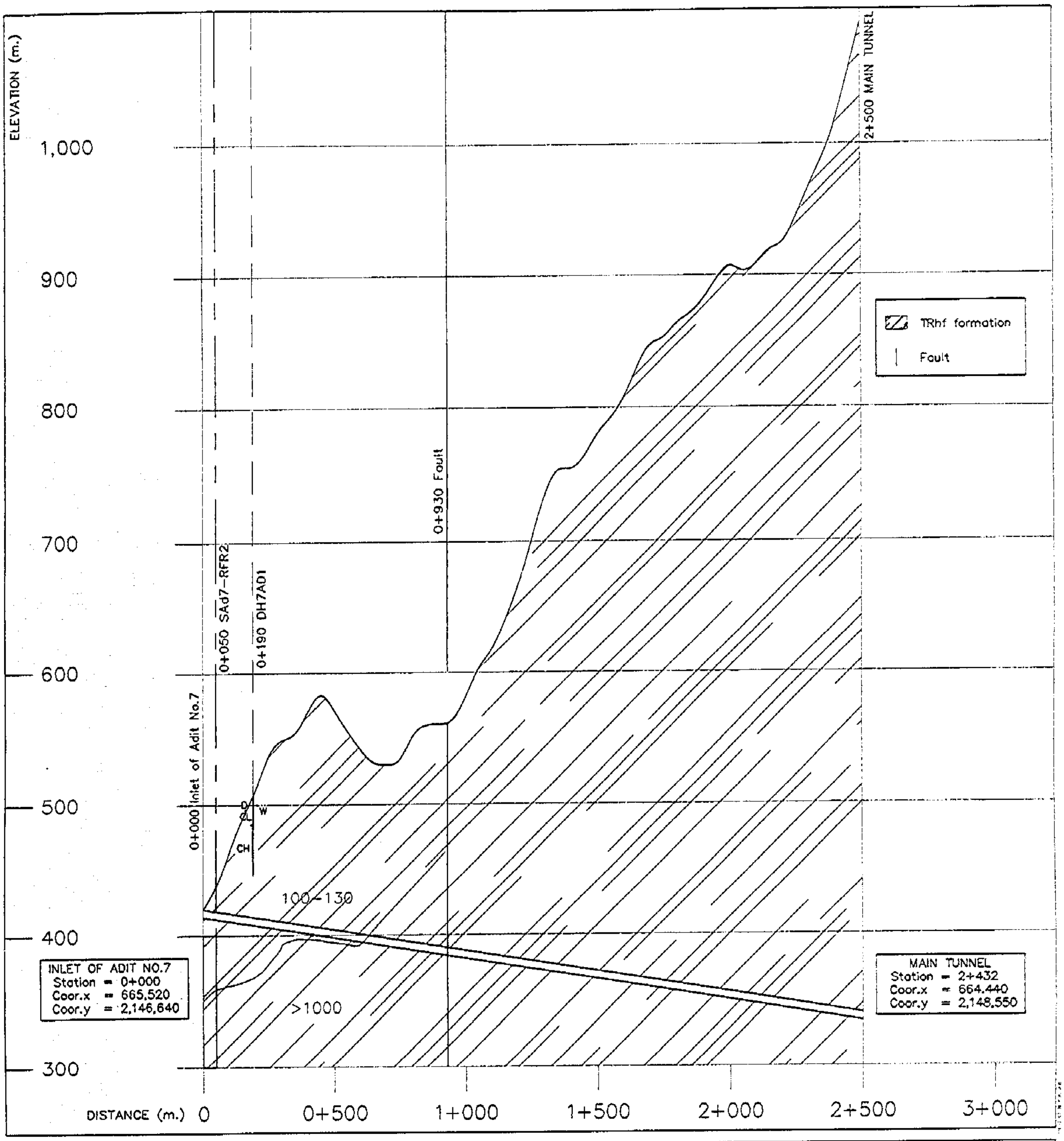
Geological Profile of Adit No.6



Geological condition	Rock facies, weathering	Highly weathered / Slightly-moderately weathered, tuff interbedded with shale hard-very hard. Slightly fractured / Sandstone, Tuff (Sandy), fine to medium grained, Interbedded thin layer of shale very frequently fresh, hard to very hard massive, up to 100 m. depth. Fe-Oxide steined along crack. TRhf formation
	strike & (α= clossing angle from strike)	41E (72) · 20W (9) · 28W (20) · 37W (80)
	Dip & (apparent dip.)	18NW(17) · 10-20 · 17W(3) · 61SW(32) · 40SW(40)
Overburden (m.)		65 · 163 · 308 · 462 · 482
Resistivity (ohm-m)	TEM, TDEM	300-450 · 1800 · 4800-7200 · 2400-3600 · 4800-9600 · 3600-2000
	Borehole logging	
Seismic (Km/sec)	Refraction Vpr	
	Reflection Vpr	
	Borehole logging	
Drilling	RQD	80-100
	qu (kg/cm²)	
Rock mass classification (CRIEPI. Japan)		D-CL · CM-CH · CH-B · CH-B · CH-B · CM-CH · CH-B
Permeability, groundwater discharge		
Tunnel type		E2 · E1 · D2 · D1 · C2 · C1 · B · C1 · C2 · C1 · B · C1 · C2
Tunnel method		
Notice for tunnel geology & counter Measure		To confirm rock facies of low resistivity zone observed by TDEM by inclined drilling along adit alignment.

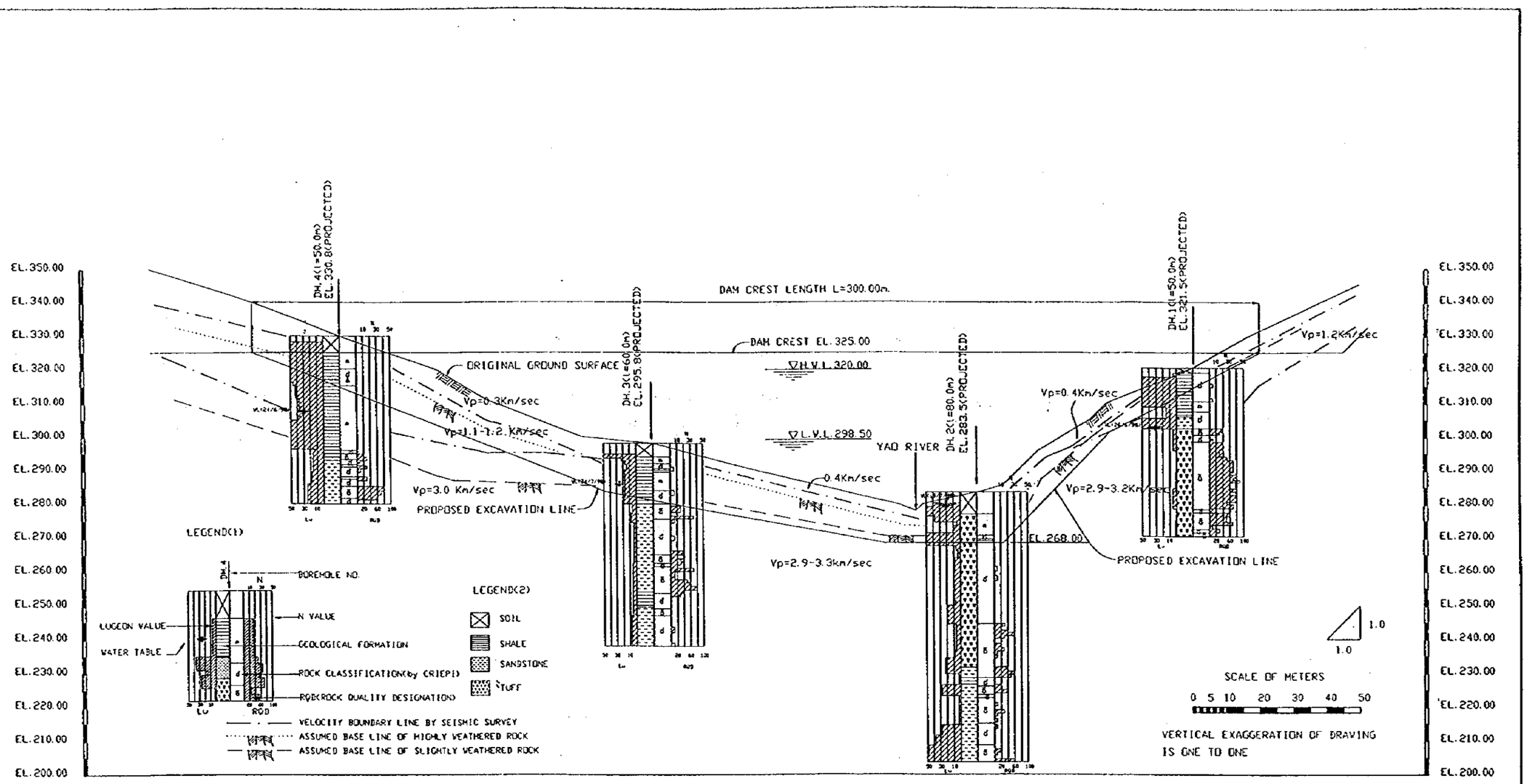
THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
GEOLOGICAL PROFILE OF ING-YOT NO.2 TUNNEL, ADIT NO.6	MAP & Drawing No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure 11.1.2. (4)-18
SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.	

Geological Profile of Adit No.7



Geological condition	Rock facies, weathering	Highly weathered sandstone, shale / Sandstone, interbedded with thin shale layer frequently, hard to very hard, massive, fresh TRhf formation
	strike & (α = clossing angle from strike)	18E (83)
	Dip & (apparent dip.)	40-45 / 50W(50)
Overburden	(m.)	67 / 176 / 132 / 172 / 382 / 550
Resistivity (ohm-m)	TEM, TDEM	>1000
	Borehole logging	
Seismic (Km/sec)	Refraction Vpr	
	Reflection Vpr	
	Borehole logging	
Drilling	RQD	70-100
	qu (kg/cm²)	
Rock mass classification (CRIEPI. Japan)		CL D / CM-CH / CH-B / CL-CM / CL D / CL CM / CM-CH / CH-B / CH-B
Permeability, groundwater discharge		
Tunnel type		E2 / D2 / D1 / C2 / C1 / C2 / D1 / C2 / C1 / B / C1 / E1
Tunnel method		
Notice for tunnel geology & counter Measure		

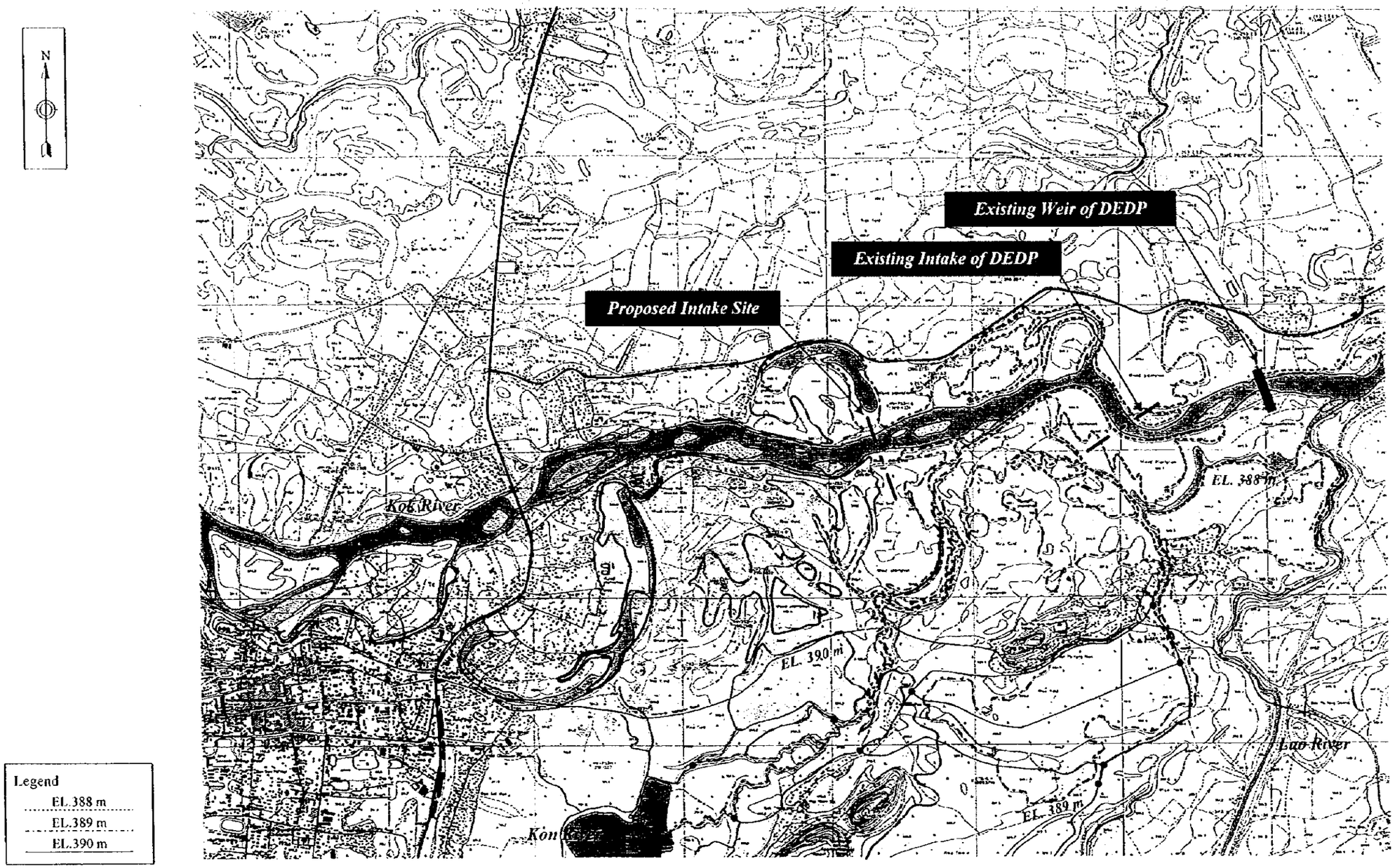
THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
GEOLOGICAL PROFILE OF ING-YOT NO.2 TUNNEL, ADIT NO.7	MAP & Drawing No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure II.1.2. (4)-19
SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.	



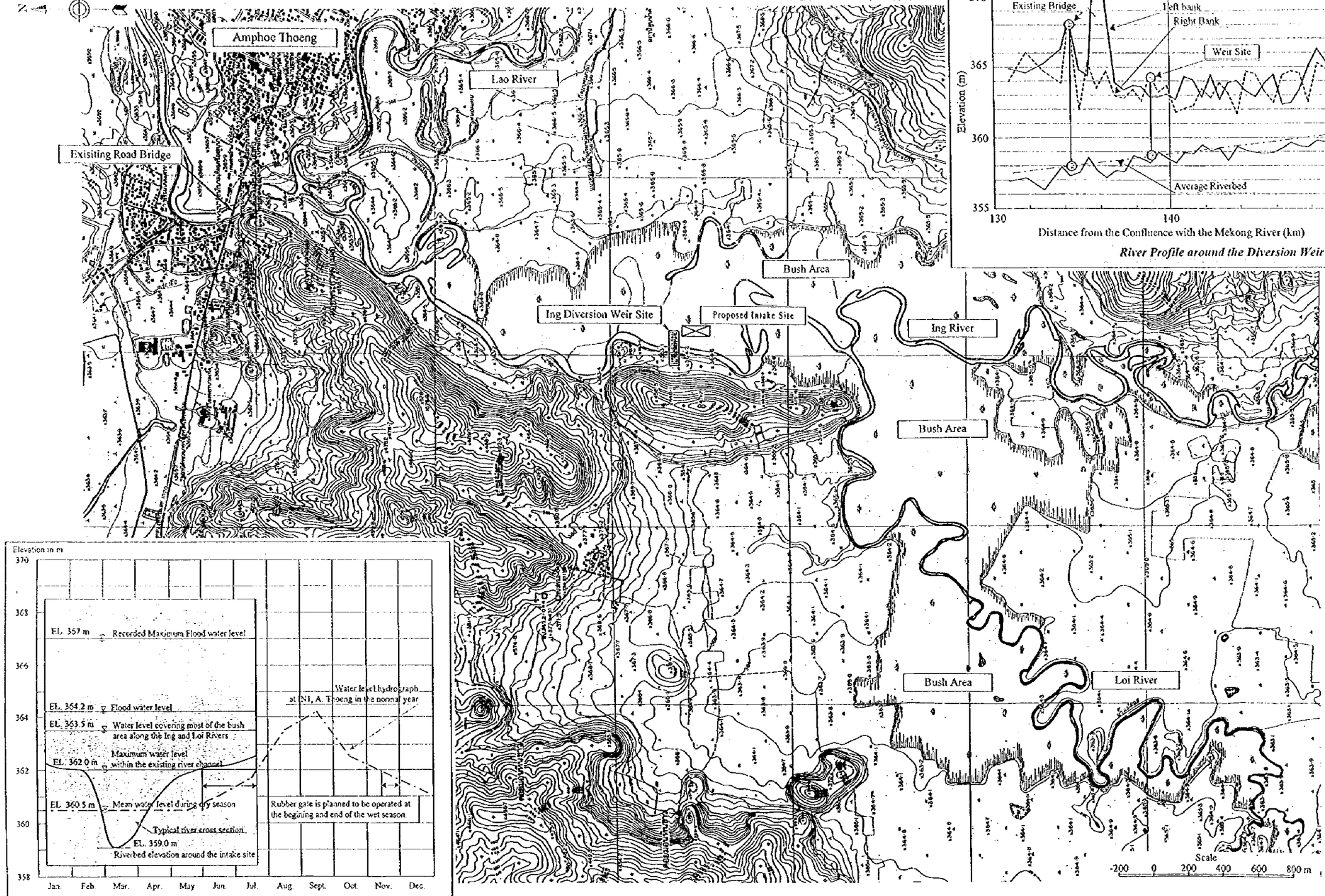
GEOLOGICAL LONGITUDINAL SECTION ALONG DAM AXIS

(YAO FLOOD CONTROL DAM)

THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
GEOLOGICAL LONGITUDINAL SECTION ALONG DAM AXIS (YAO FLOOD CONTROL DAM)	MAP & Drawing No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure 11.1.2. (4)-20
SANYU CONSULTANTS INC. & NIPPON KOEI CO.,LTD.	



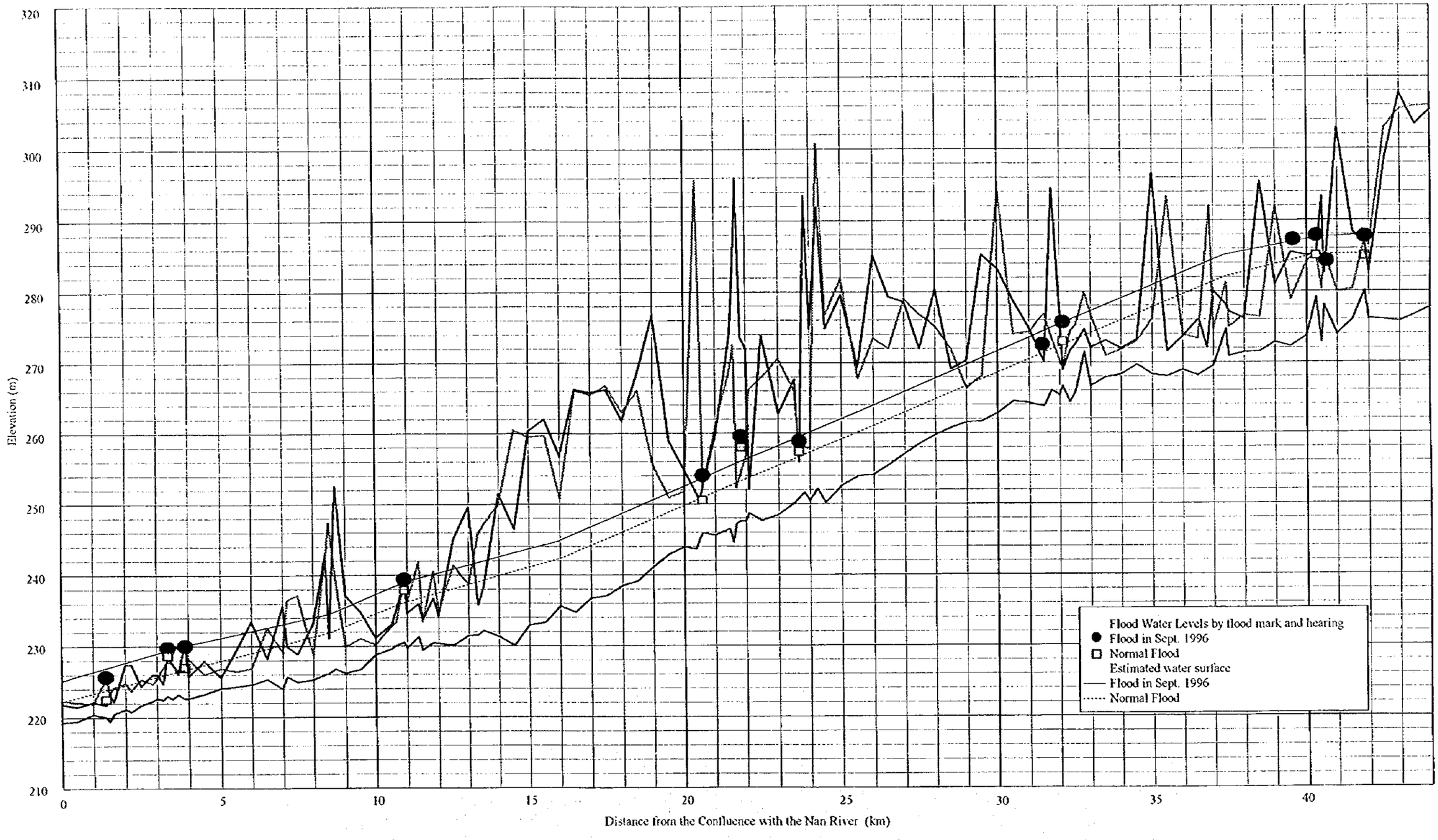
THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
General Location Map of the Kok Intake	MAP & Drawings No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure
SANYU CONSULTANTS INC. & NIPPON KOEI CO., LTD.	11.1.3 (1)-1



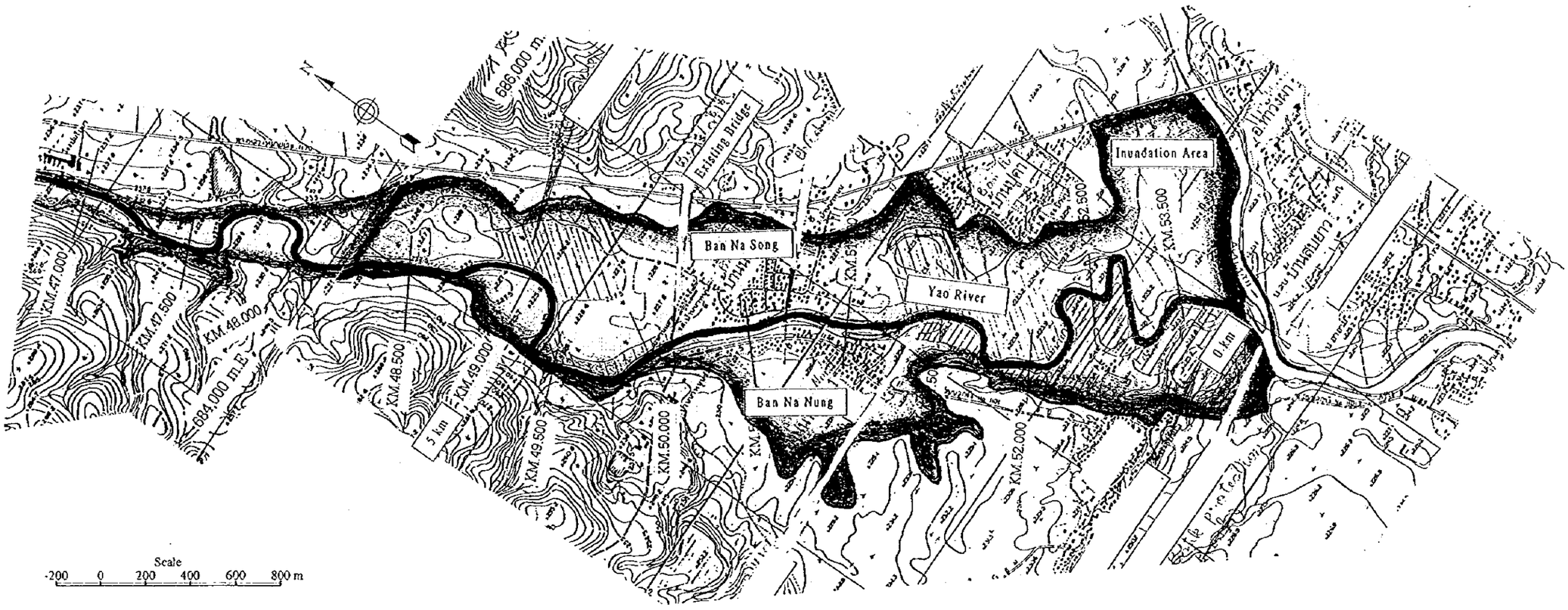
River Profile around the Diversion Weir Site

Relationship between River Water Level and River Channel at the Ing Intake Weir Site under the Present Condition

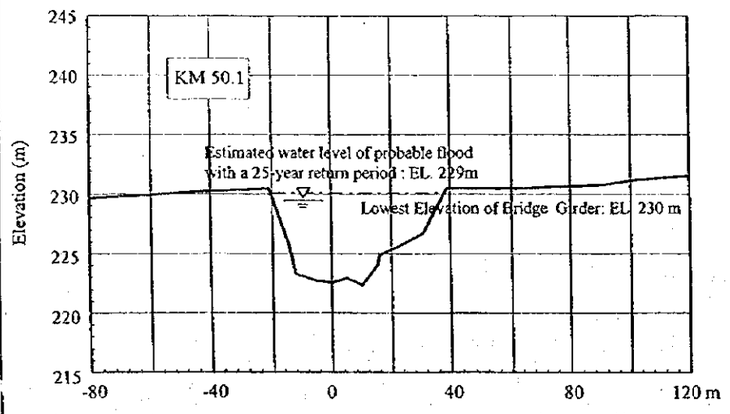
THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
General Location Map of the Ing Diversion Weir and Intake	MAP & Drawings No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure
SANYU CONSULTANTS INC. & NIPPON KOEI CO., LTD.	11.1.3 (3)-1

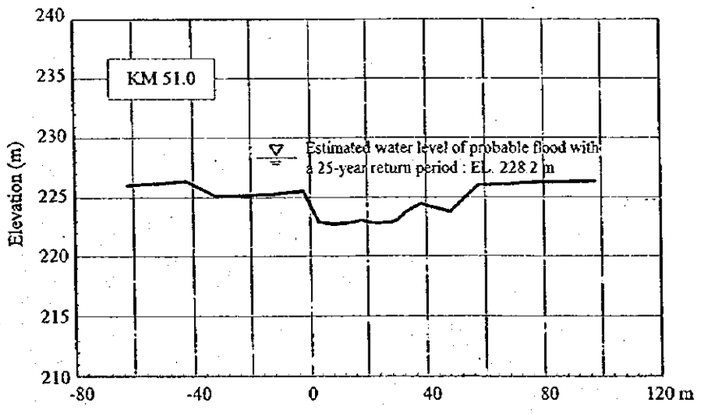


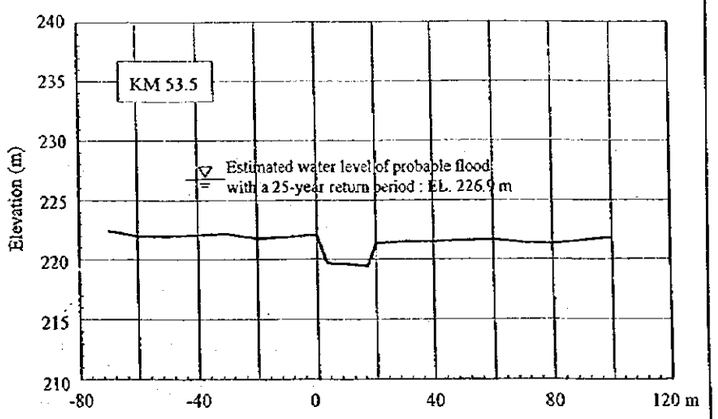
THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
Result of Flood Mark Survey and Estimated Water Levels along the Yao River	MAP & Drawings No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure
SANYU CONSULTANTS INC. & NIPPON KOEI CO., LTD.	11.1.3 (7)-1



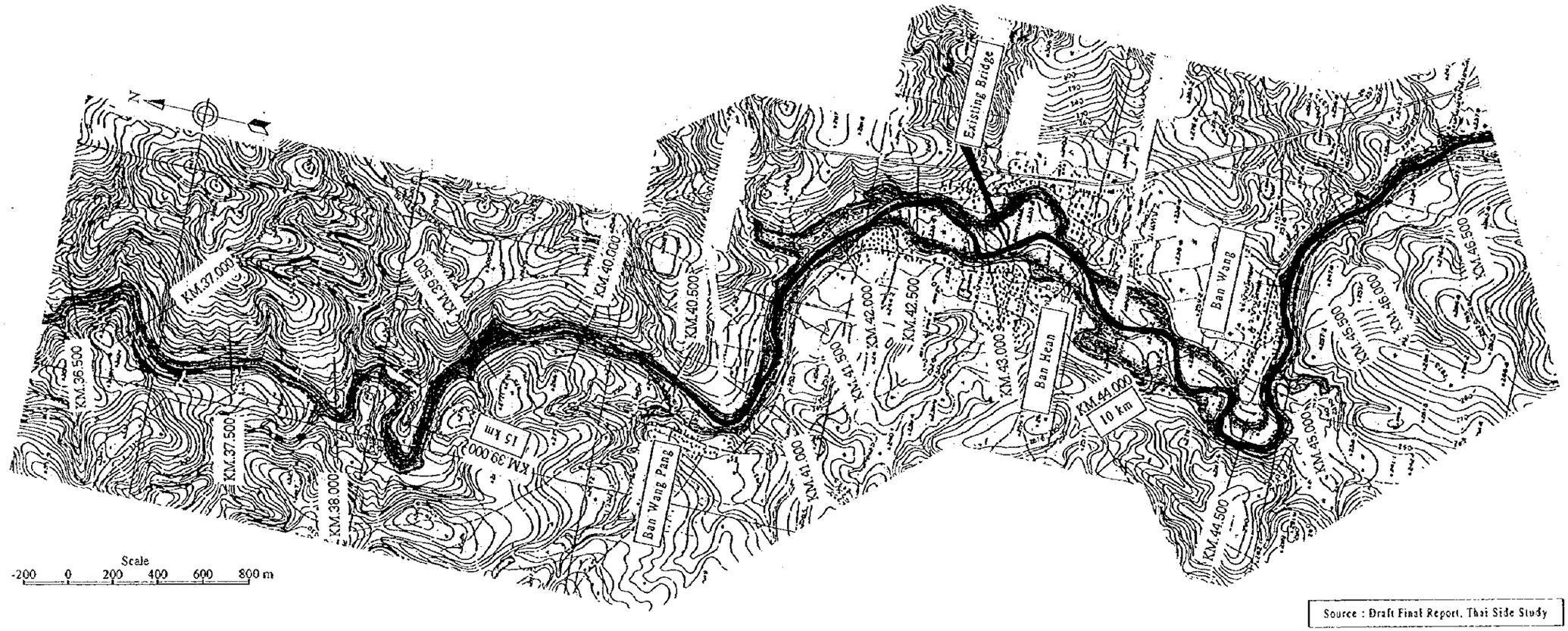
Source : Draft Final Report, Thai Side Study



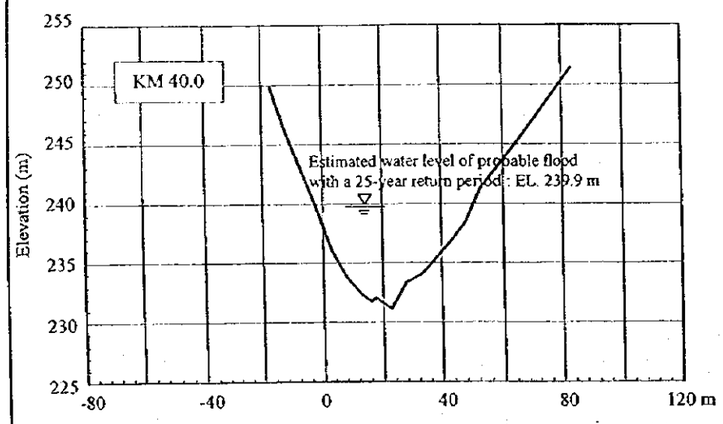


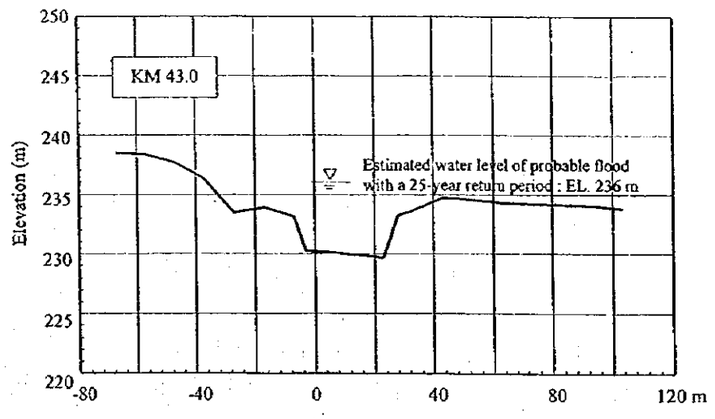


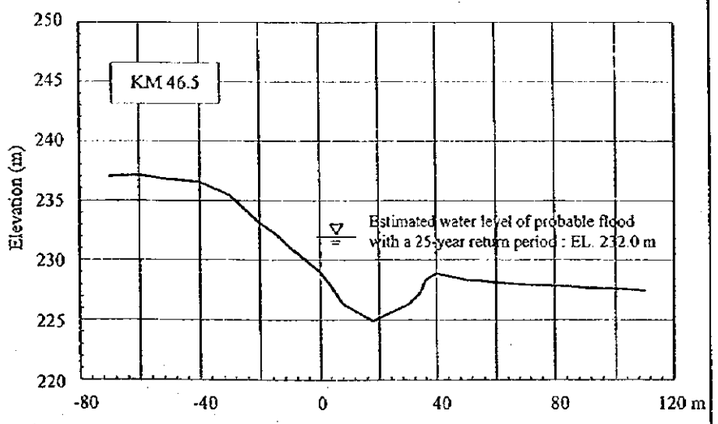
THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
Potential Inundation Area for 25-year Probable Flood (1/4)	MAP & Drawings No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure
SANYU CONSULTANTS INC. & NIPPON KOEI CO., LTD.	11.1.3 (7)-2



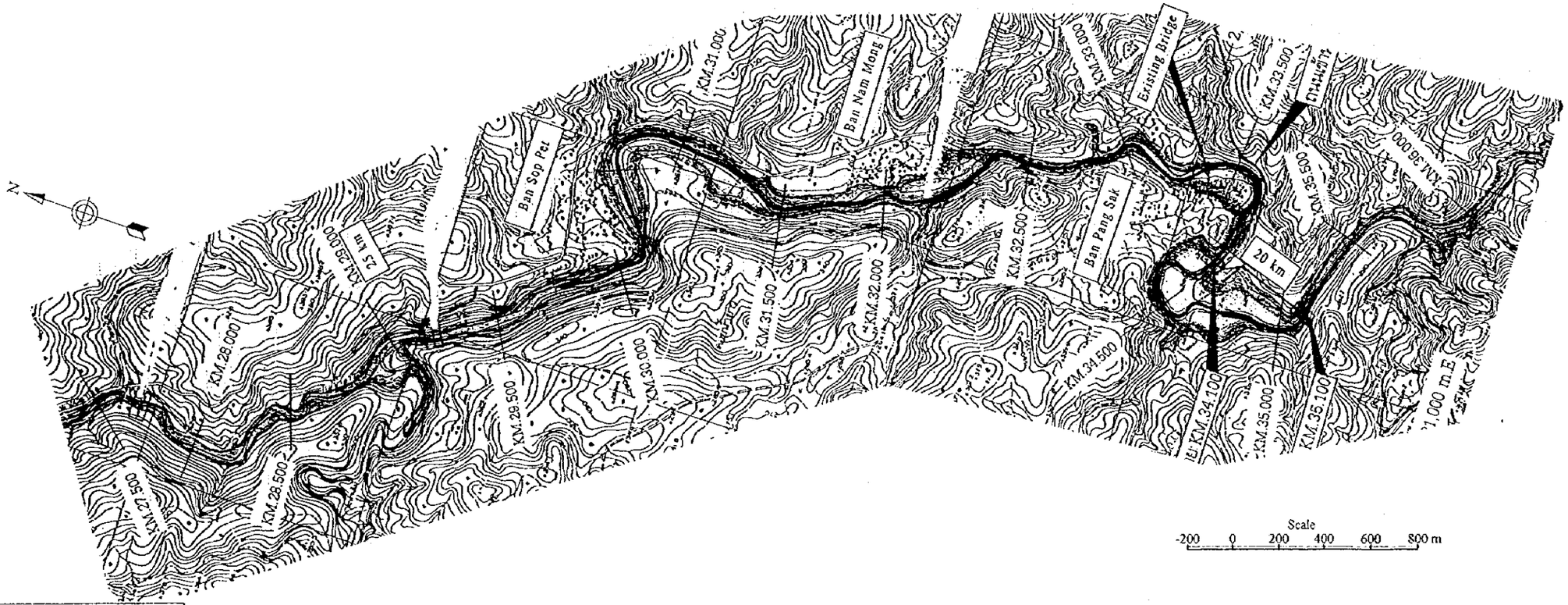
Source : Draft Final Report, Thai Side Study



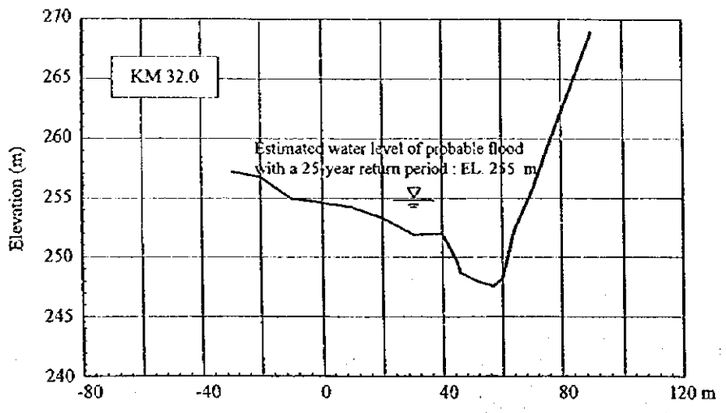


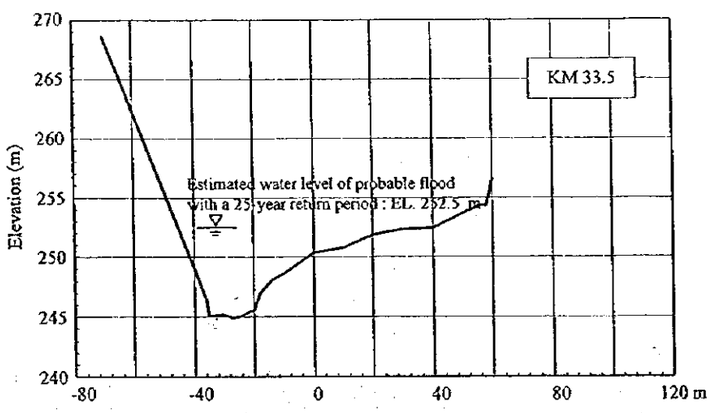


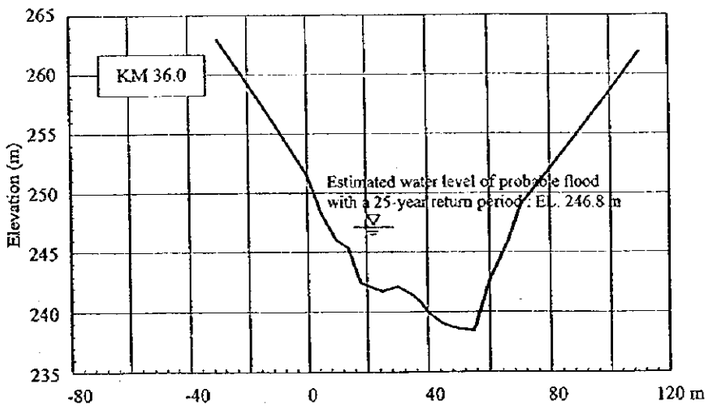
THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
Potential Inundation Area for 25-year Probable Flood (2/4)	MAP & Drawings No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure
SANYU CONSULTANTS INC. & NIPPON KOEI CO., LTD.	11.1.3 (7)-3



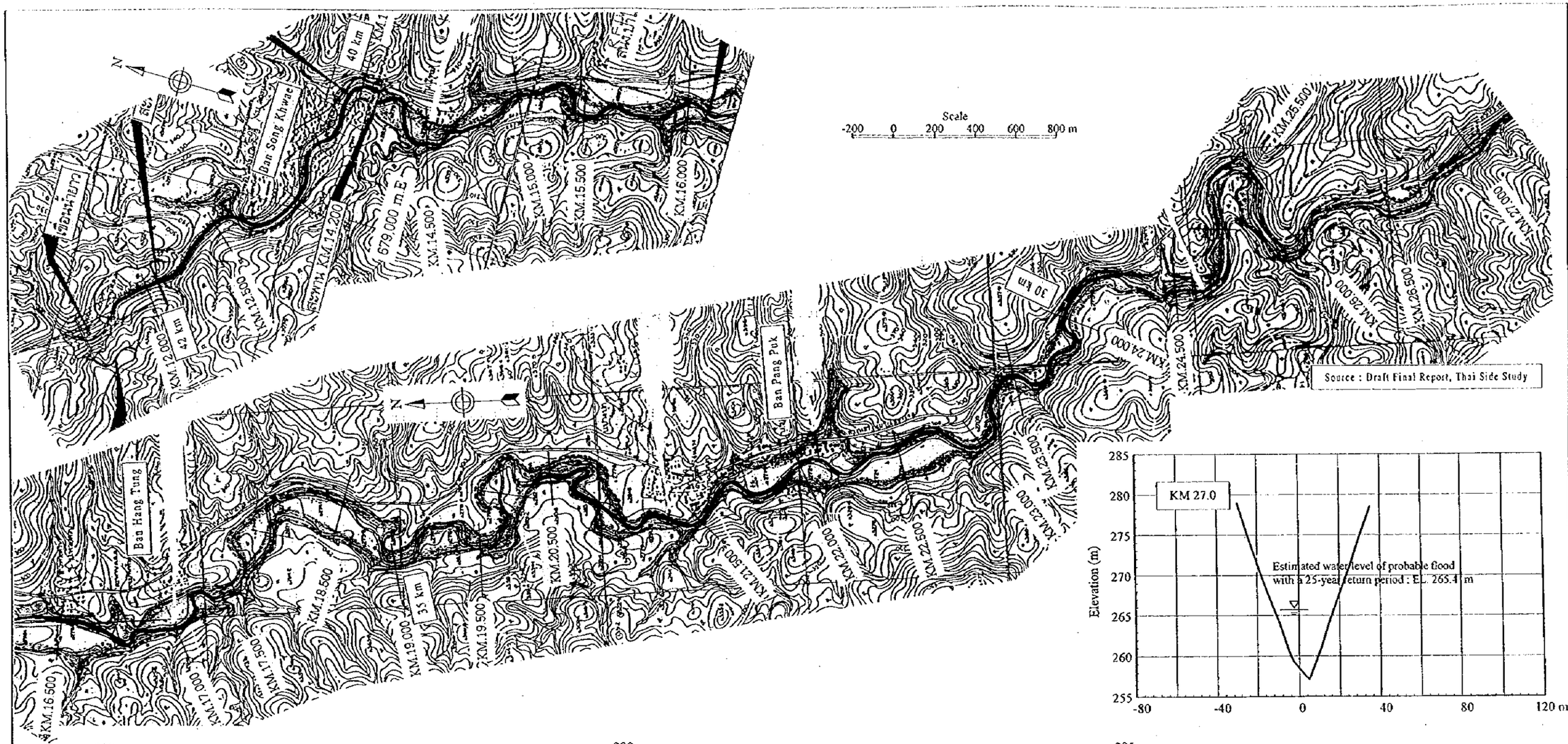
Source : Draft Final Report, Thai Side Study



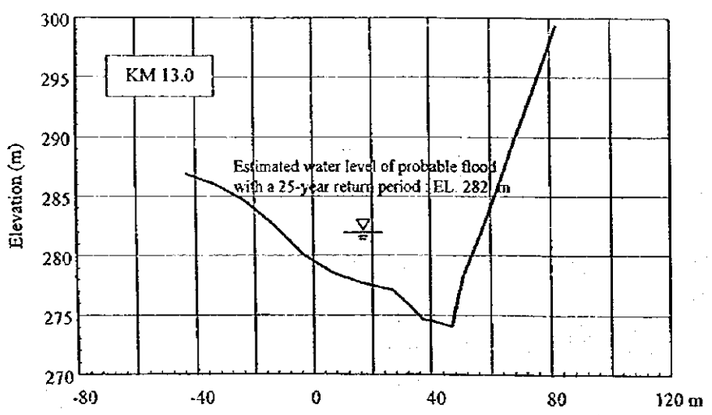


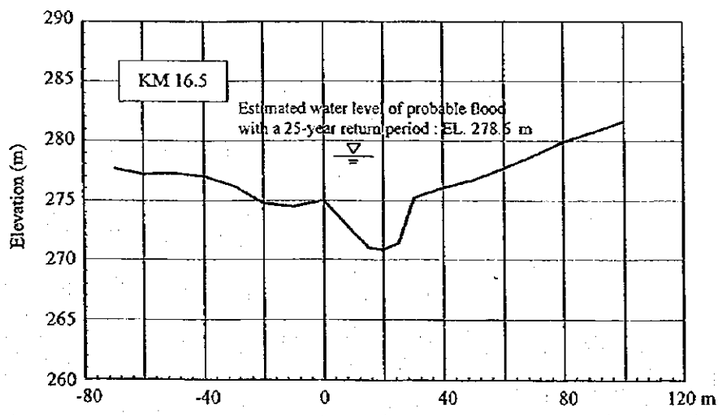


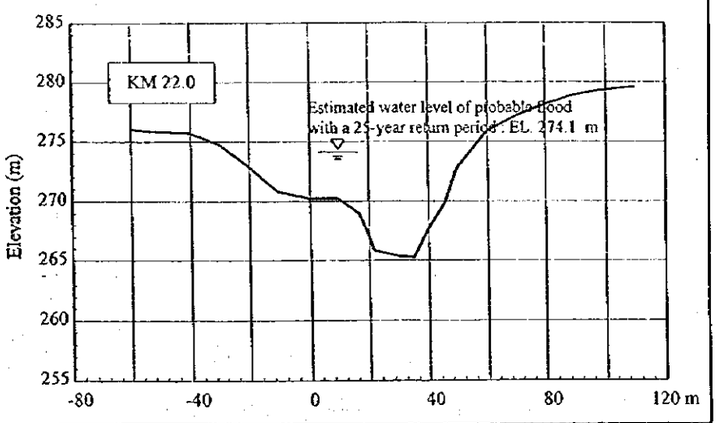
THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
Potential Inundation Area for 25-year Probable Flood (3/4)	MAP & Drawings No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure
SANYU CONSULTANTS INC. & NIPPON KOEI CO., LTD.	11.1.3 (7)-4



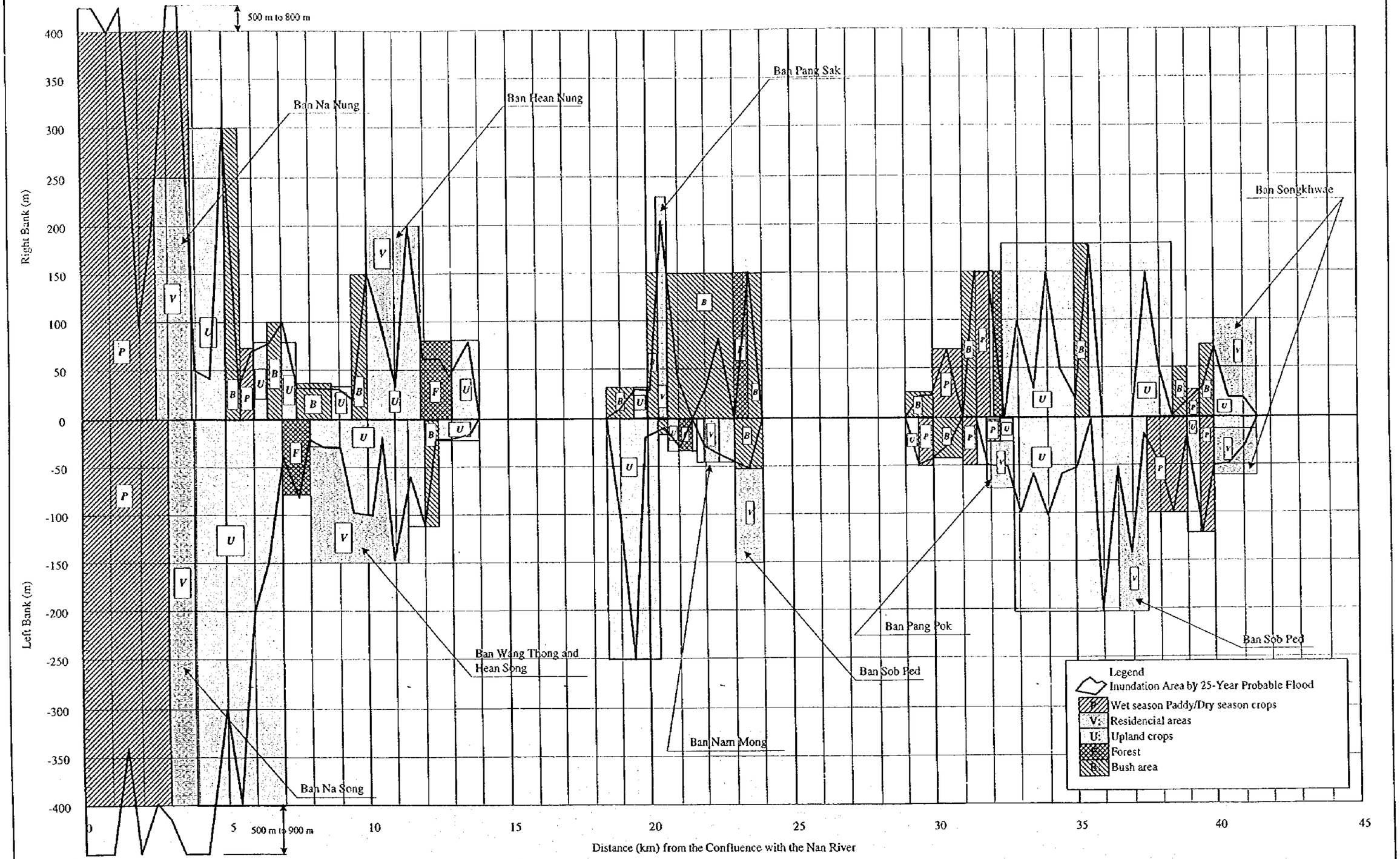
Source : Draft Final Report, Thai Side Study







THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
Potential Inundation Area for 25-year Probable Flood (4/4)	MAP & Drawings No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure
SANYU CONSULTANTS INC. & NIPPON KOEI CO., LTD.	11.1.3 (7)-5



THE STUDY ON KOK-ING-NAN WATER DIVERSION PROJECT	
Assumed Inundation Area and Land Use along the Yao River	MAP & Drawings No.
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Figure
SANYU CONSULTANTS INC. & NIPPON KOEI CO., LTD.	11.1.3 (7)-6