

Table-15.10 Unit Construction Cost for Road
unit: US\$/m

Topografical condition	Unit Construction cost (7 m in width)
Ground gradient 10 deg.	280
Ground gradient 20 deg.	410
Ground gradient 30 deg.	720

15.3 Work Quantities

The civil works work quantities were computed preparing auxiliary drawings based on Dwg. 15 to Dwg.-45 and following the work items in ISA regulations.

These work quantities are given in the "Quantity" columns of Table-15.13 to Table-15.33.

15.4 Computation of Estimated Construction Costs

The estimated construction costs was computed based on the fundamental conditions for estimation in 15.1, and using the unit construction costs of 15.2 and the work quantities of 15.3, and applying the unit price system. The results are given below.

The estimation breakdowns are given in Table 15.4 and Table 15.6

15.5 Construction Costs by Year

Construction costs by year were calculated according to the criteria below, divided into foreign currency and local currency requirements, and based on the construction schedule and construction period of 14.6, and the construction work schedules of Dwg.-48 and Dwg.-49.

Regarding civil works, the advance payment at the time of award of contract was assumed to be 10 percent with payments made individually according to work accomplished.

The final payment withheld is to be 5 percent.

Regarding equipment and apparatus, the advance payment on award of contract is to be 10 percent with the FOB price paid at the time of final loading of equipment and transportation costs paid on completion of transportation.

Installation works are to be paid individually on the basis of work accomplished.

The final amount retained in this case is to be 10 percent.

The computation results are shown in Table-15.28 and Table-15.29.

Table-15.11 El Siete No.1 Project

Item	Description	Measure	Cost (10 ³ U.S.\$)		
			Total	F.C	L.C
I	Preparation works Land and compensation		6,165	123	6,042
II			32,300	13,174	19,129
II-1	No.1 Dam Care of River		2,680	1,053	1,627
II-2	No.1 Dam		23,360	9,665	13,695
II-3	No.1 Auxiliary Intake Dam and Intake		6,260	2,453	3,807
III			32,500	12,817	19,683
III-1	No.1 Intake		1,650	507	1,143
III-2	No.1 Auxiliary Sedimentation Basin		4,640	1,507	3,133
III-3	No.1 Auxiliary Connection Tunnel		2,510	941	1,569
III-4	No.1 Headrace Tunnel		10,160	3,943	6,217
III-5	No.1 Surge Tank		1,490	556	934
III-6	No.1 Penstock Line		3,000	1,113	1,887
III-7	No.1 Power Station		7,480	3,563	3,917
III-8	No.1 Tailrace Tunnel		690	258	432
III-9	No.1 Sub-station		880	420	451
	Sub - Total	(I - III)	70,965	26,111	44,854
IV	Hydraulic Equipment		16,112	7,533	8,579
V	Electric-Mechanical Equipment		21,000	15,300	5,700
VI	Telecommunication Eq.		740	590	150
	Sub - Total	(I - VI)	108,817	49,534	59,283
VII	Contingency		14,431	6,260	8,171
VII-1	Civil works		10,645	3,917	6,728
VII-2	Hydraulic & Electric Eq.		3,712	2,284	1,428
VII-3	Telecommunication Eq.		74	59	15
	Sub - Total	(I - VII)	123,248	55,794	67,454
VIII	Engineering and Administration		11,492	5,064	6,428
VIII-1	Civil works		8,161	3,003	5,158
VIII-2	Hydraulic & Electric Eq.		3,331	2,061	1,270
	Sub - Total	(I-VIII)	134,740	60,858	73,882
IX	Transmission Line		16,862	9,723	7,139
IX-1	CF + Transp + Install		14,194	8,185	6,009
IX-2	Contingency		1,419	818	601
IX-3	Engineering and Administration		1,249	720	529
	Grand - Total		151,602	70,581	81,021

Table-15.12 El Siete No.2 Project

Item	Description	Measure	Cost (10 ³ U.S.\$)		
			Total	F.C	L.C
I	Preparation works Land and compensation		5,620	123	5,497
II			10,150	4,143	6,007
II-1	No.2 Intake Dam & Intake		10,150	4,143	6,007
III			49,750	18,569	31,181
III-1	No.2 Sedimentation Basin		1,360	471	889
III-2	No.2 Headrace Tunnel		38,240	13,815	24,425
III-3	No.2 Surge Tank		1,810	667	1,143
III-4	No.2 Penstock Line		2,210	807	1,403
III-5	No.2 Power Station		4,940	2,297	2,643
III-6	No.2 Sub-station		1,190	512	678
	Sub - Total	(I - III)	65,520	22,835	42,685
IV	Hydraulic Equipment		12,271	4,872	7,399
V	Electric-Mechanical Equipment		13,840	10,080	3,760
VI	Telecommunication Eq.		730	590	140
	Sub - Total	(I - VI)	92,361	38,377	53,984
VII	Contingency		12,513	4,980	7,533
VII-1	Civil works		9,828	3,425	6,403
VII-2	Hydraulic & Electric Eq.		2,612	1,496	1,116
VII-3	Telecommunication Eq.		73	59	14
	Sub - Total	(I - VII)	104,874	43,357	61,517
VIII	Engineering and Administration		9,897	3,994	5,903
VIII-1	Civil works		7,535	2,626	4,909
VIII-2	Hydraulic & Electric Eq.		2,362	1,368	994
	Sub - Total	(I-VIII)	114,771	47,351	67,420
IX	Transmission Line		1,350	779	571
IX-1	CIF + Trasp + Install		1,136	655	481
IX-2	Contingency		114	66	48
IX-3	Engineering and Administration		100	58	42
	Grand - Total		116,121	48,130	67,991

Table-15.13 Preparation Works and Land and Compensation

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
I-1	Land		L.S	1	-	-	-	9	-	9
I-2	Construction road Relocation road	Open	km	1.6	300,000	-	300,000	480	-	480
		Tunnel	m	-	0	-	-	0	-	-
		Open	km	9.2	180,000	-	180,000	1,656	-	1,656
	Sub-total									2,145
I-3	Bridge Temporary bridge Permanent bridge		m	60	2,000	-	2,000	120	-	120
			m	0	6,000	-	6,000	0	-	0
		Sub-total								
I-4	Electric power supply equipment for construction Transmission line	115 KV	L.S	1	-	-	-	144	-	144
		13.2 KV	L.S	1	-	-	-	1,260	-	1,260
			L.S	1	-	-	-	-	-	-
		Switch yard								
	Sub-total									1,732
I-5	Temporary construction camp		L.S	1	-	-	-	52	-	52
I-6	Compensation housing		L.S	1	-	-	-	151	-	151
I-7	Temporary communication equipment		L.S	1	-	-	-	112	-	112
		Total								
I-8	Others	(I-1 - I-7)			-	-	-	561	-	561
		10%								11
		(I-1 - I-8)								
	Grand-total									6,165

Table-15.14 No.1 Dam Care of River

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
II-1.1	Excavation, Embankment Open excavation " " " " Tunnel excavation Coffer dam " " " "	Common Rock River bed Core Filter Rock	m ³ " " " " "	1,560 5,200 2,940 10,460 2,740 1,680 6,060	4.5	2.9	1.6	8	5	3
					10	5.0	5.0	52	26	26
					9	5.8	3.2	27	17	10
					88	35.2	52.8	921	369	552
					12	7.2	4.8	33	20	13
					12	7.2	4.8	21	13	8
II-1.2	Concrete River diversion tunnel Inlet, Outlet Lining Plug Motor injection Cement grouting	m ³ " " " " "	330 4,020 520 360 560	108	32.4	75.6	36	11	25	
				182	74.7	107.3	732	301	431	
				93	27.9	65.1	49	15	34	
				150	43.5	106.5	54	16	38	
				46	17.1	28.9	26	10	16	
II-1.3	Metal work Steel rib support Reinforcement	t t	60 150		494	2,106	156	30	126	
					293	1,247	231	44	187	
II-1.4	Drilling Consolidation Curtain	m m	200 200		17.1	12.9	6	4	2	
					42.8	32.2	15	9	6	
II-1.5	Sub-total Others Sub-total Total	(II-1.1 - II-1.4) 10% (II-1.5) (II-1)	- 1		-	-	2,428	927	1,501	
					-	-	252	126	126	
							252	126	126	
							2,680	1,053	1,627	

Table-15.15 No.1 Dam

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
II-2.1	Excavation, Embankment Open excavation " " " " " " " " Tunnel excavation Embankment Backfill	Common	m ³	423,800	5	3.2	1.8	2,119	1,357	762
		Rock	"	91,900	12	6.0	6.0	1,103	552	551
		River bed	"	38,700	9	5.8	3.2	349	225	124
		Cut off (common)	"	650	7	4.5	2.5	5	3	2
		" (Rock)	"	2,670	15	7.5	7.5	41	21	20
		" (common)	"	740	65	28.0	39.0	49	20	29
II-2.2	Concrete Concrete " " Mortar injection Cement grouting	Rock	"	3,320	10	6.0	4.0	34	20	14
		Backfill	"	1,930	3	1.5	1.5	6	3	3
		Concrete	m ³	127,300	93	35.4	57.6	11,839	4,507	7,332
II-2.3	Metal work Steel rib support Reinforcement	Structure	"	16,000	125	45.0	80.0	2,000	720	1,280
		Lining (Cut off)	"	210	182	74.7	107.3	39	16	23
			"	40	150	43.5	106.5	6	2	4
			Sack	12,000	46	17.1	28.9	552	206	346
II-2.4	Drilling Consolidation Custain		"	1,230	1,540	293	1,247	1,895	361	1,534
			m	6,360	30	17.1	12.9	191	109	82
II-2.5	Excavated surface Protection Shotcrete		"	3,270	75	42.8	32.2	246	140	106
			(II-2.1 - II-2.4)					20,500	8,267	12,233
II-2.6	Bridge	t = 10 cm	m ³	1,310	250	87.5	162.5	328	115	213
II-2.7	Others Sub-total	B-500 m	m	68	6,000	3,240	2,760	408	221	187
		10%	L.S	1	-	-	-	2,124	1,062	1,062
	Sub-total	(II-2.5 - II-2.7)						2,860	1,398	1,462
	Total	(II-2)						23,360	9,665	13,695

Table-15.16 No.1 Auxiliary Intake Dam and Intake

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
II-3.1	Excavation, Backfill Open excavation	common Rock	m ³	69,100	5	3.2	1.8	346	222	124
	"	River bed	"	28,200	12	6.0	6.0	339	170	169
	"		"	15,500	9	5.8	3.2	140	90	50
	Backfill		"	420	1.5	0.8	0.7	1	1	0
II-3.2	Concrete	Dam	"	28,100	93	35.4	57.6	2,614	995	1,619
	Concrete	Structure	"	7,680	125	45.0	80.0	960	346	614
II-3.3	Metal work Reinforcement		t	370	1,540	293	1,247	570	109	461
II-3.4	Excavated surface protection Shotcrete	t = 10 cm	m ³	240	250	87.5	162.5	60	21	39
II-3.5	Bridge	B = 500 m	m	39	6,000	3,240	2,760	234	127	107
II-3.6	Care of river		L.S	1	-	-	-	420	84	336
II-3.7	Others	10%	L.S	1	-	-	-	576	288	288
	Total	(II-3)						6,260	2,453	3,807
	Grand total	(II-1 - II-3)						32,300	13,171	19,129

Table-15.17 No.1 Intake

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
III-1.1	Excavation, Backfill			0	-	-	-	-	-	-
	Open excavation	Note: Included in No.1 Dam	m ³	600	75	30.0	45.0	45	18	27
	Tunnel excavation		"	310	92	36.8	55.2	29	12	17
	Shaft excavation		"	2,710	1.5	0.8	0.7	5	3	2
	Backfill									
III-1.2	Concrete			5,200	175	52.5	122.5	910	273	637
	Concrete	Structure	"	610	158	64.8	93.2	97	40	57
	Mortar injection	Tunnel lining	"	20	150	43.5	106.5	3	1	2
	Cement grouting		Sack	540	46	17.1	28.9	25	10	15
III-1.3	Metal work			20	2,600	494	2,106	52	10	42
	Steel rib support Reinforcement		"	220	1,540	293	1,247	339	65	274
III-1.4	Drilling			600	30	17.1	12.9	18	11	7
	Consolidation									
III-1.5	Others	8%	L.S	1	-	-	-	127	64	63
	Total	(III-1)						1,650	507	1,143

Table-15.18 No.1 Auxiliary Sedimentation Basin

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
III-2.1	Excavation, Backfill Open excavation " " Tunnel excavation Backfill	Common Rock	m ³ " " "	57,700	3.2	1.8	289	185	104	
				25,200	6.0	6.0	303	152	151	
				140	26.0	39.0	10	4	6	
				5,500	0.8	0.7	9	5	4	
III-2.2	Concrete Concrete " " " " Mortar injection	Semi structure Structure Lining	" " " "	9,340	37.5	87.5	1,168	351	817	
				9,210	52.5	122.5	1,612	484	1,128	
				90	74.7	107.3	17	7	10	
				10	43.5	106.5	2	1	1	
III-2.3	Metal work Steel rib support Reinforcement	" "	t "	2	494	2,106	6	1	5	
				590	293	1,247	909	173	736	
III-2.4	Excavated surface protection Shotcrete Others	t = 10 cm 5%	m ³ L.S	370	87.5	162.5	93	33	60	
				1	-	-	222	111	111	
III-2.5	Total	(III-2)					4,640	1,507	3,133	

Table-15.19 No.2 Auxiliary Connection Tunnel

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)		Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign
III-3.1	Excavation Tunnel excavation		m ³	12,730	75	30.0	955	382	573
						38.0	62	25	37
III-3.2	Concrete Concrete Mortar injection		m ³	5,060	175	71.8	886	364	522
						43.5	132	39	93
III-3.3	Metal work Steel rib support Reinforcement		t	80	2,600	494	208	40	168
						293	139	27	112
III-3.4	Others	5%	L.S	1	-	-	128	64	64
Total		(III-3)					2,510	941	1,569

Table-15.20 No.1 Headrace Tunnel

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
III-4.1	Excavation	Common (Adit)	m ³	3,300	4.5	2.9	1.6	15	10	5
	Open excavation	Rock (")	"	320	10	5.0	5.0	4	2	2
	Tunnel excavation	Adit	"	2,390	143	57.2	85.8	342	137	205
	Inclined excavation	Headrace	"	46,080	75	30.0	45.0	3,456	1,383	2,073
III-4.2	Concrete	"	"	350	95	38.0	57.0	34	14	20
	Concrete	Lining (Headrace)	m ³	17,880	175	71.8	103.2	3,129	1,284	1,845
	"	" (Adit)	"	540	230	94.3	135.7	125	51	74
	"	Plug (")	"	220	125	37.5	87.5	28	9	19
III-4.3	Mortar injection	"	"	3,170	150	43.5	106.5	476	138	338
	Cement grouting	"	Sack	12,800	46	17.1	28.9	589	219	370
III-4.4	Metal work	30%	t	180	2,600	494	2,106	468	89	379
	Steel rib support Reinforcement	50%	"	360	1,540	293	1,247	555	106	449
III-4.5	Drilling	5%	m	14,950	30	17.1	12.9	449	256	193
	Consolidation Others	"	L.S	1	-	-	-	490	245	245
Total		(III-4)						10,160	3,943	6,217

Table-15.21 No.1 Surge Tank

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)							
					Total	Foreign	Local	Total	Foreign	Local					
III-5.1	Excavation	Common Rock	m ³	3,900	5	3.2	1.8	20	13	7					
	Open excavation										12	6.0	71	36	35
	Tunnel excavation										75	30.0	84	34	50
III-5.2	Shaft excavation	Lining (Tunnel) "	m ³	3,050	110	44.0	66.0	336	135	201					
	Concrete										175	71.8	103.2	54	78
	Concrete										1,140	94.3	135.7	108	155
III-5.3	Mortar injection	"	"	100	150	43.5	106.5	15	5	10					
	Cement grouting										46	17.1	28.9	16	27
	Metal work										40	494	2,106	20	84
III-5.4	Steel rib support	"	"	100	1,540	293	1,247	154	30	124					
	Reinforcement										50	900	2,100	45	105
	Steel liner										30	17.1	12.9	28	16
III-5.5	Drilling	"	"	930	30	87.5	162.5	15	6	9					
	Consolidation										60	250	75	38	37
III-5.6	Excavated surface protection	t = 10 cm	m ³	60	250	87.5	162.5	15	6	9					
	Shotcrete										5%	1	75	38	37
	Others		L.S	1											
	Total	(III-5)						1,490	556	934					

Table-15.22 No.1 Penstock Line

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)						
					Total	Foreign	Local	Total	Foreign	Local				
III-6.1	Excavation	Common Rock	m ³ " "	90,490 10,060 3,420	5	3.2	1.8	453	290	163				
	Open excavation										6.0	121	61	60
	Tunnel excavation										30.0	75	257	103
III-6.2	Concrete	Around penstock Structure	m ³ "	2,220 9,860	160 125	48.0 37.5	112.0 87.5	356 1,233	107 370	249 863				
	Concrete													
III-6.3	Metal work		t "	40 160	2,600 1,540	494 293	2,106 1,247	104 247	20 47	84 200				
	Steel rib support Reinforcement													
III-6.4	Others	8Z	L.S	1				229	115	114				
Total								3,000	1,113	1,887				

Table-15.23 No.1 Powerstation

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
III-7.1	Excavation Open excavation " " Backfill	Common Rock	m ³ " "	42,660 81,630 3,920	6.2	4.0	2.2	266	172	94
						6.0	6.0	980	490	490
						0.8	0.7	6	3	3
III-7.2	Concrete Concrete " " " "	Foundation Semi structure Structure Architecture	m ³ " " "	2,350 3,670 2,200 3,080	98	37.3	60.7	231	88	143
						57.3	101.7	616	222	394
						62.3	110.7	381	137	244
						150	100	770	462	308
III-7.3	Metal work Reinforcement		t	710	1,540	293	1,247	1,094	208	886
III-7.4	Excavated surface protection Shotcrete	t = 10 cm	m ³	230	250	87.5	162.5	58	21	37
						(85)	-	1,963	1,178	785
III-7.5	Architecture	20.0mx55.5mx30.8m	L.S	1	-	-	-	51	21	30
III-7.6	Qda Aquila diverting cannel		L.S	1	-	-	-	-	-	-
III-7.7	Bridge	B = 5.00 m	m	95	7,400	3,996	3,404	703	380	323
III-7.4	Others	5%	L.S	1	-	-	-	361	181	180
	Total	(III-7)						7,480	3,563	3,917

Table-15.24 No.1 Tailrace Tunnel

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
III-8.1	Excavation Tunnel excavation		m ³	3,430	75	30.0	45.0	258	103	155
III-8.2	Concrete Mortar injection	Tunnel lining	m ³ "	1,440	175	71.8	103.2	252	104	148
				190	150	43.5	106.5	29	9	20
III-8.3	Metal work Steel rib support Reinforcement		t "	18	2,600	494	2,106	47	9	38
				40	1,540	293	1,247	62	12	50
III-8.4	Others	5%	L.S	1	-	-	-	42	21	21
	Total	(III-8)						690	258	432

Table-15.25 No.1 Sub-station

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
III-9.1	Excavation Open excavation " "	Common Rock Common	m ³ " "	55,680 6,190 51,300	5	3.2	1.8	279	179	100
						5.0	5.0	62	31	31
						1.5	1.5	154	77	77
III-9.2	Concrete Concrete	Structure	m ³	1,350	193	69.5	123.5	261	94	167
III-9.3	Metal work Reinforcement		t	50	1,540	462	1,078	77	24	53
III-9.4	Others	5%	L.S	1	-	-	-	47	24	23
	Total	(III-9)						880	429	451
	Grand total	(III-1 - III-9)						32,500	12,817	19,683

Table-15.26 Preparation Works and Land and Compensation

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
I-1	Land		L.S	1	-	-	-	4	-	4
I-2	Construction road	Open	km	0.1	300,000	-	300,000	30	-	30
	Relocation road	Tunnel	m	170	5,500	-	5,500	935	-	935
	"	Open	km	8.1	180,000	-	180,000	1,458	-	1,458
	Total						2,423			2,423
I-3	Bridge		m	20	2,000	-	2,000	40	-	40
	Temporary bridge	"	m	0	6,000	-	6,000	0	-	0
	Total						40			40
I-4	Electric power supply equipment for construction	Transmission line	km	10	24,000	-	24,000	240	-	240
		"	L.S	1	-	-	-	1,260	-	1,260
		Switch yard	"	1	-	-	-	-	-	-
		Total						1,500		
I-5	Temporary construction camp		L.S	1	-	-	990	-	990	
I-6	Compensation housing		L.S	0	-	-	-	-	-	
I-7	Temporary communication equipment		L.S	1	-	-	-	151	112	39
		Sub-total	(I-1 - I-7)					5,108	112	4,996
I-8	Others	10%	L.S	1	-	-	-	512	11	501
		Grand-total	(I-1 - I-8)					5,620	123	5,497

Table-15.27 No.2 Intake Dam and No.2 Intake

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
II-1.1	Excavation, Backfill Open excavation " " " " Tunnel excavation Backfill	Common Rock River bed	m ³ " " "	178,080 45,740 2,770 3,400	5 12 9 1.5	3.2 6.0 5.8 0.8	1.8 6.0 3.2 0.7	891 549 25 6	570 275 16 3	321 274 9 3
II-1.2	Concrete Concrete " " Cement grouting	Dam Structure	m ³ " Sack	55,190 4,880 7,350	93 125 46	35.4 45.0 17.1	57.6 80.0 28.9	5,133 610 339	1,954 220 126	3,179 390 213
II-1.3	Metal work Reinforcement		t	470	1,540	293	1,247	724	138	586
II-1.4	Drilling Consolidation Curtain		m "	4,620 1,520	30 75	17.1 42.8	12.9 32.2	139 114	79 65	60 49
II-1.5	Excavation surface Protection Shotcrete	t = 10 cm	m ³	250	250	87.5	162.5	63	22	41
II-1.6	Care of river		L.S	1	-	-	-	380	76	304
II-1.7	Bridge		m	40	6,000	3,240	2,760	240	130	110
II-1.8	Others	10%	L.S	1	-	-	-	937	469	468
	Grand total	(II-1.1 - II-1.8)						10,150	4,143	6,007

Table-15.28 No.2 Sedimentation Basin

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)								
					Total	Foreign	Local	Total	Foreign	Local						
III-1.1	Excavation	Include in No.2 Intake Dam	m ³	270	75	30.0	45.0	21	8	13						
	Open excavation										150	64.0	96.0	24	10	14
	Tunnel excavation															
III-1.2	Shaft excavation															
	Concrete	Mass concrete Structure Lining (Tunnel) " (Shaft)	m ³	8,150	93	35.4	57.6	758	289	469						
	Concrete										1,550	37.5	87.5	194	58	136
	"										170	71.8	103.2	30	12	18
	"										80	94.3	135.7	19	8	11
Mortar injection	30										43.5	106.5	5	2	3	
III-1.3	Cement grouting		Sack	120	46	17.1	28.9	6	2	4						
III-1.4	Metal work		t	10	2,600	494	2,106	26	5	21						
	Steel rib support										120	293	1,247	185	35	150
	Reinforcement										6	900	2,100	18	5	13
	Steel liner															
III-1.5	Drilling	5%	m	120	30	17.1	12.9	4	2	2						
	Consolidation															
III-1.5	Others		L.S	1	-	-	-	70	35	35						
	Total	(III-1.1 - III-1.5)						1,360	471	889						

Table-15.29 No.2 Headrace Tunnel

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)		Cost (10 ³ U.S. \$)			
					Total	Foreign	Local	Total	Foreign	Local
III-2.1	Excavation	Common (Adit)	m ³	4,950	4.5	2.9	1.6	23	15	8
	Open excavation	Rock (")	"	500	10	5.0	5.0	5	3	2
	Tunnel excavation	Adit	"	5,300	143	57.2	85.8	758	304	454
	"	Headrace	"	154,120	75	30.0	45.0	11,559	4,624	6,935
III-2.2	Concrete	Lining (Headrace)	m ³	61,460	175	71.8	103.2	10,756	4,413	6,343
	"	(Adit)	"	1,200	230	94.3	135.7	276	114	162
	"	Plug (")	"	450	125	37.5	87.5	57	17	40
	Mortar injection	"	"	9,140	150	43.5	106.5	1,371	398	973
	Cement grouting	"	Sack	36,660	46	17.1	28.9	1,687	627	1,060
III-2.3	Metal work									
	Steel rib support Reinforcement		t	1,770	2,600	494	2,106	4,602	875	3,727
III-2.4	Drilling		m	2,600	1,540	293	1,247	4,004	762	3,242
	Consolidation									
III-2.5	Others	SZ		43,970	30	17.1	12.9	1,320	752	568
			L.S	1	-	-	-	1,822	911	911
	Total	(III-2.1 - III-2.5)						38,240	13,815	24,425

Table-15.30 No.2 Surge Tank

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)							
					Total	Foreign	Local	Total	Foreign	Local					
III-3.1	Excavation	Common Rock	m ³	1,990	5	3.2	1.8	10	7	3					
	Open excavation										12	6.0	36	18	18
	Tunnel excavation										75	30.0	91	37	54
	Shaft excavation										110	44.0	495	198	297
III-3.2	Concrete	Lining (Tunnel) (Shaft)	m ³	800	175	71.8	103.2	140	58	82					
	Concrete										230	94.3	375	154	221
	Mortar injection										150	43.5	15	5	10
	Cement grouting										46	17.1	43	16	27
III-3.3	Metal work		t	50	2,600	494	2,106	130	25	105					
	Steel rib support										130	293	201	39	162
	Reinforcement										48	900	144	44	100
	Steel liner														
III-3.4	Drilling		m	970	30	17.1	12.9	30	17	13					
	Consolidation														
III-3.5	Excavated surface	t = 10 cm	m ³	40	250	87.5	162.5	10	4	6					
	Protection														
III-3.5	Shotcrete	5%	L.S	1	-	-	-	90	45	45					
	Others														
	Total	(III-3)						1,810	667	1,143					

Table-15.31 No.2 Penstock Line

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)		
					Total	Foreign	Local	Total	Foreign	Local
III-4.1	Excavation Open excavation " " Tunnel excavation	Common Rock	m ³ " "	65,400	3.2	1.8	327	210	117	
				7,270	6.0	6.0	88	44	44	
				1,480	30.0	45.0	111	45	66	
III-4.2	Concrete Concrete "	Around penstock Structure	m ³ "	920	48.0	112.0	148	45	103	
				8,690	37.5	87.5	1,087	326	761	
III-4.3	Metal work Steel rib support Reinforcement		t "	20	494	2,106	52	10	42	
				150	293	1,247	231	44	187	
III-4.5	Others	8%	L.S	1	-	-	166	83	83	
Total							2,210	807	1,403	

Table-15.32 No.2 Power Station

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)			
					Total	Foreign	Local	Total	Foreign	Local	
III-5.1	Excavation, Backfill										
	Open excavation	Common	m ³	39,100	6.2	4.0	2.2	243	157	86	
	"	Rock	"	32,400	12	6.0	6.0	389	195	194	
III-5.2	Backfill			3,400	1.5	0.8	0.7	6	3	3	
	Concrete	Foundation	m ³	3,690	98	37.3	60.7	362	138	224	
	"	Semi structure	"	1,920	159	57.3	101.7	306	111	195	
	"	Structure	"	1,280	173	62.3	110.7	222	80	142	
III-5.3	"	Architecture	"	2,530	250	150.0	100.0	633	380	253	
	Metal work		t	490	1,540	293	1,247	755	144	611	
III-5.4	Reinforcement										
	Excavation surface protection	t = 10 cm	m ³	300	250	87.5	162.5	75	27	48	
III-5.5	Shotcrete	18.0mx52.0mx18.8m	L.S	1	-	-	-	1,496	898	598	
III-5.6	Architecture		"	1	-	-	-	210	42	168	
III-5.7	Care of river		L.S	1	-	-	-	243	122	121	
	Others	5%									
	Total	(III-5.1 - III-5.7)						4,940	2,297	2,643	

Table-15.33 No.2 Sub-station

Item	Description	Measure	Unit	Quantity	Unit Price (U.S.\$)			Cost (10 ³ U.S. \$)				
					Total	Foreign	Local	Total	Foreign	Local		
III-6.1	Excavation, Embankment		m ³	44,600								
	Open excavation	Common	"	5,000	3.2	1.8	223	143	80			
	Embankment	Rock Common	"	28,200	5.0 1.5	5.0 1.5	50 85	25 43	25 42			
III-6.2	Concrete Concrete	Structure	m ³	3,340	69.5	123.5	645	232	413			
III-6.3	Metal work Reinforcement		t	80	462	1,078	124	37	87			
III-6.4	Others	5%	L.S	1	-	-	63	32	31			
	Total	(III-6.1 - III-6.4)					1,190	512	678			
	Grand total	(III-1 - III-6)					49,750	18,569	31,181			

Table-15.34 Cost of Hydraulic Equipment, Electrical Equipment, Telecommunication Equipment and Transmission Line

Description	Cost				F.O.B	C.I.F	Tax	Tr	Install				
	Total	F.C		L.C					F.C	L.C	F.C		L.C
		F.C	L.C								F.C	L.C	
E1 Siete No.1													
IV Hydraulic Equipment	16,112	7,533	8,579	6,848	685	1,508	243	-	6,828				
Gate	8,566	5,513	3,053	5,012	501	1,103	235	-	1,715				
Trashrack	361	128	233	116	12	26	8	-	199				
Penstock	7,185	1,892	5,293	1,720	172	379	-	-	4,914				
V Electric-Mechanical Eq.	21,000	15,300	5,700	13,640	1,360	3,000	1,500	300	1,200				
VI Telecommunication Eq.	740	590	150	465	45	103	26	80	21				
VIII Transmission Line	15,330	8,840	6,490	7,600	1,240	1,670	420	-	4,400				
E1 Siete No.2													
IV Hydraulic Equipment	12,271	4,872	7,399	4,428	444	976	131	-	6,292				
Gate	4,331	2,780	1,551	2,527	253	556	130	-	865				
Trashrack	18	6	12	5	1	2	1	-	9				
Penstock	7,922	2,086	5,836	1,896	190	418	-	-	5,418				
V Electric-Mechanical Eq.	13,840	10,080	3,760	8,980	900	1,980	990	200	790				
VI Telecommunication Eq.	730	590	140	465	45	97	24	80	19				

Table-15.35 Annual Construction Cost

El Siete No. 1 Power Station

Item	Description	Measure	Cost (10 ³ US\$)			1988						1989						1990		
			Total	F.C.	L.C.	1 - 6			7 - 12			1 - 6			7 - 12					
						Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.			
I.	Preparation Works, Land and Compensation		6,165	123	6,042	554	0	554	3,769	123	3,646	1,842	0	1,842						
II.			32,300	13,171	19,129							2,190	977	1,213	4,736	2,444	2,292	7,206	2,881	4,325
II-1	No.1 Dam Care of River		2,680	1,053	1,627							988	395	593	1,586	615	971			
II-2	No.1 Dam		23,360	9,665	13,695							881	515	366	2,725	1,575	1,150	5,795	2,355	3,440
II-3	No.1 Auxiliary Intake Dam and Intake		6,260	2,453	3,807							321	67	254	425	254	171	1,411	526	885
III.			32,500	12,817	19,683	185	100	85	369	200	169	723	388	335	2,512	1,208	1,304	7,178	2,776	4,402
III-1	No.1 Intake		1,650	507	1,143													105	32	73
III-2	No.1 Auxiliary Sedimentation Basin		4,640	1,507	3,133							78	45	33	471	273	198	1,286	396	890
III-3	No.1 Auxiliary Connection Tunnel		2,510	941	1,569															
III-4	No.1 Headrace Tunnel		10,160	3,943	6,217										170	68	102	1,183	448	735
III-5	No.1 Surge Tank		1,490	556	934										58	32	26	661	240	421
III-6	No.1 Penstock Line		3,000	1,113	1,887							48	30	18	681	318	363	291	181	110
III-7	No.1 Power Station		7,480	3,563	3,917	185	100	85	369	200	169	597	313	284	1,132	517	615	3,422	1,366	2,056
III-8	No.1 Tailrace Tunnel		690	258	432													120	45	75
III-9	No.1 Sub-station		880	429	451													110	68	42
	Sub-total	(I-III)	70,965	26,111	44,854	739	100	639	4,138	323	3,815	4,755	1,365	3,390	7,248	3,552	3,596	14,384	5,657	8,727
IV.	Hydraulic Equipment		16,112	7,533	8,579													1,165	471	694
V.	Electric - Mechanical Equipment		21,000	15,300	5,700							2,100	1,530	570				7,650	6,375	1,275
VI.	Telecommunication Equipment		740	590	150							74	59	15						
	Sub-total	(I-VI)	108,817	49,534	59,283	739	100	639	4,138	323	3,815	6,929	2,954	3,975	7,248	3,652	3,596	23,199	12,503	10,696
VII.	Contingency		14,431	6,260	8,171	111	15	96	621	49	572	930	364	566	1,087	548	539	3,040	1,534	1,506
VII-1	Civil Works		10,645	3,917	6,728	111	15	96	621	49	572	713	205	508	1,087	548	539	2,158	849	1,309
VII-2	Hydraulic & Electrical Equipment		3,712	2,284	1,428							210	153	57				882	685	197
VII-3	Telecommunication Equipment		74	59	15							7	6	1						
	Sub-total	(I-VII)	123,248	55,794	67,454	850	115	735	4,759	372	4,387	7,859	3,318	4,541	8,335	4,200	4,135	26,239	14,037	12,202
VIII.	Engineering and Administration		11,492	5,064	6,428	85	12	73	476	37	439	738	297	441	834	420	414	2,430	1,253	1,177
VIII-1	Civil Works		8,161	3,003	5,158	85	12	73	476	37	439	547	157	390	834	420	414	1,654	650	1,004
VIII-2	Hydraulic & Electrical Equipment		3,331	2,061	1,270							191	140	51				776	603	173
	Sub-total	(I-VIII)	134,740	60,858	73,882	935	127	808	5,235	409	4,826	8,597	3,615	4,982	9,169	4,620	4,549	28,669	15,290	13,379
IX.	Transmission Line		16,862	9,723	7,139													1,686	972	714
IX-1	CIF + Transp + Install		14,194	8,185	6,009													1,419	818	601
IX-2	Contingency		1,419	818	601													142	82	60
IX-3	Engineering and Administration		1,249	720	529													125	72	53
	Grand-total		151,602	70,581	81,021	935	127	808	5,235	409	4,826	8,597	3,615	4,982	9,169	4,620	4,549	30,355	16,262	14,093

(Unit: Thousand US\$)

			1989						1990						1991						1992					
7 - 12			1 - 6			7 - 12			1 - 6			7 - 12			1 - 6			7 - 12			1 - 6			7 - 12		
F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	
123	3,646	1,842	0	1,842																						
		2,190	977	1,213	4,736	2,444	2,292	7,206	2,881	4,325	7,097	2,605	4,492	7,558	2,791	4,767	2,567	1,064	1,503	946	409	537				
		988	395	593	1,586	615	971									93	37	56	13	6	7					
		881	515	366	2,725	1,575	1,150	5,795	2,355	3,440	6,479	2,354	4,125	6,479	2,354	4,125	866	448	418	135	64	71				
		321	67	254	425	254	171	1,411	526	885	618	251	367	1,079	437	642	1,608	579	1,029	798	339	459				
200	169	723	388	335	2,512	1,208	1,304	7,178	2,776	4,402	5,759	2,270	3,489	6,941	2,579	4,362	7,006	2,556	4,450	1,827	740	1,087				
					105	32	73				45	21	24	1,458	433	1,025	42	21	21							
		78	45	33	471	273	198	1,286	396	890	1,291	364	927	860	241	619	654	188	466							
					170	68	102	1,183	448	735	1,547	597	950	1,511	582	929	4,265	1,619	2,646	258	88	170				
					58	32	26	661	240	421	583	210	373	188	74	114										
		48	30	18	681	318	363	291	181	110	504	147	357	888	267	621	503	147	356	85	23	62				
200	169	597	313	284	1,132	517	615	3,422	1,366	2,056	890	535	355	885	532	353										
					120	45	75	205	77	128	365	136	229													
					110	68	42	295	169	126	118	67	51	357	125	232										
323	3,815	4,755	1,365	3,390	7,248	3,652	3,596	14,384	5,657	8,727	12,856	4,875	7,981	14,499	5,370	9,129	9,573	3,620	5,953	2,773	1,149	1,624				
								1,165	471	694	910	282	628	7,562	4,964	2,598	4,599	1,439	3,160	1,876	377	1,499				
		2,100	1,530	570				7,650	6,375	1,275	8,306	6,441	1,865	874	87	787	801	80	721	1,269	787	482				
		74	59	15							575	467	108	54	34	20	37	30	7							
323	3,815	6,929	2,954	3,975	7,248	3,652	3,596	23,199	12,503	10,696	22,072	11,598	10,474	23,510	10,888	12,622	15,027	5,173	9,854	5,955	2,343	3,612				
49	572	930	364	566	1,087	548	539	3,040	1,534	1,506	2,849	1,403	1,446	3,077	1,358	1,719	1,981	698	1,283	735	291	444				
49	572	713	205	508	1,087	548	539	2,158	849	1,309	1,928	731	1,197	2,175	806	1,369	1,436	543	893	416	171	245				
		210	153	57				882	685	197	921	672	249	844	505	399	540	152	388	315	117	198				
		7	6	1							58	47	11	5	3	2	4	3	1							
372	4,387	7,859	3,318	4,541	8,335	4,200	4,135	26,239	14,037	12,202	24,921	13,001	11,920	26,587	12,246	14,341	17,008	5,871	11,137	6,690	2,634	4,056				
37	439	738	297	441	834	420	414	2,430	1,253	1,177	2,289	1,152	1,137	2,460	1,103	1,357	1,581	553	1,028	599	237	362				
37	439	547	157	390	834	420	414	1,654	650	1,004	1,478	560	918	1,667	617	1,050	1,101	416	685	319	134	185				
		191	140	51				776	603	173	811	592	219	793	486	307	480	137	343	280	103	177				
409	4,826	8,597	3,615	4,982	9,169	4,620	4,549	28,669	15,290	13,379	27,210	14,153	13,057	29,047	13,349	15,698	18,589	6,424	12,165	7,289	2,871	4,418				
								1,686	972	714	11,329	8,265	3,064	1,804	-	1,804	2,043	486	1,557							
								1,419	818	601	9,537	6,958	2,579	1,518	-	1,518	1,720	409	1,311							
								142	82	60	953	695	258	152	-	152	172	41	131							
								125	72	53	839	612	227	134	-	134	151	36	115							
409	4,826	8,597	3,615	4,982	9,169	4,620	4,549	30,355	16,262	14,093	38,539	22,418	16,121	30,851	13,349	17,502	20,632	6,910	13,722	7,289	2,871	4,418	-	-		

Table-15.36 Annual Construction Cost

El Siete No. 2 Power Station

Item	Description	Measure	Cost (10 ³ US\$)			1988						1989								
			Total	F.C.	L.C.	1 - 6			7 - 12			1 - 6			7 - 12					
						Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.			
I.	Preparation Works, Land and Compensation		5,620	123	5,497	330	-	330	2,011	123	1,888	2,394	-	2,394	885	-	885			
II.			10,150	4,143	6,007							311	64	247	1,234	699	535	2,541	1,003	1,538
II-1	No.2 Intake Dam & Intake		10,150	4,143	6,007							311	64	247	1,234	699	535	2,541	1,003	1,538
III.			49,750	18,569	31,181							867	340	527	2,945	1,211	1,734	6,421	2,300	4,121
III-1	No.2 Sedimentation Basin		1,360	471	889													94	30	64
III-2	No.2 Headrace Tunnel		38,240	13,815	24,425							362	130	232	2,281	829	1,452	4,362	1,519	2,843
III-3	No.2 Surge Tank		1,810	667	1,143										14	8	6	422	146	276
III-4	No.2 Penstock Line		2,210	807	1,403										77	47	30	227	142	85
III-5	No.2 Power Station		4,940	2,297	2,643							386	137	249	333	185	148	1,295	452	843
III-6	No.2 Sub-station		1,190	512	678							119	73	46	240	142	98	21	11	10
	Sub-total	(I-III)	65,520	22,835	42,685	330	-	330	2,011	123	1,888	3,572	404	3,168	5,064	1,910	3,154	8,962	3,303	5,659
IV.	Hydraulic Equipment		12,271	4,872	7,399													792	208	584
V.	Electric - Mechanical Equipment		13,840	10,080	3,760							1,384	1,008	376						
VI.	Telecommunication Equipment		730	590	140							73	59	14						
	Sub-total	(I-VI)	92,361	38,377	53,984	330	-	330	2,011	123	1,888	5,029	1,471	3,558	5,064	1,910	3,154	9,754	3,511	6,243
VII.	Contingency		12,513	4,980	7,533	50	-	50	302	19	283	681	168	513	760	287	473	1,423	516	907
VII-1	Civil Works		9,828	3,425	6,403	50	-	50	302	19	283	536	61	475	760	287	473	1,344	495	849
VII-2	Hydraulic & Electrical Equipment		2,612	1,496	1,116							138	101	37				79	21	58
VII-3	Telecommunication Equipment		73	59	14							7	6	1						
VIII.	Engineering and Administration		9,897	3,994	5,903	38	-	38	231	14	217	539	141	398	582	220	362	1,101	398	703
VIII-1	Civil Works		7,535	2,626	4,909	38	-	38	231	14	217	411	47	364	582	220	362	1,031	380	651
VIII-2	Hydraulic & Electrical Equipment		2,362	1,368	994							128	94	34				70	18	52
	Sub-total	(I-VIII)	114,771	47,351	67,420	418	-	418	2,544	156	2,388	6,249	1,780	4,469	6,406	2,417	3,989	12,278	4,425	7,853
IX.	Transmission Line		1,350	779	571													136	79	57
IX-1	ClF + Transp + Install		1,136	655	481													114	66	48
IX-2	Contingency		114	66	48													12	7	5
IX-3	Engineering and Administration		100	58	42													10	6	4
	Grand-total		116,121	48,130	67,991	418	-	418	2,544	156	2,388	6,249	1,780	4,469	6,406	2,417	3,989	12,414	4,504	7,910

(Unit: Thousand US\$)

		1989						1990						1991						1992					
7 - 12		1 - 6		7 - 12		1 - 6		7 - 12		1 - 6		7 - 12		1 - 6		7 - 12		1 - 6		7 - 12		1 - 6		7 - 12	
F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.
123	1,888	2,394	-	2,394	885	-	885																		
		311	64	247	1,234	699	535	2,541	1,003	1,538	1,236	494	742	1,980	766	1,214	2,399	884	1,515	449	233	216			
		311	64	247	1,234	699	535	2,541	1,003	1,538	1,236	494	742	1,980	766	1,214	2,399	884	1,515	449	233	216			
		867	340	527	2,945	1,211	1,734	6,421	2,300	4,121	6,745	2,504	4,241	6,472	2,492	3,980	9,847	3,601	6,246	14,402	5,275	9,127	2,051	846	1,205
					94		30	64		64	233	89	144	420	160	260	453	148	305	160	44	116			
		362	130	232	2,281	829	1,452	4,362	1,519	2,843	4,362	1,519	2,843	4,362	1,519	2,843	7,615	2,702	4,913	12,921	4,786	8,135	1,975	811	1,164
					14	8	6	422	146	276	322	123	199	297	114	183	340	120	220	339	121	218	76	35	41
					77	47	30	227	142	85	476	198	278	448	130	318	608	181	427	374	109	265			
		386	137	249	333	185	148	1,295	452	843	1,352	575	777	945	569	376	629	379	250						
		119	73	46	240	142	98	21	11	10						202	71	131	608	215	393				
123	1,888	3,572	404	3,168	5,064	1,910	3,154	8,962	3,303	5,659	7,981	2,998	4,983	8,452	3,258	5,194	12,246	4,485	7,761	14,851	5,508	9,343	2,051	846	1,205
					792		208	584		435	279	156		3,152	1,774	1,378	3,591	1,657	1,934	3,109	710	2,399	1,192	244	948
		1,384	1,008	376				5,183		4,212	971			5,523	4,249	1,274	577	58	519	779	296	483	394	257	137
		73	59	14										568	467	101	52	34	18	37	30	7			
123	1,888	5,029	1,471	3,558	5,064	1,910	3,154	9,754	3,511	6,243	13,599	7,489	6,110	17,695	9,748	7,947	16,466	6,234	10,232	18,776	6,544	12,232	3,637	1,347	2,290
19	283	681	168	513	760	287	473	1,423	516	907	1,759	899	860	2,193	1,139	1,054	2,259	848	1,411	2,621	930	1,691	465	174	291
19	283	536	61	475	760	287	473	1,344	495	849	1,197	450	747	1,268	489	779	1,837	673	1,164	2,228	826	1,402	306	125	181
		138	101	37				79	21	58	562	449	113	868	603	265	417	172	245	389	101	288	159	49	110
		7	6	1										57	47	10	5	3	2	4	3	1			
14	217	539	141	398	582	220	362	1,101	398	703	1,412	740	672	1,785	946	839	1,779	670	1,109	2,053	724	1,329	377	141	236
14	217	411	47	364	582	220	362	1,031	380	651	918	345	573	972	375	597	1,408	516	892	1,708	633	1,075	236	96	140
		128	94	34				70	18	52	494	395	99	813	571	242	371	154	217	345	91	254	141	45	96
156	2,388	6,249	1,780	4,469	6,406	2,417	3,989	12,278	4,425	7,853	16,770	9,128	7,642	21,673	11,833	9,840	20,504	7,752	12,752	23,450	8,198	15,252	4,479	1,662	2,817
					136		79	906		57	906	661	245	144	-	144	164	39	125						
					114		66	763		48	763	556	207	121	-	121	138	33	105						
					12		7	76		5	76	56	20	12	-	12	14	3	11						
					10		6	67		4	67	49	18	11	-	11	12	3	9						
156	2,388	6,249	1,780	4,469	6,406	2,417	3,989	12,414	4,504	7,910	17,676	9,789	7,887	21,817	11,833	9,984	20,668	7,791	12,877	23,450	8,198	15,252	4,479	1,662	2,817

CHAPTER 16: FINANCIAL AND ECONOMIC ANALYSES

CHAPTER 16 FINANCIAL AND ECONOMIC ANALYSES

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CHAPTER 16. FINANCIAL AND ECONOMIC ANALYSES

According to the present construction schedule, the Atrato Hydroelectric Power Project (160 MW) will be completed and the power stations connected to the national interconnected power system of Colombia in 1993 (the power system having the maximum demand of 8,072 MW by that time).

It cannot be proven that the Atrato Project is that providing the lowest present worth price, in terms of the total power generation cost of the interconnected grid, among all the conceivable alternative power supply sources. However, this project does have the lowest average generation cost among other hydroelectric development proposals, and it can be regarded that the following method can be applied in evaluation this project's financial and economic values.

The Atrato Project is composed of two power stations, El Siete No.1 (75.0 MW) and El Siete No.2 (85.0 MW).

This project's rational water system design makes it quite uneconomical to construct each power station separately. The dam at the uppermost stream in this project functions for both El Siete No.1 Power Station and El Siete No.2 Power Station, and only not for El Siete No.1. Nor is it rational, due to the nature of the water way structures, to construct El Siete No.2 Power Station only.

The balance of supply and demand in the national power system of Colombia in 1993 also dictates that both El Siete No.1 and El Siete No.2 Power Stations are completed at the same time in this year.

Thus, in view of the project's water system, and the status of power supply and demand in the power system, it is not appropriate to evaluate the two power stations separately, and they have to be assessed as the one hydroelectric power development plan.

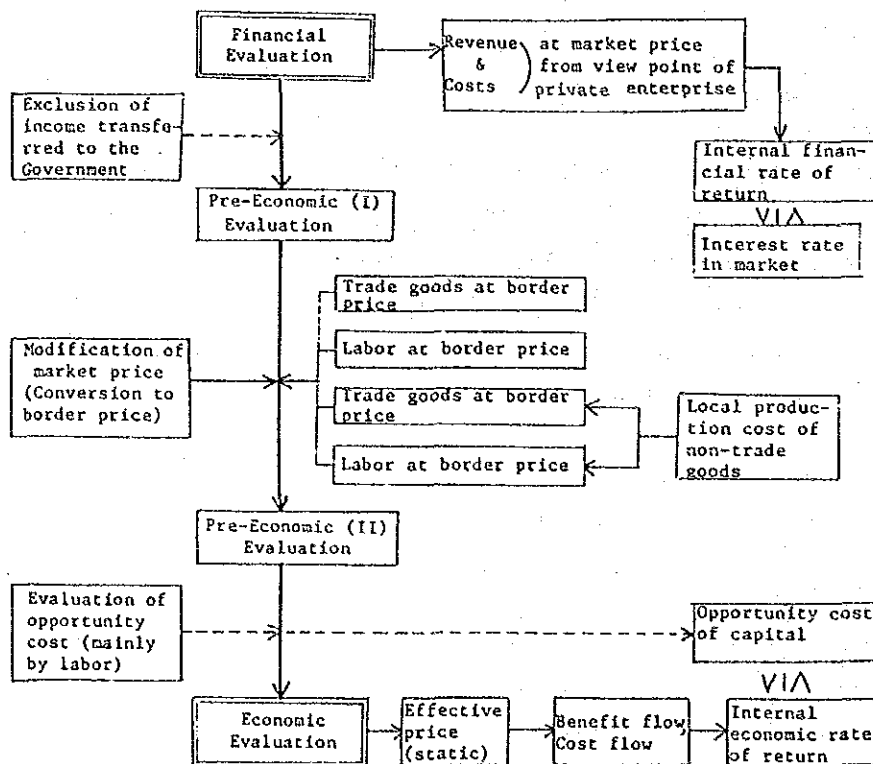
16.1 Evaluation Flow

The impact of a hydroelectric power development is not limited to the local area in which it is located, but it affects a nation's entire society and economy. In general, the construction expenses paid by Colombian pesos

create demand for materials and equipment, leading to increased income and employment opportunities in the local society. As hydroelectric power generating cost is little affected by inflation, once completed, it can stabilize electricity rates for a long period and reduces the consumption of fossil fuels such as oil and coal. There are also secondary effects, such as the development of roads in the project area.

To measure these impacts, the Feasibility Study Mission performed financial and economic analysis along the evaluation flow as illustrated in the figure below, which is designed to be as similar as possible to the project evaluation methods recommended by the international financing institutions, including the World Bank.

[Flow Chart of Economic Evaluation of Project]



16.2 Financial Analysis

Electric power projects are often treated as public goods, and the electric rate of such a project is determined at a low level by the administered pricing system in the national energy supply policy. Colombia's electric rates are relatively low in comparison to the prices of other goods, and the international financing institutions suggest that Colombia adjust this low electric rate.

The Study Mission, being aware of this situation, decided to adopt an evaluation method in which the materials, equipment and services procured inside Colombia are evaluated at the competitive market price, and the wholesale rate of electricity, the output of this project, is evaluated by the rate unilaterally determined by ISA for all utilities at the time of the site survey, on February, 1985.

For products such as turbine generators, outdoor switching equipment, steel towers, transmission line insulators and conductors and such structures as water gates and penstocks, we assumed internationally competitive prices. It was also assumed that 20% custom duty is levied on these goods by CIF prices.

The market prices used to calculate the project's construction costs (or the investment amount), are based on international market prices and market prices in Colombia as of the end of 1984.

The construction costs used for the financial evaluation of this project are presented in Table-16.1 below.

Table-16.1 Construction Cost of the Project

	Foreign Currency (10 ³ U.S.\$)	Local Currency (10 ³ U.S.\$)	Total (10 ³ U.S.\$)
1) Civil Works	77,063	129,312	206,375
2) Electrical & Mechanical Equipment	29,847	11,672	41,519
3) Communication Equipment	1,299	318	1,617
4) Transmission Lines	10,502	7,710	18,212
Total	118,711	149,012	267,723

16.2.1 Basis for Financial Evaluation

As described, competitive market prices were used to perform the financial analysis.

The financial soundness evaluation was conducted in two ways. First, the internal rate of return on the total investment capital. Second, the internal rate of return on the project equity.

In evaluating the internal rate of return on the project equity, it was assumed that the foreign currency was borrowed from foreign nations, and the local currency was funded by the national government, as the project is public investment.

16.2.2 Financial Analysis Calculation Conditions

(1) Funding

- 1) All the local currency required is funded by the Government of Colombia.
- 2) The foreign currency is borrowed at a 7% interest rate, reimbursement is deferred for the period of construction, and the principal and capital returned in 10 years.

(2) Project Cost

The records of other hydroelectric projects in Colombia were studied, and the market prices used for the imported goods, domestically procured goods, and service costs such as labor.

It was assumed that 20% custom duties are levied on the CIF prices of imported goods, and these paid by the local currency.

(3) Investment Cash Flow in Each Fiscal Year

Based on the construction finance (investment) in each fiscal year, determined in Chapter 15, the fund and interest were calculated.

(4) Operation and Maintenance Expenses after Completion of Project

Operation and maintenance expenses were calculated by taking into account the project's particular siting conditions and plant operating conditions, to obtain the following coefficients.

	Coefficient to Construction Cost
1) Civil Structures (including gates and penstocks)	0.010
2) Electrical & Mechanical Equipment	0.025
3) Communication Equipment	0.020
4) Transmission Lines	0.015

The above coefficients are the ratio to the construction cost (investment) of each facility item.

In reference to the operation and maintenance expenses in common hydroelectric power plants, the figures seem appropriate.

(5) Financial Benefit

The following items were taken into account in calculating the benefit cash flow, which is to be compared to the cost cash flow.

1) The wholesale rate of electricity supplied by ISA to the utilities joining the national interconnection system is presented below, as of February 1985.

a) kWh rate: 14.7 U.S. dollars/MWh

(1,675 Colombia pesos/MWh)

b) Demand rate: 3,961.3 U.S. dollars/MW/month

(451,360 Colombia pesos/MW/month)

Since these electric rates are determined unilaterally for all utilities, this should be applied to the electric power of this project when the power stations under this project are connected to the 230 kV bus in Ancon Sur Substation, which is the receiving terminal for the generated power.

2) Rate on Secondary Electricity of This Project

As this project has power stations with daily regulation ponds, the electricity generated over that corresponding to the firm flow of the river is regarded as secondary electricity.

This portion of the power does not suit the demand curve of the power system, and it is not appropriate to apply the electric rates described in paragraph 1) above. However, since this secondary electricity can reduce the fuel costs of thermal power plants in the national grid, it was assumed that the secondary electricity can be sold at a price below, which corresponds to the fuel cost of a new coal fired thermal power plant.

a) Secondary electricity rate:

US\$22.3/MWh (2,541.0 Colombia pesos/MWh)

This value should be applied at the receiving terminal in Ancon Sur Substation.

16.3 Economic Analysis

Project economy analysis is undertaken to determine whether or not the project should be implemented from the point of view of the national economy. For this purpose, the analysis method differs from the financial analysis, and the project cost is calculated based on the actual price of all goods and services required for it, by converting the all the prices to the border price.

To convert the prices of materials, labor costs, etc. inside Colombia to the border prices, the Study Mission relied on the conversion factors in the "Estimating Shadow Prices for Colombia in an Input-output Table Framework", published by the World Bank September, 1979. This document was produced by the staff working group of the World Bank, and the World Bank recommends the effective use of the data in formulating project economic evaluations in Colombia.

Although 20% custom duties are levied on imported goods, this is not included in the project cost, as custom duty is a transfer of income to the Government of Colombia.

16.3.1 Conversion Factors for Goods and Services Procured inside Colombia

Of the project's total construction cost (investment) of US\$267,723 thousand, US\$149,012 thousand are financed by the local currency. This amount includes the custom duties on imported goods, and US\$139,451 thousand, excluding the custom duties, is the total of the real prices of goods and services procured inside Colombia, on which conversion factors are to be applied.

(1) Conversion Factors

The conversion factors for the economic cost calculation are as listed below.

	Social Price
a. Standard Conversion Factor;	1.00
b. Shadow Wage Rate Ratio (for high subsidy on oil)	
- Urban unskilled labor;	0.61
- Rural unskilled labor;	0.46
- Assistant or skilled worker;	0.81
- Engineer and manager;	0.94
c. Goods Conversion Factors to Boarder Prices	
(for high subsidy on oil)	
c-1. Trade goods	
- Metal products;	0.89
- Cement and other manufactures;	0.83
- Refined petroleum;	3.00
c-2. Non-trade goods	
- Construction works;	0.87
- Transportation;	1.09
- Non-metal product;	0.94

(2) Classification for Application of Conversion Factors

1) Standard Conversion Factor

The standard conversion factor shall be applied to those goods and services procured inside Colombia, and the overhead expense and management cost incurred by ICEL.

This conversion factor was also used to convert the local currency to the foreign currency, which is a border price.

2) Contents of Civil Construction Works

This project's civil work content is as listed below.

	Percentage
Labor costs	12.7
Material (cement, steel bar, etc.)	41.9
Construction machines	13.9
Fuel cost	1.5
Management costs and profit *	30.0
Total	100.0

* Note: Those of the contractor.

3) Calculation of Shadow Wage Rate

In calculating the shadow wage rate, the required amount of labor in each of the 4 construction work items (civil construction, electrical and mechanical equipment, communication equipment, and transmission line) was calculated, and the weighted average standard conversion factor applied.

The calculation results are presented in the Appendix-V.

16.3.2 Long Term Marginal Cost of Colombia's Power System

The long term marginal cost of the Colombia's Power system was used to determine the value of electricity which is this project's output, because the measurement of the benefit based on the present rate structure or the willingness to pay, was difficult.

ISA had reviewed the power development programs and formulated the Power Development Plan covering the period to the Year 2000.

The long term marginal cost calculated in the formulation of this plan was US\$40.0/MWh. This marginal cost includes, in addition to the marginal costs of power generation, those for the transmission lines and substations to be constructed by ISA.

The study mission relied on this marginal cost in calculating the economic benefit of this project. However, in evaluating the secondary electricity, the benefit was based on the fuel cost of a new thermal power plant, or US\$22.3/MWh, as in the case of the financial evaluation.

16.4 Conclusion

To clearly indicate the relations h.p between the financial analysis and the economic analysis, the financial and economic cost items, and the financial and economic benefits, were listed correspondingly in generating the lists.

The financial costs and economic costs are listed in Table-16.2 for each item. The outline of these results is as below.

(in 10³ U.S. dollars)

	Foreign Currency	Local Currency	Total
A. Project Financial Cost (Investment)	118,711	149,012	267,723
B. Project Economic Cost (Investment)	118,711	124,751	243,462
Difference (A-B)	0	24,261	24,261

16.4.1 Financial Rate of Return

As described, the financial rate of return was evaluated in two ways, return on the total investment capital, and on project equity.

(1) Evaluation of Project in Terms of Investment Capital

Loan condition such as the interest rate, reimbursement, and the deferment period, are not considered, the financial rate of return is 7.3%. (See Table-16.5.)

This rate of return is considerably lower than the interest rates of 26 to 28% at which Colombian banks provide loans to good business corporations. However, considering that Colombian utilities are financed by foreign loans and government funding, it has little meaning to compare this rate of return to the interest rate in Colombia's money market.

Generally, the 7.3% financial rate of return is relatively low, but this is due to the low wholesale price of electricity adopted by ISA.

(2) Evaluation of Project in Terms of Project Equity

In this case, the foreign currency is borrowed from abroad. The conditions of the loan was assumed as below:

- Interest rate; 7%.
- Principal and interest uniformly reimbursed in 10 years, after 5 years deferment.

It was also assumed that the local currency is funded by the Government of Colombia.

The calculation results based on the above conditions are presented in Table-16.5.

The rate of return is approximately the same as that on the investment capital, being 7.3%. This is because the fund is reimbursed in a relatively short period after completion of the project.

In conclusion, we can state that the financial internal rate of return (FIRR) of this project is 7.3%.

16.4.2 Rate of Return of This Project on the National Economy

In this calculation, the goods and services procured inside Colombia are converted to the border prices. In evaluating this project's output, or the value of electricity, the long term marginal cost recommended by the international financial institutions such as the World Bank, is used.

The calculation results are presented in Table-16.6. The economic internal rate of return (EIRR) is 11.1%.

This value is to be compared to the opportunity cost. As the capital opportunity cost of international financing institutions is generally regarded to be around 10%, we can conclude that this project is feasible from the point of view of the national economy.

16.4.3 Sensitivity Analysis

A sensitivity analysis was performed on this project plan by changing the project cost by plus and minus 10% the total project cost.

The result of the sensitivity analysis is outlined below (See Fig. 16-1).

Financial Cost (in 10^3 U.S. \$)	FIRR (1) (%)	FIRR (2) (%)	FIRR (%)
240,915 (90%)	8.8	8.2	12.2
267,723 (100%)	7.3	7.3	11.1
294,495 (110%)	6.0	6.5	10.1

Note: FIRR (1) : return on project equity.
FIRR (2) : return on investment capital.

Fig. 16-1 Sensitivity Analysis

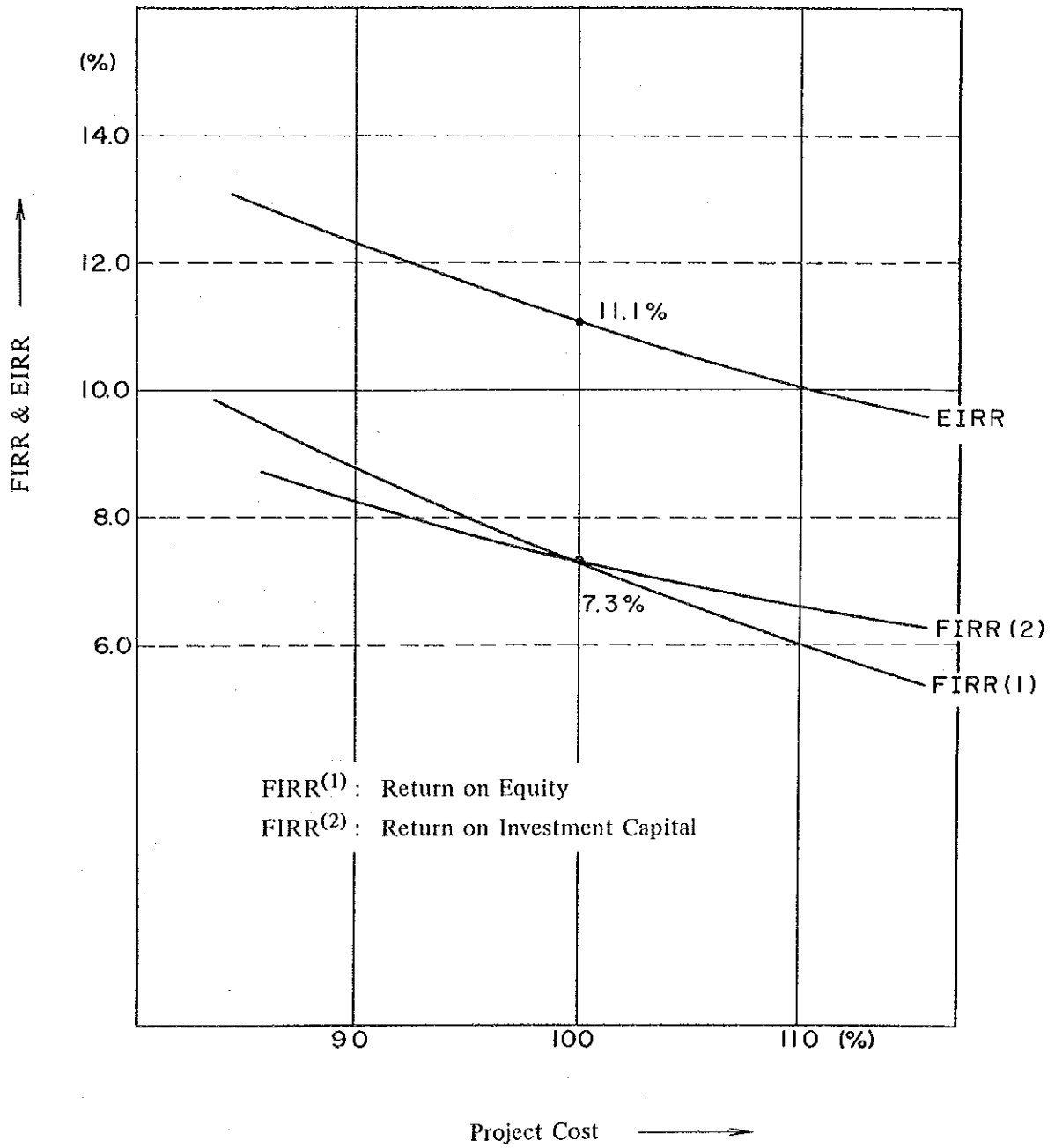


Table-16.2 Financial & Economic Costs Comparison

Unit: Thousand US\$

	El Siete No.1 P.S.				El Siete No.2 P.S.				Total			Remarks
	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.			
	<p>A. Financial Cost</p> <p>1) Civil Works</p> <p>Civil Structure : 0.010 Hydraulic Equip. : 0.025 Telecom. Equip.: 0.020 Trans. Line : 0.015</p> <p>O&M Cost Factor: Civil Works : 0.010 SM Equip. : 0.025 Telecom. Equip.: 0.020 Trans. Line : 0.015</p> <p>Unit: 10³US\$</p>											
89,771	33,031	56,740	82,883	28,886	53,997	172,654	61,917	110,737				
19,223	9,213	10,010	14,498	5,933	8,565	33,721	15,146	18,575				
24,932	17,965	6,967	16,587	11,882	4,705	41,519	29,847	11,672				
814	649	165	803	650	153	1,617	1,299	318				
16,862	9,723	7,139	1,350	779	571	18,212	10,302	7,710				
151,602	70,581	81,021	116,121	48,130	67,991	267,723	118,711	149,012				
<p>B. Economic Cost</p> <p>1) Civil Works</p> <p>Civil Works : 2,064 SM Equip. : 1,038 Telecom. Equip.: 32 Trans. Line : 273 Total : 3,407</p>												
83,481	33,031	50,450	76,898	28,886	48,012	160,379	61,917	98,462				
17,184	9,213	7,971	12,753	5,933	6,820	29,937	15,146	14,791				
21,871	17,965	3,906	14,519	11,882	2,637	36,390	29,847	6,543				
691	649	42	689	650	39	1,380	1,299	81				
14,236	9,723	4,513	1,140	779	361	15,376	10,502	4,874				
137,463	70,581	66,882	105,999	48,130	57,869	243,462	118,711	124,751				
1,294	531	763	1,903	499	1,404	3,197	1,030	2,167				
<p>F.C. L.C. Total</p> <p>1,030 2,377 3,407</p> <p>Refer to Appendix V.</p>												

Table-16.3 Financial & Economic Benefits Comparison

Order	Year	Generating End			Receiving End			Financial Benefit			Economic Benefit			Remarks	
		Power (MW)	P. Energy (GWh)	S. Energy (GWh)	Power (MW)	P. Energy (10 ³ USS)	S. Energy (10 ³ USS)	Total (10 ³ USS)	P. Energy (10 ³ USS)	S. Energy (10 ³ USS)	Total (10 ³ USS)				
-4	1988													Financial Benefit: US\$14.7/MWh (Col\$1.675/MWh) US\$1.963.1/MWh/Month (Col\$451,360/MWh/Month) Economic Benefit: Primary Energy (L.T.M. Cost) US\$40.0/MWh Secondary Energy: US\$22.3/MWh	
-3	1989														
-2	1990														
-1	1991														
0	1992														
1	1993	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586		35,346
2	1994	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586		35,346
3	1995	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586		35,346
4	1996	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586		35,346
5	1997	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586		35,346
6	1998	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586	35,346	
7	1999	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586	35,346	
8	2000	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586	35,346	
9	2001	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586	35,346	
10	2002	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586	35,346	
46	2038	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586	35,346	
47	2039	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586	35,346	
48	2040	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586	35,346	
49	2041	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586	35,346	
50	2042	160	675	388	158	669	385	7,514	9,834	8,586	25,934	26,760	8,586	35,346	

Table-16.4 Financial and Economic Cost Flow

Unit: Thousand US\$

Order	Year	Financial Cost Flow				Economic Cost Flow				O&M Cost	Total	
		Investment		Interest F.C.	O&M Cost	Investment		O&M Cost				
		Total	L.C.			Total	L.C.					
-4	1988	9,132	8,440	17		9,149	9,132	7,758	692	7,066	7,758	
-3	1989	30,421	17,989	455		30,876	30,421	27,492	12,432	15,060	27,492	
-2	1990	98,984	46,011	2,573		101,557	98,984	91,493	52,973	38,520	91,493	
-1	1991	93,968	54,085	6,206		100,174	93,968	85,162	39,883	45,279	85,162	
0	1992	35,218	22,487	8,029		43,247	35,218	31,557	12,731	18,826	31,557	
1	1993				3,407	3,407	3,407					3,197
2	1994				3,407	3,407	3,407					3,197
3	1995				3,407	3,407	3,407					3,197
4	1996				3,407	3,407	3,407					3,197
5	1997				3,407	3,407	3,407					3,197
6	1998				3,407	3,407	3,407					3,197
7	1999				3,407	3,407	3,407					3,197
8	2000				3,407	3,407	3,407					3,197
9	2001				3,407	3,407	3,407					3,197
10	2002				3,407	3,407	3,407					3,197
					ditto	ditto	ditto					ditto
					3,407	3,407	3,047					3,197
46	2038				3,407	3,407	3,047					3,197
47	2039				3,407	3,407	3,047					3,197
48	2040				3,407	3,407	3,047					3,197
49	2041				3,407	3,407	3,047					3,197
50	2042				3,407	3,407	3,047					3,197
Total		267,723	118,711	17,280	170,350	455,353	438,073	243,462	118,711	124,751	243,462	159,850
												403,312

Table-16.5 Financial Internal Rate of Return (FIRR)

Order	Year	Financial Benefit						Financial Cost									
		Energy Sale (B) (10 ³ US\$)	Borrowings (10 ³ US\$)	Total (A) (10 ³ US\$)	Discount rate i=7.3%	Present value(A) (10 ³ US\$)	Discount rate i=7.3%	Present value(B) (10 ³ US\$)	Interest (A) (10 ³ US\$)	W/	Repayment F.C. (10 ³ US\$)	Total (A') (10 ³ US\$)	Discount rate i=7.3%	Present value(A') (10 ³ US\$)	Interest (B) (10 ³ US\$)	W/O	Discount rate i=7.3%
-4	1988		692	692	1.325	693			9,149		9,149	1.325	12,122	9,132		1.325	12,100
-3	1989		12,432	12,432	1.235	15,353		30,876	30,876		30,876	1.235	38,132	30,421		1.235	37,570
-2	1990		52,973	52,973	1.151	60,972		101,557	101,557		101,557	1.151	116,892	98,984		1.151	113,930
-1	1991		39,883	39,883	1.073	42,794		100,174	100,174		100,174	1.073	107,487	93,968		1.073	100,828
0	1992		12,731	12,731	1.000	12,731		43,247	43,247		43,247	1.000	43,247	35,218		1.000	35,218
1	1993	25,934		25,934			24,145	3,407		16,856	20,263			3,407		0.931	
2	1994	25,934		25,934			22,511	3,407		16,856	20,263			3,407		0.868	
3	1995	25,934		25,934			20,981	3,407		16,856	20,263			3,407		0.809	
4	1996	25,934		25,934			19,554	3,407		16,856	20,263			3,407		0.754	
5	1997	25,934		25,934			18,232	3,407		16,856	20,263			3,407		0.703	
6	1998	25,934		25,934			16,987	3,407		16,856	20,263			3,407		0.655	
7	1999	25,934		25,934			15,820	3,407		16,856	20,263			3,407		0.610	
8	2000	25,934		25,934			14,756	3,407		16,856	20,263			3,407		0.569	
9	2001	25,934		25,934			13,745	3,407		16,856	20,263			3,407		0.530	
10	2002	25,934		25,934			12,811	3,407		16,856	20,263			3,407		0.494	
								ditto			3,407						
				ditto					ditto		3,407						
											3,407						
											3,407						
											3,407						
											3,407						
											3,407						
											3,407						
46	2038	25,934		25,934				990	3,407		3,407			3,407		0.039	
47	2039	25,934		25,934				914	3,407		3,407			3,407		0.036	
48	2040	25,934		25,934				855	3,407		3,407			3,407		0.033	
49	2041	25,934		25,934				804	3,407		3,407			3,407		0.031	
50	2042	25,934		25,934				752	3,407		3,407			3,407		0.029	
			118,711							168,560			479,919				344,939

Table-16.6 Economic Internal Rate of Return (EIRR)

Order	Year	Discount Rate i=11.1%	Economic Benefit		Economic Cost			
			Net Value (10 ³ US\$)	Present Value (10 ³ US\$)	Net Value (10 ³ US\$)	Present Value (10 ³ US\$)		
-4	1988	1.523			7,758	11,815		
-3	1989	1.371			27,492	37,692		
-2	1990	1.234			91,493	112,902		
-1	1991	1.111			85,162	94,615		
0	1992	1.000			31,557	31,557		
1	1993	0.900	35,346	}	3,197	}		
2	1994	0.810	35,346					
3	1995	0.729	35,346					
4	1996		35,346					
5	1997		35,346					
6	1998		35,346					
7	1999		35,346					
8	2000		35,346					
9	2001		35,346					
10	2002		35,346					
⋮	⋮		⋮					
⋮	⋮		ditto		35,346 x 8.962 = 316,771		ditto	3,197 x 8.962 = 28,651
⋮	⋮		⋮					
46	2038		35,346					
47	2039		35,346					
48	2040		35,346					
49	2041		35,346					
50	2042		35,346					
Total				316,771		317,232		

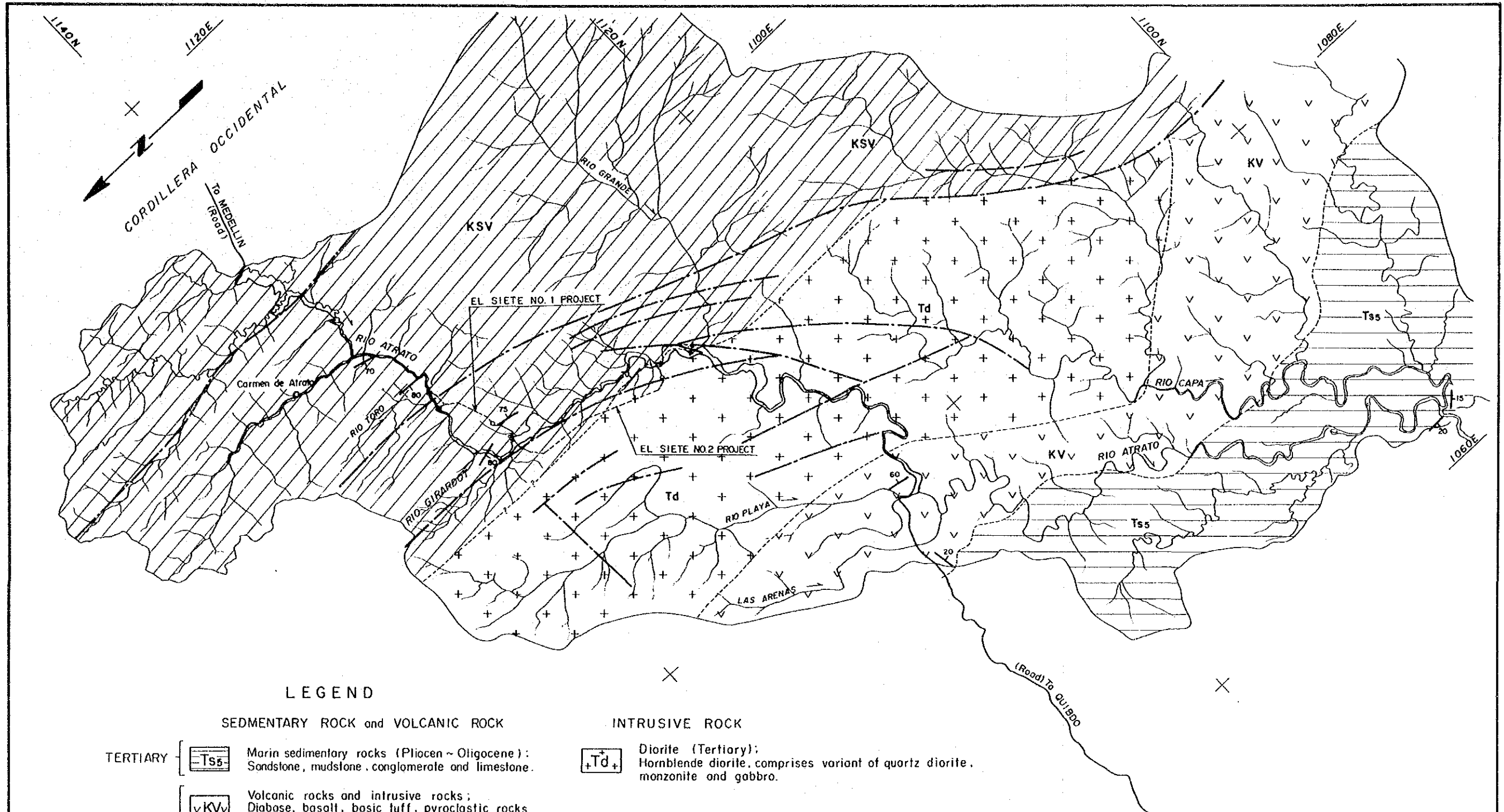
DRAWING

DRAWING LIST

- Dwg. 00 PANORAMA OF PROJECT AREA
- 01 LOCATION KEY MAP
- 02 MAP OF CATCHMENT AREA
- 03 LOCATION AND INTERCONNECTING SYSTEM MAP IN COLUMBIA
- 04 EL SIETE NO.1 AND NO.2 POWER PROJECT, GENERAL PLAN AND PROFILE
- 05 REGIONAL GEOLOGICAL MAP
- 06 GEOLOGICAL PLAN OF PROJECT AREA
- 07 GEOLOGICAL PROFILES OF EL SIETE NO. 1 AND NO. 2 WATERWAY ALIGNMENT
- 08 GEOLOGICAL PLAN OF EL SIETE NO. 1 DAMSITE AND RESERVOIR AREA
- 09 GEOLOGICAL PROFILE OF EL SIETE NO. 1 DAM
- 10 GEOLOGICAL PROFILE OF EL SIETE NO. 1 AUXILIARY DAM AND NO. 2 INTAKE DAM
- 11 GEOLOGICAL PLAN OF EL SIETE NO. 1 SURGE TANK, PENSTOCK AND POWERHOUSE
- 12 GEOLOGICAL PROFILE OF EL SIETE NO. 1 SURGE TANK, PENSTOCK AND POWERHOUSE
- 13 GEOLOGICAL PLAN OF EL SIETE NO. 2 SURGE TANK, PENSTOCK AND POWERHOUSE
- 14 GEOLOGICAL PROFILE OF EL SIETE NO. 2 SURGE TANK, PENSTOCK AND POWERHOUSE
- 15 EL SIETE NO. 1 RESERVOIR GENERAL PLAN
- 16 EL SIETE NO. 1 RESERVOIR STORAGE CAPACITY AND AREA CURVES
- 17 EL SIETE NO. 1 DAM PLAN AND PROFILE
- 18 EL SIETE NO. 1 DAM FRONT VIEW AND PROFILE

- 19 NO. 1 DAM DIVERSION TUNNEL PLAN,
PROFILE AND TYPICAL CROSS SECTION
- 20 EL SIETE NO. 1 AUXILIARY DAM PLAN,
PROFILE AND SECTIONS
- 21 NO. 1 AUXILIARY SEDIMENTATION BASIN
PROFILE AND SECTIONS
- 22 NO. 1 AUXILIARY SEDIMENTATION BASIN
PLAN
- 23 AUXILIARY CONNECTION TUNNEL PLAN,
PROFILE AND SECTION
- 24 EL SIETE NO. 1 INTAKE PLAN, PROFILE
AND SECTION
- 25 EL SIETE NO. 1 HEADRACE TUNNEL PLAN,
PROFILE AND SECTION
- 26 EL SIETE NO. 1 SURGE TANK PLAN,
PROFILE AND SECTION
- 27 EL SIETE NO. 1 PENSTOCK, SURGE TANK,
POWER STATION PLAN
- 28 EL SIETE NO. 1 PENSTOCK LINE PROFILE
AND SECTION
- 29 EL SIETE NO. 1 PENSTOCK PRESSURE CURVE
- 30 EL SIETE NO. 1 POWERHOUSE PLAN AND
SECTION
- 31 EL SIETE NO. 1 POWERHOUSE PLAN AND
SECTIONS
- 32 EL SIETE NO. 1 TAILRACE TUNNEL PLAN,
PROFILE AND SECTIONS
- 33 EL SIETE NO. 1 SWITCHYARD PLAN AND
SECTIONS
- 34 EL SIETE NO. 2 INTAKE DAM PLAN,
PROFILE AND SECTION
- 35 NO. 2 SEDIMENTATION BASIN PLAN,
PROFILE AND SECTIONS
- 36 EL SIETE NO. 2 HEADRACE TUNNEL PLAN,
PROFILE AND SECTION

- 37 EL SIETE NO. 2 SURGE TANK PLAN,
PROFILE AND SECTIONS
- 38 EL SIETE NO. 2 PENSTOCK, SURGE TANK,
POWER STATION PLAN
- 39 EL SIETE NO. 2 PENSTOCK PROFILE AND
SECTIONS
- 40 EL SIETE NO. 2 PENSTOCK PRESSURE CURVE
- 41 EL SIETE NO. 2 POWERHOUSE PLAN
- 42 EL SIETE NO. 2 POWERHOUSE PLAN AND
SECTIONS
- 43 EL SIETE NO. 2 SWITCHYARD PLAN AND
SECTIONS
- 44 CONSTRUCTION PLAN
- 45 EL SIETE NO. 1 POWER STATION
CONSTRUCTION SCHEDULE
- 46 EL SIETE NO. 2 POWER STATION
CONSTRUCTION SCHEDULE
- 47 ALTERNATIVE PLAN
EL SIETE NO. 1 CONCRETE FACING DAM
- 48 ALTERNATIVE PLAN
EL SIETE NO. 1 POWER STATION
IN UNDERGROUND TYPE
- 49 ALTERNATIVE PLAN
EL SIETE NO. 2 POWER STATION
IN UNDERGROUND TYPE



LEGEND

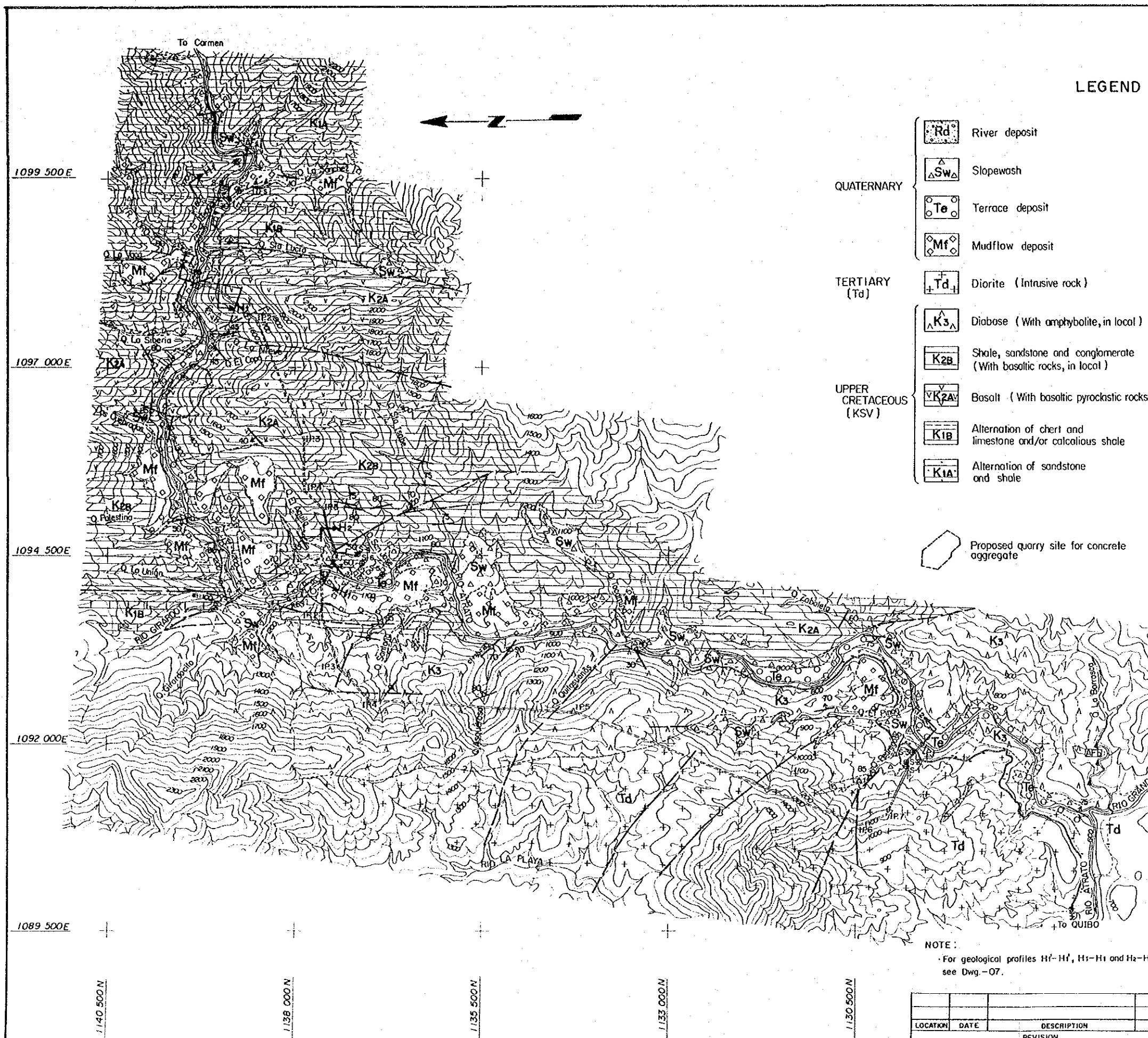
- | | | |
|------------------|---|---|
| | SEDIMENTARY ROCK and VOLCANIC ROCK | INTRUSIVE ROCK |
| TERTIARY | <p>Ts5 Marine sedimentary rocks (Pliocen ~ Oligocene): Sandstone, mudstone, conglomerate and limestone.</p> | <p>Td Diorite (Tertiary); Hornblende diorite, comprises variant of quartz diorite, monzonite and gabbro.</p> |
| UPPER CRETACEOUS | <p>KV Volcanic rocks and intrusive rocks; Diabase, basalt, basic tuff, pyroclastic rocks and intercalations of chert and black shale.</p> | |
| | <p>KSV Sedimentary rocks and volcanic rocks; Black chert, sandstone, shale, limestone and conglomerate, interbedded with diabase and basalt.</p> | |
| | <p>— Geological boundary</p> | |
| | <p>— Fault (Assumed) and/or air photo lineament</p> | |
| | <p>50 Strike and dip of bed</p> | |
| | <p>X Strike and dip of lithologic contact</p> | |

NOTE: This map is compiled from "HIDROELECTRICO DEL RIO ATRATO, GENERAL GEOLOGIA (DNP, 1979)", "MAPA GEOLOGICO DE COLOMBIA (INGIOMINAS, 1976)" and "MAPA GEOLOGICO DEL DEPARTAMENTO DE ANTIOQUIA (INGIOMINAS, 1979)".
The geologic boundary of this map is locally based on the results of JICA Mission's Reconnaissance in 1981 and 1985.



LOCATION	DATE	DESCRIPTION	BY
		REVISION	

JAPAN INTERNATIONAL COOPERATION AGENCY	
INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA	
ATRATO HYDRO-ELECTRIC POWER PROJECT	
REGIONAL GEOLOGICAL MAP	
ELECTRIC POWER DEVELOPMENT Co., LTD TOKYO JAPAN	
Dwg.-05	



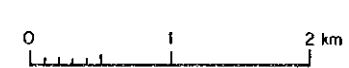
LEGEND

- QUATERNARY**
 - Rd River deposit
 - Sw Slopewash
 - Te Terrace deposit
 - Mf Mudflow deposit
 - TERTIARY (Td)**
 - Td Diorite (Intrusive rock)
 - UPPER CRETACEOUS (KSV)**
 - K3A Diabase (With amphybolite, in local)
 - K2B Shale, sandstone and conglomerate (With basaltic rocks, in local)
 - K2AV Basalt (With basaltic pyroclastic rocks)
 - K1B Alternation of chert and limestone and/or calcaceous shale
 - K1A Alternation of sandstone and shale
- Geological boundary
 - Strike and dip of bed
 - Strike and dip of intrusive contact
 - Fault sh; Width of sheared zone (In cm)
 - Assumed fault and or linear image
 - Strike and dip of fault
 - Strike and dip of joint
 - Slope collapse
 - Sampling spot (Construction material)
 - Vertical electrical sounding

Proposed quarry site for concrete aggregate

References

1. ESTUDIOS E INVESTIGACIONES DE CAMPO PARA LA FACTIBILIDAD TECNICA, APROVECHAMIENTOS HIDROELECTRICOS DEL RIO ATRATO, INFORME FINAL, ESTUDIOS GEOLOGICOS, ICEL, 1985.
2. JICA's reconnaissance in 1984 and 1985.
3. Photogeological interpretation by JICA MISSION in 1985.

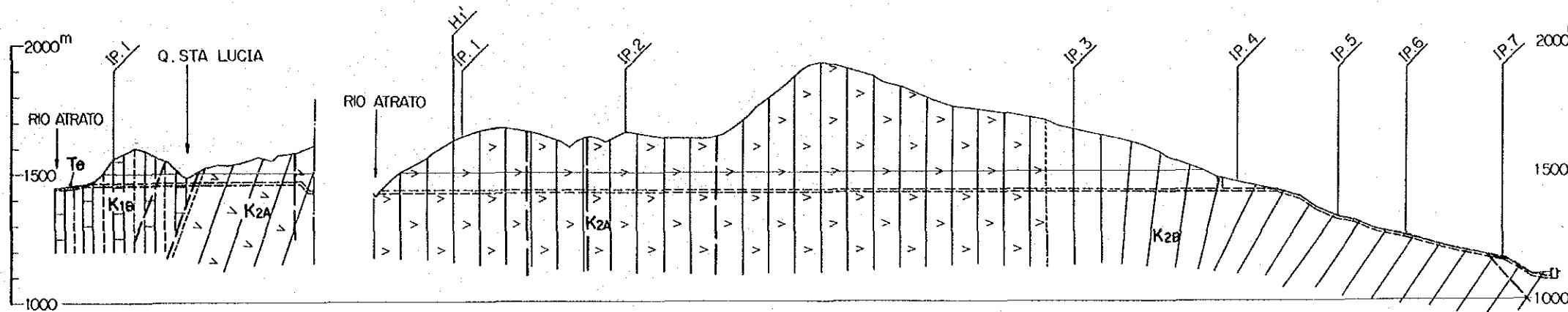


NOTE:
For geological profiles H1'-H1', H1-H1 and H2-H2 see Dwg.-07.

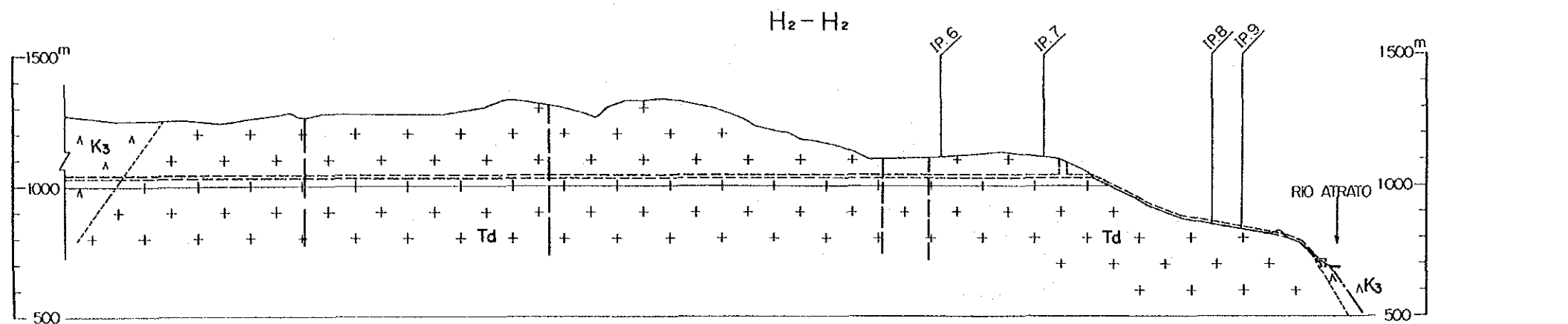
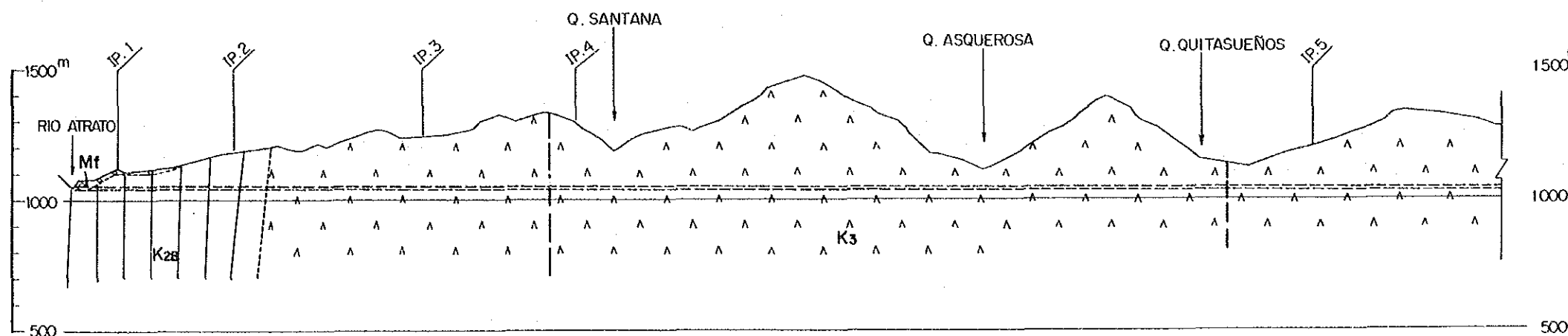
LOCATION	DATE	DESCRIPTION	BY
REVISION			

JAPAN INTERNATIONAL COOPERATION AGENCY	
INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA	
ATRATO HYDRO-ELECTRIC POWER PROJECT	
GEOLOGICAL PLAN OF PROJECT AREA	
ELECTRIC POWER DEVELOPMENT Co., LTD TOKYO JAPAN	
Dwg.-06	

PROFILE OF EL SIETE NO.1 WATERWAY ALIGNMENT
H₁-H₁

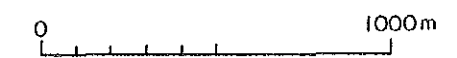


PROFILE OF EL SIETE NO.2 WATERWAY ALIGNMENT
H₂-H₂



LEGEND

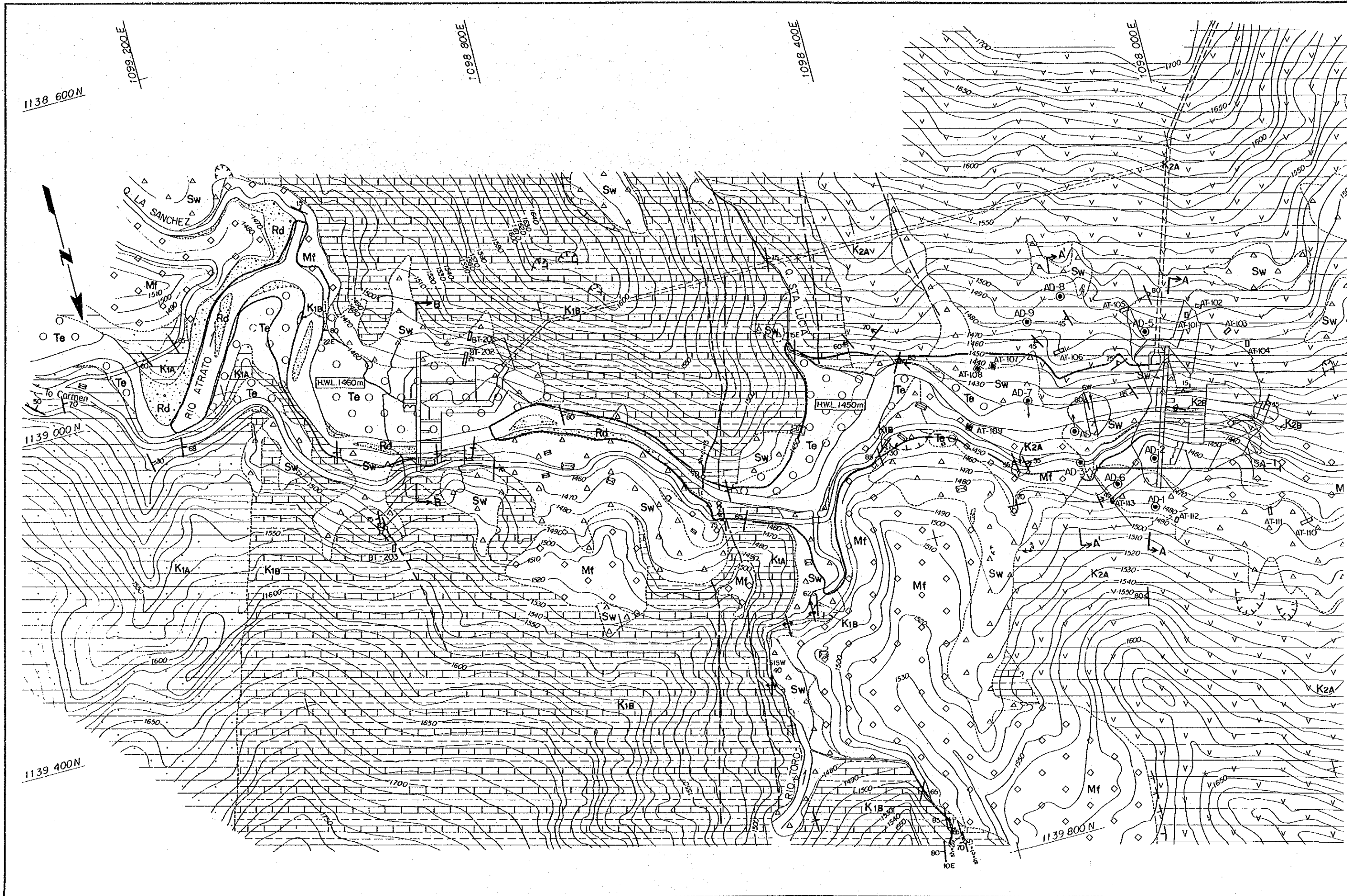
- Terrace deposit
- Mudflow deposit
- Diorite
- Diabase (With amphybolite, in local)
- Shale, sandstone and conglomerate (With basaltic rocks, in local)
- Basalt (With basaltic pyroclastic rocks)
- Alternation of chert and limestone and/or calcaceous shale
- Geological boundary
- Fault
- Assumed fault

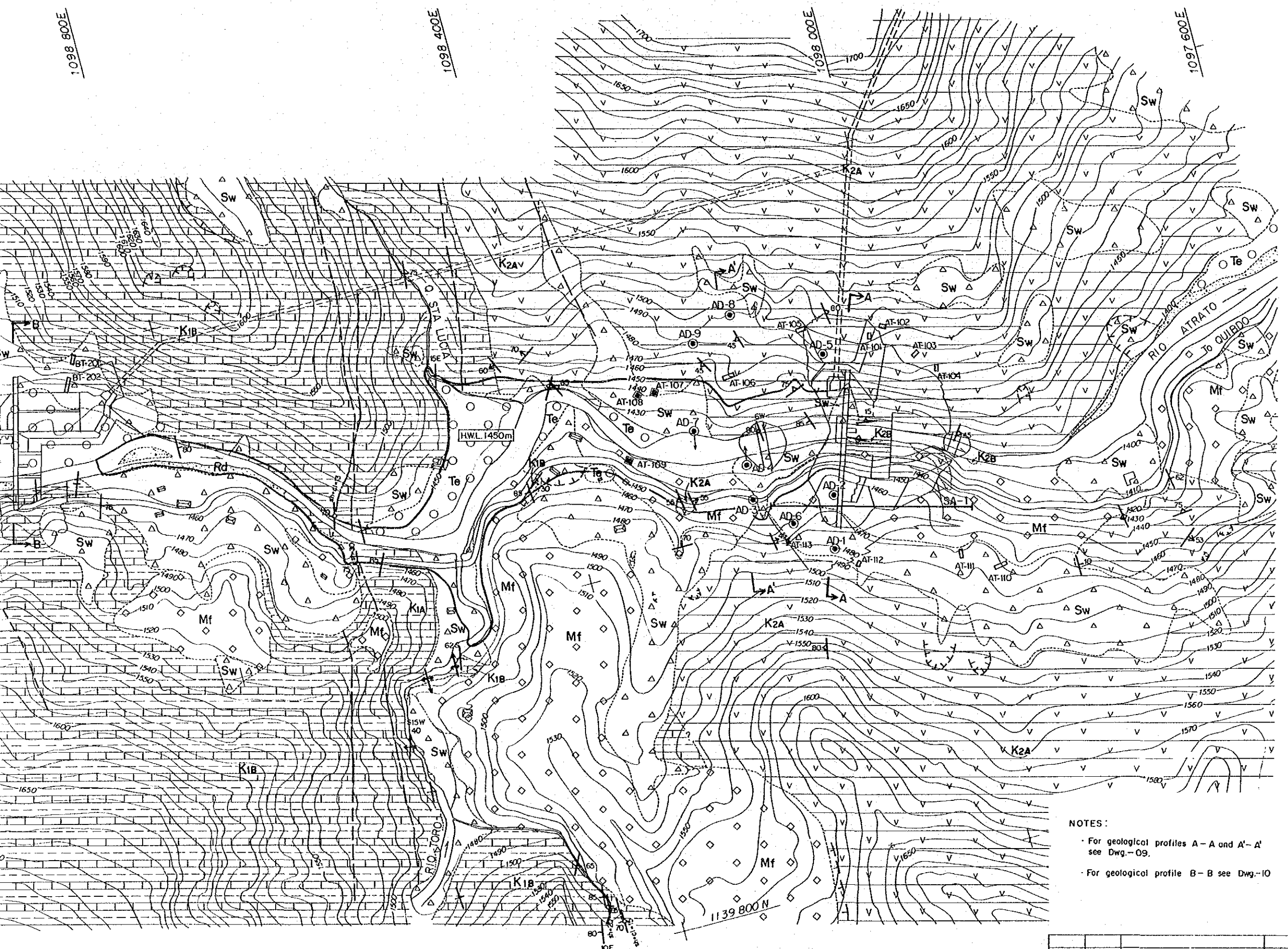


NOTE:
For location of profiles see Dwg.-06

LOCATION	DATE	DESCRIPTION	BY
		REVISION	

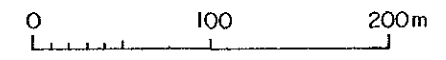
JAPAN INTERNATIONAL COOPERATION AGENCY	
INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA	
ATRATO HYDRO-ELECTRIC POWER PROJECT	
GEOLOGICAL PROFILES OF EL SIETE	
NO.1 AND NO.2 WATERWAY ALIGNMENT	
ELECTRIC POWER DEVELOPMENT Co., LTD TOKYO JAPAN	
Dwg. -07	





LEGEND

- Rd River deposit
- Sw Stopewash
- Te Terrace deposit
- Mf Mudflow deposit
- K2A Basalt (Basalt, basaltic tuff breccia and basaltic tuff)
- K1B Alternation of chert and limestone and/or calc. shale
- K1A Alternation of sandstone and shale
- Geological boundary
- \swarrow_{50} Strike and dip of bed
- \swarrow_{50} Strike and dip of intrusive contact
- \swarrow_{20} Minor anticlinal axis and plunging dip
- \swarrow_{sh-10} Fault Sh; Width of sheared zone.
Cl; Width of fault clay.
(in cm)
- Assumed fault
- \swarrow_{50} Strike and dip of fault
- \swarrow_{30} Strike and dip of joint
- \curvearrowright Slope collapse
- AD- ● Drillhole ● Inclined drillhole
- AT- □ Trench □ Pit
- SA- Seismic prospecting line

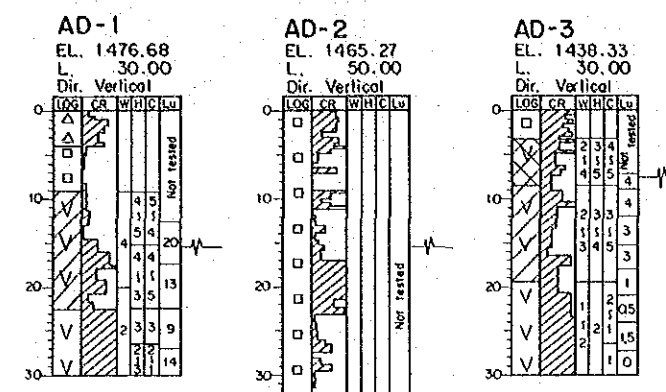
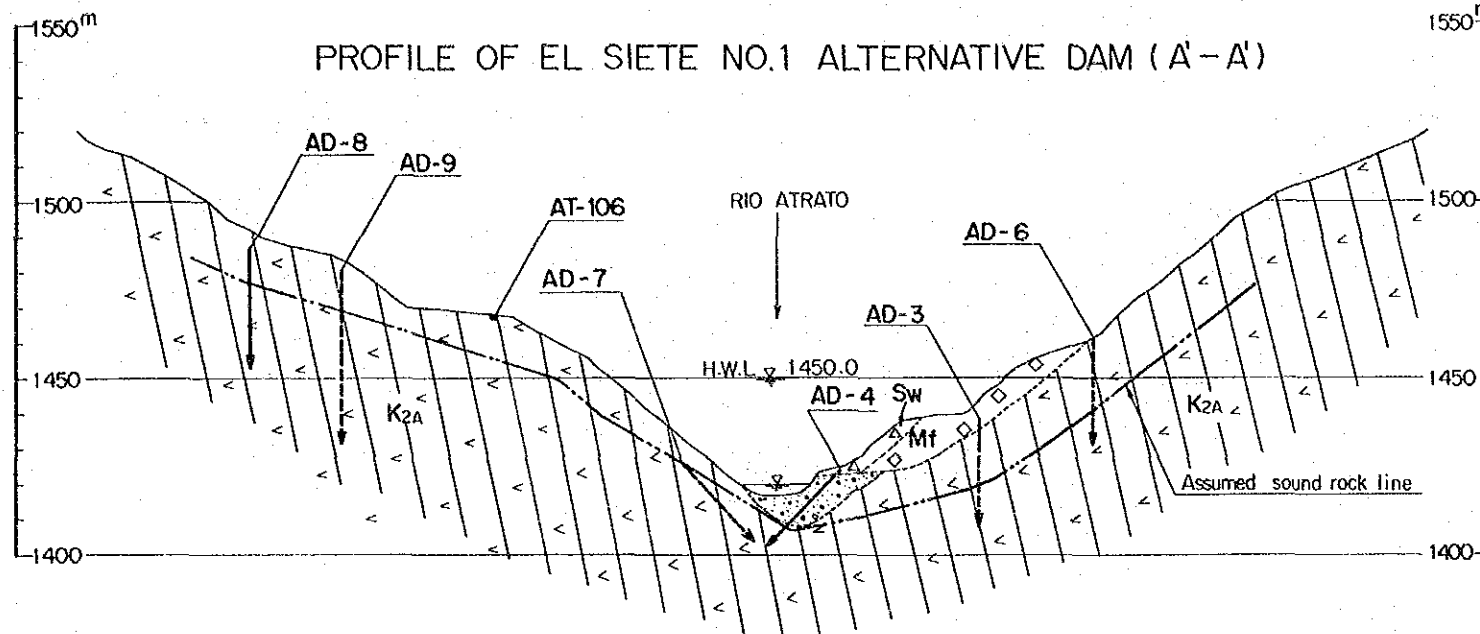


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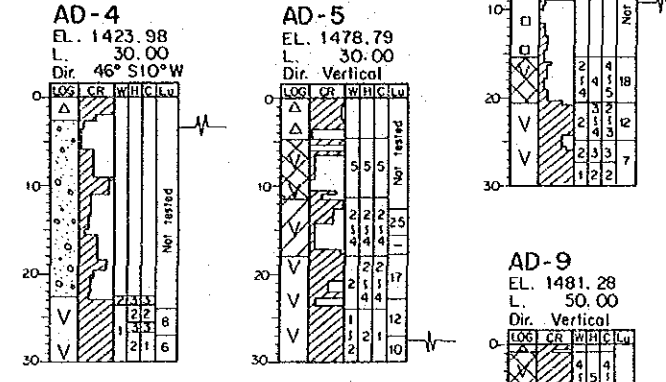
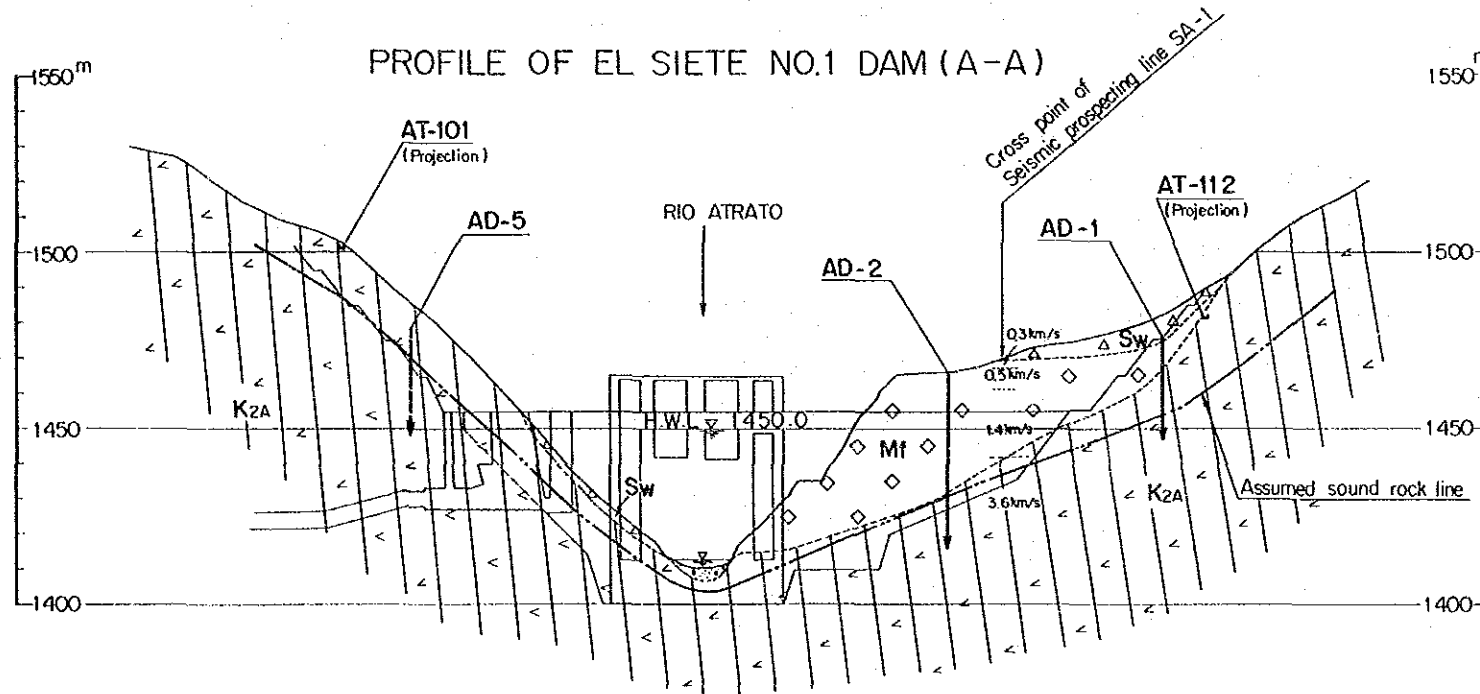
- For geological profiles A - A and A' - A' see Dwg.-09.
- For geological profile B - B see Dwg.-10

JAPAN INTERNATIONAL COOPERATION AGENCY	
INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA	
ATRATO HYDRO-ELECTRIC POWER PROJECT	
GEOLOGICAL PLAN OF EL SIETE NO.1	
DAM SITE AND RESERVOIR AREA	
ELECTRIC POWER DEVELOPMENT Co., LTD TOKYO JAPAN	
Dwg.-08	

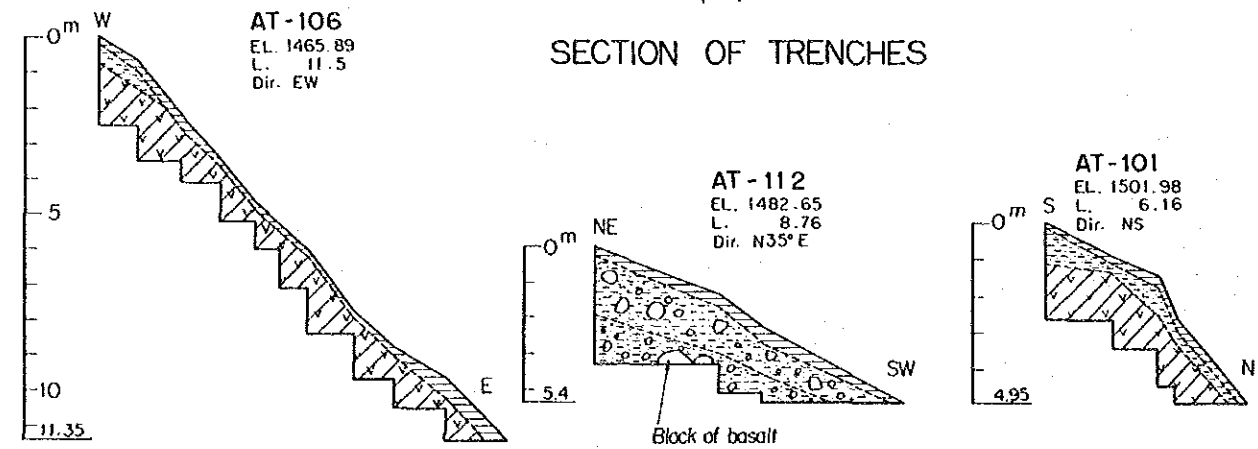
LOCATION	DATE	DESCRIPTION	BY
REVISION			



- LEGEND FOR PROFILE
- River deposit
 - Slopewash
 - Mudflow deposit
 - Basalt (Basalt, basaltic tuff breccia and basaltic tuff.)
 - Geological boundary
 - Drillhole
 - Drillhole (Projection)
 - Trench
 - 0.3km/s
1.4 km/s Seismic wave velocity and its boundary



- LEGEND FOR CORE LOG
- Log
Core recovery
Core classification
Lugeon value
- W ; Weathering
1 ; Fresh
5 ; Decomposed
- H ; Hardness
1 ; Hard
5 ; Soft
- C ; Core cutting
1 ; Stick
5 ; Grain
- Slopewash
 River deposit
 Mudflow deposit
 Decomposed weathered and crackly
 Fresh
 Fault
- Ground water level



- LEGEND FOR TRENCH
- Topsoil with plant roots
 - Sandy silt
 - Stilty sand with boulder gravel
 - Weathered basaltic rock
 - Geological boundary

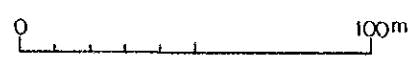
NOTE :
For location of sections see Dwg.-08

LOCATION	DATE	DESCRIPTION	BY
		REVISION	

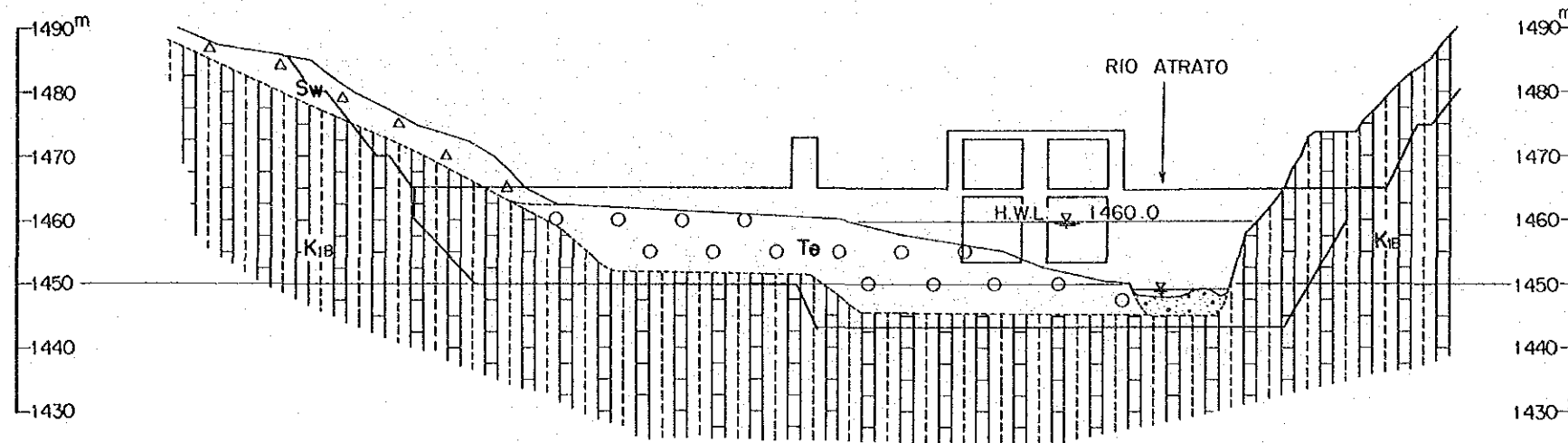
JAPAN INTERNATIONAL COOPERATION AGENCY
INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA
ATRATO HYDRO-ELECTRIC POWER PROJECT
GEOLOGICAL PROFILE OF
EL SIETE NO.1 DAM

ELECTRIC POWER DEVELOPMENT Co., LTD
TOKYO JAPAN

Dwg.-09



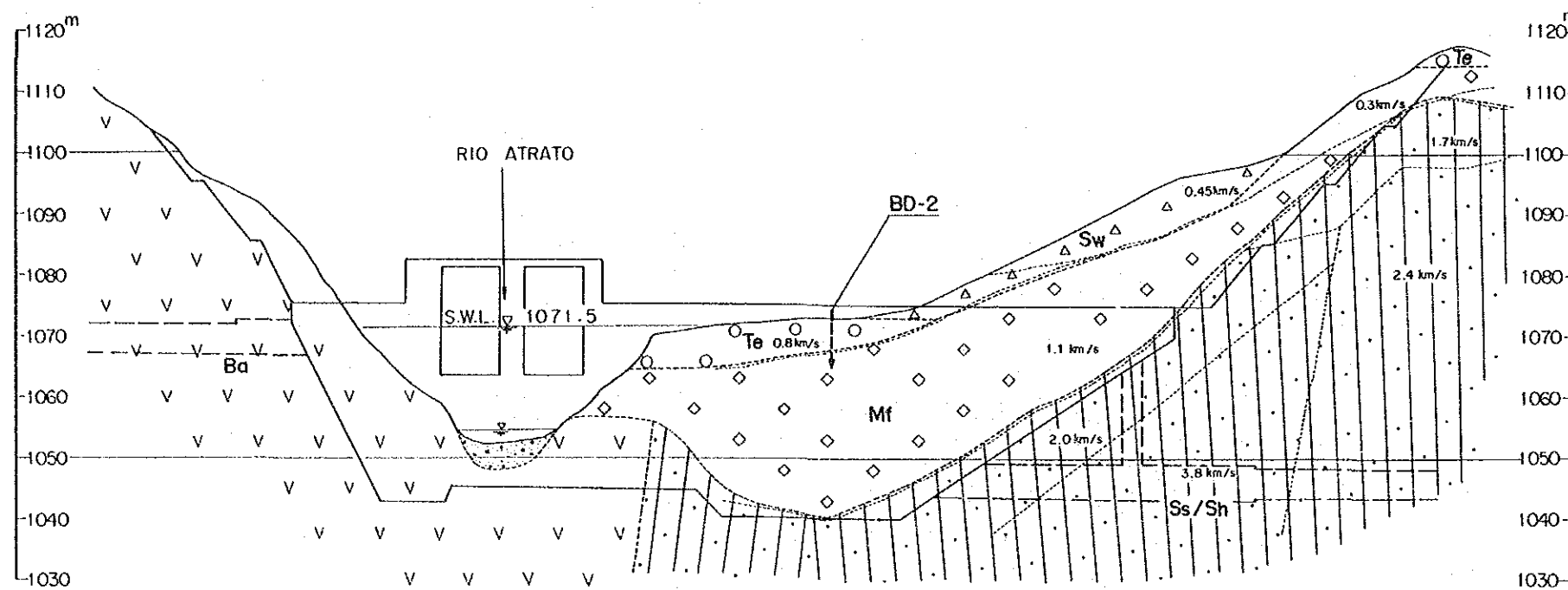
PROFILE OF EL SIETE NO.1 AUXILIARY DAM (B-B)



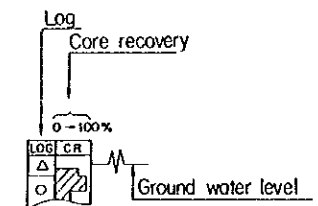
LEGEND

- River deposit
- Slopewash
- Terrace deposit
- Mudflow deposit
- Alternation of sandstone and shale
- Basalt (Basalt and basaltic tuff breccia)
- Alternation of chert and limestone and/or calc. shale
- Geological boundary
- Drillhole (Projection)
- Seismic wave velocity and its boundary

PROFILE OF EL SIETE NO.2 INTAKE DAM (C-C)



BD-2
EL. 1074.34
L. 9.5
Dir. Vertical



- Slopewash
- Terrace deposit

0 50 m

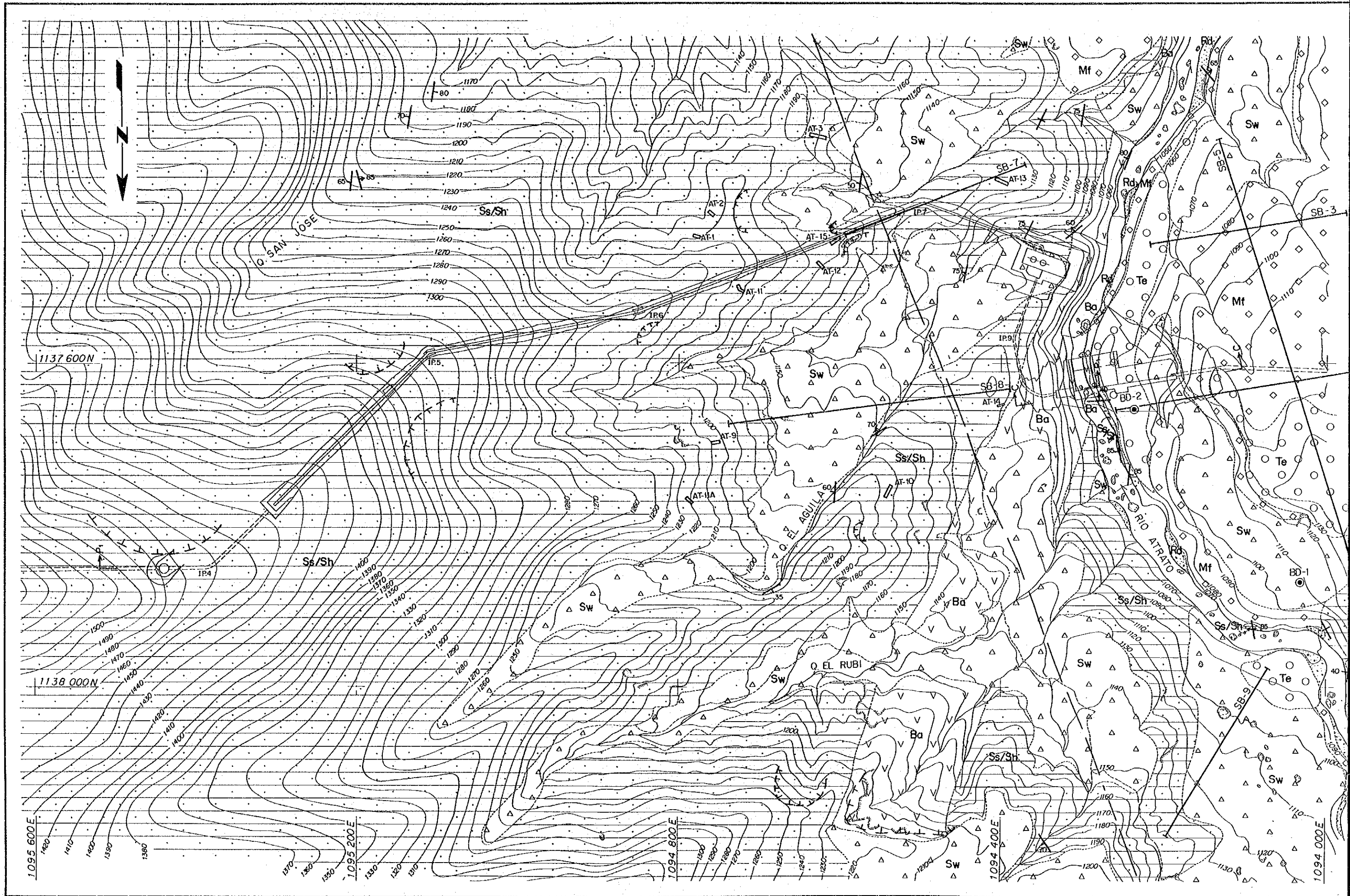
NOTE:
For location of profile B-B see Dwg.-08
For location of profile C-C see Dwg.-13

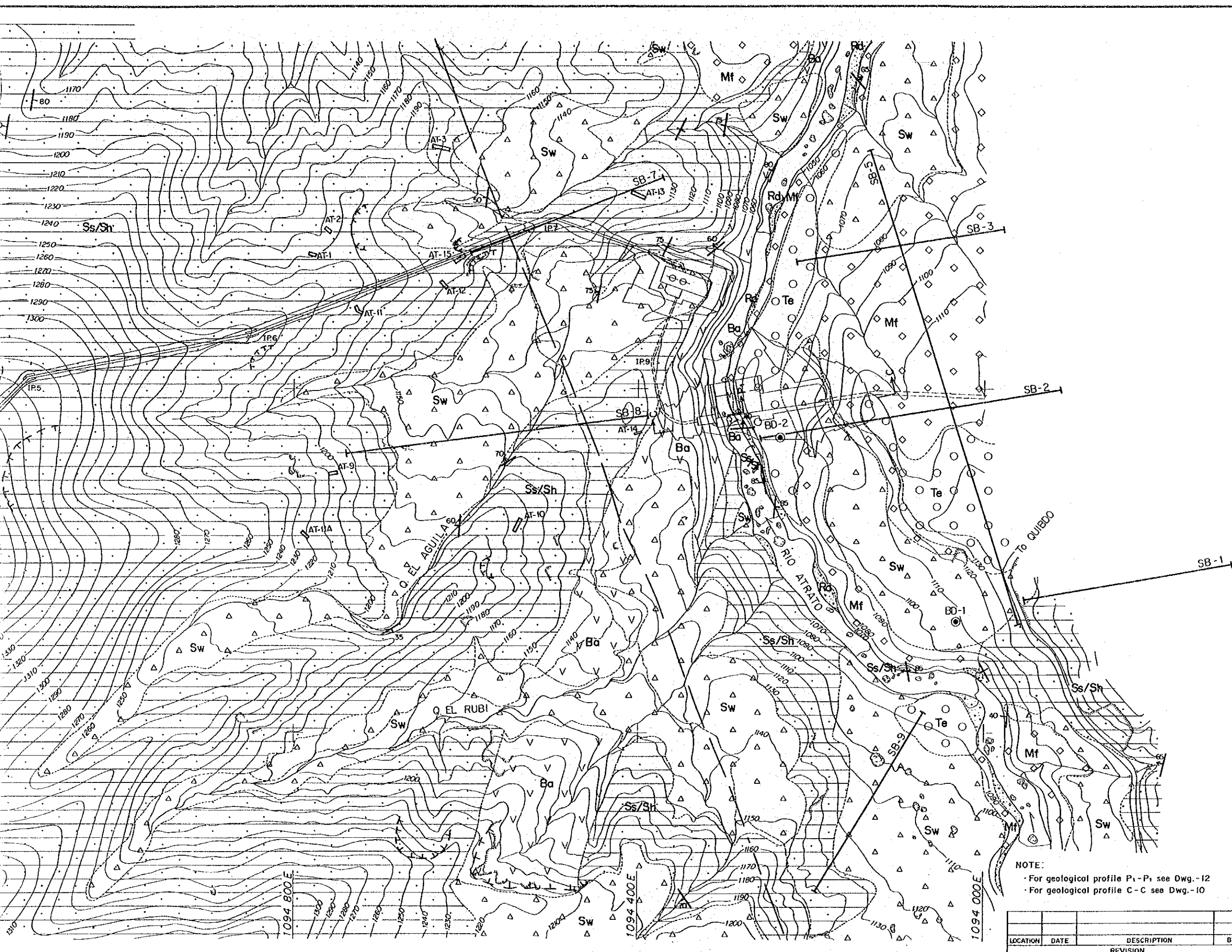
JAPAN INTERNATIONAL COOPERATION AGENCY
INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA
ATRATO HYDRO-ELECTRIC POWER PROJECT
GEOLOGICAL PROFILES OF EL SIETE NO.1
AUXILIARY DAM AND NO.2 INTAKE DAM

ELECTRIC POWER DEVELOPMENT Co., LTD
TOKYO JAPAN

Dwg.-10

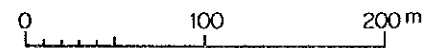
LOCATION	DATE	DESCRIPTION	BY
		REVISION	





LEGEND

- Rd River deposit
- Sw Slopewash
- Te Terrace deposit
- Mt Mudflow deposit
- Ba Basalt (Indicate only near the No.1 power station site)
- Ss/Sh Alternation of sandstone, shale and conglomerate (With basaltic rock in local)
- Geological boundary
- \swarrow_{50} Strike and dip of bed
- \swarrow_{50} Strike and dip of intrusive contact
- - - Assumed fault
- \swarrow_{50} Strike and dip of joint
- ⤵ Slope collapse
- BD- Drillhole
- AT- Trench
- SB- Seismic prospecting line (Indicating approximate location)



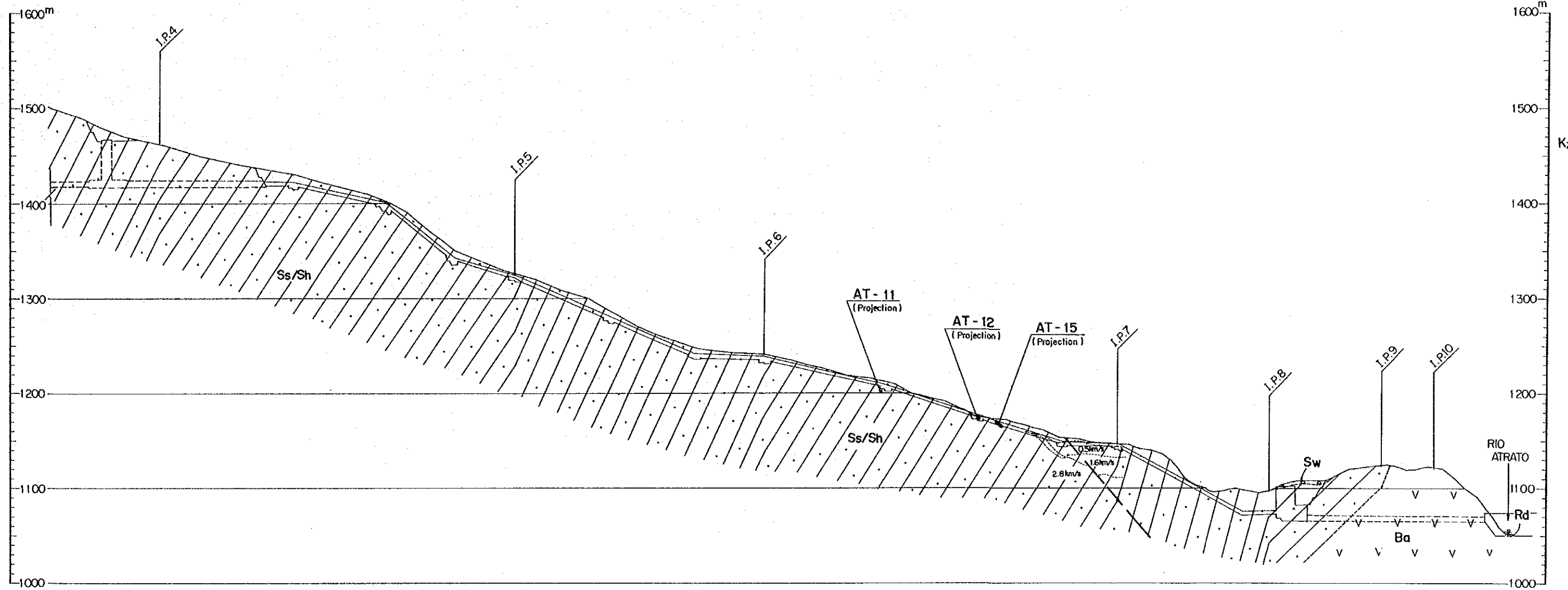
JAPAN INTERNATIONAL COOPERATION AGENCY
 INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA
 ATRATO HYDRO ELECTRIC POWER PROJECT
 GEOLOGICAL PLAN OF EL SIETE NO.1
 SURGE TANK, PENSTOCK AND POWERHOUSE
 ELECTRIC POWER DEVELOPMENT Co.,LTD
 TOKYO JAPAN

NOTE:
 - For geological profile P₁-P₁ see Dwg.-12
 - For geological profile C-C see Dwg.-10

LOCATION	DATE	DESCRIPTION	BY

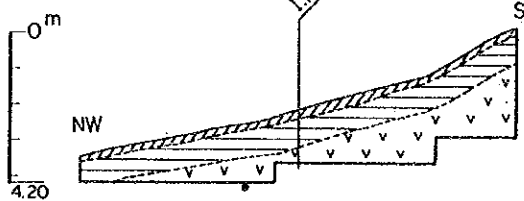
Dwg.-11

PROFILE OF EL SIETE NO.1 SURGE TANK, PENSTOCK AND POWERHOUSE (P1-P1)

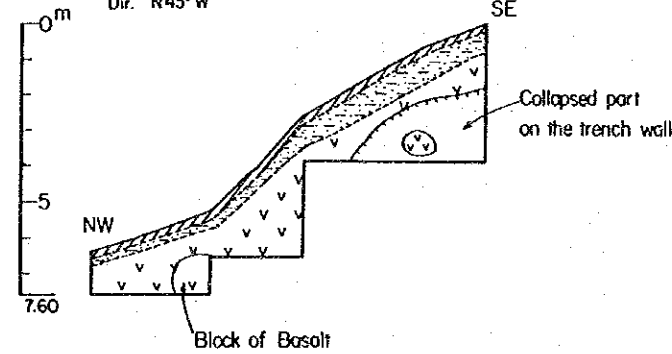


SECTION OF TRENCHES

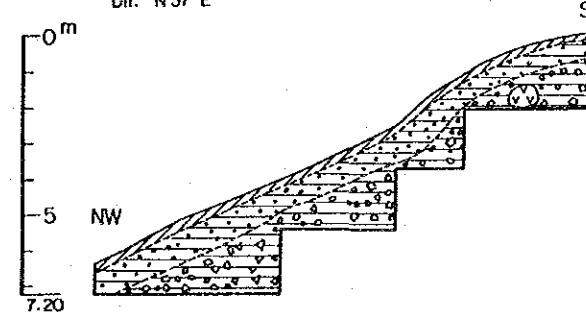
AT-11
 EL. 1201.65
 L. 13.6
 Dir. N60°W, N28°W



AT-12
 EL. 1172.17
 L. 10.80
 Dir. N45°W



AT-15
 EL. 1166.00
 L. 13.70
 Dir. N57°E



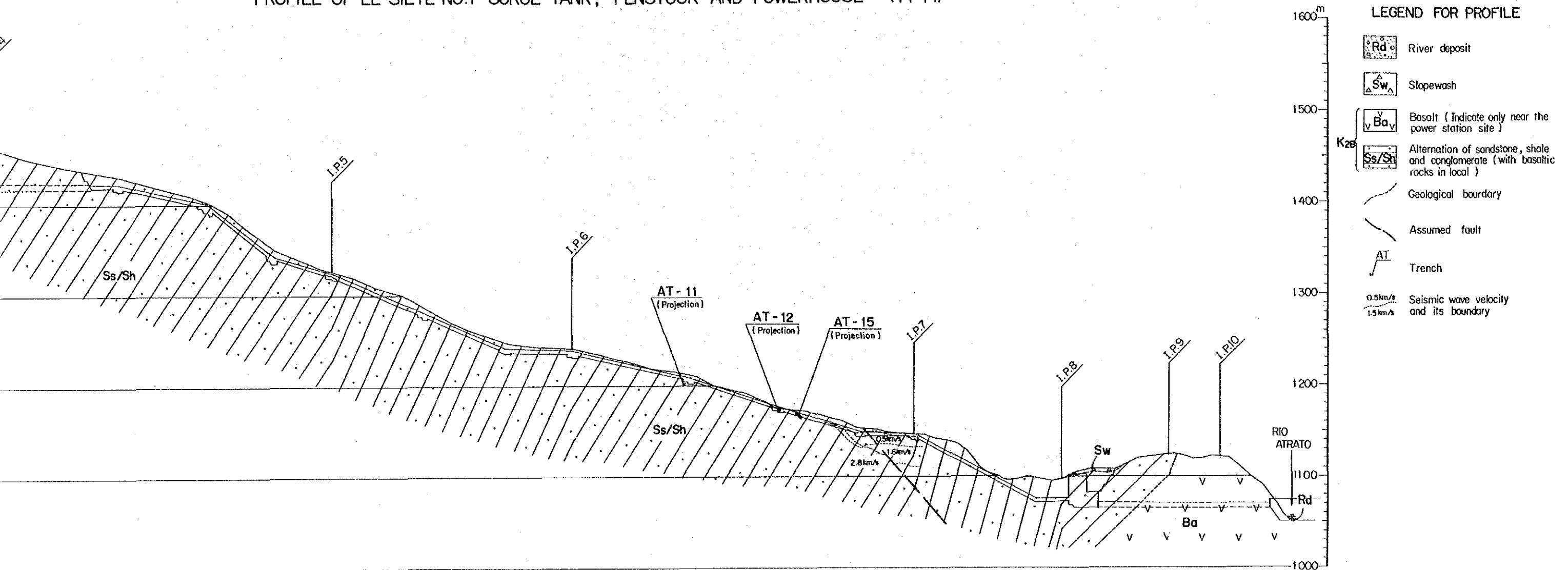
LEGEND FOR TRENCH

- Topsoil
- Clayey silt
- Sandy silt
- Clay with subrounded fragments of basalt
- Fragments of basalt in clayey silt matrix (Decomposed basaltic rock?)
- Decomposed basaltic rock (Softened)
- Geological boundary

NOTE:
 - For location of profile see Dwg.-11

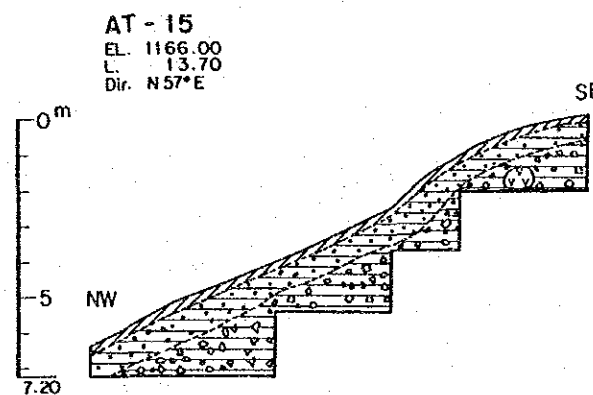
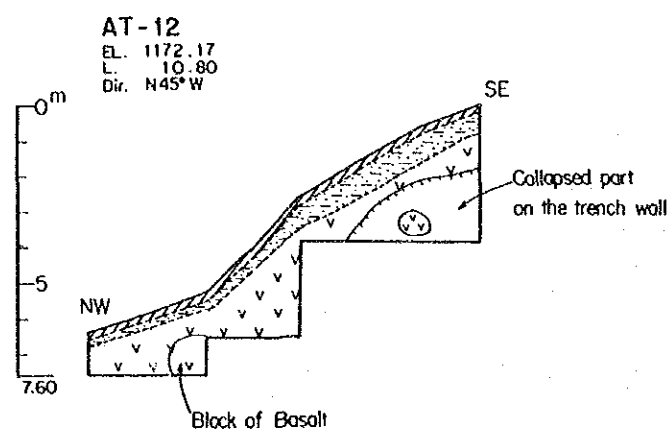
LOCATION	DATE	DESCRIPTION	BY
REVISION			

PROFILE OF EL SIETE NO.1 SURGE TANK, PENSTOCK AND POWERHOUSE (P₁-P₁)



- LEGEND FOR PROFILE**
- River deposit
 - Slopewash
 - Basalt (Indicate only near the power station site)
 - Alternation of sandstone, shale and conglomerate (with basaltic rocks in local)
 - Geological boundary
 - Assumed fault
 - Trench
 - Seismic wave velocity and its boundary

SECTION OF TRENCHES

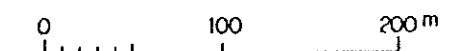


LEGEND FOR TRENCH

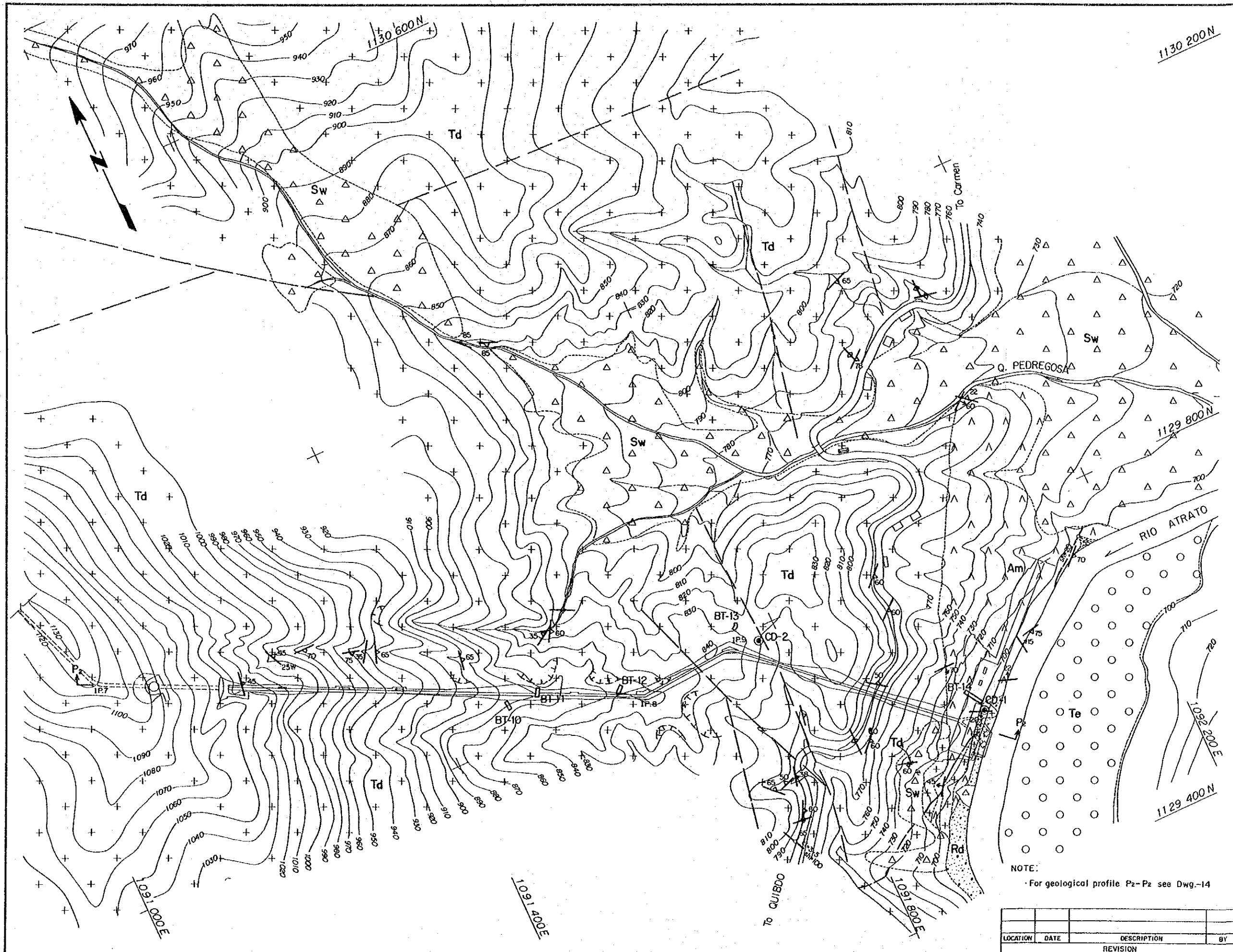
- Topsoil
- Clayey silt
- Sandy silt
- Clay with subrounded fragments of basalt
- Fragments of basalt in clayey silt matrix (Decomposed basaltic rock?)
- Decomposed basaltic rock (Softened)
- Geological boundary

NOTE:
 For location of profile see Dwg.-11

LOCATION	DATE	DESCRIPTION	BY
		REVISION	



JAPAN INTERNATIONAL COOPERATION AGENCY	
INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA	
ATRATO HYDRO-ELECTRIC POWER PROJECT	
GEOLOGICAL PROFILE OF EL SIETE NO.1	
SURGE TANK, PENSTOCK AND POWERHOUSE	
ELECTRIC POWER DEVELOPMENT CO., LTD. TOKYO, JAPAN	
Dwg. - 12	



- ### LEGEND
- Rd River deposit
 - Sw Slopewash
 - Te Terrace deposit
 - Td Diorite
 - Am Amphibolite
 - Geological boundary
 - $\frac{1}{50}$ Strike and dip of bed
 - $\frac{1}{50}$ Strike and dip of intrusive or foliation
 - $\frac{1}{30}$ Fault sh ; Width of shear
cl ; Width of fault
 - Photolineament
 - $\frac{1}{50}$ Strike and dip of fault
 - $\frac{1}{50}$ Strike and dip of joint
 - $\frac{1}{50}$ Slope collapse
 - CD- Drillhole
 - BT- Trench

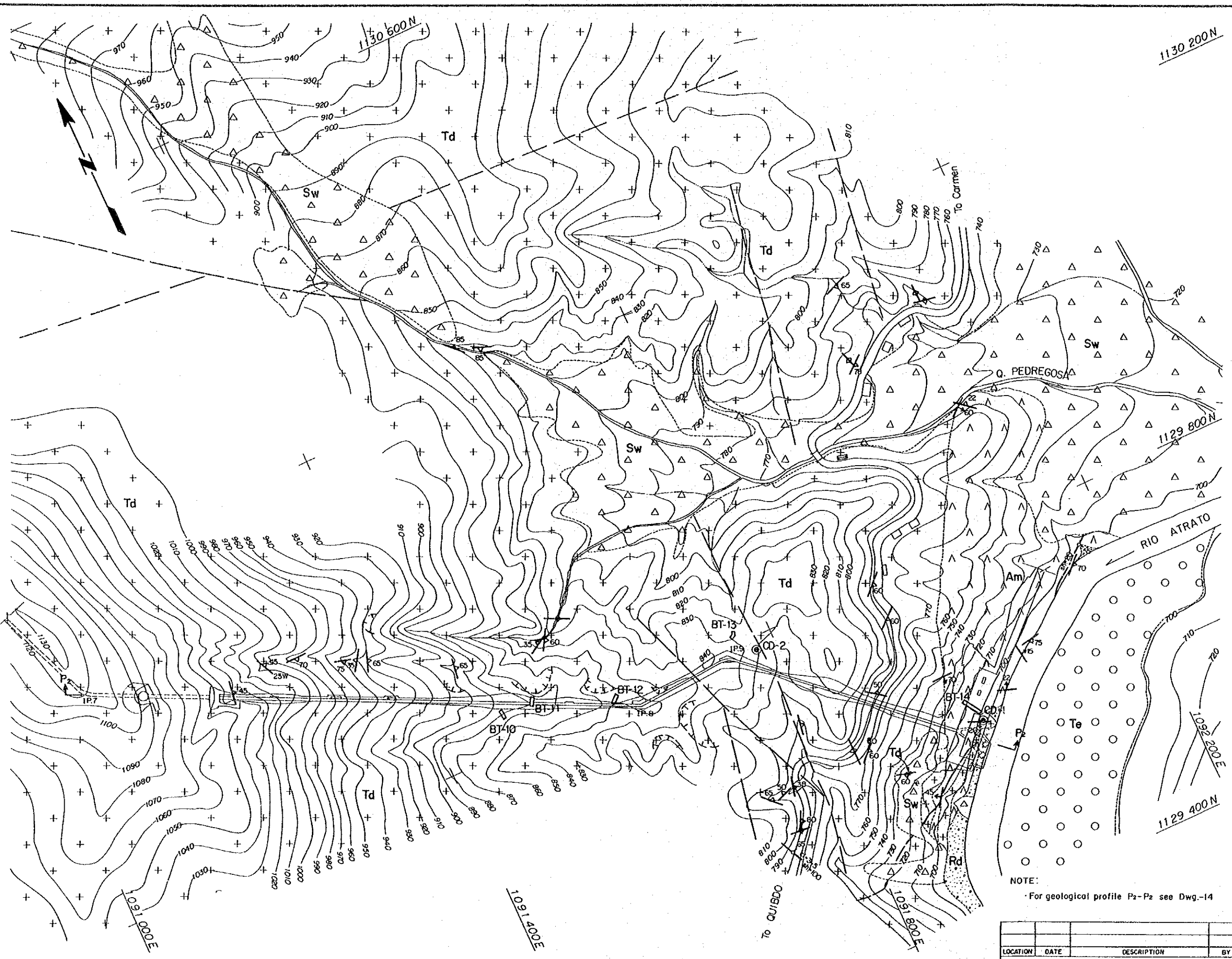


JAPAN INTERNATIONAL COOPERATION
 INSTITUTO COLOMBIANO DE ENERGIA I
 ATRATO HYDRO-ELECTRIC POWER
 GEOLOGICAL PLAN OF EL SIETE
 SURGE TANK, PENSTOCK AND POW

NOTE:
 For geological profile P2-P2 see Dwg.-14

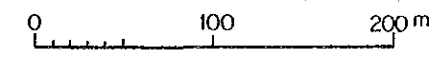
LOCATION	DATE	DESCRIPTION	BY

ELECTRIC POWER DEVELOPME
 TOKYO JAPAN



- ### LEGEND
- Rd River deposit
 - Sw Stopwash
 - Te Terrace deposit
 - Td Diorite
 - Am Amphibolite
 - Geological boundary
 - \swarrow_{50} Strike and dip of bed
 - \swarrow_{50} Strike and dip of intrusive contact or foliation
 - \swarrow_{50-30} Fault sh; Width of sheared zone. cl; Width of fault clay. (In cm)
 - Photolineament
 - \swarrow_{50} Strike and dip of fault
 - \swarrow_{50} Strike and dip of joint
 - \curvearrowright Slope collapse
 - CD- Drillhole
 - BT- Trench

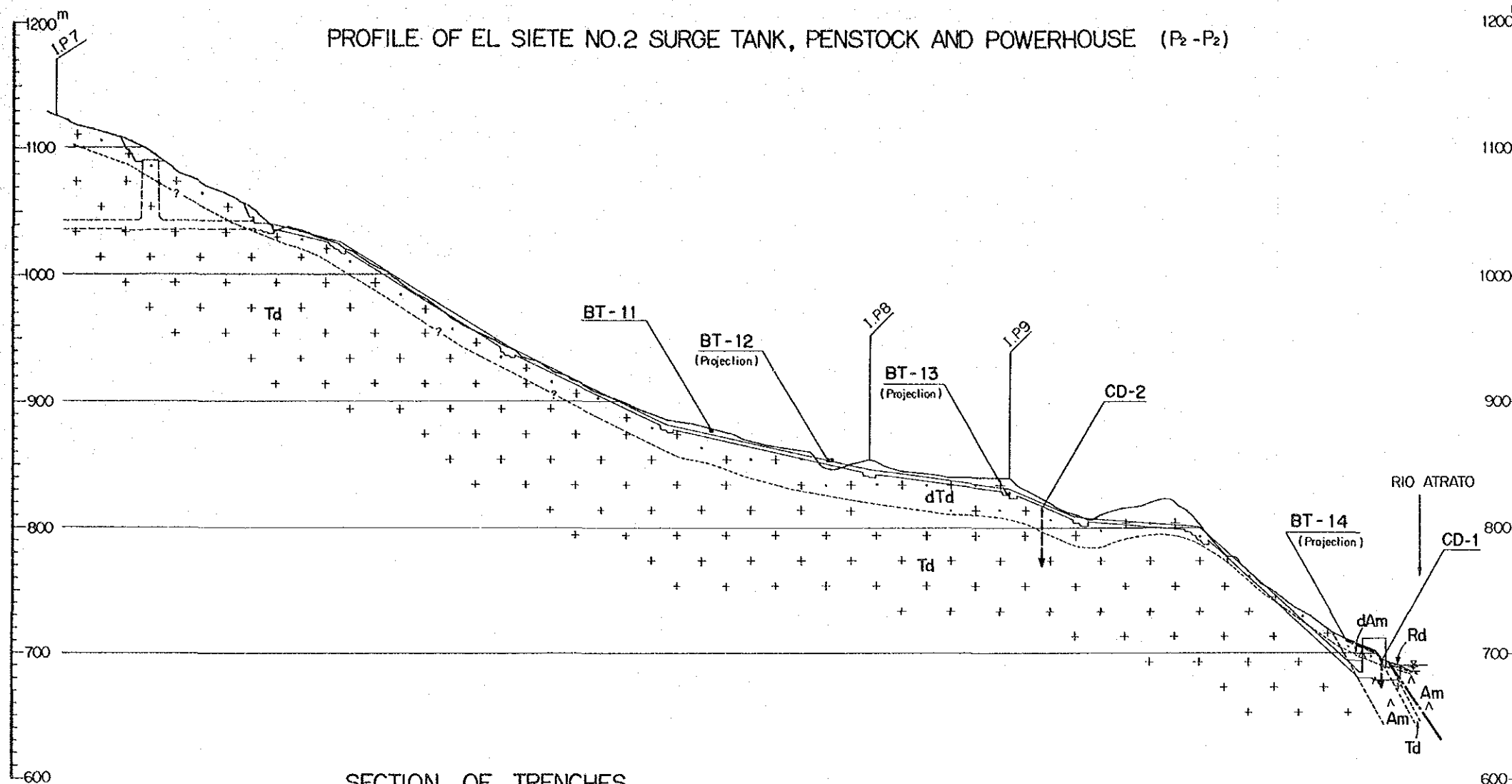
JAPAN INTERNATIONAL COOPERATION AGENCY
 INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA
 ATRATO HYDRO-ELECTRIC POWER PROJECT
**GEOLOGICAL PLAN OF EL SIETE NO. 2
 SURGE TANK, PENSTOCK AND POWERHOUSE**
 ELECTRIC POWER DEVELOPMENT Co., LTD
 TOKYO JAPAN



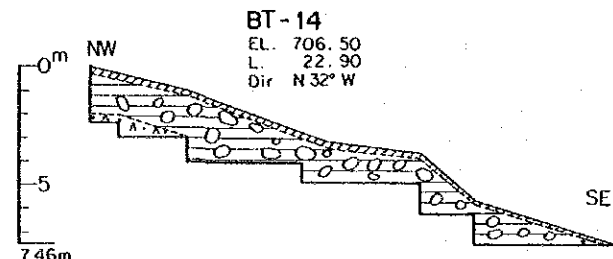
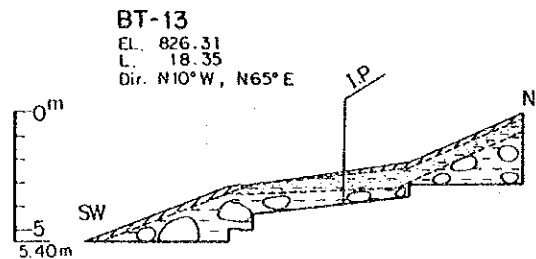
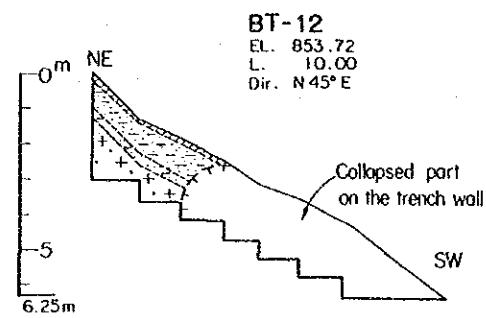
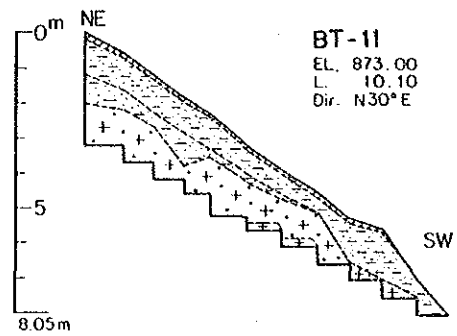
LOCATION	DATE	DESCRIPTION	BY
		REVISION	

Dwg.-13

PROFILE OF EL SIETE NO.2 SURGE TANK, PENSTOCK AND POWERHOUSE (P₂-P₂)

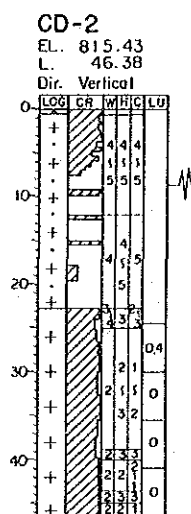
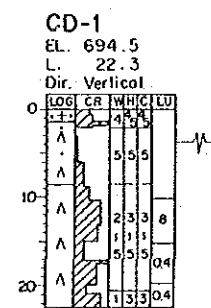


SECTION OF TRENCHES



LEGEND FOR TRENCH

- Topsoil
- Sandy silt
- Silty sand
- Pebble or boulder of basalt in clay matrix
- Block of diorite in sandy silt matrix
- Decomposed diorite
- Somewhat fresh diorite
- Weathered amphibolite
- Geological boundary



LEGEND FOR CORE LOG

- Log
- Core recovery
- Core classification
- Lugeon value
- W; Weathering
 - 1; Fresh
 - 5; Decomposed
- H; Hardness
 - 1; Hard
 - 5; Soft
- C; Core cutting
 - 1; Stick
 - 5; Grain
- Residual soil
- Decomposed diorite
- Diorite
- Decomposed amphibolite
- Amphibolite



NOTE:
For location of profile see Dwg. 13

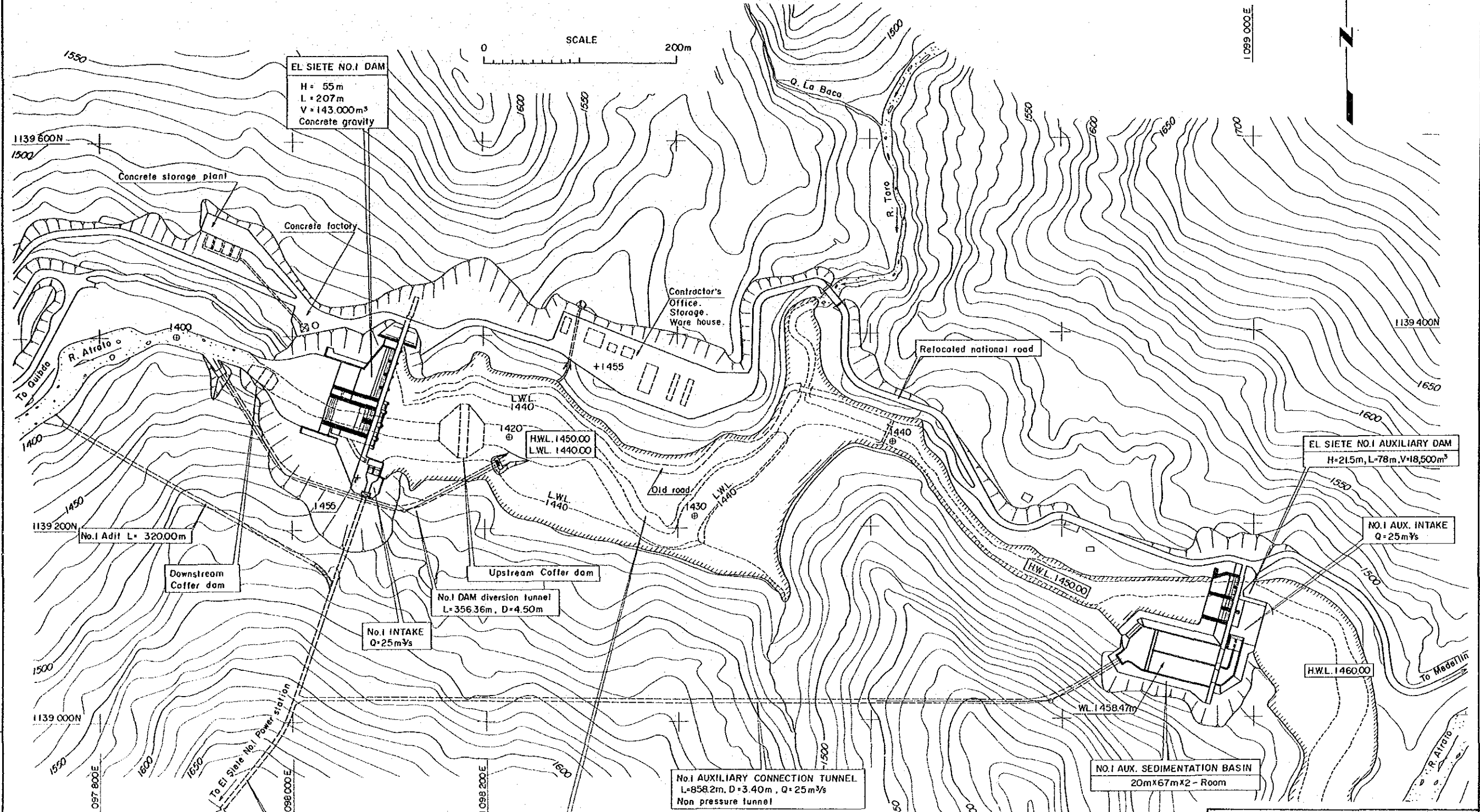
LOCATION	DATE	DESCRIPTION	BY
		REVISION	

JAPAN INTERNATIONAL COOPERATION AGENCY
 INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA
 ATRATO HYDRO-ELECTRIC POWER PROJECT
 GEOLOGICAL PROFILE OF EL SIETE NO.2
 SURGE TANK, PENSTOCK AND POWERHOUSE
 ELECTRIC POWER DEVELOPMENT Co., LTD
 TOKYO, JAPAN

Dwg.-14

GENERAL PLAN OF EL SIETE NO.1 DAM AND EL SIETE NO.1 AUXILIARY DAM

SCALE 0 200m



EL SIETE NO.1 DAM
 H = 55m
 L = 207m
 V = 143,000m³
 Concrete gravity

EL SIETE NO.1 AUXILIARY DAM
 H = 21.5m, L = 78m, V = 18,500m³

EL SIETE NO.1 RESERVOIR
 H.W.L. = 1450m
 L.W.L. = 1440m
 Storage capacity = 540,000m³
 Area = 76,000m²

NO.1 HEADRACE TUNNEL
 L = 3145m, D = 3.40m, Q = 25m³/s
 Pressure tunnel

NO.1 AUXILIARY CONNECTION TUNNEL
 L = 858.2m, D = 3.40m, Q = 25m³/s
 Non pressure tunnel

NO.1 AUX. SEDIMENTATION BASIN
 20m x 67m x 2 - Room

NO.1 AUX. INTAKE
 Q = 25m³/s

NO.1 DAM DIVERSION TUNNEL
 L = 356.36m, D = 4.50m

NO.1 Adit L = 3200m

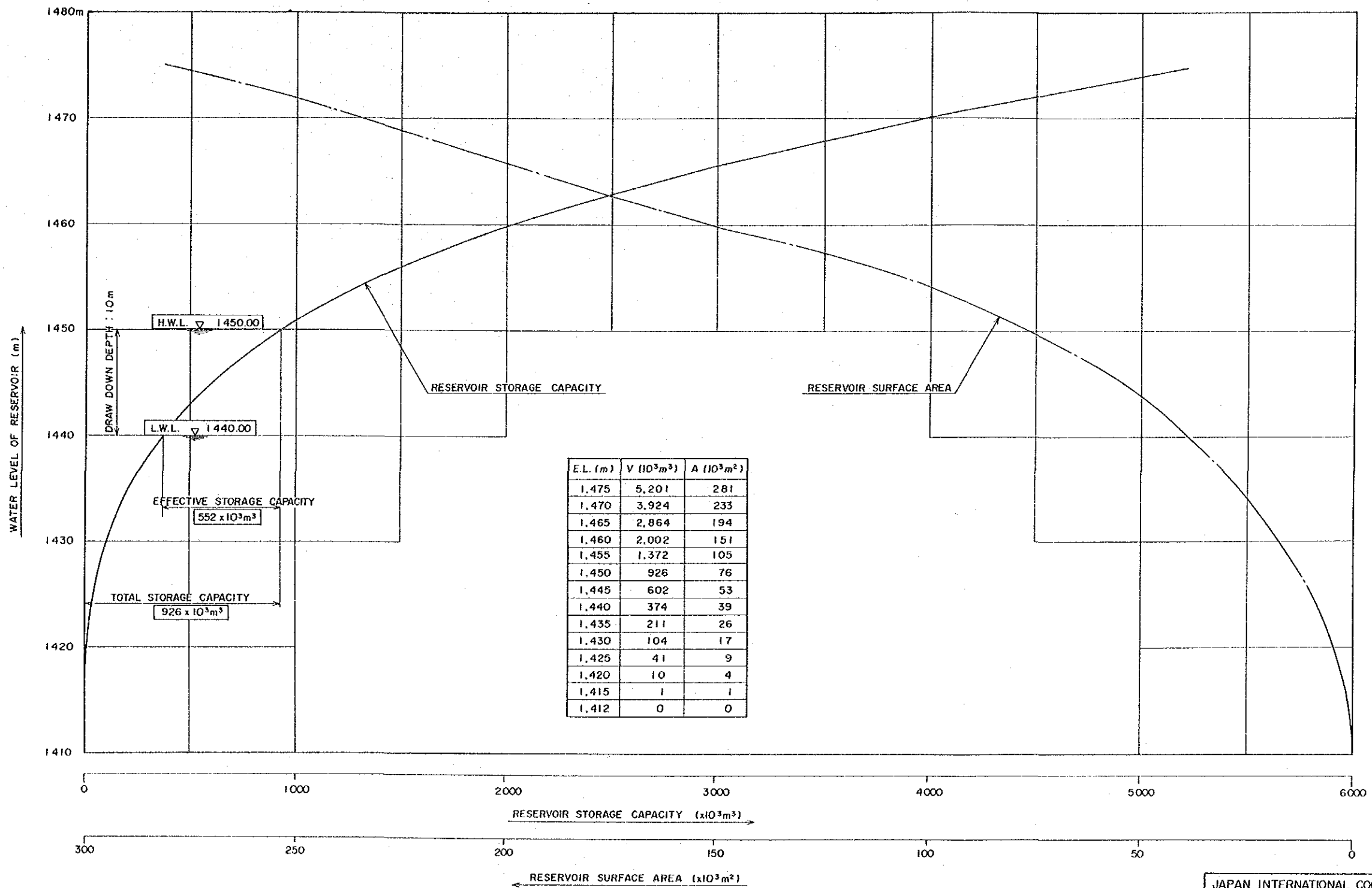
JAPAN INTERNATIONAL COOPERATION AGENCY
 INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA

ATRATO HYDRO-ELECTRIC POWER PROJECT
EL SIETE NO.1 RESERVOIR
GENERAL PLAN

ELECTRIC POWER DEVELOPMENT CO., LTD
 TOKYO, JAPAN

Dwg. - 15

LOCATION	DATE	DESCRIPTION	BY
		REVISION	

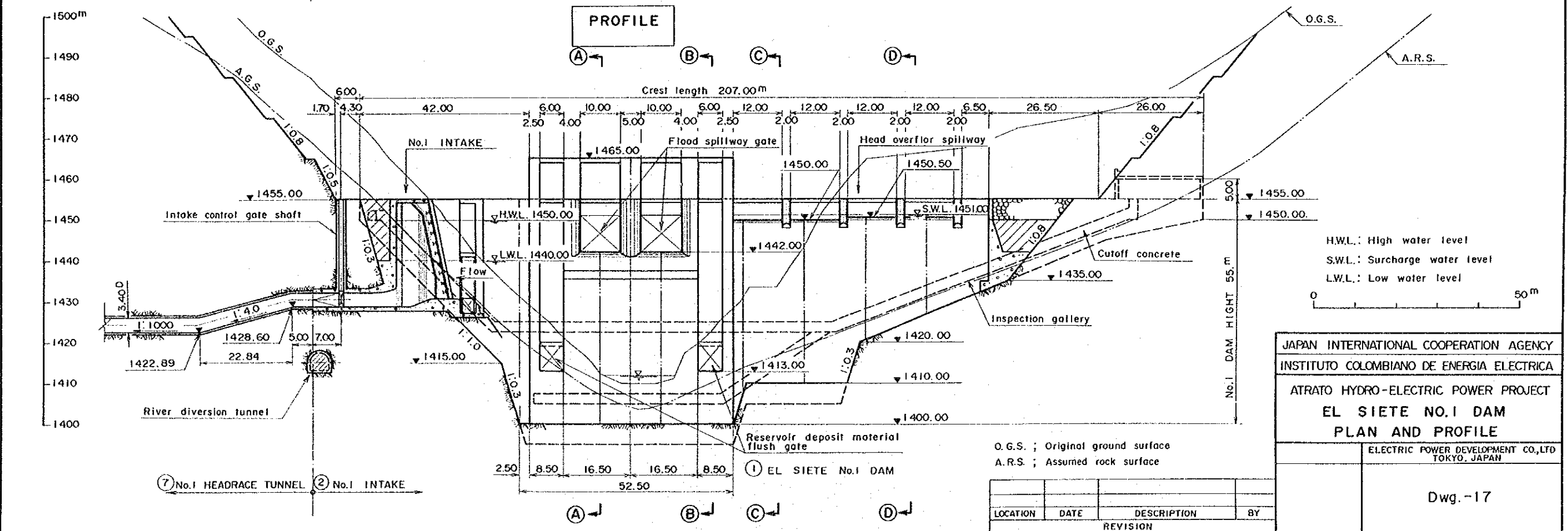
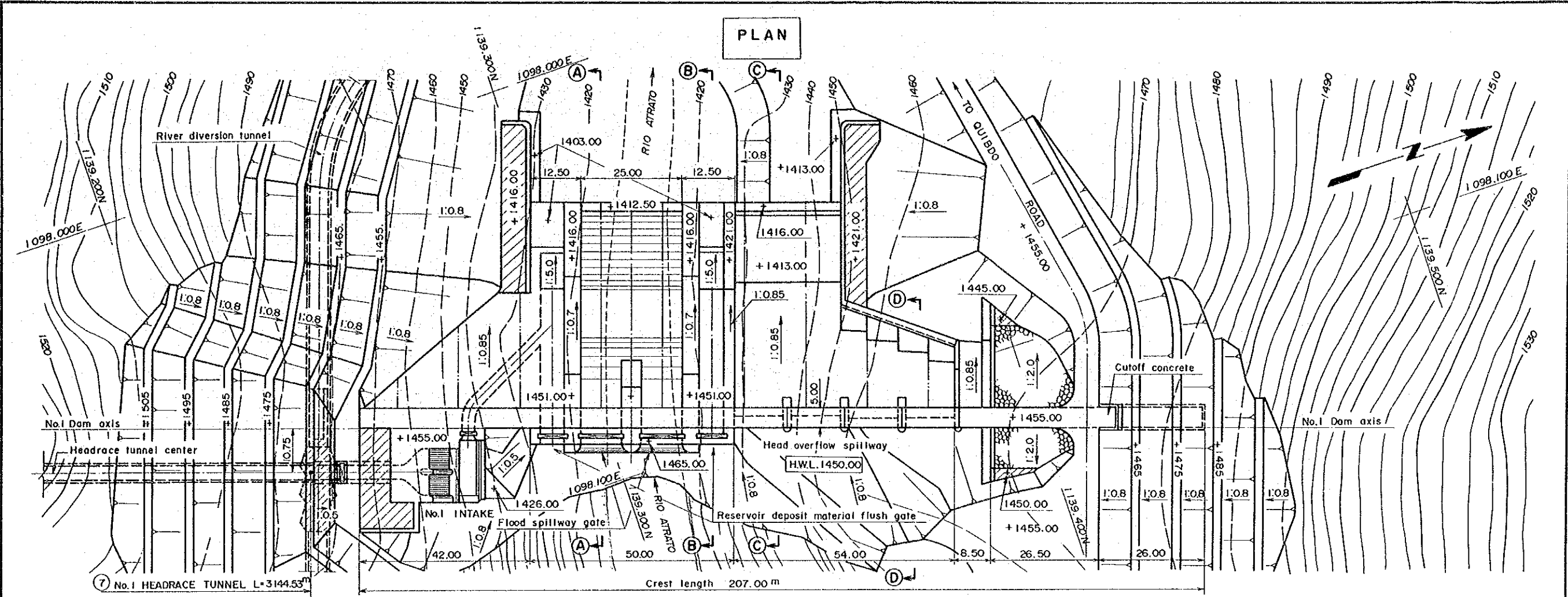


EL SIETE NO.1 REGULATING RESERVOIR

JAPAN INTERNATIONAL COOPERATION AGENCY
 INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA
 ATRATO HYDRO-ELECTRIC POWER PROJECT
 EL SIETE NO.1 RESERVOIR
 STORAGE CAPACITY AND AREA CURVES
 ELECTRIC POWER DEVELOPMENT CO.,LTD
 TOKYO, JAPAN

LOCATION	DATE	DESCRIPTION	BY

Dwg.-16

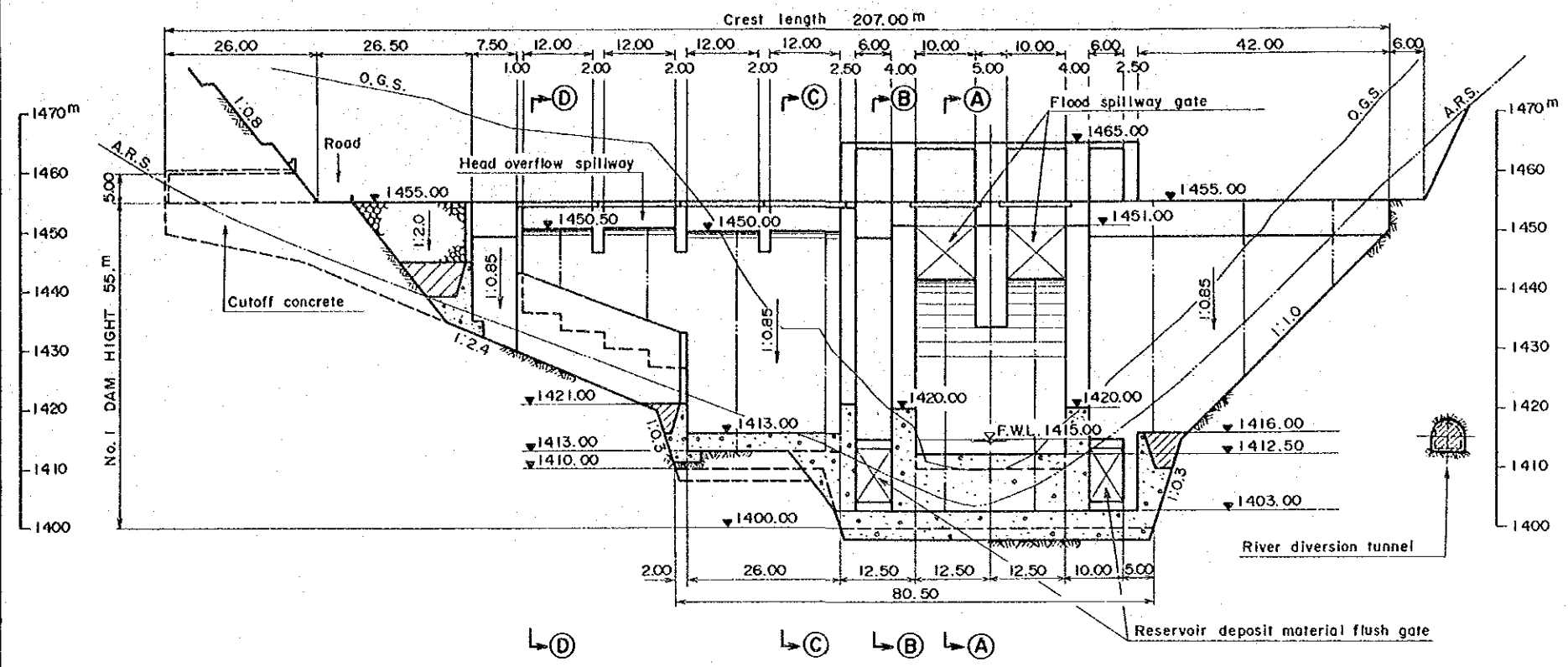


JAPAN INTERNATIONAL COOPERATION AGENCY
 INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA
 ATRATO HYDRO-ELECTRIC POWER PROJECT
 EL SIETE NO. 1 DAM
 PLAN AND PROFILE

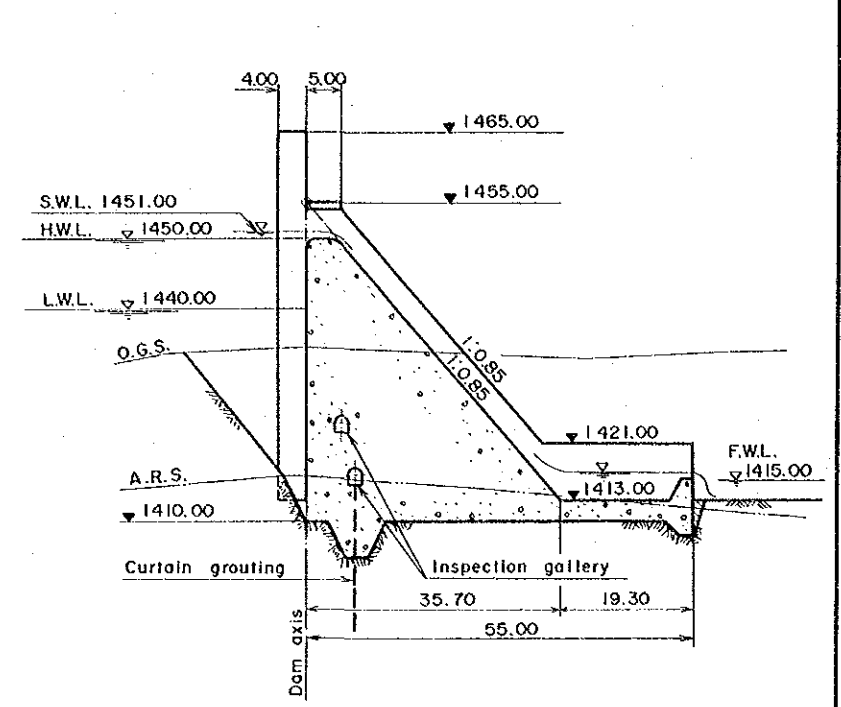
ELECTRIC POWER DEVELOPMENT CO., LTD
 TOKYO, JAPAN

Dwg. -17

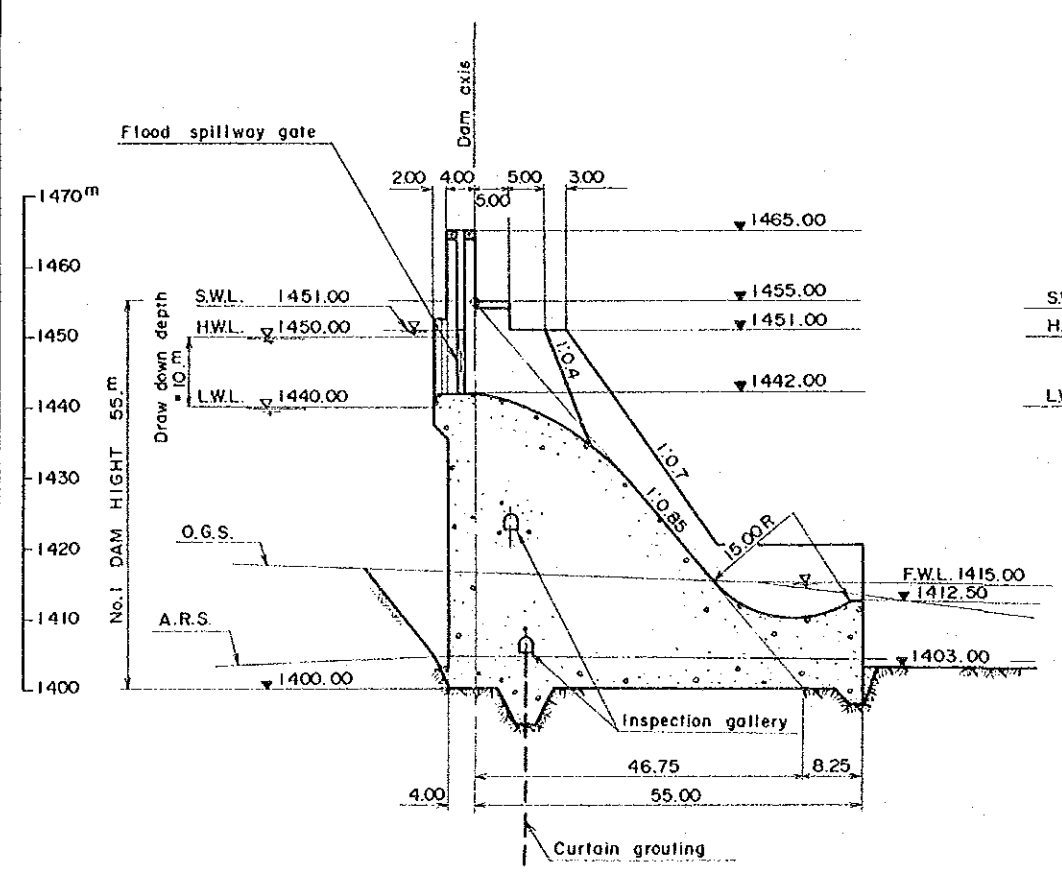
PROFILE
No.1 dam's front view



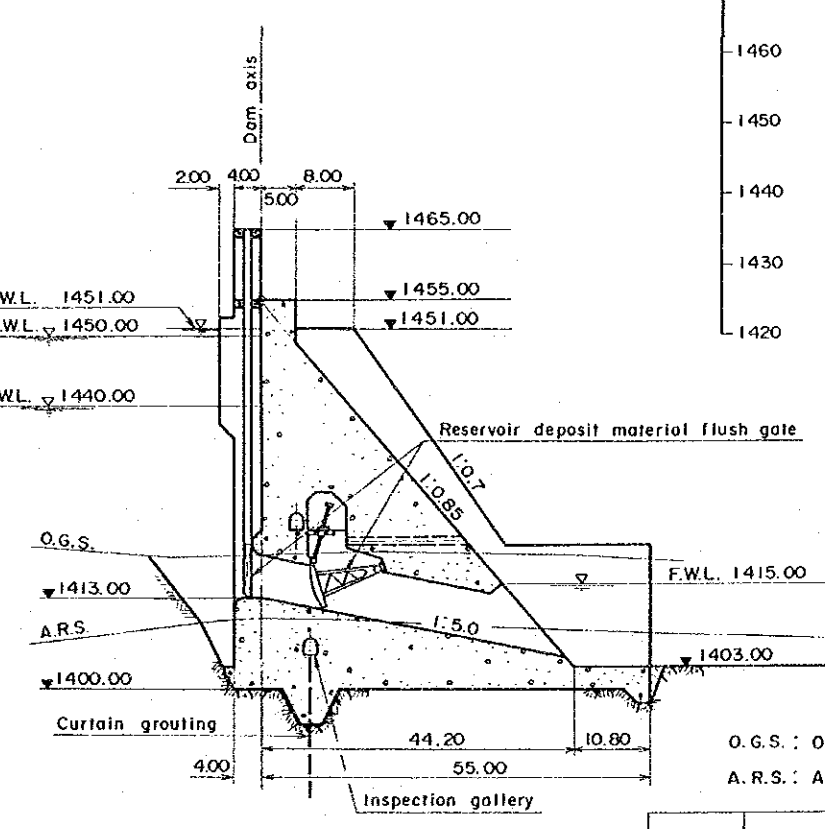
SECTION C-C
Head overflow spillway



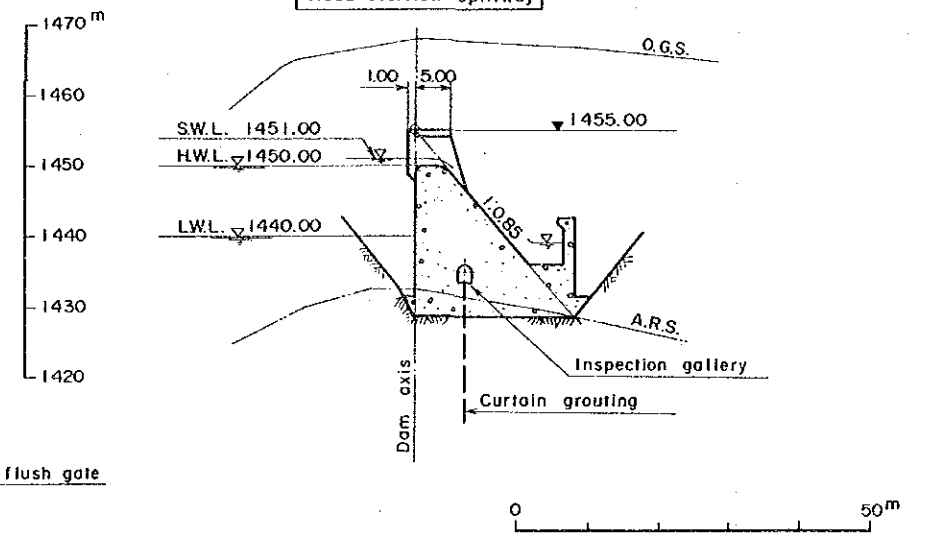
SECTION A-A
Flood spillway



SECTION B-B



SECTION D-D
Head overflow spillway



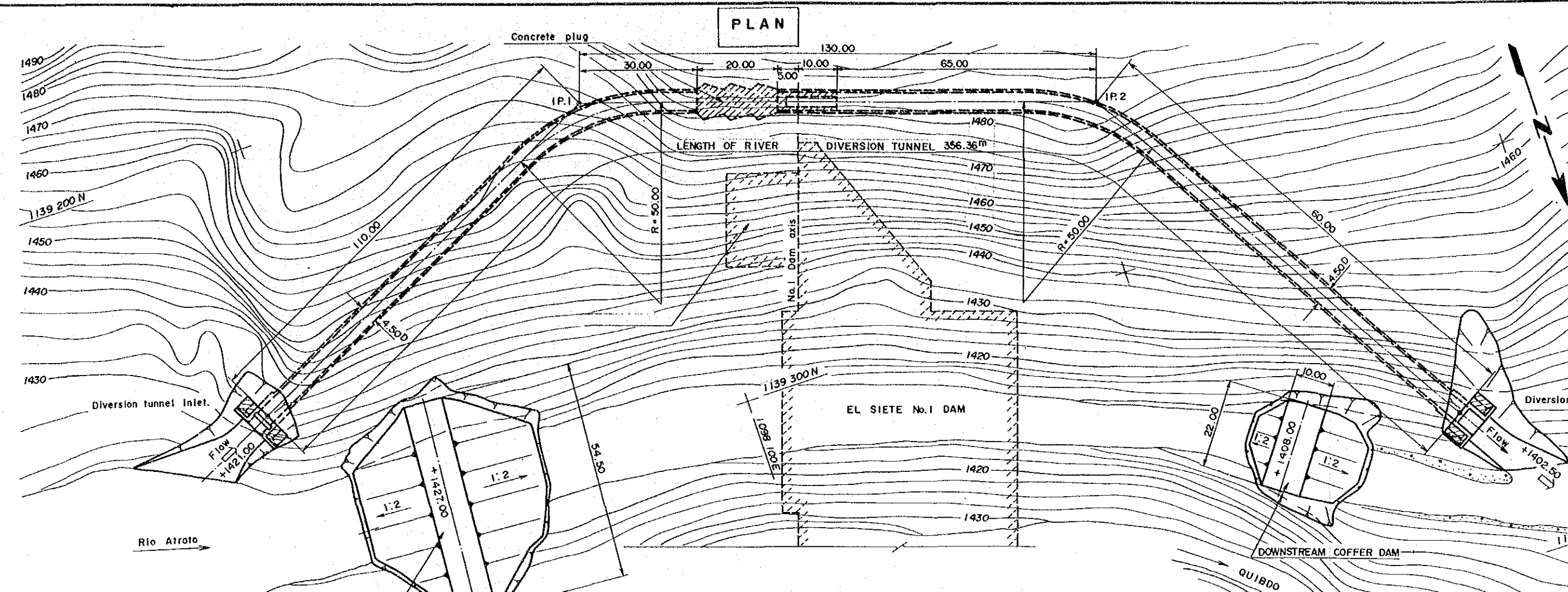
O.G.S.: Original ground surface
A.R.S.: Assumed rock surface

LOCATION	DATE	DESCRIPTION	BY
REVISION			

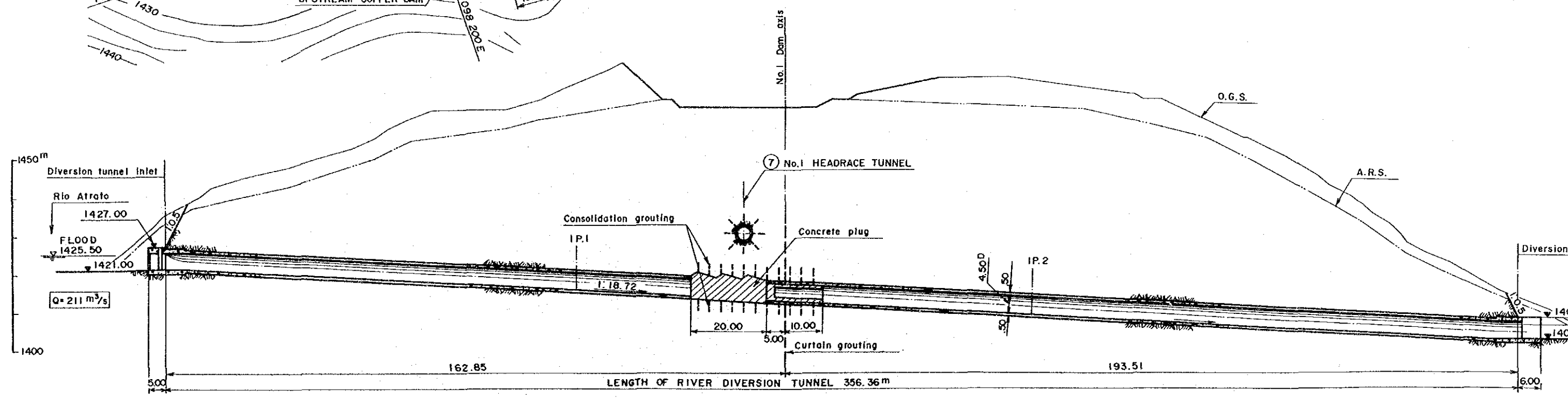
JAPAN INTERNATIONAL COOPERATION AGENCY
INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA
ATRATO HYDRO-ELECTRIC POWER PROJECT
EL SIETE NO.1 DAM
FRONT VIEW AND SECTION

ELECTRIC POWER DEVELOPMENT CO., LTD
TOKYO, JAPAN

Dwg.-18

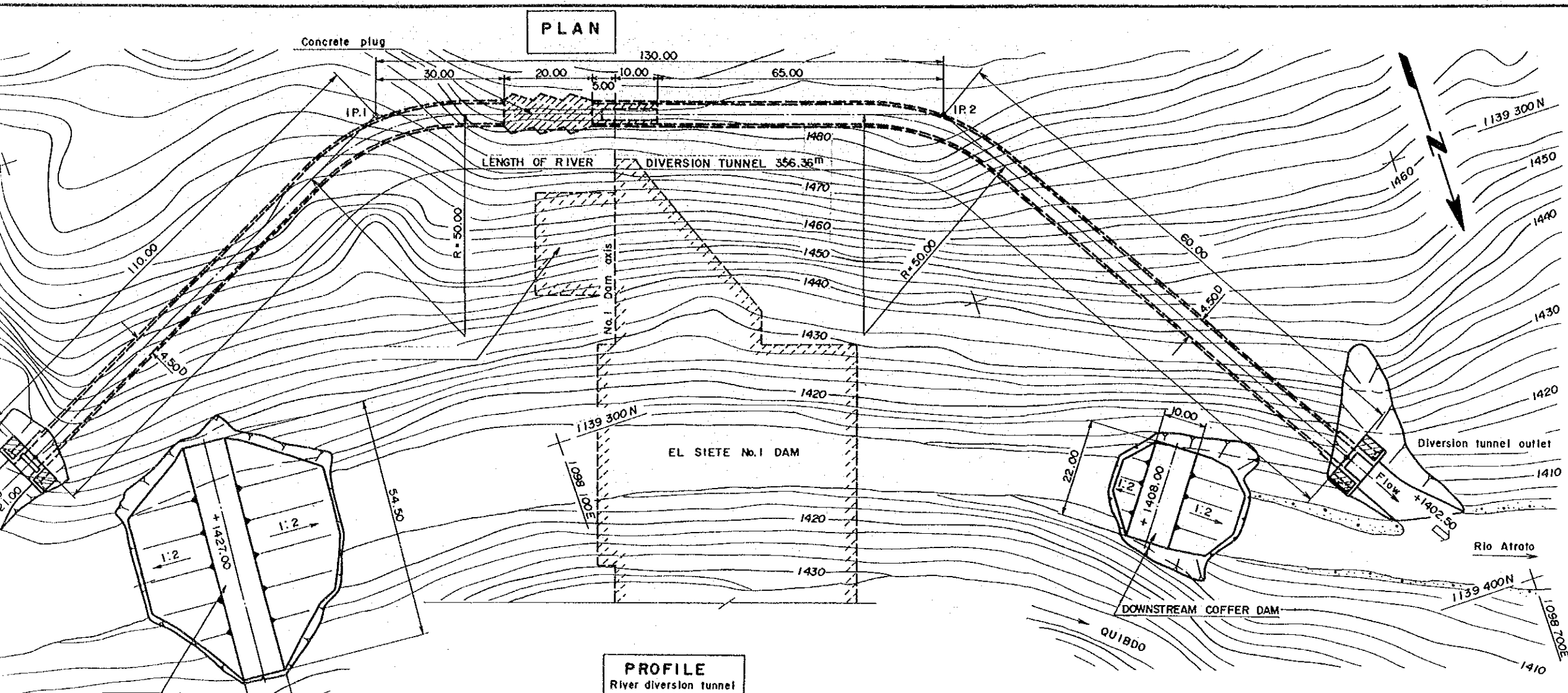


PROFILE
River diversion tunnel

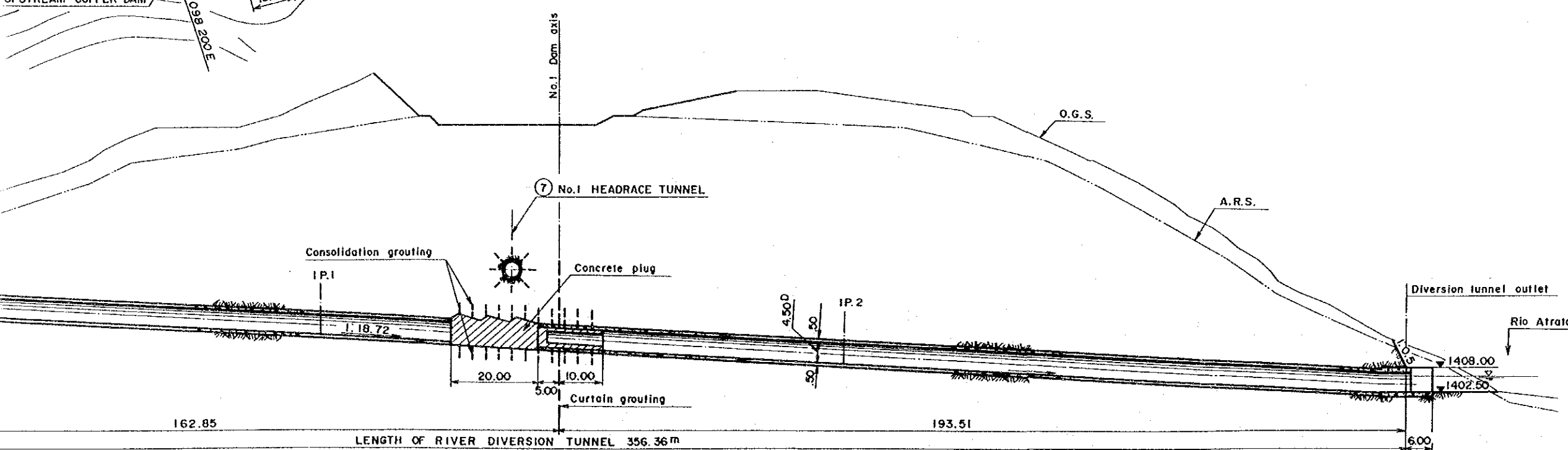


O.G.S.; Original ground surface
A.R.S.; Assumed rock surface

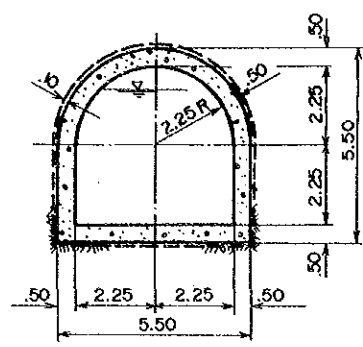
LOCATION	DATE	DES



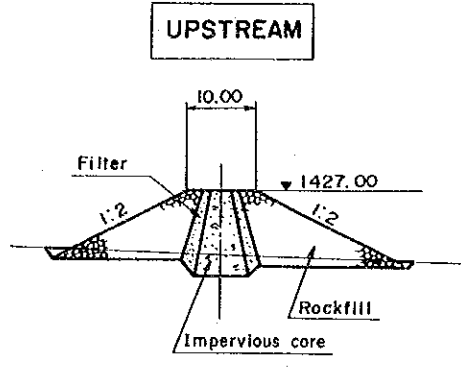
PROFILE
River diversion tunnel



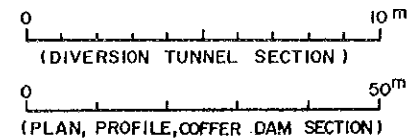
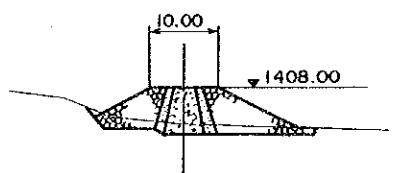
DIVERSION TUNNEL SECTION



COFFER DAM SECTION



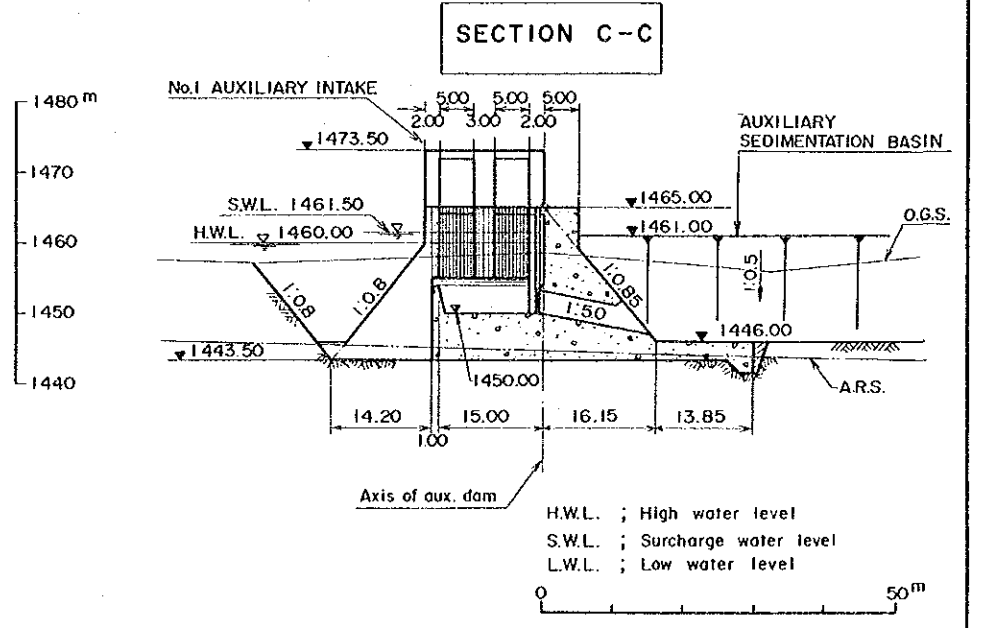
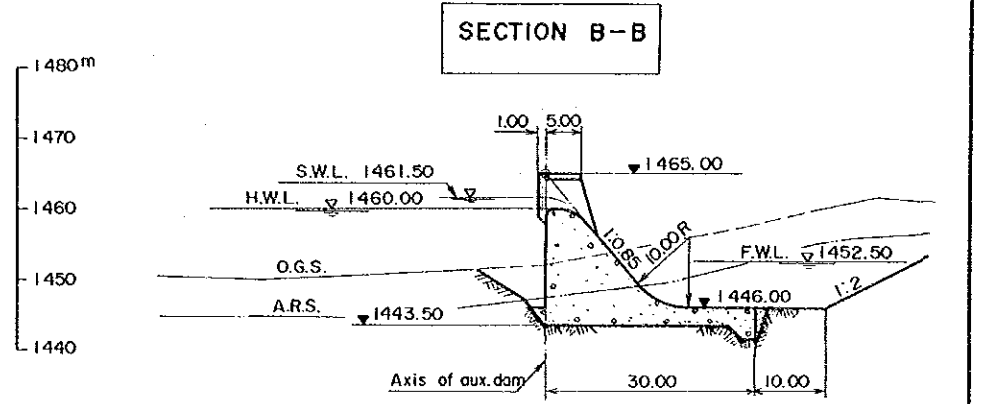
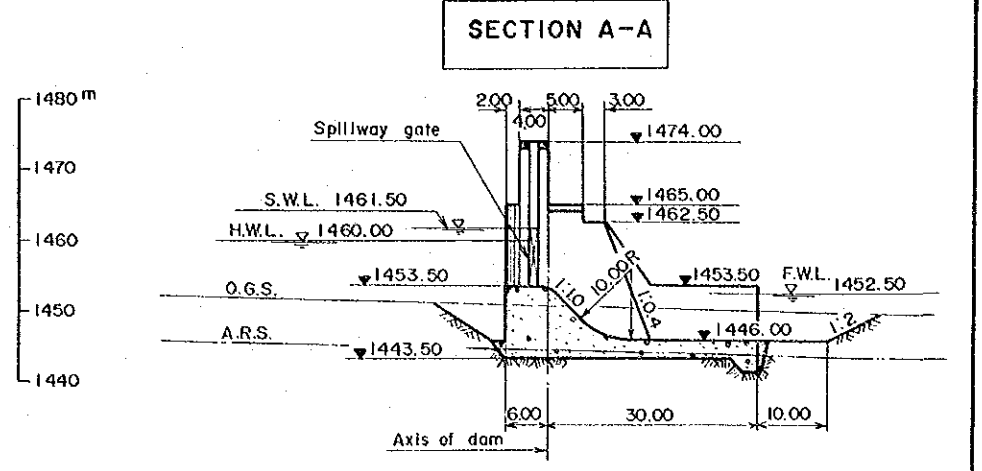
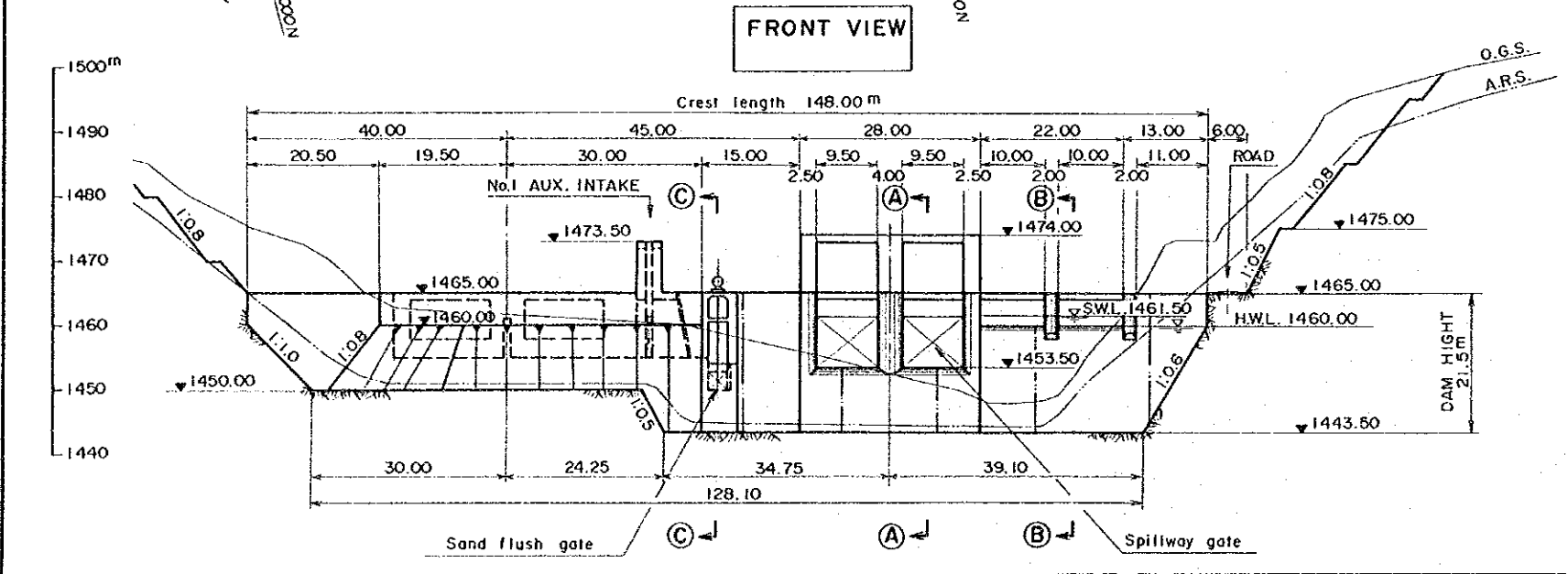
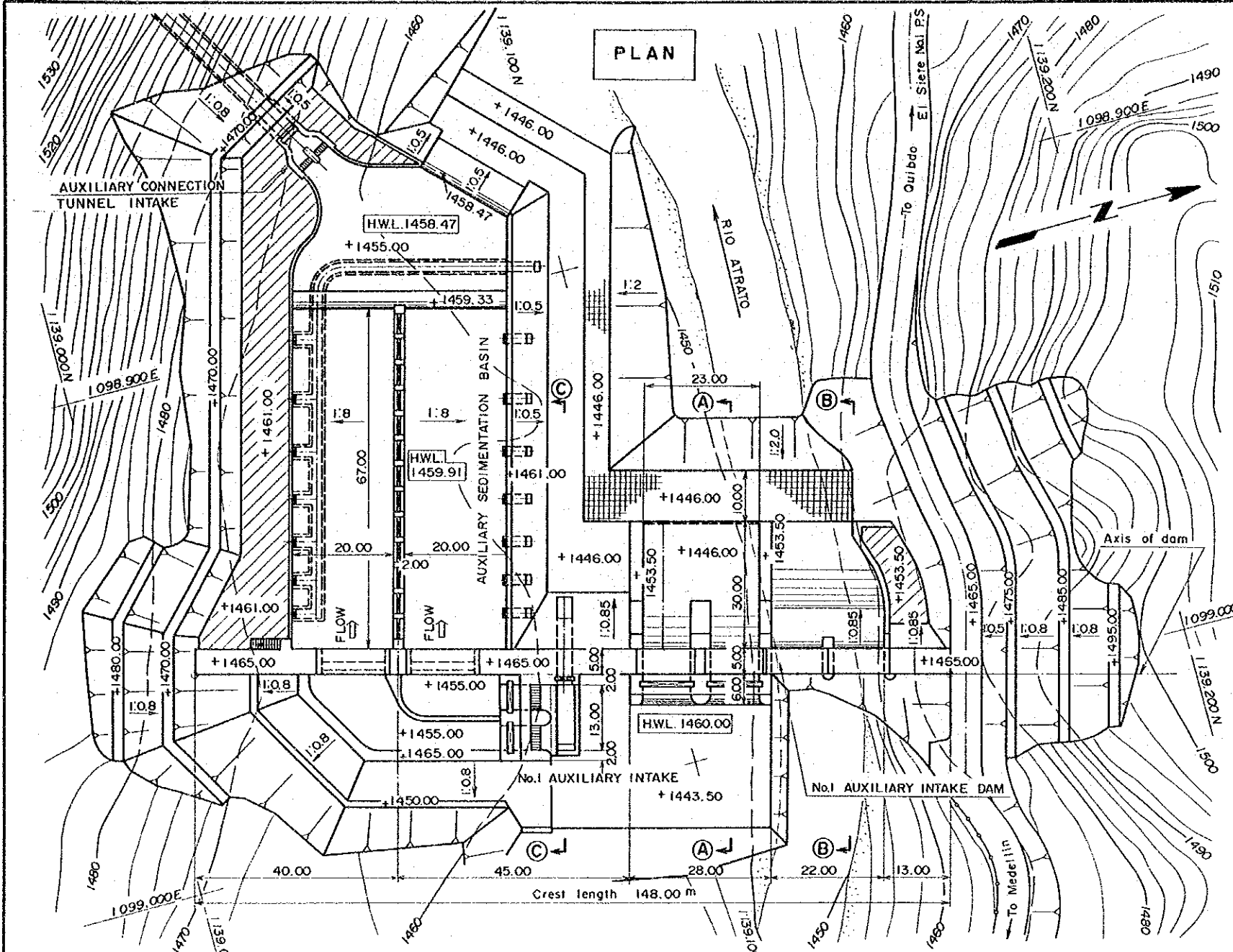
DOWNSTREAM



JAPAN INTERNATIONAL COOPERATION AGENCY
 INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA
 ATRATO HYDRO-ELECTRIC POWER PROJECT
 NO.1 DAM DIVERSION TUNNEL
 PLAN, PROFILE AND TYPICAL CROSS SECTION
 ELECTRIC POWER DEVELOPMENT CO., LTD.
 TOKYO, JAPAN

O.G.S.; Original ground surface
 A.R.S.; Assumed rock surface

LOCATION	DATE	DESCRIPTION	BY
		REVISION	



H.W.L. ; High water level
 S.W.L. ; Surcharge water level
 L.W.L. ; Low water level

0 50m

O.G.S. ; Original ground surface
 A.R.S. ; Assumed rock surface

LOCATION	DATE	DESCRIPTION	BY
REVISION			

JAPAN INTERNATIONAL COOPERATION AGENCY
 INSTITUTO COLOMBIANO DE ENERGIA ELECTRICA
 ATRATO HYDRO-ELECTRIC POWER PROJECT
 EL SIETE NO.1 AUXILIARY DAM
 PLAN, PROFILE AND SECTIONS
 ELECTRIC POWER DEVELOPMENT CO., LTD
 TOKYO, JAPAN

Dwg. - 20