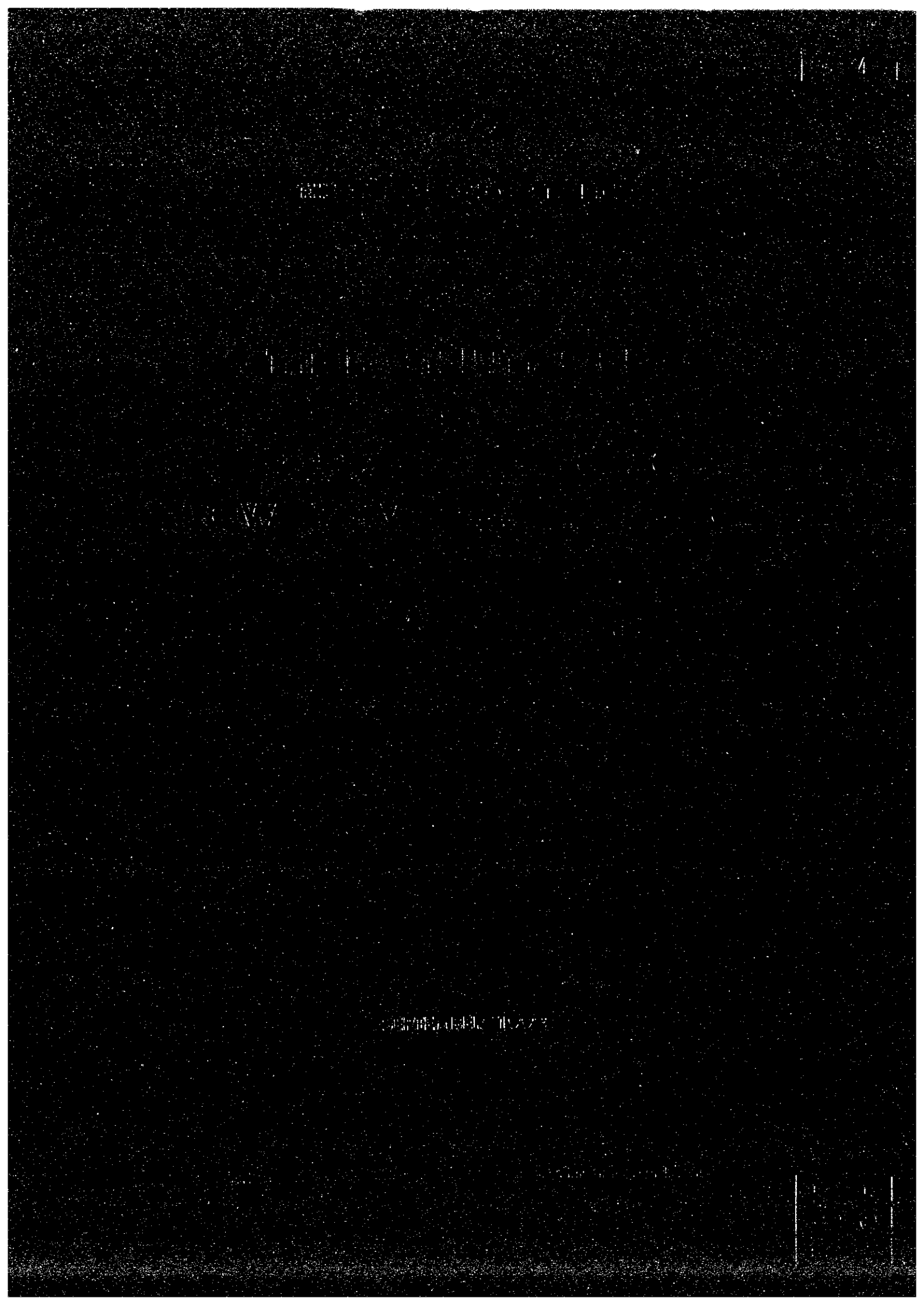

THE REPUBLIC OF COSTA RICA

THE FEASIBILITY STUDY ON PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

FINAL REPORT

APPENDIX

SEPTEMBER 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

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APPENDIX A-1 METEOROLOGY AND HYDROLOGY

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Table A-1-1 Monthly Runoff at No. 2601 Gauging Station

(1963.6 ~ 88.4)

UNIT : 10**6 M3

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1963	********	********	********	********	********	64.69	79.09	44.75	183.98	195.78	193.45	50.34	**********
1964	26.49	18.60	15.48	13.98	18.15	69.78	145.79	121.48	171.95	246.11	122.96	44.76	1015.53
1965	27.04	15.49	13.47	11.91	30.23	72.59	40.20	41.96	123.56	191.94	97.18	46.60	712.17
1966	28.97	18.40	14.52	13.22	44.32	139.22	132.67	140.89	111.06	224.48	81.92	40.44	990.11
1967	26.03	16.31	13.27	16.34	11.74	58.22	38.77	50.36	177.17	189.01	66.32	38.44	701.99
1968	21.57	17.98	11.82	12.33	55.99	132.33	113.90	132.21	248.62	234.90	170.47	73.17	1225.30
1969	41.25	28.34	27.32	22.99	28.43	63.86	53.84	153.28	211.33	482.20	254.34	102.35	1469.52
1970	43.54	24.98	23.16	32.00	60.61	102.31	125.40	190.89	238.85	313.15	153.09	65.28	1373.28
1971	45.79	20.02	17.92	14.47	78.12	93.69	92.90	177.21	293.54	363.02	113.62	43.55	1353.83
1972	27.08	16.73	14.09	17.39	55.63	47.88	30.41	66.77	116.09	187.15	92.83	35.45	707.50
1973	24.17	15.07	12.86	14.73	37.95	191.40	144.72	239.92	197.49	235.48	97.47	69.72	1280.99
1974	35.93	19.05	16.37	14.85	43.17	126.58	87.13	106.38	201.71	221.93	87.59	41.29	1001.99
1975	25.72	17.99	15.80	12.50	37.36	84.08	92.97	126.32	290.01	232.56	215.62	71.88	1222.84
1976	37.80	18.97	16.61	15.43	30.44	85.59	53.14	46.59	51.01	162.48	76.50	38.48	633.04
1977	22.61	14.45	11.21	9.81	24.31	67.64	18.77	63.96	122.09	208.72	127.53	53.40	744.49
1978	28.55	16.57	15.38	11.31	32.08	49.60	47.83	59.88	137.01	276.64	108.95	48.07	831.89
1979	32.75	21.74	19.04	32.49	96.35	164.51	79.37	111.48	312.06	341.63	222.92	63.71	1498.05
1980	31.72	19.59	13.71	11.34	34.00	79.50	65.06	115.45	152.52	195.13	143.45	52.25	913.72
1981	28.91	16.99	16.19	14.33	56.14	159.95	113.45	182.30	184.08	226.84	136.05	55.69	1190.93
1982	30.02	17.92	14.79	17.79	131.54	146.70	69.82	42.99	84.16	159.04	70.27	33.11	818.14
1983	20.97	15.13	14.19	13.84	16.10	51.34	39.76	37.78	119.30	230.13	159.52	56.28	774.34
1984	28.92	20.42	17.49	17.72	49.05	83.12	140.84	124.10	240.82	179.37	124.51	50.96	1077.33
1985	29.52	18.23	14.36	12.10	23.11	89.17	48.98	98.24	112.54	291.39	207.43	50.40	995.47
1986	25.75	17.43	13.65	11.66	47.30	59.04	41.41	29.36	60.90	154.79	52.75	28.90	542.93
1987	17.00	9.06	12.13	10.56	20.15	34.88	59.68	117.81	101.29	127.63	55.71	32.58	598.48
1988	19.31	12.65	11.19	9.93	********	********	********	********	********	********	********	********	**********
TOTAL	727.43	448.11	386.03	385.02	1062.28	2317.67	1955.91	2622.34	4243.15	5871.49	3232.46	1287.12	23673.86
MEAN	29.10	17.92	15.44	15.40	44.26	92.71	78.24	104.89	169.73	234.86	129.30	51.48	986.41
MAX	45.79	28.34	27.32	32.49	131.54	191.40	145.79	239.92	312.06	482.20	254.34	102.35	1498.05
MIN	17.00	9.06	11.19	9.81	11.74	34.88	18.77	29.36	51.01	127.63	52.75	28.90	542.93

Table A-1-2 Monthly Runoff at No. 2602 Gauging Station

(1971.5 ~ 89.4)

UNIT : 10**6 M3

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1971	********	********	********	********	9.69	13.70	14.94	27.40	37.20	36.31	17.19	9.21	**********
1972	6.28	4.46	3.41	3.25	10.99	11.40	6.49	11.27	15.96	23.70	14.63	6.93	118.76
1973	6.57	4.76	3.38	2.90	7.09	22.97	21.56	24.31	28.25	48.19	21.32	16.26	207.57
1974	8.27	5.48	4.41	3.03	8.41	16.78	13.06	15.38	21.81	30.18	16.93	13.98	157.72
1975	6.42	4.04	3.60	2.85	5.06	8.98	10.79	27.17	45.74	46.34	28.62	16.90	206.50
1976	6.67	3.14	2.18	2.61	5.19	14.29	10.75	11.94	15.39	20.10	12.65	8.12	113.05
1977	4.96	3.25	2.43	1.95	2.93	7.89	4.52	14.63	21.48	33.42	18.85	9.43	125.75
1978	4.71	3.24	2.80	2.65	4.72	7.94	9.29	14.11	22.51	32.36	17.08	9.43	130.83
1979	5.72	3.52	2.82	4.50	12.64	22.93	18.80	22.40	31.70	33.35	28.68	12.24	199.30
1980	7.60	5.14	3.76	3.04	5.01	14.14	11.06	24.88	24.34	19.64	27.10	17.85	163.56
1981	9.62	5.11	4.47	3.52	6.77	20.56	17.07	22.11	28.98	31.32	22.66	10.59	182.77
1982	6.33	4.03	3.43	3.13	9.48	16.54	11.82	9.81	15.76	22.83	15.18	8.26	126.59
1983	5.53	3.49	3.52	3.27	3.81	7.10	9.12	8.15	17.11	39.48	33.09	14.48	148.15
1984	8.71	5.61	5.13	4.01	7.20	16.26	21.80	19.43	33.38	27.04	21.42	12.04	182.03
1985	6.88	4.81	3.62	2.84	4.09	11.40	9.81	18.23	19.62	26.76	25.71	8.87	142.63
1986	5.79	3.71	3.68	3.00	5.77	10.51	10.56	5.93	8.49	20.62	8.92	5.59	92.57
1987	4.05	2.74	2.50	2.85	3.63	7.74	10.35	21.40	14.00	20.16	11.55	6.05	107.02
1988	4.84	3.00	2.49	2.35	3.71	8.12	10.91	20.76	41.67	60.59	31.03	12.42	201.88
1989	7.40	6.05	5.28	2.67	********	********	********	********	********	********	********	********	**********
TOTAL	116.34	75.57	62.90	54.41	116.19	239.24	222.70	319.31	443.39	572.40	372.60	198.65	2606.68
MEAN	6.46	4.20	3.49	3.02	6.45	13.29	12.37	17.74	24.63	31.80	20.70	11.04	153.33
MAX	9.62	6.05	5.28	4.50	12.64	22.97	21.80	27.40	45.74	60.59	33.09	17.85	207.57
MIN	4.05	2.74	2.18	1.95	2.93	7.10	4.52	5.93	8.49	19.64	8.92	5.59	92.57

Table A-1-3 Monthly Runoff at No. 2603 Gauging Station

(1971.5 ~ 88.4)

UNIT : 10**6 M3

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1971	********	********	********	********	59.73	94.04	92.40	168.90	234.47	185.40	98.90	51.23	**********
1972	32.83	20.35	17.43	18.33	64.58	60.97	39.97	67.61	91.54	133.35	91.33	47.57	685.86
1973	28.53	18.10	15.74	18.96	38.31	153.80	143.69	188.81	212.37	274.46	103.63	59.51	1255.92
1974	33.78	18.45	16.99	15.38	53.35	111.19	92.45	94.21	144.91	175.14	89.61	43.62	889.08
1975	26.53	16.91	13.94	12.77	********	********	********	********	193.54	********	********	********	**********
1976	********	********	15.98	13.77	26.95	81.74	63.26	54.58	72.94	138.26	73.59	39.51	**********
1977	23.46	15.45	13.75	12.40	24.03	52.46	28.21	65.36	109.13	160.32	95.02	47.33	646.92
1978	27.55	17.09	15.46	16.30	37.41	65.38	89.35	99.08	148.64	224.00	91.83	46.60	878.70
1979	29.12	21.55	15.42	15.51	53.52	129.51	86.37	116.66	187.89	218.06	135.67	46.74	1056.02
1980	29.62	21.40	17.65	17.40	31.69	82.74	86.31	128.17	145.12	152.06	160.07	65.91	938.12
1981	36.17	20.75	18.53	15.25	69.72	149.36	100.09	159.04	153.07	182.11	122.60	45.06	1071.76
1982	27.09	18.25	15.49	14.38	82.83	111.65	70.68	53.59	101.70	147.37	62.20	33.49	738.71
1983	21.00	14.59	15.11	15.12	16.94	48.69	39.66	41.16	164.79	211.71	161.52	68.38	818.68
1984	36.68	22.10	19.70	16.67	54.22	105.18	127.57	114.00	182.54	153.69	112.31	54.75	999.41
1985	30.13	18.32	13.70	11.40	28.07	83.01	80.71	129.69	126.13	226.44	166.70	57.32	971.61
1986	29.95	18.49	15.03	11.35	46.88	65.46	63.16	40.41	53.98	99.35	57.08	37.50	538.64
1987	22.58	13.80	13.23	13.25	32.95	41.34	64.29	112.80	67.86	129.97	70.80	38.37	621.22
1988	23.58	16.82	14.97	12.37	********	********	********	********	********	********	********	********	**********
TOTAL	458.58	292.44	268.11	250.61	721.19	1436.52	1268.18	1634.05	2390.63	2811.68	1692.87	782.88	12110.66
MEAN	28.66	18.28	15.77	14.74	45.07	89.78	79.26	102.13	140.63	175.73	105.80	48.93	865.05
MAX	36.68	22.10	19.70	18.96	82.83	153.80	143.69	188.81	234.47	274.46	166.70	68.38	1255.92
MIN	21.00	13.80	13.23	11.35	16.94	41.34	28.21	40.41	53.98	99.35	57.08	33.49	538.64

Table A-1-4 Monthly Runoff at No. 2604 Gauging Station

(1978.8 ~ 89.4)

UNIT : 10**6 M3

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1978	********	********	********	********	********	********	********	31.25	59.10	98.18	40.35	15.98	**********
1979	10.78	6.96	6.57	8.74	20.21	44.95	33.60	47.85	78.79	92.82	62.04	21.27	434.59
1980	12.72	8.68	7.75	6.58	8.78	24.43	24.21	48.95	56.88	53.00	64.03	29.12	345.10
1981	15.22	7.05	6.42	5.61	19.51	60.07	34.77	52.64	70.29	77.27	36.45	15.50	400.82
1982	10.49	7.19	6.95	6.48	19.60	32.32	21.69	17.63	27.76	47.24	24.86	14.25	236.45
1983	10.23	6.72	6.41	6.33	6.83	9.48	10.86	10.46	33.01	87.48	70.61	24.05	282.48
1984	14.50	10.00	9.31	7.85	14.41	28.33	43.56	42.77	77.79	61.07	36.06	16.92	362.57
1985	10.48	7.49	6.50	6.54	7.96	20.80	24.49	42.41	56.86	67.19	63.45	19.22	333.39
1986	11.96	8.48	8.51	7.34	13.17	22.76	23.24	14.33	19.98	57.12	21.73	13.62	222.24
1987	9.65	7.17	6.46	6.39	7.47	10.70	18.15	56.88	27.53	42.68	19.61	11.48	224.17
1988	8.44	5.22	4.78	4.18	5.97	16.64	17.52	40.66	145.45	116.18	53.54	19.02	437.59
1989	12.47	6.82	6.24	5.11	********	********	********	********	********	********	********	********	**********
TOTAL	126.96	81.77	75.90	71.14	123.89	270.49	252.10	405.84	653.43	800.23	492.75	200.44	3279.41
MEAN	11.54	7.43	6.90	6.47	12.39	27.05	25.21	36.89	59.40	72.75	44.80	18.22	327.94
MAX	15.22	10.00	9.31	8.74	20.21	60.07	43.56	56.88	145.45	116.18	70.61	29.12	437.59
MIN	8.44	5.22	4.78	4.18	5.97	9.48	10.86	10.46	19.98	42.68	19.61	11.48	222.24

Table A-1-5 Monthly Rainfall at Playon Station

(1979.1 ~ 88.12)

UNIT : MM

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1979	7.6	68.9	4.4	447.7	649.2	325.4	400.2	464.3	688.3	559.7	249.6	92.0	3957.3
1980	64.1	45.0	15.6	184.2	494.1	422.1	433.2	443.1	451.5	707.3	498.0	144.3	3902.5
1981	0.7	20.2	123.9	290.4	513.7	361.2	381.0	689.0	277.9	409.8	154.3	140.4	3362.5
1982	39.7	32.8	58.6	129.7	516.0	452.2	207.7	219.9	644.3	518.9	116.4	4.4	2940.6
1983	0.2	21.3	180.8	79.7	188.5	165.3	294.3	280.0	765.7	461.3	701.7	134.5	3273.3
1984	49.4	165.4	57.9	157.2	578.1	524.8	430.7	453.2	468.3	557.5	201.1	2.5	3646.1
1985	1.2	0.3	4.3	99.5	406.5	383.8	419.1	679.1	524.5	955.8	200.2	105.1	3779.4
1986	0.6	6.5	6.2	125.5	766.1	335.5	327.5	335.3	586.3	551.6	232.0	43.0	3316.1
1987	0.6	16.9	110.0	263.5	466.6	559.1	455.1	359.3	335.9	449.2	307.0	127.9	3451.1
1988	39.8	17.8	65.5	163.5	450.4	514.0	514.6	630.6	649.4	1159.3	471.7	75.8	4752.4
TOTAL	203.9	395.1	627.2	1940.9	5029.2	4043.4	3863.4	4553.8	5392.1	6330.4	3132.0	869.9	36381.3
MEAN	20.4	39.5	62.7	194.1	502.9	404.3	386.3	455.4	539.2	633.0	313.2	87.0	3638.1
MAX	64.1	165.4	180.8	447.7	766.1	559.1	514.6	689.0	765.7	1159.3	701.7	144.3	4752.4
MIN	0.2	0.3	4.3	79.7	188.5	165.3	207.7	219.9	277.9	409.8	116.4	2.5	2940.6

Table A-1-6 Monthly Rainfall at El Cañon Station

(1956.11 ~ 88.12)

UNIT : MM

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1956										349.8	80.7	101.0	531.5
1957	9.1	10.5		17.2	247.5	84.8	124.5	136.8		34.2	44.5	19.7	728.8
1958	29.3	0.5	26.8	17.4	74.9	203.2	222.8	264.3	230.2	200.8	62.0	1.4	1333.6
1959						368.8	192.9	267.0	245.7	374.8	99.5	28.0	1576.7
1960	37.5	27.3	33.1	31.0	211.2	183.3	302.1	269.3	330.7	511.9	91.4	44.4	2073.2
1961	7.3	11.0	5.7	68.4	159.0	282.0	237.2	157.5	422.3	239.1	210.1	115.4	1915.0
1962	21.8	4.7	6.5	64.1	249.8	384.7	240.0	207.8	318.0	368.3	204.7	60.5	2130.9
1963	5.2	22.0	27.7	80.6	160.3	205.4	171.6	265.2	419.3	402.8	241.2	20.0	2021.3
1964	5.0	0.6	0.0	46.3	89.7	290.3	373.0	325.0	326.7	311.2	110.6	26.1	1904.5
1965	17.4	6.9	3.3	3.6	332.6	249.3	135.9	192.0	309.6	292.9	128.3	78.4	1750.2
1966	13.8	9.4	20.4	22.4	298.5	412.0	263.3	252.8	196.1	299.5	70.4	109.1	1967.7
1967	12.9	1.7	2.6	98.1	76.5	282.2	83.8	254.0	294.2	178.1	78.7	19.6	1382.4
1968	16.4	61.6	26.0	29.0	195.5	174.3	138.0	167.6	317.8	266.4	124.6	25.9	1543.1
1969	33.9	7.9	58.1	81.2	158.1	155.0	209.6	414.6	354.6	445.7	279.8	75.6	2274.1
1970	89.0	38.4	95.0	261.4	191.3	152.8	254.6	311.8	358.2	300.3	195.7	341.7	2590.2
1971	79.5	26.5	46.8	41.4	271.2	248.6	159.9	264.9	375.1	439.5	131.6	15.1	2100.1
1972	56.7	10.7	3.9	33.3	327.6	211.2	128.4	308.7	248.4	264.1	152.3	93.7	1839.0
1973	24.1	10.3	0.0	18.3	293.5	443.6	249.5	424.2	289.2	411.4	242.8	149.2	2556.1
1974	39.3	13.9	9.4	30.3	430.8	373.2	191.3	296.2	292.6	346.4	68.5	96.8	2188.7
1975	12.2	2.2	31.0	4.7	242.1	280.8	211.5	421.3	531.1	341.9	282.9	194.5	2556.2
1976	44.2	27.8	7.7	111.0	457.4	433.1	309.9	248.9	259.4	286.0	157.5	37.2	2380.1
1977	13.1	4.9	7.7	10.3	232.6	269.6	106.7	373.5	261.2	328.5	135.5	49.9	1793.5
1978	9.5	22.2	35.8	57.4	265.8	152.2	208.9	272.7	445.6	353.2	121.1	58.8	2003.2
1979	31.3	12.4	6.4	292.8	333.4	438.5	270.2	381.8	372.4	387.6	180.4	101.5	2808.7
1980	60.7	25.5	4.5	30.9	258.9	399.0	232.7	345.1	385.4	249.1	277.3	155.3	2424.4
1981	29.8	18.4	43.1	81.4	415.1	312.8	192.4	376.8	325.1	410.0	261.9	50.0	2516.8
1982	32.5	6.9	8.2	53.0	541.7	316.9	221.5	136.7	338.3	321.5	105.8	15.4	2098.4
1983	13.4	15.2	64.2	34.3	175.8	291.0	188.7	236.1	356.0	442.7	349.1	71.3	2237.8
1984	71.5	63.6	14.0	66.7	276.0	330.7	369.6	281.3	340.9	212.4	150.3	62.2	2239.2
1985	8.2	14.3	5.9	31.9	176.2	345.1	294.0	336.4	266.1	463.7	143.9	32.1	2117.8
1986	38.0	13.2	57.5	37.3	346.0	288.5	166.7	129.4	233.0	344.0	76.8	34.3	1764.7
1987	28.0	3.3	36.4	140.4	167.5	296.6	276.5	329.5	248.1	316.2	69.0	49.3	1960.8
1988	98.5	8.3	33.5	65.0	233.9	351.7	247.5	439.5	592.6	601.6	93.7	76.3	2842.1
TOTAL	989.1	502.1	721.2	1961.1	7890.4	9211.2	6975.2	9088.7	10283.9	11095.6	5022.6	2409.7	66150.8
MEAN	31.9	16.2	25.8	63.3	254.5	287.8	218.0	284.0	331.7	336.2	152.2	73.0	2004.6
MAX	98.5	63.6	95.0	292.8	541.7	443.6	373.0	439.5	592.6	601.6	349.1	341.7	2842.1
MIN	5.0	0.5	2.6	3.6	74.9	84.8	83.8	129.4	196.1	34.2	44.5	1.4	531.5

Table A-1-7 Monthly Rainfall at Copey de Dota Station

(1981.6 ~ 87.12)

UNIT : MM

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1981						311.8	228.5	364.2	439.8	373.7	112.4	6.2	1836.6
1982	16.6	0.6	6.2	87.6	436.0	279.5	173.8	86.2	311.2	286.6	75.7	30.5	1790.5
1983	8.0	30.3	51.5	33.4	146.7	370.3	236.1	213.6	394.5	447.2	258.2	65.3	2255.1
1984	6.0	76.8	30.1	81.1	276.6	329.6	354.4	344.4	369.1	312.2	125.3	9.5	2315.1
1985	2.0	1.0	0.8	24.9	250.5	382.9	257.1	341.0	213.6	397.2	98.2	9.0	1978.2
1986	12.6	9.7	20.5	47.7	288.0	310.3	120.7	116.1	218.9	290.6	37.1	17.9	1490.1
1987	2.5	7.3	26.6	102.5	178.2	349.2	237.3	327.1	212.4	342.7		26.5	1812.3
TOTAL	47.7	125.7	135.7	377.2	1576.0	2333.6	1607.9	1792.6	2159.5	2450.2	706.9	164.9	13477.9
MEAN	7.9	20.9	22.6	62.9	262.7	333.4	229.7	256.1	308.5	350.0	117.8	23.6	1925.4
MAX	16.6	76.8	51.5	102.5	436.0	382.9	354.4	364.2	439.8	447.2	258.2	65.3	2315.1
MIN	2.0	0.6	0.8	24.9	146.7	279.5	120.7	86.2	212.4	286.6	37.1	6.2	1490.1

Table A-1-8 Daily Temperature at Playon Station

(1978.1 ~ 84.12, 1986.1 ~ 87.12)

UNIT : C

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1978	20.2	22.9	22.3	23.6	23.7	23.2	22.4	22.7	22.3	22.4	22.7	22.3	22.6
1979	20.7	21.0	21.8	23.4	23.6	23.3	23.0	23.2	22.8	23.1	22.9	22.7	22.6
1980	25.5	24.0	22.6	25.0	25.2	23.5	23.0	22.6	24.2	23.3	22.9	25.2	23.9
1981	27.7	28.9	29.5	28.6	25.9	24.9	23.3	22.7	22.4	22.5	22.9	23.4	25.2
1982	23.0	28.6	31.1	29.1	25.3	24.7	23.8	24.1	23.9	24.0	25.1	28.1	25.9
1983	32.1	32.5	31.8	30.9	30.1	25.6	25.2	24.7	24.3	24.1	23.8	23.0	27.3
1984	22.0	22.8	22.8	24.2	23.8	22.7	23.0	23.1	22.9	23.1	24.9	22.6	23.2
1985	********	********	********	********	********	********	********	********	********	********	********	********	**********
1986	20.9	22.4	24.9	25.2	25.0	24.2	24.1	24.1	24.3	23.9	24.1	23.0	23.8
1987	23.6	23.4	24.1	24.3	24.1	24.3	23.6	23.4	23.6	23.3	23.0	22.5	23.6
MEAN	24.0	25.2	25.7	26.0	25.2	24.0	23.5	23.4	23.4	23.3	23.6	23.6	24.2
MAX	32.1	32.5	31.8	30.9	30.1	25.6	25.2	24.7	24.3	24.1	25.1	28.1	27.3
MIN	20.2	21.0	21.8	23.4	23.6	22.7	22.4	22.6	22.3	22.4	22.7	22.3	22.6

Table A-1-9 Daily Relative Humidity at Playon Station

(1978.1 ~ 84.12, 1986.1 ~ 87.12)

UNIT : %

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1978	97.9	88.9	96.2	92.0	95.4	94.6	96.5	95.7	96.6	97.8	96.0	93.1	95.0
1979	95.0	95.4	97.8	95.7	96.2	95.6	97.3	96.4	97.7	97.6	94.8	98.0	96.5
1980	68.5	71.9	67.7	70.1	85.7	96.0	96.5	96.9	85.0	89.5	89.8	73.1	82.6
1981	57.6	53.3	54.8	61.2	84.3	80.0	84.0	86.0	89.8	96.4	93.2	86.3	77.3
1982	82.3	59.5	47.5	58.5	81.5	85.6	87.9	85.9	82.4	82.8	76.5	59.9	74.2
1983	42.1	40.1	48.6	52.9	59.1	80.0	80.5	83.3	85.5	89.4	90.5	86.7	69.9
1984	86.9	82.4	83.1	78.3	84.0	90.2	87.7	91.1	92.1	92.3	87.3	86.7	86.8
1985	********	********	********	********	********	********	********	********	********	********	********	********	**********
1986	87.5	80.4	71.2	76.6	84.7	86.9	87.4	87.2	86.6	91.0	87.4	85.3	84.3
1987	78.3	79.3	80.3	85.4	89.5	88.9	91.3	91.7	91.9	92.2	92.3	92.7	87.8
MEAN	77.3	72.4	71.9	74.5	84.5	88.6	89.9	90.5	89.7	92.1	89.7	84.6	83.8
MAX	97.9	95.4	97.8	95.7	96.2	96.0	97.3	96.9	97.7	97.8	96.0	98.0	96.5
MIN	42.1	40.1	47.5	52.9	59.1	80.0	80.5	83.3	82.4	82.8	76.5	59.9	69.9

Table A-1-10 Daily Vapor Pressure at Playon Station

(1978.1 ~ 84.12, 1986.1 ~ 87.12)

UNIT : MMHG

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1978	17.5	18.0	19.5	19.9	21.0	20.4	19.7	19.9	19.5	19.9	19.9	18.7	19.5
1979	17.4	17.9	19.2	20.8	21.1	20.6	20.7	20.5	20.5	20.8	20.1	20.4	20.0
1980	15.1	15.6	13.8	16.5	20.1	20.9	20.4	19.9	19.0	19.2	18.7	17.0	18.0
1981	15.1	15.2	16.4	17.2	19.1	18.8	18.0	17.8	18.2	19.8	19.5	18.4	17.8
1982	16.9	16.1	15.8	17.3	19.4	19.7	19.3	19.2	18.2	18.3	17.8	16.1	17.8
1983	14.6	14.7	16.7	17.0	18.5	19.3	19.3	19.5	19.5	20.2	20.2	18.4	18.2
1984	17.4	17.2	17.4	17.8	18.6	18.8	18.6	19.4	19.4	19.7	18.8	17.9	18.4
1985	********	********	********	********	********	********	********	********	********	********	********	********	**********
1986	16.3	16.4	16.7	18.3	20.1	19.8	19.9	19.8	19.9	20.3	19.8	17.9	18.8
1987	17.2	17.1	18.2	19.6	20.2	20.4	20.0	19.9	20.2	19.9	19.6	19.1	19.3
MEAN	16.4	16.5	17.1	18.3	19.8	19.8	19.5	19.5	19.4	19.8	19.4	18.2	18.6
MAX	17.5	18.0	19.5	20.8	21.1	20.9	20.7	20.5	20.5	20.8	20.2	20.4	20.0
MIN	14.6	14.7	13.8	16.5	18.5	18.8	18.0	17.8	18.2	18.3	17.8	16.1	17.8

Table A-1-11 Hourly Rainfall at Playon Station

(1988.9,10)

Hourly Precipitation Data
Station PLAYON
Period 10 to 15 Sep. 1988

Time \ Date	10	11	12	13	14	15 (mm)
8	0.0	0.0	0.0	0.0	8.7	0.0
9	0.0	0.0	0.0	4.2	2.0	0.0
10	0.0	0.0	0.0	26.0	0.8	0.0
11	0.0	0.0	0.0	7.4	2.2	0.0
12	4.6	0.0	0.0	2.5	1.8	0.0
13	0.0	0.0	0.0	1.6	5.5	0.0
14	0.0	0.0	0.0	6.7	6.7	0.0
15	24.0	0.0	0.4	2.5	0.8	0.0
16	8.6	0.0	0.0	4.3	0.0	0.0
17	7.5	0.0	0.0	3.0	0.0	0.0
18	3.6	0.0	0.0	1.4	0.0	0.0
19	0.0	1.2	2.5	6.3	0.0	1.2
20	0.0	2.2	0.0	5.3	0.0	0.0
21	0.4	3.5	0.8	4.2	0.0	0.0
22	0.3	0.3	15.8	6.0	0.0	0.0
23	0.1	0.0	8.0	5.5	0.0	0.0
24	0.0	0.0	9.7	5.1	0.0	0.0
1	0.0	0.0	3.2	5.5	0.0	0.0
2	0.0	0.2	4.7	3.5	0.0	0.0
3	0.0	1.3	5.7	8.7	0.0	0.0
4	0.0	0.0	4.3	12.3	0.0	0.0
5	0.0	0.0	8.0	5.7	0.0	0.0
6	0.0	0.0	5.3	32.0	0.0	0.0
7	0.0	0.0	7.0	5.0	0.0	0.0
Total	49.1	8.7	75.4	164.7	28.5	1.2

Period 17 to 25 Oct. 1988

Time \ Date	17	18	19	20	21	22	23	24	25 (mm)
8	0.0	0.0	0.4	0.0	0.0	20.1	0.8	0.0	0.0
9	0.0	0.0	0.9	0.0	0.0	11.8	2.5	0.0	0.0
10	0.0	0.0	1.9	0.0	0.0	15.8	0.5	0.0	0.0
11	0.0	0.0	0.7	0.0	0.0	8.0	0.0	0.0	0.0
12	0.2	0.0	0.8	0.0	0.0	24.0	0.0	0.0	0.0
13	0.1	36.4	0.6	0.0	0.0	18.8	0.9	0.0	0.7
14	5.7	23.3	0.1	0.0	0.0	1.3	6.0	31.2	7.6
15	8.0	4.4	0.8	0.0	0.2	3.5	2.0	4.7	3.1
16	1.0	4.7	0.0	1.7	0.9	6.0	0.2	1.5	0.2
17	0.1	5.1	0.2	0.0	0.0	2.3	0.8	0.6	1.5
18	0.0	1.8	0.5	0.0	0.0	0.0	0.0	0.2	0.9
19	0.0	0.5	0.4	0.0	0.0	6.5	0.3	1.8	13.0
20	0.0	0.0	0.4	0.0	0.0	21.3	0.3	16.7	0.5
21	0.0	0.0	0.1	0.0	0.0	16.4	0.2	17.9	9.4
22	0.0	0.0	0.1	0.0	0.0	21.3	0.0	4.3	4.5
23	0.0	0.3	0.0	0.0	0.0	15.0	0.0	0.0	0.6
24	0.0	0.2	0.0	0.0	0.0	11.8	0.0	0.0	1.2
1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.4
2	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	2.6	3.6	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	23.4	5.8	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	34.2	5.6	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	29.7	24.1	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	5.4	8.6	0.0	0.0	0.0
Total	15.1	76.7	7.9	1.7	96.4	252.3	14.5	78.9	43.6

Table A-1-12 Hourly Rainfall at El Cañon Station

(1988.9,10)

Hourly Precipitation Data
Station EL CANON
Period 10 to 15 Sep. 1988

Time \ Date	10	11	12	13	14	15 (mm)
8	0.0	0.0	0.0	6.8	3.1	0.0
9	0.0	0.0	0.0	9.8	0.7	0.0
10	0.0	0.0	0.0	10.5	1.5	0.0
11	0.0	0.0	0.0	7.5	2.6	0.0
12	0.0	0.0	0.6	8.3	1.3	0.0
13	1.5	0.6	6.6	2.8	2.1	0.0
14	0.2	0.0	10.5	2.0	0.9	0.0
15	0.7	0.3	2.1	2.9	0.6	0.0
16	5.1	0.0	1.4	1.5	0.0	0.0
17	6.3	7.8	0.6	3.8	0.0	0.0
18	7.7	0.1	0.4	1.8	0.1	0.1
19	0.5	0.3	2.2	4.0	0.0	0.0
20	0.1	0.9	2.1	9.0	0.0	0.0
21	0.0	5.0	0.5	3.6	0.0	0.0
22	0.0	5.4	1.5	1.7	0.0	0.0
23	0.0	0.0	7.4	0.8	0.0	0.0
24	0.0	0.0	4.0	2.5	0.0	0.0
1	0.1	0.0	13.7	1.2	0.1	0.0
2	0.0	0.1	2.0	0.3	0.0	0.0
3	0.1	1.9	2.5	0.4	0.0	0.0
4	0.1	1.2	14.2	0.4	0.0	0.0
5	0.0	0.3	3.7	1.2	0.0	0.0
6	0.0	0.3	9.5	0.9	0.0	0.0
7	0.0	0.0	8.6	0.7	0.0	0.0
Total	22.4	24.2	94.1	84.4	13.0	0.1

Period 17 to 25 Oct. 1988

Time \ Date	17	18	19	20	21	22	23	24	25 (mm)
8	0.3	0.0	5.3	0.0	0.0	13.0	0.3	0.0	0.0
9	0.0	0.0	4.1	0.1	0.0	16.0	0.0	0.0	0.1
10	0.0	0.0	3.1	0.0	0.0	21.9	0.0	0.0	0.0
11	0.0	0.0	4.2	0.0	0.0	18.3	5.4	0.1	0.0
12	0.0	0.0	4.0	0.0	0.0	9.6	7.7	0.0	0.0
13	0.0	0.0	2.6	0.1	0.0	21.9	1.4	0.0	0.0
14	0.0	0.3	0.2	0.0	0.1	20.5	1.0	0.0	0.0
15	1.1	0.4	0.0	0.2	0.0	32.0	0.6	0.0	3.5
16	4.7	4.6	0.1	0.0	0.0	18.3	0.9	3.2	3.6
17	0.2	15.2	0.1	0.0	0.0	3.2	2.1	1.2	0.0
18	0.5	5.2	0.3	0.0	0.0	4.2	0.6	1.1	0.0
19	0.1	0.3	0.1	0.0	0.0	3.0	0.2	3.7	0.1
20	0.0	0.0	0.2	0.0	0.0	2.8	0.0	16.0	0.0
21	0.0	0.0	0.0	0.0	0.0	2.5	0.0	1.4	0.0
22	0.0	0.2	0.1	0.0	0.2	1.3	0.0	0.6	0.1
23	0.0	0.0	0.3	0.0	0.8	11.2	0.0	0.3	0.0
24	0.0	0.0	0.1	0.0	1.1	4.0	0.1	0.1	0.0
1	0.0	0.1	0.5	0.0	0.2	0.2	0.0	0.0	0.0
2	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0
3	0.0	0.0	0.0	0.0	2.3	0.1	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	4.8	0.1	0.0	0.1	0.0
5	0.0	0.2	0.0	0.0	6.3	0.2	0.1	0.0	0.0
6	0.1	2.0	0.0	0.0	5.4	0.2	0.0	0.0	0.1
7	0.0	2.1	0.0	0.0	6.4	0.1	0.0	0.1	0.0
Total	7.1	30.6	25.3	0.4	27.7	204.7	20.5	27.9	7.5

Table A-1-13 Hourly Rainfall at Copey de Dota Station

(1988.9,10)

Hourly Precipitation Data
Station Copey de Dota
Period 12 to 15 Sep. 1988

Time \ Date	12	13	14	15
				(mm)
8		6.2	1.4	0.0
9		8.9	1.5	0.0
10		9.5	0.1	0.0
11		6.8	1.7	0.0
12		7.5	0.0	0.0
13	1.8	2.5	0.0	0.0
14	6.1	1.8	0.3	0.0
15	9.8	2.6	0.1	0.0
16	0.4	1.4	0.2	0.0
17	0.7	3.4	0.0	0.0
18	0.5	1.6	0.0	0.0
19	0.5	3.6	0.0	0.0
20	0.9	8.2	0.0	0.0
21	0.1	3.3	0.0	0.0
22	1.0	1.5	0.0	0.0
23	5.7	0.7	0.0	0.0
24	3.7	2.3	0.0	0.0
1	11.8	1.1	0.0	0.0
2	2.3	0.3	0.0	0.0
3	2.1	0.4	0.1	0.0
4	13.5	0.4	0.0	0.0
5	9.3	1.1	0.0	0.0
6	6.8	0.8	0.0	0.0
7	7.3	0.6	0.1	0.0
Total	84.3	76.5	5.5	0.0

Period 17 to 25 Oct. 1988

Time \ Date	17	18	19	20	21	22	23	24	25
									(mm)
8	0.0	0.0	3.5	0.0	0.0	13.7	0.0	0.0	0.0
9	0.0	0.0	2.7	0.0	0.0	17.1	0.0	0.0	0.0
10	0.0	0.0	2.0	0.0	0.0	23.1	0.1	0.0	0.0
11	0.0	1.2	2.7	0.0	0.0	19.3	6.2	0.3	0.0
12	0.0	2.3	2.6	0.0	0.0	10.1	15.4	0.0	0.0
13	0.0	0.0	1.7	0.0	0.0	23.1	15.4	0.0	0.0
14	0.5	1.4	0.1	0.0	0.2	21.6	1.6	0.0	0.0
15	0.2	0.0	0.0	0.0	0.0	33.7	0.1	0.0	0.0
16	4.0	1.3	0.1	0.0	0.0	19.3	0.1	8.0	14.2
17	3.2	4.1	0.1	0.0	0.0	3.4	1.6	3.0	2.7
18	2.6	7.6	0.2	0.0	0.0	4.4	0.0	2.8	0.2
19	2.1	3.3	0.1	0.0	0.0	3.2	0.1	9.3	0.0
20	0.2	0.3	0.1	0.0	0.0	3.0	0.0	40.2	0.0
21	0.1	0.0	0.0	0.0	0.0	2.6	0.0	3.5	0.1
22	0.0	0.0	0.1	0.0	0.0	1.4	0.0	1.5	0.0
23	0.0	0.1	0.2	0.0	0.3	11.8	0.0	0.8	0.0
24	0.0	0.2	0.1	0.0	0.2	4.2	0.1	0.3	0.1
1	0.1	0.0	0.3	0.0	0.0	0.2	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	2.8	0.1	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	6.4	0.1	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	5.1	0.1	0.0	0.2	0.1
5	0.0	0.2	0.0	0.0	5.0	0.2	0.0	0.0	0.0
6	0.0	1.3	0.0	0.0	4.6	0.2	0.1	0.0	0.0
7	0.0	1.3	0.0	0.0	1.9	0.1	0.0	0.2	0.1
Total	13.0	24.6	16.6	0.0	26.5	216.0	40.8	70.1	17.5

Table A-1-14 Hourly Flood Discharge at No. 2604 Gauging Station

(1988.9)

Hourly Flood Discharge
Station No. 2604 G. S.
Period 11 to 16 Sep. 1988

Time \ Date	11	12	13	14	15	16 (m³/s)
0	60.44	47.92	62.91	275.75	144.11	78.58
2	50.17	42.65	128.07	250.77	139.98	75.83
4	47.92	39.71	128.07	235.96	131.96	73.16
6	46.83	37.85	224.78	235.96	124.26	70.54
8	45.75	37.85	579.55	250.77	113.27	67.99
10	43.66	37.85	710.36	256.87	109.76	65.50
12	42.65	37.85	569.01	235.96	106.32	62.91
14	37.85	38.77	590.23	216.22	101.30	60.44
16	37.85	47.92	434.63	195.06	93.30	50.17
18	40.67	47.92	352.94	182.56	85.73	49.04
20	47.92	46.83	316.27	170.62	82.82	49.04
22	44.70	46.83	309.26	159.21	81.39	48.48

APPENDIX A-2 POWER DEMAND FORECAST AND SUPPLY PROGRAM

APPENDIX A-2 POWER DEMAND FORECAST AND SUPPLY PROGRAM

Contents

Appendix A-2-1 Power (kW) Balance of Demand and Supply (with consideration of daily load curve)

Year	① (MW) Peak-Demand	② (MW) Hydro Depembable Peak Capacity	③ (MW) Thermal Available Capacity	④ (MW) Maximum Thermal Unit Capacity	⑤ (MWh) Hydro Dependable Daily Energy	⑥ (MW) Hydro, +Thermal Available Capacity	⑦ (MWh) Daily Energy Demand	⑧ (MWh) Thermal Daily Available Energy	⑨ (MWh) Hydro+Thermal Daily Available Energy	⑥−① / ①×100(%)
								(③−④)×24	(⑤+⑧)	
1990	682	639.0	142.3	21	7,796.2	684.8	10,614.0	2,911.2	10,707.4	0.4
91	744	651.2	243.2	36	8,089.0	804.6	11,606.4	4,972.8	13,061.8	8.1
92	781	651.2	236.1	36	8,089.0	810.5	12,183.6	4,802.4	12,891.4	3.8
93	826	683.2	265.0	36	8,472.6	871.2	12,885.6	5,496.0	13,968.6	5.5
94	877	687.2	312.9	55	8,568.5	921.9	13,681.2	6,189.6	14,758.1	5.1
95	933	727.2	360.8	55	9,010.4	1,007.8	14,554.8	7,339.2	16,349.6	8.0
96	991	727.2	417.7	55	9,010.4	1,085.0	15,459.6	8,704.8	17,715.2	9.5
97	1,054	727.2	442.6	55	9,010.4	1,114.8	16,442.4	9,302.4	18,312.8	5.8
98	1,119	851.1	435.5	55	10,269.0	1,200.0	17,456.4	9,132.0	19,401.0	7.2
99	1,188	851.1	428.4	55	10,269.0	1,217.1	18,532.8	8,961.6	19,230.6	2.4
2000	1,261	851.1	485.3	55	10,269.0	1,281.4	19,671.6	10,327.2	20,596.2	1.6
01	1,336	977.1	478.2	55	10,899.2	1,344.9	20,841.6	10,156.8	21,056.0	0.7
02	1,413	977.1	526.1	55	10,899.2	1,419.8	22,042.8	11,306.4	22,205.6	0.5
03	1,491	1,057.1	519.0	55	12,740.5	1,516.7	23,259.6	11,136.0	23,876.5	1.7
04	1,570	1,211.6	511.9	55	13,480.5	1,568.1	24,492.0	10,965.6	24,446.1	0.1
05	1,644	1,366.1	504.8	55	16,015.9	1,692.5	25,646.4	10,795.2	26,811.1	3.0
06	1,715	1,366.1	533.7	55	16,015.9	1,746.3	26,754.0	11,488.8	27,504.7	1.8
07	1,789	1,448.6	526.6	55	17,287.1	1,818.0	27,908.4	11,318.4	28,605.5	1.6
08	1,866	1,448.6	551.5	55	17,287.1	1,869.9	29,109.6	11,916.0	29,203.1	0.2
09	1,947	1,561.1	608.4	55	18,504.9	2,005.9	30,373.2	13,281.6	31,786.5	3.0
2010	2,031	1,561.1	633.0	55	18,504.9	2,059.9	31,683.6	13,872.0	32,376.9	1.4

Appendix A-2-2 CONSTRUCTION SCHEDULE of Power Plants in Costa Rica (1/2)
(For Demand and Supply Program)

Year	Plant							Year	Plant						
	Name of Station	Unit No.	Thermal, Hydraulic	Installed Capacity (MW)	Available Capacity (MW)	Annual Ave Energy (Gwh)	Firm Energy (Gwh)		Name of Station	Unit No.	Thermal, Hydraulic	Installed Capacity (MW)	Available Capacity (MW)	Annual Ave Energy (Gwh)	Firm Energy (Gwh)
1990	Existing	—	—	*6 889.6	781.3 *1 (760.3)	4,397.3	3,493.1 *2 (3,782.1)								
1991	Moin	1,2,3	Thermal (Gas)	3×36=108.0	108.0	283.8	283.8	1996	Motor Baja Vel	1,2	Thermal(Diesel)	2×32=64.0	64.0	448.5	448.5
	Belen	1	Hydraulic	5.6	} 12.2	} 106.9	} 106.9								
	Electriona	1		2.8											
	Birris	1		16.0											
	Ret. Thermal			-7.1	-7.1	-32.4	-32.4		Ret. Thermal			-7.1	-7.1	-32.4	-32.4
Sub-Total				125.3	113.1	358.3	358.3	Sub-Total				56.9	56.9	416.1	416.1
Total				1,014.9	894.4 (858.4)	4,755.6	3,851.4 (3,901.4)	Total				1,311.4	1,144.9 (1,089.9)	6,577.9	5,436.0 (5,436.0)
1992								1997	Motor Baja Vel	3	Thermal(Diesel)	32.0	32.0	224.3	224.3
	Ret. Thermal			-7.1	-7.1	-32.4	-32.4		Ret. Thermal			-7.1	-7.1	-32.4	-32.4
Sub-Total				-7.1	-7.1	-32.4	-32.4	Sub-Total				24.9	24.9	191.9	191.9
Total				1,007.8	887.3 (851.3)	4,723.2	3,819.0 (4,074.0)	Total				1,336.3	1,169.8 (1,114.8)	6,769.8	5,627.9 (5,627.9)
1993	Sandillal	1	Hydraulic	32.0	32.0	140.0	140.0	1998	Angostura	1,2	Hydraulic	177.0	123.9	996.0	459.4
	Gas	4	Thermal (Gas)	36.0	36.0	94.6	94.6								
	Ret. Thermal			-7.1	-7.1	-32.4	-32.4		Ret. Thermal			-7.1	-7.1	-32.4	-32.4
Sub-Total				60.9	60.9	202.2	202.2	Sub-Total				169.9	116.8	963.6	427.0
Total				1,068.7	948.2 (912.2)	4,925.4	4,021.2 (4,311.2)	Total				1,506.2	1,286.6 (1,231.6)	7,733.4	6,054.9 (6,054.9)
1994	Toro I	1	Hydraulic	24.0	4.0	119.0	35.0	1999							
	Miravalles	1	Geo thermal	55.0	55.0	433.6	433.6								
	Ret. Thermal			-7.1	-7.1	-32.4	-32.4		Ret. Thermal			-7.1	-7.1	-32.4	-32.4
Sub-Total				71.9	51.9	520.2	436.2	Sub-Total				-7.1	-7.1	-32.4	-32.4
Total				1,140.6	1,000.1 (945.1)	5,445.6	4,457.4 (4,607.4)	Total				1,499.1	1,279.5 (1,224.5)	7,701.0	6,022.5 (6,172.5)
1995	Toro II	2	Hydraulic	66.0	40.0	315.0	161.3	2000	Motor Baja Vel	4,5	Thermal(Diesel)	2×32=64.0	64.0	448.5	448.5
	Miravalles	2	Geo thermal	55.0	55.0	433.6	433.6								
	Ret. Thermal			-7.1	-7.1	-32.4	-32.4		Ret. Thermal			-7.1	-7.1	-32.4	-32.4
Sub-Total				113.9	87.9	716.2	562.5	Sub-Total				56.9	56.9	416.1	416.1
Total				1,254.5	1,088.0 (1,033.0)	6,161.8	5,019.9 (5,019.9)	Total				1,556.0	1,336.4 (1,281.4)	8,117.1	6,438.6 (6,588.6)

Note : Gas 30% Ret. Thermal : Retierment of thermal
Diesel 80% *1 : ( ) Value = Available capacity - Max. thermal unit capacity
Geo thermal 90% *2 : ( ) Value = Including import energy (kWh)

Appendix A-2-2 CONSTRUCTION SCHEDULE of Power Plants in Costa Rica (2/2)
(For Demand and Supply Program)

Year	Plant							Year	Plant						
	Name of Station	Unit No.	Thermal, Hydraulic	Installed Capacity (MW)	Available Capacity (MW)	Annual Ave Energy (Gwh)	Firm Energy (Gwh)		Name of Station	Unit No.	Thermal Hydraulic	Installed Capacity (MW)	Available Capacity (MW)	Annual Ave Energy (Gwh)	Firm Energy (Gwh)
2001	Pirris	1,2	Hydraulic	128.0	126.0	609.3	230.0	2006	Gas	5	Thermal(Gas)	36.0	36.0	94.6	94.6
	Ret. Thermal			-7.1	-7.1	-32.4	-32.4		Ret. Thermal			-7.1	-7.1	-32.4	-32.4
Sub-Total				120.9	118.9	576.9	197.6	Sub-Total				28.9	28.9	62.2	62.2
Total				1,676.9	1,455.3	8,694.0	6,636.2	Total				2,389.4	1,899.8	12,597.2	8,870.0
					(1,400.3)		(6,941.2)						(1,844.8)		(8,970.0)
2002	Miravalles	3	Geo thermal	55.0	55.0	433.6	433.6	2007	Savegre *3		Hydraulic	165	*5 82.5	917.0	464.0
	Ret. Thermal			-7.1	-7.1	-32.4	-32.4		Ret. Thermal			-7.1	-7.1	-32.4	-32.4
Sub-Total				47.9	47.9	401.2	401.2	Sub-Total				157.9	75.4	884.6	431.6
Total				1,724.8	1,503.2	9,095.2	7,037.4	Total				2,547.3	1,975.2	13,481.8	9,301.6
					(1,448.2)		(7,342.4)						(1,920.2)		(9,351.6)
2003	Guayabo		Hydraulic	245.0	80.0	1,436.0	672.1	2008	Motor Baja Vel	6	Thermal(Diesel)	32.0	32.0	224.3	224.3
	Ret. Thermal			-7.1	-7.1	-32.4	-32.4		Ret. Thermal			-7.1	-7.1	-32.4	-32.4
Sub-Total				237.9	72.9	1,403.6	639.7	Sub-Total				24.9	24.9	191.9	191.9
Total				1,962.7	1,576.1	10,498.8	7,677.1	Total				2,572.2	2,000.1	13,673.7	9,493.5
					(1,521.1)		(7,777.1)						(1,945.1)		(9,773.5)
2004	Siquirres I	1 2	Hydraulic	206.0	154.5	759.0	270.1	2009	Pacuare *4		Hydraulic	225.0	*5 112.5	889	*5 444.5
									Motor Baja Vel	7,8	Thermal(Diesel)	2×32=64.0	64.0	448.5	448.5
	Ret. Thermal			-7.1	-7.1	-32.4	-32.4		Ret. Thermal			-7.1	-7.1	-32.4	-32.4
Sub-Total				198.9	147.4	726.6	237.7	Sub-Total				281.9	169.4	1,305.1	860.6
Total				2,161.6	1,723.5	11,225.4	7,914.8	Total				2,854.1	2,169.5	14,978.8	10,354.1
					(1,668.5)		(8,164.8)						(2,114.5)		(10,354.1)
2005	Siquirres II	3 4	Hydraulic	206.0	154.5	1,342.0	925.4	2010	Motor Baja Vel	9	Thermal(Diesel)	32.0	32.0	224.3	224.3
	Ret. Thermal			-7.1	-7.1	-32.4	-32.4		Ret. Thermal			-7.4	-7.4	-31.9	-31.9
Sub-Total				198.9	147.4	1,309.6	893.0	Sub-Total				24.6	24.6	192.4	192.4
Total				2,360.5	1,870.9	12,535.0	8,807.8	Total				2,878.7	2,194.1	15,171.2	10,546.5
					(1,815.9)		(8,807.8)						(2,139.1)		(10,666.5)

*3 : Preliminary report by ICE
*4 : Logos data : ICE
*5 : Tentative Value
*6 : Annual Report 1990 by ICE

Appendix A-2-3 Summary of Physical Characteristics
(Preparation by ICE)

INSTITUTO COSTARRICENSE DE ELECTRICIDAD

SISTEMA NACIONAL INTERCONECTADO

POWER PLANTS

SUMMARY OF PHYSICAL CHARACTERISTICS

	POWER (MW)		ENERGY / YEAR (GWh)				
	INSTALLED CAPACITY	FIRM OUTPUT	TOTAL	FIRM A	FIRM B	SECONDARY A	SECONDARY B
1. EXISTING HYDRO P.P.							
ARENAL	156.0	156.0	669.0	669.0	669.0	0.0	0.0
COROBICI	174.0	174.0	805.0	805.0	805.0	0.0	0.0
CACHI	100.0	90.0	659.0	304.3	446.9	354.7	212.1
GARITA	30.0	15.0	189.0	89.7	131.4	99.3	57.6
MENORES	26.0	13.0	195.0	113.8	113.8	81.2	81.2
RIO MACHO	120.0	90.0	615.0	137.7	240.7	477.3	374.3
VENTANAS GARITA	96.0	80.0	515.0	192.8	254.8	322.2	260.2
2. UNDER CONSTRUCTION							
SANDILLAL	32.0	32.0	140.0	140.0	140.0	0.0	0.0
AMPLIA. VARIAS	28.6	14.3	175.0	125.3	125.3	49.7	49.7
3. PLANNING HYDRO P.P.							
TORO I	24.0	4.0	119.0	28.3	35.0	90.7	84.0
TORO II	66.0	40.0	315.0	74.6	161.3	240.4	153.7
ANGOSTURA	177.0	123.9	996.0	305.7	459.4	690.3	536.6
GUAYABO	245.0	80.0	1436.0	438.0	672.1	998.0	763.9
SIQUIRRES I	206.0	154.5	759.0	159.2	270.1	599.8	488.9
SIQUIRRES II	412.0	309.0	1342.0	591.1	925.4	750.9	416.6

Notes :

Firm energy column A : Assumes that the energy available during each month of the year is equivalent to the energy available in the driest month of the dry season of the period January 1965, December 1986.

Firm energy column B : Assumes that the energy available in each month of the year is equivalent to the average calculated with the energy of the driest month of every dry season of every year of the period 1965 - 1986.

Total energy : Available energy during normal year. (Average of the energy available each year of the period 1965 - 1986)

Appendix A-2-4 Plan of Expansion of the Generation

(Preparation by ICE)

INSTITUTO COSTARRICENSE DE ELECTRICIDA

Cuadro

SISTEMA NACIONAL INTERCONECTADO DE COSTA RICA

PLAN DE EXPANSION DE LA GENERACION
(SEGUN MODELO LOGOS)
ESCENARIO DE DEMANDA : MEDIO (mayo 1991)
ESCENARIO DE COMBUSTIBLES : CASO BASE

Año	Energía (Gwh)	Crecim. (%)	Pot. (MW)	Crecim. (%)	Proyectos de generación	Año	Mes
1987	3246					1987	
1988	3324	2.4	613			1988	
1989	3493	5.1	658	7.3		1989	
1990	3707	6.1	682	3.6		1990	
1991	3854	4.0	741	8.7	Ampliac. varias hidro. (Ver nota)	1991	1
					P.T. Gas (3 x 36 MW)		1
1992	4044	4.9	778	5.0		1992	
1993	4276	5.7	823	5.8	P.H. Sandillal (32 MW)	1993	7
					P.T. Gas (1 x 36 MW)		1
1994	4538	6.1	874	6.2	P.H. Toro I (24 MW)	1994	9
					P.G. Miravalles I (55 MW)		7
1995	4825	6.3	930	6.4	P.H. Toro II (66 MW)	1995	1
					P.G. Miravalles II (55 MW)		1
1996	5129	6.3	989	6.3	P.T. Motor Baja Vel.(2 x 32 MW)	1996	1
1997	5454	6.3	1052	6.4	P.T. Motor Baja Vel.(1 x 32 MW)	1997	1
1998	5790	6.2	1117	6.2	P.H. Angostura (177 MW)	1998	1
1999	6151	6.2	1187	6.3		1999	
2000	6531	6.2	1260	6.1	P.T. Motor Baja Vel.(2 x 32 MW)	2000	1
2001	6916	5.9	1334	5.9	P.H. Pirrís (128 MW)	2001	1
2002	7310	5.7	1410	5.7	P.G. Miravalles III (55 MW)	2002	1
2003	7712	5.5	1486	5.4	P.H. Guayabo (245 MW)	2003	1
2004	8120	5.3	1564	5.2		2004	
2005	8506	4.8	1636	4.6	P.H. Siquirres I (206 MW)	2005	1
2006	8887	4.5	1707	4.3		2006	
2007	9286	4.5	1781	4.3	P.H. Siquirres II (206 MW)	2007	1
2008	9705	4.5	1859	4.4		2008	
2009	10142	4.5	1939	4.3	P.T. Motor Baja Vel.(2 x 32 MW)	2009	1
2010	10600	4.5	2024	4.4	P.T. Motor Baja Vel.(2 x 32 MW)	2010	1

Período :	1991-2010
Valor presente del plan de expansión : (Millones de dólares)	1065.86
Costo marginal de largo plazo ($/MWh) :	44.00
Nivel de precios :	Diciembre de 1990
Actualización a :	Diciembre de 1990
Fecha :	26-julio-1991

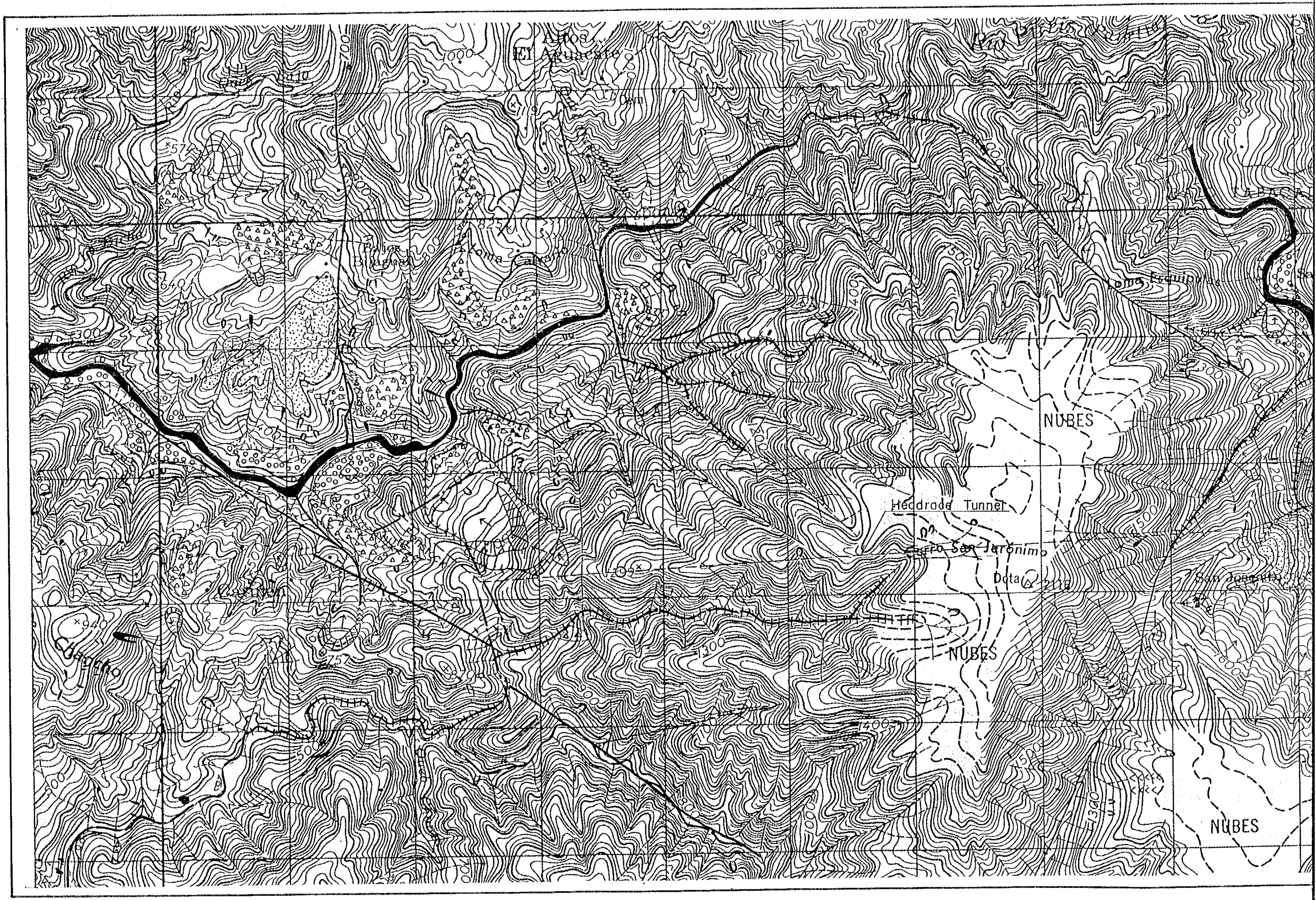
Notas: 1. Las ampliaciones son las siguientes: P.H. Belén (5.6 MW), P.H. Electriona (2.8 MW), y P.H. Birrís (16 MW).

2. El valor presente considera un período de evaluación económica infinito, con reinversiones en los proyectos de generación.

APPENDIX A-3 GEOLOGY

APPENDIX A-3 GEOLOGY

Contents



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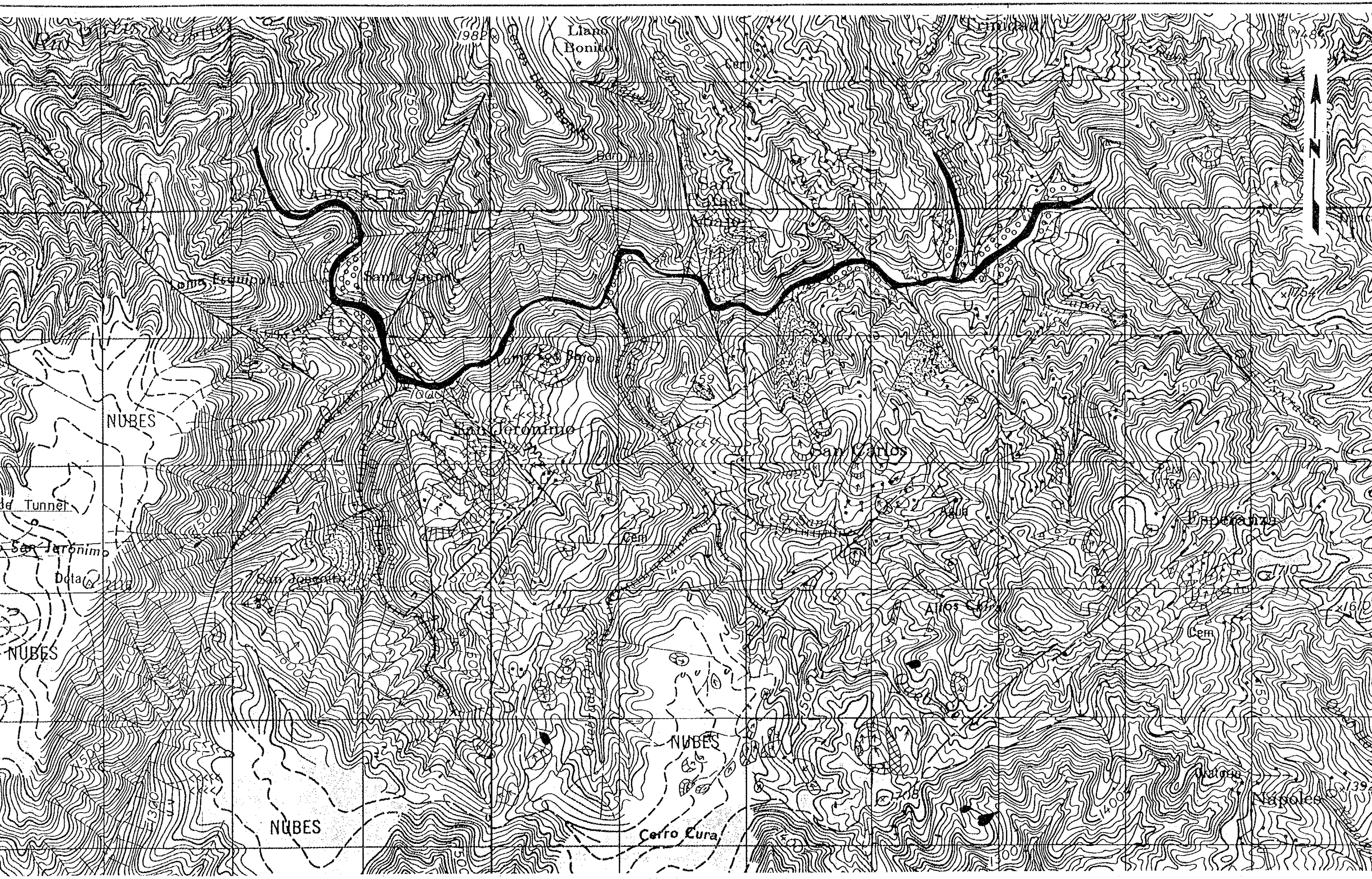
NUBES
Headrace Tunnel
Cerro San Jerónimo
Dota
NUBES
NUBES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Tunnel
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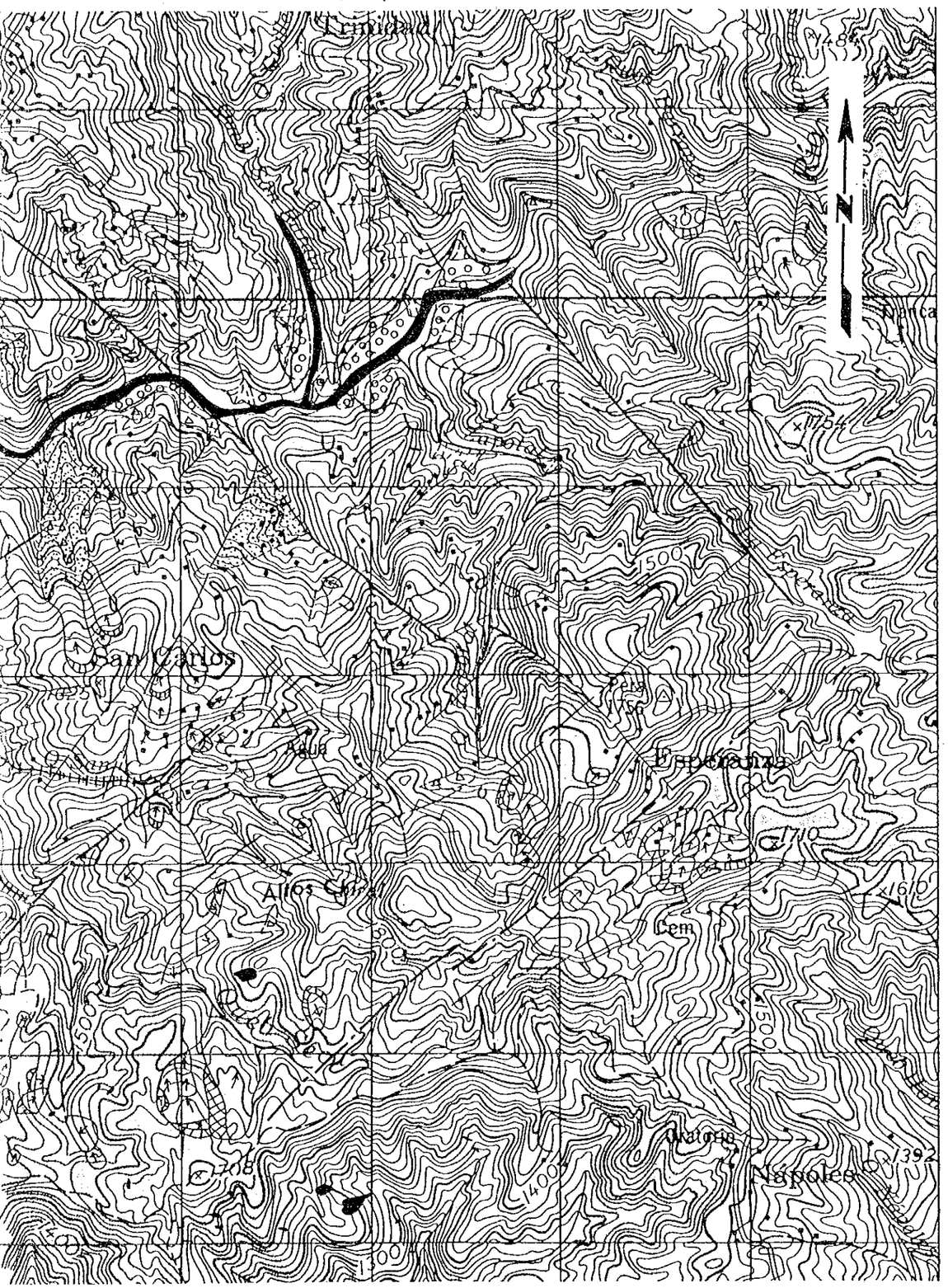


LEGEND

(Landslide)

- Landslide with clear head scarp
- Sinking zone
- Sliding direction
- Landslide with obscure head scarp
- Assumed landslide

(Slope failure)

- Slope failure
- Slope failure scar

(Depositional land form)

- Terrace
- Fan
- Talus
- River-bed

(Valley)

- Remarkable gully
- Surface water flow (assumed)
- Outcrop thin deposit
- No water flow range (assumed)

(Lineament)

- Lineament assumed to be fault
- Lineament possible to be fault
- Other small lineament
- Planned route

0 — 1 — 2km

REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

Aero-photo Interpretation of the Project area

A-3-1

A-3-1

A-3-2 Microscopic Observation of Rock

(1) Table A3.2.1 Result of Microscopic Observation

(2) Result of Microscopic Observation (Sheet No. 1 ~ No. 26)

(3) Photograph of Thin Section under Microscope
(Sheet No. 1 ~ No. 4)

Table A3.2.1 Results of Microscopic Observation

Sample No.	Locality	Rock Name
S-1	Rightbank of Reservoir (EL 1,400 m)	Lapilli tuff
S-2	Right bank of Reservoir	Fine sandstone
S-3	Right bank of Qda. Zapote	Altered augite dolerite
S-4	Right ridge of Downstream damsite	Volcanic sandstone
S-5	Right bank of Downstream damsite	Altered augite dolerite
S-6	- ditto -	- ditto -
S-7	- ditto -	- ditto -
S-8	Riverbed of Upstream damsite	Sandstone
S-9	Riverbed of Downstream damsite	Altered augite dolerite
S-10	Right bank of Downstream damsite	Altered augite basalt
S-11	- ditto -	Siltstone
S-12	- ditto -	Altered augite dolerite
S-13	Qda. Seca	Siltstone
S-14	Oda. Napoleon	Altered basalt
S-15	Left bank of Qda. Napoleon	Mudstone
S-16	East side of Penstock route	Augite welded tuff
S-17	- ditto -	Altered augite basalt lava
S-18	- ditto -	Shaly slate
S-19	Upstream of Power station	Basaltic volcanic sandstone
S-20	Penstock route	Altered basalt
S-21	East side of Penstock route	Lapilli tuff
S-22	West side of Penstock route	Calcaceous siltstone
S-23	- ditto -	Tuffaceous sandstone
S-24	- ditto -	Tuff
S-25	- ditto -	Tuff
S-26	Right bank of Pirris river	Altered siltstone

Note: Locations of S-1 to S-12 and S-13 to S-26 are shown in Figs. 7-2 and 7-9, respectively.

Microscopic Observation

Project:	
Locality:	
Sample No. S-1	**Slice No.** 2
Rock Name: Lapilli tuff	
Texture: Pyroclastic	
Rock Forming Minerals:	
Lithic fragments:	Tuff >> silified rock > basalt
Crystal fragments:	Mainly plagioclase
Matrix:	Turn to secondary minerals
Secondary minerals:	Smectite >> quartz > epidote > hornblende
Description: Lithic and crystal fragments of tuff and plagioclase with small or rare amounts of basalt silicified rock, clinopyroxene and quartz are cemented by altered minerals as quartz, smectite, epidote and hornblende.	
Degree of Alteration: Moderate	
Macroscopic Observation: Grey breccia rock	
Remarks:	

Microscopic Observation

Project:

Locality:

Sample No. S-2 **Slice No.** 3

Rock Name: Fine sandstone

Texture: Clastic

Rock Forming Minerals:

Lithic fragments: Mudstone - fine sandstone > basalt

Crystal fragments: Carbonate > plagioclase >> quartz

Matrix: Clay - very fine, turn to chlorite

Secondary minerals: Rare

Fossils: Globigerina

Description:

Crystal fragments of quartz, plagioclase and orthoclase are cemented by clayey materials. Fossils and matrix turn to carbonate and chlorite partially.

Degree of Alteration:

Weak - moderate

Macroscopic Observation:

Dark grey fine-grained sandstone with small silty patches

Remarks:

Microscopic Observation

Project:

Locality:

Sample No. S-3 **Slice No.** 2-S-6

Rock Name: Altered augite dolerite

Texture: Ophitic

Rock Forming Minerals:

Phenocryst: Plagioclase >> augite

Groundmass: Plagioclase >> augite > magnetite, volcanic glass

Description:

Albitization of plagioclase is perfect, with formation of minor epidote and sericite. Augite crystals have been almost wholly altered into the assemblage of calcite and clay minerals.

Degree of Alteration:

Strong

Macroscopic Observation:

Green compact rock with calcite-quartz veins

Remarks:

Druses filled with chlorite/smectite interstratified minerals are observed.

Microscopic Observation

Project:

Locality:

Sample No. S-4 **Slice No.** 2-S-7

Rock Name: Volcanic sandstone

Texture: Clastic

Rock Forming Minerals:

Lithic fragments: Dolerite

Crystal fragments: Plagioclase > quartz > augite

Matrix: Fine-grained hematite, quartz, clay minerals

Secondary minerals: Epidote, sericite, smectite

Description:

Augite and plagioclase have been completely altered into epidote-clay mineral and albite-clay mineral-sericite respectively.

Degree of Alteration:

Strong

Macroscopic Observation:

Light green, coarse-grained rock

Remarks:

Microscopic Observation

Project:

Locality:

Sample No. S-5 **Slice No.** 1-S-6

Rock Name: Hydrothermally altered augite dolerite

Texture: Ophitic

Rock Forming Minerals:

Phenocryst: Plagioclase >> augite > magnetite

Groundmass: Plagioclase >> augite > clay minerals

Description:

Augite crystals have been partly replaced by chlorite. Plagioclase crystals have been completely altered into albite with minor amount of illite or sericite.

Degree of Alteration:

Strong

Macroscopic Observation:

Weakly weathered rock with discolored joints.

Remarks:

Druses filled with chlorite are commonly observed.

Microscopic Observation

Project:

Locality:

Sample No. S-6 **Slice No.** 1-S-2

Rock Name: Hydrothermally altered augite dolerite

Texture: Ophitic

Rock Forming Minerals:

Phenocryst: Plagioclase >> augite > magnetite

Groundmass: Plagioclase >> augite > clayminerals

Description:

Augite crystals have been partly replaced by chlorite. Plagioclase crystals have been completely altered into albite with minor amount of illite or sericite.

Degree of Alteration:

Strong

Macroscopic Observation:

Dark green compact rock with discolored joints.

Remarks:

Druses filled with chlorite are commonly observed.

Microscopic Observation

Project:	
Locality:	
Sample No. S-7	**Slice No.** 1-S-1
Rock Name:	Hydrothermally altered augite dolerite
Texture:	Ophitic
Rock Forming Minerals:	
Phenocryst:	Plagioclase >> augite > magnetite
Groundmass:	Plagioclase > augite > clay minerals
Description:	Augite crystals have been partly replaced by chlorite. Plagioclase crystals have been completely altered into albite with minor amount of illite or sericite.
Degree of Alteration:	Strong
Macroscopic Observation:	Dark green compact rock with discolored joints.
Remarks:	Druses filled with chlorite are commonly observed.

Microscopic Observation

Project:

Locality:

Sample No. S-8 **Slice No.** 1-UD-2

Rock Name: Sandstone

Texture: Clastic

Rock Forming Minerals:

Lithic fragments: Dolerite

Crystal fragments: Plagioclase > quartz > augite

Matrix: Clay, quartz, albite, calcite

Description:

Lithic and crystal fragments are cemented by clayey materials. This rock has been partly replaced by hydrothermal minerals such as albite, chlorite, calcite and quartz.

Degree of Alteration:

Strong

Macroscopic Observation:

Dark grey compact rock with weak foliation.

Remarks:

Microscopic Observation

Project:

Locality:

Sample No. S-9 **Slice No.** 1-LD-1

Rock Name: Hydrothermally altered augite dolerite

Texture: Ophitic

Rock Forming Minerals:

Phenocryst: Plagioclase >> chlorite, augite

Groundmass: Plagioclase >> augite > magnetite

Description:

Augite crystals have been partly replaced by chlorite. Plagioclase crystals have been completely altered into albite with minor amount of illite and quartz.

Degree of Alteration:

Strong

Macroscopic Observation:

Dark green compact rock

Remarks:

Druses are filled with pumpellyite, chlorite and quartz.

Microscopic Observation

Project:

Locality:

Sample No. S-10 **Slice No.** 2-S-5

Rock Name: Altered augite basalt

Texture: Ophitic

Rock Forming Minerals:

Phenocryst: Plagioclase >> augite

Groundmass: Plagioclase >> augite > magnetite

Description:

Plagioclase crystals of phenocrysts and groundmass have been completely decomposed into albite with minor amount of sericite. Augite crystals were partly altered to brown chlorite/smectite interstratified minerals.

Degree of Alteration:

Strong

Macroscopic Observation:

Dark green compact rock with a lot of druses.

Remarks:

Druses are completely filled with brown clay minerals (probably chlorite/smectite interstratified minerals).

Microscopic Observation

Project:

Locality:

Sample No. S-11 **Slice No.** 1

Rock Name: Siltstone

Texture: Clastic

Rock Forming Minerals:

Crystal fragments: Rare

Matrix: Mainly clay-amorphous

Secondary minerals: Epidote (<0.013 mm, irregular grains, colorless-brown, replace matrix and fossils)

Description:

The greater parts of rock turn to epidote, and epidote with small amounts of quartz, plagioclace and mica are cemented by clayey materials.

Degree of Alteration:

Strong

Macroscopic Observation:

Pale green fine-grained compact rock

Remarks:

Microscopic Observation

Project:

Locality:

Sample No. S-12 **Slice No.** 2-S-4

Rock Name: Altered augite dolerite

Texture: Ophitic

Rock Forming Minerals:

Phenocryst: Plagioclase >> augite

Groundmass: Plagioclase >> augite > magnetite, leucoxene

Description:

Augite crystals have been partly altered to clay minerals. Plagioclase have been completely altered into epidote and albite with minor amount of sericite.

Degree of Alteration:

Strong

Macroscopic Observation:

Dark greyish green compact rock.

Remarks:

Interstices of plagioclase and augite crystals are filled with small amounts of leucoxene, magnetite and epidote.

Microscopic Observation

Project:	
Locality:	
Sample No. S-13	**Slice No.** 1-C-1
Rock Name: Siltstone	
Texture: Clastic	
Rock Forming Minerals:	
Crystal fragments: Quartz >> plagioclase	
Matrix: Clay minerals, quartz	
Description:	
Crystal fragments of quartz and plagioclase are cemented by calcite and clayey materials such as chlorite and illite or sericite.	
Degree of Alteration:	
Moderate	
Macroscopic Observation:	
Cream colored compact silty rock.	
Remarks:	

Microscopic Observation

Project:

Locality:

Sample No. S-14 **Slice No.** G

Rock Name: Altered basalt

Texture: Intersertal

Rock Forming Minerals:

Phenocrysts: Plagioclase, augite

Groundmass: Plagioclase, augite, magnetite, volcanic glass

Description:

By hydrothermal activity, plagioclase and augite have been perfectly replaced by albite-prehnite-sericite-epidote-calcite and chlorite-smectite-calcite-leucoxene respectivley.

Degree of Alteration:

Strong

Macroscopic Observation:

Grey compact rock

Remarks:

Microscopic Observation

Project:

Locality:

Sample No. S-15 **Slice No.** 4

Rock Name: Mudstone

Texture: Clastic

Rock Forming Minerals:

Crystal fragments: Plagioclase > smectite > quartz

Matrix: Clay

Secondary minerals: Smectite >> ferrous hydroxide

Fossils: Globigerina

Description:

Crystal fragments of small amounts of fine quartz, plagoclase and clinopyroxene are cemented by large amounts of mudy clay.

Degree of Alteration:

Weak

Macroscopic Observation:

Olive-green compact rock with black veinlets and spots

Remarks:

Microscopic Observation

Project:	
Locality:	
Sample No. S-16	**Slice No.** F
Rock Name: Augite welded tuff	
Texture: Welding	
Rock Forming Minerals:	
Lithic fragments:	Basalt
Crystal fragments:	Augite
Matrix:	Clay minerals, chlorite, smectite, leucoxene, prehnite
Description:	
By hydrothermal activity (probably over 200°C), augite welded tuff was almost completely replaced by secondary mineral. Original texture is still well remained.	
Degree of Alteration:	
Strong	
Macroscopic Observation:	
Grey compact rock	
Remarks:	

Microscopic Observation

Project:

Locality:

Sample No. S-17 **Slice No.** D

Rock Name: Altered augite basalt lava

Texture: Ophitic

Rock Forming Minerals:

Phenocryst: Plagioclase >> augits

Groundmass: Plagioclase >> augite > magnetite

Description:

Hydrothermal alteration of augite into calcite and chlorite-smectite with small amount of epidote is distinct. Plagioclase also suffered albitization and calcitization.

Degree of Alteration:

Strong

Macroscopic Observation:

Dark greyish green compact rock

Remarks:

Calcite druses and veins are common.

Microscopic Observation

Project:	
Locality:	
Sample No. S-18	**Slice No.** E
Rock Name: Shaly slate	
Texture: Clastic	
Rock Forming Minerals:	
Lithic fragments: Tuff, basalt	
Crystal fragments: Quartz, albite, graphite	
Matrix: Clay minerals, hematite, calcite	
Description: Equigranular sandstone with calcite vein and quartz vein.	
Degree of Alteration: Strong	
Macroscopic Observation: Dark red slate with white veins	
Remarks:	

Microscopic Observation

Project:	
Locality:	
Sample No. S-19	**Slice No.** C
Rock Name:	Basaltic volcanic sandstone
Texture:	Clastic
Rock Forming Minerals:	
Lithic fragments:	Basaltic tuff
Crystal fragments:	Plagioclase >> augite
Matrix:	Clay minerals, calcite

Description:

Original rock was fine-grained basaltic tuff chiefly composed of augite, plagioclase and volcanic glass. Augite and plagioclase were replaced by calcite and chlorite-smectite interstratified clay mineral.

Degree of Alteration:

Strong

Macroscopic Observation:

Grey compact rock with white veins

Remarks:

Thin veinlets and druses are composed of calcite.

Microscopic Observation

Project:

Locality:

Sample No. S-20 **Slice No.** A

Rock Name: Altered basalt or tuff breccia

Texture: Pyroclastic

Rock Forming Minerals:

Lithic fragments: Basalt

Crystal fragments: Plagioclase >> augite

Matrix: Clay minerals (chlorite/smectite) Ca-zeolite, albite

Description:

By strong zeolite-facies hydrothermal alteration, almost half of augite crystals have been altered into chlorite/smectite plagioclase phenocrysts were also completely replaced by Ca-zeolite, albite and quartz, magnetite turns to hematite.

Degree of Alteration:

Strong

Macroscopic Observation:

Reddish-brown pyroclastic rock.

Remarks:

Laumontite veins are common.

Microscopic Observation

Project:

Locality:

Sample No. S-21 **Slice No.** 5

Rock Name: Lapilli tuff

Texture: Pyroclastic

Rock Forming Minerals:

Lithic fragments: Mudstone

Crystal fragments: Mainly glass >> alunite > clinopyroxene

Matrix: Alunite

Secondary minerals: Sercite - smectite

Description:

Devitriform glass fragments turn to spherulitic smectite and zeolite partially and spaces between fragments turn to alunite aggregate.

Degree of Alteration:

Moderate

Macroscopic Observation:

Dark green medium grained rock with white fillings.

Remarks:

Microscopic Observation

Project:	
Locality:	
Sample No. S-22	**Slice No.** 9
Rock Name:	Calcareous siltstone
Texture:	Clastic
Rock Forming Minerals:	
Crystal fragments:	Mainly carbonate >> plagioclase > quartz
Matrix:	Carbonate (very fine, segregation vein), Clay (very fine grains, amorphous)
Description:	Crystal fragments of quartz, plagioclase and matrix turn to fine-grained carbonate minerals irregularly.
Degree of Alteration:	Moderate - Strong
Macroscopic Observation:	Dark greenish grey compact rock. Rock turns to greenish tint in weathered part.
Remarks:	

Microscopic Observation

Project:	
Locality:	
Sample No. S-23	**Slice No.** 8
Rock Name:	Tuffaceous sandstone
Texture:	Clastic
Rock Forming Minerals:	
Lithic fragments:	Mudstone
Crystal fragments:	Glass - clinopyroxene >> carbonate
Matrix:	Altered minerals as chlorite sericite and albite
Secondary minerals:	Mainly albite >> sericite > chlorite
Description:	Lithic and crystal fragments of angular mudstone, clinopyroxene and glass are cemented by altered minerals of albite, chlorite and sericite.
Degree of Alteration:	Strong
Macroscopic Observation:	Bluish green compact rock.
Remarks:	

Microscopic Observation

Project:

Locality:

Sample No. S-24 **Slice No.** 7

Rock Name: Tuff

Texture: Pyroclastic

Rock Forming Minerals:

Lithic fragments: Mudstone >> basalt

Crystal fragments: Glass >> clinopyroxene

Matrix: Altered minerals as chlorite, epidote, smectite and albite

Secondary minerals: Albite >> chlorite > carbonate > epidote > smectite

Description:

Subangular glass fragments with small amounts of clinopyroxene are cemented by altered minerals of smectite, epidote, chlorite and albite.

Degree of Alteration:

Strong

Macroscopic Observation:

Bluish grey compact rock with rounded silty patches.

Remarks:

Microscopic Observation

Project:

Locality:

Sample No. S-25 **Slice No.** 6

Rock Name: Tuff

Texture: Pyroclastic

Rock Forming Minerals:

Lithic fragments: Mudstone (angular, turn to smectite)

Crystal fragments: Glass >> clinopyroxene > plagioclase

Matrix: Altered minerals as chlorite, sericite and epidote

Secondary minerals: Chlorite > sericite > epidote > smectite

Fossils: Globigerina

Description:

Angular mudstone patches, glass and crystal fragments of plagioclase are cemented by altered minerals as chlorite, sericite, smectite and epidote.

Degree of Alteration:

Moderate

Macroscopic Observation:

Dark green compact rock.

Remarks:

Microscopic Observation

Project:

Locality:

Sample No. S-26 **Slice No.** 10

Rock Name: Altered siltstone

Texture: Clastic

Rock Forming Minerals:

Lithic fragments: Fine tuff

Crystal fragments: Plagioclase > quartz > clinopyroxene

Matrix: Clay

Secondary minerals: Alunite >> chlorite > epidote

Alunite-carbonate vein: Width 0.75 mm, irregular veinlet

Description:

Lithic fragments and crystal fragments of quartz and feldsper are cemented by mudy clay. Plagioclase and fossils turn to secondary minerals of alunite, chlorite, epidote and carbonate with alunite-carbonate veins.

Degree of Alteration:

Strong

Macroscopic Observation:

Dark grey compact rock with alunite.

Remarks:

Irregular alunite carbonate veins.

Photograph of Thin Section under Microscope (Sheet 1-4)

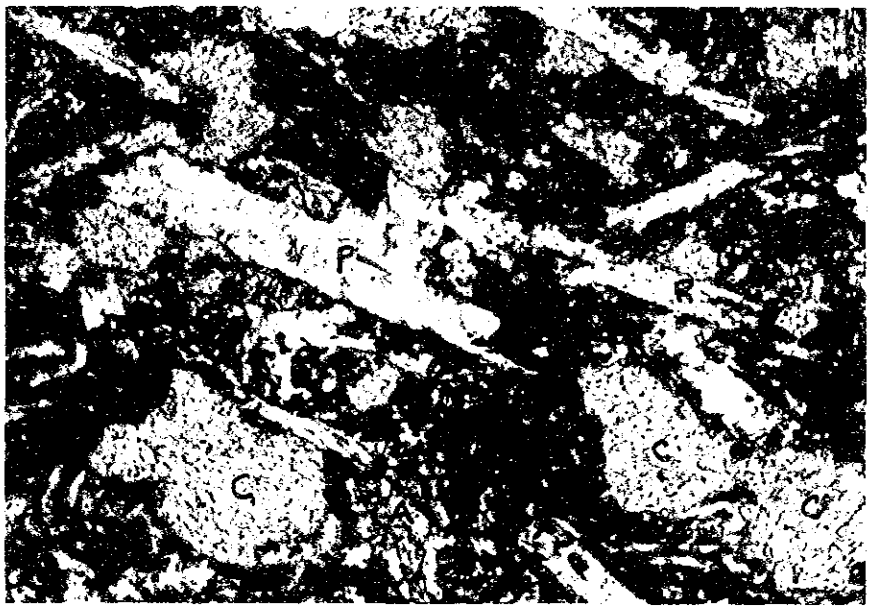
Sample No. : S-7

Locality : Right bank of Downstream Damsite

Rock Name : Altered augite dolerite

Texture : Ophitic

Open Nicol



0 0.5mm

Cross Nicol

P : Plagioclase
A : Augite
C : Chlorite

0 0.5mm

Photograph of Thin Section under Microscope (Sheet 2-4)

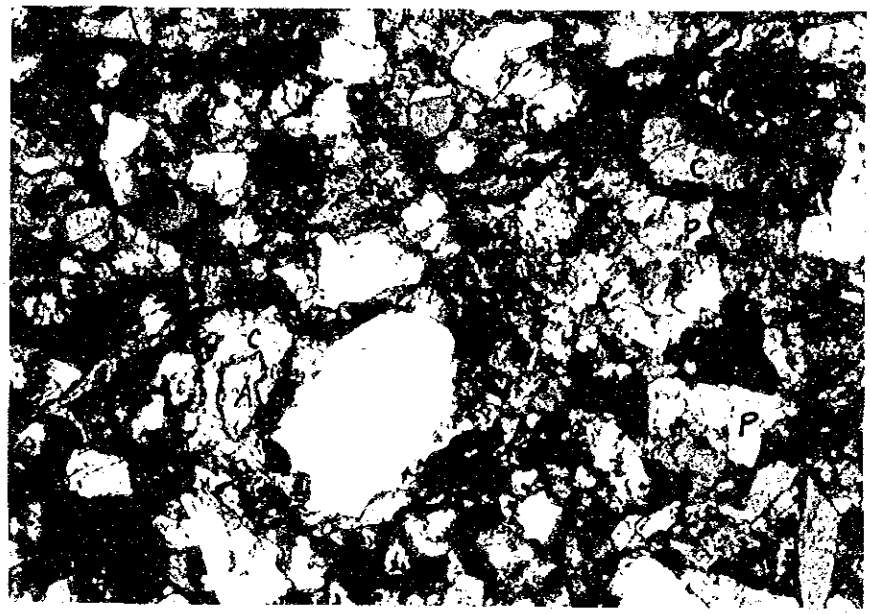
Sample No. : S-8

Locality : Riverbed of Upstream Damsite

Rock Name : Sandstone

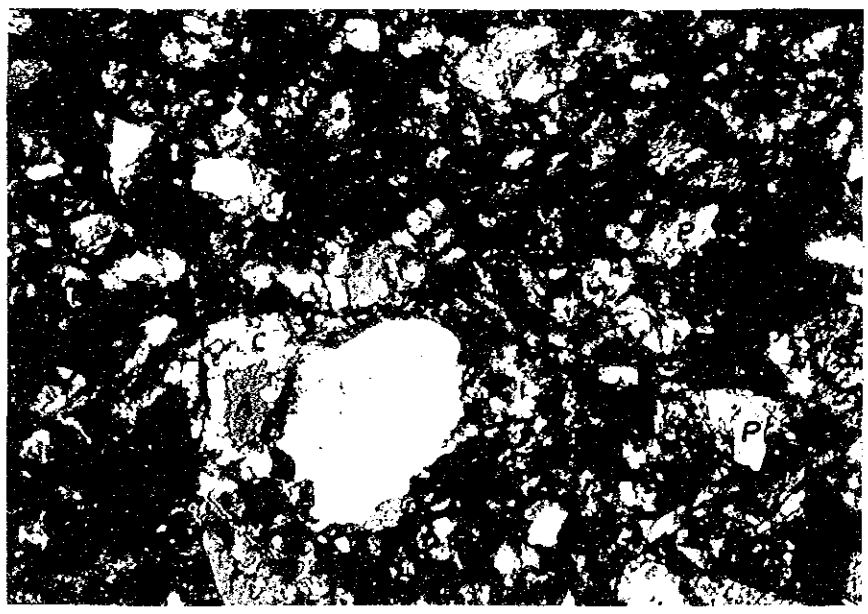
Texture : Clastic

Open Nicol



0 0.5mm

Cross Nicol



P : Plagioclase
A : Augite
C : Chlorite

0 0.5mm

Photograph of Thin Section under Microscope (Sheet 3－4

Sample No. : S－9

Locality : Riverbed of Downstream Damsite

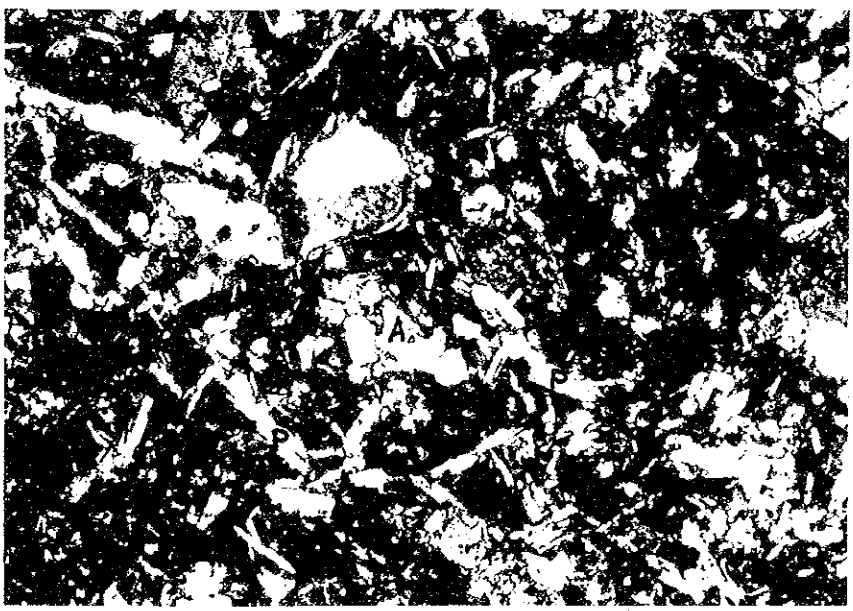
Rock Name : Altered augite dolerite

Texture : Ophitic

Open Nicol

0 0.5mm

Cross Nicol



P : Plagioclase
A : Augite
C : Chlorite

0 0.5mm

Photograph of Thin Section under Microscope (Sheet 4-4)

Sample No. : S-10

Locality : Right bank of Downstream Damsite

Rock Name : Altered augite basalt

Texture : Ophitic

Open Nicol

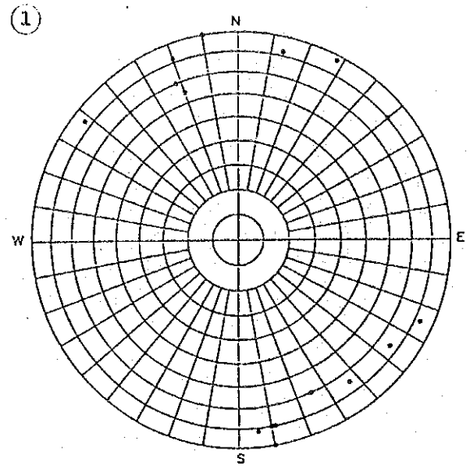
0 0.5mm

Cross Nicol

P : Plagioclase
A : Augite
D : Druse (Chlorite)

0 0.5mm

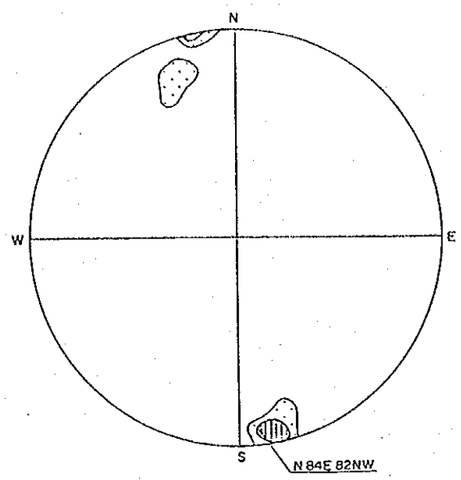
(1)



Point Diagram

Schmidt's Polar Net

Lower Hemisphere Projection



Number of Sample : 16

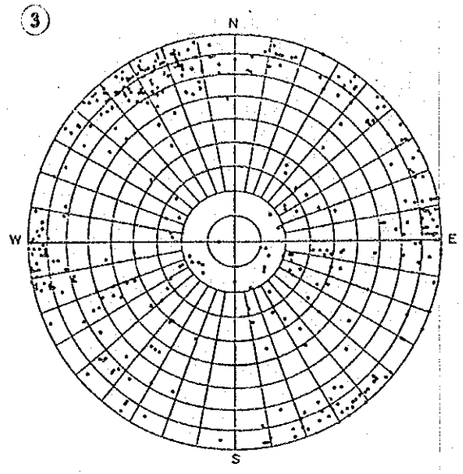
Contour Diagram

Schmidt's Polar Net

Lower Hemisphere Projection

Concentration	Percentages
	0 ~ 10%
	10 ~ 20%
	20 ~ 25%
	+ 25%

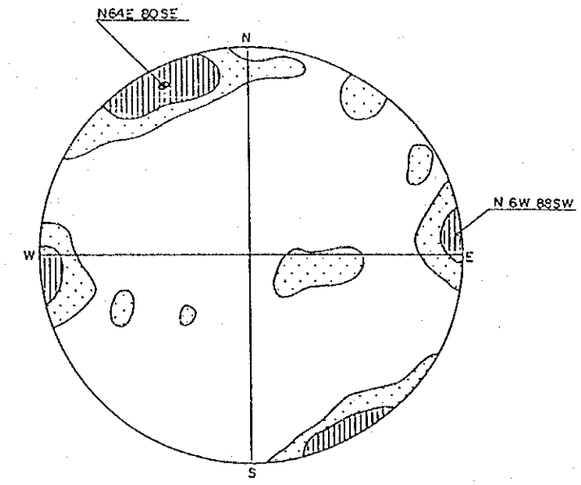
(3)



Point Diagram

Schmidt's Polar Net

Lower Hemisphere Projection



Number of Sample : 560

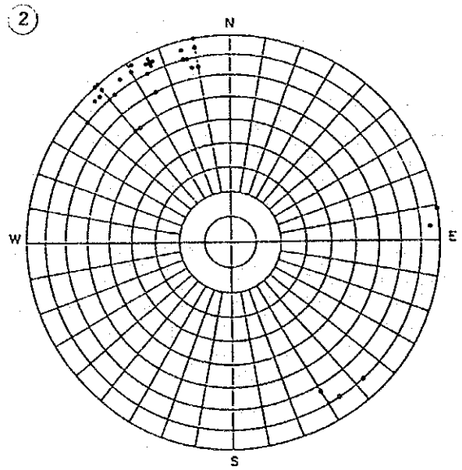
Contour Diagram

Schmidt's Polar Net

Lower Hemisphere Projection

Concentration	Percentages
	0 ~ 1%
	1 ~ 3%
	3 ~ 5%
	+ 5%

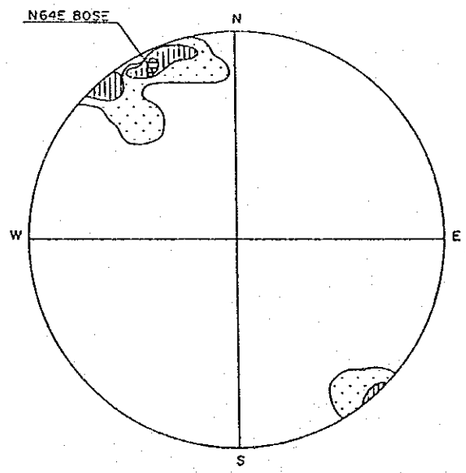
(2)



Point Diagram

Schmidt's Polar Net

Lower Hemisphere Projection



Number of Sample : 33

Contour Diagram

Schmidt's :Polar Net

Lower Hemisphere Projection

Concentration	Percentages
	0 ~ 5%
	5 ~ 15%
	15 ~ 25%
	+ 25%

Explanation

(1) Clay Seams at the Up-stream Damsite

(2) Clay Seams at the Down-stream Damsite

(3) Joints and Crakes at the Down-stream Damstie

REPUBLIC OF COSTA RICA

PIRRIS HYDROELECTRIC POWER DEVELOPMENT PROJECT

POINT AND CONTOUR DIAGRAMS OF

DISCONTINUITIES AT THE DAMSITE

A-3-3

Table A3.4.1 List of Drillhole

Hole No.	Site	Coordinate		Elevation (m)	Length (m)	Hole Diameter (mm)	Direction	Dip	Permeability Test (Stage)
		X	Y						
UB-1	Upper Dam	399,199.00	451,944.50	1,150.00	50.0	75.3 (NQ)		90°	6
UB-2	Ditto	399,294.00	451,945.00	1,103.20	50.0	Ditto	N -> S	60°	10
UB-3	Ditto	399,394.20	451,943.94	1,224.75	50.0	Ditto		90°	2
LB-1	Lower Dam	399,432.50	451,518.00	1,148.76	70.0	Ditto		90°	13
LB-2	Ditto	399,532.82	451,515.20	1,150.00	70.0	Ditto		90°	13
LB-3	Ditto	399,599.44	451,466.66	1,239.25	100.0	Ditto		90°	10
LB-4	Ditto	399,678.70	451,447.35	1,201.32	50.0	Ditto	S14° 43' E	60°	4
PB-1	Power Station	398,047.21	441,460.21	327.93	35.0	Ditto		90°	0
PB-2	Penstock Route	397,546.50	442,085.14	547.29	20.0			90°	0
TOTAL 9 Holes					495.0				58

Table A3.4.2 List of Adit

Adit No.	Site	Coordinate		Elevation (m)	Length (m)	Remark
		X	Y			
UA-1	Upper Dam	399.197.22	451,941.99	1,150.0	50.0	
LA-1	Lower Dam	399,430.75	451,512.99	1,148.76	50.0	
LA-2	Lower Dam	399,540.82	451,528.46	1,160.66	50.0	
TOTAL 3 Adits					150.0	

Table A3.4.3 List of Test Pit

Adit No.	Site	Coordinate		Elevation (m)	Length (m)	Remark
		X	Y			
CP-1	Borrow	399.565.96	453,500.23	1,258.35	5.0	
CP-1	Borrow	399,577.07	453,520.46	1,210.66	5.0	
CP-3	Borrow	399,522.56	453,531.96	1,192.61	5.0	
TOTAL 3 Pits					15.0	

A-3-5 Geologic Log of Drillehole

GEOLOGIC LOG OF DRILL HOLE

PIRRIS PROJECT — HOLE No. UB-1 (SHEET 1 OF 28)

LOCATION	UPSTREAM DAM	DEPTH OF HOLE	50.00 m	COMMENCED	10 - 2 -1991
ELEVATION	1,150.00 m	DEPTH OF OVERBURDEN	2.90 m	COMPLETED	18 - 2 -1991
COORDINATE	X 399,199.00 Y 451,944.50	LENGTH OF ROCK DRILLING	47.10 m	DRILLED BY	CIMCOSA
ANGLE FROM HOLIZONTAL	90.0°	TOTAL LENGTH OF CORE	45.51 m	LOGGED BY	JICA
BEARING OF ANGLE HOLE		CORE RECOVERY	91.0 %		

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
0m			0→100%							0 LUGEON 40	0m	m
0–2.9	Overburden				Brown				Gravelish cores at 0m–0.4m, slimes at 0.4m–2.9m. Topsoil, talus and probably residual soil or strongly weathered rocks at 0m–2.9m.			
2.9–4.2	Medium-grained sandstone with fine-grained sandstone bands.			NQ (B.t.size) NX casing pipe	Brown ~ dark grey ~ grey	4 / 3	2-3 / 3-4 / 2-3 / 5	3 / 4 / 3 / 5	Rather hard cores, discolored gravelis cores and slimes. Probably very loosened rocks.			
4.2–11.5					Dark brown ~ dark grey ~ grey	3 / 3 / (4)	3 / 3 / (4)	4 / 5 / 3	Generally gravelish, discolored cores and partially sound and rather fresh cores.			
						3	3 / 2	2 / 5	Probably loosened and weathered rocks. Laminae (dipping at about 15° from horizon) are recognizable in part.	(d) (c) No Lugeon tests		
					Dark brown grey	3 / 3 / (4)	3 / 3 / (4)	4 / 1 / (3)				
11.5–17.0					Greyey brown ~ yellowish brown	3 / 3 / 4	3 / 1 / 4	4 / 5 / (5)	Core loss in part and gravelish and discolored cores only. Probably weathered, cracky and loosened at 11.5m–17.00m.			
							2	2-3				
17.0–20	Medium-g. conglomerate SS				Dark grey ~ grey	2 / 3	2 ~ (3) / 3-4 / 2 ~ (3) / 3	2 / 4-3 / 3 / 3-4	Sandstone interbedded with conglomerate. Cracky in part.	(c)		
20											20	

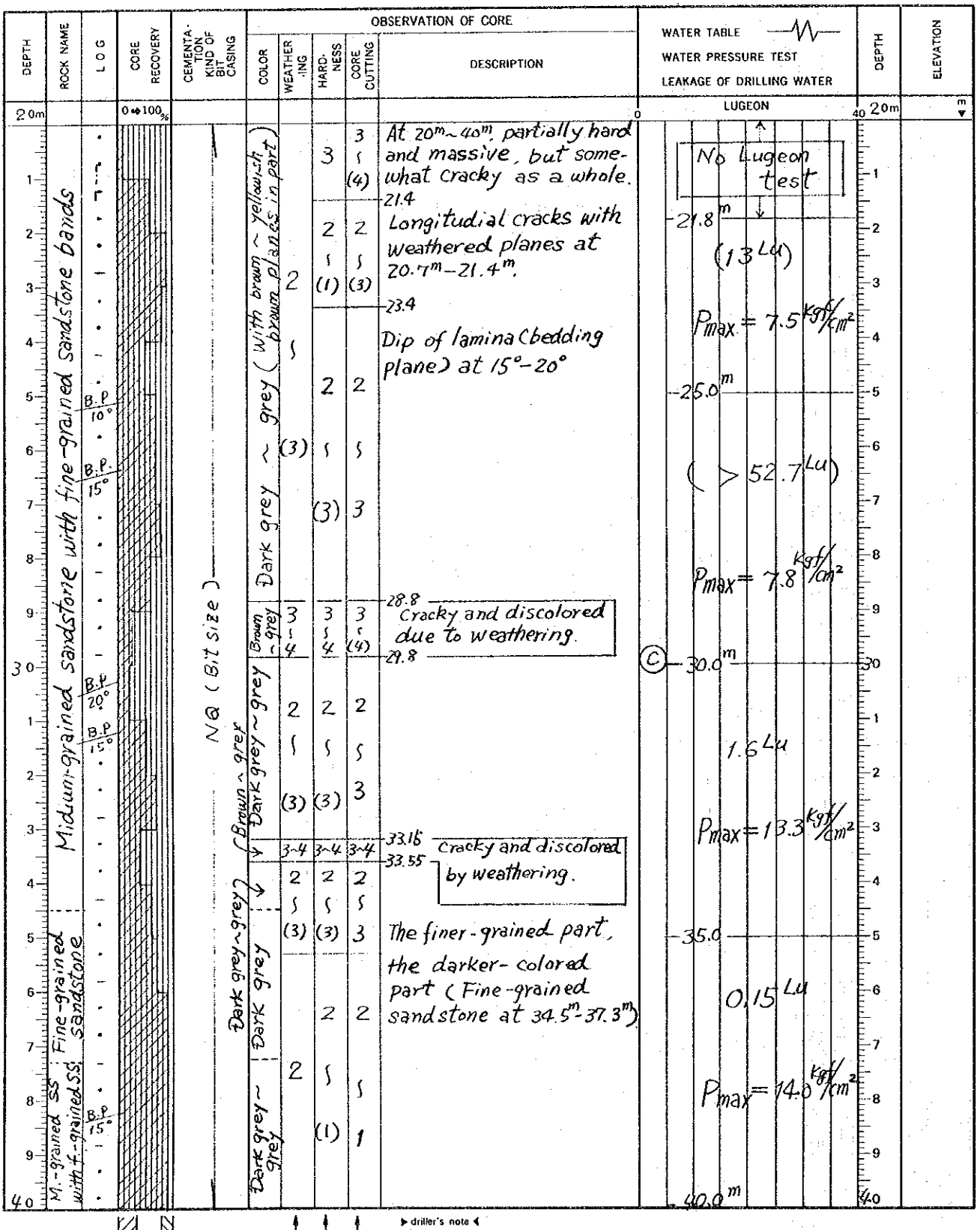
core loss
RQD
▶ driller's note ◀
1 (stick), 2 (substick), 3 (piece), 4 (freqment), 5 grain
1 (hard) ~ 5 (soft)
1 (fresh) ~ 5 (decomposed)

ELECTRIC POWER DEVELOPMENT CO., LTD.
TOKYO, JAPAN

GEOLOGIC LOG OF DRILL HOLE

PIRRIS PROJECT — HOLE No. UB-1 (SHEET 2 OF 28)

LOCATION	UPSTREAM DAM	DEPTH OF HOLE	50.00 m	COMMENCED	10 - 2 -1991
ELEVATION	1,150.00 m	DEPTH OF OVERBURDEN	2.90 m	COMPLETED	18 - 2 -1991
COORDINATE	X 399,199.00	LENGTH OF ROCK DRILLING	47.10 m	DRILLED BY	CIMCOSA
	Y 451,944.50				
ANGLE FROM HOLIZONTAL	90.0°	TOTAL LENGTH OF CORE	45.51 m	LOGGED BY	JICA
BEARING OF ANGLE HOLE		CORE RECOVERY	91.0 %		



ELECTRIC POWER DEVELOPMENT CO., LTD.
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GEOLOGIC LOG OF DRILL HOLE

PIRRIS PROJECT — HOLE No. UB-1 (SHEET 3 OF 28)

LOCATION	UPSTREAM DAM	DEPTH OF HOLE	50.00 m	COMMENCED	10 - 2 - 1991
ELEVATION	1.150.00 m	DEPTH OF OVERBURDEN	2.90 m	COMPLETED	18 - 2 - 1991
COORDINATE	X 399.199.00	LENGTH OF ROCK DRILLING	47.10 m	DRILLED BY	CIMCOSA
	Y 451.944.00				
ANGLE FROM HOLIZONTAL	90.0°	TOTAL LENGTH OF CORE	45.51 m	LOGGED BY	JICA
BEARING OF ANGLE HOLE		CORE RECOVERY	91.0 %		

DEPTH	ROCK NAME	LOG	CORE RECOVERY	CEMENTATION KIND OF BIT CASING	OBSERVATION OF CORE: COLOR	WEATHERING	HARDNESS	CORE CUTTING	DESCRIPTION	WATER TABLE / WATER PRESSURE TEST / LEAKAGE OF DRILLING WATER	DEPTH	ELEVATION
40m			0→100%							0 LUGEON 40	40m	m
1–5	Midium-grained sandstone with fine-grained sandstone	B.P 20° B.P 15°		NQ (Bit size)	Grey~dark grey	2 ≀ (3)	2 ≀ (3)	2 ≀ 3	Partially cracky and some planes are discolored.	ⓒ		
					Grey~brownish grey	(3)	3-4	3-4				
							2 ≀ (3)	2 ≀ 3				
						3 ≀ (4)	3 ≀ (4)	4 ≀ 3	Gravelish and discolored cores are remarkable as a whole. Weathered and cracky part.	ⓓ ≀ (c)		
6–9					Grey~dark grey	2 ≀	2 ≀ (1)	2 ≀ (3)	Somewhat discolored planes are observable in part, but generally rather massive.	ⓒ ≀ (b)		
50									Bottom of hole at 50.0m			
									Note on Lugeon tests; - The Lugeon value with ( ) is estimated from the P-Q curve.			

40.0m — 3.3 Lu — Pmax = 13.2 kgf/cm²

45.0m

45.7m — 2.1 Lu — Pmax = 13.4 kgf/cm²

50.0m

core loss / RQD

▶ driller's note ◀ 1 (stick), 2 (substick), 3 (piece), 4 (fragment), 5 grain

1 (hard) – 5 (soft)

1 (fresh) – 5 (decomposed)

ELECTRIC POWER DEVELOPMENT CO., LTD.
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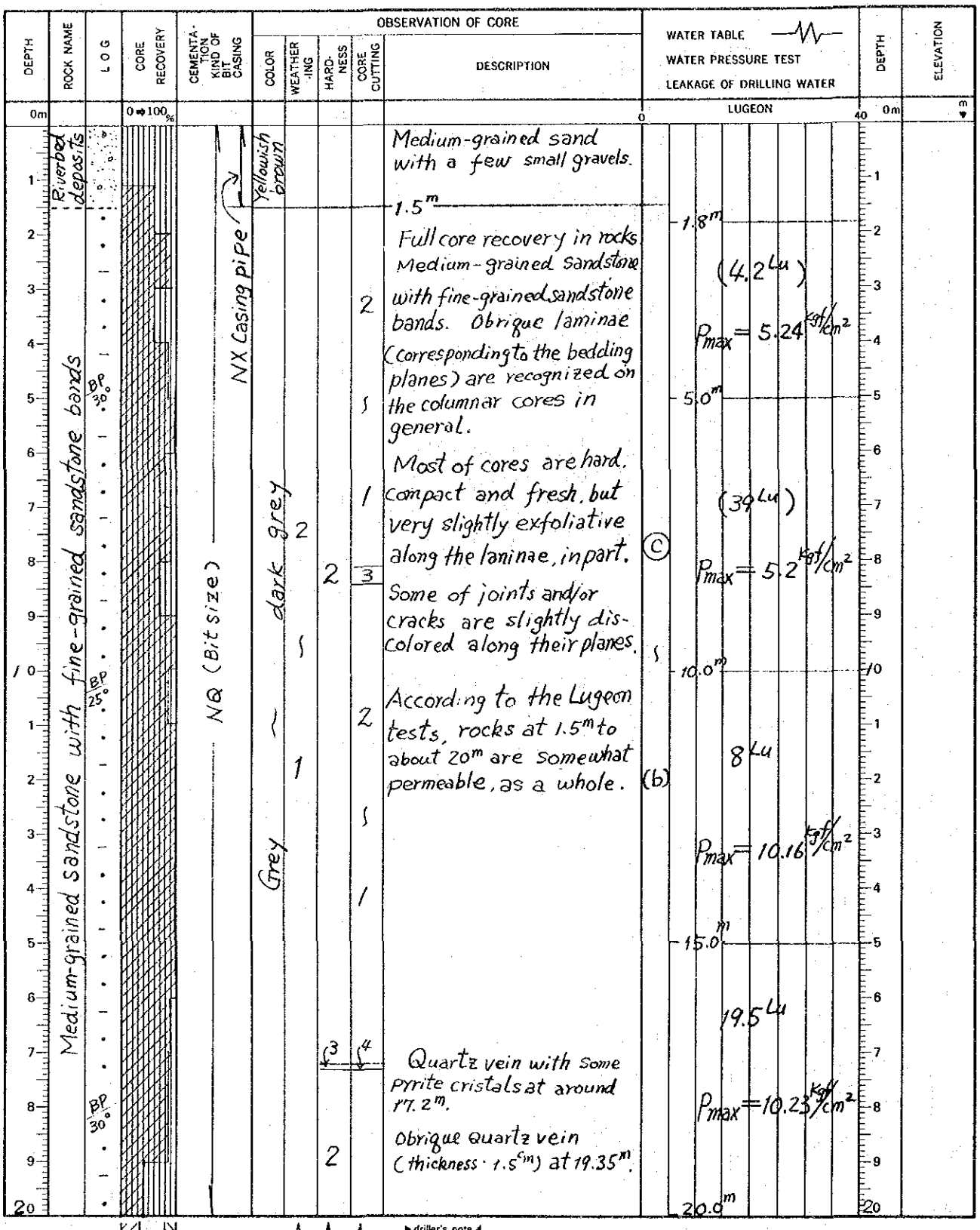
GEOLOGIC LOG OF DRILL HOLE

PIRRIS PROJECT — HOLE No. UB-2 (SHEET 4 OF 28)

LOCATION	UPSTREAM DAM	DEPTH OF HOLE	50.00 m	COMMENCED	20 - 11 -1990
ELEVATION	1,103.20 m	DEPTH OF OVERBURDEN	1.13 m	COMPLETED	30 - 11 -1990
COORDINATE	X 399,294.00	LENGTH OF ROCK DRILLING	48.87 m	DRILLED BY	CIMCOSA
	Y 451,945.00	TOTAL LENGTH OF CORE	48.85 m	LOGGED BY	JICA
ANGLE FROM HOLIZONTAL	60.0°	CORE RECOVERY	97.7 %		
BEARING OF ANGLE HOLE	N→S				



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