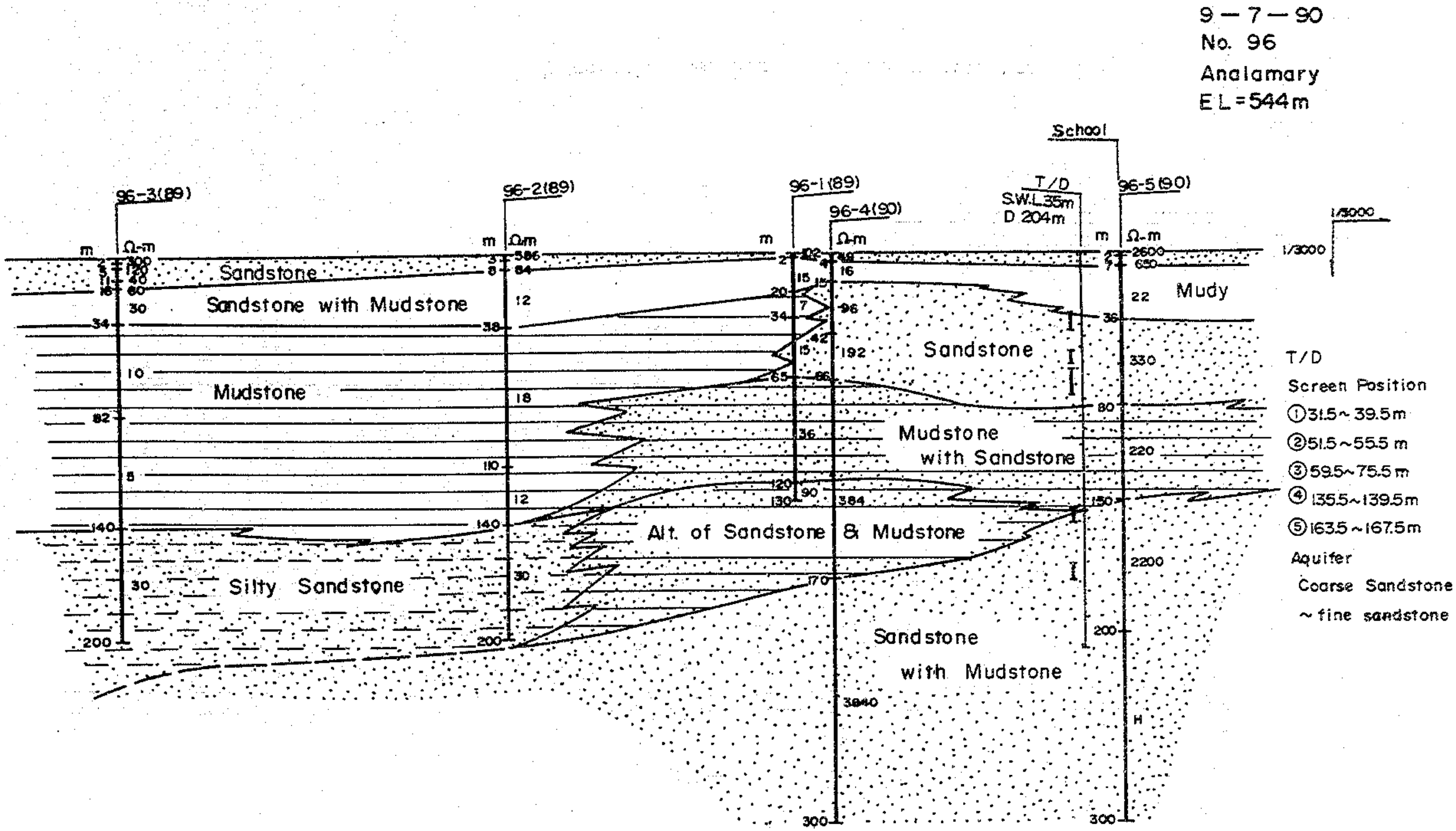
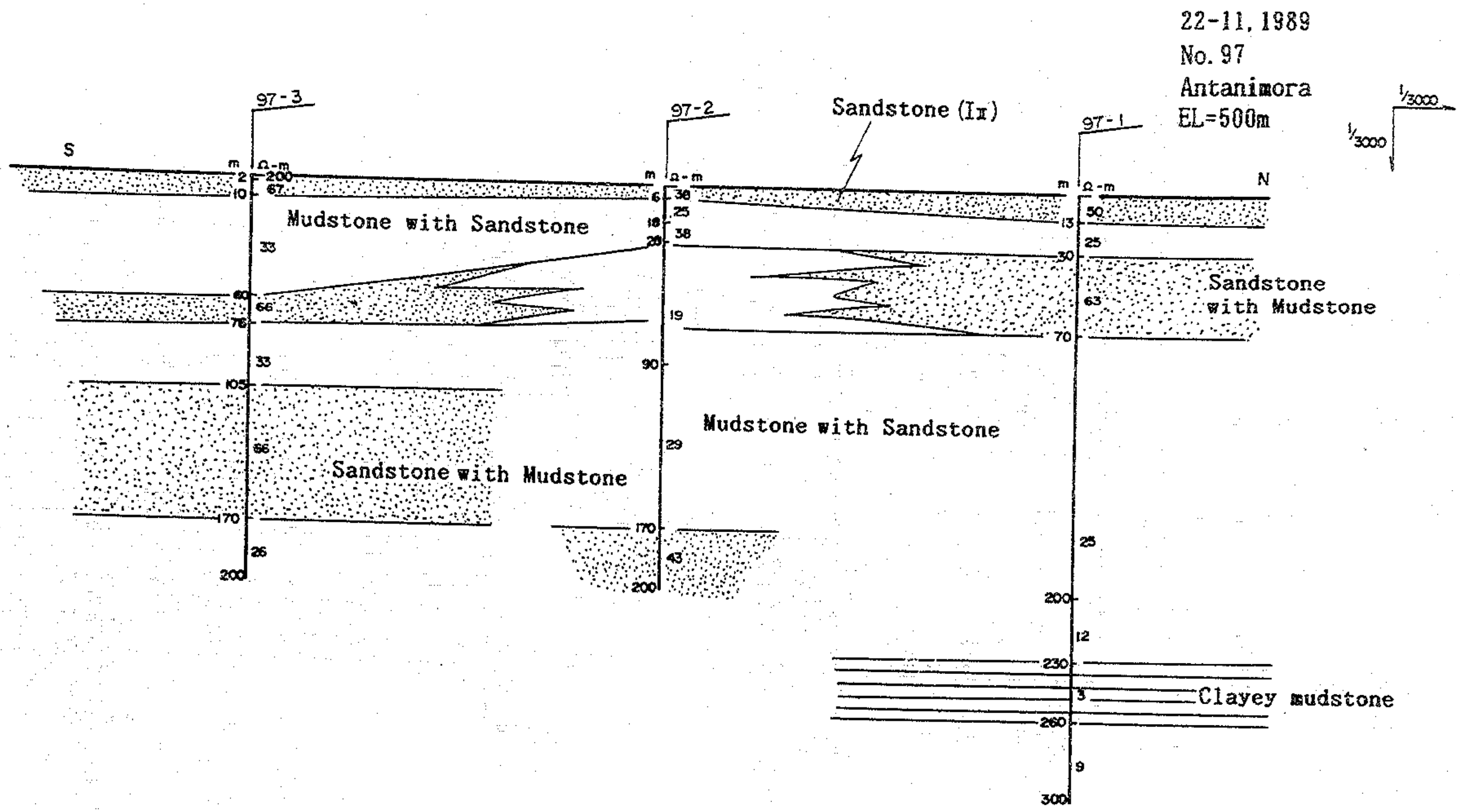
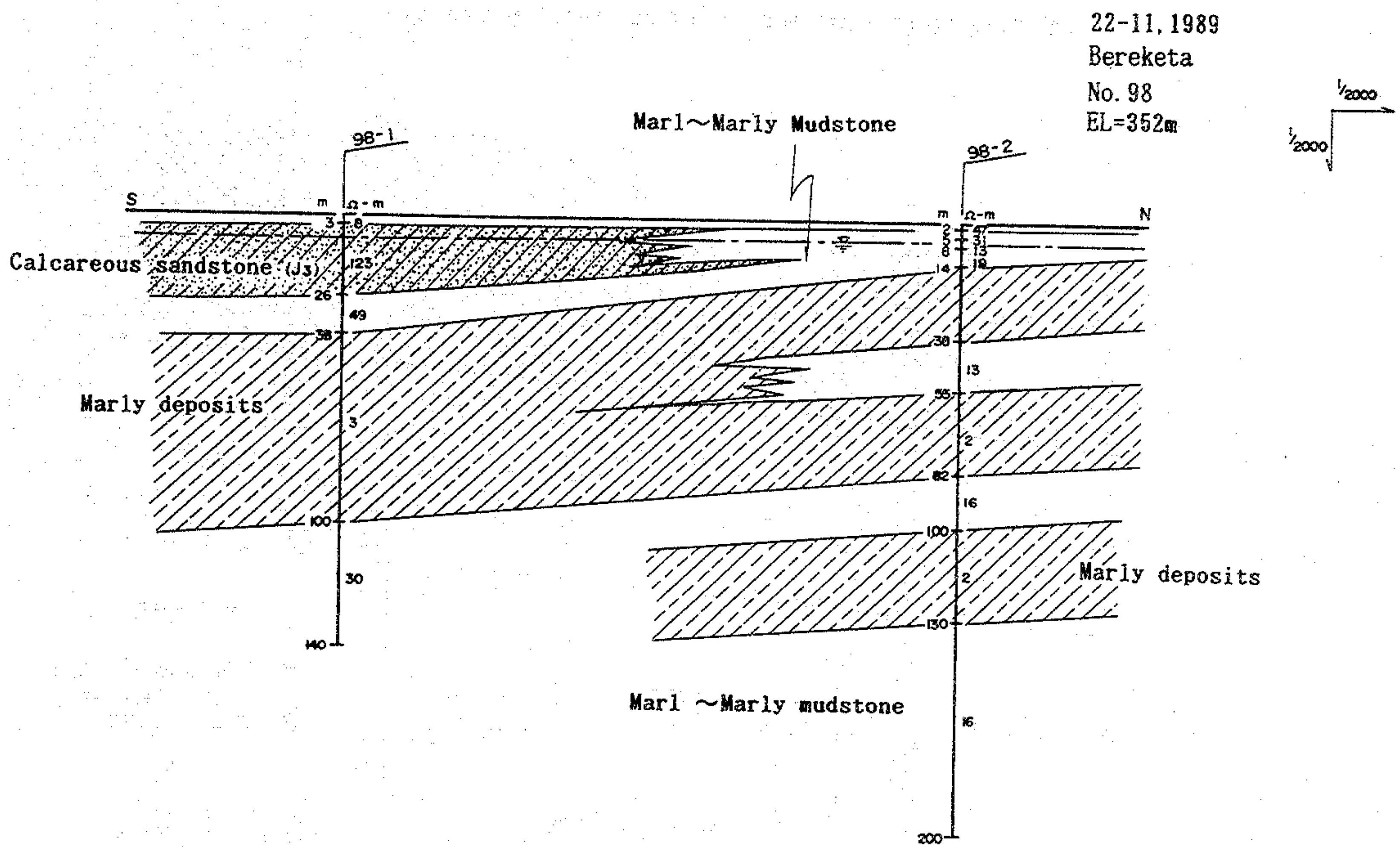


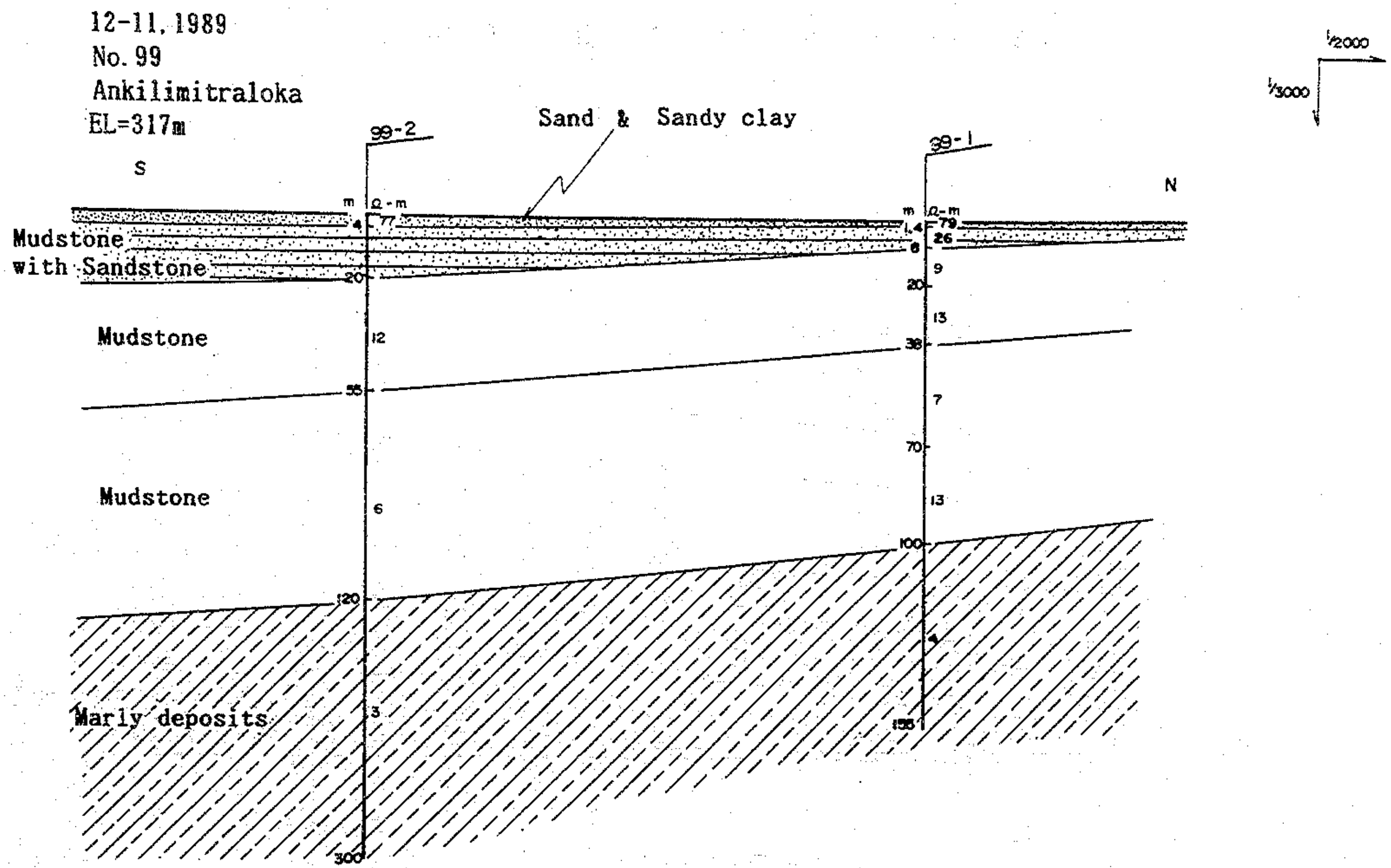
Hydrogeological Section of Analamary Area (96)



Hydrogeological Section of Antanimora Area (97)



Hydrogeological Section of Bereketa Area (98)



Hydrogeological Section of Ankilimitraloka Area (99)

The Locations of Investigation & The Topographical Feature

Candidate Village No. EL. 205 m

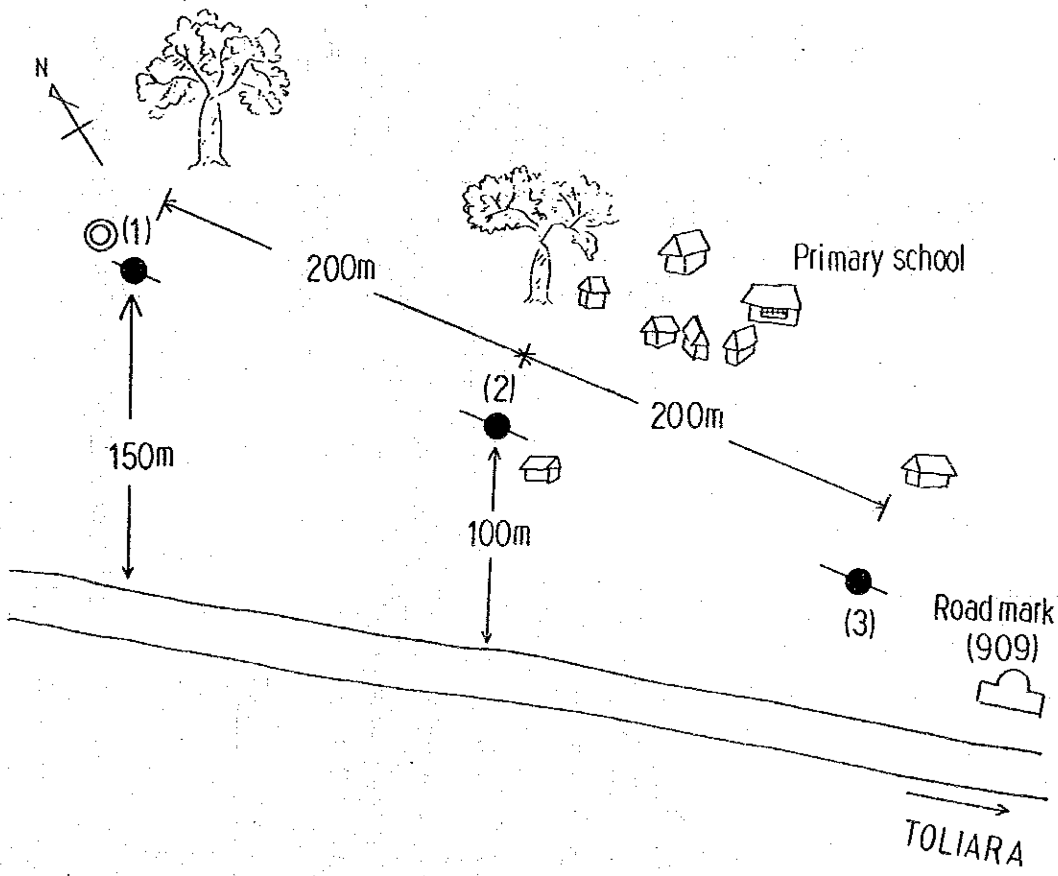
Name Andronahinaly (Rehabilitation Village)

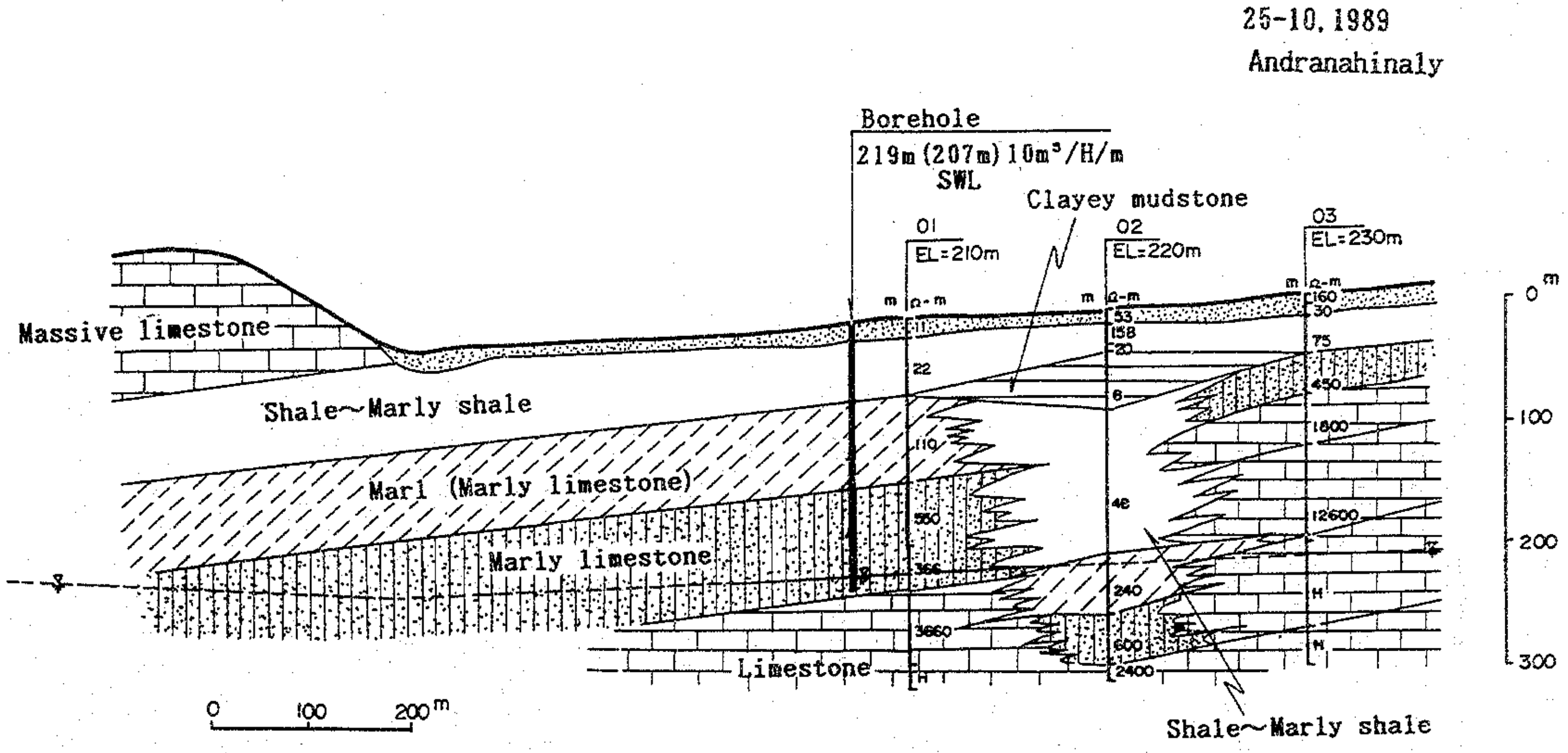
Settlement — Electric Vertical Sounding

MA Magneto-telluric Sounding Point

Well — Spring — Test Drilling Point

Candidate Drilling Point





Hydrogeological Section of Andranohinaly Area

The Locations of Investigation & The Topographical Feature

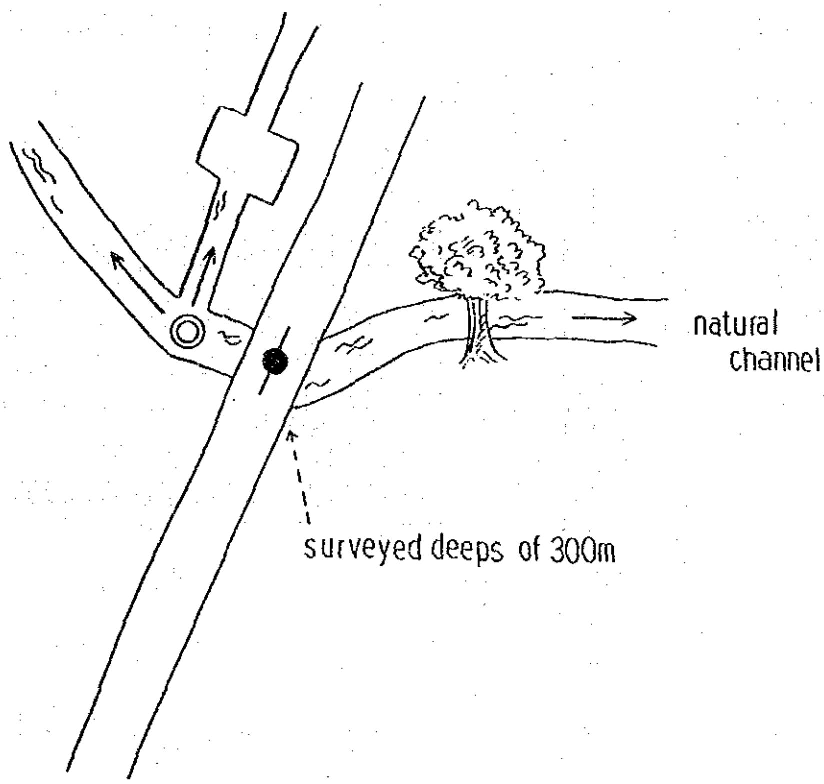
Candidate Village	No.	EL. m
	Name ANTANAMEBA (army bace)	

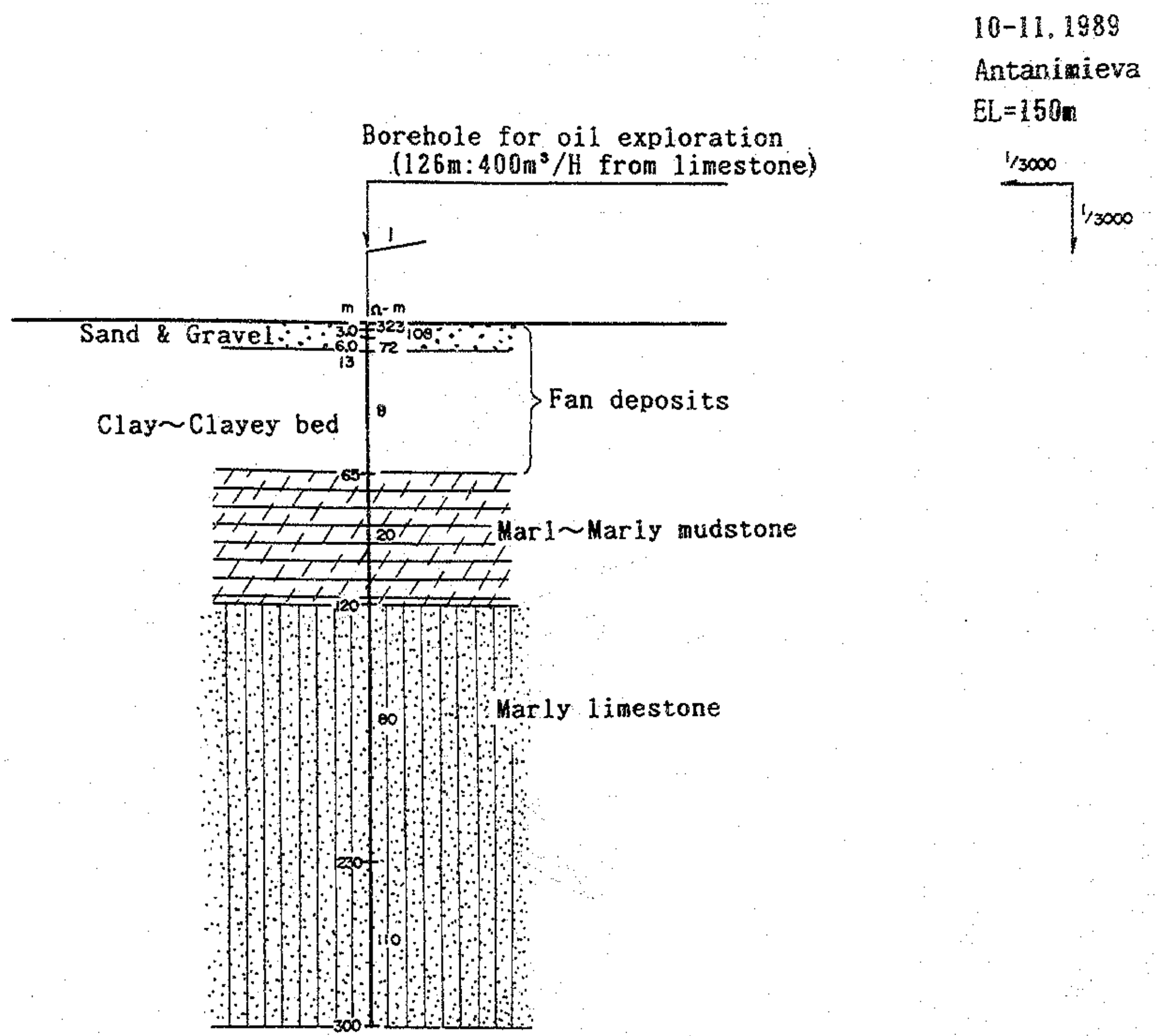
Settlement — Electric Vertical Sounding

Magneto-telluric Sounding Point

Well — Spring — Test Drilling Point

Candidate Drilling Point



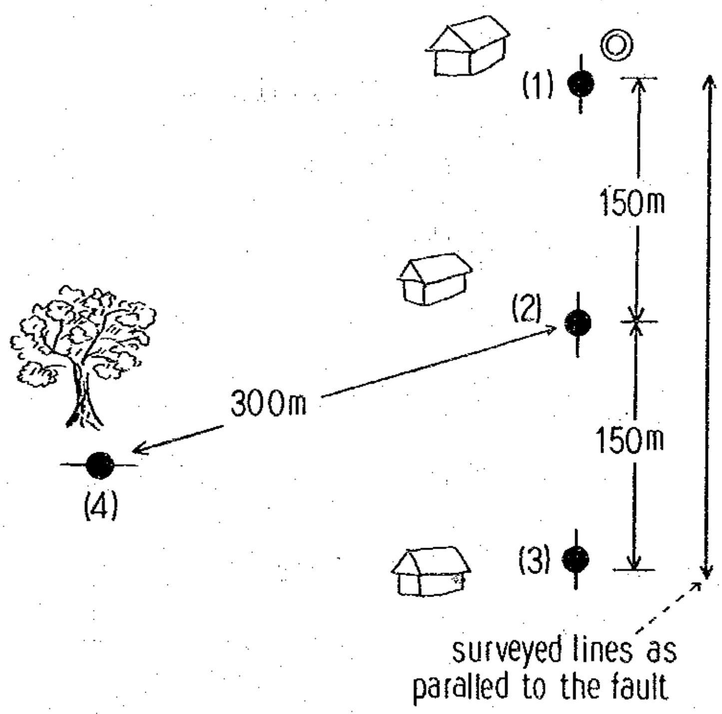


Lithological Prospecting of Existing Borehole in Antanimieva

The Locations of Investigation & The Topographical Feature

Candidate Village	No.	EL. m
	Name Betsioky-Nard	

Settlement — Electric Vertical Sounding — MA Magneto-telluric Sounding Point — Well — Spring — Test Drilling Point — Candidate Drilling Point



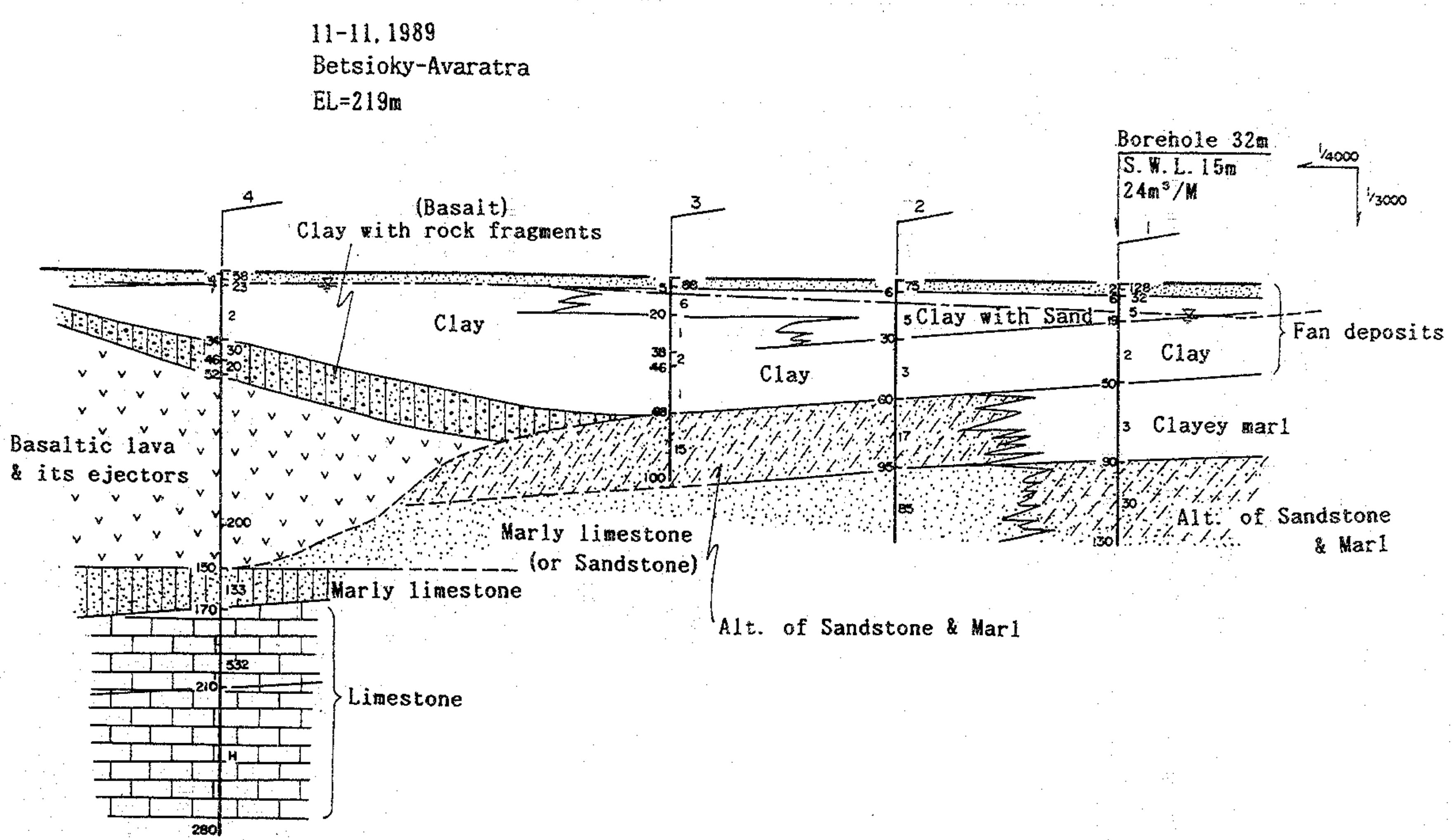
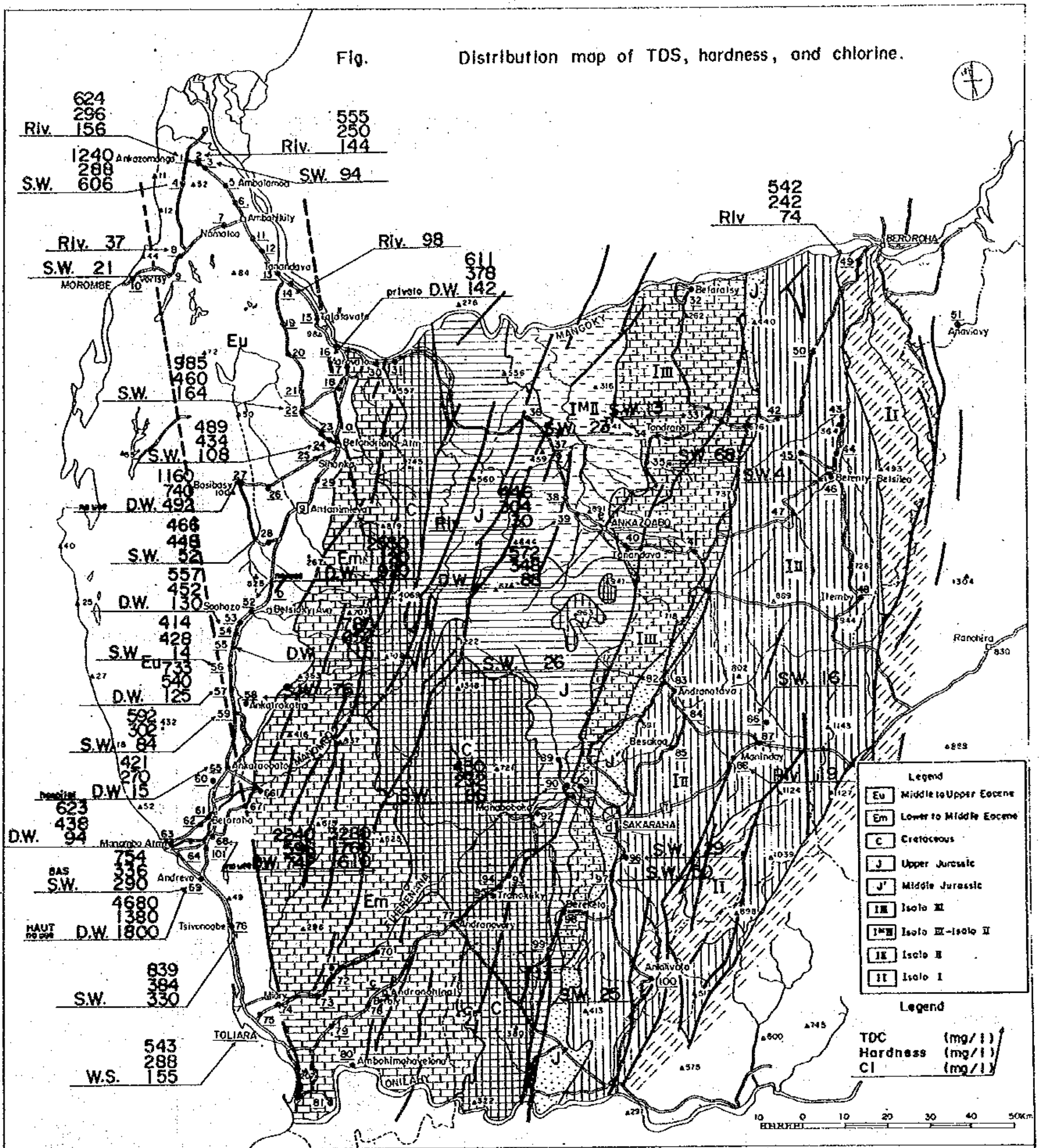


Fig. 4-2-5 Hydrogeological Section of Betsioky Area

3. RESULTS OF WATER QUALITY ANALYSIS



No Villages

I. Fiv. MOROMBE

1 Ankazomanga
2 Beadabo
3 befasy
4 Ankilifolo(1)
5 Ambalamoa
6 Tsianihy
7 Namatoa
8 Mangolovolo
9 Ankida
10 Vorisy
11 Andranomanitsy
12 Berantala
13 Tanandava
14 Antsakoabe
15 Talatavalo
16 Ambiky
17 Marovato
18 Andranoboka
19 Satrambondro
20 Mahavozokely
21 Antranosatra
22 Manoy
23 Ampoza
24 Ankilifolo(2)
25 Sihanaka
26 Bemoka
27 Basibasy
28 Analatelo
29 Mangotroka
30 Hosy-Ambositra
31 Tsiarimpioke

II. Fiv. ANKAZOABO ATM

32 Befaratsy
33 Andranomanintsy
34 Tandrano
35 Ampandramitsotaky
36 Andranomafana
37 Mamakiala
38 Berenty-Ankilimasy
39 Botsinefo
40 Tanandava
41 Ampoza
42 Ipetsa Atm
43 Mandabe Atm
44 Soatanimbary
45 Sabanory Atn
46 Berenty-Betsileo
47 Ankilivalokely
48 Ilemby

III. Fiv. BEROROHA

49 Tanandava-Antaifasy
50 Anjamitlkitra
51 Anaviavy

IV. Fiv. TOLIARA I/II

52 Soahazo
53 Analamisampy
54 Belitsaka
55 Ampasikibo
56 Mamaboha
57 Antseva
58 Ankilimiavotoka
59 Ampihamy
60 Ambondro
61 Beroroha
62 Antsomarify
63 Manombo-Atm
64 Antandroka
65 Ankaraobato
66 Andoharano
67 Tsefanoka
68 Benetsy
69 Andravo
70 Anjamala
71 Ampihalia
72 Behompy
73 Ambolonkira
74 miary
75 Befanamy
76 Tsivonoabe
77 Andranovory
78 Befoly
79 Ankeroroka
80 Ambohimahavelona
81 Manoroka
101 Ankilimalinika

V. Fiv. SAKARAHA

82 Iaborana
83 Andranolava
84 Lambomakandro
85 Besakoa(1)
85 Besakoa(2)
87 Ampandra
88 Maninday
89 Bevoalavo
90 Tanambao
91 Ambahimalitsy
92 Mahaboboka
93 Mahasoa
94 Andamasiny-Vineta
95 Tranokaky
96 Analamary
97 Antanimora
98 Bereketa
99 Ankilimitraloka
100 Ankilivalo

a Befandriana
b Betsioky Nord
c Andranohinaly
d Sakaraha
e Ankazoabo

Table F-1 Results of water quality analysis for drinking water

RESULTATS DE L'ANALYSE DE LA QUALITE D'EAU

No.Village / Nom Village		1 ANKAZOMANGA	2 BEADABO	3 BEFASY	4 ANKILIFOLO (1)	5 AMBALAMOA	6 TSIANIHY	7 NAMATOA
Rubrique Test								
1 Water temp.	°C	32.0	33.0	35.0	32.5	29.0	29.5	29.0
2 pH (25℃)		7.8	8.1	7.5	7.4	7.4	7.5	6.8
3 Hard.	mg/l as CaCO3	296	250	32	288	240	162	142
4 Ca	mg/l	64.0	58.0	4.8	67.0	64.0	40.0	33.0
5 Mg	mg/l	33.0	25.0	4.8	29.0	19.0	15.0	15.0
6 Cl	mg/l	156	144	30	606	58	58	17
7 SO4	mg/l	200	185	17	17	58	23	14
8 Fe	mg/l	0.11	0.10	1.08	0.46	0.06	0.02	0.31
9 TDS (25℃)	mg/l	624.0	555.0	93.8	1240.0	343.0	293.0	174.0
10 EC (25℃)	μS/cm	1250	1110	187	2490	687	586	348
11 Acidity	mg/l as CaCO3	30	32	18	92	39	34	48
12 Alkalinity	mg/l as CaCO3	196	178	58	398	304	226	171
13 PO4	mg/l	0.45	0.45	0.17	0.39	0.77	0.51	0.33
14 NH3-N	mg/l	0.17	0.20	0.16	1.67	0.06	0.05	0.24
15 NO2-N	mg/l	0.006	0.003	0.008	0.028	0.000	0.003	0.005
16 NO3-N	mg/l	0.3	0.7	0.4	0.0	0.2	1.8	0.3
17 F	mg/l	0.05	0.67	0.00	0.43	0.52	0.56	0.19
18 Mn	mg/l	0.2	0.3	0.2	0.2	0.1	0.3	0.3
19 E.coli	+/-	+	+	-	+	+	+	+
20 TURB & COLOR		YEL.TURB	YEL.TURB	RED TURB	YEL.TURB			RED
NOTE:		11/7 Riv.	11/7 Riv.	11/7 S.W.	11/7 S.W.	11/9 D.W.	11/9 S.W.	11/8 D.W.

Cont.

No.	No.Village / Nom Village	Unit	8 MANGOLOVOLO	9 ANKIDA	10 VORISY	11 ANDRONOMANI-TSY	12 BERANALA	13 TANANDAVA	14 ANTSAKOABE
	Rubrique Test								
1	Water temp.	°C	30.0	29.0	NO VIL.	30.0	30.0	31.5	28.5
2	pH (25°C)		6.4	5.8		7.5	7.3	7.8	7.9
3	Hard.	mg/l as CaCO3	16	12		286	232	204	60
4	Ca	mg/l	2.4	1.6		95.0	34.0	57.0	21.0
5	Mg	mg/l	2.4	1.9		12.0	36.0	15.0	1.9
6	Cl	mg/l	16	13		52	30	52	16
7	SO4	mg/l	5	5		36	9	55	26
8	Fe	mg/l	2.10	0.67		0.00	0.44	0.00	0.26
9	TDS (25°C)	mg/l	37.1	20.7		348.0	125.0	293.0	97.9
10	EC (25°C)	μS/cm	74	41		697	251	585	195
11	Acidity	mg/l as CaCO3	16	12		26	21	27	28
12	Alkalinity	mg/l as CaCO3	17	16		238	104	176	74
13	PO4	mg/l	0.00	0.02		0.84	0.73	0.22	0.23
14	NH3-N	mg/l	0.46	0.20		0.14	0.40	0.00	0.34
15	NO2-N	mg/l	0.008	0.004		0.239	0.000	0.000	0.016
16	NO3-N	mg/l	0.7	0.5		5.7	0.1	1.8	1.4
17	F	mg/l	0.00	0.02		0.59	0.73	0.54	0.00
18	Mn	mg/l	0.3	0.2		0.0	1.3	0.0	0.4
19	E.coli	+/-	+	-		+	+	+	+
20	TURB & COLOR		BROWN TURB	YEL.TURB			YEL.		WHITE TURB
	NOTE:		11/8 Riv.	11/8 S.W. spring		11/9 S.W.	11/9 D.W.	11/9 B.F.W.	11/11 canal

Cont.

No. Village Nom Village		15 TANTALAVALO	16 AMBIKY	17 MAROVATO	18 ANDRANOBOKA	19 SATRAMBONDRO	20 MOHAVOZOKELY	21 ANTRANOSATRA
Rubrique Test								
1 Water temp.	°C	27.5	28.0	28.0	33.5	NOT	NOT	28.0
2 pH (25°C)		7.9	7.8	7.7	7.3	ACCESSIBLE	ACCESSIBLE	8.0
3 Hard.	mg/l as CaCO3	82	96	278	152			172
4 Ca	mg/l	22.0	22.0	85.0	54.0			64.0
5 Mg	mg/l	6.8	9.7	16.0	4.3			2.9
6 Cl	mg/l	17	15	48	14			24
7 SO4	mg/l	26	32	38	6			22
8 Fe	mg/l	0.35	0.32	0.09	0.14			1.70
9 TDS (25°C)	mg/l	101.0	128.0	341.0	174.0			241.0
10 EC (25°C)	μS/cm	202	257	682	348			482
11 Acidity	mg/l as CaCO3	18	20	60	46			110
12 Alkalinity	mg/l as CaCO3	80	90	292	170			254
13 PO4	mg/l	0.17	0.39	0.37	1.22			0.70
14 NH3-N	mg/l	0.22	0.26	0.17	0.81			3.20
15 NO2-N	mg/l	0.007	0.010	0.000	0.014			0.054
16 NO3-N	mg/l	1.0	1.0	0.0	0.3			1.0
17 F	mg/l	0.51	0.12	0.72	0.33			0.24
18 Mn	mg/l	0.5	0.5	0.0	0.2			0.3
19 E.coli	+/-	+	+	-	+			+
20 TURB & COLOR		WHITE TURB	YEL.TURB		YEL.			BROWN TURB
NOTE:		11/11 canal	11/11 Riv.	11/11 S.W. spring	11/11 S.W.			11/10 S.W.

Cont.

No. Village / Nom Village			22 MANOY	23 AMPOZA	24 ANKILIFOLO (2)	25 SIHANAKA	26 BEMOKA	27 BASIBASY	28 ANALATELO
Rubrique Test									
1	Water temp.	°C	28.0	28.0	27.5	28.0	NOT	27.0	27.0
2	pH (25°C)		7.5	7.6	7.7	7.6	ACCESSIBLE	8.0	7.4
3	Hard.	mg/l as CaCO3	460	182	434	154		236	448
4	Ca	mg/l	142.0	68.0	168.0	56.0		67.0	154.0
5	Mg	mg/l	25.0	2.9	3.4	3.4		16.0	15.0
6	Cl	mg/l	164	20	108	10		48	52
7	SO4	mg/l	270	18	14	10		42	148
8	Fe	mg/l	0.00	0.02	0.00	0.84		0.07	0.05
9	TDS (25°C)	mg/l	985.0	314.0	489.0	166.0		312.0	466.0
10	EC (25°C)	μS/cm	1970	628	977	333		623	932
11	Acidity	mg/l as CaCO3	148	100	114	62		38	66
12	Alkalinity	mg/l as CaCO3	462	318	252	176		268	308
13	PO4	mg/l	0.75	0.62	0.81	0.57		0.29	0.06
14	NH3-N	mg/l	0.39	0.15	1.31	0.44		0.17	0.05
15	NO2-N	mg/l	0.005	0.009	0.058	0.026		0.008	0.000
16	NO3-N	mg/l	2.0	0.0	10.6	0.7		0.0	0.0
17	F	mg/l	0.64	0.46	0.32	0.00		0.28	0.12
18	Mn	mg/l	0.1	0.1	0.0	0.8		0.1	0.0
19	E.coli	+/-	+	+	+	+		+	+
20	TURB & COLOR					YEL.TURB		YEL.	
NOTE:			11/10 D.W.	11/10 S.W.	11/10 S.W.	11/10 S.W.		11/12 canal	11/15 S.W.

Cont.

No. Village / Nom Village / Rubrique Test	Unit	29 MANGOTROKA	30 NOSY-AMBOSITRA	31 TSIARMPIOKE	32 BETARATSY	33 ANDRANOMANIN-TSY	34 TANDRANO	35 AMPANDRAMI-TSETAKY
1 Water temp.	°C	28.5	NOT ACCESSIBLE	NOT ACCESSIBLE	NOT ACCESSIBLE	32.5	27.0	25.5
2 pH (25°C)		5.8				6.1	6.0	6.6
3 Hard.	mg/l as CaCO3	120				5	8	44
4 Ca	mg/l	28.0				0.8	2.4	10.0
5 Mg	mg/l	12.0				0.7	0.5	4.4
6 Cl	mg/l	42				5	1	5
7 SO4	mg/l	3				15	9	8
8 Fe	mg/l	0.03				0.45	0.33	0.54
9 TDS (25°C)	mg/l	167.0				12.7	23.4	68.0
10 EC (25°C)	μS/cm	334				25	47	136
11 Acidity	mg/l as CaCO3	14				10	16	20
12 Alkalinity	mg/l as CaCO3	8				10	22	72
13 PO4	mg/l	0.17				0.03	0.02	0.01
14 NH3-N	mg/l	0.18				0.08	0.00	0.00
15 NO2-N	mg/l	0.036				0.021	0.008	0.000
16 NO3-N	mg/l	11.9				0.5	0.4	0.4
17 F	mg/l	0.22				0.04	0.21	0.22
18 Mn	mg/l	0.0				0.2	0.1	0.1
19 E.coli	+/-	+				+	+	+
20 TURB & COLOR						WHITE TURB	WHITE TURB	
NOTE:		11/11 S.W.				10/31 S.W.	10/31 S.W.	10/31 S.W.

Cont.

No. Village / Nom Village		36 ANDRANOMA-FANA	37 MAMAKIALA	38 BERENTY-ANKILIMASY	39 BETSINEFO	40 TANANDAVA	41 AMPOZA	42 IPETSA ATM
Rubrique Test								
1 Water temp.	°C	NOT ACCESSIBLE	NOT ACCESSIBLE	NOT ACCESSIBLE	23.0		23.5	25.5
2 pH (25℃)					8.3	7.4	8.3	7.8
3 Hard.	mg/l as $CaCO_3$				304	150	166	116
4 Ca	mg/l				98.0	36.0	50.0	32.0
5 Mg	mg/l				15.0	15.0	9.7	8.7
6 Cl	mg/l				30	22	6	6
7 SO_4	mg/l				215	39	2	8
8 Fe	mg/l				0.82	0.59	0.13	0.13
9 TDS (25℃)	mg/l				446.0	213.0	166.0	137.0
10 EC (25℃)	μS/cm				891	425	333	275
11 Acidity	mg/l as $CaCO_3$				60	102	82	66
12 Alkalinity	mg/l as $CaCO_3$				148	146	162	128
13 PO_4	mg/l				0.08	0.16	0.03	0.11
14 NH_3-N	mg/l				0.22	0.34	0.00	0.08
15 NO_2-N	mg/l				0.012	0.003	0.000	0.002
16 NO_3-N	mg/l				1.5	1.2	1.0	0.7
17 F	mg/l				0.52	0.59	0.00	0.42
18 Mn	mg/l				0.8	0.1	0.0	0.0
19 E.coli	+/-				+	+	+	+
20 TURB & COLOR					WHITE TURB	YEL.		
NOTE:					11/1 Riv.	11/1 S.W.	11/1 Riv.	11/1 S.W.

Cont.

No. Village / Nom Village		43 MONDABE ATM	44 SOATANIMBARY	45 SAHANORY ATN	46 BERENTY-BETSILEO	47 ANKILIVALO-KELY	48 ILEMBY	49 TANANDAVA-ANTAIFASY
Rubrique Test								
1 Water temp.	°C	25.0	28.0	30.5	32.5	30.0	NOT	27.0
2 pH (25℃)		7.4	7.3	6.4	8.3	8.2	ACCESSIBLE	8.0
3 Hard.	mg/l as $CaCO_3$	314	171	23	97	186		242
4 Ca	mg/l	81.0	55.0	5.6	28.0	45.0		68.0
5 Mg	mg/l	27.0	8.0	2.2	6.8	18.0		17.0
6 Cl	mg/l	32	29	5	15	10		74
7 SO_4	mg/l	72	4	6	8	26		27
8 Fe	mg/l	0.01	0.09	0.88	0.67	0.30		0.24
9 TDS (25℃)	mg/l	394.0	265.0	40.5	119.0	197.0		542.0
10 EC (25℃)	μS/cm	788	530	81	238	394		1080
11 Acidity	mg/l as $CaCO_3$	74	89	18	50	63		108
12 Alkalinity	mg/l as $CaCO_3$	245	178	38	99	172		404
13 PO_4	mg/l	0.36	0.44	0.18	0.36	0.20		0.21
14 NH_3-N	mg/l	0.05	0.06	0.08	0.19	0.10		0.63
15 NO_2-N	mg/l	0.004	0.002	0.000	0.004	0.003		0.008
16 NO_3-N	mg/l	0.1	0.0	1.5	0.0	0.0		0.9
17 F	mg/l	0.71	0.19	0.00	0.24	0.32		0.65
18 Mn	mg/l	0.0	0.0	0.2	0.1	0.0		0.1
19 E.coli	+/-	+	+	+	+	+		+
20 TURB & COLOR				YEL.TURB	YEL.TURB			YEL.
NOTE:		11/2 S.W.	11/2 S.W.	11/2 S.W.	11/2 Riv.	11/2 Riv.		11/1 Riv.

Cont.

No.	No.Village / Nom Village			50 ANJAMITIKI-TRA	51 ANAVIAVY	52 SOAHAZO	53 ANALAMISAMPY	54 BELITSAKA	55 AMPASIKIBO	56 NAMABOHA
	Rubrique Test									
1	Water temp.	°C		NO VIL.	NOT ACCESSIBLE	26.0	28.0	27.5	28.0	27.0
2	pH (25℃)					7.6	7.4	7.4	6.8	7.3
3	Hard.	mg/l	as CaCO3			110	218	452	652	428
4	Ca	mg/l				32.0	70.0	159.0	243.0	142.0
5	Mg	mg/l				7.3	10.0	13.0	11.0	17.0
6	Cl	mg/l				16	60	130	115	14
7	SO4	mg/l				4	12	110	88	57
8	Fe	mg/l				0.16	0.14	0.08	0.15	2.18
9	TDS (25℃)	mg/l				141.0	348.0	557.0	780.0	414.0
10	EC (25℃)	µS/cm				282	696	1110	1560	827
11	Acidity	mg/l	as CaCO3			36	64	66	136	112
12	Alkalinity	mg/l	as CaCO3			144	300	286	375	395
13	PO4	mg/l				0.26	0.10	0.20	0.33	0.25
14	NH3-N	mg/l				0.36	0.13	0.30		4.36
15	NO2-N	mg/l				0.011	0.000	0.000	0.019	0.021
16	NO3-N	mg/l				0.4	0.8	0.9	0.1	1.0
17	F	mg/l				0.24	0.25	0.00	0.09	0.12
18	Mn	mg/l				0.2	0.1	0.1	0.1	2.4
19	E.coli	+/-				+	-	+	+	+
20	TURB & COLOR									YEL.TURB
	NOTE:					11/15 S.W.	11/15 D.W. handpump	11/15 D.W.	11/15 D.W. handpump	11/15 S.W.

Cont.

No. Village / Nom Village			57 ANTSEVA	58 ANKATRAKATRA	59 AMPIHAMY	60 AMBONDRO	61 BEROROHA	62 ANTSOMARIFY	63 MANOMBO ATM
Rubrique Test									
1 Water temp.	°C			27.0	27.5	NOT ACCESSIBLE	NOT ACCESSIBLE	NOT ACCESSIBLE	28.0
2 pH (25°C)			7.1	6.9	7.4				7.4
3 Hard.	mg/l	as CaCO3	540	42	302				438
4 Ca	mg/l		132.0	11.0	98.0				125.0
5 Mg	mg/l		51.0	3.4	14.0				30.0
6 Cl	mg/l		125	12	84				94
7 SO4	mg/l		175	12	145				145
8 Fe	mg/l		0.01	2.21	0.04				0.02
9 TDS (25°C)	mg/l		733.0	76.0	592.0				623.0
10 EC (25°C)	μS/cm		1470	152	1180				1250
11 Acidity	mg/l	as CaCO3	89	44	70				62
12 Alkalinity	mg/l	as CaCO3	472	56	350				274
13 PO4	mg/l		0.33	0.31	0.20				0.13
14 NH3-N	mg/l		0.08	1.72	0.24				0.13
15 NO2-N	mg/l		0.002	0.028	0.006				0.030
16 NO3-N	mg/l		0.2	1.0	0.5				6.2
17 F	mg/l		0.38	0.00	0.24				0.44
18 Mn	mg/l		0.0	0.1	0.0				0.0
19 E.coli	+/-		+	+	+				+
20 TURB & COLOR				YEL.TURB					
NOTE:			10/25 D.W.	11/15 S.W.	11/15 S.W.				11/17 D.W.

Cont.

No.	No.Village / Nom Village	Unit	64 ANTANDROKA	65 ANKARAOBATO	66 ANDOHARANO	67 TSEFANOKA	68 BENETSY	69 ANDREVO BAS	70 ANJAMALA
	Rubrique Test								
1	Water temp.	°C	29.0		NOT ACCESSIBLE	25.0	28.0	27.0	NOT ACCESSIBLE
2	pH (25°C)		7.4	8.1		8.0	7.5	7.6	
3	Hard.	mg/l as CaCO3	332	220		178	208	336	
4	Ca	mg/l	118.0	63.0		67.0	66.0	102.0	
5	Mg	mg/l	8.7	15.0		2.4	10.0	20.0	
6	Cl	mg/l	42	10		20	16	290	
7	SO4	mg/l	100	28		70	110	60	
8	Fe	mg/l	0.02	0.19		0.11	0.19	0.02	
9	TDS (25°C)	mg/l	371.0	216.0		196.0	238.0	754.0	
10	EC (25°C)	μS/cm	742	432		392	476	1510	
11	Acidity	mg/l as CaCO3	44	34		40	28	58	
12	Alkalinity	mg/l as CaCO3	178	108		124	94	232	
13	PO4	mg/l	0.02	0.23		0.25	0.39	0.14	
14	NH3-N	mg/l	0.05	0.00		0.13	0.21	0.07	
15	NO2-N	mg/l	0.025	0.000		0.011	0.006	0.069	
16	NO3-N	mg/l	4.6	0.1		0.1	0.0	1.3	
17	F	mg/l	0.43	0.00		0.29	0.51	0.33	
18	Mn	mg/l	0.0	0.1		0.2	0.1	0.0	
19	E.coli	+/-	+	+		+	+	-	
20	TURB & COLOR			WHITE TURB		YEL.			
	NOTE:		11/17 D.W.	10/25 Riv.		11/24 canal	11/16 canal	11/17 S.W. spring	

Cont.

No. Village / Nom Village		71 AMPIHALIA	72 BEHOMPY	73 AMBOLONKIRA	74 MIARY	75 BEFANAMY	76 TSIVONOABE	77 ANDRANOVORY
Rubrique Test								
1 Water temp.	°C	NOT ACCESSIBLE	30.0	30.0	28.0	29.0	28.0	WATER VENDER
2 pH (25°C)			8.3	8.3	7.8	7.9	7.4	
3 Hard.	mg/l as CaCO3		169	168	211	215	384	
4 Ca	mg/l		46.0	45.0	66.0	67.0	98.0	
5 Mg	mg/l		13.0	14.0	11.0	12.0	34.0	
6 Cl	mg/l		25	26	44	46	330	
7 SO4	mg/l		49	50	47	49	92	
8 Fe	mg/l		1.85	2.13	0.26	0.01	0.00	
9 TDS (25°C)	mg/l		176.0	175.0	259.0	257.0	839.0	
10 EC (25°C)	μS/cm		352	350	518	514	1680	
11 Acidity	mg/l as CaCO3		20	20	32	24	70	
12 Alkalinity	mg/l as CaCO3		152	154	170	171	264	
13 PO4	mg/l		0.12	0.15	0.12	0.19	0.11	
14 NH3-N	mg/l		0.04	0.04	0.07	0.02	0.44	
15 NO2-N	mg/l		0.002	0.002	0.000	0.000	0.024	
16 NO3-N	mg/l		0.2	0.1	0.4	0.0	1.2	
17 F	mg/l		0.10	0.08	0.41	0.25	0.13	
18 Mn	mg/l		0.7	0.8	0.2	0.0	0.0	
19 E.coli	+/-		+	+	-	-	+	
20 TURB & COLOR			RED TURB	RED TURB				
NOTE:			11/23 Riv.	11/23 Riv.	11/23 P.F.	11/23 P.F.	11/16 S.W.	

Cont.

No. Village / Nom Village			78 BEFOLY	79 ANKOROROKA	80 AMBOHIMAHA-VELONA	81 MANOROKA	82 LABORANA	83 ANDRANOLAVA	84 LAMBOMAKAND-RO
Rubrique Test									
1	Water temp.	°C	WATER VENDER	WATER VENDER	27.0	27.0			
2	pH (25°C)				7.6	7.6	5.9	7.8	8.3
3	Hard.	mg/l as CaCO3			192	280	24	181	100
4	Ca	mg/l			56.0	64.0	4.8	54.0	36.0
5	Mg	mg/l			13.0	29.0	2.9	11.0	2.4
6	Cl	mg/l			28	24	7	12	10
7	SO4	mg/l			59	37	8	18	1
8	Fe	mg/l			0.01	0.28	0.97	0.03	3.88
9	TDS (25°C)	mg/l			224.0	336.0	25.7	186.0	113.0
10	EC (25°C)	µS/cm			447	673	51	373	226
11	Acidity	mg/l as CaCO3			20	36	10	82	45
12	Alkalinity	mg/l as CaCO3			152	347	21	164	108
13	PO4	mg/l			0.22	0.32	0.06	0.13	0.10
14	NH3-N	mg/l			0.05	0.59	0.09	0.24	0.17
15	NO2-N	mg/l			0.002	0.004	0.005	0.008	0.000
16	NO3-N	mg/l			0.2	0.5	2.9	0.0	0.0
17	F	mg/l			0.37	0.45	0.00	0.29	0.30
18	Mn	mg/l			0.0	0.8	0.1	0.0	0.3
19	E.coli	+/-			+	+	+	+	+
20	TURB & COLOR					YEL.TURB	YEL.TURB		
NOTE:					11/22 Riv.	11/23 S.W.(1)	11/3 S.W.	11/3 Riv.	11/3 Riv.

Cont.

No.	Village / Nom Village Rubrique Test	Unit	85 BESAKOA (1)	86 BESAKOA (2)	87 AMPANDRA	88 MANINDAY	89 BEVOALAVO	90 TANAMBAO	91 AMBAHIMALI-TSY
1	Water temp.	°C	NOT ACCESSIBLE		NO VIL.	26.0	NOT ACCESSIBLE	27.0	33.5
2	pH (25℃)			6.2		6.6		7.1	7.8
3	Hard.	mg/l as CaCO3		2		5		232	48
4	Ca	mg/l		0.4		0.4		67.0	14.0
5	Mg	mg/l		0.2		1.0		15.0	3.4
6	Cl	mg/l		4		7		66	15
7	SO4	mg/l		4		8		136	9
8	Fe	mg/l		0.35		0.80		0.06	1.58
9	TDS (25℃)	mg/l		15.5		18.5		430.0	62.7
10	EC (25℃)	μS/cm		31		37		859	125
11	Acidity	mg/l as CaCO3		15		11		44	20
12	Alkalinity	mg/l as CaCO3		18		15		196	58
13	PO4	mg/l		0.17		0.05		0.27	0.10
14	NH3-N	mg/l		0.00		0.16		0.07	0.13
15	NO2-N	mg/l		0.003		0.006		0.017	0.005
16	NO3-N	mg/l		0.1		0.7		1.5	0.0
17	F	mg/l		0.12		0.00		0.57	0.00
18	Mn	mg/l		0.2		0.6		0.2	0.2
19	E.coli	+/-		+		+		+	+
20	TURB & COLOR								YEL.TURB
	NOTE:			10/26 S.W.		11/20 Riv.		11/20 S.W.	11/3 Riv.

Cont.

No.	Village / Nom Village	Unit	92 MOHABOBOKA	93 MAHASOA	94 ANDAMASINY-VINETA	95 TRANOKAKY	96 ANALAMARY	97 ANTANIMORA	98 BEREKETA
	Rubrique Test								
1	Water temp.	°C	28.0	29.0	26.0	WATER VENDER	25.5	26.0	39.0
2	pH (25℃)		8.0	7.3	8.2		5.8	6.8	8.5
3	Hard.	mg/l as CaCO3	96	338	266		6	26	182
4	Ca	mg/l	29.0	116.0	74.0		0.4	9.6	50.0
5	Mg	mg/l	5.6	12.0	20.0		1.2	0.5	14.0
6	Cl	mg/l	17	56	46		20	12	26
7	SO4	mg/l	24	26	55		21	10	34
8	Fe	mg/l	5.10	0.11	0.10		2.42	2.68	0.32
9	TDS (25℃)	mg/l	124.0	394.0	317.0		29.1	50.0	217.0
10	EC (25℃)	μS/cm	247	788	634		58	100	435
11	Acidity	mg/l as CaCO3	16	48	30		34	14	8
12	Alkalinity	mg/l as CaCO3	80	390	258		18	67	184
13	PO4	mg/l	0.09	0.09	0.32		0.41	0.33	0.38
14	NH3-N	mg/l		0.10	0.10		0.63	0.44	0.13
15	NO2-N	mg/l	0.000	0.001	0.003		0.031	0.007	0.008
16	NO3-N	mg/l	0.0	0.0	0.0		1.9	0.9	0.7
17	F	mg/l	0.00	0.43	0.51		0.00	0.00	0.22
18	Mn	mg/l	0.4	0.0	0.2		1.6	1.1	0.5
19	E.coli	+/-	+	+	+		+	+	+
20	TURB & COLOR		RED TURB				YEL.TURB	YEL.TURB	WHITE TURB
	NOTE:		11/21 Riv.	11/21 Riv.	11/21 Riv.		11/20 S.W. spring	11/20 S.W.	11/22 Riv.

Cont.

No. Village / Nom. Village	Unit	99 ANKILIMI-TRALOKA	100 ANKILIVALO	WHO STANDARD VALUES
Rubrique Test				
1 Water temp.	°C	34.0		
2 pH (25°C)		8.4	6.2	6.5/8.5
3 Hard.	mg/l as $CaCO_3$	337	10	500
4 Ca	mg/l	92.0	3.2	75.0
5 Mg	mg/l	26.0	0.5	30.0
6 Cl	mg/l	40	6	250
7 SO_4	mg/l	196	4	400
8 Fe	mg/l	0.34	4.22	0.3
9 TDS (25°C)	mg/l	389.0	24.5	1000
10 EC (25°C)	μS/cm	778	49	-
11 Acidity	mg/l as $CaCO_3$	10	14	-
12 Alkalinity	mg/l as $CaCO_3$	192	20	-
13 PO_4	mg/l	0.81	0.11	-
14 NH_3-N	mg/l	0.18		0.50
15 NO_2-N	mg/l	0.014	0.004	-
16 NO_3-N	mg/l	1.0	0.2	10.0
17 F	mg/l	0.41	0.00	1.50
18 Mn	mg/l	0.6	0.5	0.1
19 E.coli	+/-	+	+	-
20 TURB & COLOR		WHITE TURB	RED TURB	
NOTE:		11/22 Riv.	10/27 S.W.	

LEGEND

D.W.	:Dug Well
S.W.	:Shallow Well
B.H.	:Bore Hole
B.F.W.	:Borne Fontain Well
P.F.	:Public Fontain
W.S.	:Water Supply

Table F-2 Results of water quality analysis for salty water and reference water

RESULTATS DE L'ANALYSE DE LA QUALITE D'EAU

No. Rubrique Test	Unit	16 AMBIKY	27 BASIBASY	ANTANIMIEVA	ANKAZOABO	52 SOAHAZO	65 ANKARAOBATO	68 BENETSY
1 Water temp.	°C	29.0	28.0	30.5	27.0			27.0
2 pH (25℃)		7.5	7.5	7.7	7.4	7.4	7.3	7.3
3 Hard.	mg/l as CaCO3	378	740	172	348	1120	270	596
4 Ca	mg/l	104.0	210.0	52.0	132.0	163.0	55.0	176.0
5 Mg	mg/l	29.0	52.0	10.0	4.4	172.0	32.0	38.0
6 Cl	mg/l	142	492	14	88	920	15	742
7 SO4	mg/l	102	2	8	37	775	90	675
8 Fe	mg/l	0.00	0.18	0.00	0.00	0.11	0.01	0.03
9 TDS (25℃)	mg/l	611.0	1160.0	176.0	572.0	2530.0	421.0	2440.0
10 EC (25℃)	µS/cm	1220	2330	352	1140	5070	842	4880
11 Acidity	mg/l as CaCO3	70	115	54	124	123	100	60
12 Alkalinity	mg/l as CaCO3	355	500	206	342	490	354	438
13 PO4	mg/l	0.80	1.76	0.04	0.00	0.19	0.51	0.10
14 NH3-N	mg/l	0.22	15.40	0.00	0.38	0.79	0.06	0.30
15 NO2-N	mg/l	0.002	0.004	0.007	0.006	0.032	0.008	1.140
16 NO3-N	mg/l	0.0	0.5	0.1	12.6	1.7	0.2	0.3
17 F	mg/l	1.22	0.16	0.15	0.48	0.61	0.65	0.65
18 Mn	mg/l	0.0	1.4	0.1	0.0	0.1	0.0	0.1
19 E.coli	+/-	-	+	+	+	+	-	+
20 TURB & COLOR								
NOTE:		11/11 D.W. private	11/15 D.W.	11/7 B.H.W. spring	11/1 D.W. private	11/15 D.W.	10/25 D.W. handpump Hospital	11/16 D.W.(1) Hospital

No. Village / Nom Village			68 BENETSY	69 ANDREVO HAUT	69 ANDREVO HAUT	77 ANDRANOVORY	81 MANOROKA	·4 ·NDAMASINY- VINETA	95 TRANOKAKY
Rubrique Test									
1 Water temp.	°C		28.0	29.0	28.0		27.0	27.5	27.0
2 pH (25°C)			7.3	7.9	7.7	7.2	7.5	7.6	7.1
3 Hard.	mg/l	as CaCO3	760	214	1380	235	216	140	220
4 Ca	mg/l		216.0	72.0	222.0	92.0	60.0	54.0	82.0
5 Mg	mg/l		53.0	8.2	199.0	1.2	16.0	1.5	3.6
6 Cl	mg/l		610	14	1800	8	24	7	32
7 SO4	mg/l		1600	105	1800	3	17	5	7
8 Fe	mg/l		0.06	0.18	0.15	0.05	0.27	0.13	0.47
9 TDS (25°C)	mg/l		3280.0	229.0	4680.0	242.0	233.0	146.0	317.0
10 EC (25°C)	µS/cm		6560	458	9370	483	466	292	633
11 Acidity	mg/l	as CaCO3	90	22	112	83	34	25	52
12 Alkalinity	mg/l	as CaCO3	530	102	532	239	238	160	254
13 PO4	mg/l		0.75	0.74	1.90	0.35	0.72	0.19	0.01
14 NH3-N	mg/l		0.63	0.35	1.70	0.00	0.26	0.10	0.06
15 NO2-N	mg/l		0.146	0.015	0.008	0.006	0.002	0.001	0.004
16 NO3-N	mg/l		4.6	0.5	0.0	0.1	0.1	1.0	0.1
17 F	mg/l		0.79	0.44	0.63	0.20	0.44	0.14	0.10
18 Mn	mg/l		0.0	0.4	0.2	0.1	0.7	0.4	0.1
19 E.coli	+/-		+	+	+	+	+	+	-
20 TURB & COLOR							YEL.TURB		YEL.TURB
NOTE:			11/16 D.W.(2)	11/17 canal	11/17 D.W.	10/26 S.W.	11/23 D.W.(2)	11/21 S.W.	11/3 D.W. handpump

Cont.

No.	No.Village / Nom Village		TOLIARA	WHO STANDARD VALUES
	Rubrique Test			
1	Water temp.	°C	29.0	
2	pH (25°C)		7.3	6.5/8.5
3	Hard.	mg/l as CaCO3	288	500
4	Ca	mg/l	66.0	75.0
5	Mg	mg/l	30.0	30.0
6	Cl	mg/l	155	250
7	SO4	mg/l	98	400
8	Fe	mg/l	0.20	0.30
9	TDS (25°C)	mg/l	543.0	1000.0
10	EC (25°C)	μS/cm	1085	-
11	Acidity	mg/l as CaCO3	58	-
12	Alkalinity	mg/l as CaCO3	256	-
13	PO4	mg/l	0.41	-
14	NH3-N	mg/l	0.03	0.50
15	NO2-N	mg/l	0.001	-
16	NO3-N	mg/l	0.6	10.0
17	F	mg/l	0.43	1.50
18	Mn	mg/l	0.1	0.1
19	E.coli	+/-	-	-
20	TURB & COLOR			

NOTE: 11/27 W.S.

LEGEND
======

D.W.	:Dug Well
S.W.	:Shallow Well
B.H.	:Bore Hole
B.F.W.	:Borne Fontain Well
P.F.	:Public Fontain
W.S.	:Water Supply

Table RESULTS OF WATER QUALITY ANALISYS

NO.	LOCATION	DATE	Temp	pH	Hard.	Ca	Mg	Na	K	Cl	SO4	Fe	TDS	EC	Acid.	Alkali	PO4	NH3-N	NO2-N	NO3-N	F	Mn	E.coli	NOTE
1	ANKAZOMANGA	89/11/07	32.0	7.8	296	64.0	33.0	160.0	5.7	156	200	0.11	624.0	1250	30	196	0.45	0.17	0.006	0.3	0.05	0.2	+	Riv.
2	BEADABO	89/11/07	33.0	8.1	250	58.0	25.0	149.0	6.0	144	135	0.10	555.0	1110	32	178	0.45	0.20	0.003	0.7	0.67	0.3	+	Riv.
3	BEFASY	89/11/07	35.0	7.5	32	4.8	4.8	25.0	2.8	30	17	1.00	93.8	187	18	58	0.17	0.16	0.008	0.4	0.00	0.2	−	S.W.
4	ANKILIFOLO(1)	89/11/07	32.5	7.4	288	67.0	29.0	402.0	34.0	606	17	0.46	1240.0	2490	92	398	0.39	1.67	0.028	0.0	0.43	0.2	+	S.W.
5	AMBALAMOA	89/11/09	29.0	7.4	240	64.0	19.0	64.0	4.3	58	58	0.06	343.0	687	39	250	0.77	0.06	0.000	0.2	0.52	0.1	+	D.W.
6	TSIANIHY	89/11/09	29.5	7.5	162	40.0	15.0	34.0	60.0	58	23	0.02	293.0	586	34	226	0.51	0.05	0.003	1.8	0.56	0.3	+	S.W.
7	NAMATOA	89/11/08	29.0	6.8	142	33.0	15.0	18.0	7.5	17	14	0.31	174.0	348	48	171	0.33	0.24	0.005	0.3	0.19	0.3	+	D.W.
8	MANGOLOVOLO	89/11/08	30.0	6.4	16	2.4	2.4	8.8	1.0	16	5	2.10	37.1	74	16	12	0.00	0.46	0.008	0.7	0.00	0.3	+	Riv.
9	ANKIDA	89/11/08	29.0	5.8	12	1.6	1.9	4.7	0.5	7	5	0.67	20.7	41	12	8	0.02	0.20	0.004	0.5	0.02	0.2	−	S.W. Spring
10	VORISY	NO VIL.																						
11	ANDRONOMANITSY	89/11/09	30.0	7.5	286	95.0	12.0	27.0	20.0	52	36	0.00	348.0	697	26	238	0.84	0.14	0.239	5.7	0.59	0.0	+	S.W.
12	BERANALA	89/11/09	30.0	7.3	134	34.0	12.0	11.0	2.8	30	9	0.44	125.0	251	21	104	0.73	0.40	0.000	0.1	0.73	1.3	+	D.W.
13	TANANDAVA	89/11/09	31.5	7.8	204	57.0	15.0	48.0	5.4	52	55	0.00	293.0	585	27	176	0.22	0.00	0.000	1.8	0.54	0.0	+	B.F.W.
14	ANTSAKOABE	89/11/11	28.5	7.9	60	21.0	1.9	11.0	3.5	16	26	0.26	97.9	195	28	74	0.23	0.34	0.016	1.4	0.00	0.4	+	canal
15	TANTALAVALO	89/11/11	27.5	7.9	82	22.0	6.8	11.0	3.6	17	26	0.35	101.0	202	18	80	0.17	0.22	0.007	1.0	0.51	0.5	+	canal
16	AMBIKY	89/11/11	28.0	7.8	96	22.0	9.7	14.0	3.5	15	32	0.32	128.0	257	20	90	0.39	0.26	0.010	1.0	0.12	0.5	+	Riv.
17	MAROVATO	89/11/11	28.0	7.7	278	85.0	16.0	49.0	1.8	48	38	0.09	341.0	682	60	292	0.37	0.17	0.000	0.0	0.72	0.0	−	S.W. Spring
18	ANDRANOBOKA	89/11/11	33.5	7.3	152	54.0	4.3	2.9	22.0	14	6	0.14	174.0	348	46	170	1.22	0.81	0.014	0.3	0.33	0.2	+	S.W.
19	SATRAMBONDRO	NOT ACCESSIBLE																						
20	MOHAVOZOKELY	NOT ACCESSIBLE																						
21	ANTRANOSATRA	89/11/10	28.0	8.0	172	64.0	2.9	26.0	31.0	24	22	1.70	241.0	482	110	254	0.70	3.20	0.054	1.0	0.24	0.3	+	S.W.
22	MANOY	89/11/10	28.0	7.5	460	142.0	25.0	296.0	7.6	164	270	0.00	985.0	1970	148	462	0.75	0.39	0.005	2.0	0.64	0.1	+	D.W.
23	AMPOZA	89/11/10	28.0	7.6	182	68.0	2.9	65.0	7.3	20	18	0.02	314.0	628	100	318	0.62	0.15	0.009	0.0	0.46	0.1	+	S.W.
24	ANKILIFOLO(2)	89/11/10	27.5	7.7	434	168.0	3.4	8.0	6.8	108	14	0.00	489.0	977	114	252	0.81	1.31	0.058	10.6	0.32	0.0	+	S.W.
25	SIHANAKA	89/11/10	28.0	7.6	154	56.0	3.4	22.0	4.8	10	10	0.84	166.0	333	62	176	0.57	0.44	0.026	0.7	0.00	0.8	+	S.W.
26	BEMOKA	NOT ACCESSIBLE																						
27	BASIBASY	89/11/12	27.0	8.0	236	67.0	16.0	46.0	5.9	48	42	0.07	312.0	623	38	268	0.29	0.17	0.008	0.0	0.28	0.1	+	canal
28	ANALATELO	89/11/15	27.0	7.4	448	154.0	15.0	37.0	3.0	52	148	0.05	466.0	932	66	308	0.06	0.05	0.000	0.0	0.12	0.0	+	S.W.
29	MANGOTROKA	89/11/11	28.5	5.8	120	28.0	12.0	5.5	6.8	42	3	0.03	167.0	334	14	100	0.17	0.18	0.036	11.9	0.22	0.0	+	S.W.
30	NOSYAMBOSITRA	NOT ACCESSIBLE																						

Temp.: ℃
Hard. Acid. Alkali.: mg/l as $CaCO_3$
EC : μS/cm
Other items : mg/l

Table　RESULTS OF WATER QUALITY ANALISYS

NO.	LOCATION	DATE	Temp	pH	Hard.	Ca	Mg	Na	K	Cl	SO4	Fe	TDS	EC	Acid.	Alkali	PO4	NH3-N	NO2-N	NO3-N	F	Mn	E.coli	NOTE
31	TSIARMPIOKE	NOT ACCESSIBLE																						
32	BETARATSY	NOT ACCESSIBLE																						
33	ANDRANOMANINTSY	89/10/31	32.5	6.1	5	0.8	0.7	3.3	4.8	5	2	0.45	12.7	25	10	10	0.03	0.08	0.021	0.5	0.04	0.2	+	S.W.
34	TANDRANO	89/10/31	27.0	6.0	8	2.4	0.5	6.0	5.1	1	9	0.33	23.4	47	16	22	0.02	0.00	0.008	0.4	0.21	0.1	+	S.W.
35	AMPANDRAMITSETAKY	89/10/31	25.5	6.6	44	10.0	4.4	8.3	11.0	5	8	0.54	68.0	136	20	72	0.01	0.00	0.000	0.4	0.22	0.1	+	S.W.
36	ANDRANOMAFANA	NOT ACCESSIBLE																						
37	MAMAKIALA	NOT ACCESSIBLE																						
38	BERENTYANKILIMASY	NOT ACCESSIBLE																						
39	BETSINEFO	89/11/01	23.0	8.3	304	98.0	15.0	42.0	15.0	30	215	0.82	446.0	891	60	148	0.08	0.22	0.012	1.5	0.52	0.0	+	Riv.
40	TANANDAVA	89/11/01		7.4	150	36.0	15.0	29.0	16.0	22	39	0.59	213.0	425	102	146	0.16	0.34	0.003	1.2	0.59	0.1	+	S.W.
41	AMPOZA	89/11/01	23.5	8.3	166	50.0	8.7	5.3	5.2	6	2	0.13	166.0	333	82	162	0.03	0.00	0.000	1.0	0.00	0.0	+	Riv.
42	IPETSA ATM	89/11/01	25.5	7.8	116	32.0	8.7	17.0	1.8	6	8	0.13	137.0	275	66	128	0.11	0.08	0.002	0.7	0.42	0.0	+	S.W.
43	MONDARE ATM	89/11/02	25.0	7.4	314	81.8	27.0	60.0	10.0	32	72	0.01	394.0	788	74	245	0.36	0.05	0.004	0.1	0.71	0.0	+	S.W.
44	SOATANIMBARY	89/11/02	28.0	7.3	171	55.0	8.0	56.0	4.7	29	4	0.09	265.0	530	89	178	0.44	0.06	0.002	0.0	0.19	0.0	+	S.W.
45	SAHANORY ATM	89/11/02	30.5	6.4	23	5.6	2.2	4.3	6.3	5	6	0.88	40.5	81	18	38	0.18	0.08	0.000	1.5	0.00	0.2	+	S.W.
46	BERENTYBETSILEO	89/11/02	32.5	8.3	97	28.0	6.8	11.0	5.7	15	8	0.07	119.0	238	50	99	0.36	0.19	0.004	0.0	0.24	0.1	+	Riv.
47	ANKILIVALOKELY	89/11/02	30.0	8.2	186	45.0	18.0	12.0	6.7	10	26	0.30	197.0	394	63	172	0.20	0.10	0.003	0.0	0.32	0.0	+	Riv.
48	ILEMBY	NOT ACCESSIBLE																						
49	TANANDAVAANTAIFSY	89/11/01	27.0	8.0	242	68.0	17.0	133.0	7.6	74	27	0.24	542.0	1080	108	404	0.21	0.63	0.008	0.9	0.65	0.1	+	Riv.
50	ANJAMITIKITRA	NO VIL.																						
51	ANAVIAVY	NOT ACCESSIBLE																						
52	SOAHAZO	89/11/15	26.0	7.6	110	32.0	7.3	18.0	0.6	16	4	0.16	141.0	282	36	144	0.26	0.36	0.011	0.4	0.24	0.2	+	S.W.
53	ANALAMISAMPY	89/11/15	28.0	7.4	218	70.0	10.0	65.0	6.5	60	12	0.14	348.0	696	64	300	0.10	0.13	0.008	0.8	0.25	0.1	−	D.W. handpump
54	BELITSAKA	89/11/15	27.5	7.4	452	159.0	13.0	61.0	3.6	130	110	0.08	557.0	1110	66	286	0.20	0.30	0.000	0.9	0.00	0.1	+	D.W.
55	AMPASIKIBO	89/11/15	28.0	6.8	652	243.0	11.0	56.0	8.7	115	88	0.15	780.0	1560	136	375	0.33		0.019	0.1	0.09	0.1	+	D.W. handpump
56	NAMABOHA	89/11/15	27.0	7.3	428	142.0	17.0	11.0	16.0	14	57	2.18	414.0	827	112	395	0.25	4.36	0.021	1.0	0.12	2.4	+	S.W.
57	ANTSEVA	89/10/25		7.1	540	132.0	51.0	132.0	5.1	125	175	0.01	733.0	1470	89	472	0.33	0.08	0.002	0.2	0.38	0.0	+	D.W.
58	ANKATRAKATRA	89/11/15	27.0	6.9	42	11.0	3.4	8.3	11.0	12	12	2.21	76.0	152	44	56	0.31	1.72	0.028	1.0	0.00	0.1	+	S.W.
59	AMPIHAMY	89/11/15	27.5	7.4	302	98.0	14.0	143.0	11.0	84	145	0.04	592.0	1180	70	350	0.20	0.24	0.006	0.5	0.24	0.0	+	S.W.
60	AMBONDRO	NOT ACCESSIBLE																						

Temp.: ℃
Hard. Acid. Alkali.: mg/l as CaCO3
EC : μS/cm
Other items : mg/l

Table RESULTS OF WATER QUALITY ANALISYS

NO.	LOCATION	DATE	Temp	pH	Hard.	Ca	Mg	Na	K	Cl	SO4	Fe	TDS	EC	Acid.	Alkali	PO4	NH3-N	NO2-N	NO3-N	F	Mn	E.coli	NOTE
61	BEROROHA	NOT ACCESSIBLE																						
62	ANTSOMARIFY	NOT ACCESSIBLE																						
63	MANOMBO ATM	89/11/17	28.0	7.4	438	125.8	30.8	52.0	5.8	94	145	0.02	623.6	1250	62	274	0.13	0.13	0.030	6.2	0.44	0.0	+	D.W.
64	ANTANDROKA	89/11/17	29.0	7.4	332	118.0	8.7	18.0	3.9	42	100	0.02	371.0	742	44	178	0.02	0.05	0.025	4.6	0.43	3.0	+	D.W.
65	ANKARAOBATO	89/10/25		8.1	220	63.0	15.0	12.0	2.0	10	26	0.19	216.0	432	34	108	0.23	0.00	0.000	0.1	0.00	0.1	+	Riv.
66	ANDOHARANO	NOT ACCESSIBLE																						
67	TSEFANOKA	89/11/24	25.0	8.0	178	67.0	2.4	6.7	2.7	28	70	0.11	196.3	392	40	124	0.25	0.13	0.011	0.1	0.29	0.2	+	canal
68	BENETSY	89/11/16	28.0	7.5	288	66.0	10.0	13.0	6.9	16	110	0.19	238.0	476	28	94	0.39	0.21	0.006	0.0	0.51	0.1	+	canal
69	ANDREVOBAS	89/11/17	27.0	7.6	336	102.8	20.0	172.0	16.0	230	60	0.02	754.0	1510	58	232	0.14	0.07	0.069	1.3	3.33	0.0	--	S.W. Spring
70	ANJAMALA	NOT ACCESSIBLE																						
71	AMPIHALIA	NOT ACCESSIBLE																						
72	SEHOMPY	89/11/23	30.0	8.3	169	46.0	13.0	13.8	4.4	25	49	1.85	176.0	352	20	152	0.12	0.04	0.002	0.2	0.10	0.7	+	Riv.
73	AMBOKONKIRA	89/11/23	30.0	8.3	168	45.8	14.0	12.8	5.7	26	50	2.13	175.0	350	20	154	0.15	0.04	0.002	0.1	0.08	0.8	+	Riv.
74	MIARY	89/11/23	28.0	7.8	211	66.8	11.0	30.0	3.9	44	47	0.26	259.0	518	32	170	0.12	0.07	0.000	0.4	0.41	0.2	−	P.F.
75	BEFANAMY	89/11/23	29.0	7.9	215	67.0	12.0	30.0	4.6	46	49	0.01	257.0	514	24	171	0.19	0.02	0.000	0.0	0.25	0.0	−	P.F.
76	TSIVONOABE	89/11/16	28.0	7.4	384	98.8	34.0	185.0	20.0	330	92	0.00	839.0	1680	70	264	0.11	0.44	0.024	1.2	0.13	0.0	+	S.W.
77	ANDRANOVORY	WATER VENDER																						
78	BEFOLY	WATER VENDER																						
79	ANKOROROKA	WATER VENDER																						
80	ANBOHIMAHAVELONA	89/11/22	27.0	7.6	192	56.0	13.0	18.0	5.8	28	59	0.01	224.0	447	20	152	0.22	0.05	0.002	0.2	0.37	0.0	+	Riv.
81	MANOROKA	89/11/23	27.0	7.6	260	64.0	29.0	53.0	8.6	24	37	0.28	336.0	673	36	347	0.32	0.59	0.004	0.5	0.45	0.8	+	S.W.(1)
82	LADORANA	89/11/03		5.9	24	4.8	2.9	4.4	3.1	7	8	0.97	25.7	51	10	21	0.06	0.09	0.005	2.9	0.00	0.1	+	S.W.(1)
83	ANDRANOLAVA	89/11/03		7.8	131	54.0	11.0	9.9	6.5	12	18	0.03	186.0	373	82	164	0.13	0.24	0.008	0.0	0.29	0.0	+	Riv.
84	LAMBOMAKANDRO	89/11/03		8.3	100	36.0	2.4	9.5	7.9	10	1	3.83	113.0	226	45	100	0.10	0.17	0.000	0.0	0.30	0.3	+	Riv.
85	BESAKOA(1)	NOT ACCESSIBLE																						
86	BESAKOA(2)	89/10/26		6.2	2	0.4	0.2	1.9	4.0	4	4	0.35	15.5	31	15	5	0.17	0.00	0.003	0.1	0.12	0.2	+	S.W.
87	AMPANDRA	NO VIL.																						
88	MANINDAY	89/11/20	26.0	6.6	5	0.4	1.0	2.4	4.1	7	8	0.80	18.5	37	11	5	0.05	0.16	0.006	0.7	0.00	0.6	+	Riv.
89	BEVOALAVO	NOT ACCESSIBLE																						
90	TANAMBAO	89/11/20	27.0	7.1	232	67.0	15.0	47.0	74.0	66	136	0.06	430.0	859	44	196	0.27	0.07	0.017	1.5	0.57	0.2	+	S.W.

Temp.: ℃
Hard. Acid. Alkali.: mg/l as CaCO3
EC : μS/cm
Other items : mg/l

Table RESULTS OF WATER QUALITY ANALISYS

NO.	LOCATION	DATE	Temp	pH	Hard.	Ca	Mg	Na	K	Cl	SO4	Fe	TDS	EC	Acid.	Alkali	PO4	NH3-N	NO2-N	NO3-N	F	Mn	E.coli	NOTE
91	AMBAHIMALITSY	89/11/03	33.5	7.8	48	14.0	3.4	5.2	6.4	15	9	1.58	62.7	125	20	45	0.10	0.13	0.005	0.0	0.00	0.2	+	Riv.
92	MOHABOBOKA	89/11/21	28.0	8.0	96	29.0	5.6	8.7	6.9	17	24	5.10	124.0	247	16	80	0.09		0.000	0.0	0.00	0.4	+	Riv.
93	MAHASOA	89/11/21	29.0	7.3	333	116.0	12.0	35.0	2.8	56	26	0.11	394.0	788	48	380	0.09	0.10	0.001	0.0	0.43	0.0	+	Riv.
94	ANDAMASINY-VINETA	89/11/21	26.0	8.2	266	74.8	20.0	33.8	3.3	46	55	0.10	317.0	634	30	258	0.32	0.10	0.003	0.0	0.51	0.2	+	Riv.
95	TRANOKAKY	WATER VENDER																						
96	ANALAMARY	89/11/20	25.5	5.8	6	0.4	1.2	8.1	4.9	7	8	2.42	29.1	58	34	9	0.41	0.63	0.031	1.9	0.00	1.8	+	S.W. Spring
97	ANTANIMORA	89/11/20	26.0	6.8	26	9.6	0.5	10.0	4.3	12	10	2.08	58.0	100	14	30	0.33	0.44	0.007	0.9	0.00	1.1	+	S.W.
98	BEREKETA	89/11/22	39.0	8.5	182	50.0	14.0	22.0	6.8	26	34	0.32	217.0	435	8	184	0.38	0.13	0.008	0.7	0.22	0.5	+	Riv.
99	ANKILIMITRALOKA	89/11/22	34.0	8.4	337	92.0	26.0	43.0	7.6	40	196	0.34	389.0	778	10	192	0.81	0.18	0.014	1.0	0.41	0.6	+	Riv.
100	ANKILIVALO	89/10/27		6.2	10	3.2	0.5	3.1	4.4	6	4	4.22	24.5	49	14	15	0.11		0.004	0.2	0.00	0.5	+	S.W.
101	16 AMBIKY	89/11/11	29.0	7.5	378	104.0	29.0	106.0	37.0	142	102	0.00	611.0	1220	70	355	0.80	0.22	0.002	0.0	1.22	0.0	--	D.W. Private
102	27 BASIBASY	89/11/15	28.0	7.5	740	210.0	52.0	164.0	45.0	492	2	0.18	1160.0	2330	115	508	1.76	15.40	0.004	0.5	0.16	1.4	+	D.W.
103	ANTANIMIEVA	89/11/07	30.5	7.7	172	52.8	10.0	7.4	2.8	14	8	0.00	176.0	352	54	150	3.04	0.00	0.007	0.1	0.15	3.1	+	B.H.W. Spring
104	ANKAZOABO	89/11/01	27.0	7.4	340	132.0	4.4	54.0	15.0	88	37	0.00	572.0	1140	124	342	0.00	0.38	0.006	12.6	0.48	0.0	+	D.W., Private
105	52 SOAHAZO	89/11/15		7.4	1120	163.0	172.0	601.0	13.0	928	775	0.11	2530.0	5070	123	490	0.19	0.79	0.032	1.7	0.61	0.1	+	D.W.
106	65 ANKARAOBATO	89/10/25		7.3	270	55.0	32.0	113.0	10.0	15	90	0.01	421.0	842	100	354	0.51	0.06	0.000	0.2	0.65	0.0	−	D.W. Hosp.HP
107	68 BENETSY	89/11/16	27.0	7.3	596	176.0	38.0	1010.0	6.8	742	675	0.03	2440.0	4880	60	438	0.10	0.30	1.140	0.3	0.65	0.1	+	D.W.(1) Hosp.
108	68 BENETSY	89/11/16	28.0	7.3	760	216.0	53.0	1270.0	5.9	610	1600	0.06	3280.0	6560	90	530	0.75	0.63	0.146	4.6	0.79	0.0	+	D.W.(2)
109	69 ANDREVOHAUT	89/11/17	29.0	7.9	214	72.0	8.2	8.3	4.5	14	105	0.18	229.0	458	22	102	0.74	0.35	0.015	0.5	0.44	0.4	+	canal
110	69 ANDREVOHAUT	89/11/17	28.0	7.7	1380	222.0	199.0	1940.0	48.0	1808	1800	0.15	4680.0	9370	112	532	1.90	1.70	0.008	0.0	0.63	0.2	+	D.W.
111	77 ANDRANOVORY	89/10/26		7.2	235	92.0	1.2	13.0	4.3	8	3	0.05	242.0	483	83	239	0.35	0.00	0.006	0.1	0.20	0.1	+	S.W.
112	81 MANOROKA	89/11/23	27.0	7.5	216	60.0	16.0	31.0	5.2	24	17	0.27	233.0	466	34	238	0.72	0.26	0.002	0.1	0.44	0.7	+	D.W.(2)
113	94ANDAMASINYVINETA	89/11/21	27.5	7.6	140	54.0	1.5	3.1	5.4	7	5	0.13	146.0	292	25	160	0.19	0.16	0.001	1.6	0.14	0.4	+	S.W.
114	95 TRANOKAKY	89/11/03	27.0	7.1	220	82.0	3.6	54.0	3.5	32	7	0.47	317.0	633	52	254	0.01	0.06	0.004	0.1	0.10	0.1	−	D.W. Handpump
115	TOLIARA	89/11/27	29.0	7.3	289	66.0	30.0	133.0	8.5	155	98	0.20	543.0	1085	58	256	0.41	0.03	0.001	0.6	2.43	0.1	−	W.S.
116																								
117																								
118																								
119																								
120																								

Temp.: ℃
Hard. Acid. Alkali.: mg/l as $CaCO_3$
EC : μS/cm
Other items : mg/l

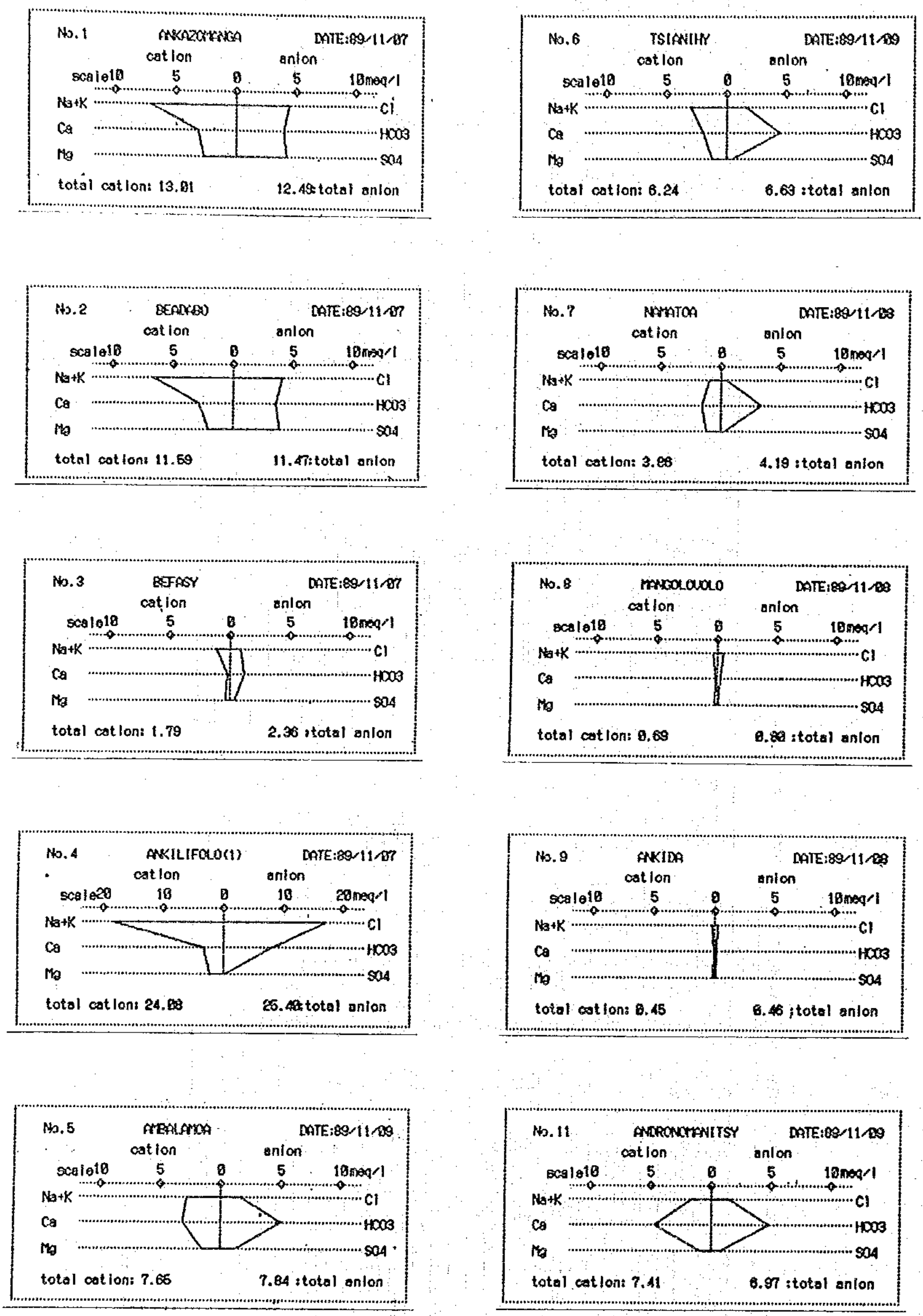
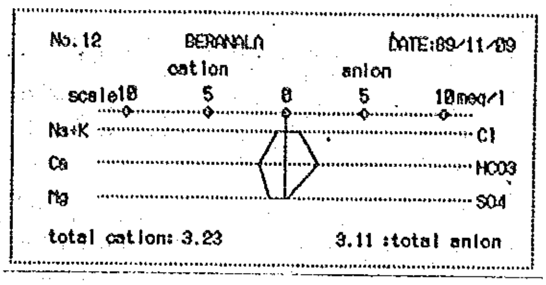
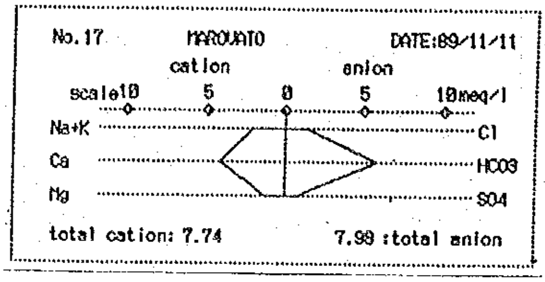
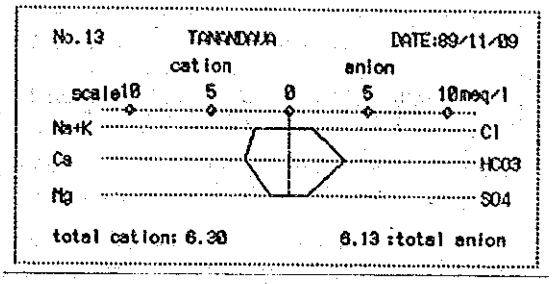
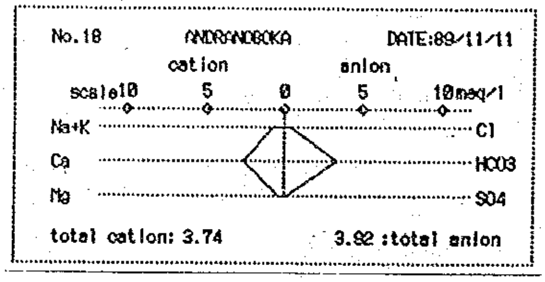


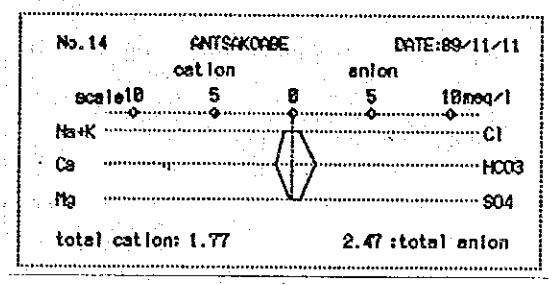
Fig. HEXADIAGRAMS OF SHALLOW GROUNDWATER (1)

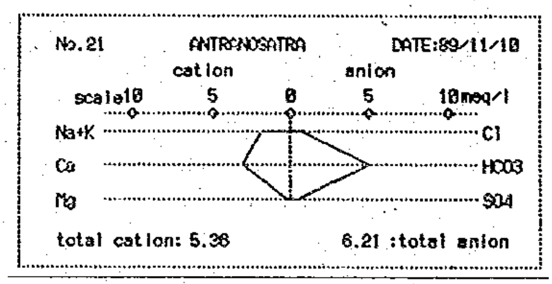


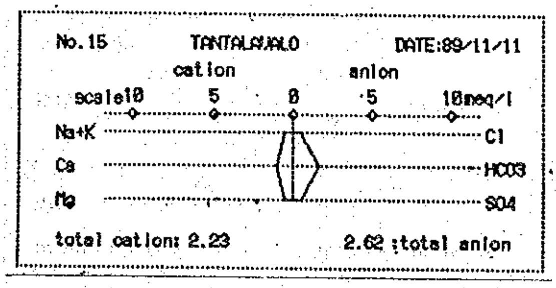


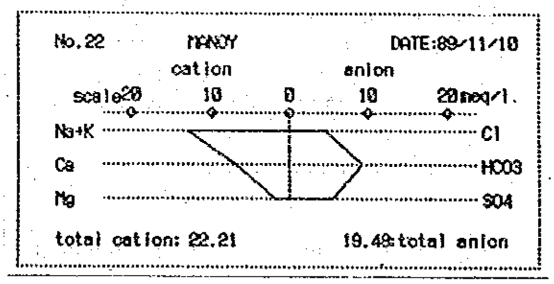


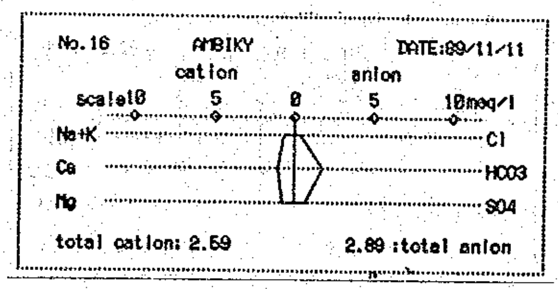












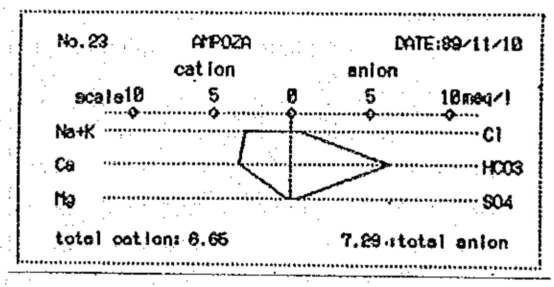
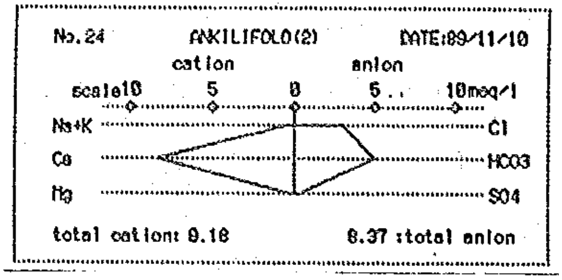
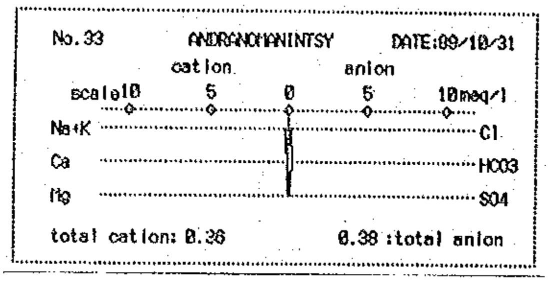
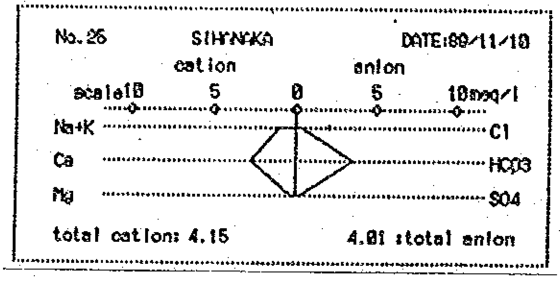
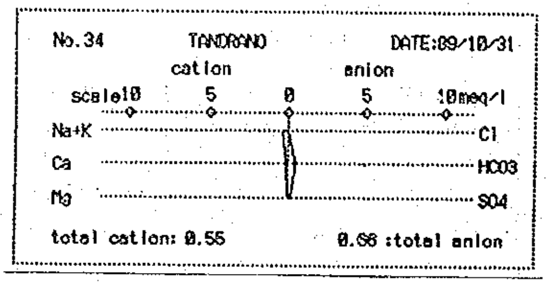


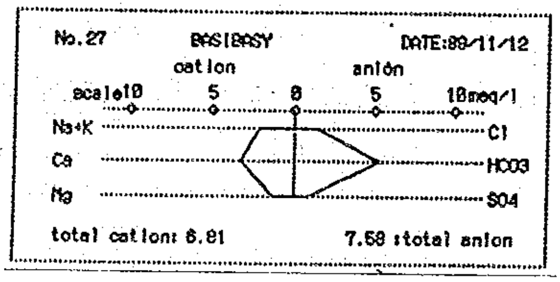
Fig. HEXADIAGRAMS OF SHALLOW GROUNDWATER (2)

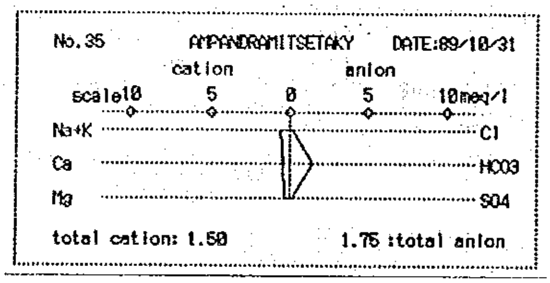


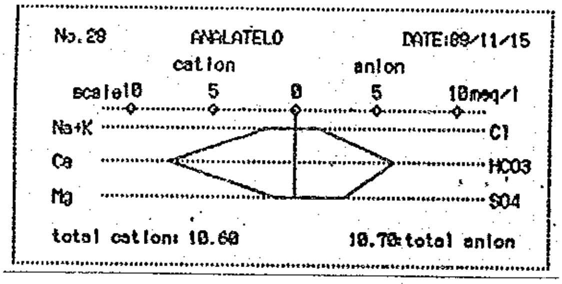


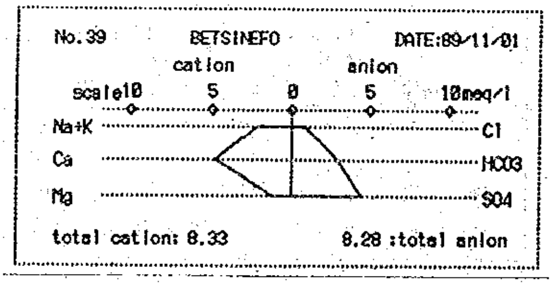


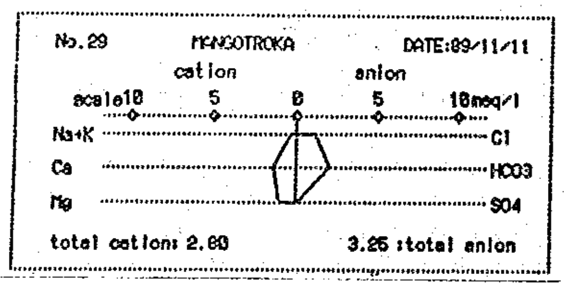












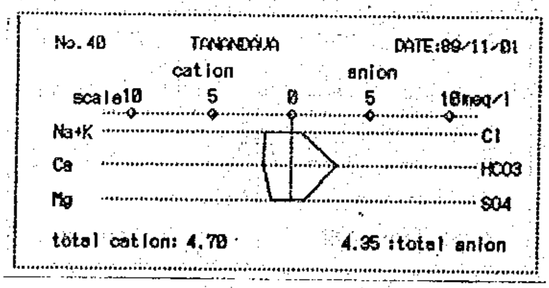
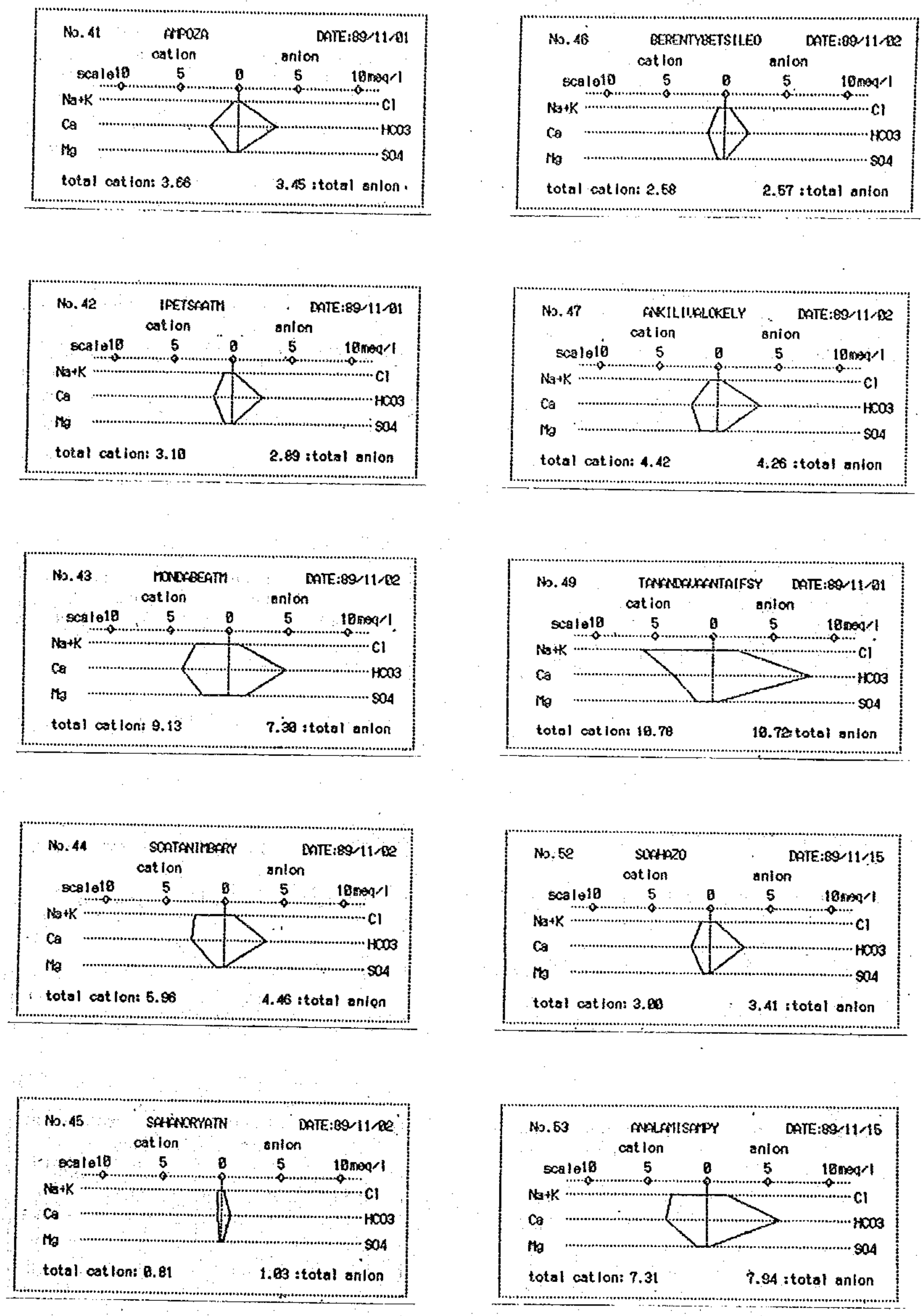


Fig. HEXADIAGRAMS OF SHALLOW GROUNDWATER (3)



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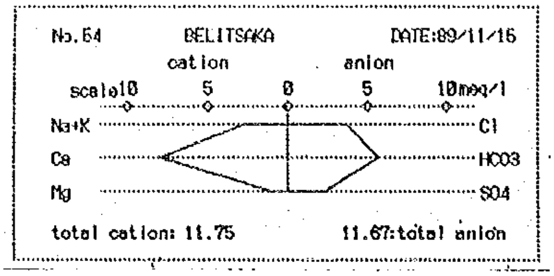
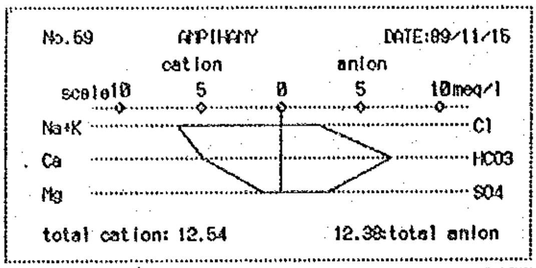
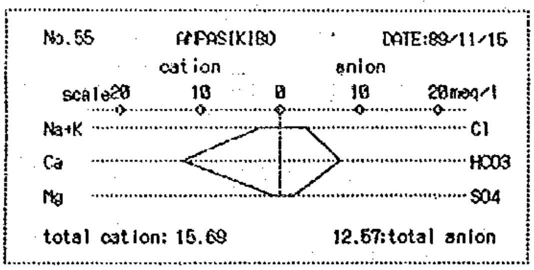
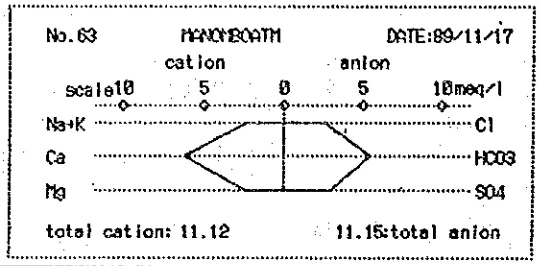
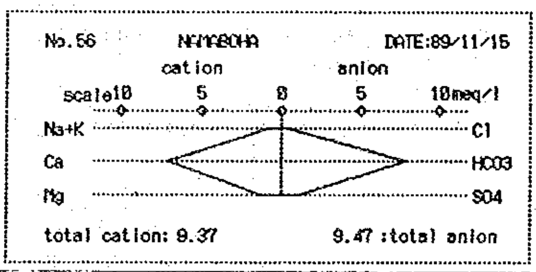
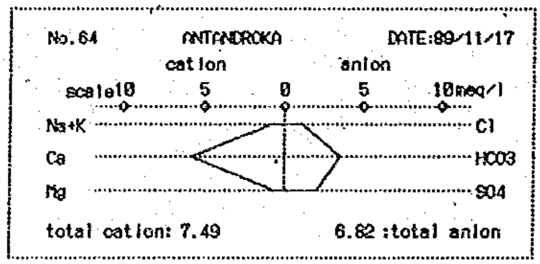


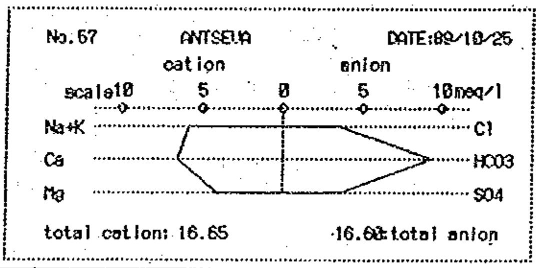


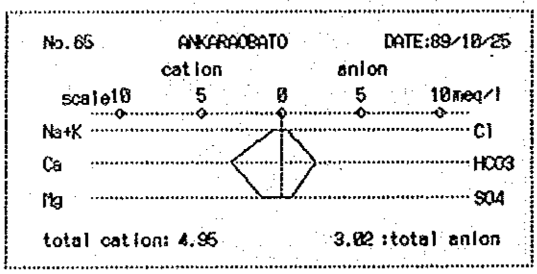


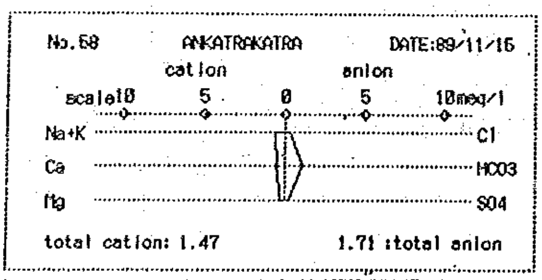












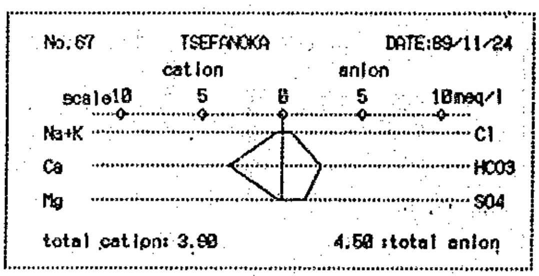
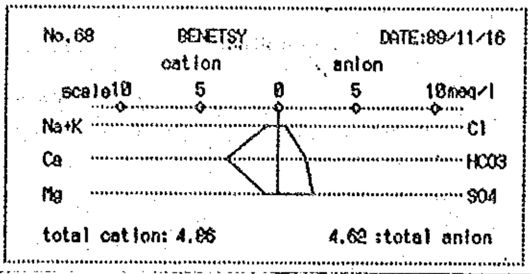
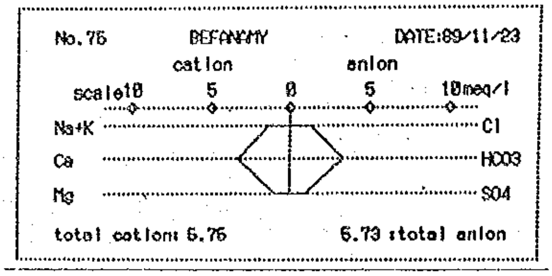
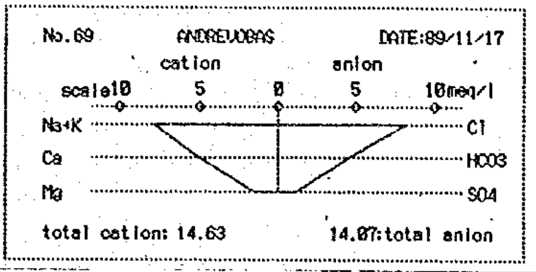
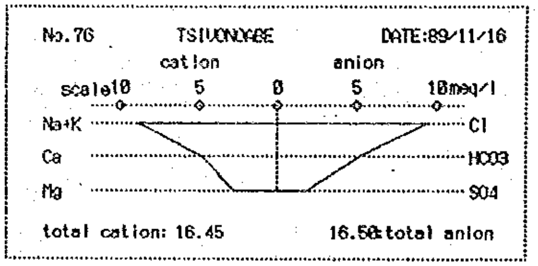


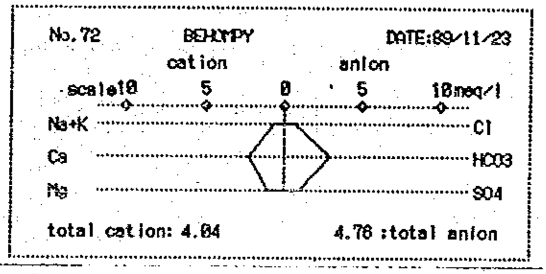
Fig. HEXADIAGRAMS OF SHALLOW GROUNDWATER (5)

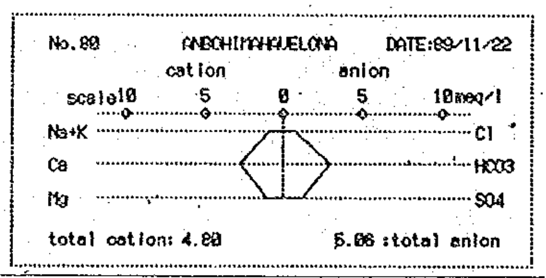


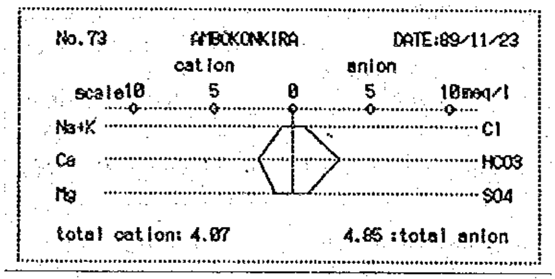


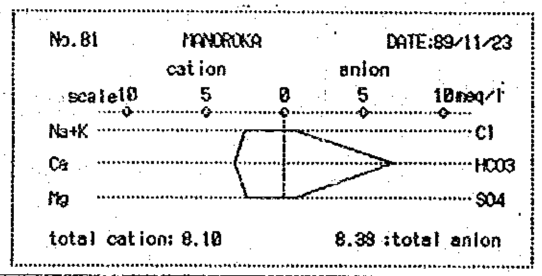


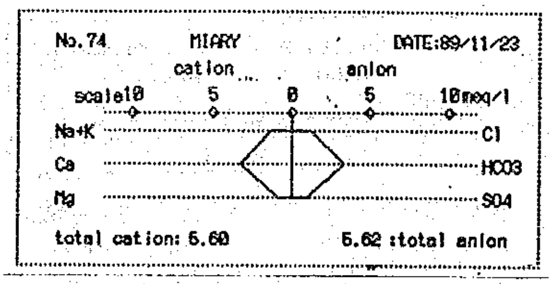












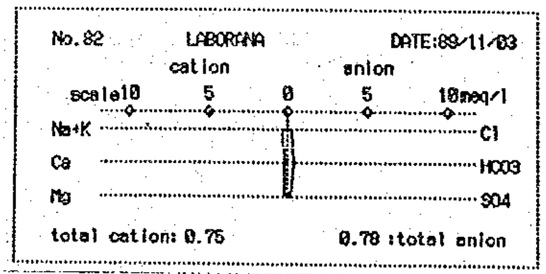
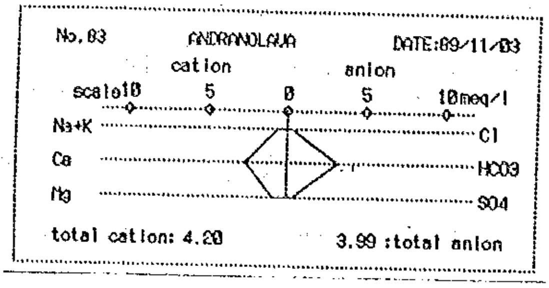
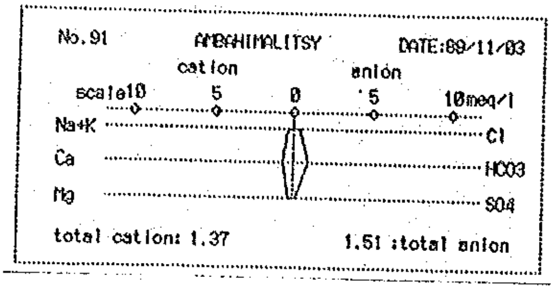
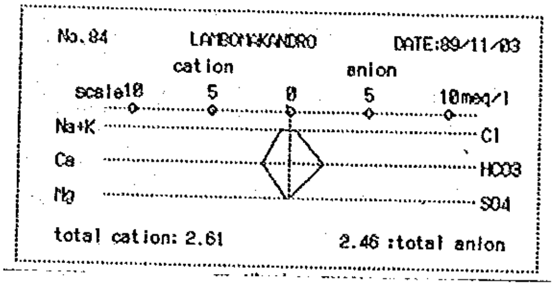
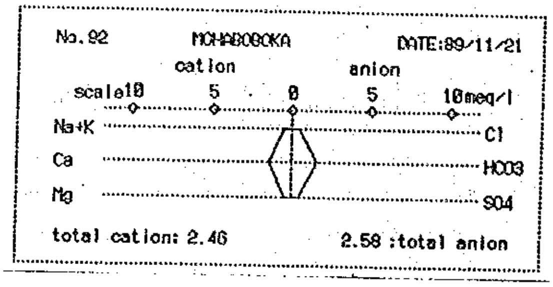


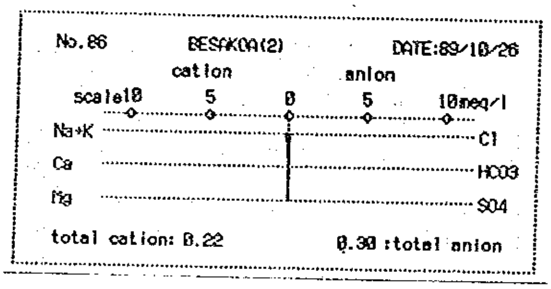
Fig. HEXADIAGRAMS OF SHALLOW GROUNDWATER (6)

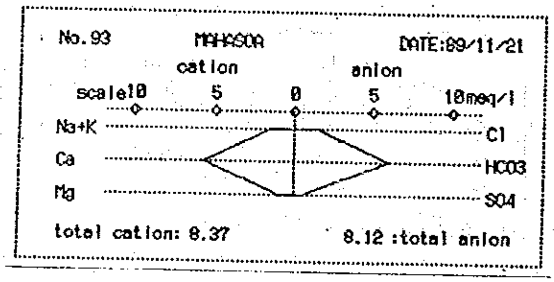


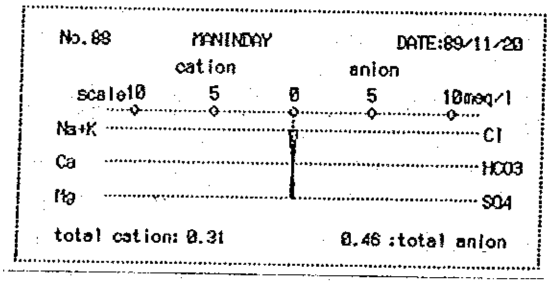


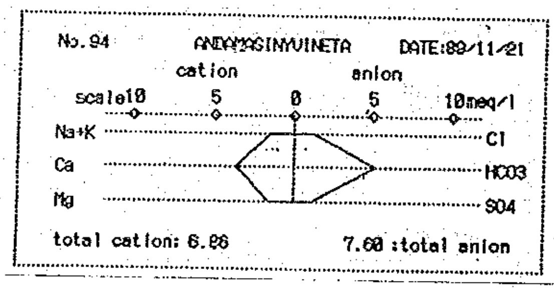


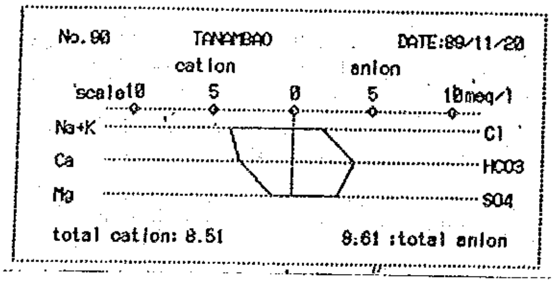












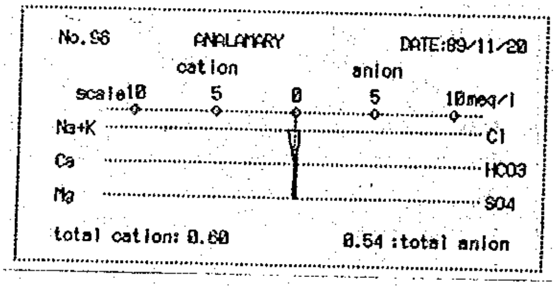
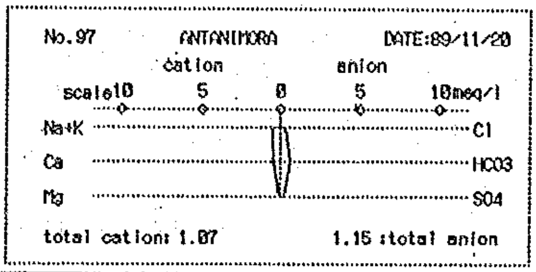
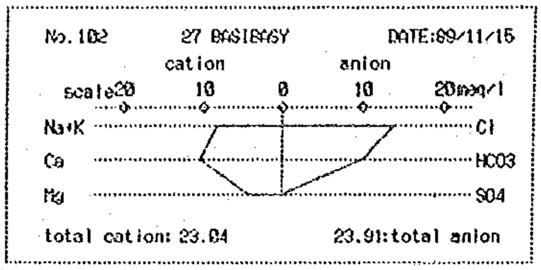
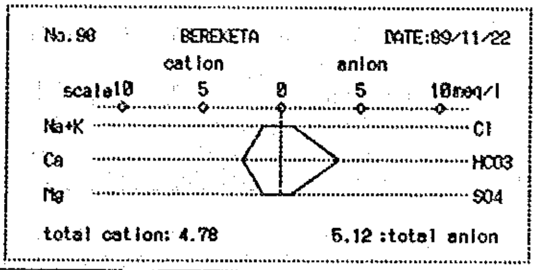
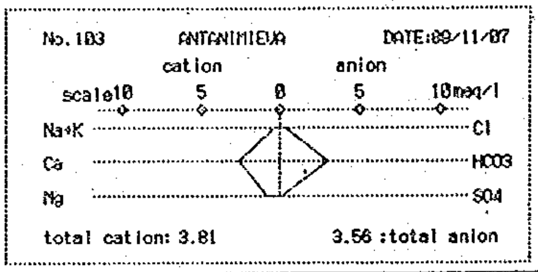


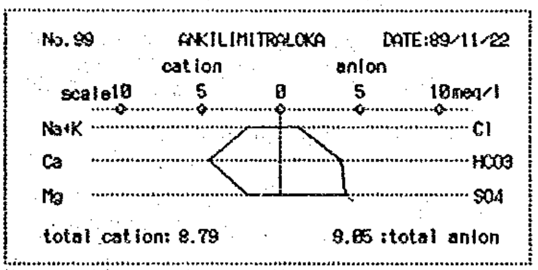
Fig. HEXADIAGRAMS OF SHALLOW GROUNDWATER (7)

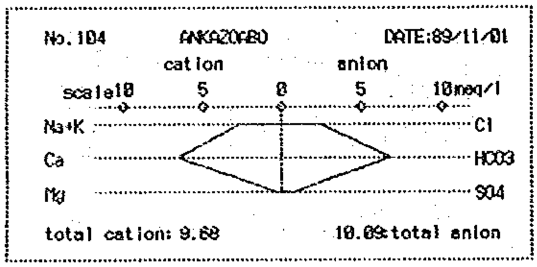


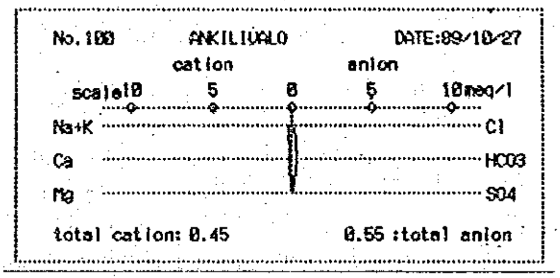


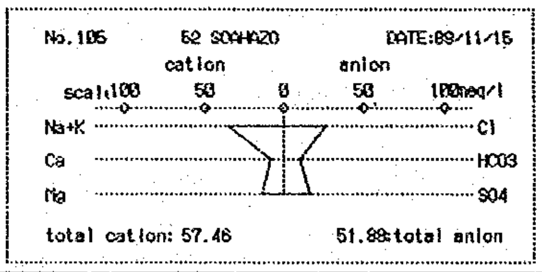


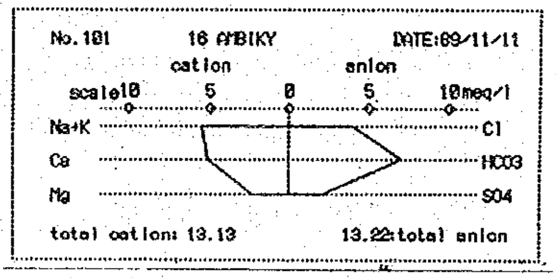












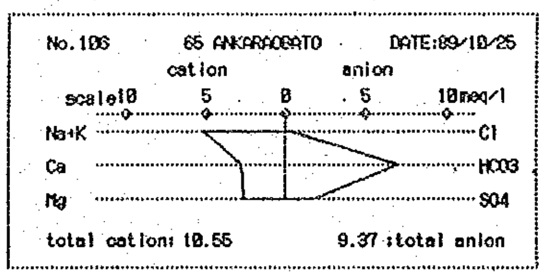
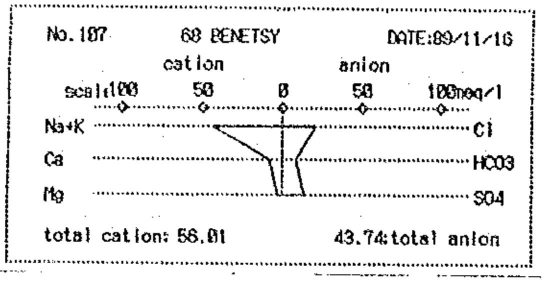
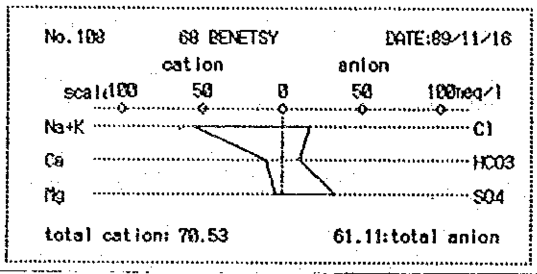
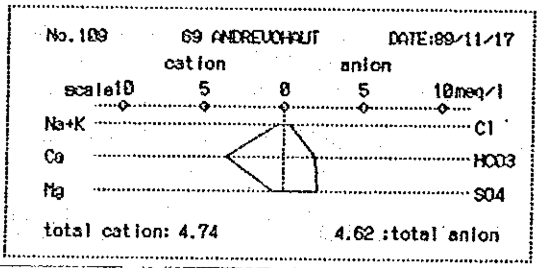
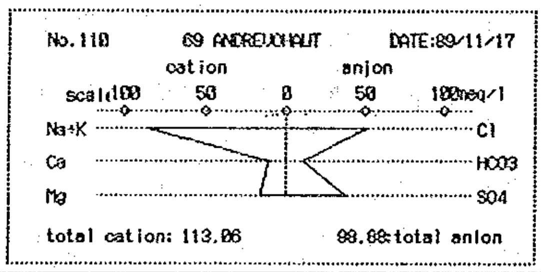


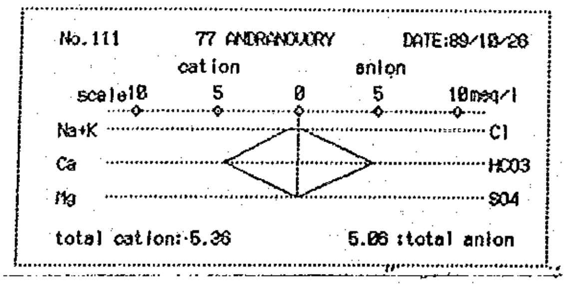
Fig. HEXADIAGRAMS OF SHALLOW GROUNDWATER (8)

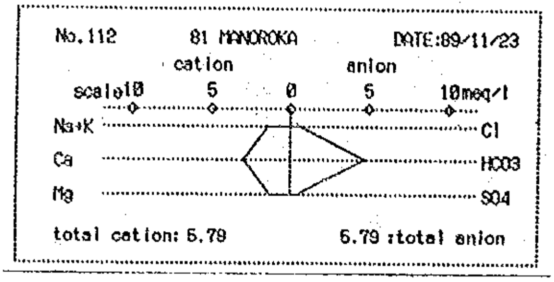


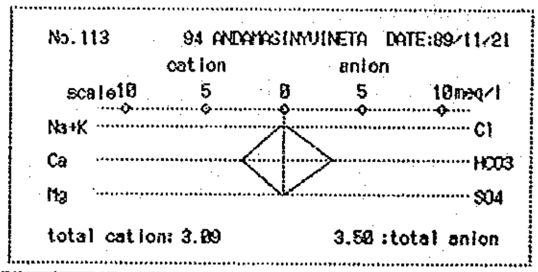


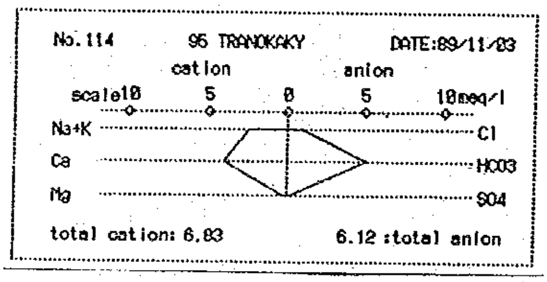












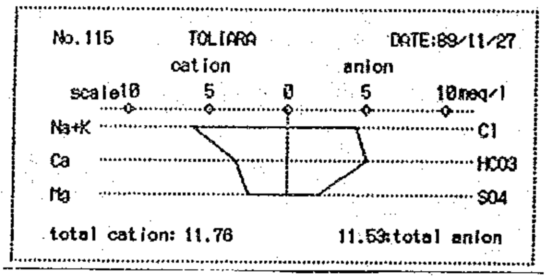


Fig. HEXADIAGRAMS OF SHALLOW GROUNDWATER (9)

4. BRIEF REVIEW OF THE SOLAR PUMP SYSTEM

SOLAR PUMP SYSTEM

Harnessing solar energy is expected to be fully operational in the next century. High expectations of the early stages of research on the practical application of solar energy were dampened by the low price of fossil fuel in recent years. However, research has continued, seeking to reduce the cost of the initial investment, that is, the cost of photovoltaic cells. Solar energy has the following characteristics.

(a) Independent and decentralized system
(b) Fuel free
(c) Simple operation and maintenance
(d) Clean energy

Given these advantages, solar energy is considered to be practically usable in local water supply projects. Solar powered pump is one of the ideas of the practical utilization of this energy, as was already carried out in Mali by a JICA project. The objective of construction of a solar powered pilot facilities in this Project is to further examine the possibility of using solar power in rural water supply systems.

1. Climatic Condition in the Study Area

(1) Sunshine energy

The Madagascar government conducted a study on the potential of new energy sources as reported in "GISEMENTS SOLAIRE ET EOLIEN A MADAGASCAR", published in 1987. This report shows the statistics of sunshine and wind observations.

The following tables show sunshine hour, percentage of sunshine and solar radiation energy in Ranohira and Toliara stations.

(a) Sunshine hour

Year:1960-1984 unit:hours/day

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ranohira	Mean	7.8	7.8	8.2	8.7	8.8	8.6	8.4	9.2	9.6	9.4	8.8	7.3
	Med.	8.5	8.4	8.9	9.2	9.4	9.2	9.2	10	10.2	10.3	9.4	7.7
	Min	0	0	0	0	0	0	0	0	0	0	0	0
	Max	12.8	12.5	11.8	11.1	10.8	10.5	10.8	11.1	11.3	12.2	12.7	12.5
Toliara	Mean	10.0	9.5	9.6	9.6	9.5	9.4	9.5	10.1	10.1	10.3	10.5	9.6
	Med.	11.3	11.0	10.8	10.5	10.2	10.0	10.1	10.6	10.6	11.0	11.6	11.1
	Min	0	0	0	0	0	0	0	0	0	0	0	0
	max	13.3	12.8	11.9	11.3	11.2	10.6	10.9	11.2	11.4	12.5	13.0	13.2

(b) Percentage of sunshine

Year:1960-1984 unit:%

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ranohira	Mean	59.1	61.6	67.9	76.0	81.1	81.1	77.9	81.7	80.5	75.4	67.6	54.6
	Med.	64.6	66.2	74.1	80.9	86.3	86.6	85.7	89.1	86.3	82.1	71.1	57.6
Toliara	Mean	75.3	74.4	79.9	84.1	87.4	88.7	88.2	90.3	85.4	82.0	79.8	71.6
	Med.	85.6	86.7	89.6	91.7	94.4	94.6	94.4	94.3	89.3	88.1	88.4	82.7

(c) Solar radiation (global)

Year:1960-1984 unit:Wh/m2

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ranohira	Mean	6354	6853	5851	5567	4903	4591	4712	5136	5662	5996	6403	6265
	Med.	6311	6515	5972	5750	4685	4506	4693	5319	5704	6304	6430	6187
	Min	2064	1439	930	2695	2845	2370	2117	2211	1278	899	2765	1959
	Max	9807	9773	8744	7372	8515	6135	6344	6384	7694	7868	6805	8942
Toliara	Mean	7184	8722	6178	5313	4477	4073	4261	5251	5803	6165	6851	6962
	Med.	7421	6965	6465	5525	4607	4120	4263	5319	6017	6267	7173	7430
	Min	2771	1645	404	2302	2097	2443	2160	2224	1114	2053	1274	1540
	Max	9244	8636	8174	7035	5902	5132	5452	6444	7376	8431	8953	8693

From the results of monthly radiation contour map for Madagascar was prepared as shown in Fig.A. According to this map, the southwestern region has the highest potentiality in Madagascar.

Since the Study Area is located on the tropic of Capricorn, radiation is low in July, and high in January. Maximum daily sunshine hours is highest in January, 12.8 and 13.3 hours/day being recorded at Ranohira and Toliara stations, respectively. Maximum daily sunshine hours is lowest in June, 10.5 hours/day in Ranohira and 10.6 hours/day in Toliara.
However, when these values are averaged, December shows the lowest value in Ranohira station. In the Ranohira station, only 50-60 % of original day light is available because of the frequency of rainy days during December-February.
In the end, monthly mean of solar radiation varied from 4000-4500 Wh/m2 in June to 6400-7200 wh/m2 in January in the Ranohira and Toliara stations, respectively. These values are quite enough to implement solar powered pump stations.

(2) Rainy days

Rainy days with more than 1mm, 5mm and 10mm, obtained from daily rainfall records in Toliara and Ankaraobato stations, are examined as follows.

(a) Toliara station, 1979-1988

unit: No. of rainy days

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
R>1mm	4.9	5.5	3.2	2.1	0.8	2.0	0.7	0.7	0.8	1.4	2.1	4.2
R>5mm	2.7	3.4	1.8	1.2	0.4	0.5	0.3	0.3	0.4	0.5	1.2	2.4
R>10mm	2.1	2.5	1.4	0.8	0.3	0.1	0.1	0.2	0.3	0.2	0.9	1.9

(b) Ankaraobato station, 1972-1981

unit: No. of rainy days

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
R>1mm	9.1	8.9	5.3	2.7	1.9	2.6	1.1	0.9	1.6	1.9	3.9	10.2
R>5mm	7.2	6.4	3.3	1.8	0.9	0.9	0.5	0.3	0.9	0.9	2.6	8.3
R>10mm	5.5	5.2	2.4	1.4	0.3	0.3	0.2	0.1	0.5	0.6	2.0	6.1

These tables show 2-3 days in Toliara and 7-8 days in Ankaraobato with more than 5mm of rain as average. According to the field experience, rainfall is concentrated in a very short span in the afternoon or at night. Therefore, some sunshine hours can be expected even in these rainy days.
However, it is required an extra pumping system or a water storing facility for the days with insufficient solar energy and other emergencies.

2. Solar System for the Project

2.1 General

Climatic data from Antananarive station were used. Design of the facility was based on the following conditions.

(a) Purpose: test facility for potable water
(b) Water demand: 10 m3/day
(c) Total head: 34 m
(d) Climatic condition and pumping capacity

Item	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
Rad. (30°)	5.67	5.86	5.83	5.78	5.28	5.02	5.04	5.94	6.77	7.17	6.96	6.24	5.96
Tem.	27.2	27.1	26.4	24.7	22.3	20.3	19.8	20.5	22.1	23.7	25.2	26.5	23.8
Power Ratio	.518	.528	.527	.527	.483	.469	.472	.555	.627	.658	.633	.564	.546
Water Capa. (m3/day)	9.9	10.2	10.2	10.2	9.3	9.1	9.1	10.7	12.1	12.7	12.2	10.9	10.6

(e) Specification

Detailed specification is attached in Annex 1.

3. Results of Monitoring

In order to measure actual solar and pumping capacity, monitoring equipments were set in the solar pump system. However, mechanical troubles occurred in the system, thereby precluding start of detailed monitoring until March 1991.

As a way to overcome deficient monitoring equipments, pumping discharge was measured by reading the storage tank water level in November and December of 1990, as shown below.

Water level of the tank

unit:l

Time	Nov./18	Nov./22	Dec./19
8:00-9:00	484	581	-
-10:00	1210	1355	397
-11:00	1403	1592	580
-12:00	1452	1646	1468
-13:00	1113	1791	2129
-14:00	242	(1600)	1791
-15:00	-	(1500)	1113
-16:00	-	(1000)	871
-17:00	-	-	678
-18:00	-	-	-
	5904	11065	9027

However, these results are influenced by rain, cloudy sky, and "tank capacity". Pumping was once stopped before full tank, and water was supplied to the villagers. Therefore, the data of November/22 between 13:00 and 16:00 hours are estimated. The measurements of Nov./18 and Dec./19 were interrupted by rainfall.

From March 1991, monitoring equipment worked well and the following results were obtained.

Flow meter

unit:l

Time	Mar./20	Mar./21	Mar./22
8:00-9:00	-	-	-
-10:00	-	117	437
-11:00	-	595	974
-12:00	1065	1350	1325
-13:00	1227	1477	1305
-14:00	1313	1478	1317
-15:00	690	1241	1050
-16:00	-	141	256
-17:00	-	-	-
-18:00	-	-	-
Total	4295	6399	6664

During the rainy season, village people use other water sources, such as water stored in their own drum or dug-wells. Therefore, daily water consumption was smaller than in the dry season. As a result, care takers stopped the solar pump when the tank was full, without using up the full solar capacity.

The daily distribution of the radiation is presented in Fig.B. This figure showing the result of Mar.22 gives a relatively complete picture of this season. The pump was operated between 9:00-16:00 hours.
Maximum radiation is almost 6.0 mV equipment to 0.8 kW/m2, and 4.5 mV equipment to 0.6 kW/m2. Accumulated radiation during this period is calculated as follows.

$(0.8+0.6)/2 \times 3$ hrs $+ 0.8 \times 2$ hrs $+ (0.8+0.6) \times 2$ hrs
$= 5.1$ kWh/day

Actual inclined radiation on solar panel should be smaller than this amount, with an estimated discharge capacity of 6.7 m3/day.

Considering the above records, the following comparison can be made.

Month	Q Max. (l/min)	Q Daily (m3)	Time (hrs)	Design Q (m3)	Remarks
November	30	11.1	8	12.2	
December	35	(9.0)	8	10.9	with rainfall
March	22	6.7	7	10.2	

Even in March, daily capacity is different from designed capacity because of the difference in radiation value. Daily radiation is lower from November to March, and, the lower peak occurs in June (both in monthly average and monthly maximum). Therefore, in order to consider the design-base, this system must be maintained at least up to next March 1992.

Operation and maintenance of the solar system is quite simple when the line from converter/solar battery is directly connected to the submersible pump. This connection is possible when the motor and pump are under water during operation. No special knowledge is required for the care-takers. Only the surface of solar panels have to be kept clean because dirt lowers the energy efficiency. Also since the solar panel is easily breakable, a caretaker or guardsman should be watching night and day against vandals.

4. Evaluation and recommendation

(1) Cost of operation

(a) Model village

(i) Population: 1000
(ii) Unit water consumption: 20 l/person/day
(iii) Total head of the well: 25m
(iii) Revenue from village

1 household= 7 persons
1000 people = 143 households
1 household pays 200 FMG/month

Total revenue from the model village will be
143 x 200 x 12 = 343,200 FMG /year

(b) Investment

For the solar pump operation, components include solar system, submersible motor pump, portable generator, head tank, pipeline and public hydrant. As alternative, pumping system with diesel generator and handpump system is discussed. Most of equipment cost is adopted from the pilot facility constructed during the Study.

(i) Solar pump system

Item	Unit cost	Quantity	Cost	Remarks
Solar system	3,800,000	1set	3,800,000	Incl. spare parts
Submersible motor pump	400,000	1set	400,000	Incl. spare parts
Portable generator (gasoline)	150,000	1set	150,000	Incl. spare parts
S-Total			4,350,000 yen	
Shipment etc.(25 %)			1,087,500 yen	
Foreign Total			5,437,500 yen	
/10.5			57,000,000 FMG	
Civil Works				
Head tank				
Pipeline				
Public hydrant				
S-Total			40,000,000 FMG	
Total			97,000,000 FMG	

(ii) Generator and pump system

In place of the portable generator, diesel generator is used for this system, including construction of a generator house.

unit:yen

Item	Unit cost	Quantity	Cost	Remarks
Generator (diesel)	950,000	1set	950,000	Incl. spare parts
Civil Works Generator house			400,000 FMG	

(c) Pump Operation Schedule

Basically, solar system will be backed up by gasoline generator for rainy days or cases of machinery trouble.
In order to estimate annual operating time of gasoline generator, average rainy days at Ankaraobato station is used as shown below.

Daily Rainfall (mm/day)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1<R<10	3.6	3.7	2.9	1.3	1.6	2.3	0.9	0.8	1.1	1.3	1.9	4.1
10<R	5.5	5.2	2.4	1.4	0.3	0.3	0.2	0.1	0.5	0.6	2.0	6.1

When daily rainfall is more than 10 mm/day, operating time of generator is assumed to be full day, while if daily rainfall is between 1 and 10 mm/day, operating time is assumed to be a half day. In the end, annual operating time is calculated as follows.

$$25.5 \times 0.5 + 24.6 \times 1.0 = 37.35 \text{ days}$$

Total head of the well is assumed as 25 m. From the capacity of submersible pump, 75 l/min is expected by generator(full capacity). When solar pump system is used, full capacity is not expected because of the variation of the radiation. Therefore, average capacity is assumed as 80%, or 60 l/min.

Water demand: 20 m3/day

Item	Generator system	Solar system
Pump capacity	75 l/min	60 l/min(average)
Pumping time	4.5 hr/day	5.6 hr/day
Annual operation time of generator (hrs.)	1643 hr (365 day)	213 hr (38 day)

(d) Unit cost

--- Fuel

Item	Unit cost	Remarks
Diesel	422 FMG/l	
Gasoline	840 FMG/l	

--- Efficiency of the generator

Item	Generator Capacity(kVA)	Output (PS)	Fuel (l/h)
Diesel	5.5	10	0.6
Gasoline	1.3	2.2	1.1

Fuel consumption is calculated
for diesel
Fuel consumption = Output x Consumption rate (0.117) x 0.5
for gasoline
Fuel consumption = Output x Consumption rate (0.5)

(e) Replacement, operation and maintenance costs

(i) Other items (spare parts, etc.)

Solar system --- 100,000 FMG/year
Generator system --- 50,000 FMG/year

(ii) Wages for care-taker

60,000 FMG/year

(iii) Dues for the central organization

30,000 FMG/year (periodic patrol)

(iv) Replacement

- Solar panel
  50 % of replacement in 15 years

- Generator
  Replacement in 8 years for diesel
  Replacement in 5 years for gasoline

- Submersible Pump

- Other small equipments

Cash flow of this model is shown in Table 1 and 2.
In this table, calculation is performed by "   ".

From this flow, following results can be considered;

(a) Investment and replacement costs of both systems are not so different for the estimated 30 years useful life.

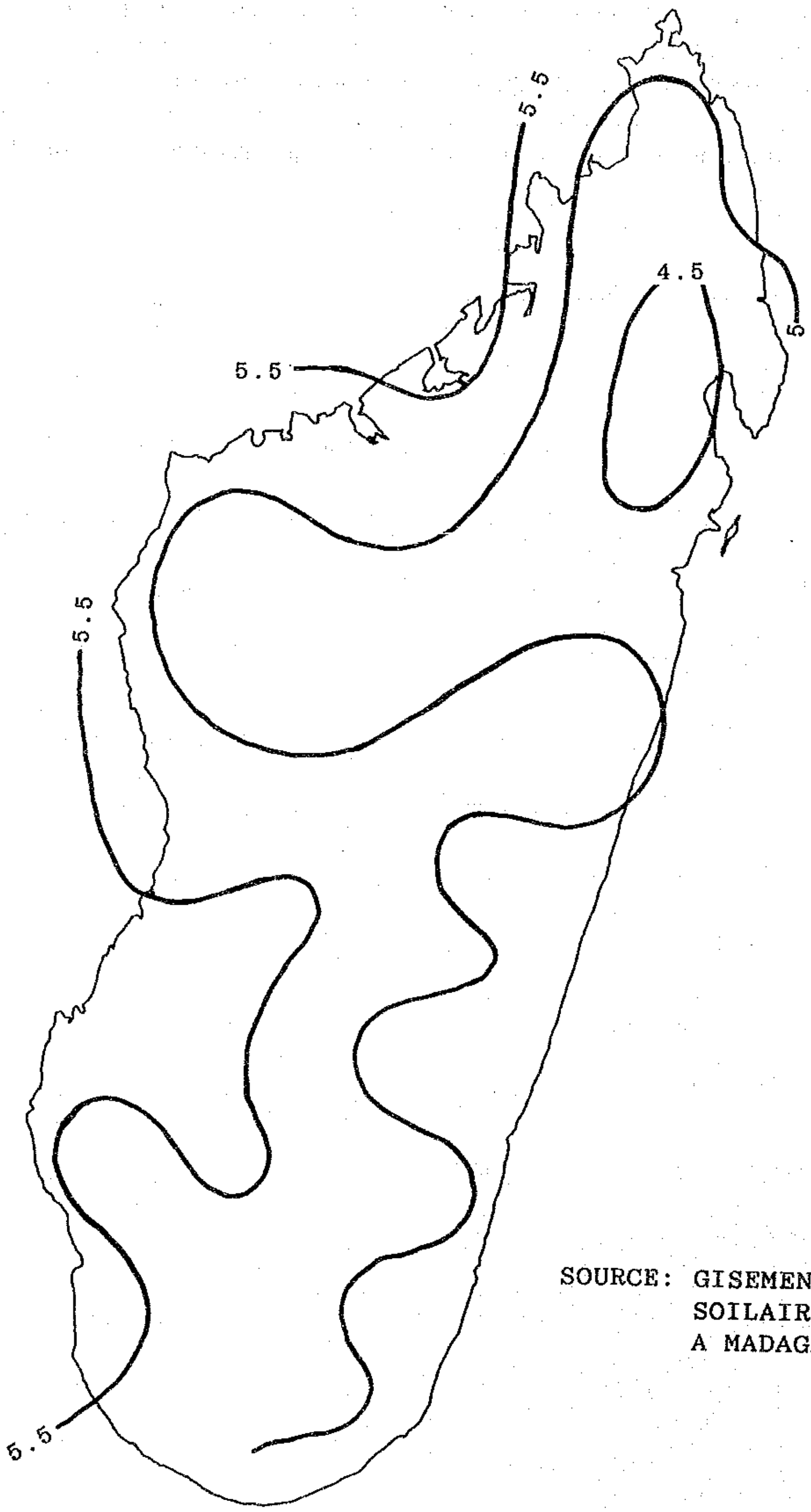
(b) In the case of the solar system, O&M and fuel cost is well balanced with the revenue from the village.

(2) Recommendation

From these cash flows, a solar pump is considered a viable system for rural communities like the Study Area, if investment and replacement costs are neglected.
It is still difficult to expect rural people pay all of investment cost for a mechanical pumping system, or even for the replacement.
However, they able to cover operation and maintenance cost, including fuel cost. From this point of view, the O&M cost of the solar system is cheaper than the cost of the generator system.

It should be pointed out that no reliable climatic data for solar systems are available in the Study Area. Therefore, the pilot solar pump station of the Study is expected to provide the necessary data of the actual condition in a few years. When these data become available, complete reviews should be made on the practical use of solar energy for pumping water supply systems in southern Madagascar, as well as on the economic condition of villages.

Fig. MAYENNE ANNUELLE DEL I'IRRADIATION SOLAIRE GLOBALE (en $kWh/m^2/jour$)



SOURCE: GISEMENTS SOILAIRE ET EOLIEN A MADAGASCAR, 1987

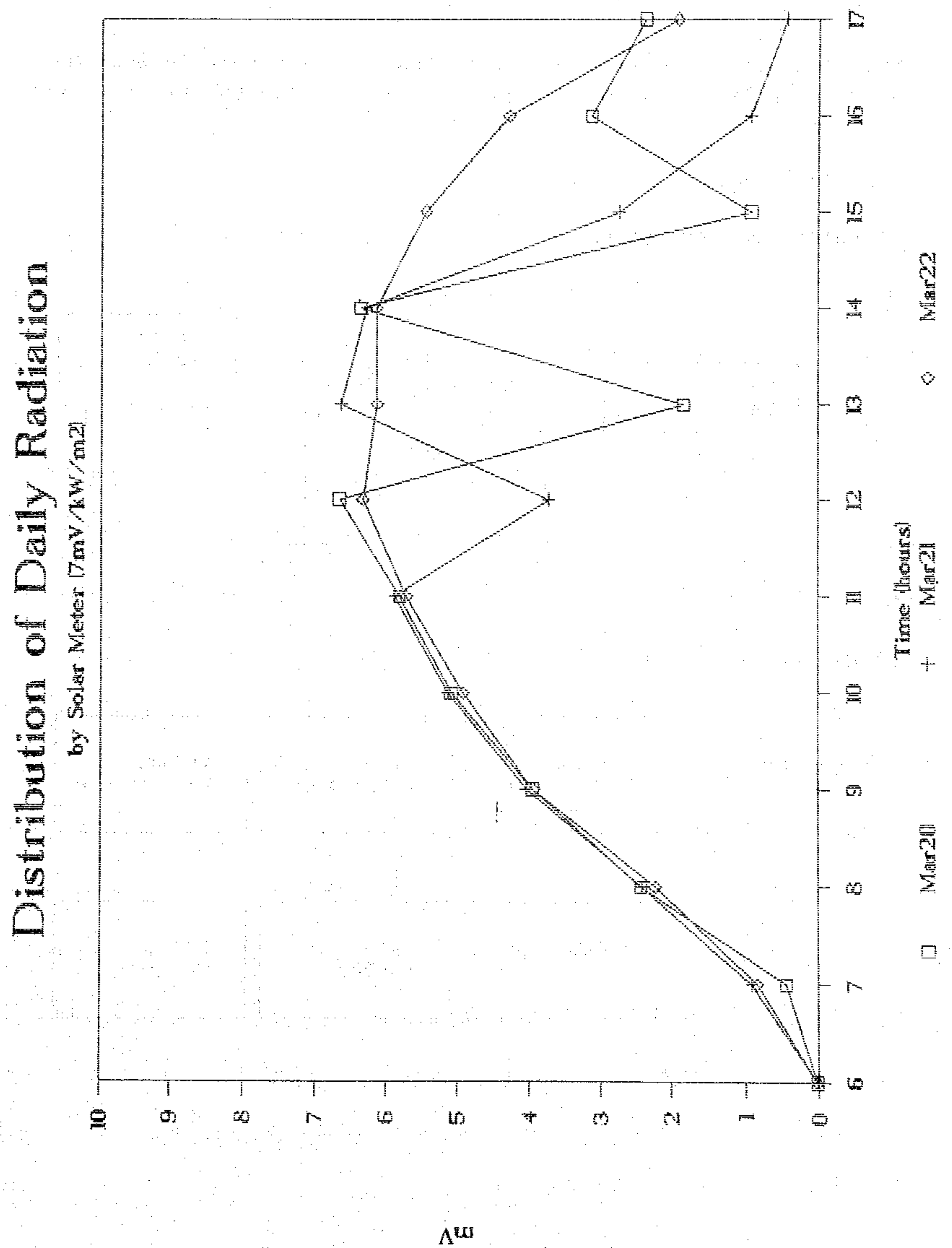


Fig.B DIALY DISTRIBUTION OF RARIATION

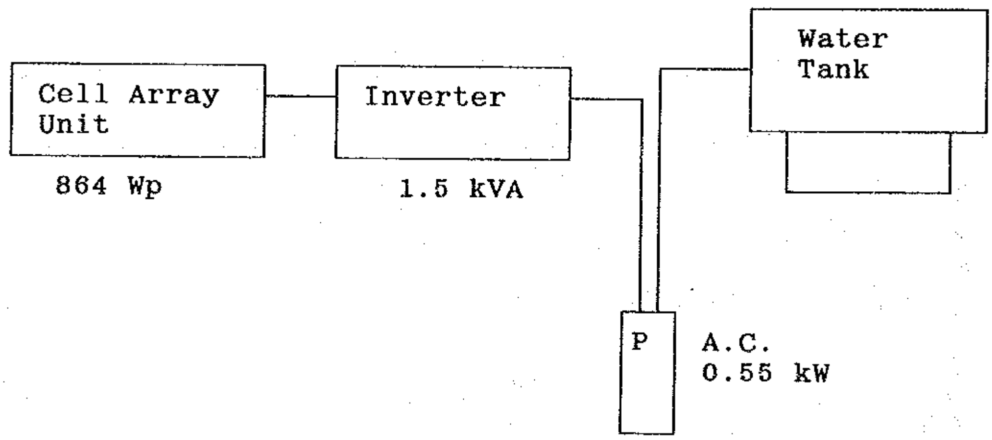
Attachment - (technical specification) Annex 1

1. GENERAL

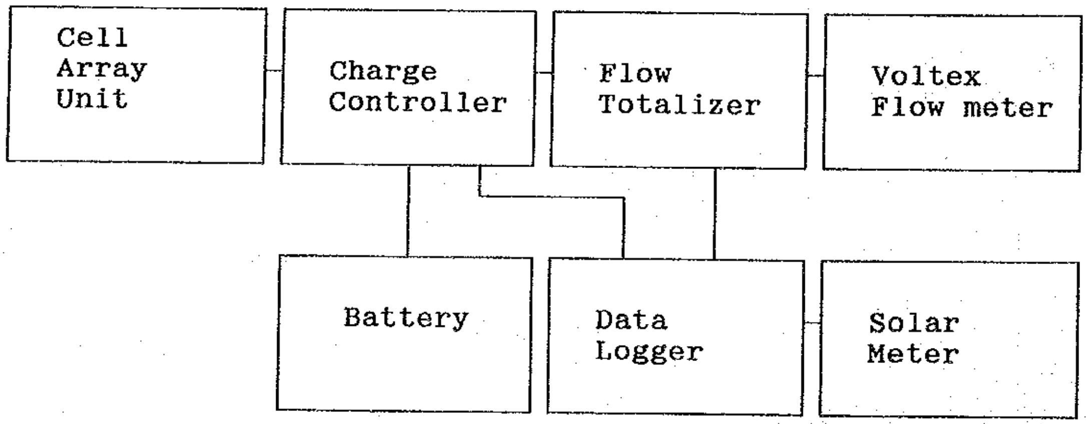
This technical specification describes the photovoltaic equipment for water pumping and measuring installed in Madagascar as a test facility.

2. SYSTEM DIAGRAM

(1) Water pumping system



(2) Measuring system



3. DESIGN CRITERIA

1) Location	:	Madagascar / south-west area
2) Total head	:	34 m
	:	(Static water level 10m)
	:	(Dynamic water level 30m)
	:	(Water tank height 4m)
3) Water demand	:	10 m^3/day
4) Water source	:	Deep well
5) Water quality	:	Potable water
6) Well diameter	:	100 mm
7) Purpose	:	Test facility

4. CLIMATIC DATA

1) Irradiation data : Monthly mean daily global horizontal solar radiation at Tananarive (lat. 18 54' S, long. 47 32' E, elv. 1310m)

2) Temperature data : Monthly mean atmospheric temperature at Toliara (lat.23 24'S,long.43 44'E,elv.9m)

5. RESULT OF CALCULATION

1) Climatic data for simulation

ITEM	J	F	M	A	M	J	J	A	S	O	N	D	Yr.
IRRADIATION (KWh/m^2/day)	5.98	5.95	5.70	5.42	4.72	4.24	4.43	5.49	6.53	7.20	7.26	6.74	4.99
TEMPERATURE (°C)	27.2	27.1	26.4	24.7	22.3	20.3	19.8	20.5	22.1	23.7	25.2	26.5	23.8

2) Simulated pumping capacity

ITEM	J	F	M	A	M	J	J	A	S	O	N	D	Yr.
IRRADIATION at 30 deg.	5.67	5.86	5.83	5.78	5.28	5.02	5.04	5.94	6.77	7.17	6.96	6.24	5.96
POWER RATIO	.518	.528	.527	.527	.483	.469	.472	.555	.627	.658	.633	.564	.546
WATER CAP. (m^3)	9.9	10.2	10.2	10.2	9.3	9.1	9.1	10.7	12.1	12.7	12.2	10.9	10.6

6. SPECIFICATION

(1) Pumping system

1) Module

Item	Specification
Model	LA361J48
Type	Multi crystal silicone
Cell size	100x100 mm
Nos. of cell	36 pcs.
Frame material	Aluminum
Weight	5.9 kg

2) Array

Item	Specification
Model	SAG-486
Construction	Module 6 pcs.
Tilt angle	25 deg.
Frame material	Aluminum
Wind Velocity	Up to 40 m per sec.

ITEM \ CLASS	MODULE		SOLAR ARRAY		TOTAL	
Type	LA361J48		SAG-456			
Nos of module/or array	Module 1 pc.		Module 6 pcs.			
System voltage	12 V				270 V	
	typical	minimum	typical	minimum	typical	minimum
Maximum output power (Pm)	48.0 W	45.6 W	288.0 W	273.6 W	864 W	820.8 W
Optimum voltage (Vm)	16.7 V	16.7 V	100.2 V	100.2 V	300.6 V	300.6 V
Optimum current (Im)	2.88 A	2.73 A	2.88 A	2.73 A	2.88 A	2.73 A
Open circuit voltage (Voc)	20.7 V	18.6 V	124.2 V	111.6 V	372.6 V	334.8 V
Short circuit current (Isc)	3.10 A	2.79 A	3.10 A	2.79 A	3.10 A	2.79 A

Conditions

1. Irradiation 100mW/cm^2 AM 1.5
2. Cell temperature 25°C

3) Photovoltaic Inverter

Model	SPI-1
Series connection of photovoltiac modules	LA361J48 type module x 18 series
Rated input (photpvoltaic)	Max. 864 Wp
Rated input voltaic Rated input current	270VDC±5% (Max. 372.6VDC) Max. 6.2 ADC
Rated output	
Rated output voltaic Output frequency	* Max. 200 VAC Max. 60 Hz * 3-phase variable voltage matched with the voltage requirements of the pumps.
Function	(1) Input voltage regulation circuit (2) Over-voltage protection circuit (3) Over-heat protection circuit
Switch	ON-OFF switch to connect (or disconnect) the solar array to the main circuit
Insulation resistance	More than 10MΩ (DC500V megger)
Dielectric strength	DC500V one minute
Operating temperature	-10°C - +45°C
Dimension	Refer to DWG. No. MDS-511

4) SUbmersible motor / pump

Item	Specification
Model	SA2A-13
Type	Submersible motor pump
Rated output	0.55 kW
Frequency	50 Hz
Phase x Volt	3 x 200 V
Amperage	3.9 A
Poles	2
Revolution	3000 r.p.m.
Discharge size	25 A
Material	Stainless steel

Cash flow
(1) Solar pump system

Unit:1000 FMG

Year	Investment & Replace	O&M	Revenue
1	97000	357	343
2	–	357	343
3	–	357	343
4	–	357	343
5	–	357	343
6	2000	357	343
7	–	357	343
8	5250	357	343
9	–	357	343
10	–	357	343
11	2000	357	343
12	–	357	343
13	–	357	343
14	–	357	343
15	–	357	343
16	35190	357	343
17	–	357	343
18	–	357	343
19	–	357	343
21	2000	357	343
22	–	357	343
23	–	357	343
24	5250	357	343
25	–	357	343
26	2000	357	343
27	–	357	343
28	–	357	343
29	–	357	343
30	–	357	343

(2) Generator pump system

Unit:1000 FMG

Year	Investment & Replace	O&M	Revenue
1	111600	606	343
2	–	606	343
3	–	606	343
4	–	606	343
5	–	606	343
6	–	606	343
7	–	606	343
8	17800	606	343
9	–	606	343
10	–	606	343
11	–	606	343
12	–	606	343
13	–	606	343
14	–	606	343
15	–	606	343
16	17800	606	343
17	–	606	343
18	–	606	343
19	–	606	343
20	–	606	343
21	–	606	343
22	–	606	343
23	–	606	343
24	17800	606	343
25	–	606	343
26	–	606	343
27	–	606	343
28	–	606	343
29	–	606	343
30	–	606	343

5. SELECTION OF THE PUMP SYTEM

Selection of the Pump System

It is important to select more advantageous lifting system for implementation plan of water supply facility.
The final comparison is performed in 4 villages, Manoy, Antseva, Ankatrakatra and Ambondra, expected promising aquifer with shallow groundwater level.

Basically, it is necessary to consider many factors in order to decide which system is suitable for candidate village. Village's individual conditions of economy and living standard are background to make final decision of the system selection. And, required service level must be considered by the hard and soft viewpoints, such as investment cost, operation and maintenance cost and facility/organization management capability.
However, in order to simplify this argument, only investment cost is used for this comparison in this time.

At least concerning investment, cost of three handpumps is equal to mechanized pump systems. Therefore, handpump system is selected for these villages.

Comparison of Handpump and Mechanized pump

unit:US$

Village	No.	Population	G.W.C.	Motor Pump	Handpump (3)	Handpump (4)
Manoy	22	707	21	57570	37046	49395
Antseva	57	1048	21	73928	56816	75755
Ankatrakatra	58	603	19	58410	56816	75755
Ambondro	60	1310	26	63480	43636	58181

G.W.C. --- Gross Water Consumption (m3/day)
pump discharge rate:
motorized pump --- 6 hours a day
handpump --- 4-7 m3/day

1. Manoy

No; 22
Population in 2000; 707
Gross Water Consumption; 21 m3/day
Type; WHP-CT

Handpump

ITEM	SPECIFICATION	QUANTITY	COST(US$)
Well construction	ø4" x 40.0 m	3	26,360
Pumping Test		3	5,242
Handpump	20 l/sec x 10 m	3	3,478
Concrete Base		3	1,966
Total			37,046

Motor pump

ITEM	SPECIFICATION	QUANTITY	COST(US$)
Well construction	ø4" x 40.0 m	1	8,787
Pumping Test		1	5,242
Motor pump	21.0l/sec x 20 m		19,943
Generator	10 KVA	1	10,650
Pump House	3 m x 4 m	1	5,286
Tank	10 m3	1	17,620
Pipe line	3"	250 m	1,941
Joint			582
Standpost		2	1,607
Total			57,570

2. Village; Antseva

No; 57
Population in 2000; 1048
Gross Water Consumption; 23 m3/day
Type; WHP

Handpump

ITEM	SPECIFICATION	QUANTITY	COST(US$)
Well construction	ø4" x 70.0 m	3	46,129
Pumping Test		3	5,242
Handpump	20 l/sec x 20 m	3	3,478
Concrete Base		3	1,966
Total			56,816

Motor pump

ITEM	SPECIFICATION	QUANTITY	COST(US$)
Well construction	ø4" x 70.0 m	1	15,376
Pumping Test		1	1,747
Motor pump	21.0l/sec x 26 m		19,943
Generator	10 KVA	1	10,650
Pump House	3 m x 4 m	1	5,286
Tank	10 m3	1	17,620
Pipe line	3"	250 m	7,762
Joint			2,329
Standpost		4	3,214
Total			57,570

3. Village; Ankatrakatra

No;58
Population in 2000; 603
Gross Water Consumption; 19 m3/day
Type; WHP-CT

Handpump

ITEM	SPECIFICATION	QUANTITY	COST(US$)
Well construction	ø4" x 70.0 m	3	46,129
Pumping Test		3	5,242
Handpump	20 l/sec	3	3,478
Concrete Base		3	1,966
Total			56,816

Motor pump

ITEM	SPECIFICATION	QUANTITY	COST(US$)
Well construction	ø4" x 70.0 m	1	15,376
Pumping Test		1	1,747
Motor pump	20 l/sec x 20 m		19,943
Generator	10 KVA	1	3,804
Pump House	3 m x 4 m	1	5,286
Tank	10 m3	1	17,620
Pipe line	3"	300 m	2,329
Joint			699
Standpost		2	1,607
Total			58,410

4. Ambondro

No; 60
Population in 2000; 1,310
Gross Water Consumption; 26 m3/day
Type; WMP

Handpump

ITEM	SPECIFICATION	QUANTITY	COST(US$)
Well construction	ø4" x 50.0 m	3	32,950
Pumping Test		3	5,242
Handpump	20 l/sec	3	3,478
Concrete Base		3	1,966
Total			43,636

Motor pump

ITEM	SPECIFICATION	QUANTITY	COST(US$)
Well construction	ø4" x 50.0 m	1	10,983
Pumping Test		1	1,747
Motor pump	26.01/sec x 21 m		19,943
Generator	10 KVA	1	10,650
Pump House	3 m x 4 m	1	5,286
Tank	10 m3	1	17,620
Pipe line	3"	400 m	3,105
Joint			931
Standpost		4	3,214
Total			63,480

APPENDIX (1)

LIST OF COLLECTED DATA

BIBLIOGRAPHIE

01. Patrick RAJOELINA & Alain RAMELET, "MADAGASCAR, la Grande Ile", Editions l'Harmattan, 1989

02. Hubert DESCHAMPS, "Madagascar", Collection QUE SAIS-JE?, No.529

03. "Bulletin semestriel de Statistiques Sanitaires ", Ministère de la Santé, Direction des Services Sanitaires et Médicaux, 1987

04. "Cahiers démographiques des Fokontany, les résultats obtenus en 1987 et 1988", Ministère de la Santé, Direction des services sanitaires et médicaux, 1989

05. "Etude des Ressources en Eaux Souterraines à Madagascar, Annexe I - Planches ", ONU, 1966

06. "Etude des Ressources en Eaux Souterraines à Madagascar, Annexe II - Equipement et essais de pompage dans les forages S12 et S12bis", ONU, 1966

07. "Etude des Ressources en Eaux Souterraines à Madagascar, Annexe III -Notices explicatives et Carte phréatique entre Fiherenana et Manogoky", ONU, 1966

08. "Etude des Ressources en Eaux Souterraines à Madagascar, Annexe IV - Hydrochimie", ONU, 1966

09. "Etude des Ressources en Eaux Souterraines à Madagascar, Annexe V - Implantations précises recommandées pour les forages artésiens dans le cadre d'un premier projet de mise en valeur de la plaine de Befandriana", ONU, 1966

10. "Etude des Ressources en Eaux Souterraines à Madagascar, Annexe VI - Etudes complémentaires relatives à la nappe captive de Befandriana", ONU, 1966

11. "Etude des Ressources en Eaux Souterraines à Madagascar, Annexe VII - Coupes de forages", ONU, 1966

12. "Etude des Ressources en Eaux Souterraines de la Plaine de Morondava, Annexe I - Forages et essais de pompage", PNUD, 1970

13. "Etude des Ressources en Eaux Souterraines de la Plaine de Morondava, Annexe II - Chimie des eaux", ONU, 1970

14. "Etude des Ressources en Eaux Souterraines de la Plaine de Morondava, Annexe III - Fluctuations des nappes", ONU, 1970

15. "Etude des Ressources en Eaux Souterraines de la Plaine de Morondava, Annexe IV - Hydrogéologie de la ville de MORONDAVA", ONU, 1970

16. "EAU POTABLE PUBLIQUE, Production par unité productrice, zones desservies"

17. "Note technique concernant le Projet d'Exploitation d'Eaux Souterraines de la Région comprise entre l'Onilahy et Morondava", Ministère de l'Industrie, de l'Energie et des Mines, sept.1987

18. "Approvisionnement en Eau et Assainissement de Tananarive, Tome VII - Programmation nationale pour l'Approvisionnement en eau et l'Assainissement à Madagascar", OMS, juin 1975

19. "Programme d'Investissement Public 1989-91, 1990-92, 1991-93"

20. "Répartition des Formations sanitaires - 1988"

21. "Barèmes tarifaires eau - janvier 1990", JIRAMA, janv.1990

22. "Bilan des Travaux exécutés par l'AID dans la province de Tuléar de novembre 1963 au 15 août 1965", Ministère de l'Industrie, de l'Energie et des Mines, sept.1965

23. "Planning d'exécution des Travaux de 22 forages dans la Région Nord-Ouest de Madagascar", Ministère de l'Industrie, de l'Energie et des Mines, mai 1989

24. "Ressources en Eaux Souterraines de la Région de Tuléar, Résumé des Connaissances aquises - Note sommaire sur les études complémentaires à entreprendre", Ministère de l'Industrie, de l'Energie et des Mines, mars 1967

25. Henri BESAIRIE, "Géologie de Madagascar, I - Les terrains sédimentaires", Annales géologiques de Madagascar, Fascicule XXXV, 1972

26. "Rapport d'exécution de deux forages pour l'Alimentation en eau du poste sanitaire d'Ankilizato et du centre médical de Mandabe", Ministère de l'Industrie, de l'Energie et des Mines

27. "Approvisionnement en eau potable et Assainissement en milieu rural", OMS & Banque Mondiale, nov.1982

28. "Guide des Affaires à Madagascar", édition 1986/87

29. Pakotondrainibe Jean HERIVELO, "Les eaux souterraines de Madagascar", avril 1983

30. "Rapport Economique et Financière, année 1989", Ministère de l'Economie et du Plan

31. "Rapport sur la situation actuelle, secteur Eau et Assainissement", PNUD & Banque Mondiale, oct.1989

32. "Plan 1986-90", Journal offciel No.1755, juillet 1986

33. "Programme d'études et de travaux d'AEP", Ministère de l'Industrie, de l'Energie et des Mines

34. L. Andriamihaja, "L'organisation financière de Madagascar"

35. "Bulletin mensuel de Statistique (Edition spéciale)", No.372-83, Direction générale de la Banque des données de l'Etat, mars 1987

36. "Situation économique au 1er janvier 1988", Direction générale de la Banque des données de l'Etat

37. "Inventaire socio-économique, Tomes 1 et 2", Direction générale de la Banque des données de l'Etat, fév.1988

38. "Investir à Madagascar", Ministère de l'Industrie, de l'Energie et des Mines, 1990

39. Jean-Michel HOERNER, "Géographie régionale du Sud-Ouest de Madagascar", Association des Géographes de Madagascar, 1986

APPENDIX (2)

WELL INVENTORY SHEET

DEMOCRATIC REPUBLIC OF MADAGASCAR
MINISTRY OF INDUSTRIES, ENERGY AND MINES
DIRECTORATE OF ENERGY AND WATER
SERVICE OF WATER AND HYDROGEOLOGY

BOREHOLE LOCATION

1	PRESENT OWNER:	3	REGION:
	PREF., TOWN, VILLAGE:	4	NWRC WELL NO.
2	ORIGINAL WELL NO.:	5	MAP NO. SCALE:

	DATA	TRANSFERRED FROM WELL LOG	ON SITE GATHERED DATA
6	DRILLING COMPLETION DATE/BY:	a	b
7	CASING DIAMETER	a	b
8	DRILLING DEPTH	a B.G.R.	b
9	WATER LEVEL DEPTH	a B.G.R.	b
10	DISCHARGE	a	b
11	DRAWDOWN	a	b
12	TYPE OF SCREEN AND PERFORATION	a	b

18	MEASURING WATER LEVEL POSSIBLE?	Yes No
19	GROUND ELEVATION:	M_B^A M.S.L.
20	WATER LEVEL DEPTH:	M_B^A
21	WATER LEVEL ELEVATION:	M_B^A M.S.L.
22	VERTICAL SKETCH OF WELL	

13 INFORMATION WRITTEN BY:

14 TYPE/HP. OF PUMP:

23 REMARKS:

15 WATER ANALYSES: PCB

16 USE:

17 INFORMATION GIVEN BY:

24 SKETCH OF WELL SITE

MAP NO.
SCALE
DISTANCES FROM THE EDGES
OF THE MAP IN MILLIMETERS

N

W E

S

25 LOCATED ON:

BY:

26 BASIN'S NO. & NAME:

27 COORDINATES:

LAT. LONG.

DEMOCRATIC REPUBLIC OF MADAGASCAR
MINISTRY OF INDUSTRIES, ENERGY AND MINES
DIRECTORATE OF ENERGY AND WATER
SERVICE OF WATER AND HYDROGEOLOGY

WELL LOG RECORD SHEET

1	**PRESENT OWNER:** :EGION:		**WELL NO.:** D.	
2	LOCALITY		ORIGINAL WELL NO.	
2a	BASIN NO.:		BASIN NAME:	
3	MAP NO./SCALE:	4	COORDINATES:	
5	COMPLETION DATE:	6	ELEVATION OF GROUND:	
7	CASING DIAMETER:	8	CASING BELOW GROUND:	
9	SCREEN	DIAMETER	FROM	TO
			BELOW GROUND	
		1.		
		2.		
		3.		
		4		
10	TYPE OF SCREEN & PERFORATION			
11	STATIC WATER LEVEL	BELOW GROUND	DATE	ELEVATION
		1.		
		2.		
		3.		
		4.		
12	LATER. MEAS. OF W.L.:			
13	$M^3/H/M$:		14	IN MIN:
14	PUMP TEST PERFORMED? Yes No.	16 STORAGE COEFF.	17	$TM^2/hr.$:
18	WATER RIGHT DATE:		19 WATER RIGHT QUANTITY:	MI.L M^3/YR
20	WATER ANALYSES:	21 SIEVE TEST ANALYSES:	22	DESCRIPTION OF SAMPLES:
23	SAMPLE BOX NOS.:			
24	DATE AND WRITTEN BY:			
28	REMARKS:			

25 DEPTH OF EACH LAYER (BELOW GROUND)	26 SYMBOLS	27 SHORT DESCRIPTION OF PENETRATED DATA