REPUBLIC OF KENYA

MINISTRY OF WATER DEVELOPMENT

WATER RESOURCES ASSESSMENT STUDY

IN

LAIKIPIA DISTRICT

APPENDICES

MAY 1987

WATER RESOURCES ASSESSMENT DIVISION
NAIROBI, KENYA

TNO-DGV INSTITUTE OF APPLIED GEOSCIENCE
DELFT, THE NETHERLANDS

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LIST OF APPENDICES, CHAPTER 1

1.1 Kenyan and Netherland staff involved in the WRAP Investigations

APPENDIX 1.1

Kenyan and Netherland Staff Involved in the WRAP Investigations.

Appendix 1.1 Kenyan and Netherland Staff involved in the WRAP investigations

KENYA TEAM

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Machakos Reconnaissance Study	
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Lamu District Reconnaissance Study	
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	P.M. Macharia (October 1986) N.N. Ndirangu (October 1986) M.N. Musyoka

* = people employed in more than one discipline or study
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Pump test Unit and Well Logging

Assistant Hydrologists	C.G. Gitonga
	C.M. Waweru
	D.W. Mwangi
	S.G. Wainaina

Support Staff

Secretary for CTA	Mrs. Norah Ndunda
Secretary for Project Manager	Mrs. M.W. Mwaniki
Messenger for CTA	Miss Hellen Wangenzi
Messenger for Project Manager	Mr. M. Safina
Draughtsman	Mr. A.Annam
	-

Drivers	M. Kibara	KWS 467
	A.N. Muchiri	KXG 550
	J.M. Maina	KXG 549
	J.K. Kibara	KXJ 811
	A.O. Ohanya	KXG 716
	J.K. Kirubi	KWS 468
	J.O. Ohanya	GKA 403
	L.A. Adaka	KTV 597
	-	GKA 402
	L. Gacheru	KWZ 102

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Chief Technical Advisor	P.G. van Dongen	01 May 1984 - 01 Feb 1986
	J.L.J. de Sonneville	01 Feb 1986 -
Hydrogeologist	L. Vasak	01 May 1984 -
Hydrologist	J.P. Heederik	01 May 1984 - 01 Jul 1984
	D.C. van Enk	01 Jul 1984 -
Ass. geophysicist	J.W.T.M. Reckman	01 May 1984 -

* = people employed in more than one discipline or study

LIST OF APPENDICES, CHAPTER 3

3.1 Site Investigations
3.2 Photogeological Maps and Geophysical Site Locations Maps
3.3 Vertical Electrical Soundings
3.4 Resisstivity Profiles
3.6 Seismic Spreads

APPENDIX 3.1

Site Investigations

3.1.1 Ngomongo (proposed shopping centre)

The site is located 4 km southeast of Ndurumo market. Groundwater occurrence was expected in old-land-surfaces, in a lineament (probably a fault) observed in aerial photographs about 0.7 km northeast of the site, and probably in the contact between the Ndurumo and Aiyam Phonolites running about 0.5 km west of the site. Some portions of the North Aiyam Stream follow the lineament and possibly in those portions the stream is influent into the fault zone.

Geophysical fieldwork was planned so as to investigate the observed lineament, to identify the exact position of the contact and hopefully to explore for the existence of old-land-surfaces.

Two parallel resistivity profiles, 2,010 m and 405 m long and 400 m apart were made and 5 vertical electric soundings (VES); one on the lineament itself, another on the eastern compartment, two on the western compartment and the fifth near borehole C37 for comparison purposes. This borehole is 3 km east of the proposed shopping centre. These locations are shown in Plate 3.1 and 3.2.2 while the records and results of the geophysical work are shown on Figures 3.3.1, 3.4.1 and 3.3.14. Two electromagnetic profiles overlapping the resistivity ones were also tried (see Figure 3.5.1).

The resistivity and electromagnetic profiles did not show the strong anomalies it was hoped they would over the lineament. In fact the resistivity profiles gave higher values than were recorded in the surrounding areas whereas lower values were expected due to weathering along the lineament. The contact between the two phonolites was also not identified by the profiles.

The three soundings VES 2, 3 and 4 lying on Ndurumo Phonolite show some correlation but only at depth. The top layers differed sharply in all the three soundings. VES 2 even at depth shows much lower values probably due to its being located on the lineament. VES 5 lying on Aiyam phonolies, at a depth of 30 m indicates a resistivity of 800 ohmmetres, which is comparable to the above 3 soundings on Ndurumo Phonote. This may indicate a lateral eastward extension of the Ndurumo phonolite (although the existing geological log of borehole C37 refutes this).

The two soundings VES 1 and VES 5 located on Aiyam Phonolites do not seem to correlate very much.

The presence (or absence) of old-land-surfaces could not be confirmed probably due to this lack of correlation between the soundings, the masking effect on deep thin layers, and the uncertainty caused by equivalent solutions of the soundings' interpretations.

The site of VES 2 was selected for drilling mainly on account of being close to the lineament, the shopping centre and the possibility of recharge of groundwater from the North Aiyam Stream.

3.1.2 Bondeni (Proposed shopping centre)

The site is located in the Mukutan valley about 3 km north of Sipili Market. Water is also required for the nearby Bondeni Primary School.

(see Figure 3.2.3).

A series of parallel faults were assumed to border the valley on either side and any groundwater existing within the collapsed valley to be recharged by the Mukutan stream which flows along this valley.

Three short resistivity profiles were made between the stream and the eastern escarpment (where the proposed shopping centre will be constructed). They are 270, 300 and 600 m long and are 0.75 and 1.5 km apart (see Figure 3.4.2). Their aim was to confirm the existence of a fault believed to run along the bottom of the eastern flank of the valley. A fourth resistivity profile was made in the area to the north of Bondeni Primary School. This was meant to investigate any possible extension of the fault to the north.

Five vertical electric soundings were made, one on each profile and an additional one on profile RP 1 between the fault and the stream. For comparison purposes three more soundings were made; one about one km north of borehole C913 (operational), another next to borehole C3115 (dry) and the third near Kabati Primary School further north of Bondeni School. The one near borehole C913 and the one at the primary school were both of poor quality and can only be used qualitatively (see Figures 3.3.2, 3.3.15(a) and 3.3.15(b).

The resistivity profiles made near the site of the shopping centre indicated higher resistivity values on the slopes of the escarpment. This however was interpreted as not conclusive to ascertain the presence of the fault as the slopes were expected to have shallower overburden. This prompted the trial of electromagnetic profiling along RP 1 with the hope of better results but it was also a failure (see Figure 3.5.2). The fourth profile further north however gave more conclusive results as low resistivity values were observed within the fault zone.

All the four soundings made in the valley indicated the presence of a clay layer at a relatively shallow depth.

Drilling was recommended at the site of VES 2 mainly due to its closeness to the stream (which hopefully recharges the groundwater) and to the site of the shopping centre.

3.1.3 Mwenje

Water was required for Mwenje Secondary School, the surrounding Mlima Tatu Settlement Scheme, and Ng'elesha Primary School in the scheme.

There is shallow phreatic water about 2-3 m deep in most parts of the area which may account for the many successful hand-dug wells in the area. Deeper aquifers may also exist as borehole C5069 (see Figure 3.2.3) struck water at 128 m deep.

Several north-south oriented faults feature prominently in this area as it is on the edge of the Rift Valley.
The completed geophysical work included two resistivity profiles and five vertical electric soundings. The profiles were intended to locate the positions of the faults. The first was very long (4,480 m) while the other was 840 m long and about 2 km south of the first (see Figures 3.4.3(a) and

3.4.3(b).

Four soundings were made on the first profile each on a different faulting compartment. A fifth sounding was made near borehole C5069 about 1.5 km west of Kinamba Centre.

All these soundings identify the shallow phreatic aquifer though at varying depths (0.8 m in VES 4 to 9.5 m in VES 5). Other than this the interpretations of the soundings could not be correlated as consistent results could not be obtained (Figure 3.3.3). The geological logs of boreholes C2144 and C2190 show the Iguamiti Phonolite (about 100 m thick) to overlie the Marmanet (Aiyam) Phonolite which in turn overlies the Ndurumo Phonolite at about 180 m deep. This layering however could not be confirmed by the geophysical interpretation (see Figure 3.3.16).

The resistivity profiles responded well to the fault zones which could thus be identified.

Drilling had originally been recommeded at the site of VES 4 due to its closeness to the Ng'elesha Primary School (see Progress Report for Laikipia) but it was later changed to the site of VES 2 as water can be pumped to the various destinations necessary.

3.1.4 Muruku

Water was required for Muruku shopping Centre and Muruku Primary School both shown on Figure 3.2.4.

The area is very rocky and bushy. A geological contact between the Thomson Falls Phonolite and the Aiyam Phonolite passes about 0.5 km northeast of the market. To the west Laikipian Basalts are sandwiched between the Aiyam Phonolite and the Thomson Falls Phonolite. In this basalt several lava cliffs were formed when the lava solidified and the rivers have cut small gorges in these cliffs piling up hillwash material below them.

Several small springs dot the area especially in this hillwash material but it was not clear whether the water originates from the contact between the various lava flows, the old-land-surfaces or just water accumulated in the hillwash deposits. The most notable of these springs is called the Kandoro Spring which is reportedly permanent and is the current source of water for the shopping centre. Another spring with a (measured) discharge of about 0.7 l/sec was noted about 3 km east of Kandoro spring. Its water seemed to originate from the cracks within the rocks.

Two resistivity profiles, the first 800 m long and AB/2 of 50 m and station intervals of 15 m and the other 660 m long with AB/2 of 32 m and same station intervals were made, see Figure 3.4.4. Also three vertical electric soundings were made. One was near Kandoro Spring, a second was at Gwa-Kiguru Primary School (to attempt to probe the depth to the contact between the Laikipia Basalt and the Aiyam Phonolite) and a third near the second spring mentioned above (Figures 3.3.4 and 3.3.17).

The resistivity profiles identified the position of the contact between the two phonolites as one of them showed higher readings than the other. The soundings however could not be correlated due to sharply differing interpretation results. This was partly to be expected as each sounding

was made on a different geological set-up. Drilling was recommended at the site of VES 1 on account of its closeness to the shopping centre and to Kandoro spring.

3.1.5 Kanyingi (proposed shopping centre)

Water is required for a shopping centre and a Primary School both proposed to be constructed about 7 km east of Salama Market (see Figure 3.2.4). The site has a complicated geology with Upper Ewaso Narok Phonolite, Aiyam Phonolite and Thomson Falls Phonolite all outcropping there. Two small springs about 300 m apart ooze water onto the small valley which starts from near the site of the proposed market. The upper spring is reportedly permanent albeit too small to supply sufficient water to the proposed shopping centre.

Two resistivity profiles and five soundings were made mainly in the area above the upper spring. The profiles were intended to locate the positions of the contacts between the various phonolites mentioned above. They were arranged in a radial pattern from the spring outwards. AB/2 distances were 50m MN/2 was 5m and station intervals of 20m. The results are shown in Figure 3.4.5.

Five soundings were also made mainly in the area above the springs with their AB/2 distances varying between 320 m and 1,000 m.

On interpreting this data, the profiles were found to locate the positions of the contacts. All the soundings, except VES 3, showed a thin (1.0 m or less) high resistivity layer on the surface underlain by a slightly thicker (5-10m) but low resistivity layer (13-27 ohmmetres). Below this another high resistivity (200 to 600 ohmmetres) but of very variable thickness layer was interpreted. Then below this it is no longer possible to correlate the interpretations but overall it seems to be an alternation of high and low resistivity layers. Sounding No. 3 could only be used qualitatively due to its poor quality. These results are shown in Figures 3.3.5 and 3.3.17.

Drilling was recommended at site of VES 2 above the upper spring.

3.1.6 Lariakorok

Lariakorok is located about 7 km southeast of Dol Dol shopping centre (see Figure 3.2.5). It is on Basement rocks. Water is required for the nearby Manyattas and a primary school. Groundwater was expected to occur in some alluvial sands and deposits along the Essore (Katongaa) River Valley and probably in the weathered parts of the Basement rocks. Some hand-dug wells on this valley are the current sources of water for the area (Lariak = well; Orok = black in Maasai language referring to these wells. Reportedly they have been there since the Second World War).

Four electromagnetic profiles were made in the locations shown on Figure 3.2.5. In the first and second profiles (Em 1 and Em 2) all the 5 frequencies (222, 444, 888, 1,777 and 3,555 Hz) were tried as Lariakorok was the first site for WRAP to try electromagnetic profiling in Laikipia. The most convenient frequencies for this area had to be experimented on. So were the station intervals. These profiles are shown in Figure 3.5.3.

Two resistivity profiles were also tried, 3 short soundings and 2 seismic spreads (see Figures 3.3.6, 3.4.6 and 3.6.1, (and Table 3.6.1). On correlating the results of these investigations it was concluded that a thin overburden of compact cracking clays cover the site investigated, which becomes more sandy with depth. The Basement rocks underneath have their top layer weathered also. The whole packet of permeable rocks may probably not exceed 30-35 m (see VES 3) and gets much shallower away from the river bed. Drilling was thus recommended at the site of VES 3.

3.1.7 Kopio

Kopio area lies just 3 km to the northeast of Dol Dol centre. The site is heavily forested.

Water is required for a newly constructed cattle dip and for the few Manyattas in the nearby forest. The current sources of water are some springs which ooze water only during the net season, and Dol Dol borehole (C1813).

Six short electromagnetic profiles, one short sounding and one short seismic spread (all of them short because of the limited manouvering space due to the forest) were made in the area surroundings the cattle dip (see Figure 3.2.5 for the location and Figures 3.3.7, 3.5.4 and 3.6.2 and Table 3.6.2 for the results of the geophysical work.

From this work it was concluded that there is a very thin soil layer on the surface underlain by a shallow weathered Basement layer below which is fresh Basement. The weathered layer may not exceed 5-10 m and therefore drilling may not be recommended. A hand-dug well could however be tried and probably may supply sufficient water for the Manyattas. For supplying the cattle dip, water can be transported from elsewhere (e.g from Dol Dol-borehole C1813, Catholic Mission borehole C5360, Alkinyei borehole C5197 or the newly constructed Osoitoitashe subsurface dam).

3.1.8 Kuri Kuri

Kuri Kuri area was investigated as an alternative site for Kopio. It lies on the same valley (the Dol Dol River Valley) as the Kuri Kuri well above the site, the Dol Dol dam below and the Dol Dol borehole C1813 and the Catholic Mission borehole C5360 both below the dam. Like Kopio this site is also heavily forested and several barbed wire fences compounded the difficulties in executing geophysical work.

Groundwater was expected to occur in the weathered part of the Basement rocks along the valley.

Only one electromagnetic profile and two soundings could be made on the locations shown or Figure 3.2.5. The results are shown in Figure 3.3.8 and 3.5.5.

During the interpretation of the sounding curves some segments of the curves were found to rise steeper than the expected 45° slope. The cause of this problem could not be identified. Nonetheless the results indicate a deeper weathered zone (up to 30 metres) than at Kopio. Drilling was however discounted due to the closeness of the site to Kuri Kuri well and

Dol Dol dam, and any possible interference with the two important boreholes downstream which already have poor yields.

3.1.9 Dol Dol

The geophysical investigations done at Dol Dol were meant to provide comparative data from a site within the area where groundwater was certain to exist. Dol Dol has two operational boreholes C1813 and C5360.

One sounding was made near borehole C5360 and one electromagnetic profile details of which are shown in Figures 3.2.5; 3.3.9 and 3.5.6.

The sounding showed a weathered layer up to 55 m thick and with intermediate resistivity variations within it. Correlation of the geophysical interpretation and the geological log of the borehole could be made but with minor variations here and there.

The electromagnetic profile showed an exceptionally strong anomaly but away (west wards) from the borehole. The localization of the anomaly away from the river valley was difficult to explain and probably more geophysical work may give more details. For this project, data on depth of weathering, resistivity values and electromagnetic values to be sought in other Basement areas were sufficiently exemplified.

3.1.10 Osoit Oudo

Water was required for the few Manyattas scattered within a radius of about 3-4 km of the site. Groundwater was expected to occur in the sands and alluvial deposits accumulated along the dry Katongaa River bed and the top weathered parts of the Basement Rocks within this valley.

Five electromagnetic profiles and one sounding were made mainly along the valley (see Figure 3.2.5) whose results are given in Figures 3.5.7 and 3.3.10 respectively.

On interpreting the sounding curve, the rising segment was found to rise steeper than the expected 45°, a problem that was attributed to the geophysical equipment used.

A shallow weathered layer up to 4 m deep was interpreted from the sounding. It has very low resistivity values (about 3 ohmmetres) probably indicative of brackish groundwater. This shallow weathering was also shown by the electromagnetic profiles which also showed slight lateral variations in weathering depth especially along the river valley.

Due to the shallow weathering drilling was not recommended and the geophysical investigations were extended to Il Morupusi area about 4.5 km to the northeast.

3.1.11 Il Morupusi

This site was intended to replace the unsuitable Osoit Oudo one.
A rectangular drainage pattern of the river valleys in this area was observed and it was hoped that the north - south oriented anticlinal and

synclinal folds of the rocks may contain weathering resistant (gneisses and granitoid gneisses) and less resistant (schists, marble etc) rocks. The latter were assumed to be locally weathered in to shallow aquifers. A few faults were also expected to exist and these too could give groundwater accumulation zones.

Six short electromagnetic profiles were made in the area shown on Figure 3.6.1, one resistivity profile along EM 6 and two vertical electric soundings (arranged in form of a cross). The data of this work is shown on Figure 3.3.11, 3.4.7 and 3.5.8. A short seismic spread was also made as shown in Figure 3.6.3, and Table 3.6.3.

The electromagnetic profile EM 6 gave an exceptionally strong anomaly. The two soundings, the resistivity profile and the seismic spread mentioned above were all made over this anomaly.

The interpreted data of the two soundings could not be correlated though both showed thick low resistivity layer. The resistivity profile also showed a minima over the anomaly zone while the seismic spread showed shallow low velocity layers. The cause of this anomaly is still uncertain. Not much evidence of it is observable on the surface except perhaps for the general trend of the river valley in which it lies and some quartzitic fragments which may indicate a buried dyke. It was tentatively assumed to be a fault or a dyke although other factors such as some minerals with high magnetic susceptibility and low resistivity (e.g magnetite) which may be disseminated in the schists in the area may have had some effect.

This site is suitable for "exploratory" drilling but accessibility for the heavy drilling machinery might be difficult.

3.1.12 Tura - Ol Kimanjo (Ol Kimadjoi)

Water is required for Tura Shopping Centre and Tura Primary School within the centre. The water shortage problem is here so acute that the centre is almost closing down.

Geophysical investigations were localized in several sites lying around the centre. The work done at Ol Kimanjo was mainly required for comparison purposes as there is a productive borehole there.

Seven electromagnetic profiles were made in the points shown on Figure 3.2.6. Seven resistivity soundings and four seismic spreads were also made in the sites shown in that Figure. The data obtained is shown on Figures 3.3.12, 3.5.9 and 3.6.4, and Table 3.6.4.

Generalized results of this work show some weathering albeit shallow along the river valleys. No suitable drilling site was found near Tura Centre. A suitable site was found in a valley about 2 kilometres southwest of the centre. The depth of weathering seems to increase downstream of these valleys. At Ol Kimanjo the geophysical work done near the borehole (C3420) showed deep weathering (up to 32 m).

Another site had been selected earlier (prior to this project) about 5 kilometres south west of Tura centre by the Ministry's Nakuru office.

3.1.13 Musul

Water was required for the Manyattas scattered around Musul rocky hill. The area has an acute shortage of water as the rock catchment masonry tank constructed on the hill holds rainwater only for a short time. Groundwater was expected to occur in the alluvial and weathered zones of the river valleys.

One electromagnetic profile, one sounding and two short seismic spreads (one of which aborted as the seismic equipment broke down) were tried at the locations shown on Figure 3.2.6. This geophysical investigation data is shown on Figures 3.3.13, 3.5.10 and 3.6.5, and Table 3.6.5.

The data shows the river valleys investigated to be covered by a very thin and very loose soil cover less than one m deep. Highly weathered Basement rocks extend for another 20 m or so before reaching fresh rocks. No signs of faulting were observed anywhere.

With this depth of weathering, drilling was not recommended.

APPENDIX 3.2

Photogeological and Location Maps

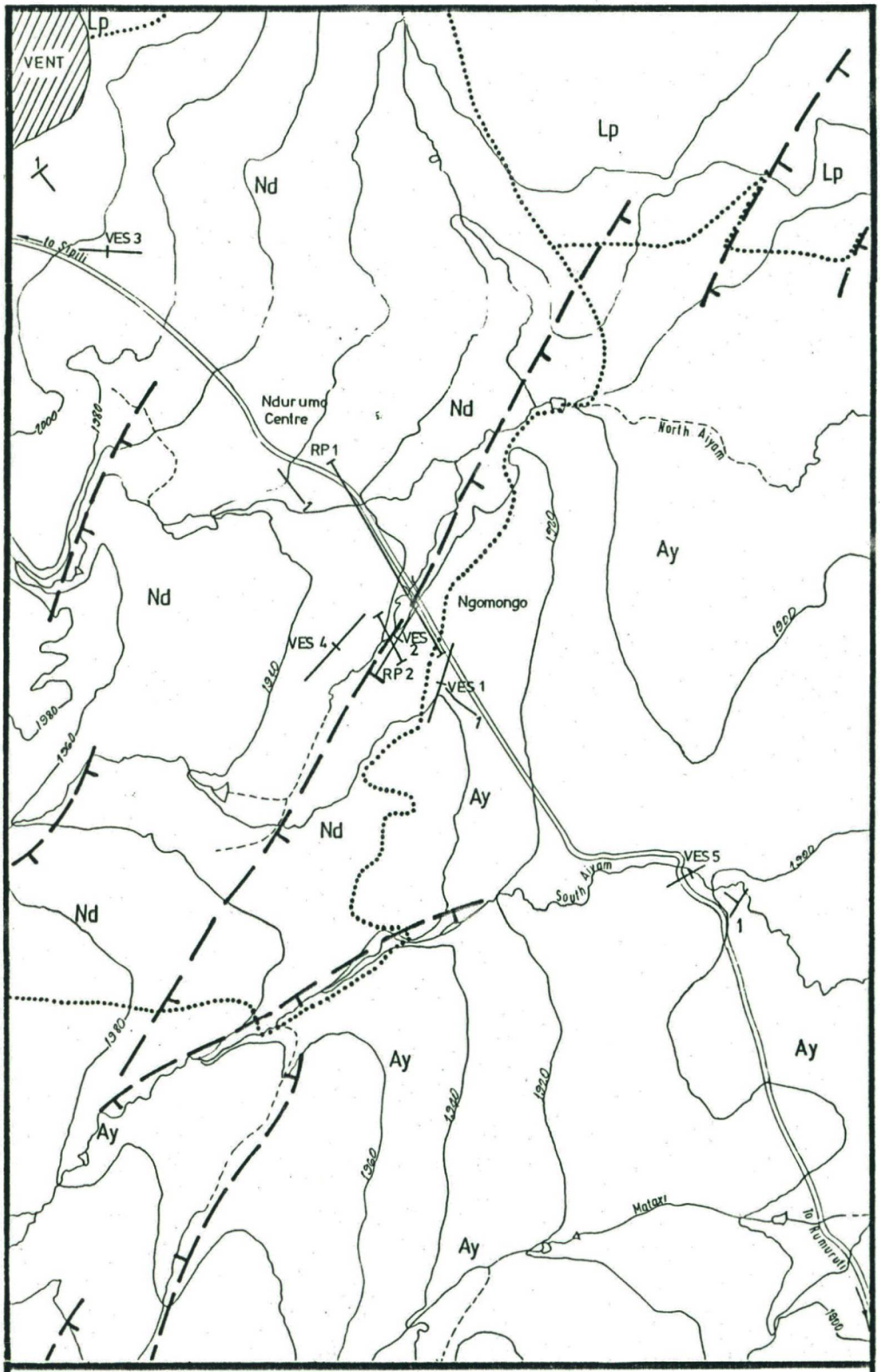


FIG. 3.2.2 PHOTO-GEOLOGICAL MAP OF NGOMONGO AREA

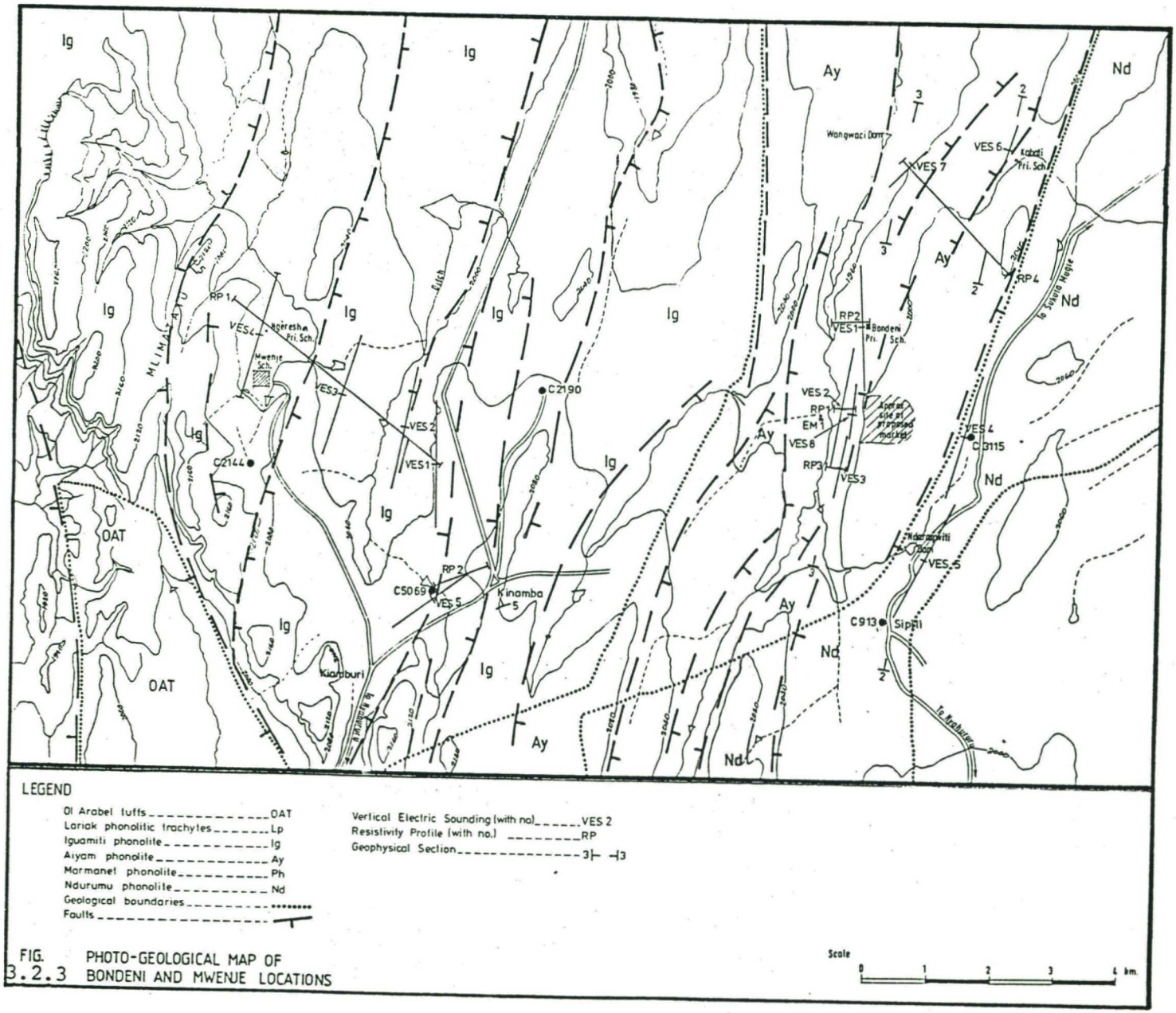


FIG. 3.2.3 PHOTO-GEOLOGICAL MAP OF BONDENI AND MWENJE LOCATIONS

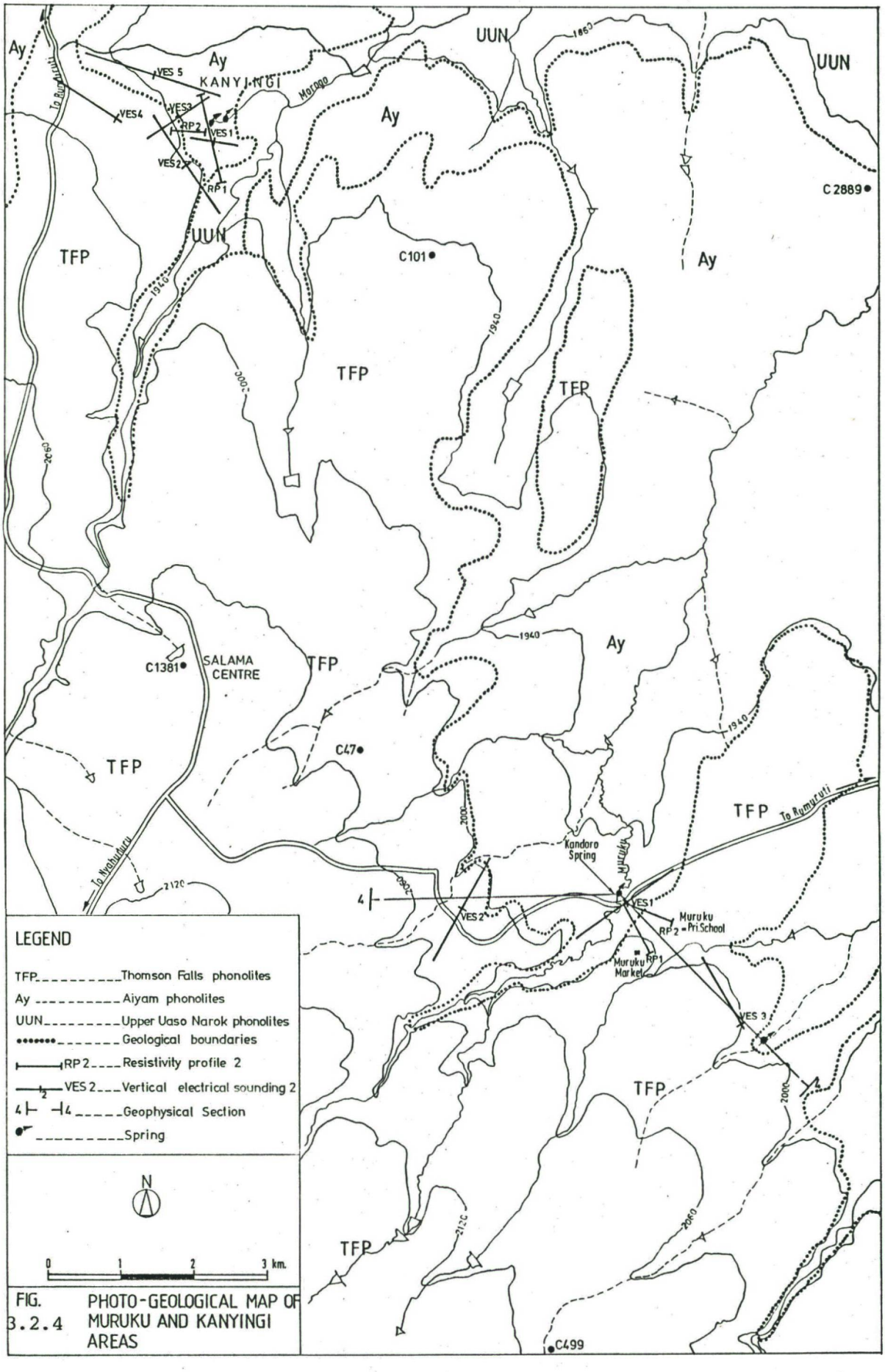


FIG. 3.2.4 PHOTO-GEOLOGICAL MAP OF MURUKU AND KANYINGI AREAS

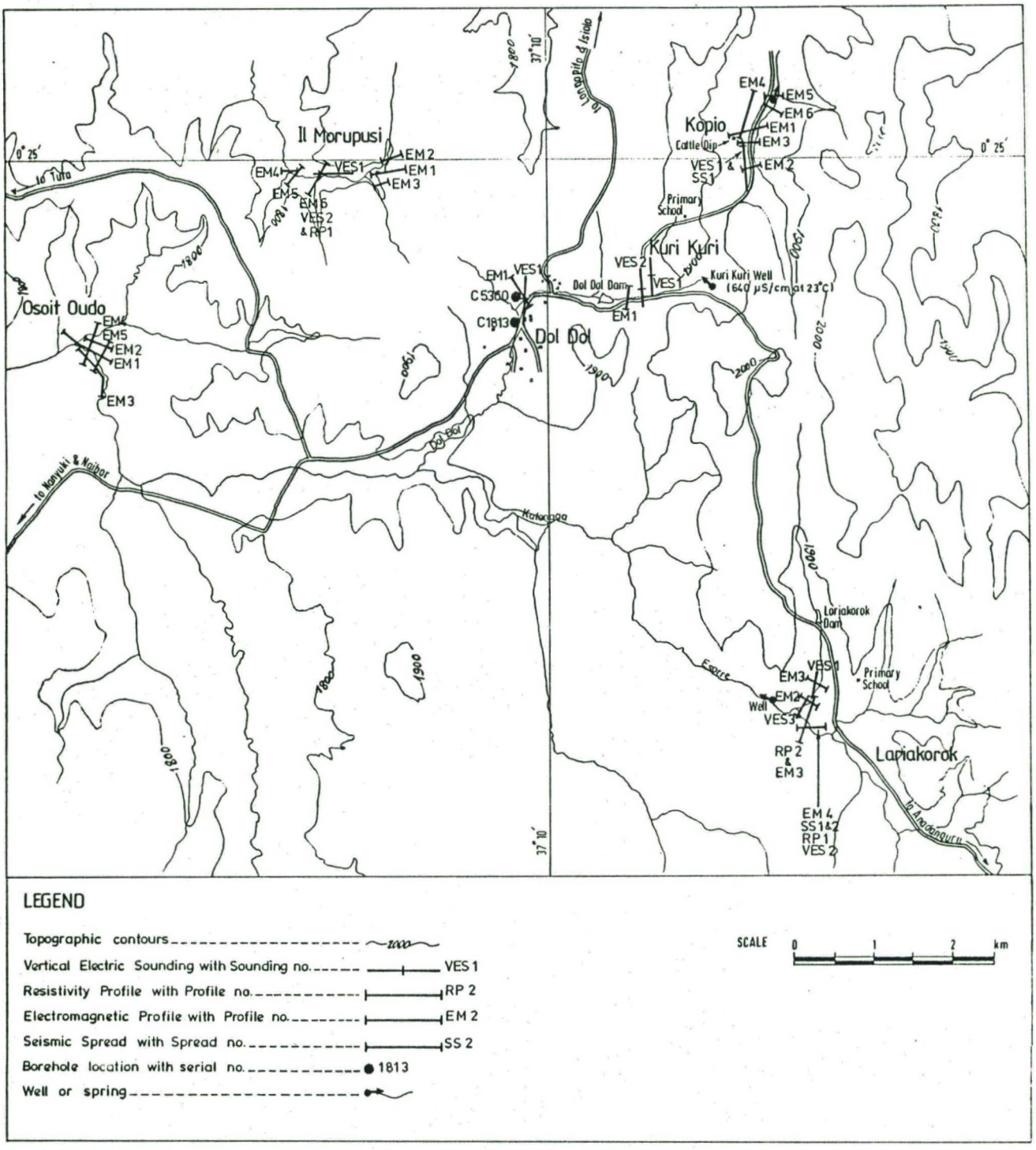


Fig. 3.2.5 Location map for geophysical fieldwork done at Kopio, Lariakorok, Dol Dol, Kuri Kuri, Osoit Oudo and Il Morupusi sites

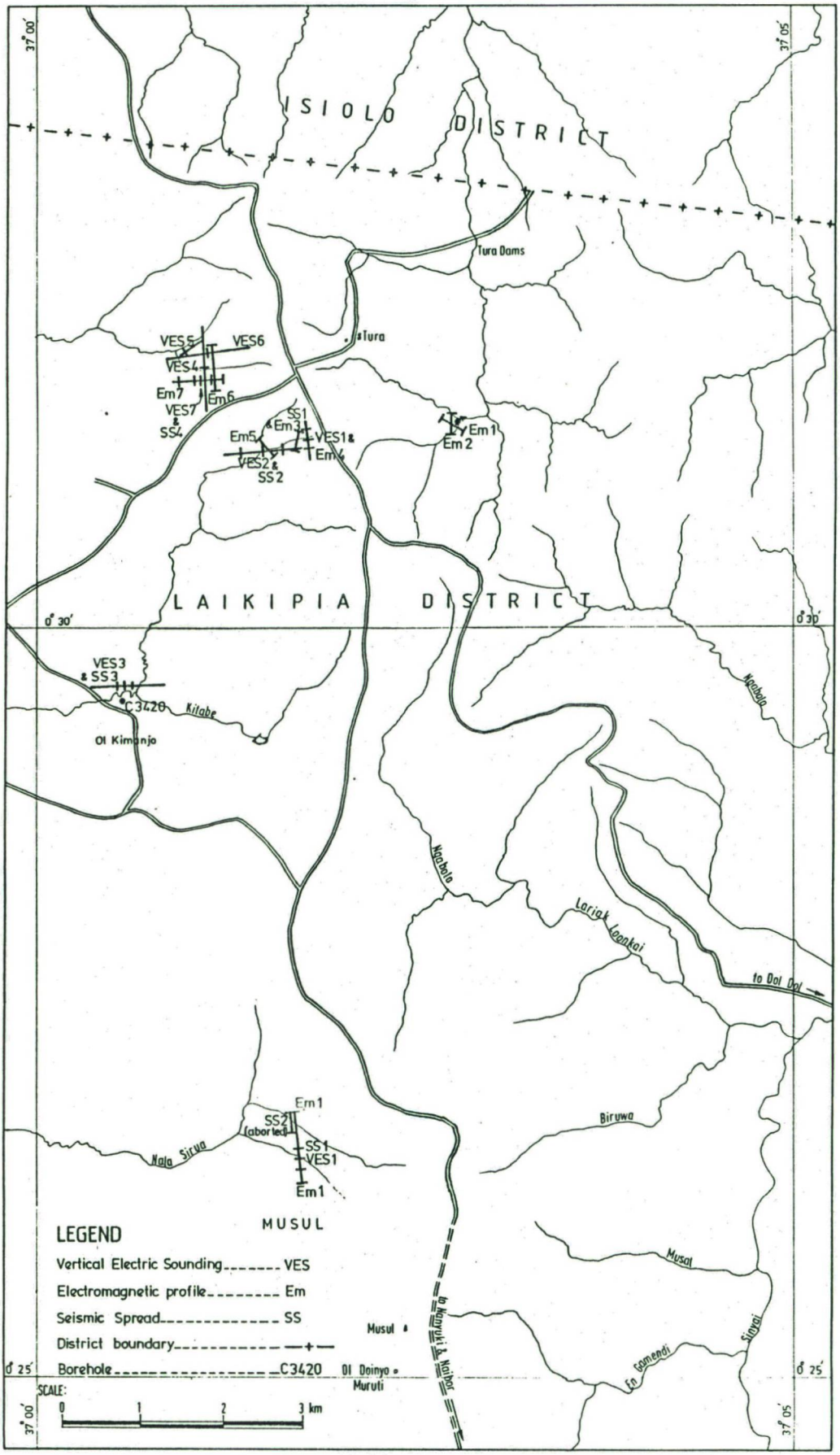


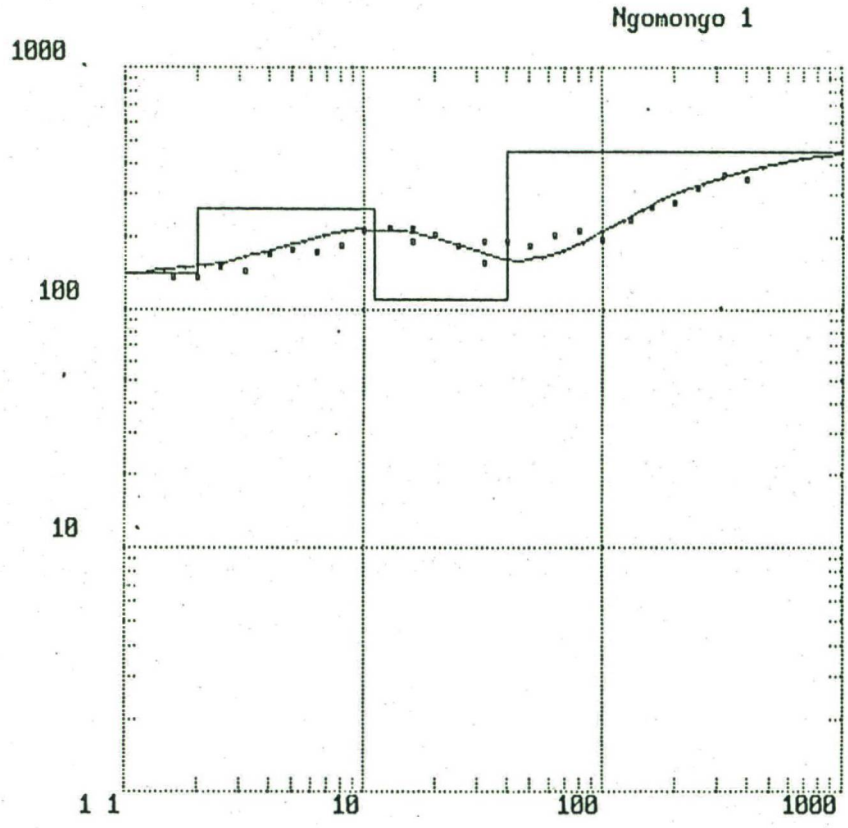
Fig. 3.2.6 Locations where geophysical work was done at Tura, Ol Kimanjo and Musul areas

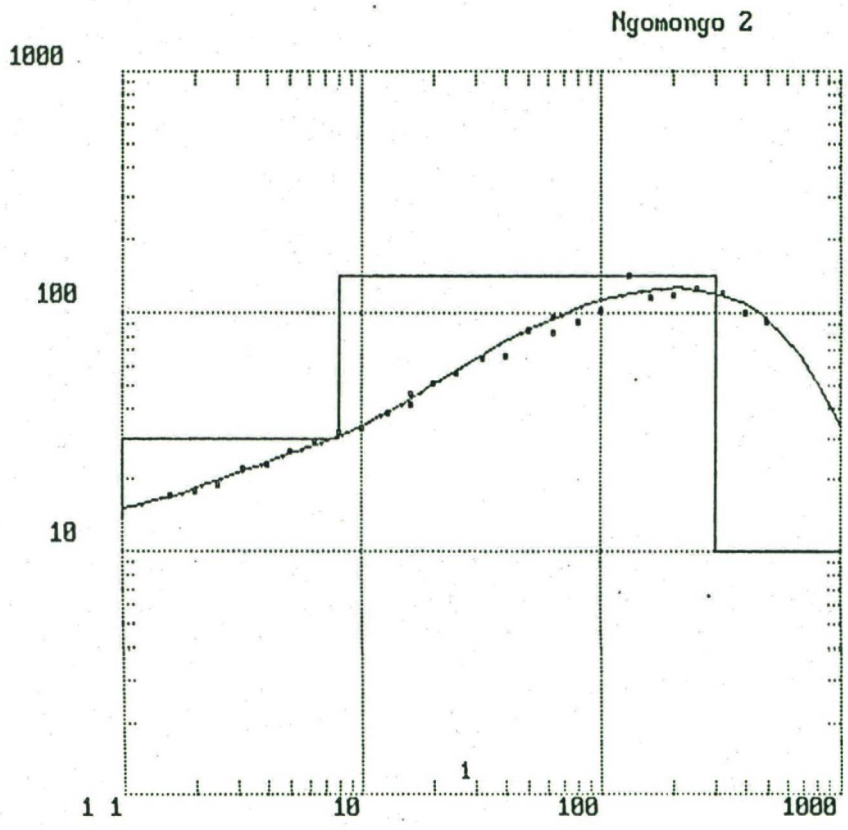
N.B. Locations of geophysical sites are also shown on Plate 3.1.

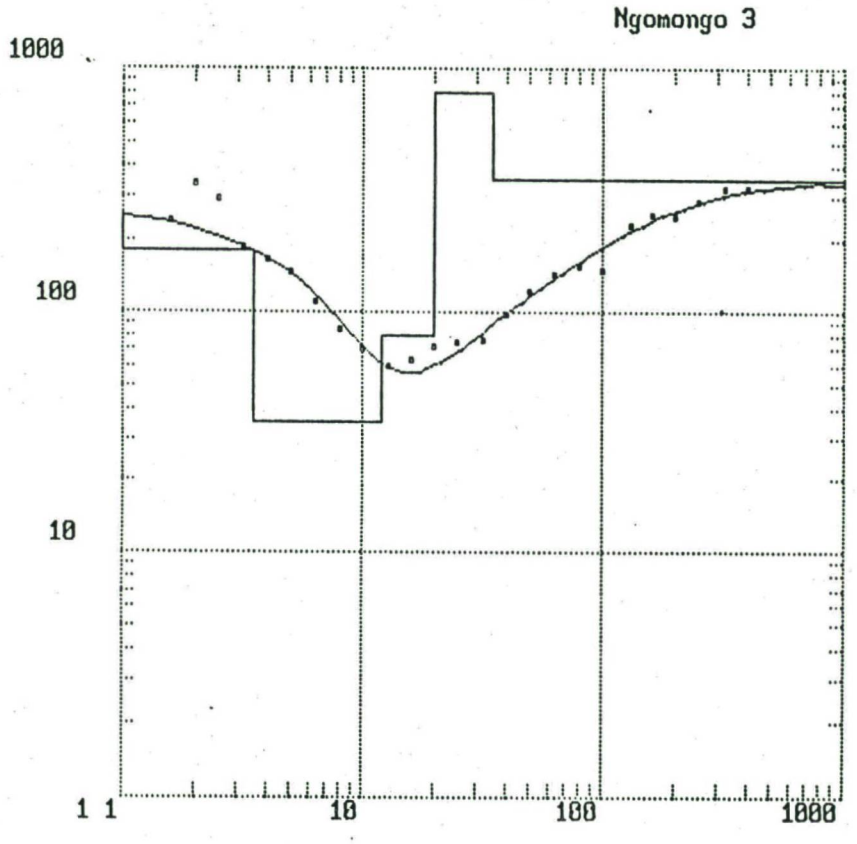
APPENDIX 3.3

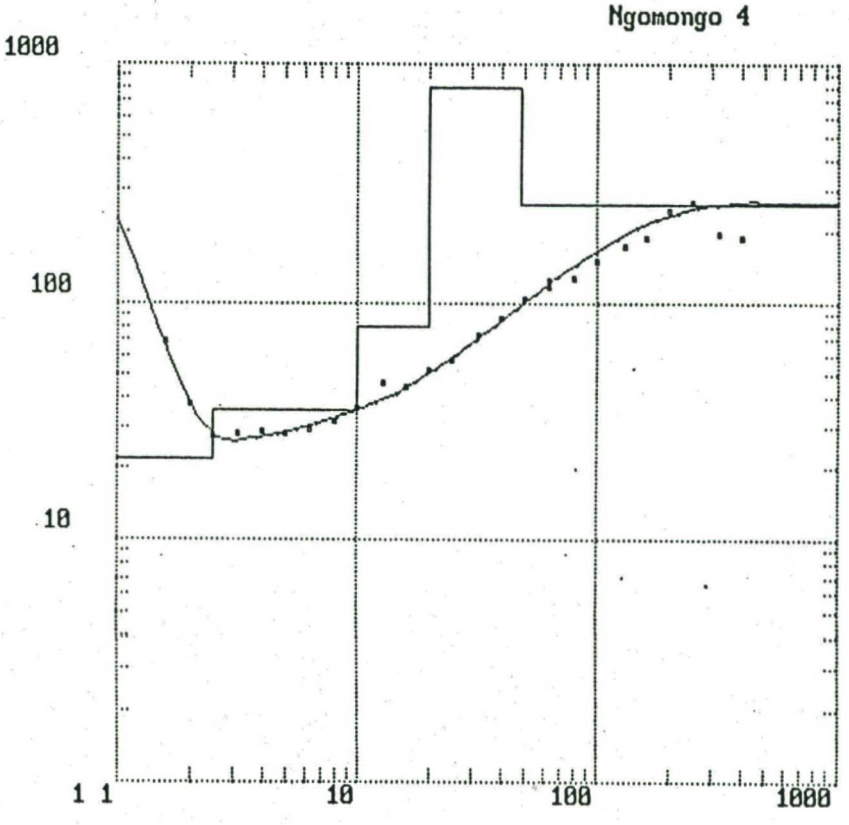
Vertical Electric Soundings

Figure 3.3.1 Vertical Electric Soundings at Ngomongo (Ngomongo 1-5)






Ngomongo 3
1000
100
10
1 1
10
100
1000


Ngomongo 4
1000
100
10
1 1
10
100
1000

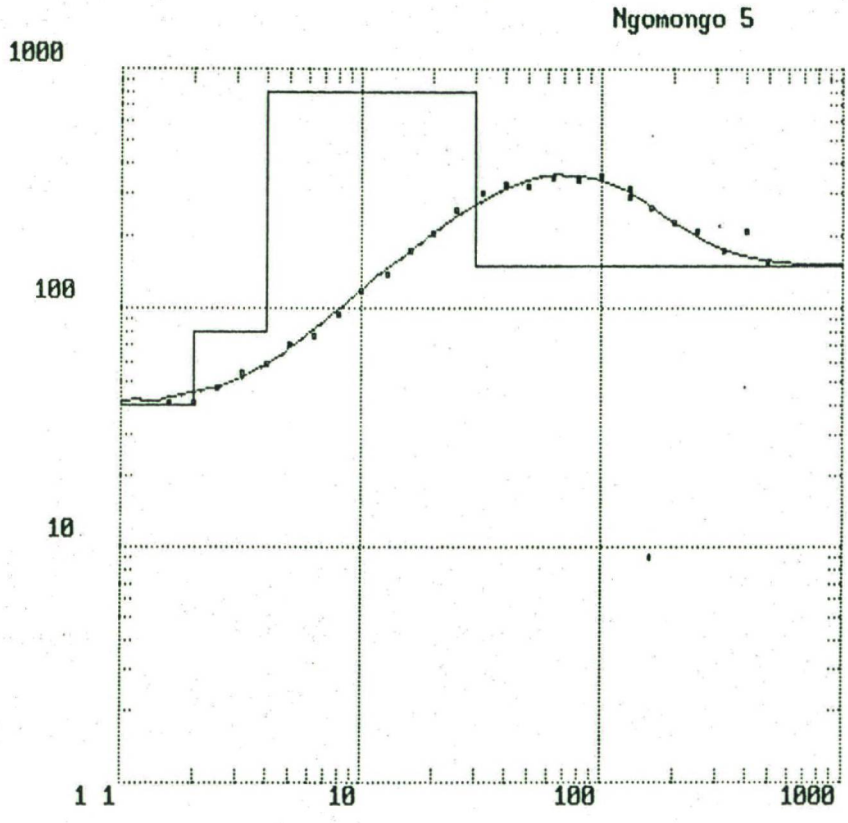
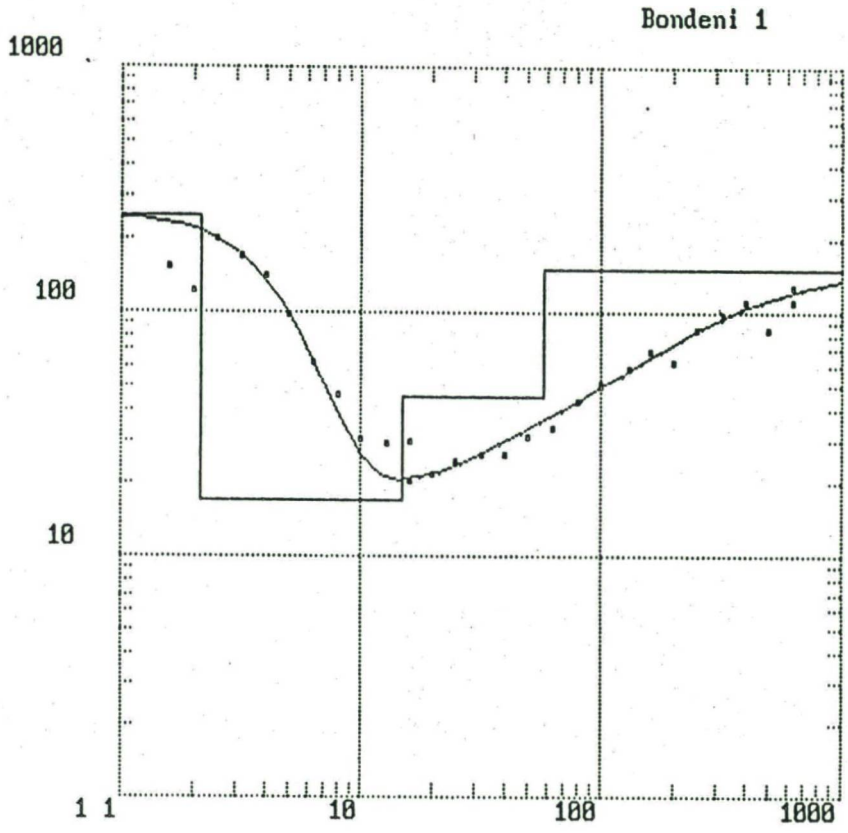
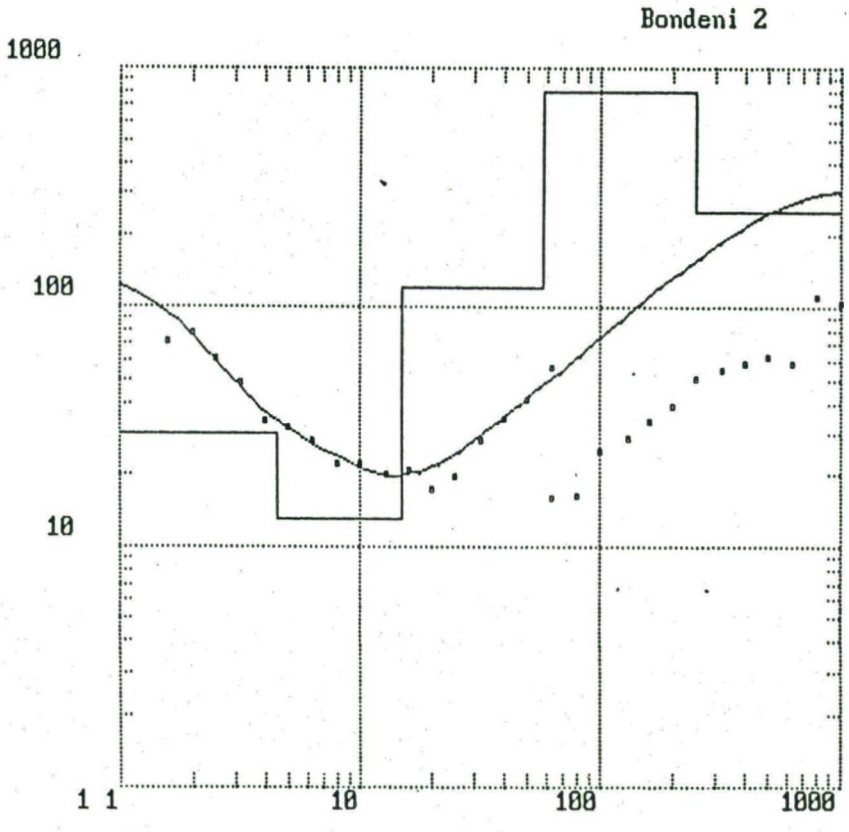
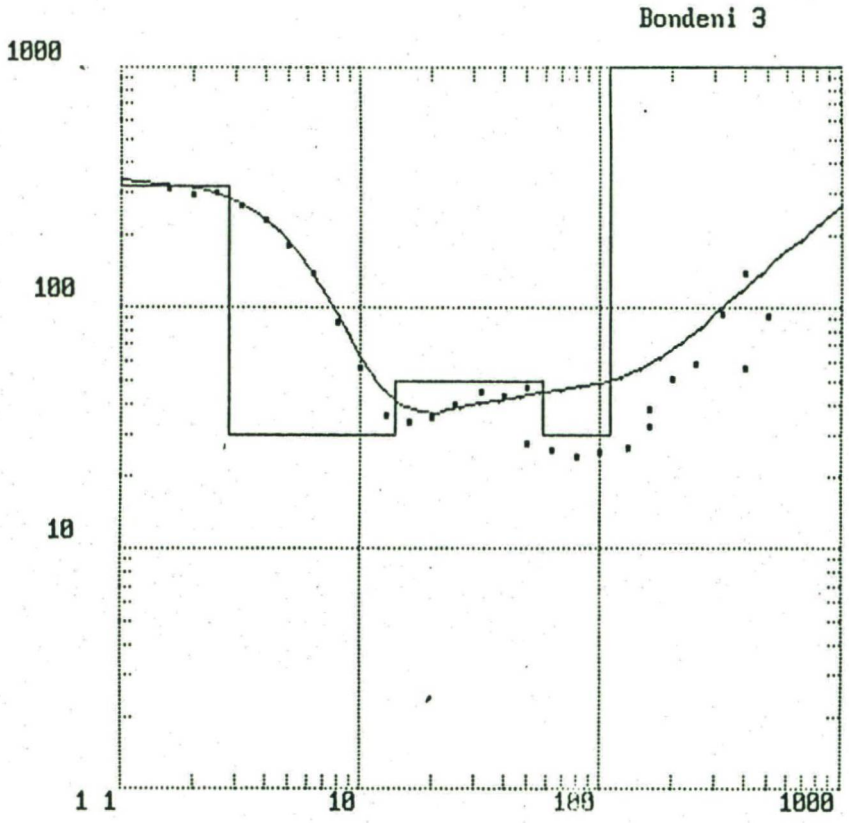
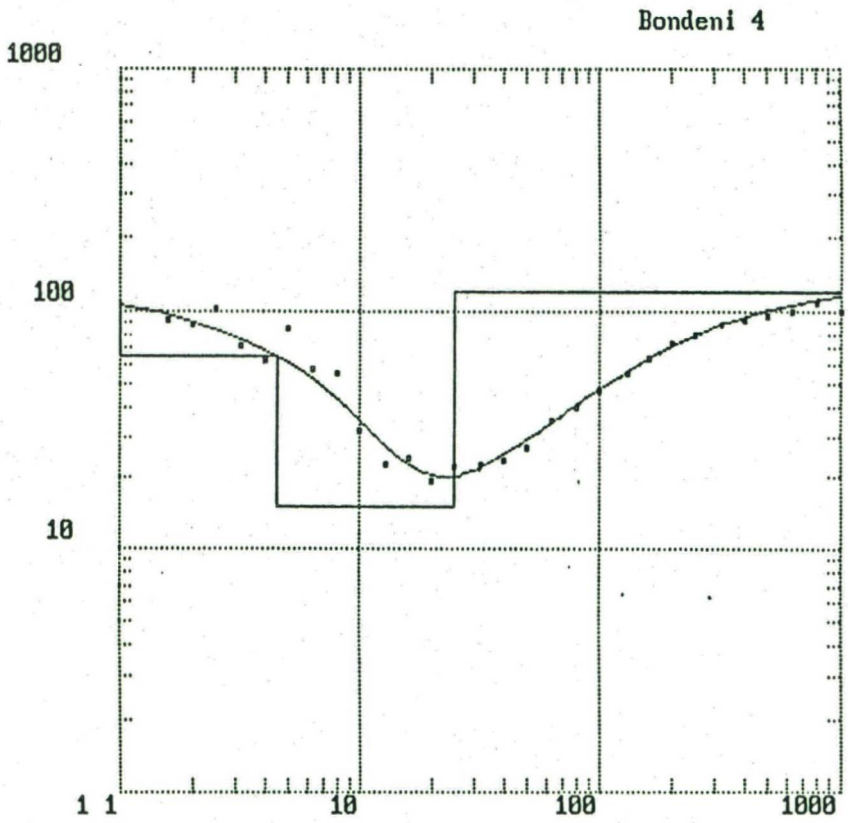

Ngomongo 5
1000
100
10
1 1
10
100
1000

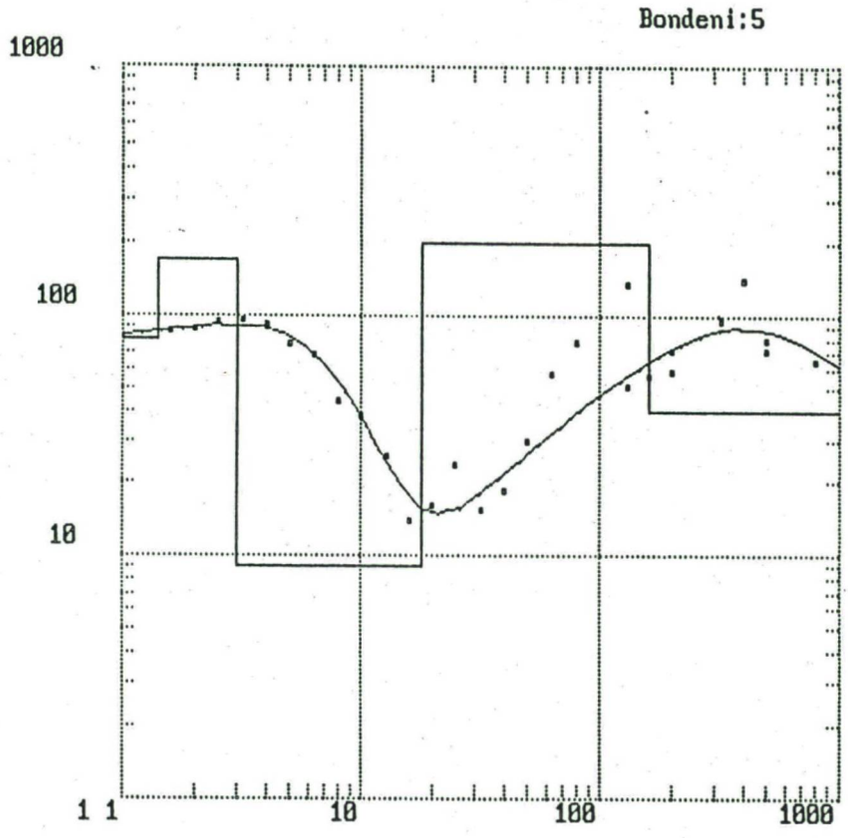
Figure 3.3.2 Vertical Electric Soundings done at Bondeni (Bondeni 1-8)

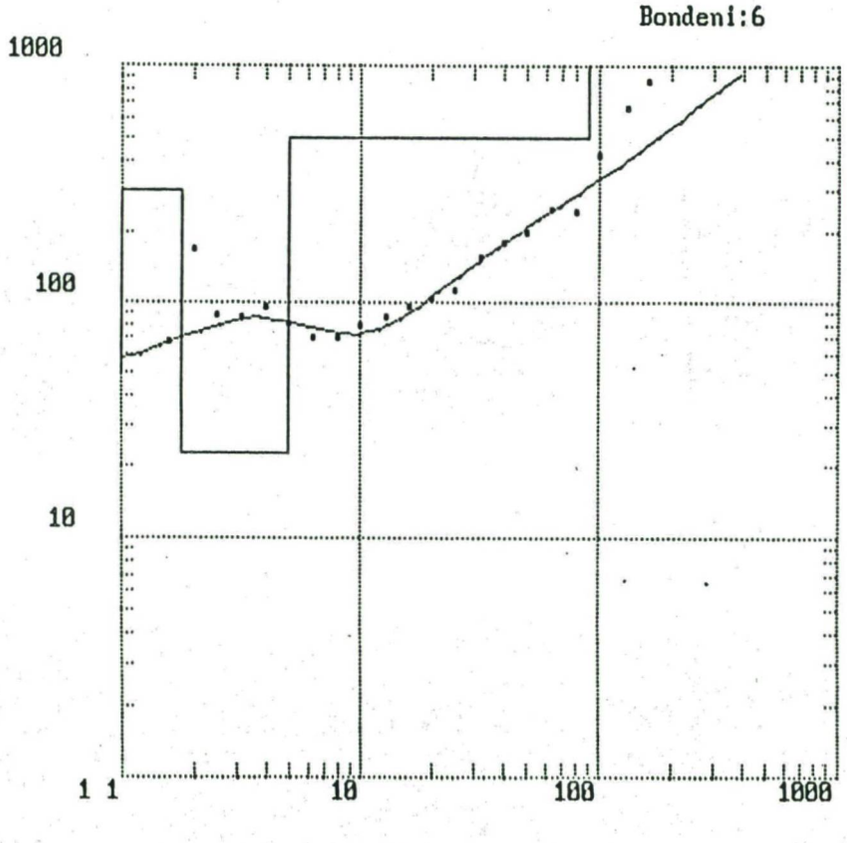


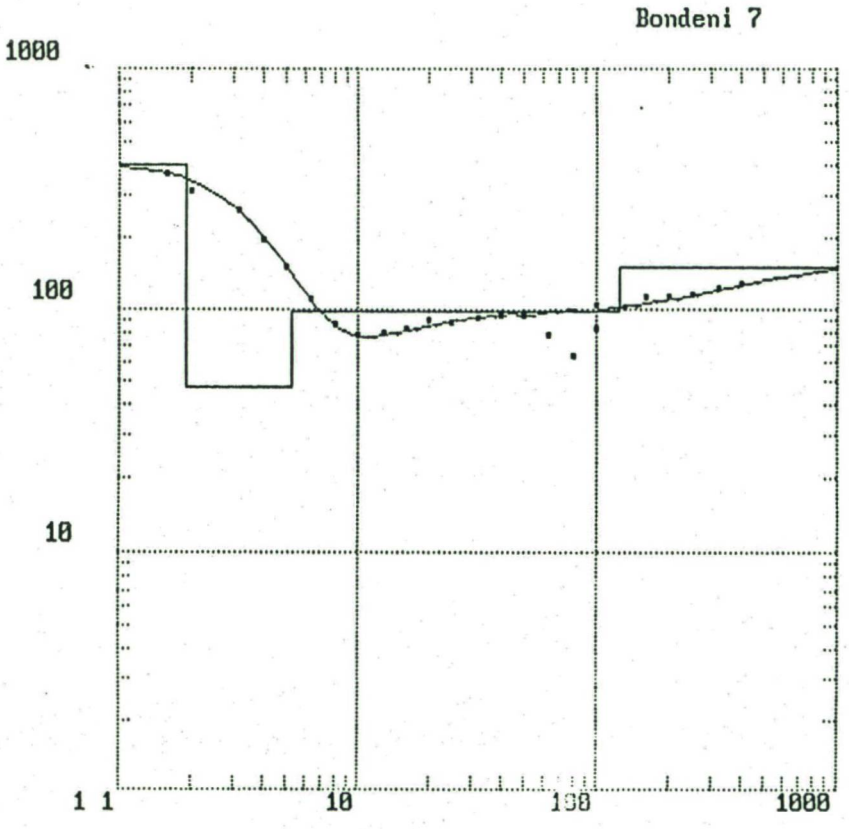



Bondeni 3
1000
100
10
1 1
10
100
1000


Bondeni 4
1000
100
10
1 1
10
100
1000


Bondeni:5
1000
100
10
1 1
10
100
1000


Bondeni:6
1000
100
10
1 1
10
100
1000


Bondeni 7
1000
100
10
1 1
10
100
1000

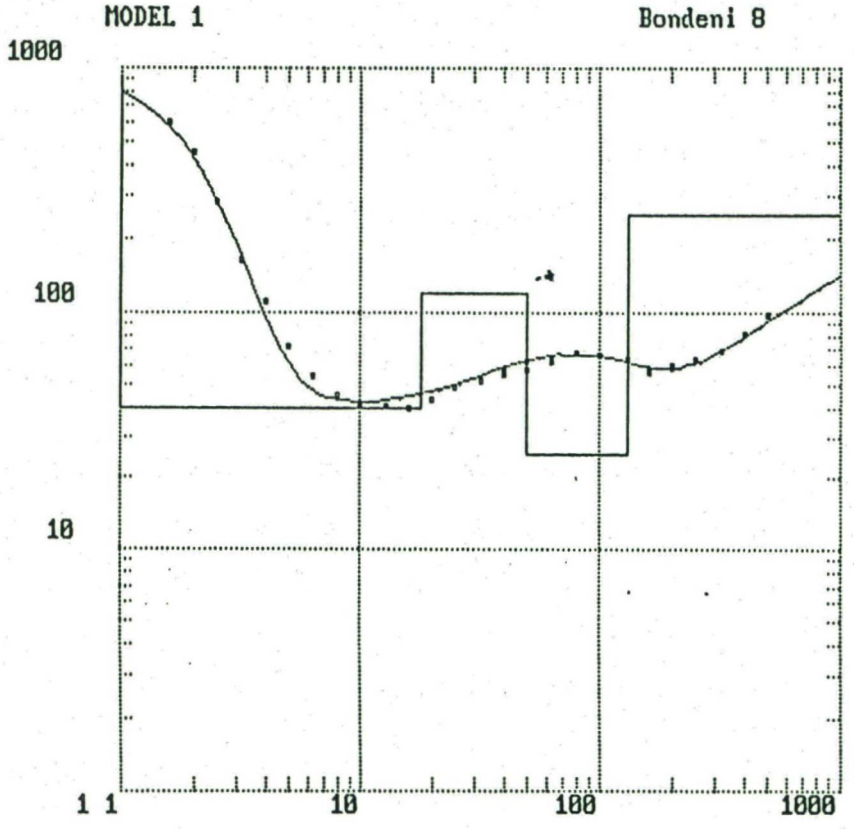
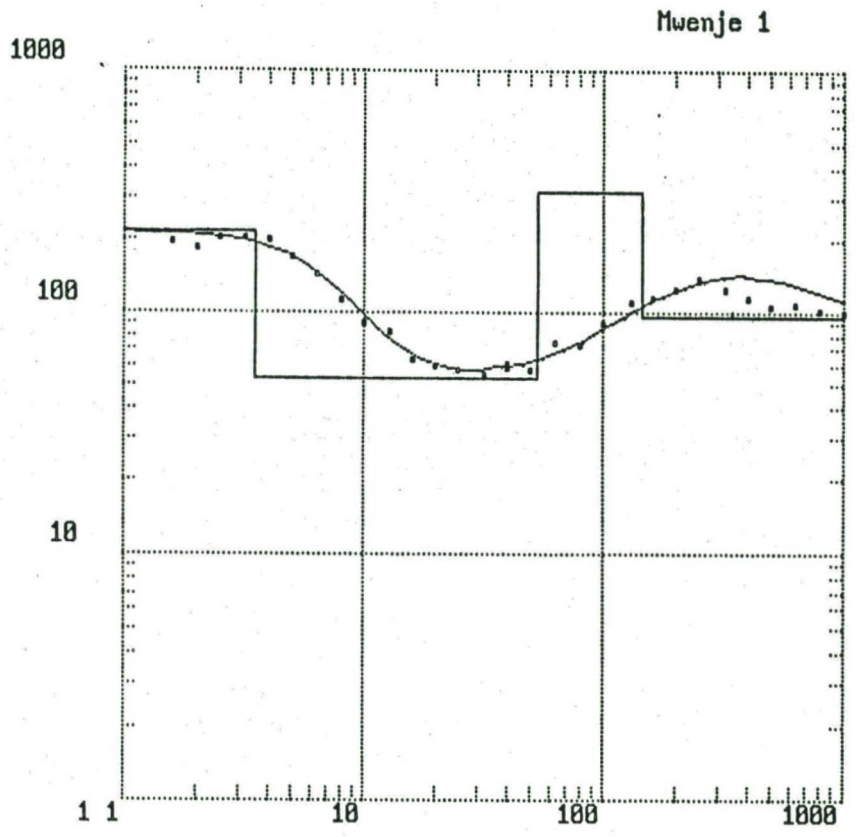
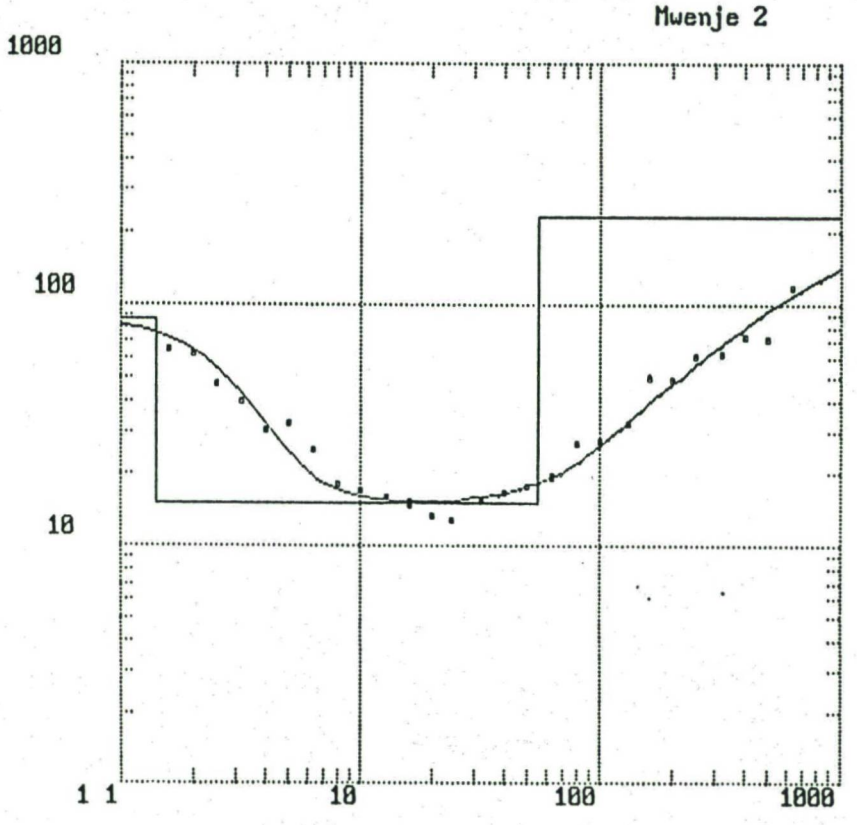
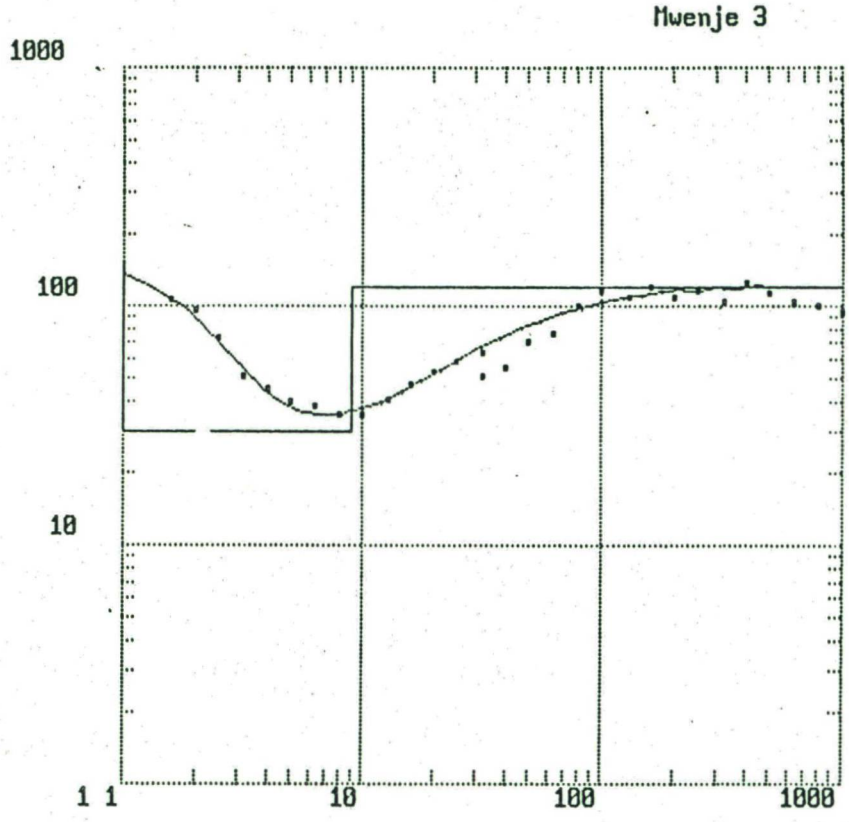
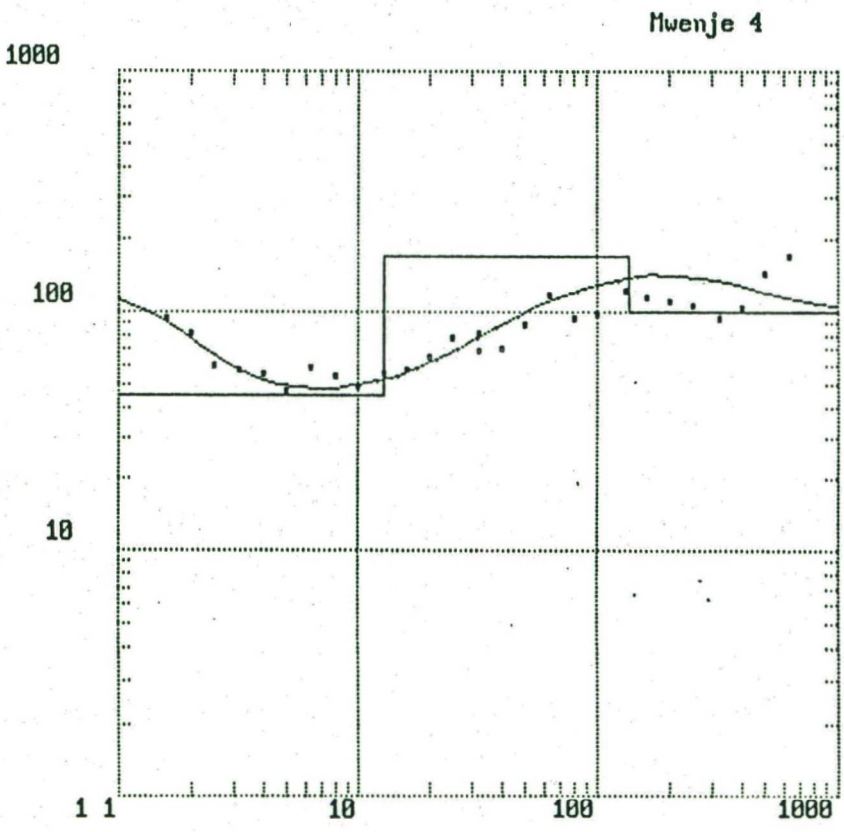

MODEL 1
Bondeni 8
1000
100
10
1 1
10
100
1000

Figure 3.3.3 Vertical Electric Soundings done at Mwenje (Mwenje 1-5)






Mwenje 3
1000
100
10
1 1
10
100
1000


Mwenje 4
1000
100
10
1 1
10
100
1000

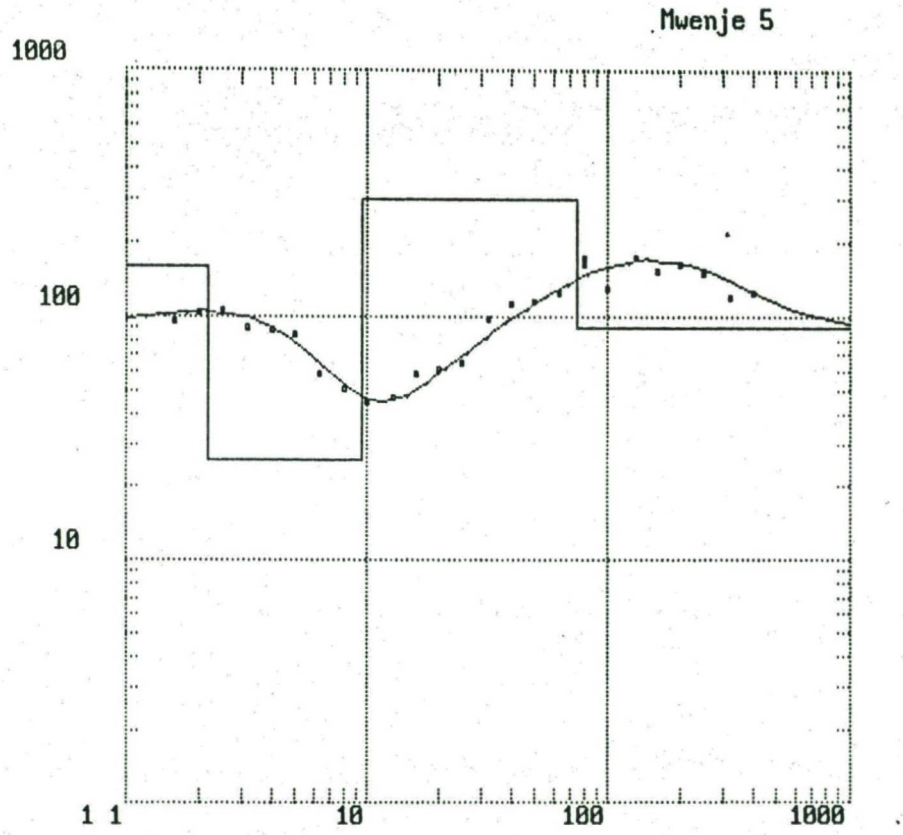
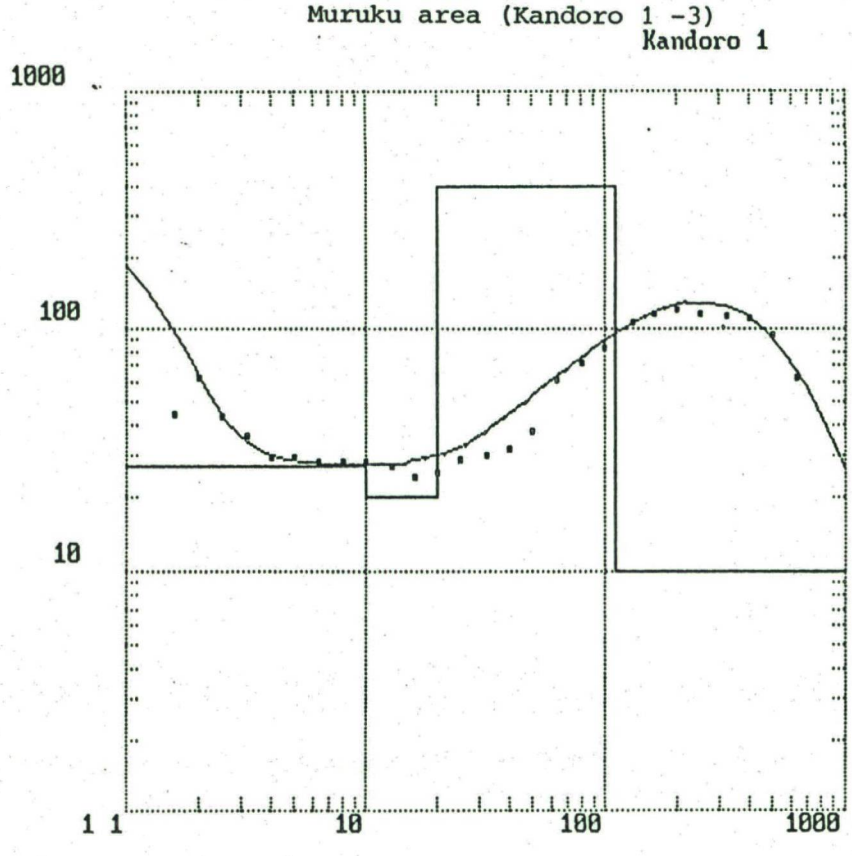
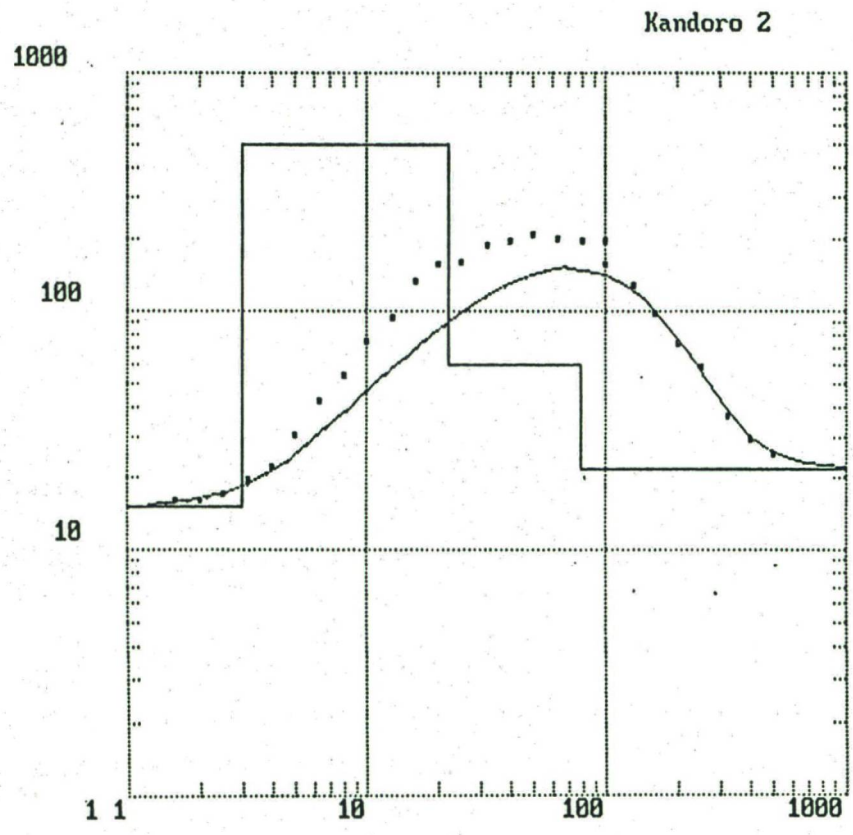

Mwenje 5
1000
100
10
1 1
10
100
1000

Figure 3.3.4 Vertical Electric Soundings done at Kandoro, Muruku area (Kandoro 1 -3)





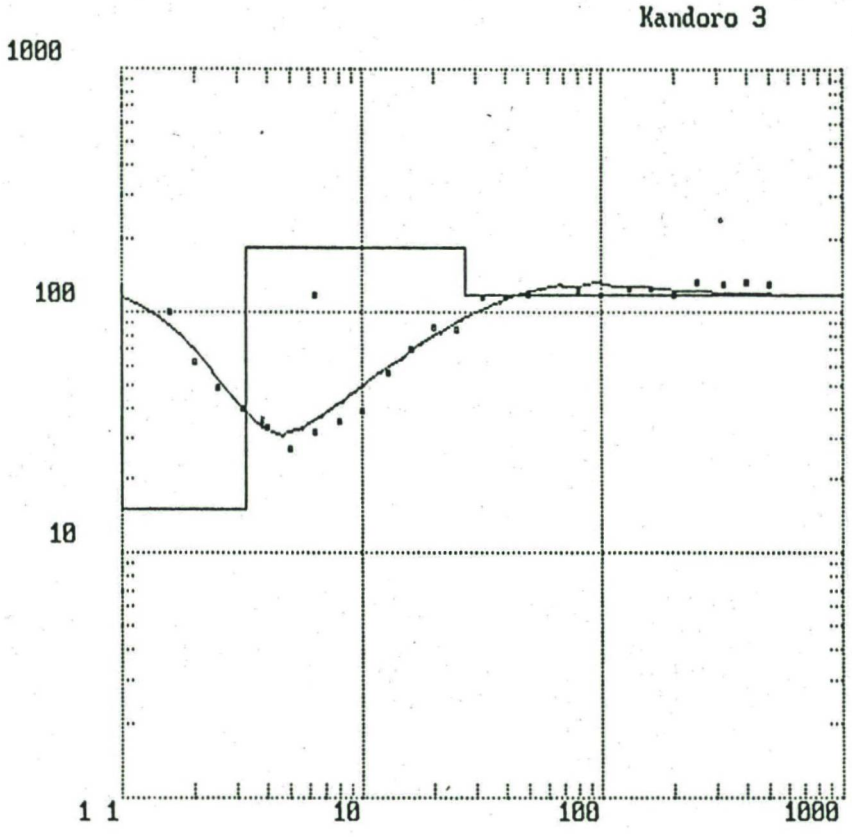
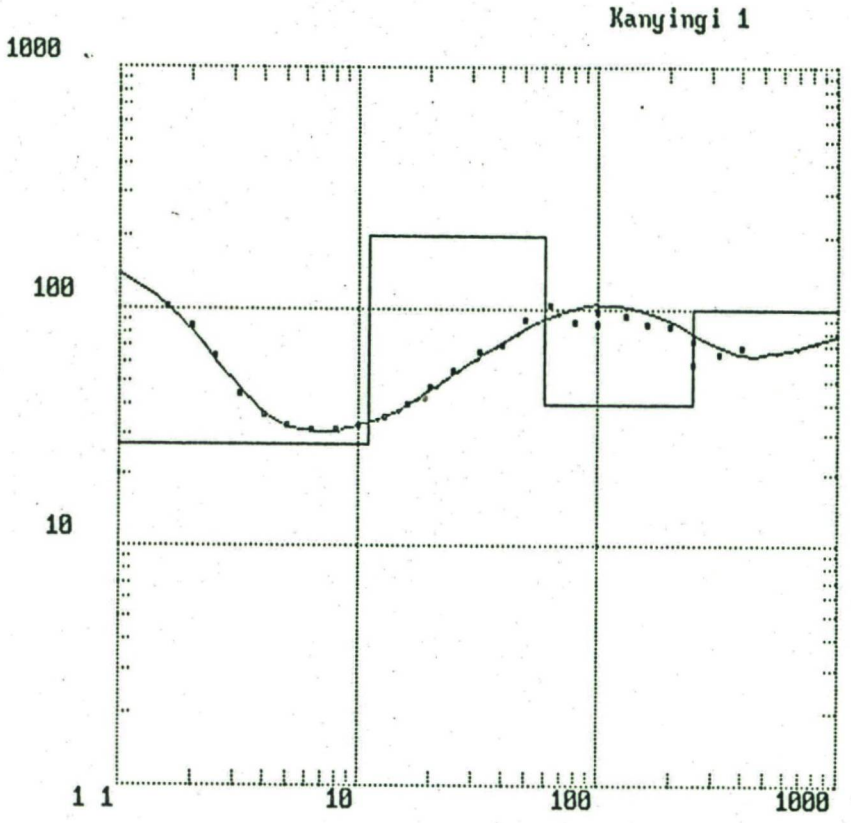
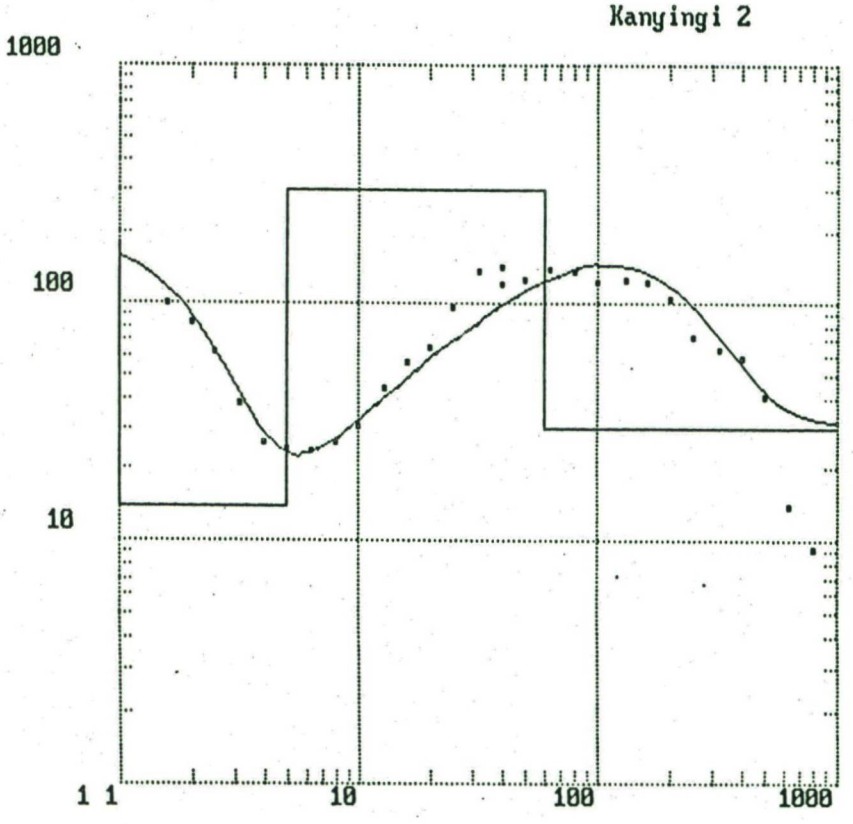
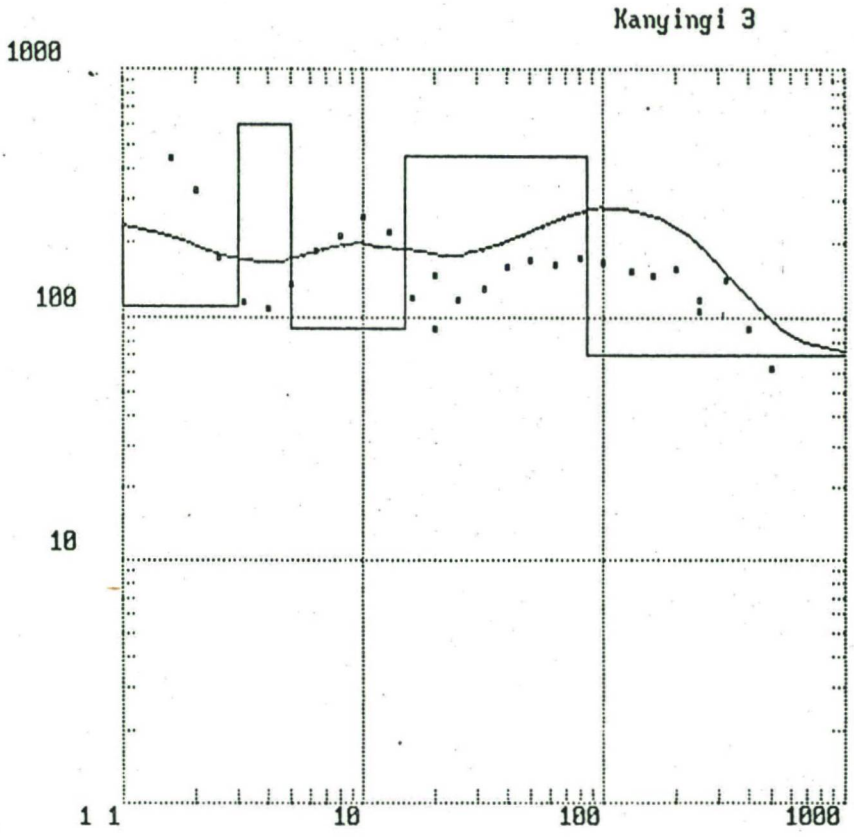
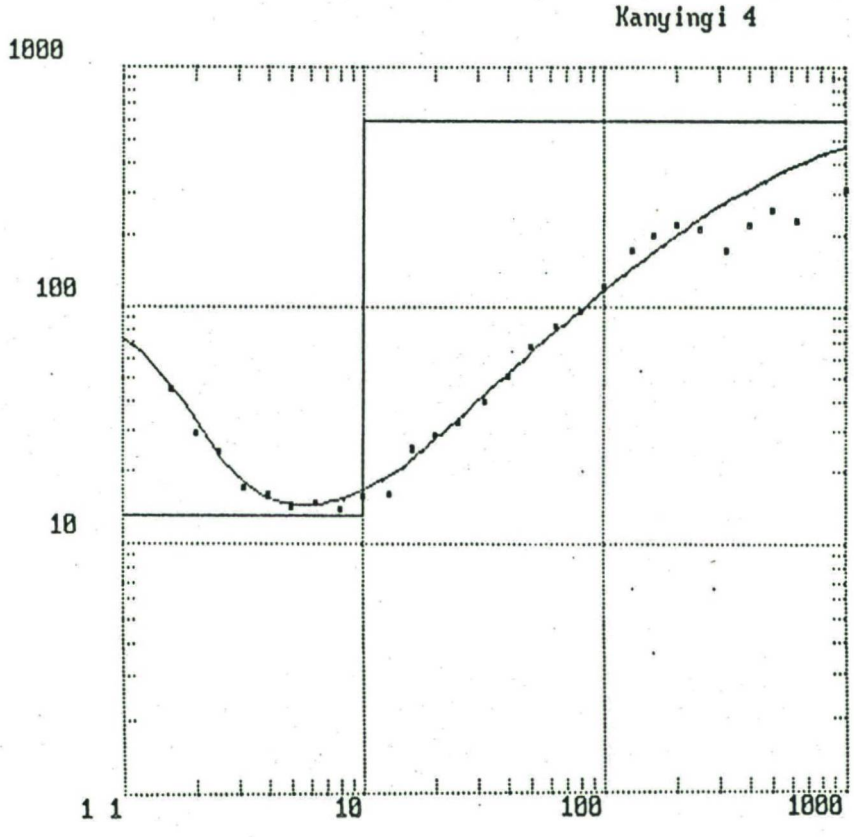

Kandoro 3
1000
100
10
1 1
10
100
1000

Figure 3.3.6 Vertical Electric Soundings done at Kanyingi (Kanyingi 1-5)






Kanyingi 3
1000
100
10
1 1
10
100
1000


Kanyingi 4
1000
100
10
1 1
10
100
1000

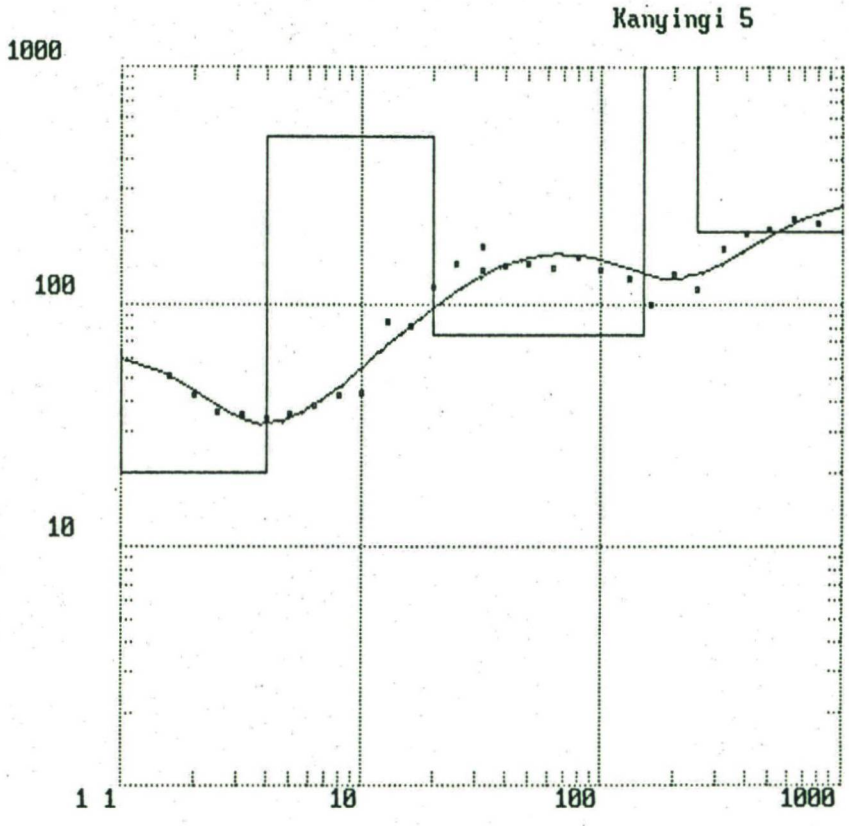
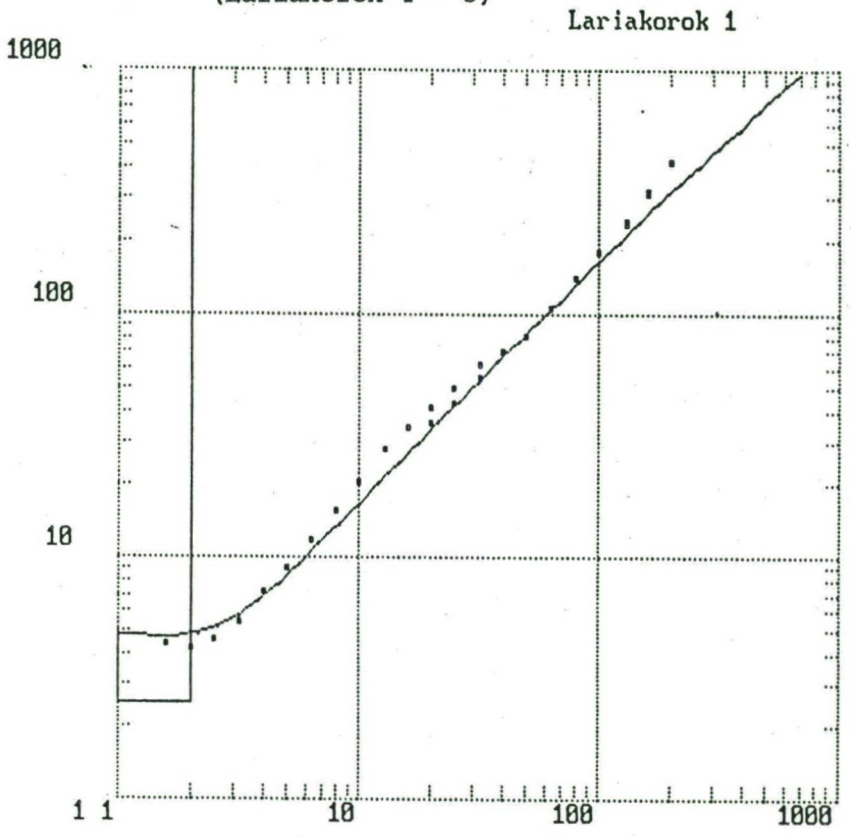
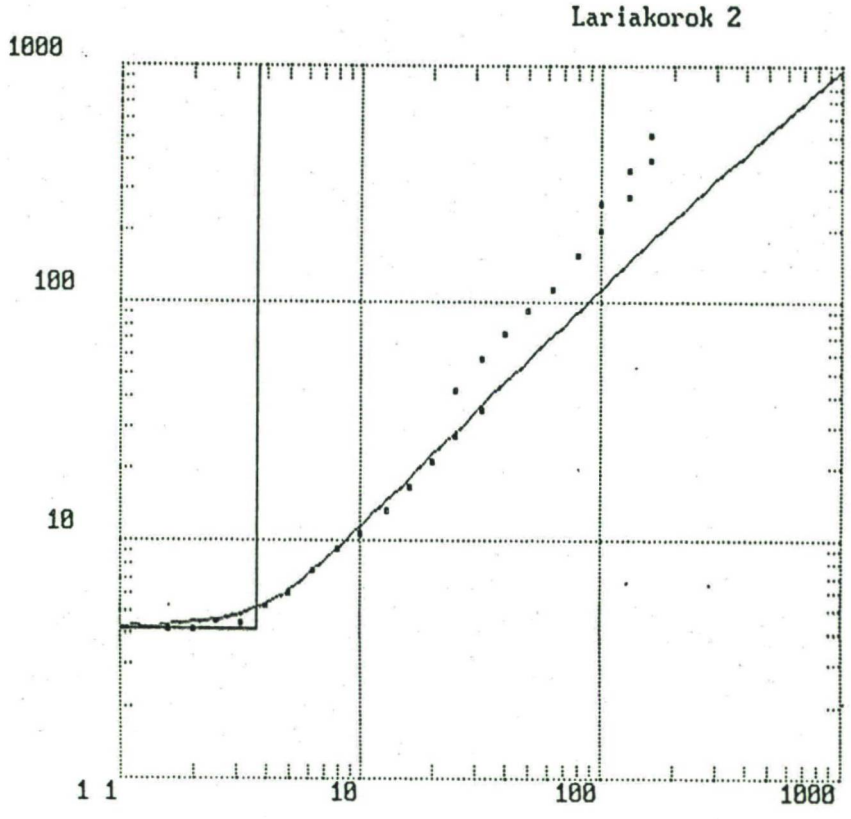

Kanyingi 5
1000
100
10
1 1
10
100
1000

Fig. 3.3.6 Vertical Electric Soundings done at Lariakorok (Lariakorok 1 - 3)





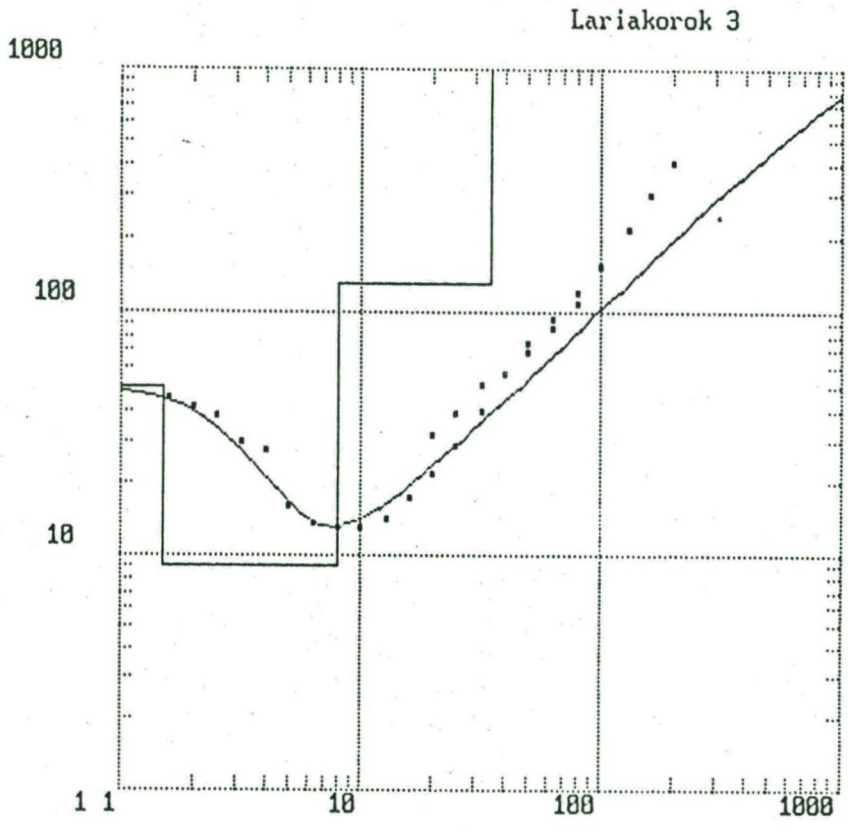

Lariakorok 3
1000
100
10
1 1
10
100
1000

Figure 3.3.7 Vertical Electric Soundings done at Kopio

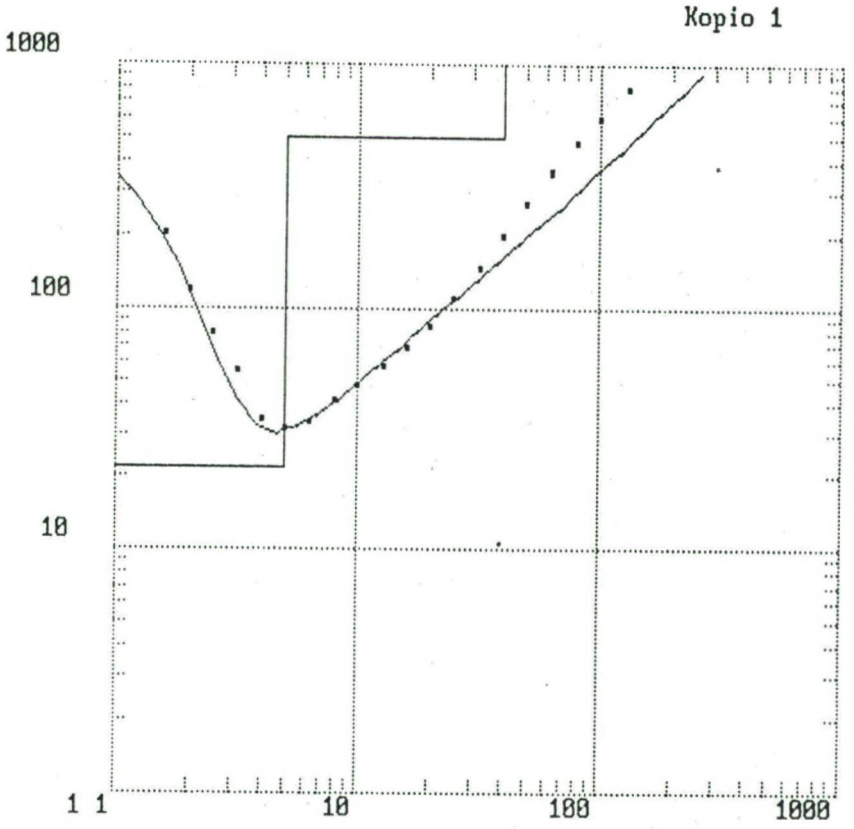


Figure 3.3.9 Vertical Electric Sounding done at Done at Dol Dol

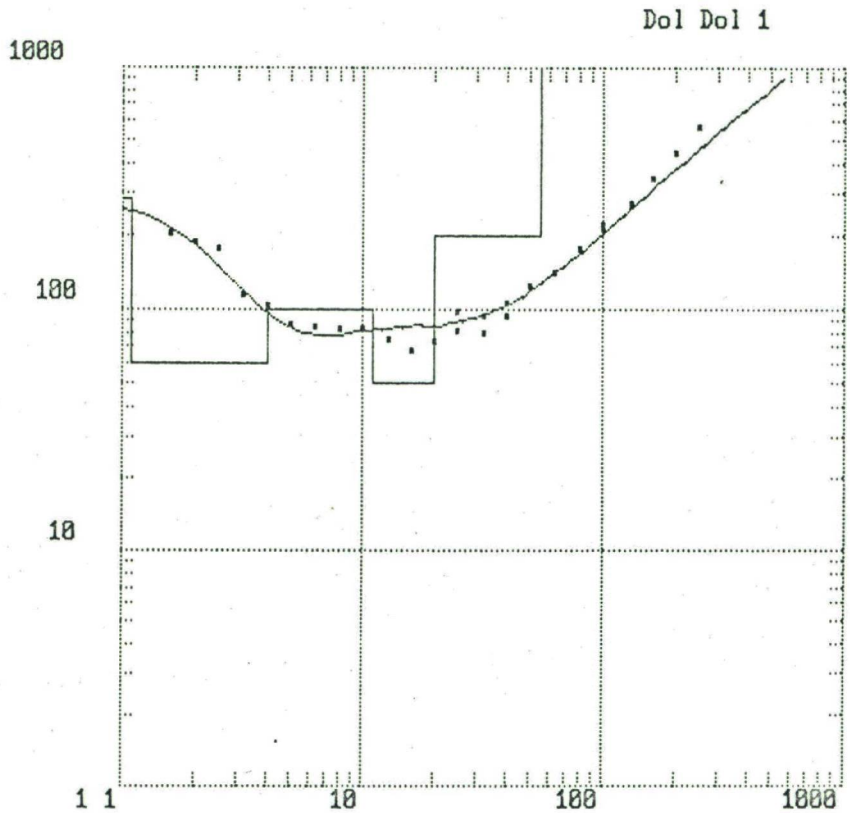


Figure 3.3.10 Vertical Electric Sounding done at Osoit Ondo

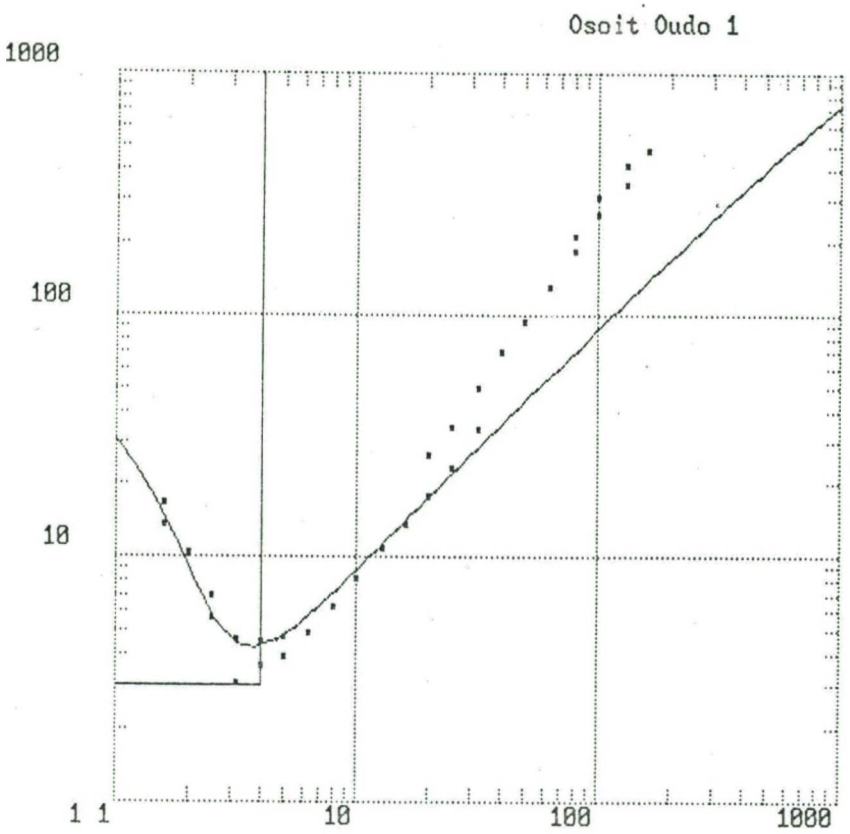
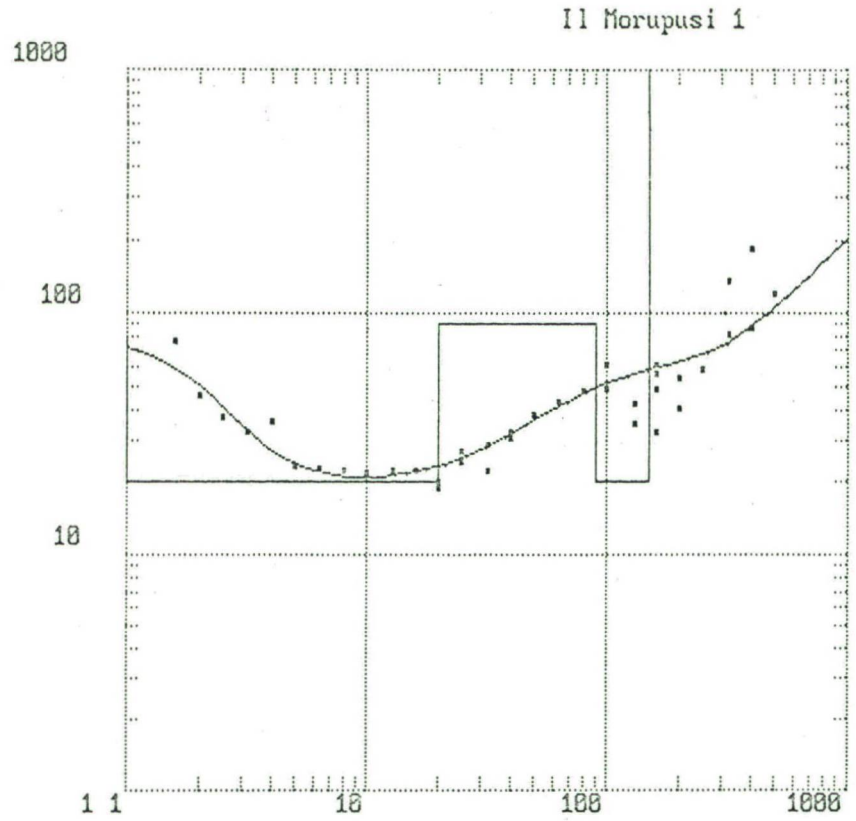


Figure 3.3.11 Vertical Electric Soundings done at Il Morupusi



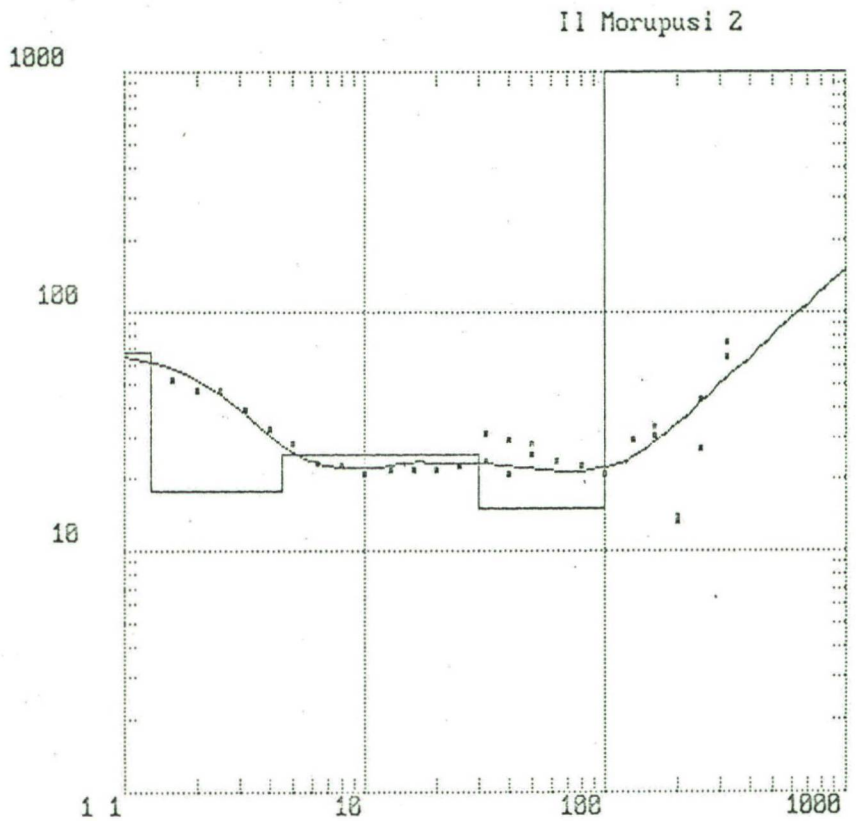
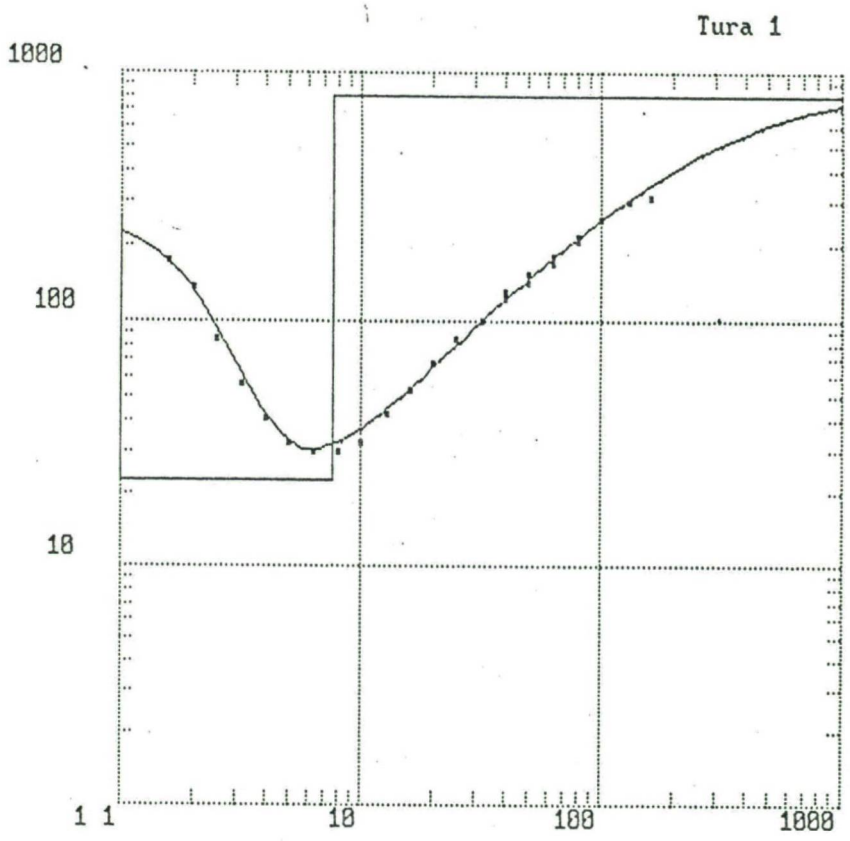
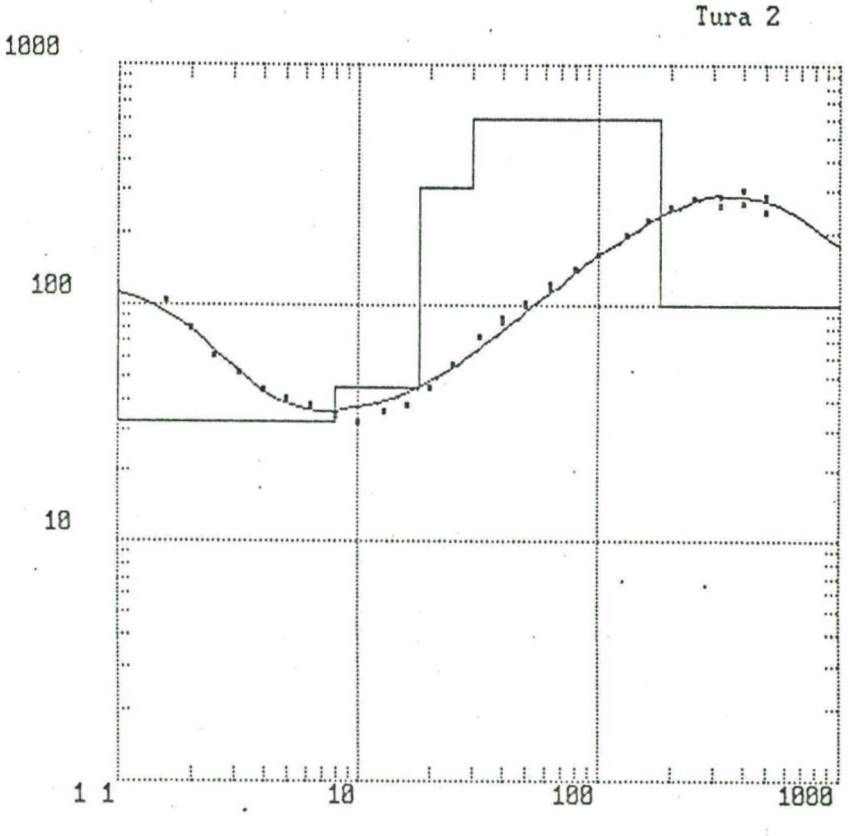
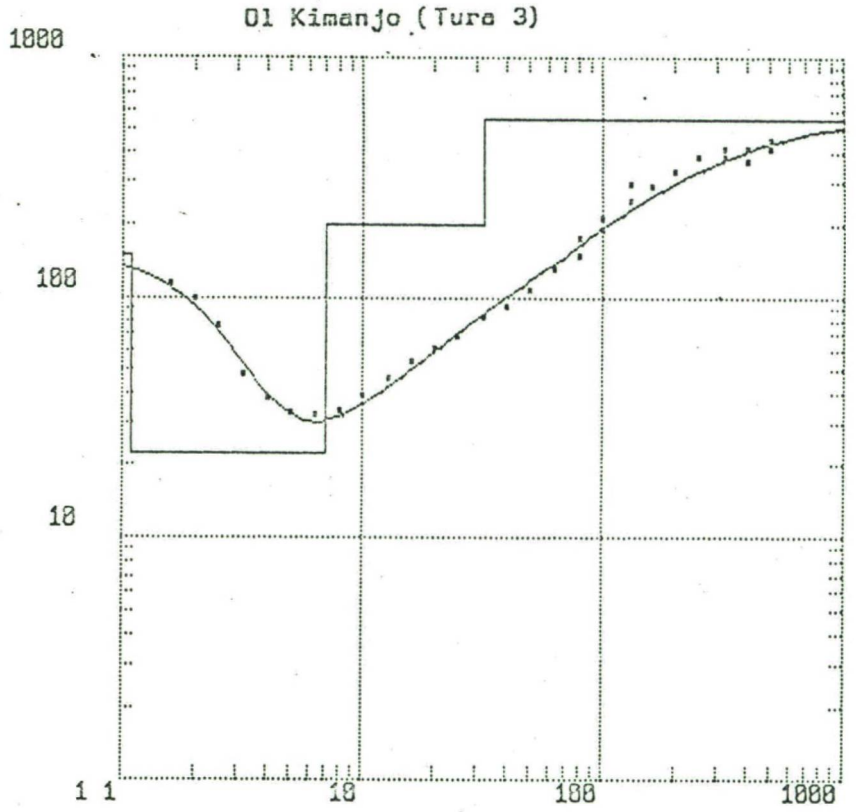
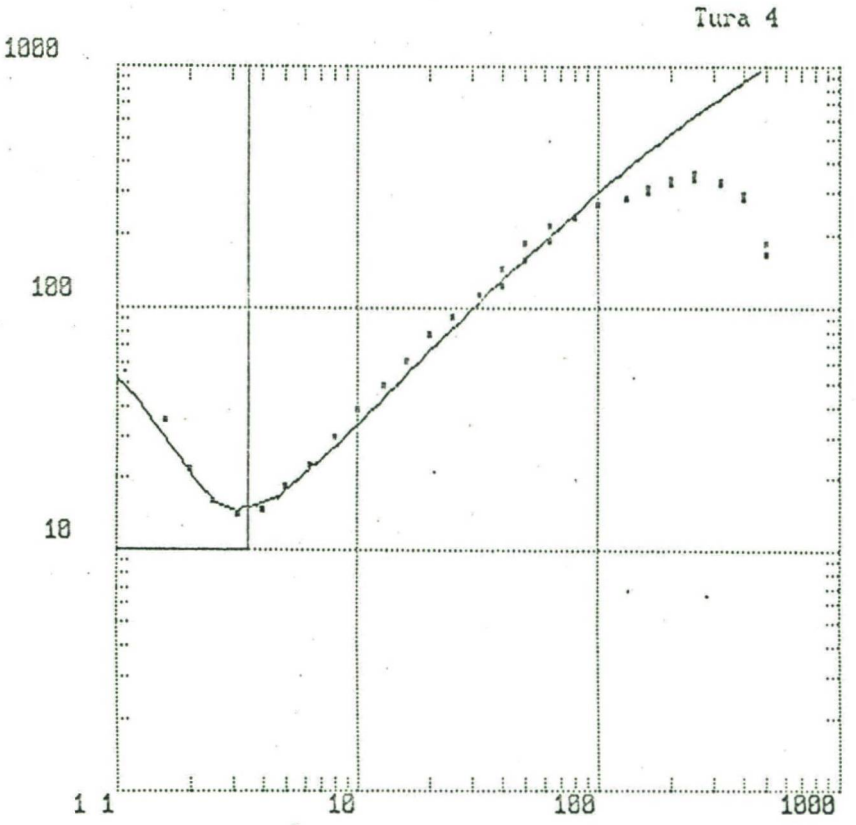


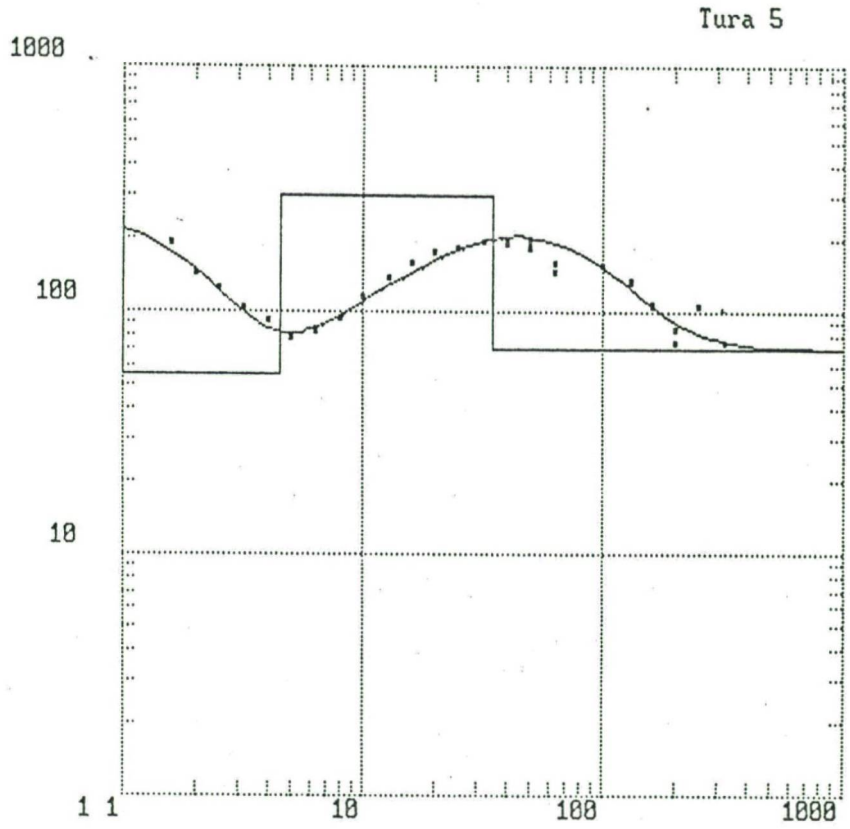
Figure 3.3.12 Vertical Electric Soundings done at Tura (Tura 1-7)

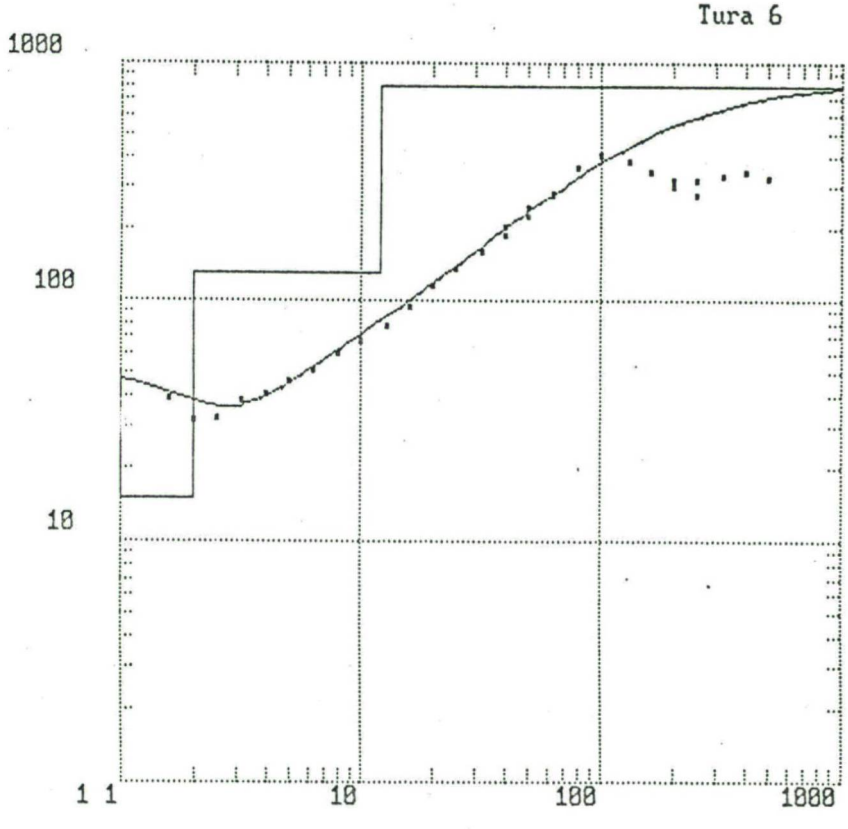





Ol Kimanjo (Tura 3)
1000
100
10
1 1
10
100
1000


Tura 4
1000
100
10
1 1
10
100
1000


Tura 5
1000
100
10
1 1
10
100
1000


Tura 6
1000
100
10
1 1
10
100
1000

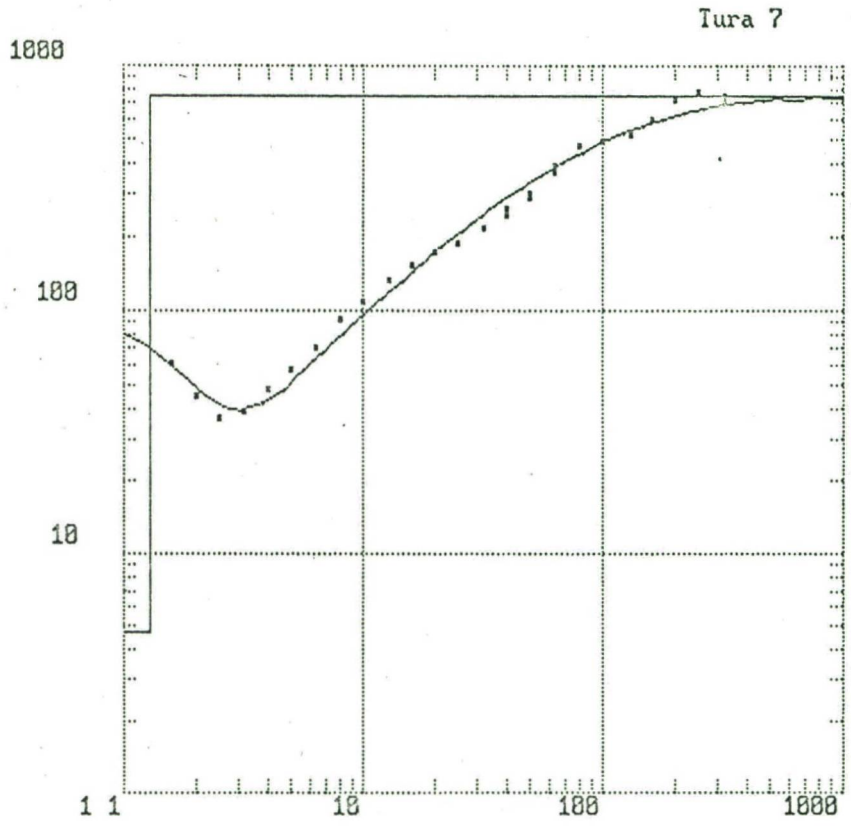
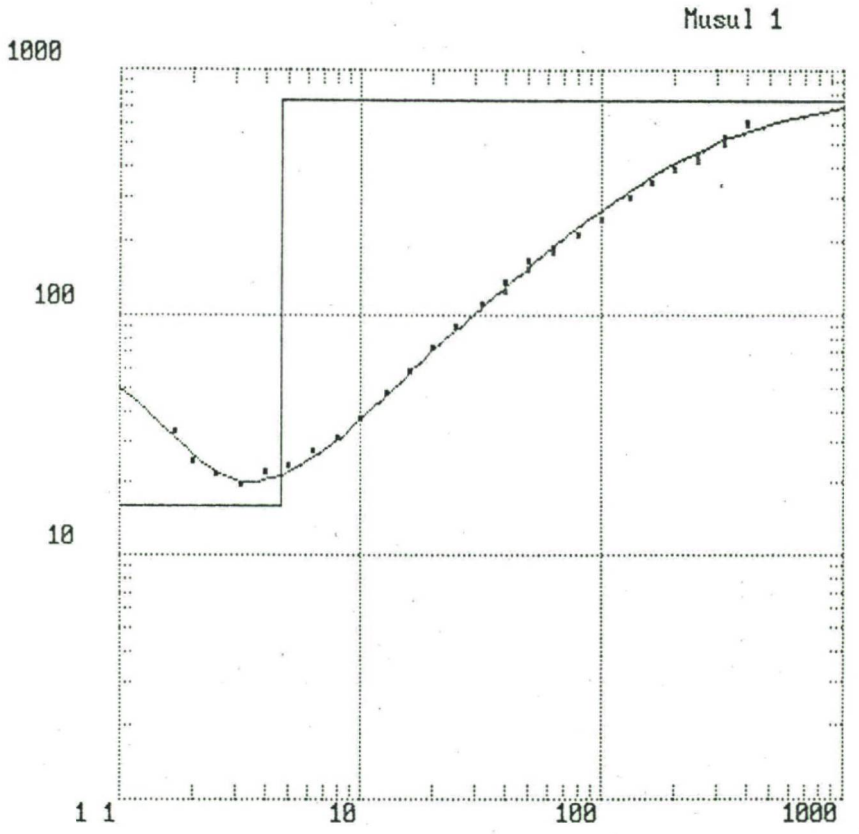

Tura 7
1000
100
10
1 1
10
100
1000

Figure 3.3.13 Vertical Electric Sounding done at Musul



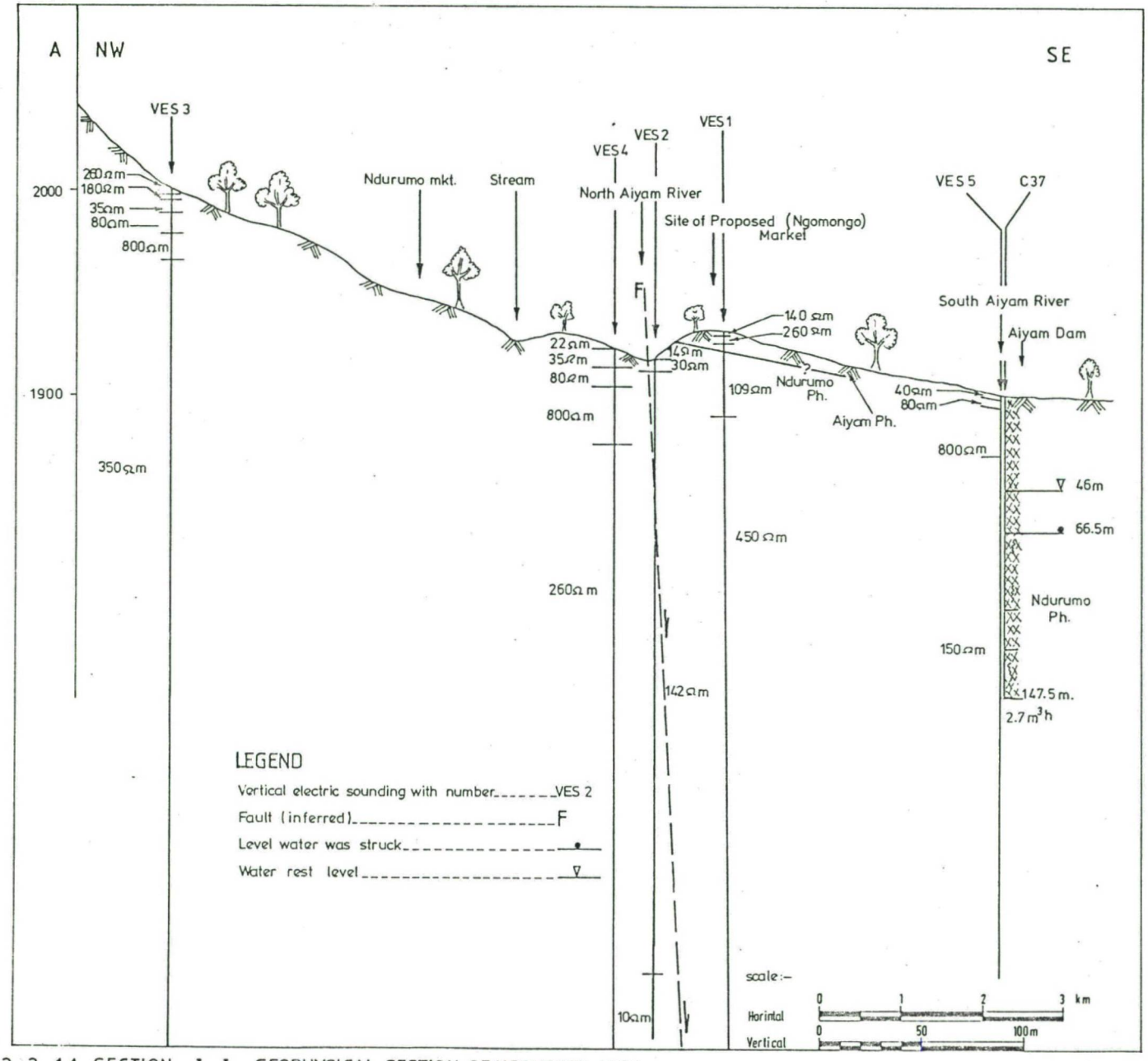


Fig.3.3.14 SECTION I—I GEOPHYSICAL SECTION OF NGOMONGO AREA

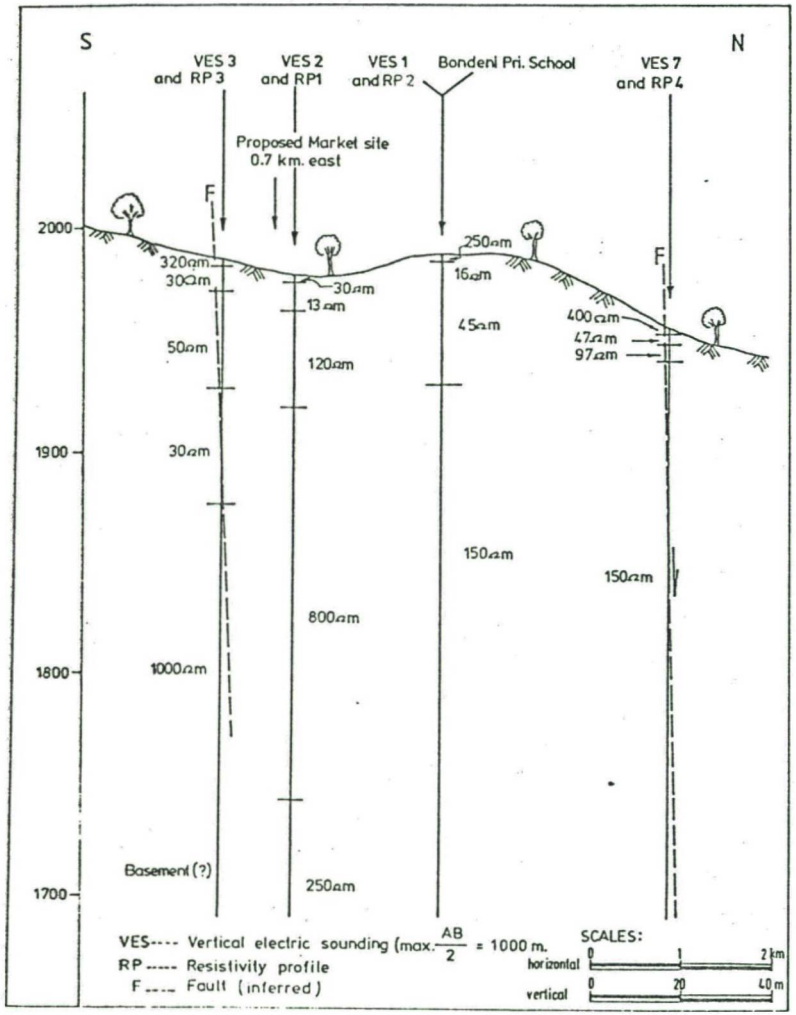


Fig.3.3.15a SECTION 2-2 GEOPHYSICAL SECTION OF BONDENI AREA, WESTERN SIDE (—This section runs more or less parallel to Mukutan River's upper course)

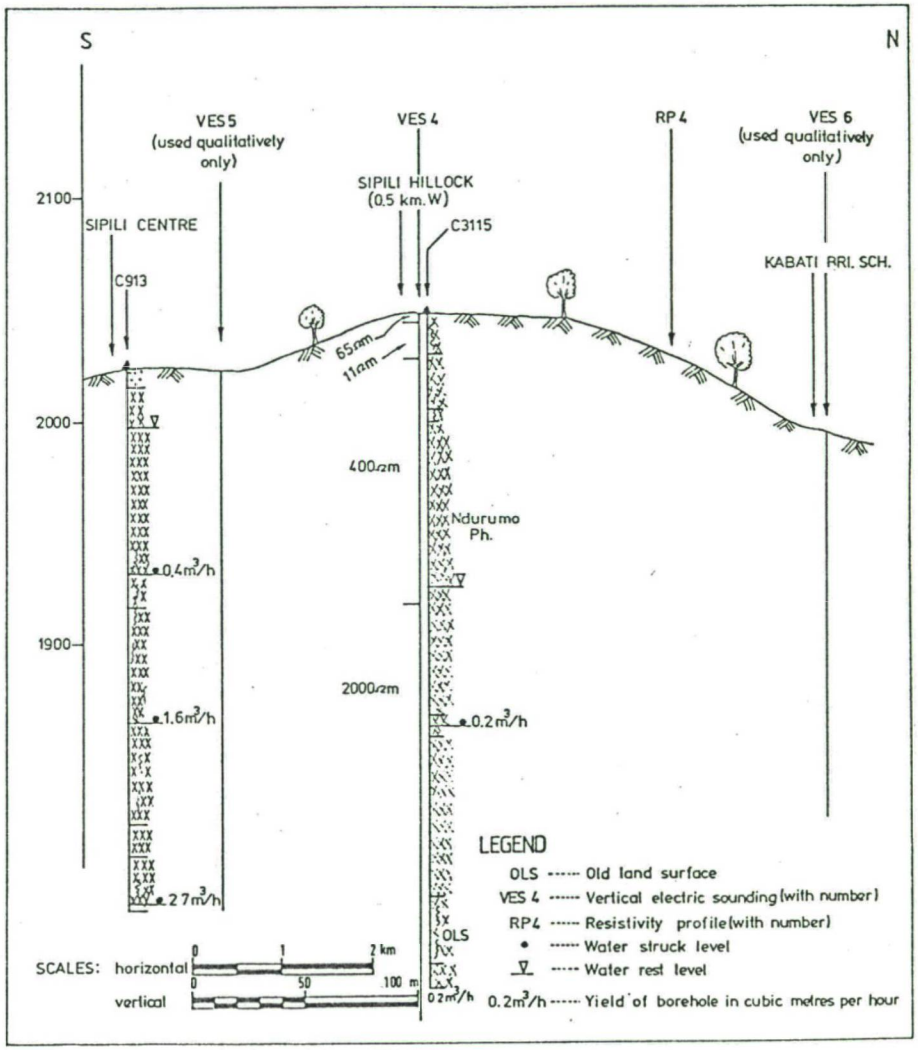


Fig. 3.3.15b SECTION 3-3 GEOPHYSICAL SECTION OF BONDENI AREA, EASTERN SIDE

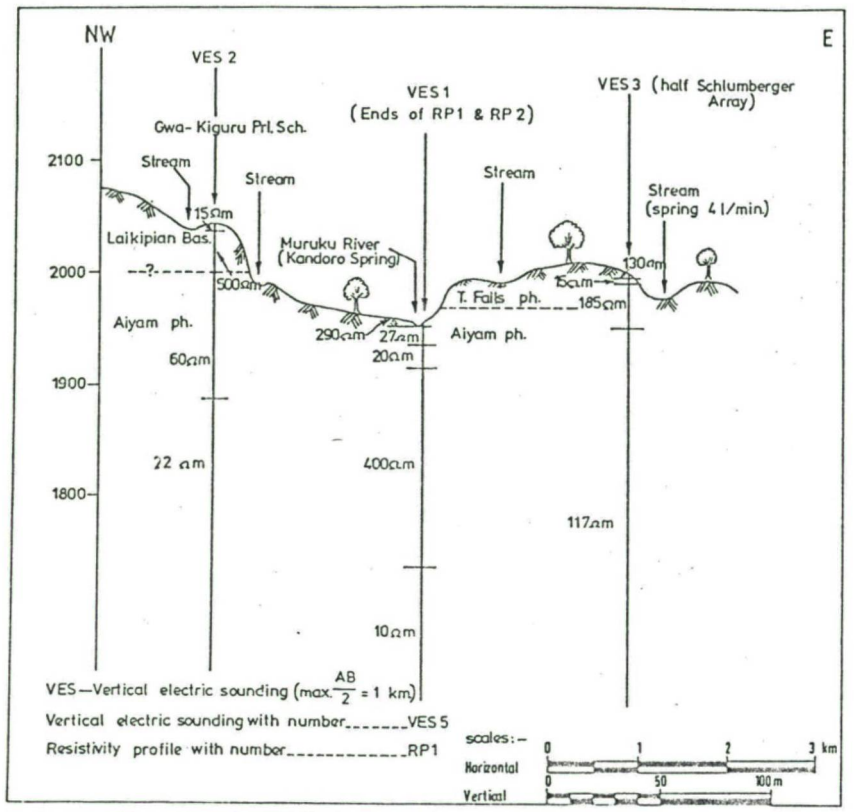


Fig.3.3.16 SECTION 4–4 GEOPHYSICAL SECTION OF MURUKU AREA

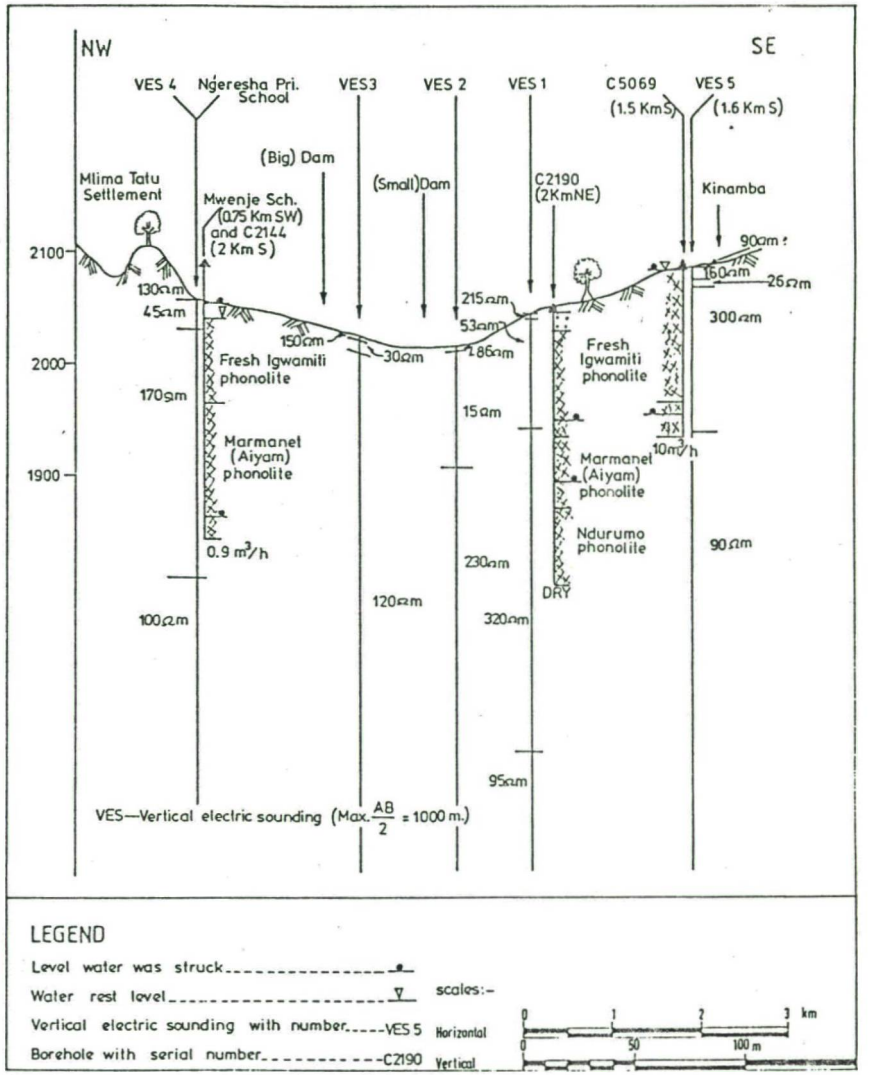


Fig.3.3.17 SECTION 5–5 GEOPHYSICAL SECTION OF MWENJE AREA, KINAMBA

APPENDIX 3.4

Resistivity Profiles

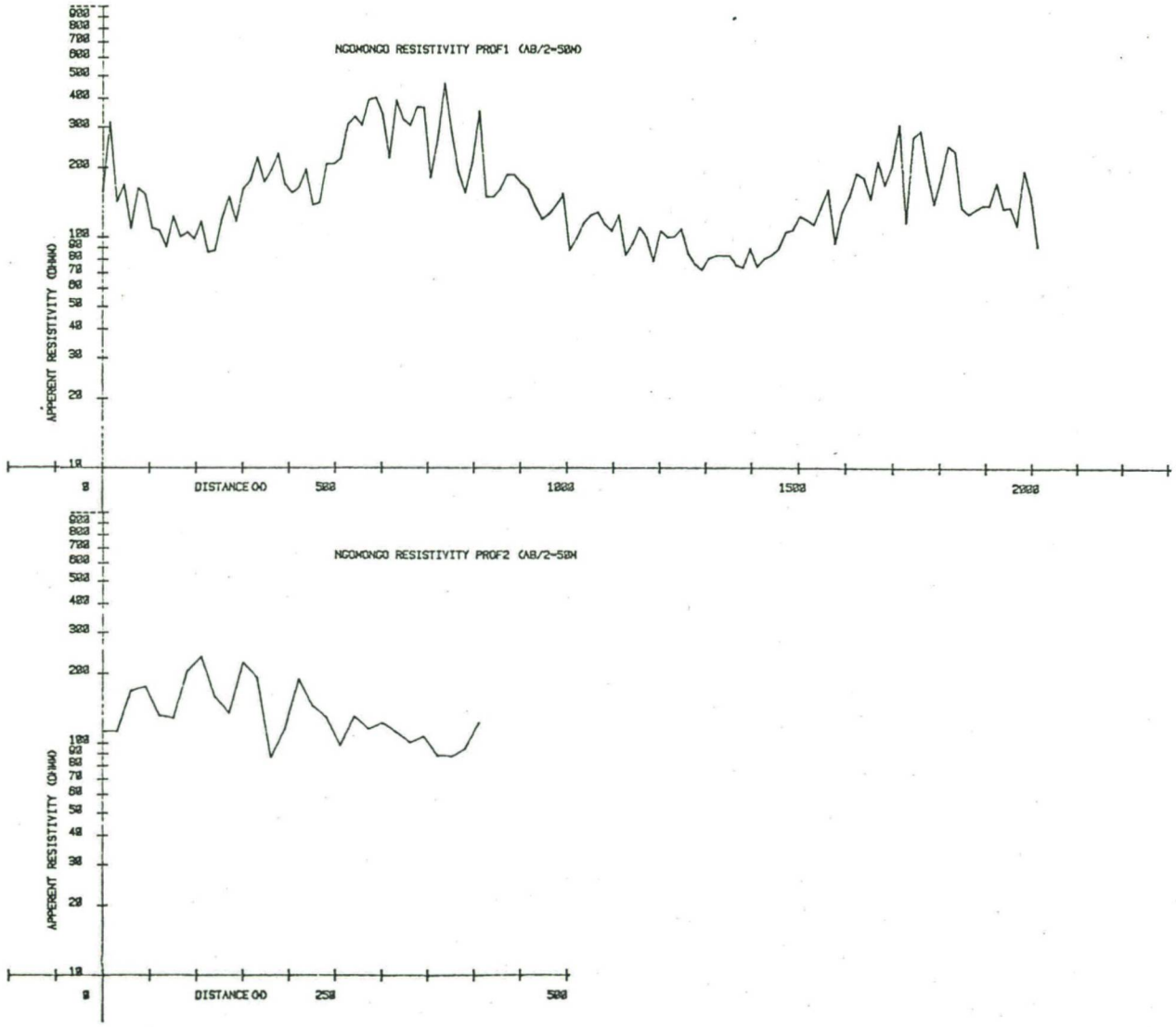


Fig. 3.4.1 Resistivity Profiles made at Ngomongo

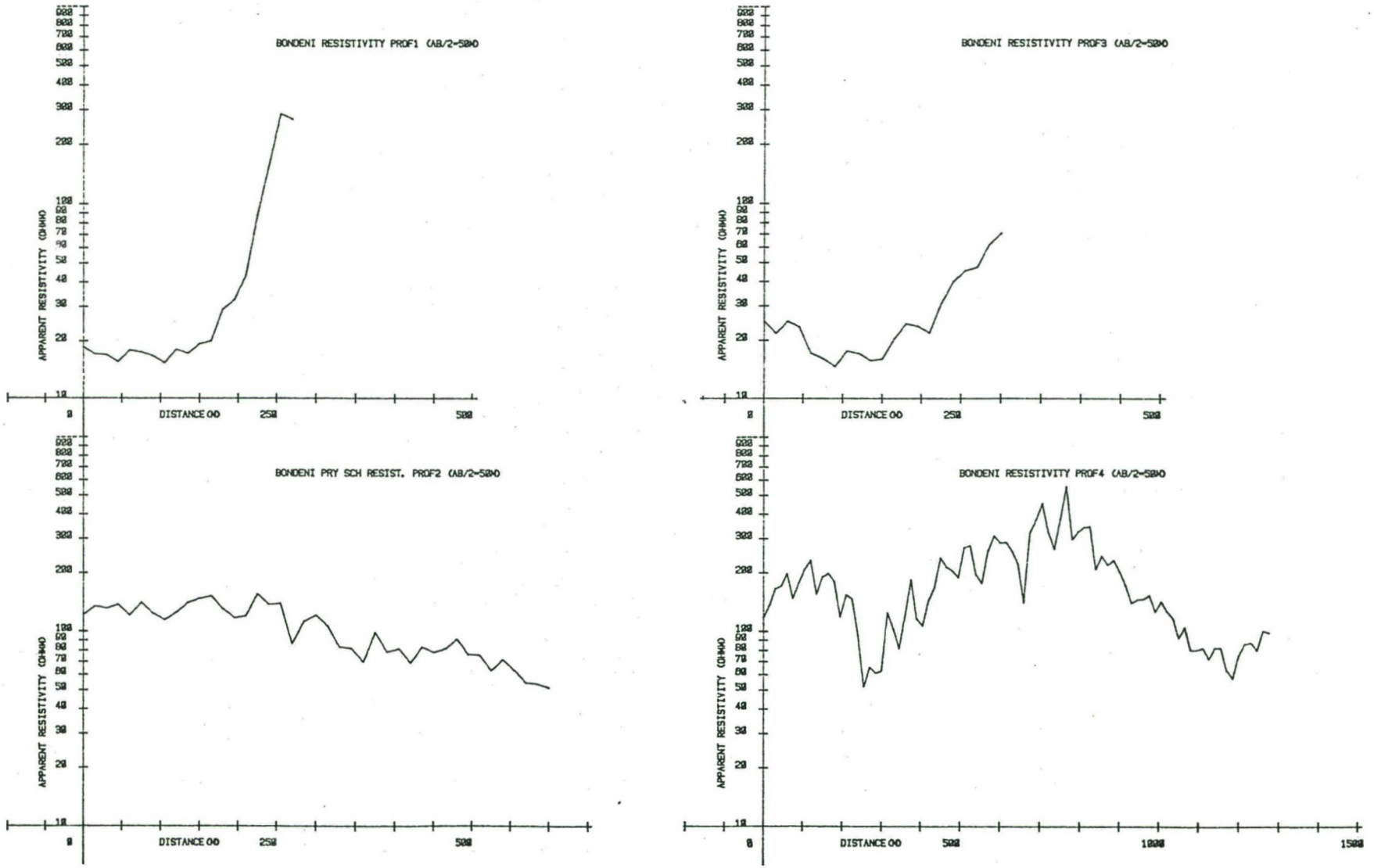


Fig. 3.4.2 Resistivity Profiles made at Bondeni

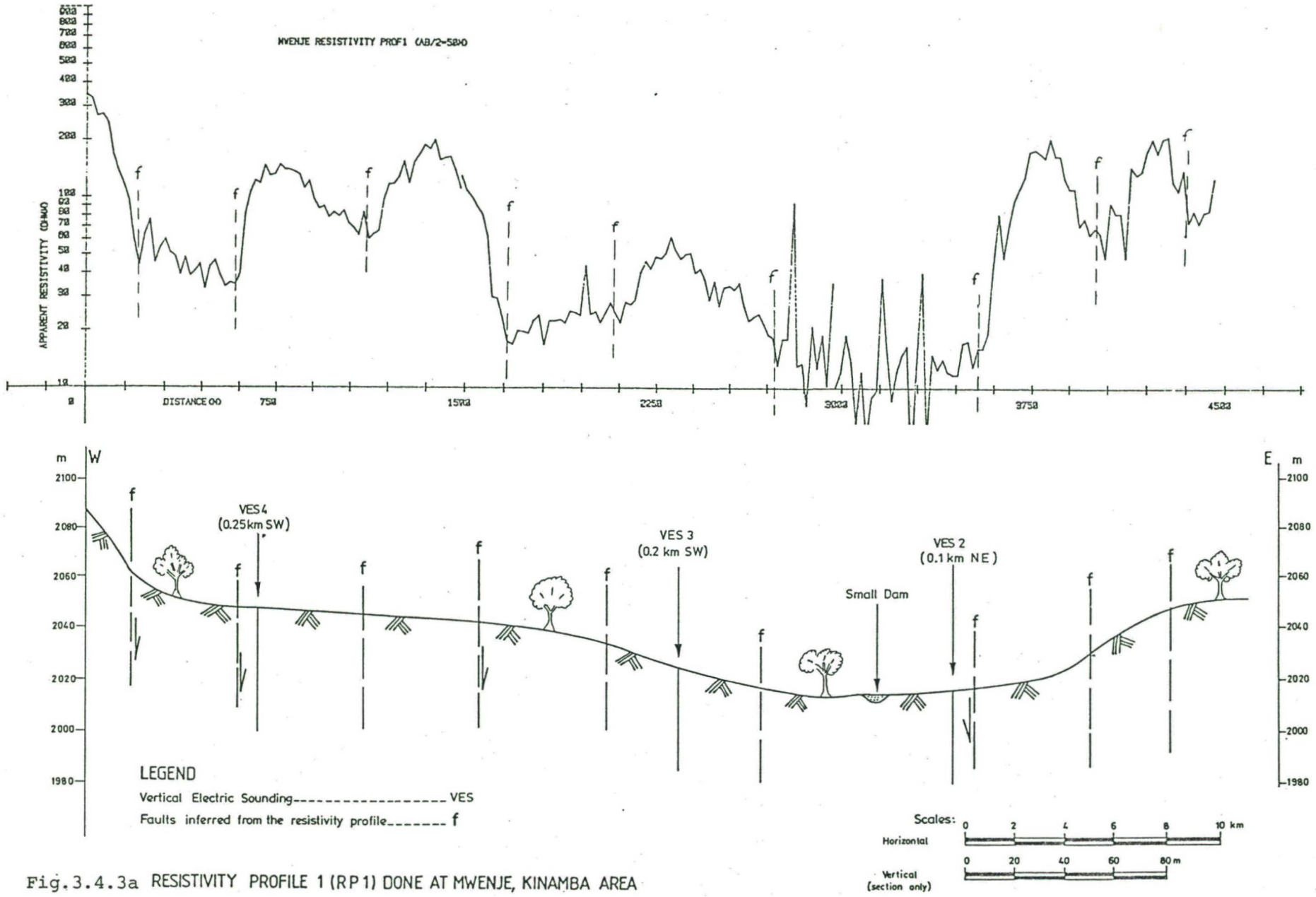


Fig.3.4.3a RESISTIVITY PROFILE 1 (RP1) DONE AT MWENJE, KINAMBA AREA

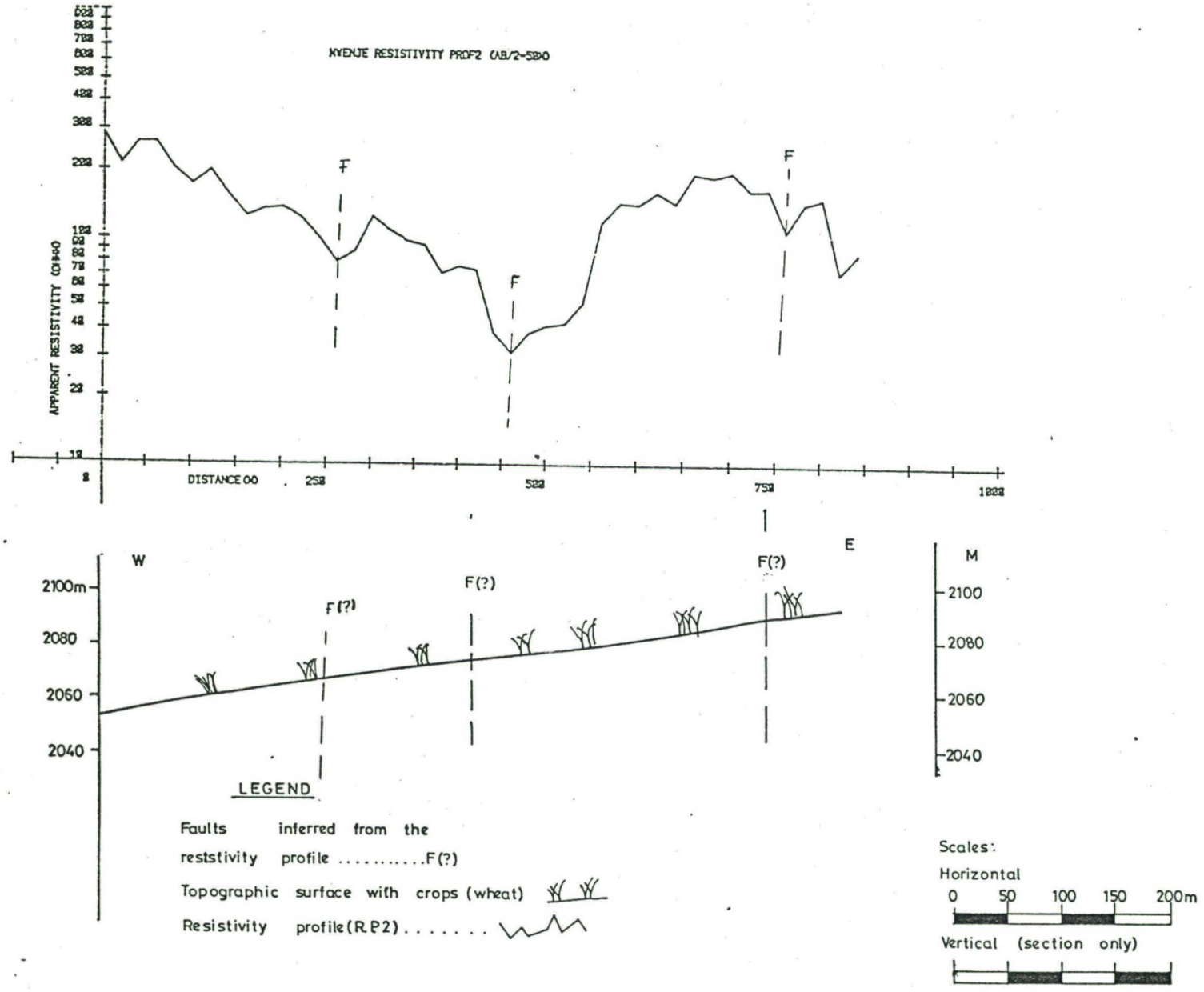


Fig 3.4.3(b) Resistivity profile 2 (RP 2) done at Mwenje, Kinamba area.

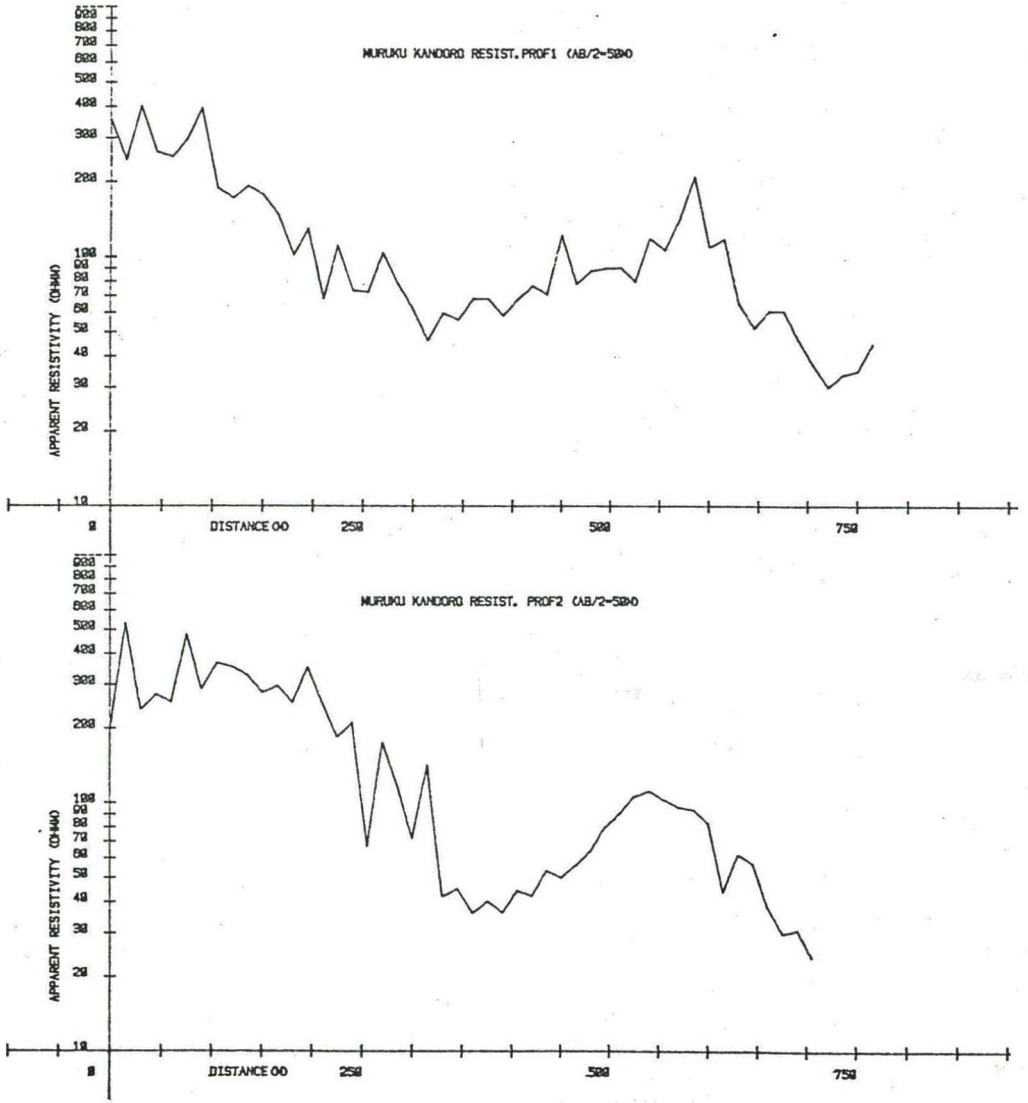


Fig. 3.4.4 Resistivity Profiles done at Kandoro, Muruku area

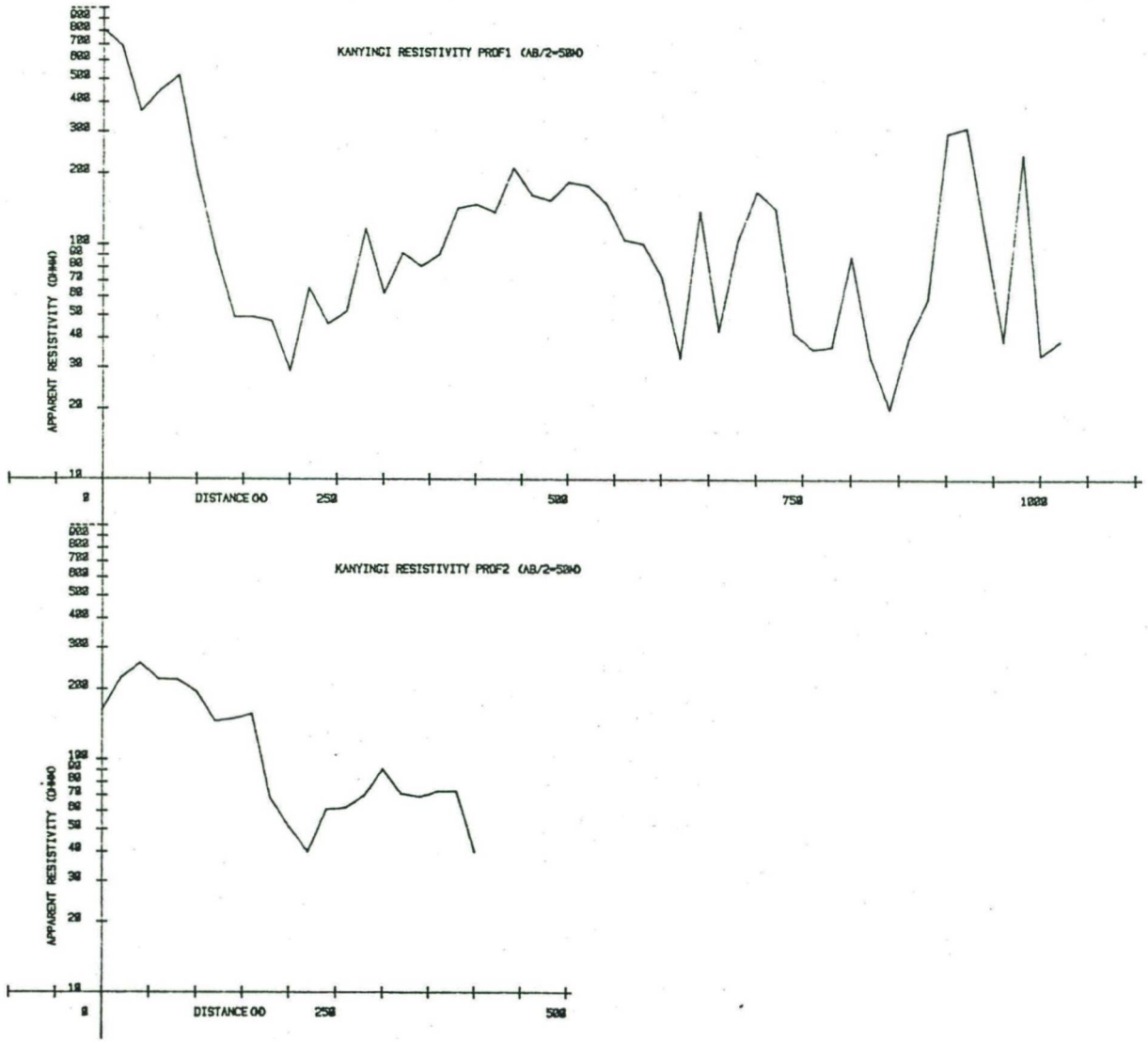


Fig. 3.4.5 Resistivity Profiles done at Kanyingi

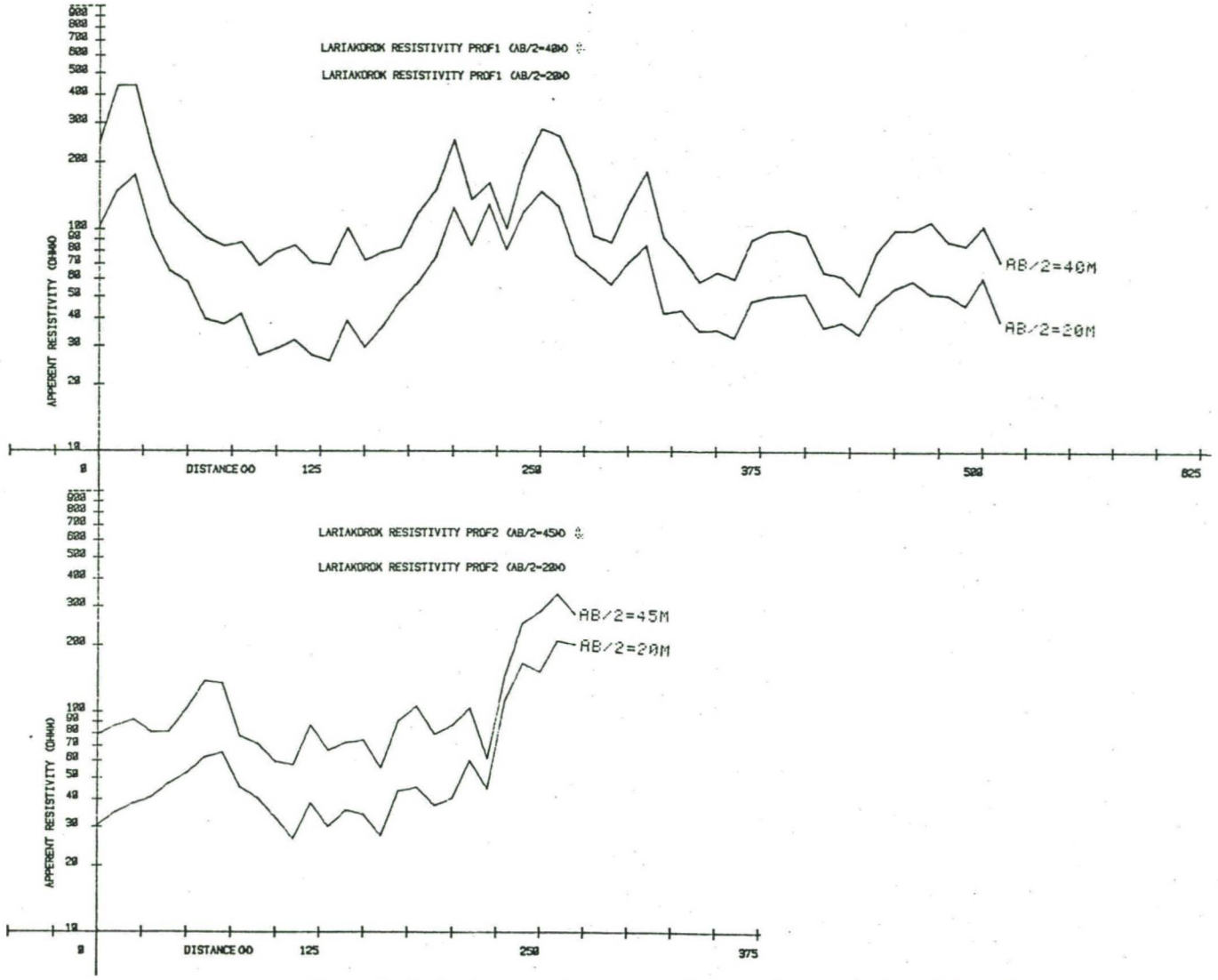


Fig. 3.4.6 Resistivity Profiles done at Lariakorok

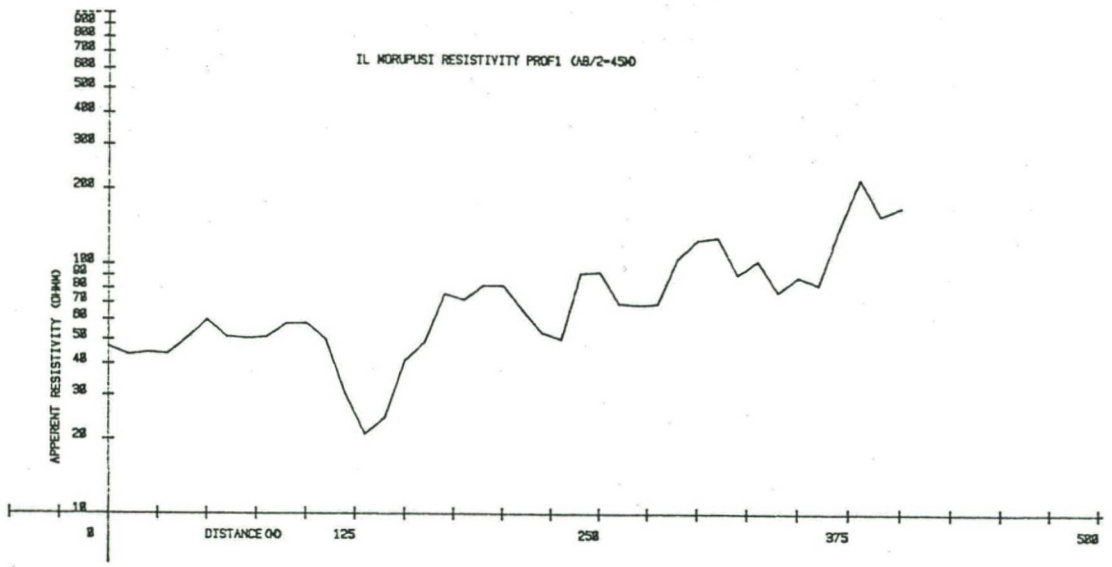


Fig. 3.4.7 Resistivity Profile done at Il Morupusi

APPENDIX 3.5

Electromagnetic Profiles

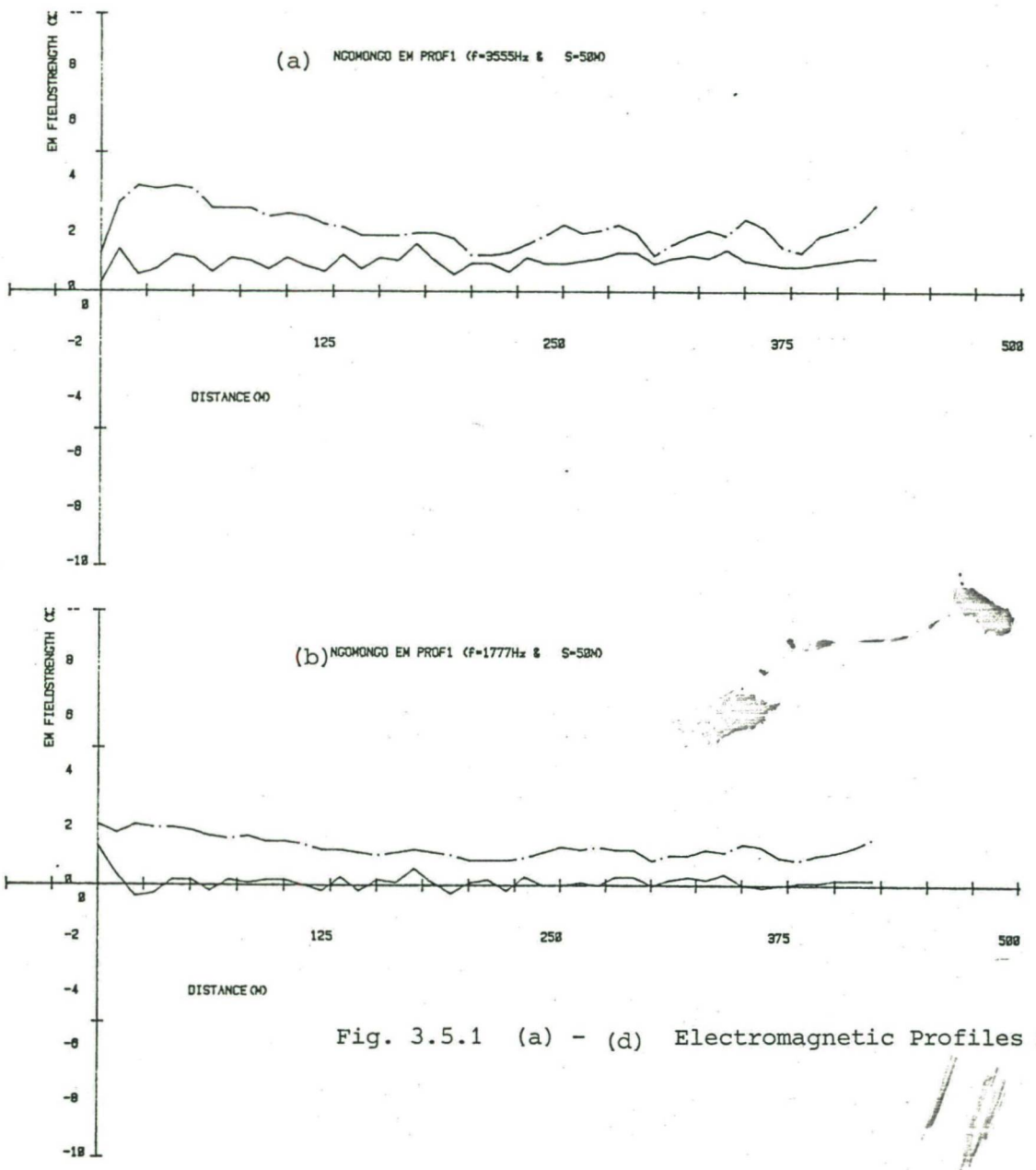
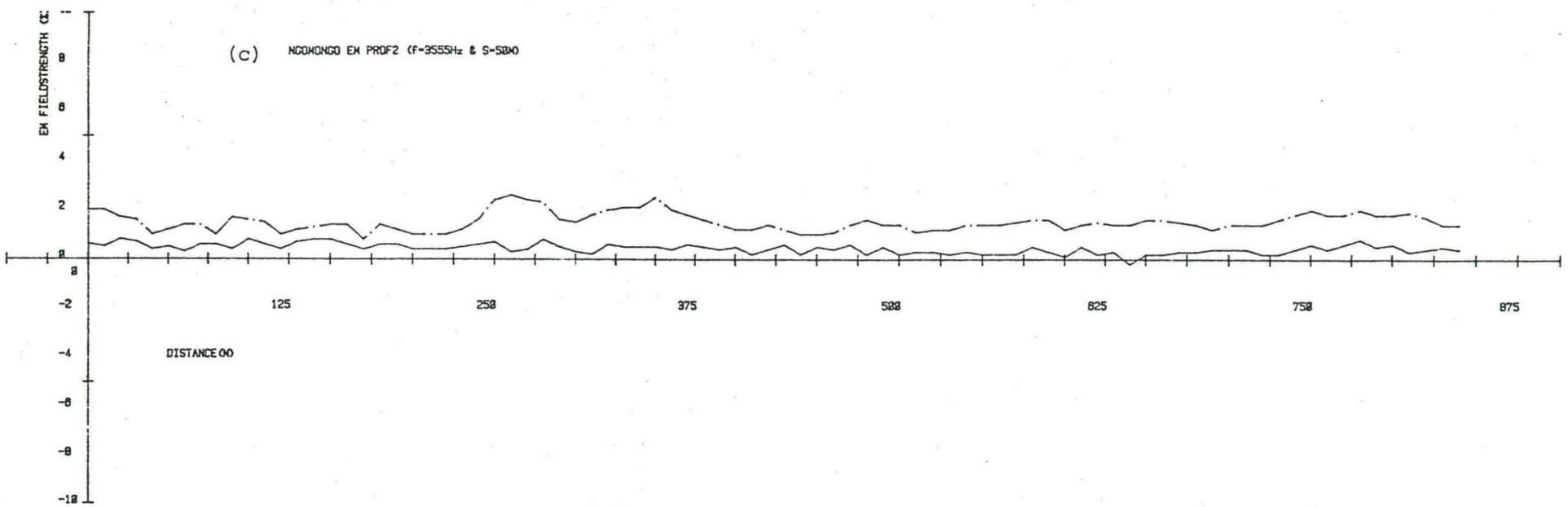
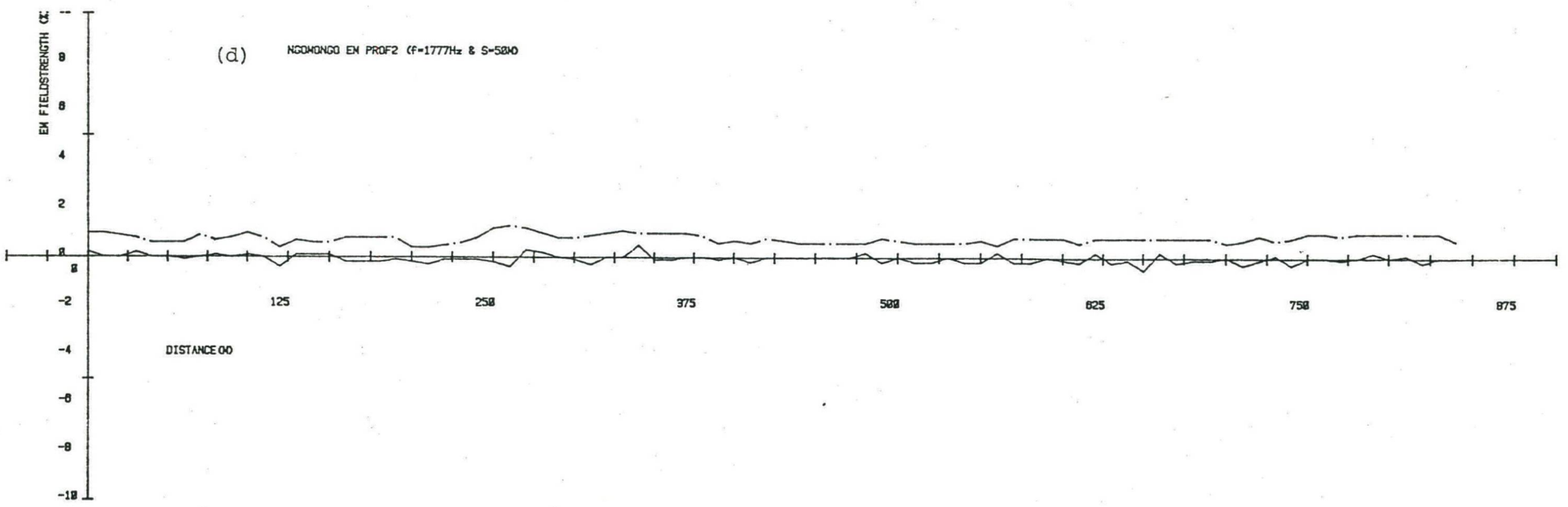


Fig. 3.5.1 (a) - (d) Electromagnetic Profiles made at Ngomongo


(c) NGOMONGO EM PROF2 (f=3555Hz & S=50M)
EM FIELDSTRENGTH (%)
10
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
500
625
750
875
DISTANCE (M)


(d) NGOMONGO EM PROF2 (f=1777Hz & S=50M)
EM FIELDSTRENGTH (%)
10
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
500
625
750
875
DISTANCE (M)

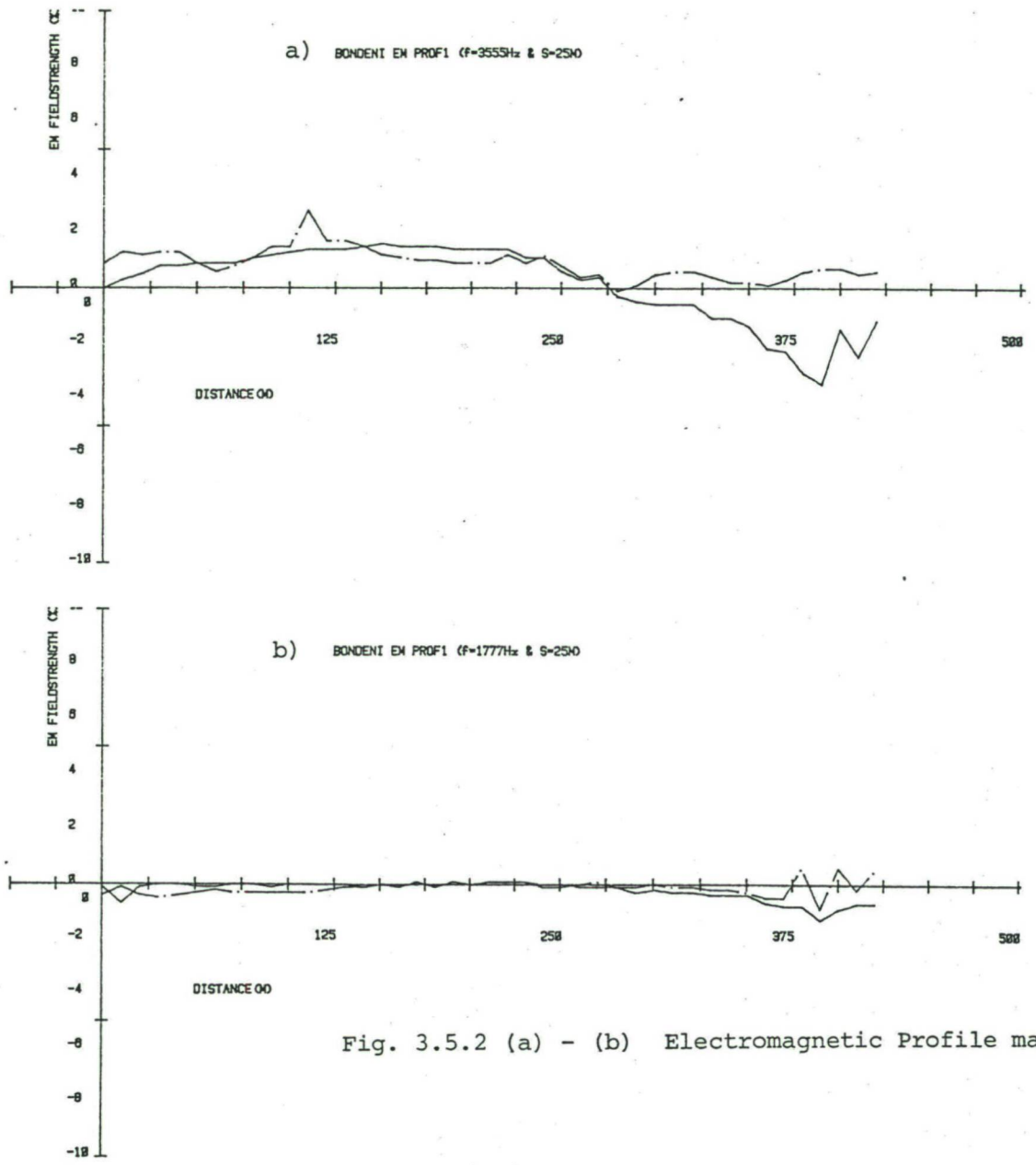


Fig. 3.5.2 (a) - (b) Electromagnetic Profile made at Bondeni

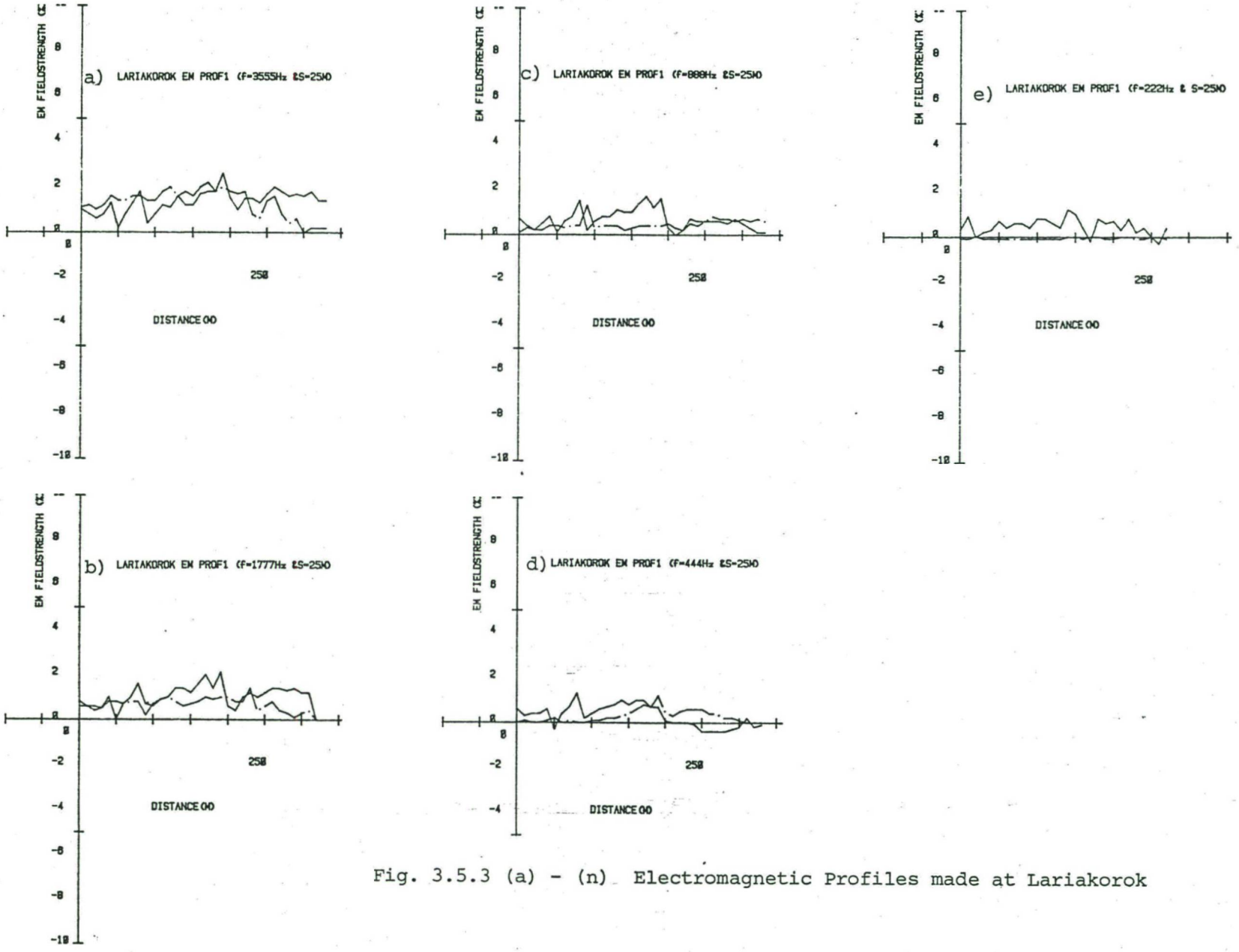
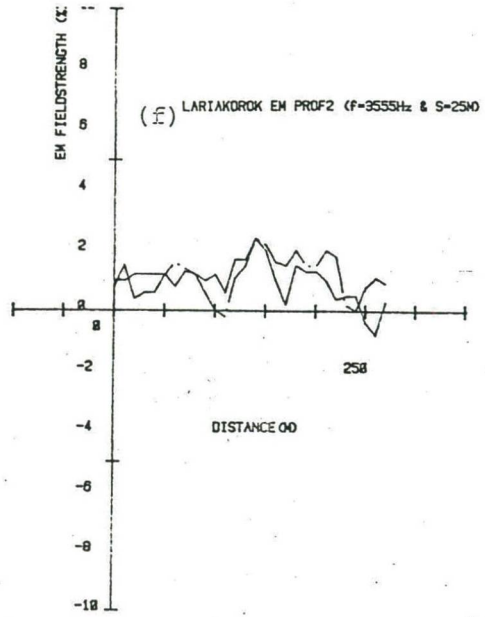
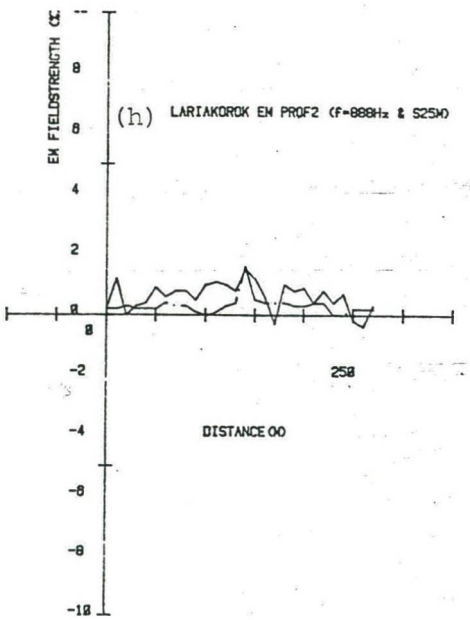
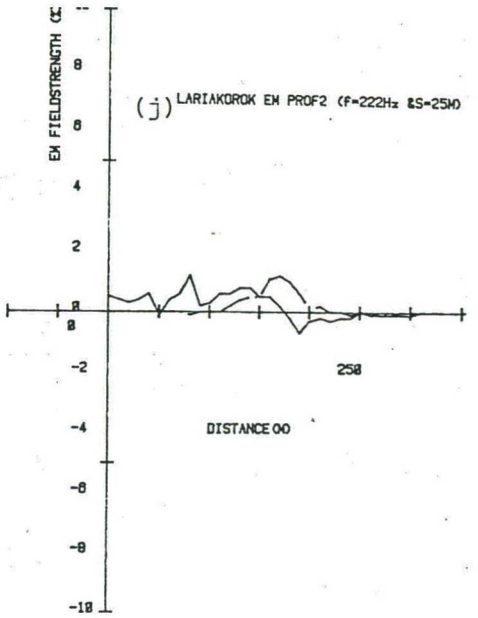
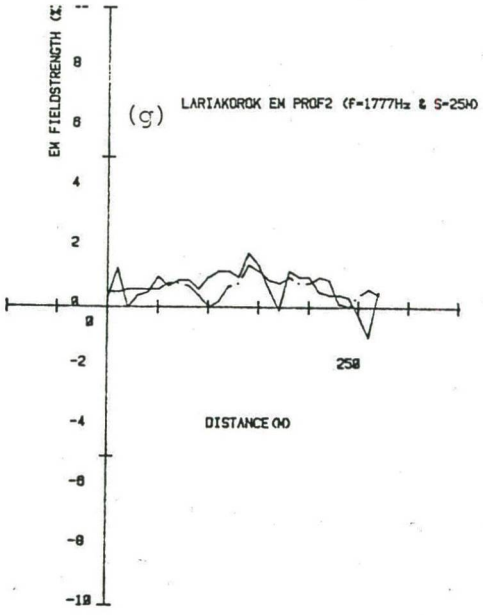


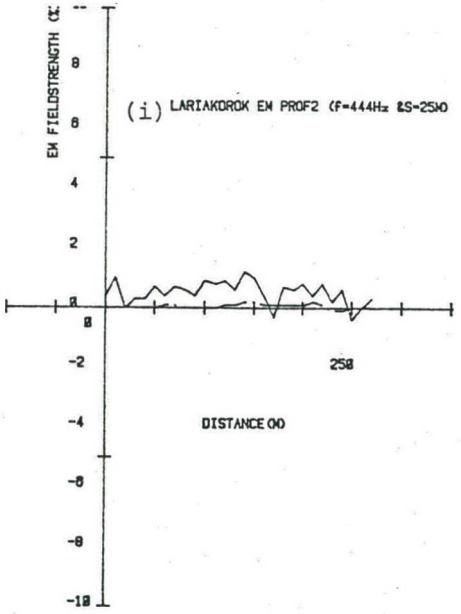
Fig. 3.5.3 (a) - (n) Electromagnetic Profiles made at Lariakorok

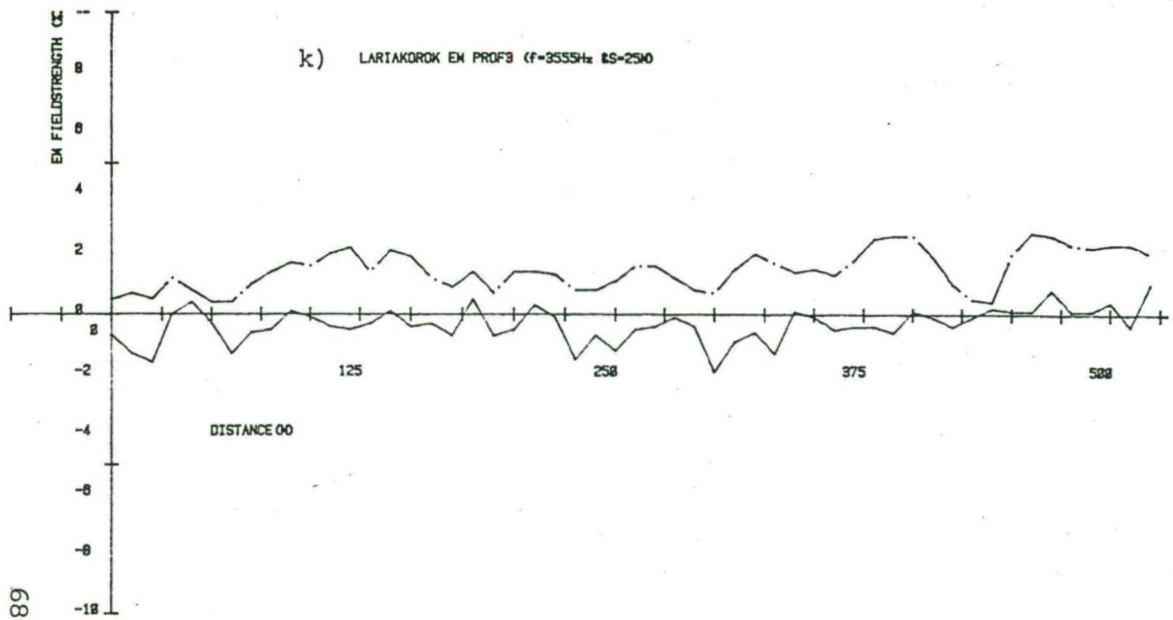

(f) LARIAKOROK EM PROF2 (f=3555Hz & S=25M)
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
250
DISTANCE 00

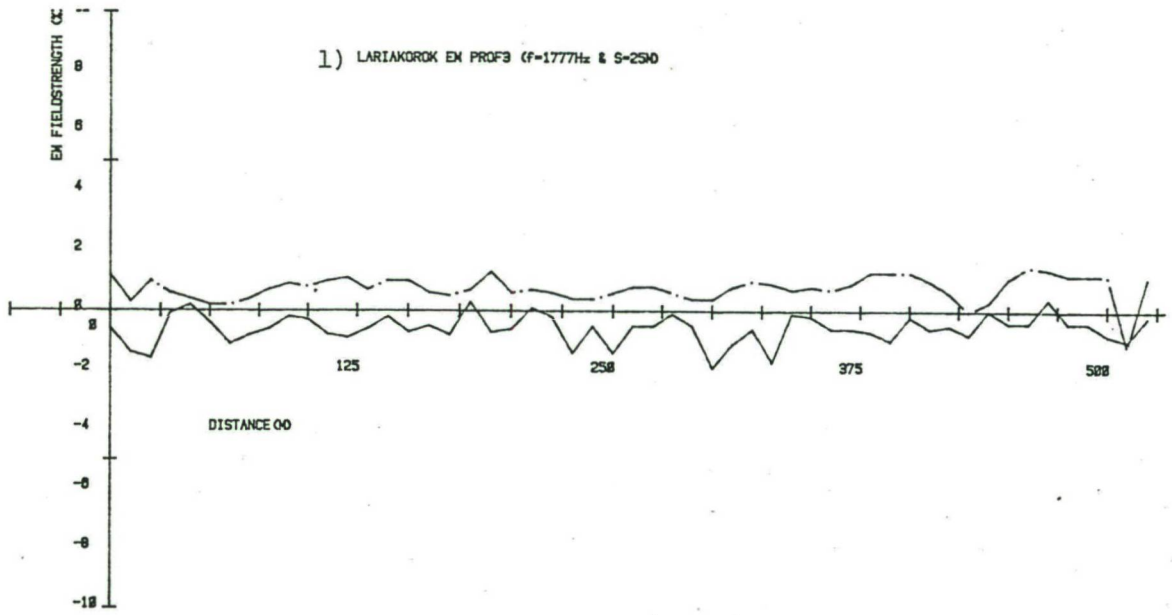

(h) LARIAKOROK EM PROF2 (f=888Hz & S25M)
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
250
DISTANCE 00

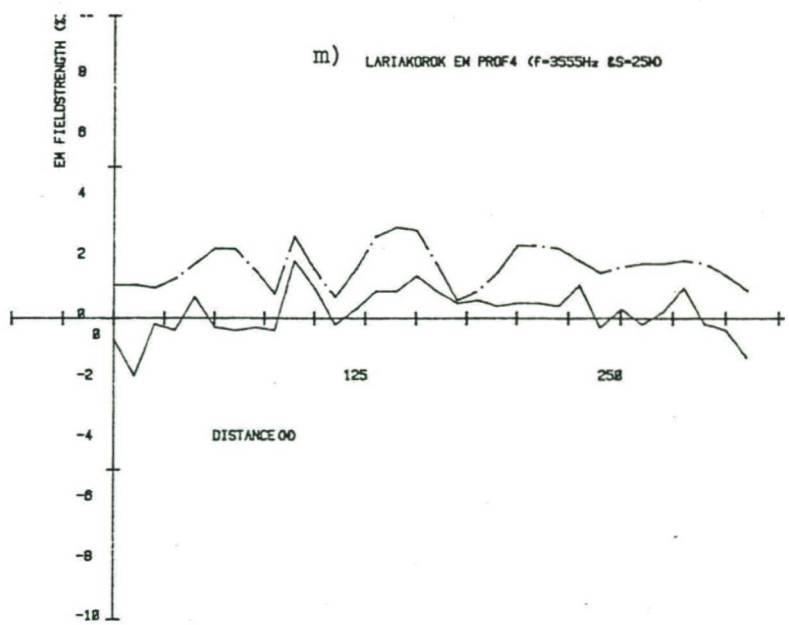

(j) LARIAKOROK EM PROF2 (f=222Hz &S=25M)
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
250
DISTANCE 00

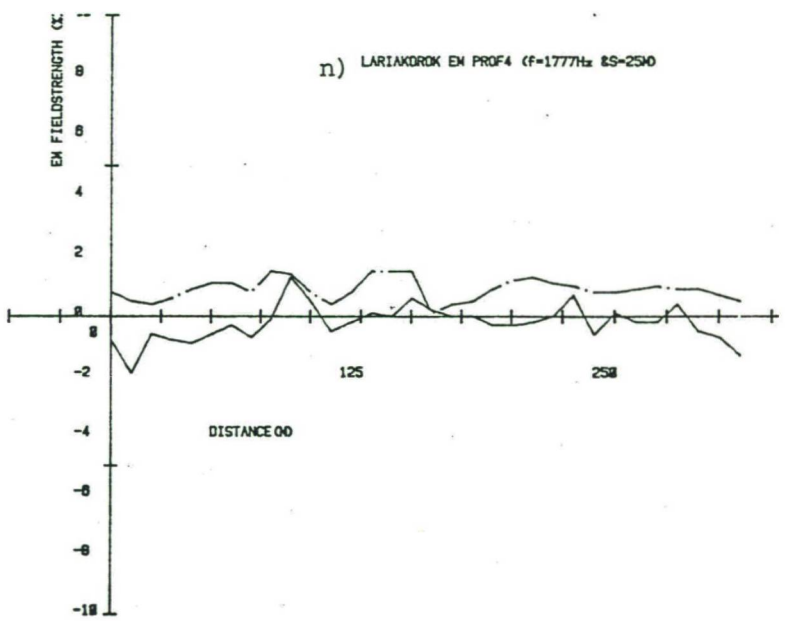

(g) LARIAKOROK EM PROF2 (f=1777Hz & S=25M)
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
250
DISTANCE 00


(i) LARIAKOROK EM PROF2 (f=444Hz &S=25M)
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
250
DISTANCE 00


k) LARIAKOROK EM PROF3 (f=3555Hz &S=250
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
500
DISTANCE (M)


l) LARIAKOROK EM PROF3 (f=1777Hz & S=250
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
500
DISTANCE (M)


m) LARIAKOROK EM PROF4 (f=3555Hz &S=250
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE (M)


n) LARIAKOROK EM PROF4 (f=1777Hz &S=250
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE (M)

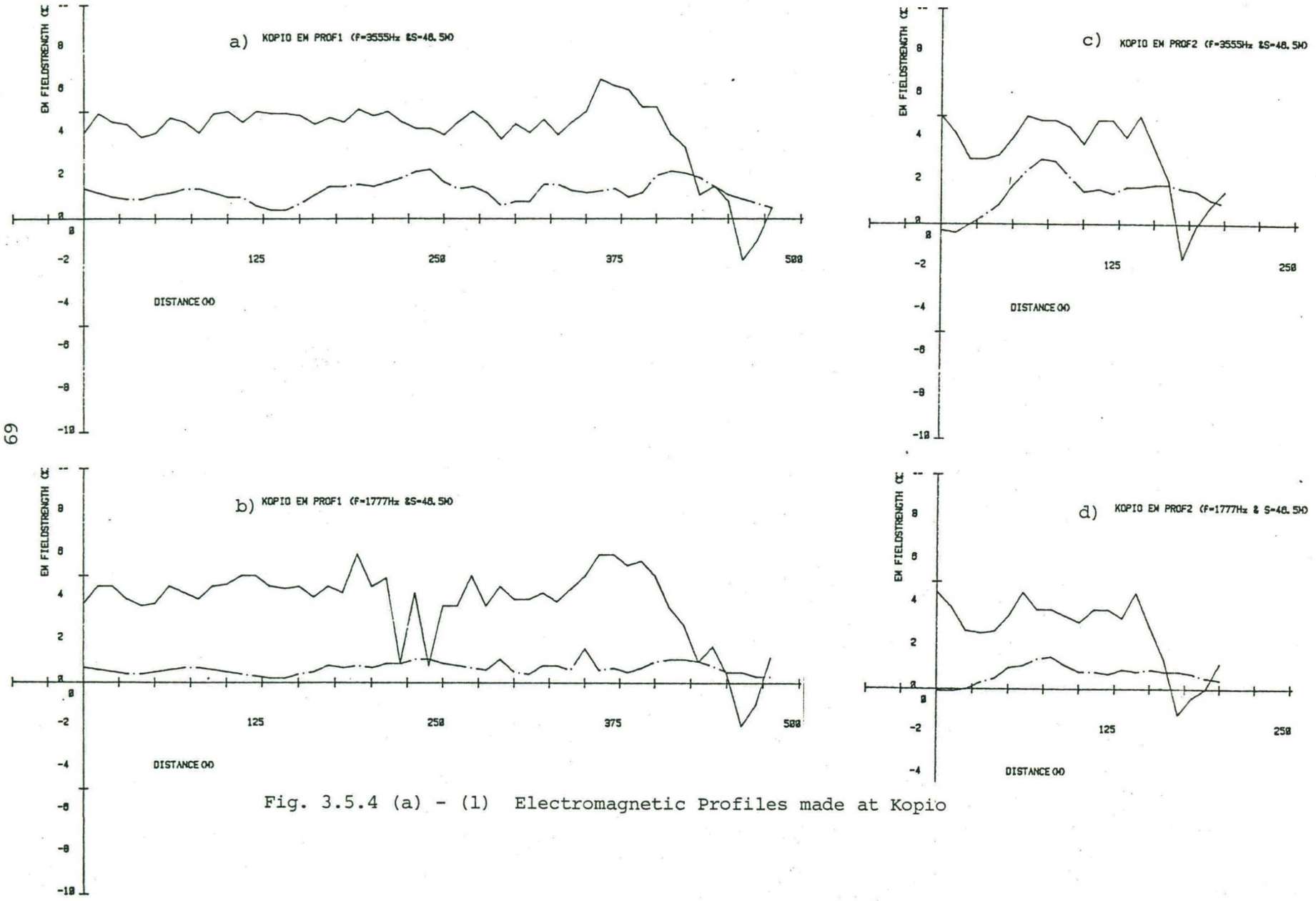
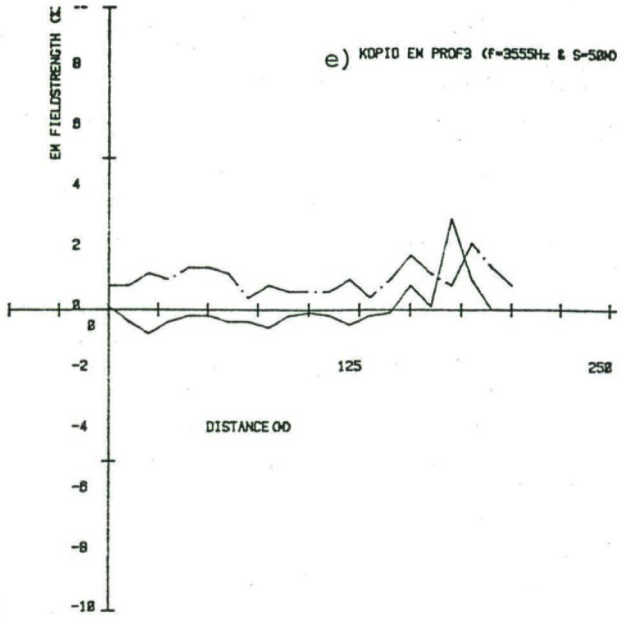
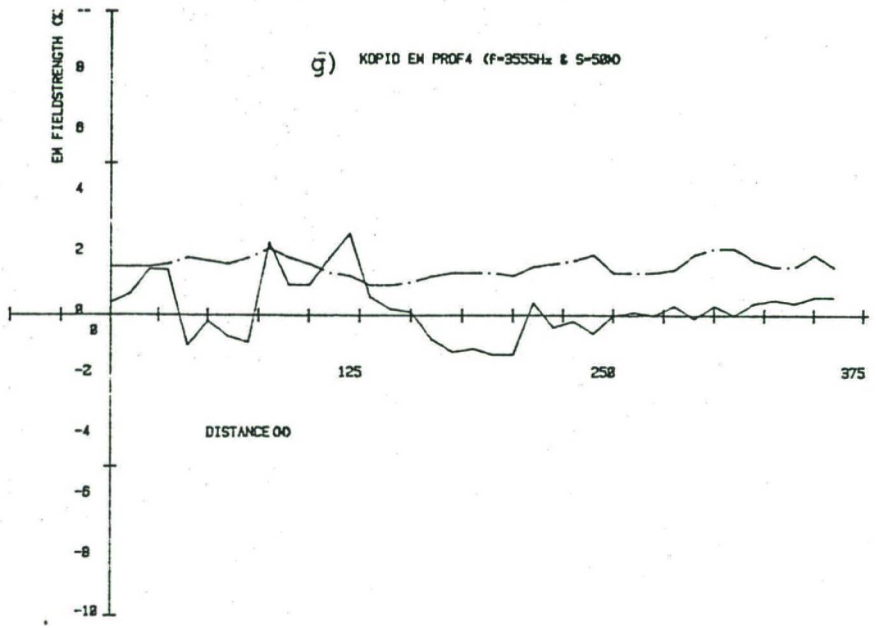
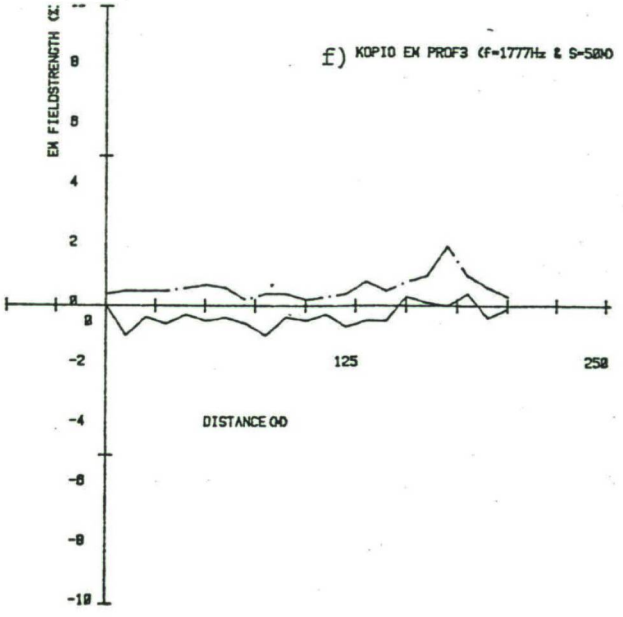
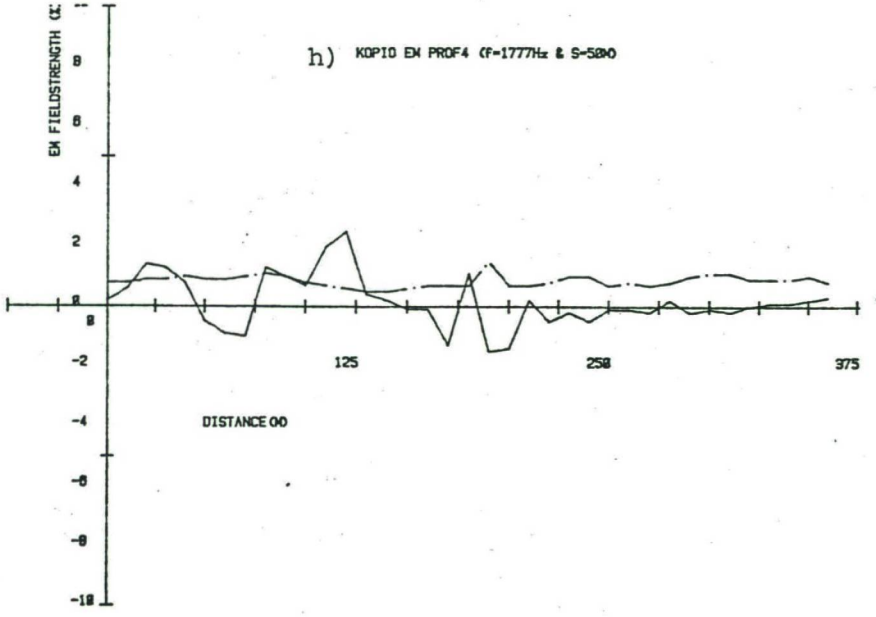


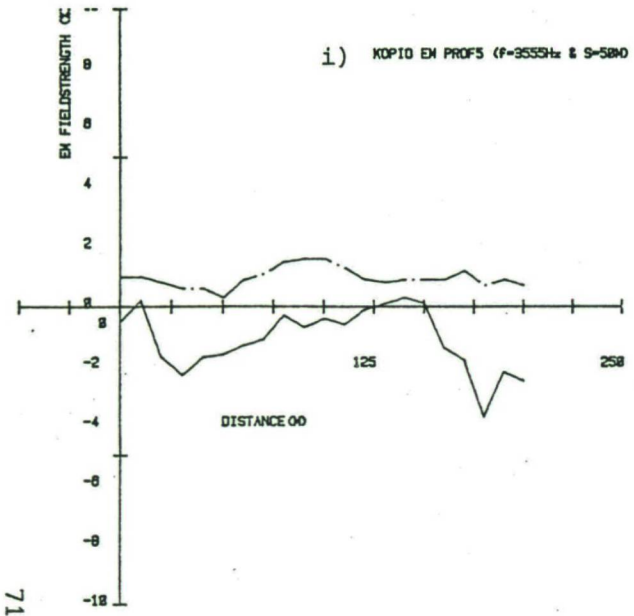
Fig. 3.5.4 (a) - (1) Electromagnetic Profiles made at Kopio

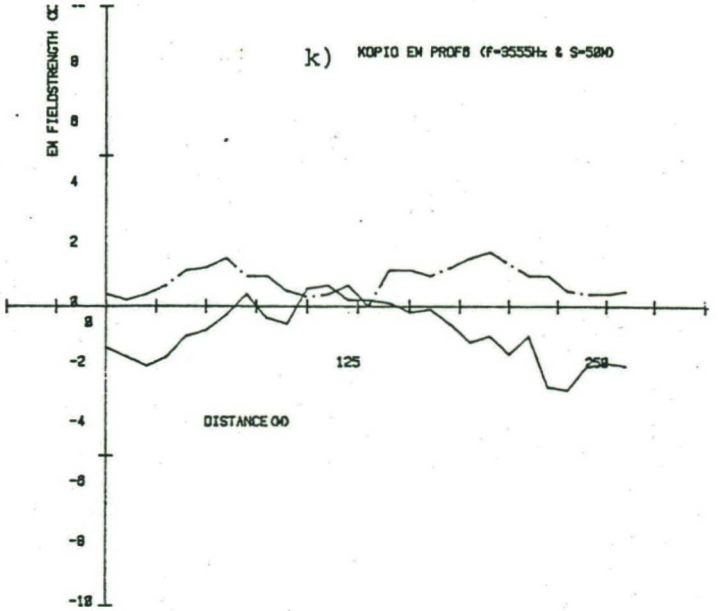

e) KOPIO EM PROF3 (f=3555Hz & S=50m
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE (m)

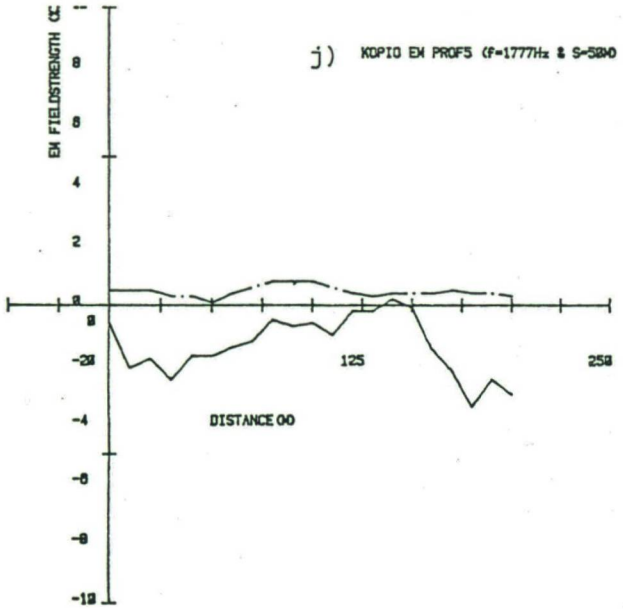

g) KOPIO EM PROF4 (f=3555Hz & S=50m
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
DISTANCE (m)

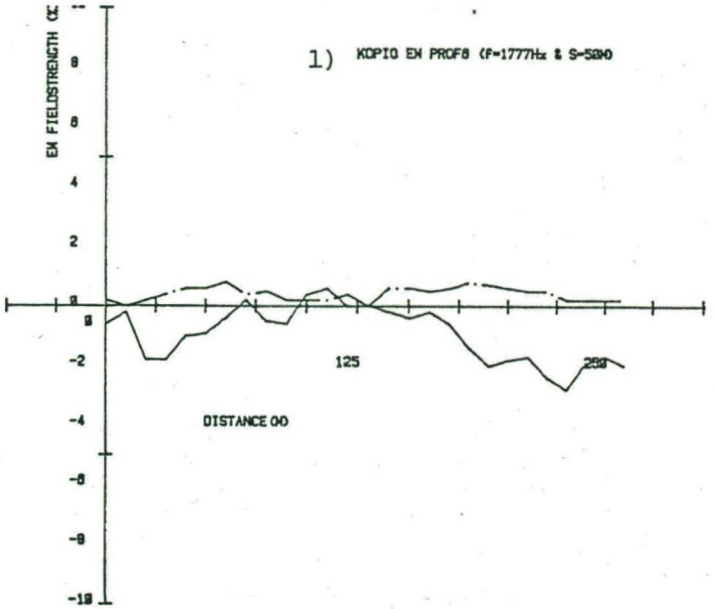

f) KOPIO EM PROF3 (f=1777Hz & S=50m
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE (m)


h) KOPIO EM PROF4 (f=1777Hz & S=50m
EM FIELDSTRENGTH (%
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
DISTANCE (m)


i) KOPIO EM PROF5 (f=3555Hz & S=50M0
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE 00


k) KOPIO EM PROF8 (f=3555Hz & S=50M0
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE 00


j) KOPIO EM PROF5 (f=1777Hz & S=50M0
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE 00


l) KOPIO EM PROF8 (f=1777Hz & S=50M0
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE 00

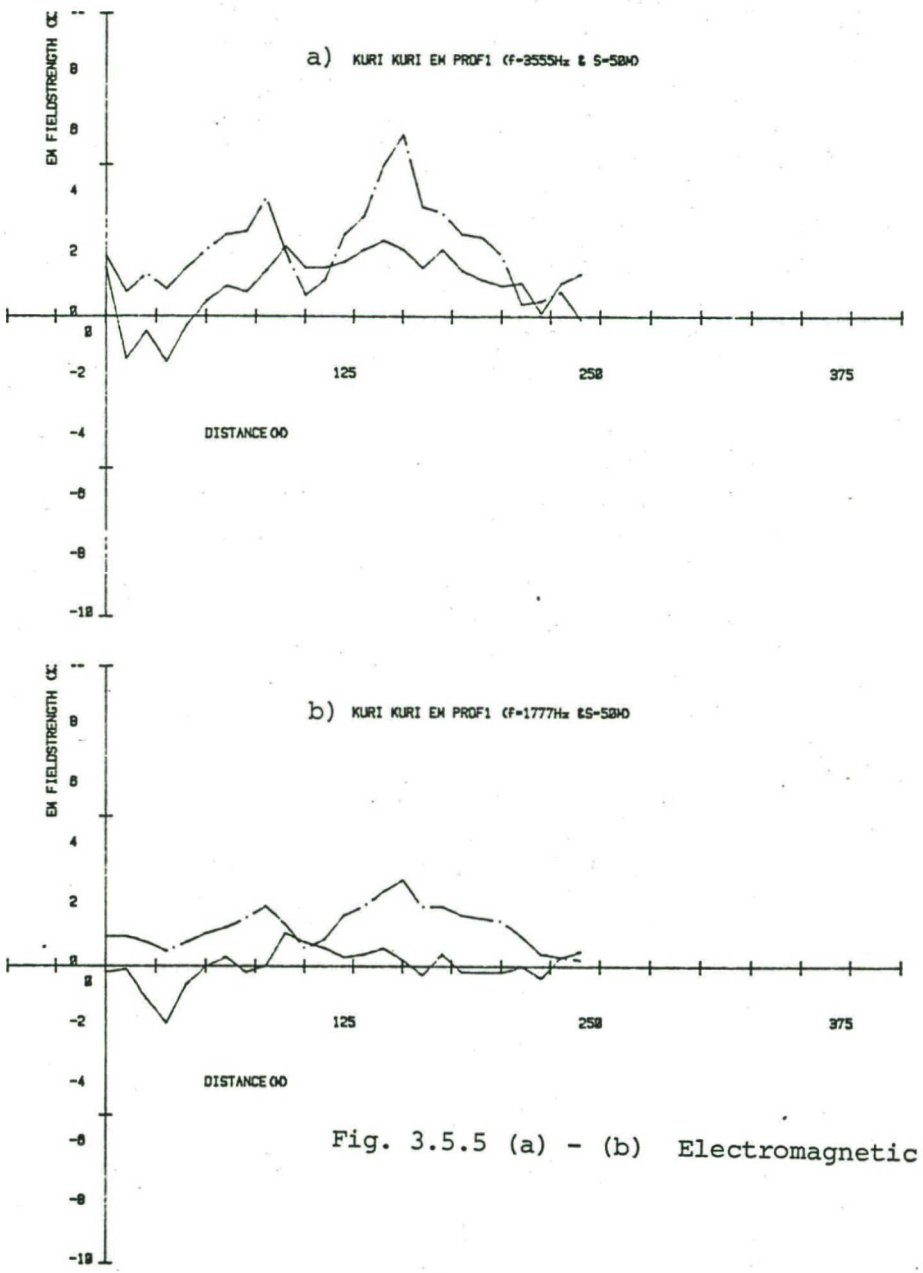


Fig. 3.5.5 (a) - (b) Electromagnetic Profile made at Kuri Kuri

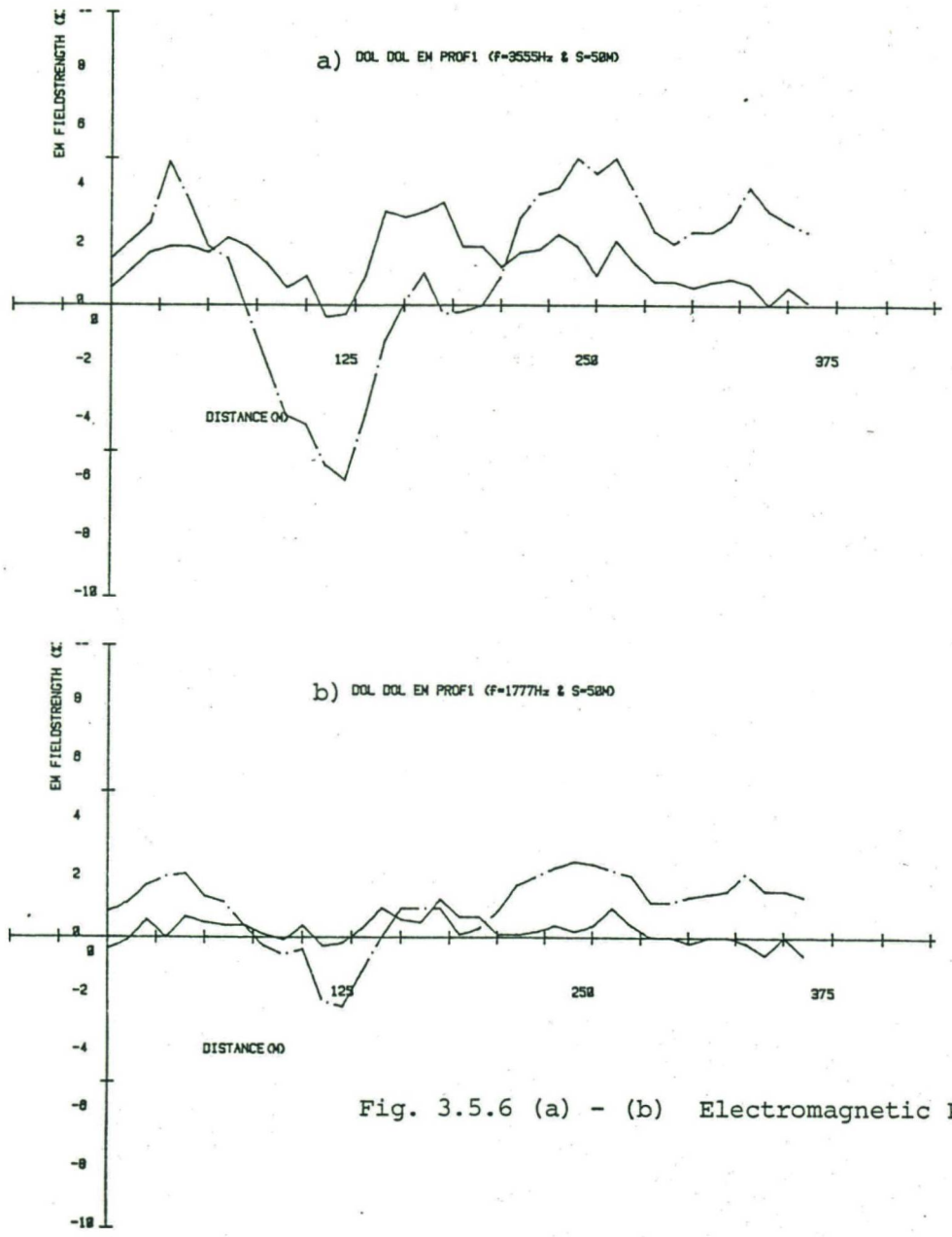


Fig. 3.5.6 (a) - (b) Electromagnetic Profile made at Dol Dol

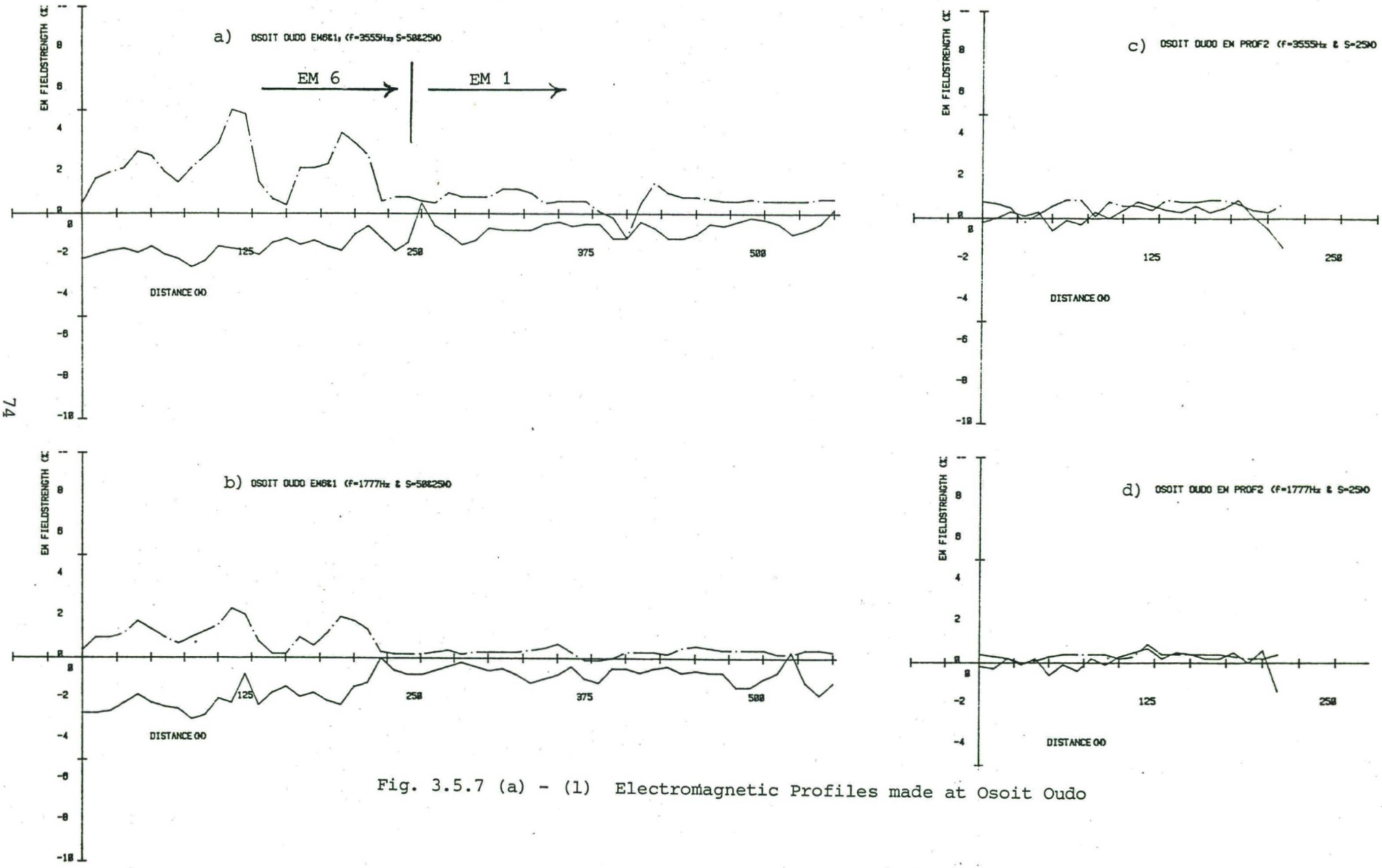
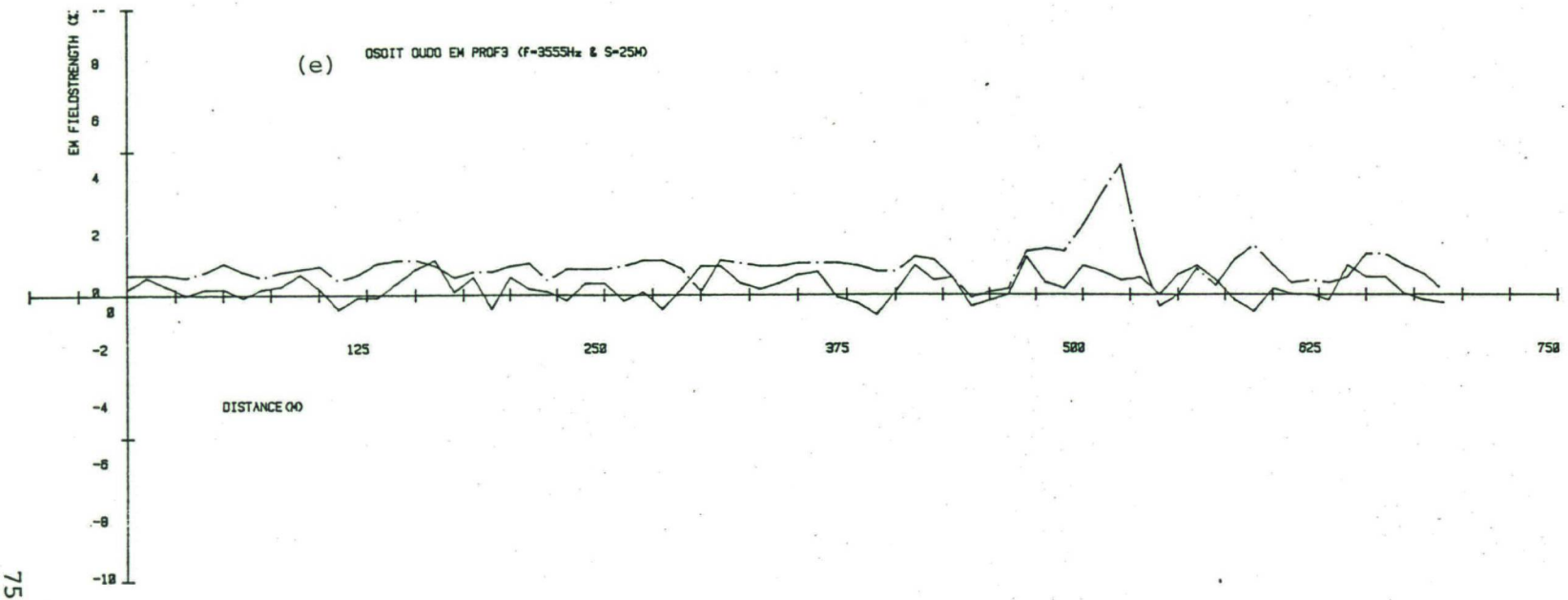
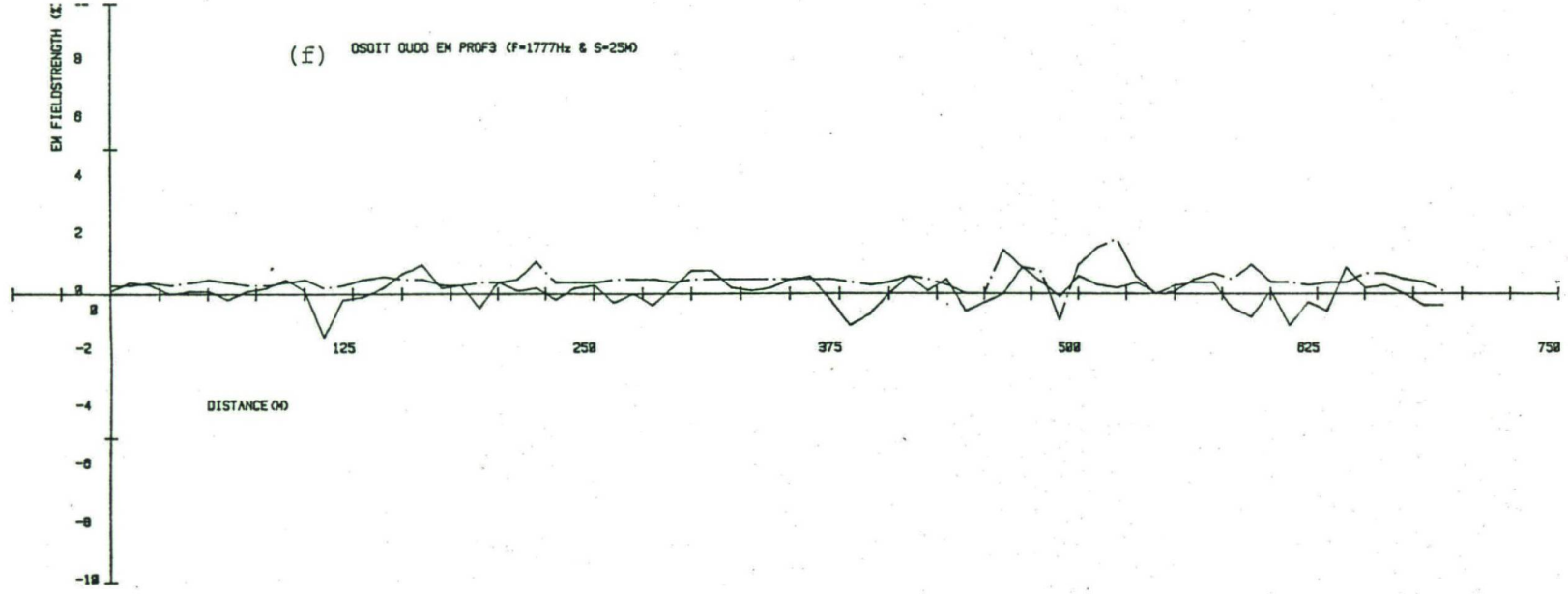
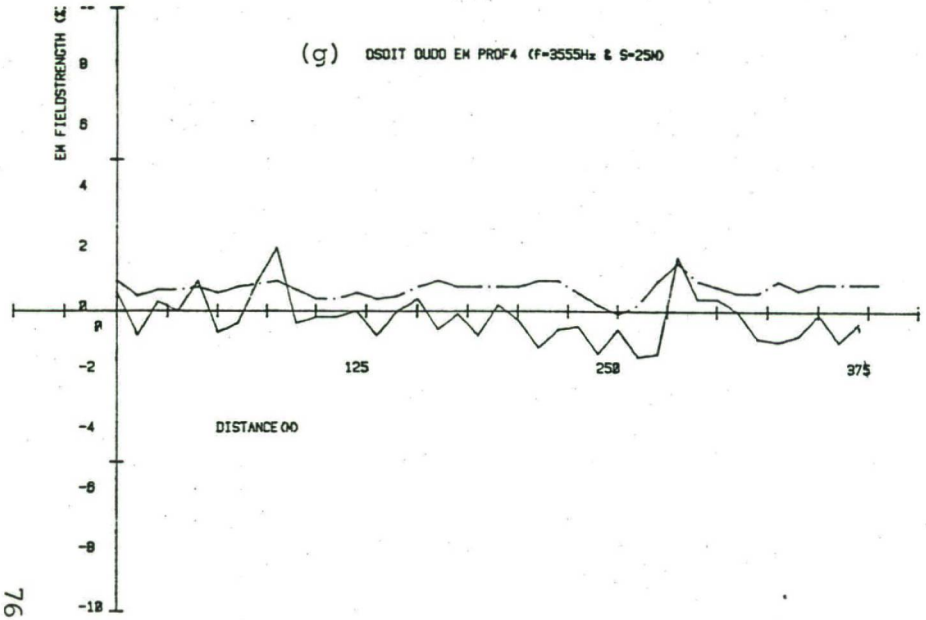
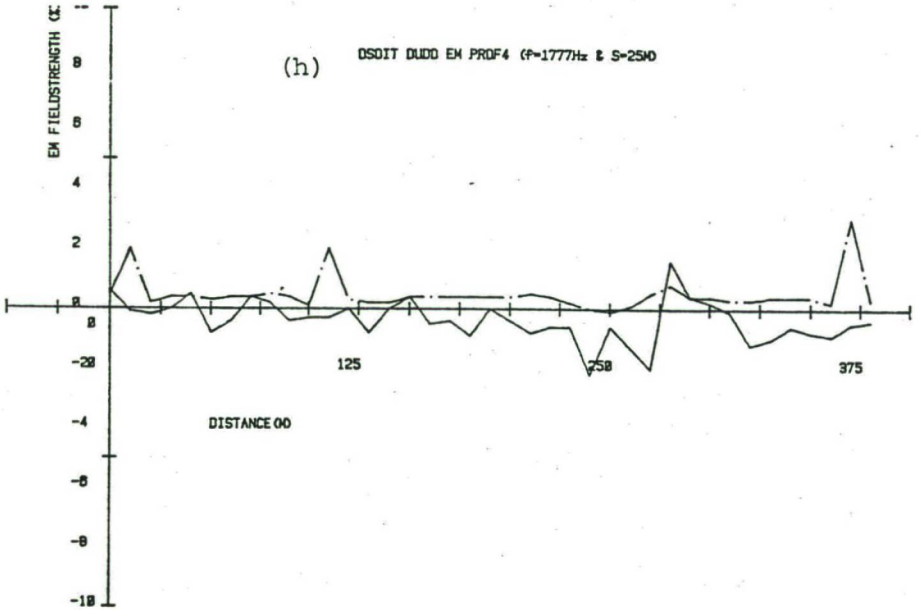


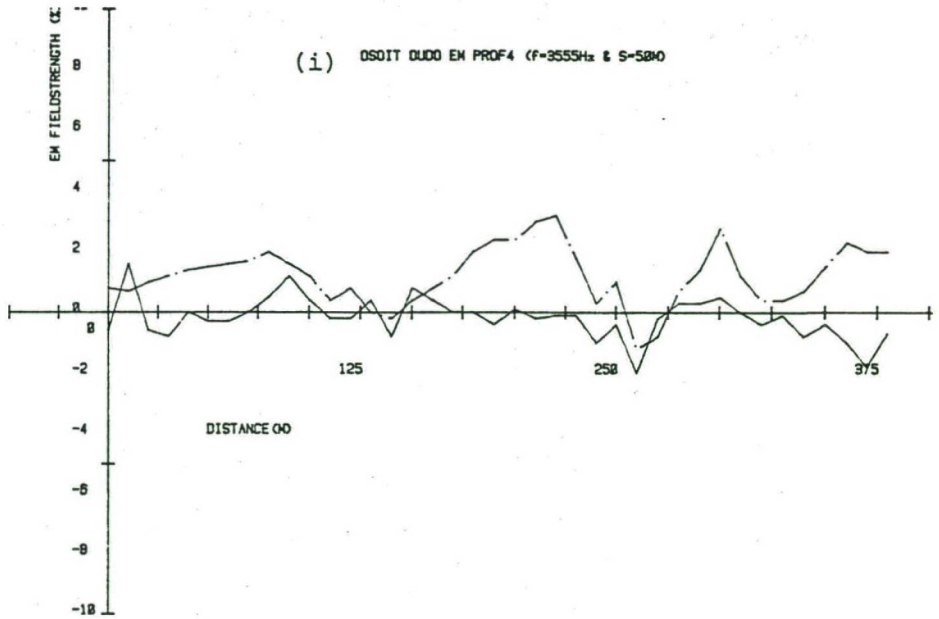
Fig. 3.5.7 (a) - (1) Electromagnetic Profiles made at Osoit Oudo

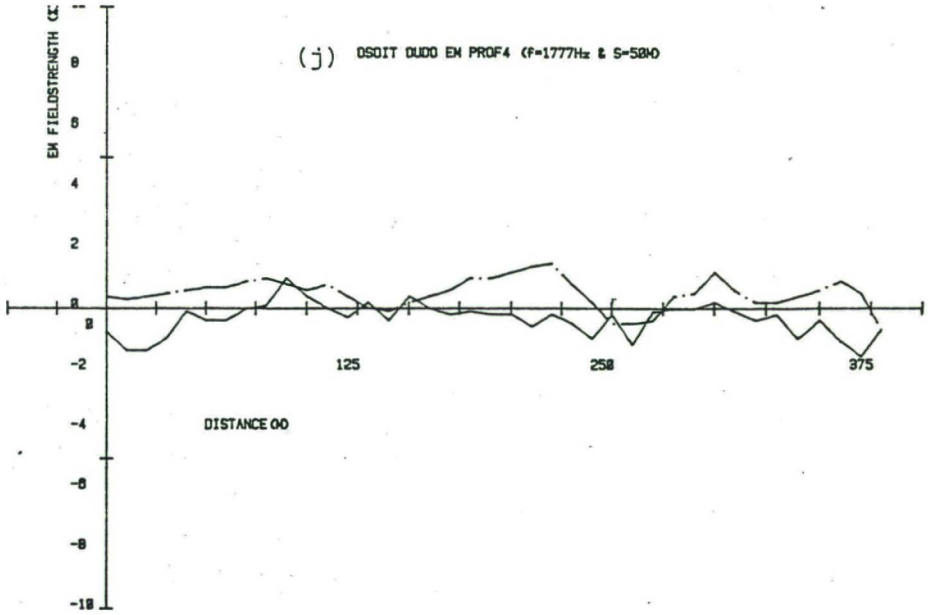

(e)
OSOIT OUDO EM PROF3 (F=3555Hz & S=25M)
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
500
625
750
DISTANCE (M)

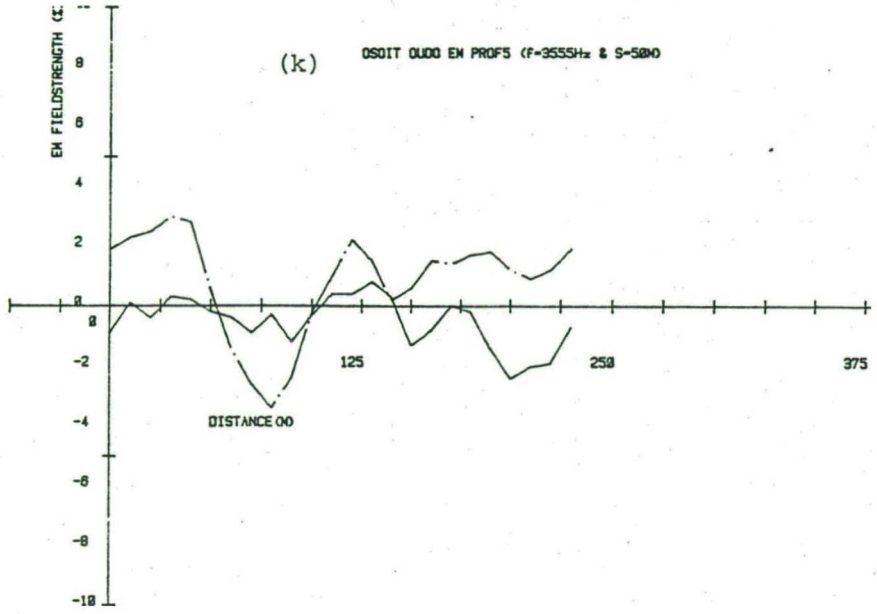

(f)
OSOIT OUDO EM PROF3 (F=1777Hz & S=25M)
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
500
625
750
DISTANCE (M)

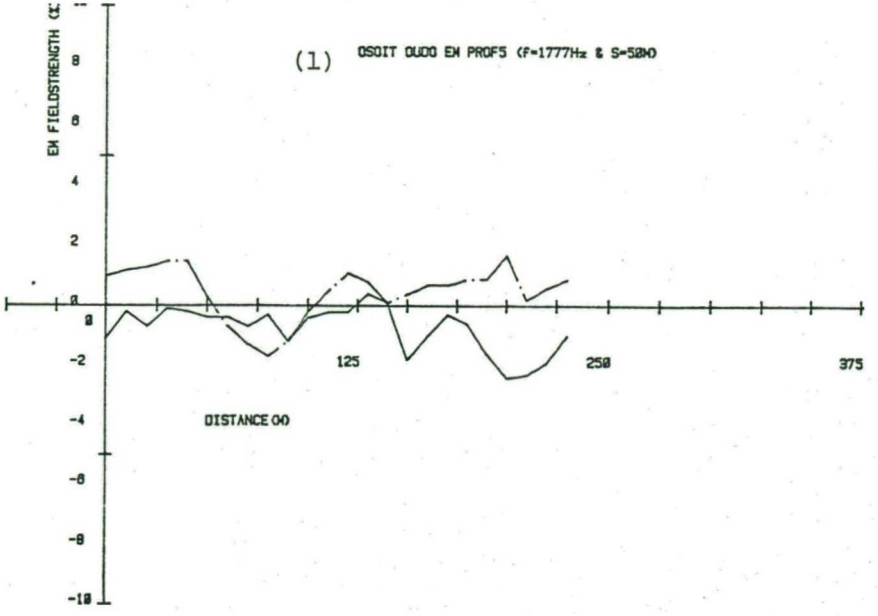

(g) OSOIT OUDO EM PROF4 (f=3555Hz & S=25M0
EM FIELDSTRENGTH (E
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
DISTANCE (M)


(h) OSOIT OUDO EM PROF4 (f=1777Hz & S=25M0
EM FIELDSTRENGTH (E
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
DISTANCE (M)


(i) OSOIT OUDO EM PROF4 (f=3555Hz & S=50M0
EM FIELDSTRENGTH (E
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
DISTANCE (M)


(j) OSOIT OUDO EM PROF4 (f=1777Hz & S=50M0
EM FIELDSTRENGTH (E
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
DISTANCE (M)


(k)
OSOIT OUOO EM PROFS (F=3555Hz & S=50MO
EM FIELDSTRENGTH (E
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
DISTANCE OO


(l)
OSOIT OUOO EM PROFS (F=1777Hz & S=50MO
EM FIELDSTRENGTH (E
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
DISTANCE OO

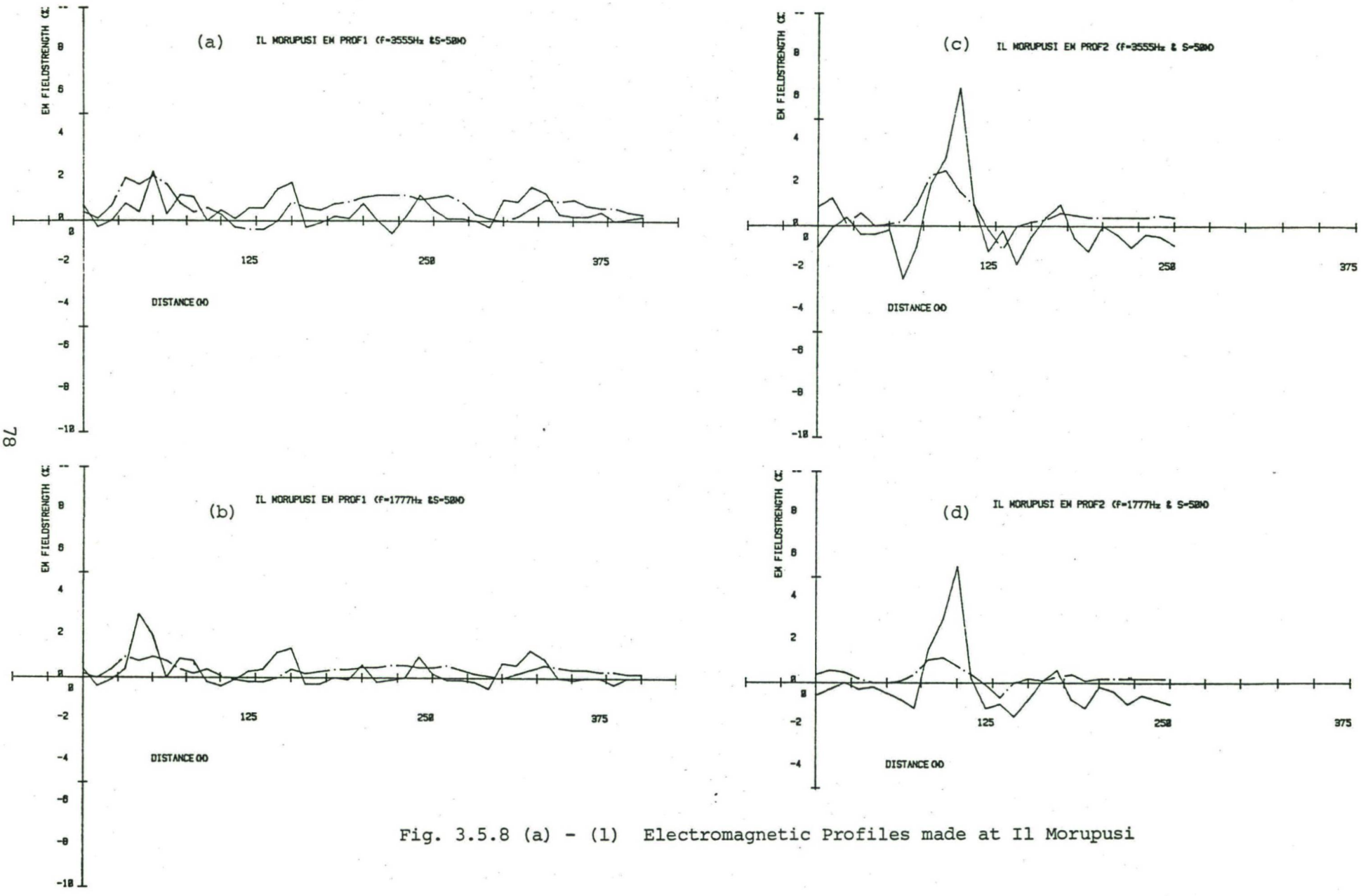
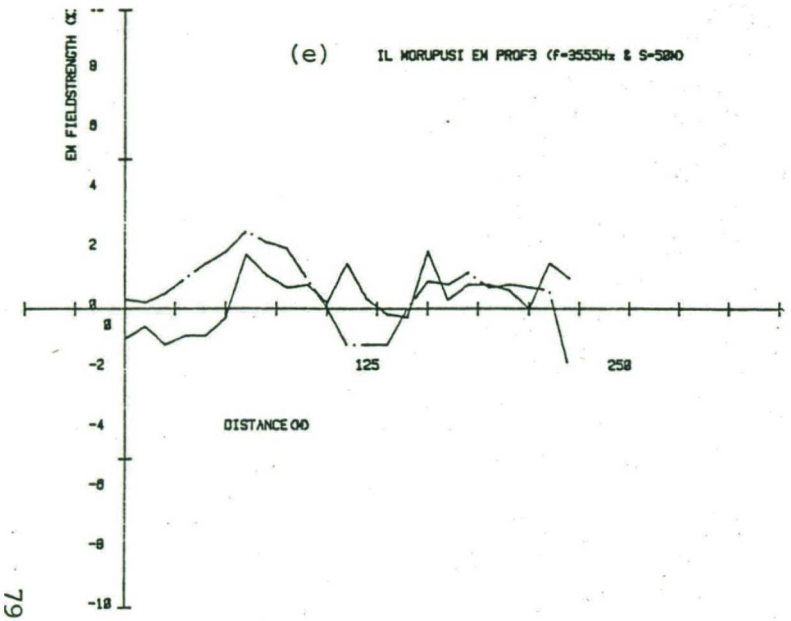
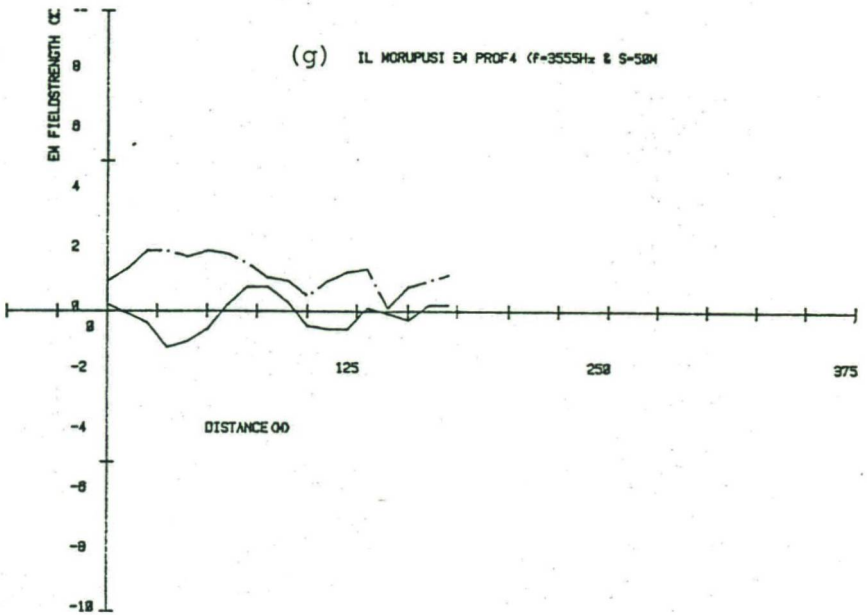
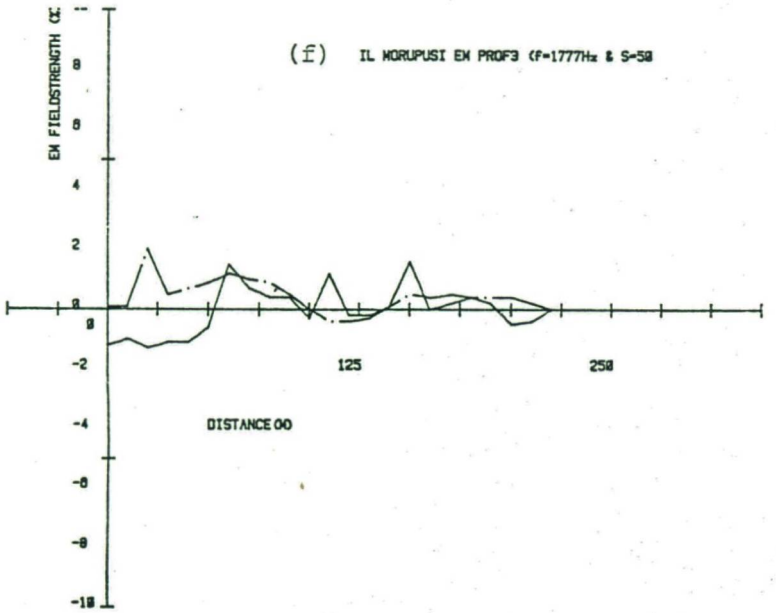
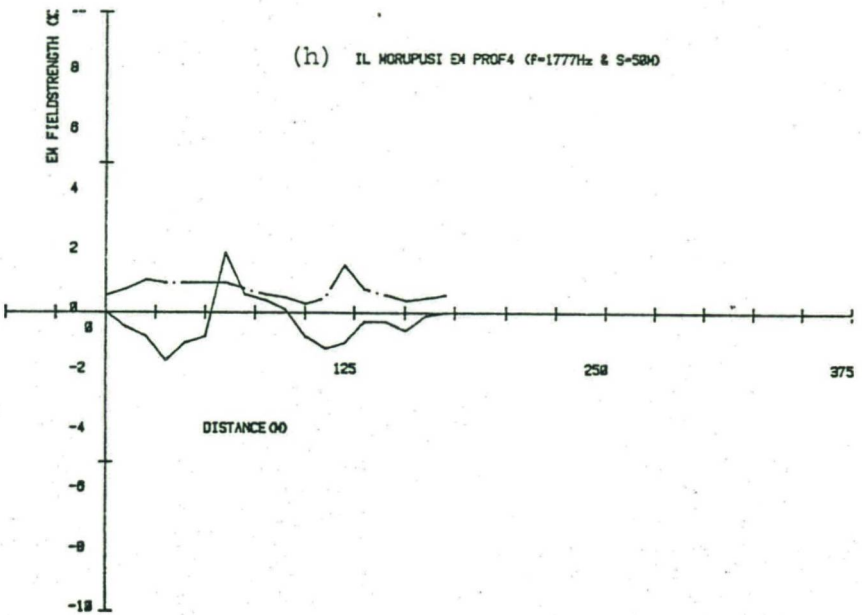


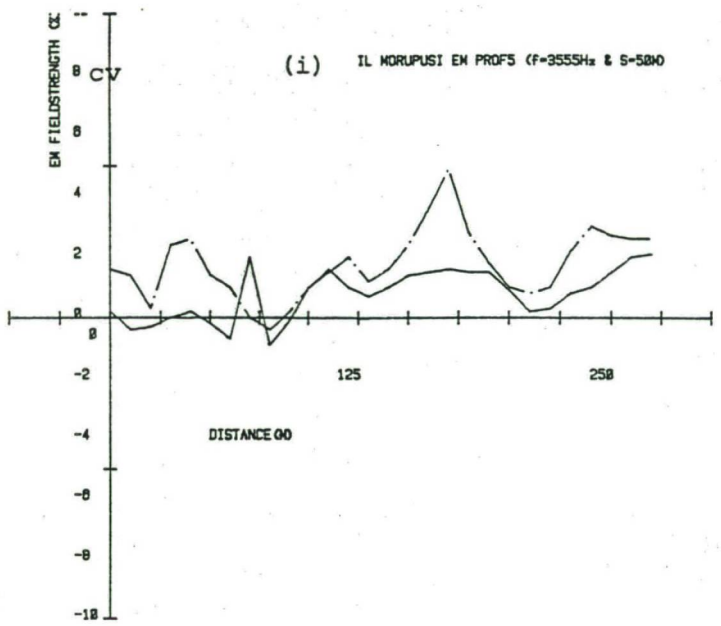
Fig. 3.5.8 (a) - (1) Electromagnetic Profiles made at Il Morupusi


(e) IL MORUPUSI EM PROF3 (F=3555Hz & S=50M
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE OO

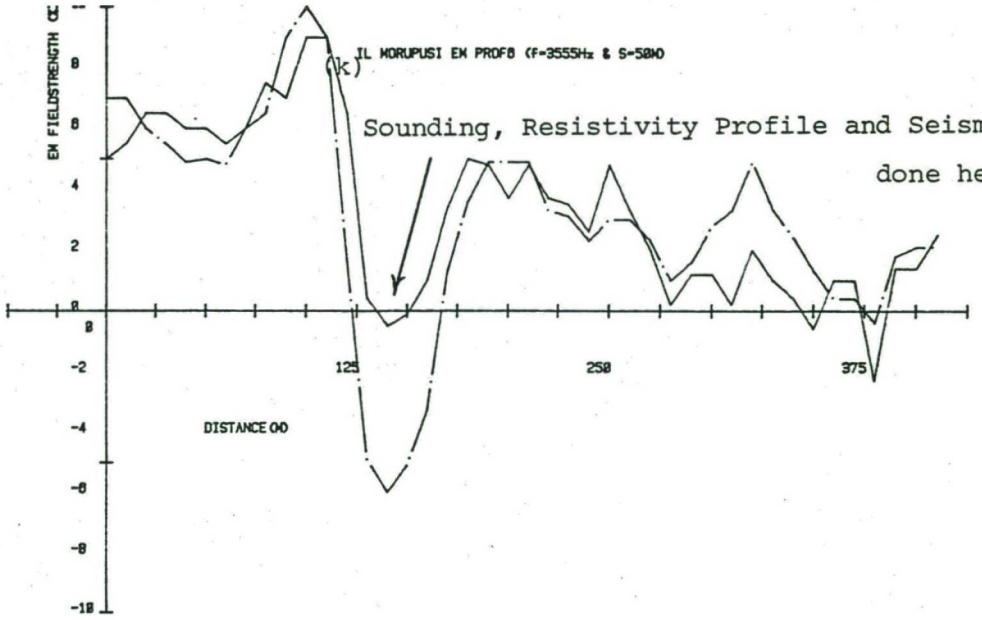

(g) IL MORUPUSI EM PROF4 (F=3555Hz & S=50M
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
DISTANCE OO


(f) IL MORUPUSI EM PROF3 (F=1777Hz & S=50
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE OO

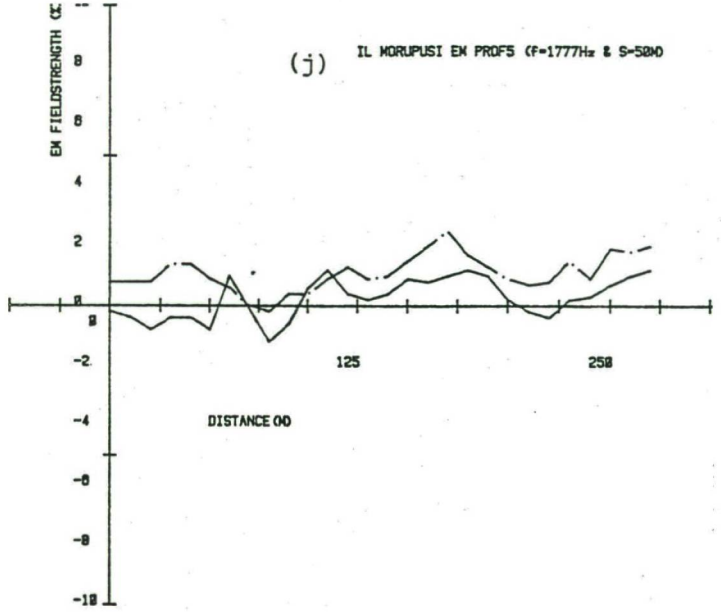

(h) IL MORUPUSI EM PROF4 (F=1777Hz & S=50M
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
DISTANCE OO

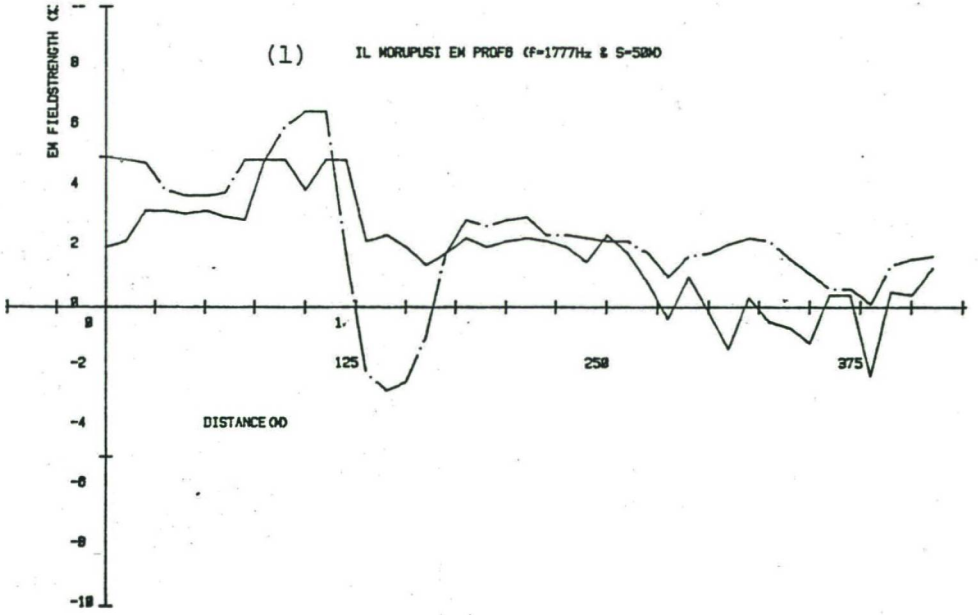


CV



Sounding, Resistivity Profile and Seismic Spread done here





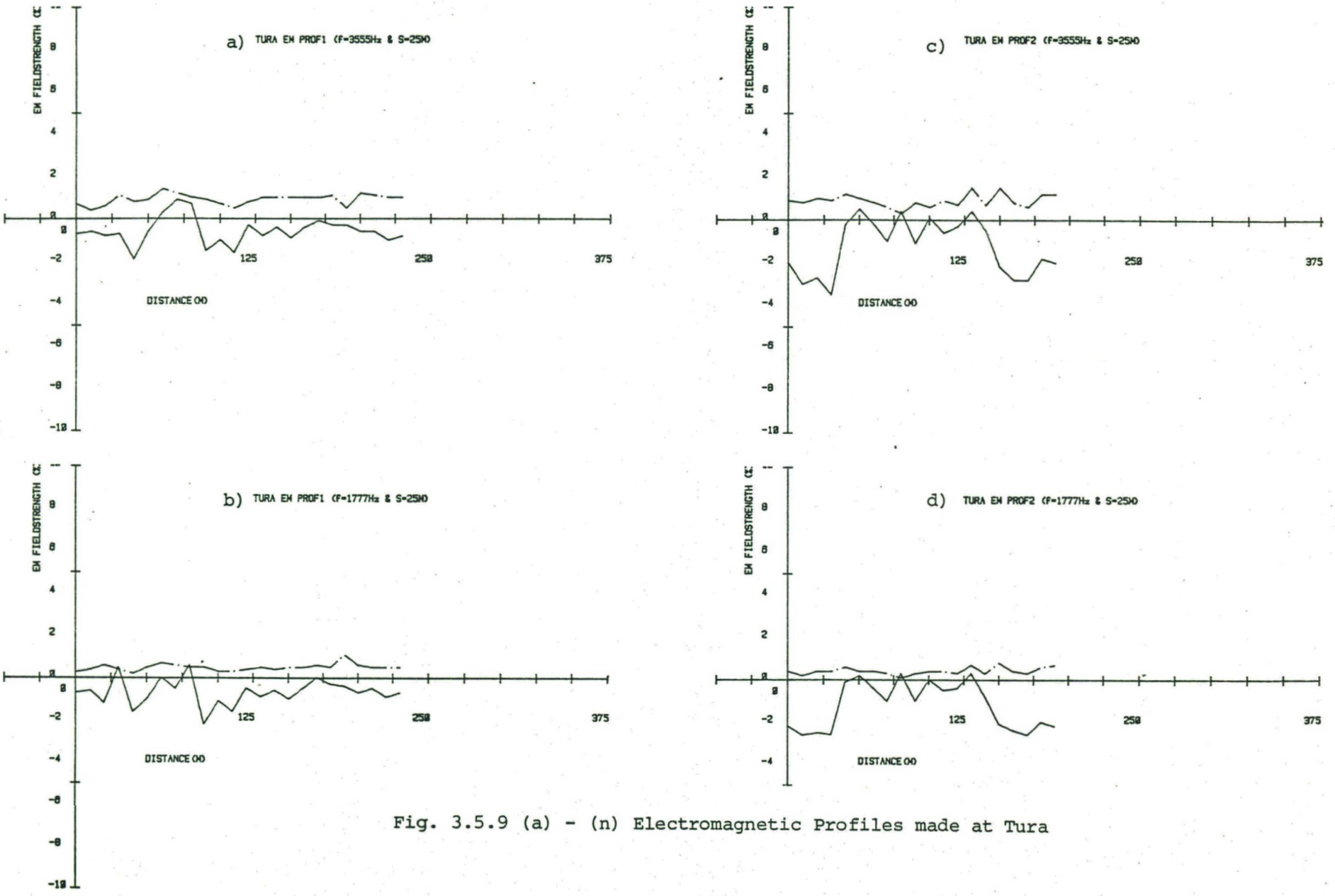
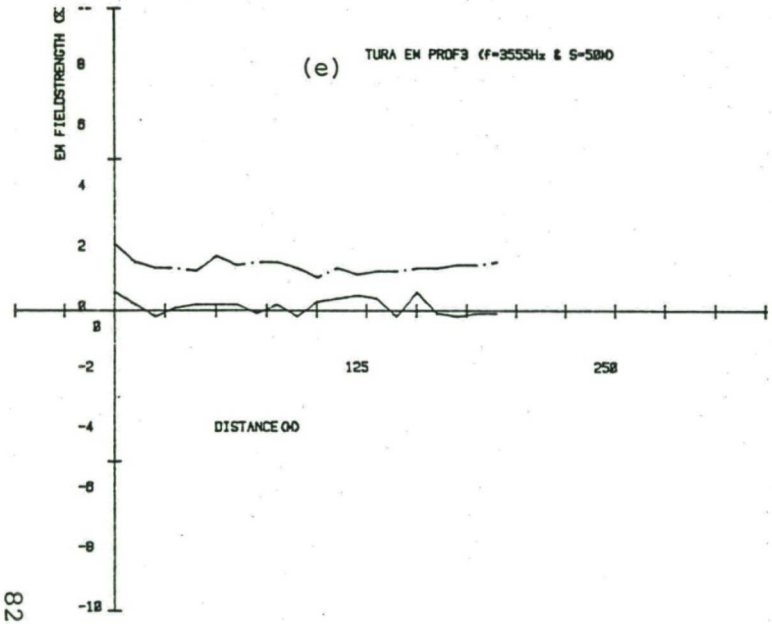
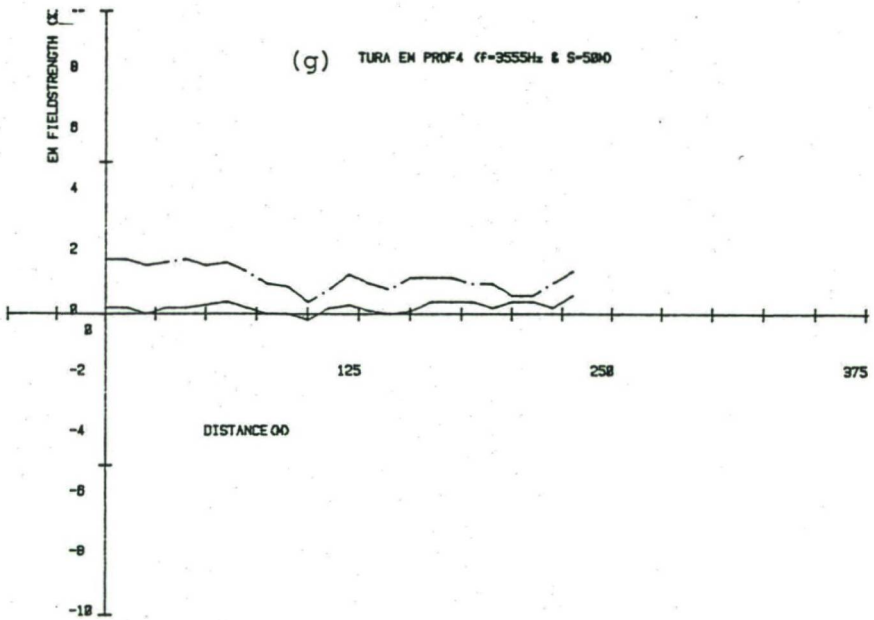
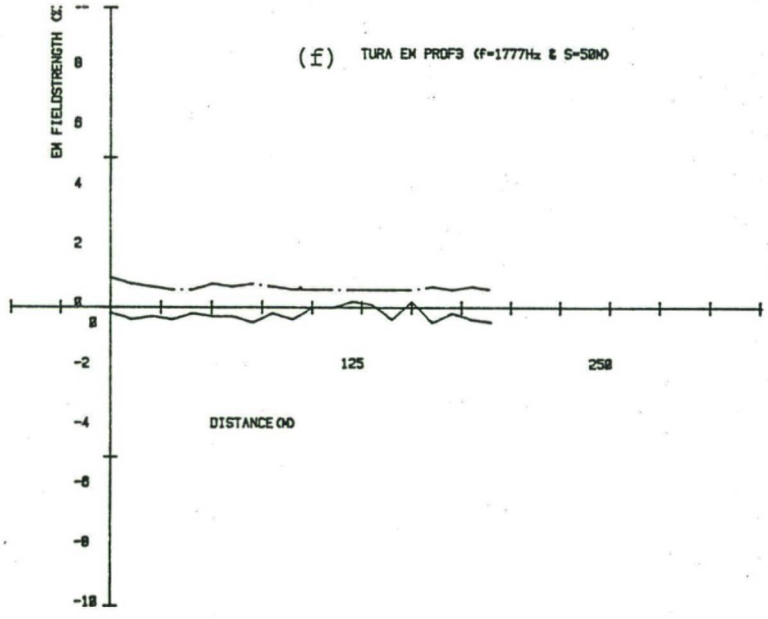
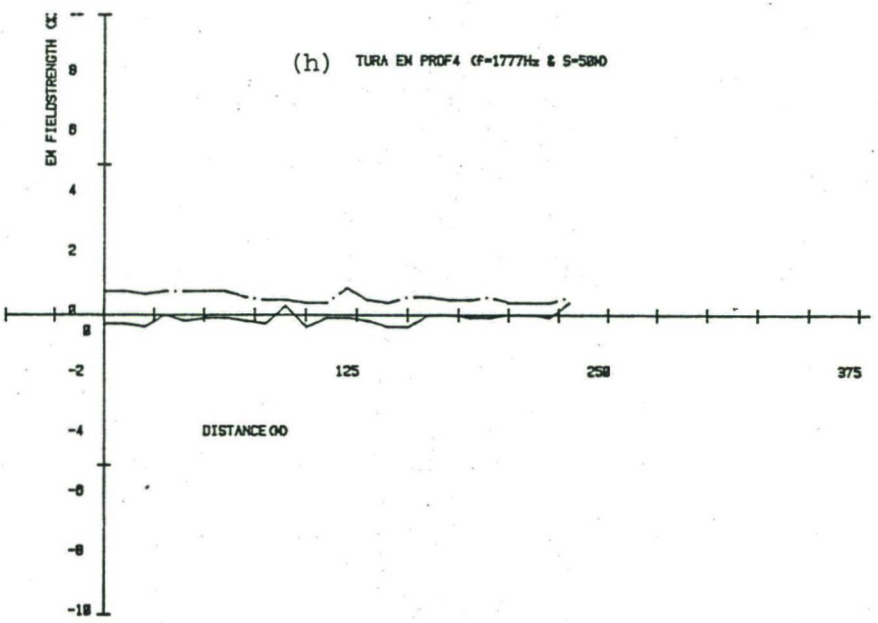


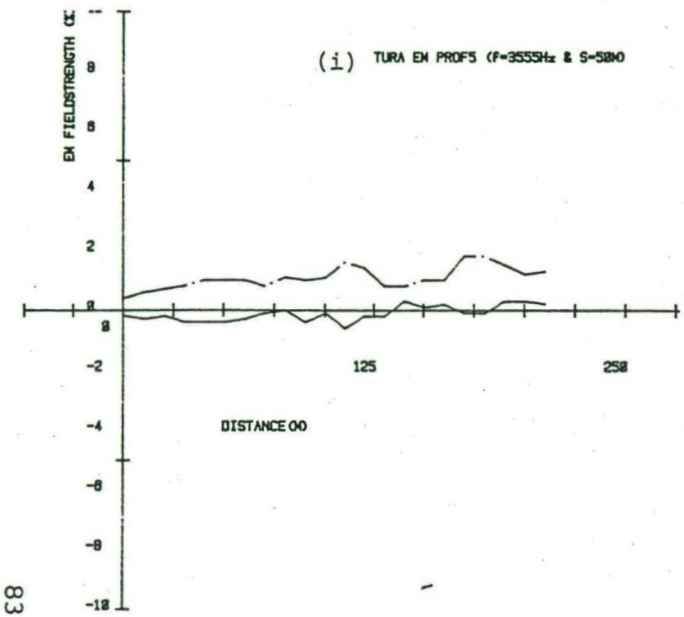
Fig. 3.5.9 (a) - (n) Electromagnetic Profiles made at Tura

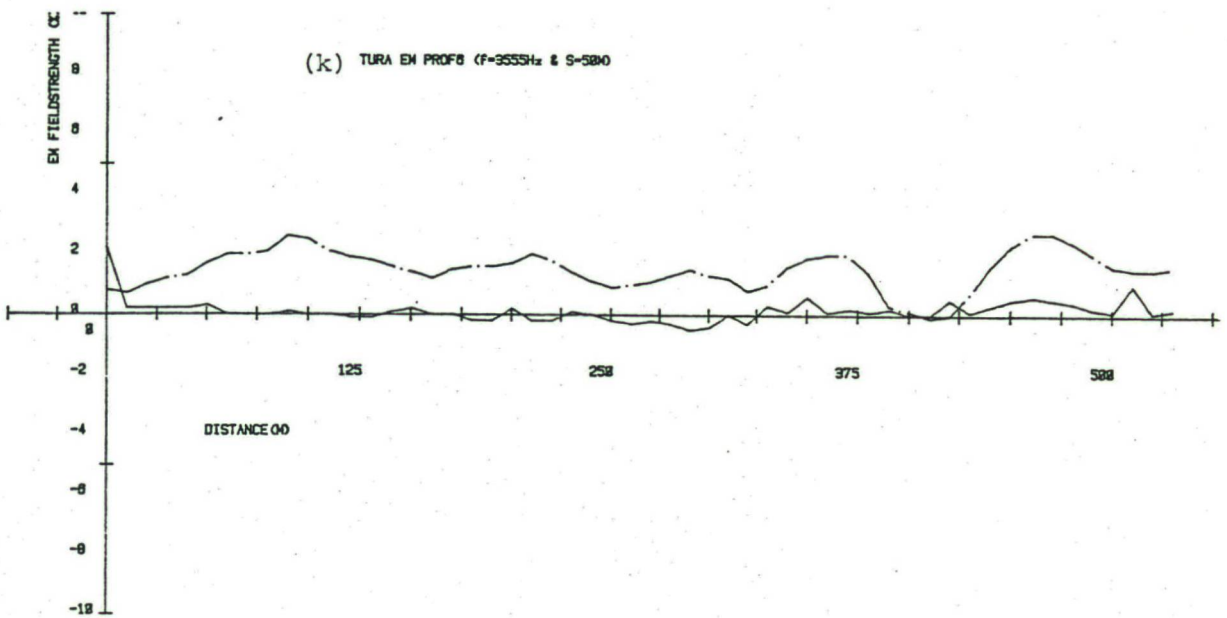

(e) TURA EM PROF3 (f=3555Hz & S=50M0
EM FIELDSTRENGTH dB
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4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE 00

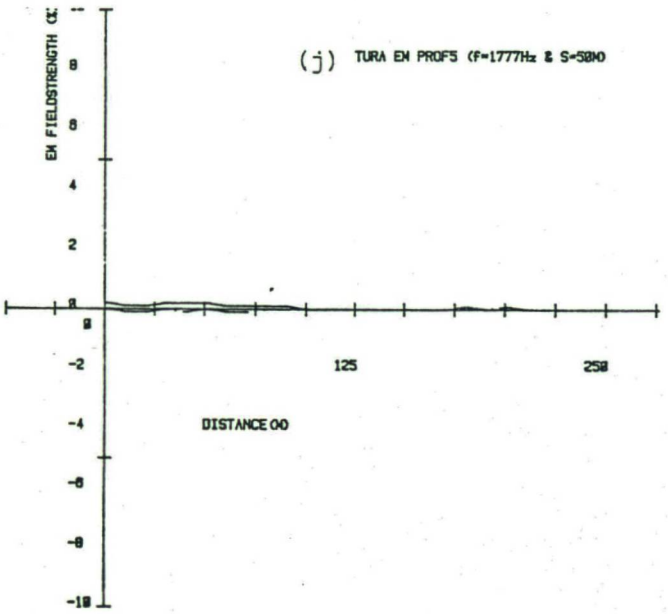

(g) TURA EM PROF4 (F=3555Hz & S=50M0
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
DISTANCE 00

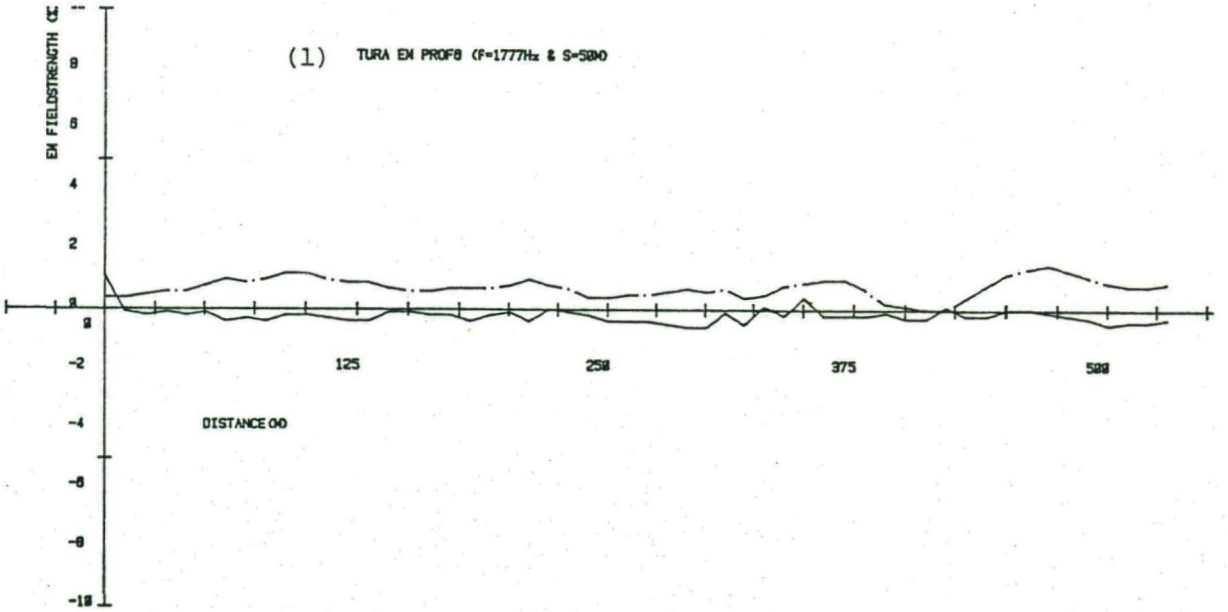

(f) TURA EM PROF3 (F=1777Hz & S=50M0
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE 00

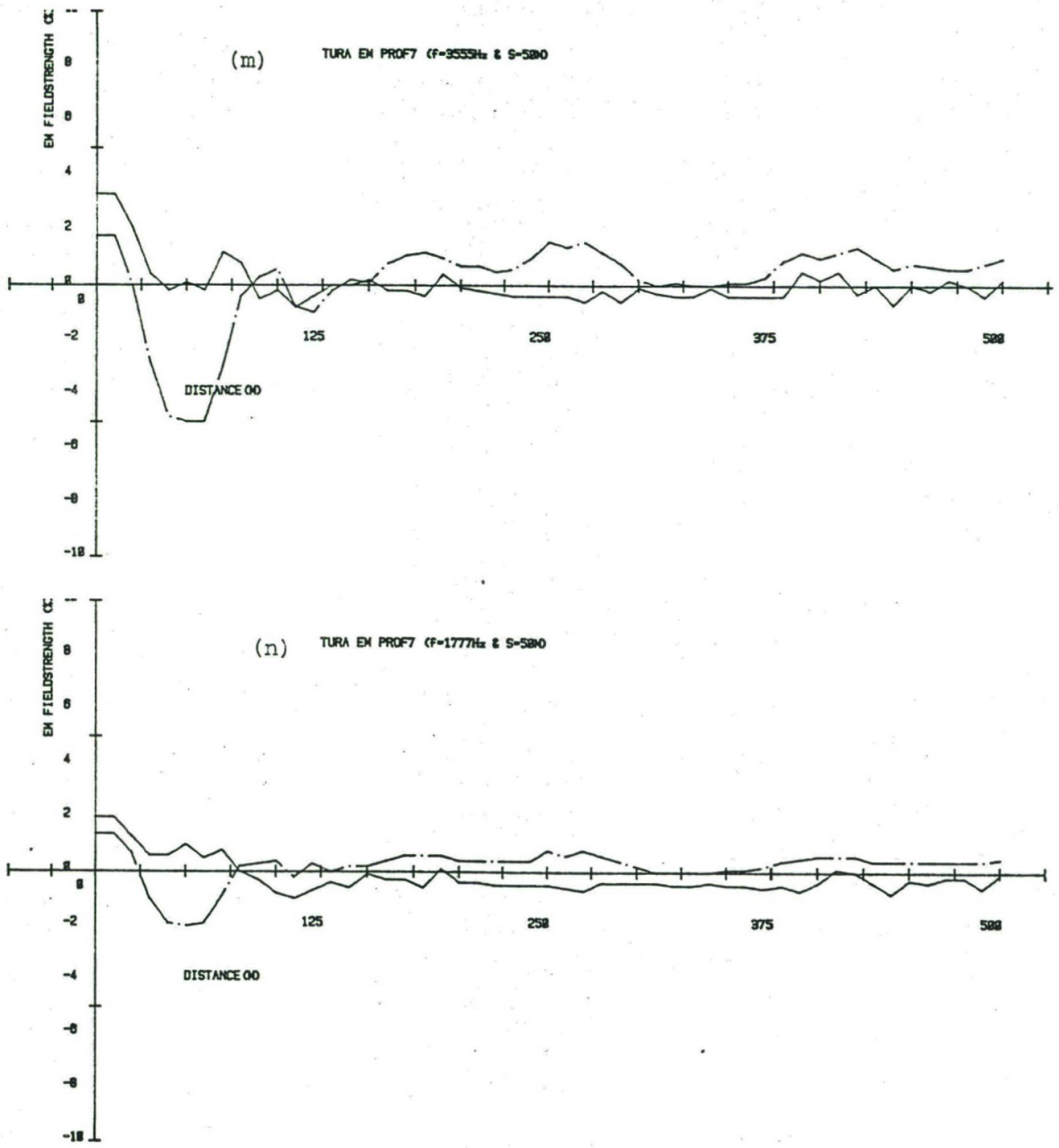

(h) TURA EM PROF4 (F=1777Hz & S=50M0
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
DISTANCE 00


(i) TURA EM PROF5 (F=3555Hz & S=50M0
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE 00


(k) TURA EM PROF8 (F=3555Hz & S=50M0
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
500
DISTANCE 00


(j) TURA EM PROF5 (F=1777Hz & S=50M0
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
DISTANCE 00


(l) TURA EM PROF8 (F=1777Hz & S=50M0
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
500
DISTANCE 00


(m)
TURA EM PROF7 (F=3555Hz & S=5800
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
500
DISTANCE 00
(n)
TURA EM PROF7 (F=1777Hz & S=5800
EM FIELDSTRENGTH dB
8
6
4
2
0
-2
-4
-6
-8
-10
125
250
375
500
DISTANCE 00

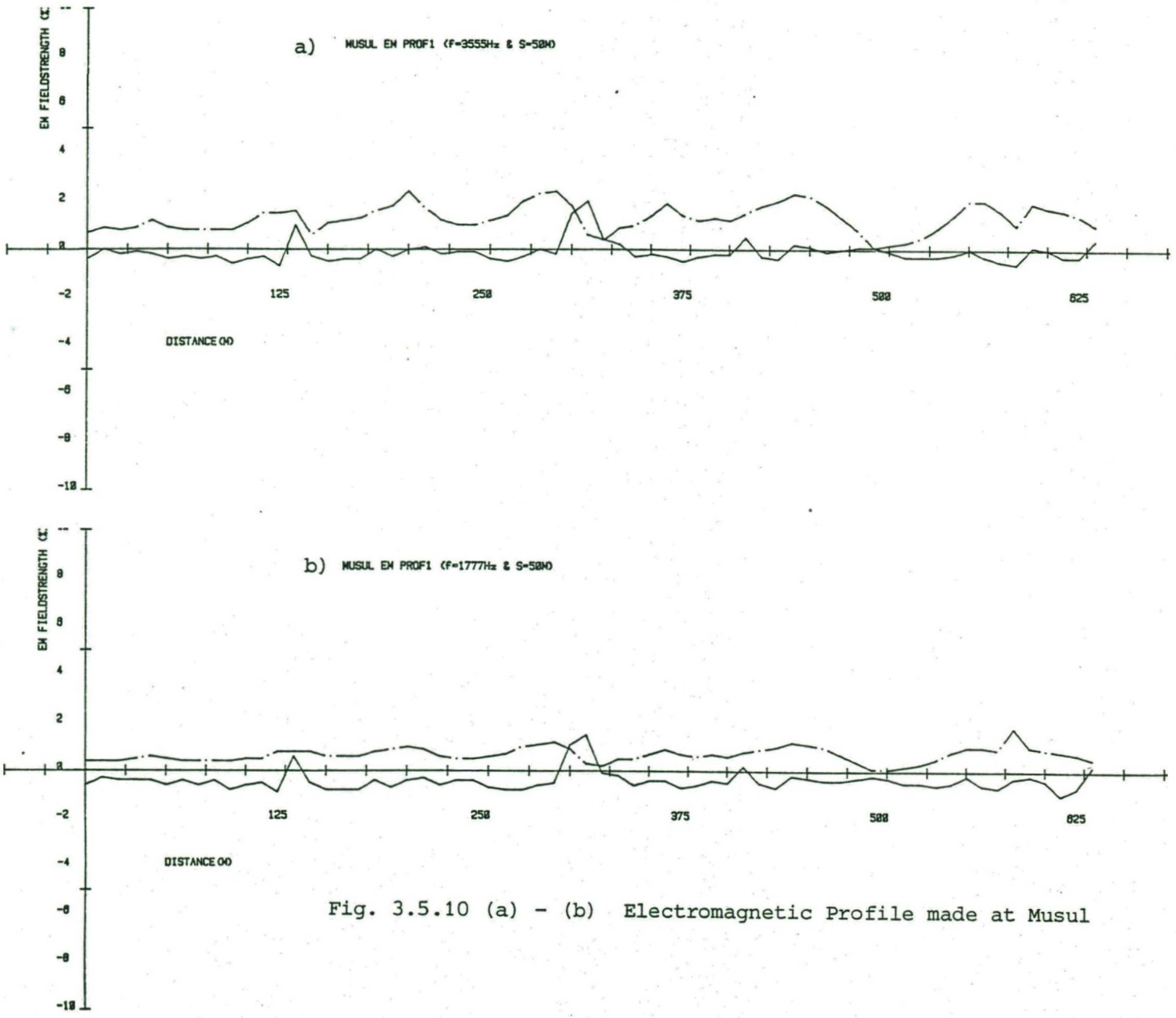


Fig. 3.5.10 (a) - (b) Electromagnetic Profile made at Musul

APPENDIX 3.6

Seismic Spreads

Table No. 3.6.1 (a) First Arrival Times for Spread No. 1 at Lariakorok

Short Point	Distance to nearest Geophone (m)
Far forward (FF)	82.5
Forward (F)	3.75
Centre (C)	3.75
Reverse (R)	3.75
Far Reverse (FR)	82.5
Geophone spacing	7.5
Depth of Charge	1.2

	First Arrival times (ms)				
Geophone No.	Short Point FF	Short Point F	Short Point C	Short Point R	Short Point FR
1.	42	10	37	42	57
2.	43	19	34	41	54
3.	47	28	31.5	39	53
4.	48	31	27.5	37	52
5.	49	33.5	18.5	36	51
6.	54	37.5	9.5	35	50.5
7.	57	40.5	8.5	34	50
8.	58	41.5	25	32	49
9.	61	47	35	31	47
10.	62	49.5	38	27	45
11.	63	50	39	22	42
12.	64	51	40	9	37

Table No. 3.6.1 (b) First Arrival Times for Spread No. 2 at Lariakorok

Short Point	Distance to nearest Geophone (m)
Far forward (FF)	82.5
Forward (F)	3.75
Centre (C)	3.75
Reverse (R)	3.75
Far Reverse (FR)	82.5
Geophone spacing	7.5
Depth of Charge	1.2

	First Arrival times (ms)				
Geophone No.	Short Point FF	Short Point F	Short Point C	Short Point R	Short Point FR
1.	51	10.5	40	48	62
2.	53	26	39	46	61
3.	54	32	38	44	59
4.	56	34	36.5	42	57
5.	57	38	29	41.5	56
6.	58	39	8	40	55
7.	59	39.5	10	38.5	54
8.	60	40	31	38.5	52
9.	62	40.5	33.5	37.5	51
10.	63	41	34	32	50
11.	64	43	35	21	48
12.	65	45	37	12	47

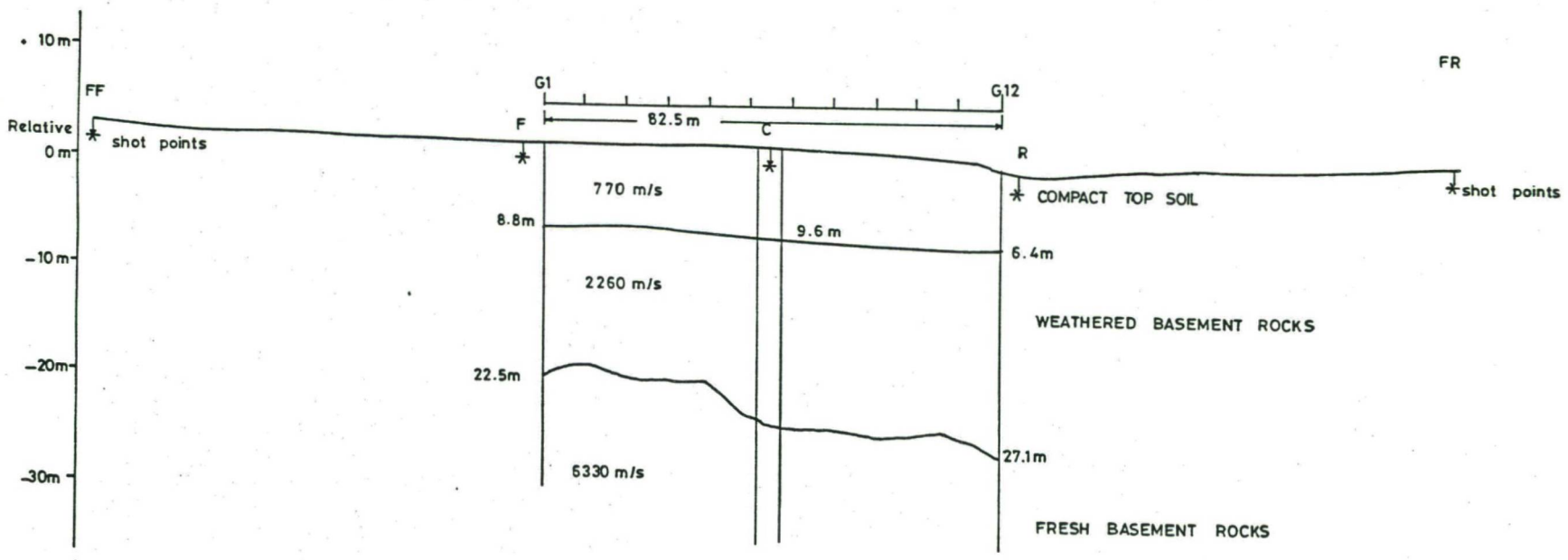


Fig. 3.6.1 (a) seismic spread Nr1, Laiakorok
(Geophone spacing = 7.5m)

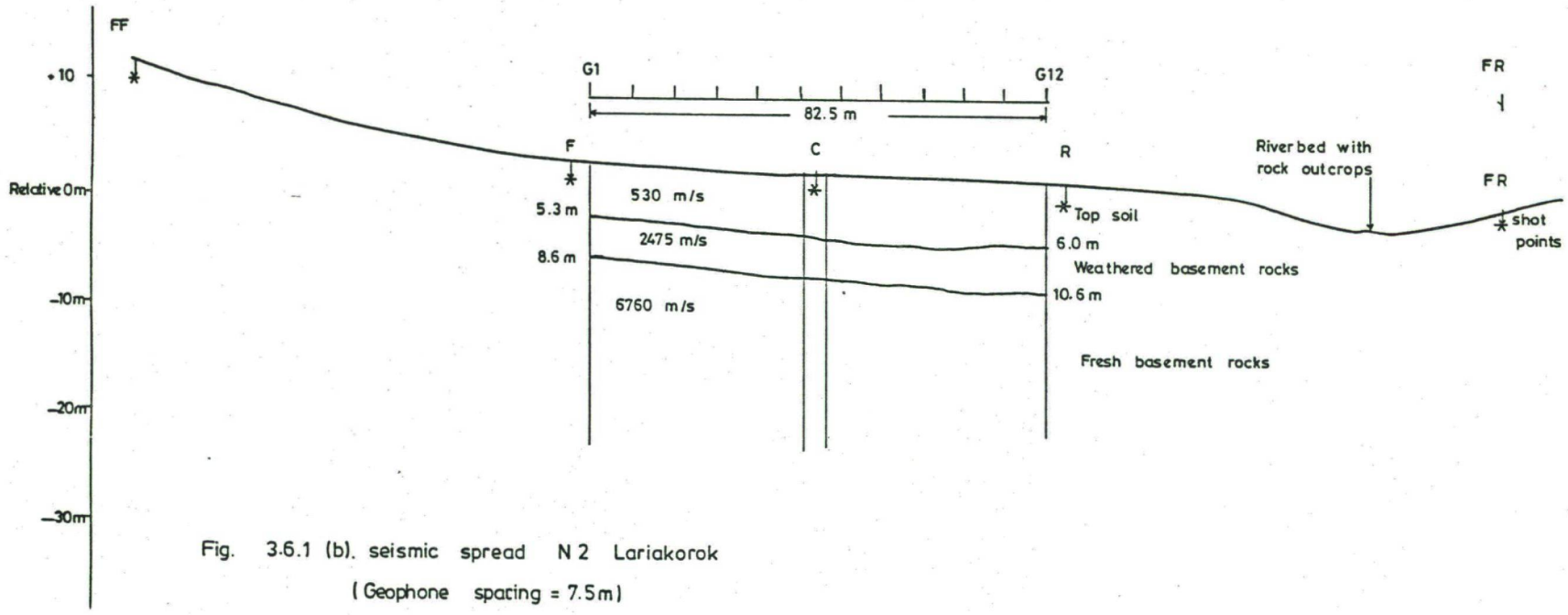


Fig. 3.6.1 (b). seismic spread N 2 Lariakorok

(Geophone spacing = 7.5m)

Table No. 3.6.2 First Arrival Times for Spread No. 1 at Kopio

Short Point	Distance to nearest Geophone (m)
Far forward (FF)	55.0
Forward (F)	2.5
Centre (C)	2.5
Reverse (R)	2.5
Far Reverse (FR)	55.0
Geophone spacing	5
Depth of Charge	1.2

	First Arrival times (ms)				
Geophone No.	Short Point FF	Short Point F	Short Point C	Short Point R	Short Point FR
1.	29.5	5	24	34	46
2.	30.5	14	22.5	33	45
3.	31.5	18	22	32	44.5
4.	33	20.5	19.5	31	44
5.	34	21	17	30	43
6.	35	22.5	6.5	29	42
7.	35.5	24.0	7.0	27	41
8.	36	26	14.5	26	40
9.	37	26.5	18.5	25	39.5
10.	38	27.5	22	24	39
11.	39	28.5	25	17	38.5
12.	42	32	27	4	38

Table No. 3.6.3 First Arrival Times for Spread No. 1 at Il Morupusi

Short Point	Distance to nearest Geophone (m)
Far forward (FF)	55.0
Forward (F)	2.5
Centre (C)	2.5
Reverse (R)	2.5
Far Reverse (FR)	55.0
Geophone spacing	2.5
Depth of Charge	1.2 (Far Reverse at 0.75m depth)

	First Arrival times (ms)				
Geophone No.	Short Point FF	Short Point F	Short Point C	Short Point R	Short Point FR
1.	54.5	7	37	46	52.5
2.	55	15	32	44.5	50
3.	55.5	21	25.5	42	48.5
4.	56	25	19.5	39	46
5.	57.5	33	18.5	37.5	45.5
6.	58	35	8	36	44.5
7.	58.5	40.5	8.5	34.5	43.5
8.	59.0	45	17	33	43
9.	59.5	46	23	30	42.5
10.	59.5	47	27	24	42
11.	59.5	48	29	20.5	40
12.	60	50	31.5	11	36.5

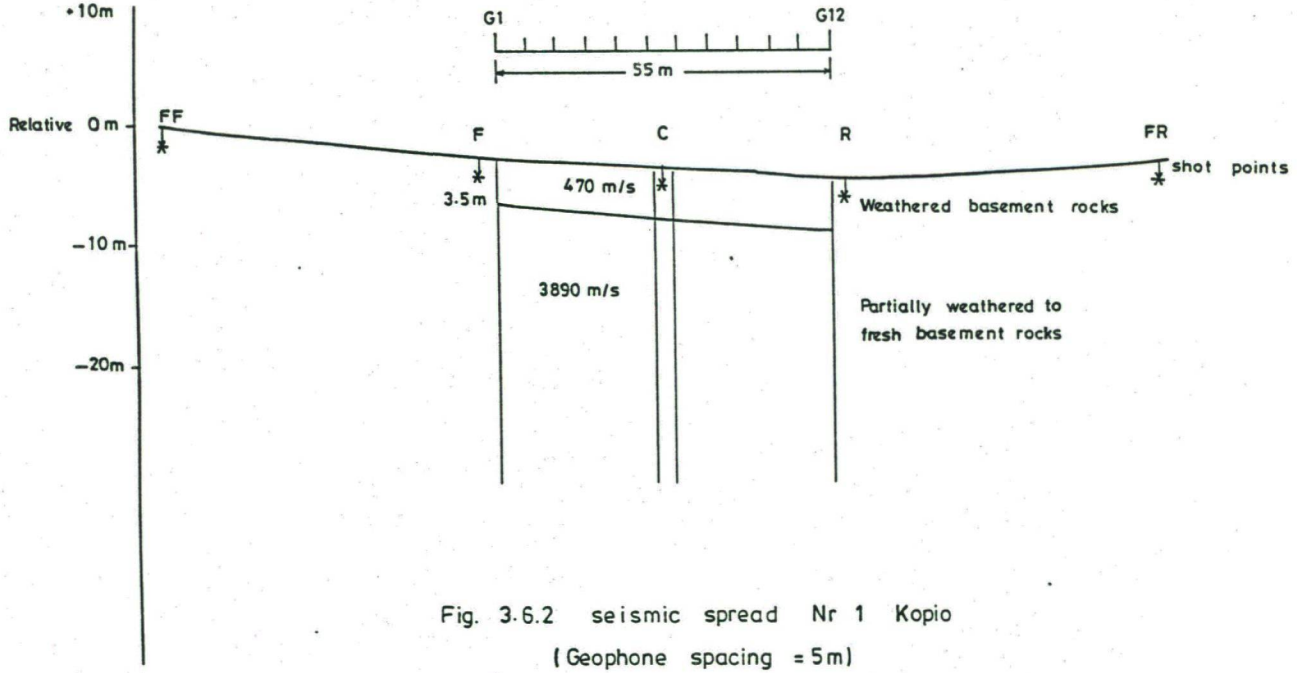


Fig. 3.6.2 seismic spread Nr 1 Kopio
(Geophone spacing = 5m)

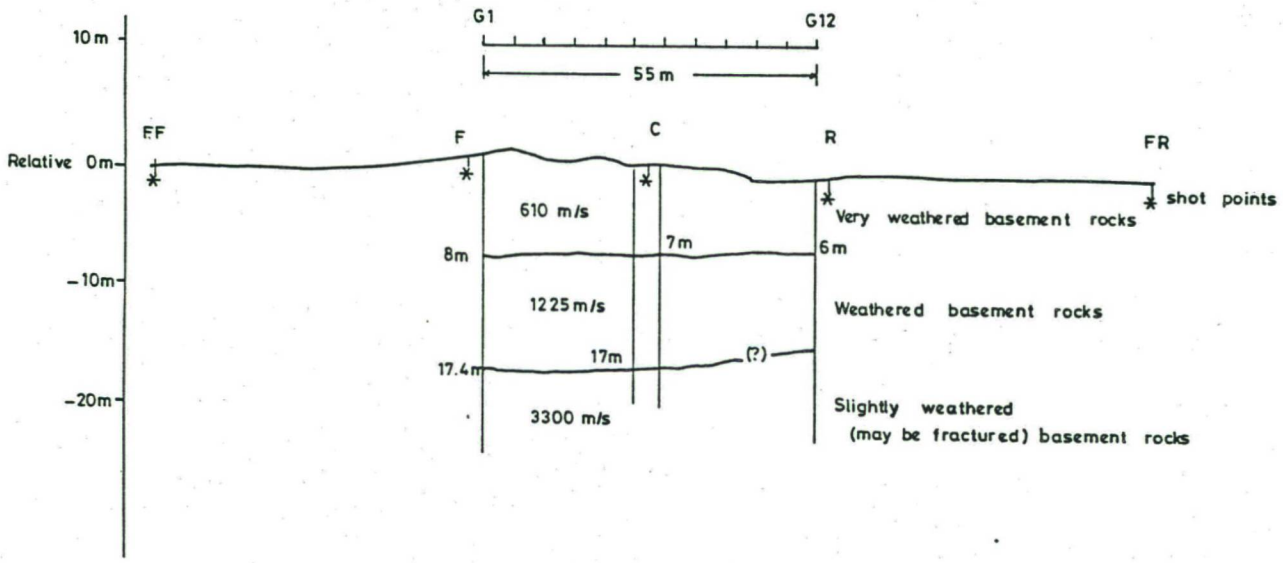


Fig 3.6.3. seismic spread Nr 1, Il morupusi
(Geophone spacing = 5m)

Table No. 3.6.4 (a) First Arrival Times for Spread No. 1 at Tura

Short Point	Distance to nearest Geophone (m)
Far forward (FF)	55.0
Forward (F)	2.5
Centre (C)	2.5
Reverse (R)	2.5
Far Reverse (FR)	55.0
Geophone spacing	5
Depth of Charge	1.2

	First Arrival times (ms)				
Geophone No.	Short Point	Short Point	Short Point	Short Point	Short Point
1.	46	8	34	50	63
2.	50	17	33.5	48	62
3.	53	24	29.5	46	60
4.	54.5	27.5	25	43.5	57
5.	56	32	21	41	56
6.	58	35	8	38	55.5
7.	59	38	8	34.5	54
8.	60	40.5	19	32.5	52
9.	61	43	25	29.5	51
10.	62	45	27.5	26	49
11.	62.5	47	31.5	19.5	46
12.	63	48.5	34.0	14	44

Table No. 3.6.4 (b) First Arrival Times for Spread No. 2 at Tura

Short Point	Distance to nearest Geophone (m)
Far forward (FF)	55.0
Forward (F)	2.5
Centre (C)	2.5
Reverse (R)	2.5
Far Reverse (FR)	55
Geophone spacing	5
Depth of Charge	1.2

	First Arrival times (ms)				
Geophone No.	Short Point	Short Point	Short Point	Short Point	Short Point
1.	41.5	5	41	58	75
2.	43.5	20.5	38	57	74.5
3.	44.5	27.5	35.5	56	74
4.	48.5	29.5	32	54	74
5.	49.5	37	20	52	74
6.	51	39	7	50	74
7.	52.5	43	5.5	45	74
8.	53	46.5	21	41	74
9.	54	50	32	37	72
10.	55	54	38	31	70
11.	56.5	56	40.5	21	68
12.	58	59	46	10	65

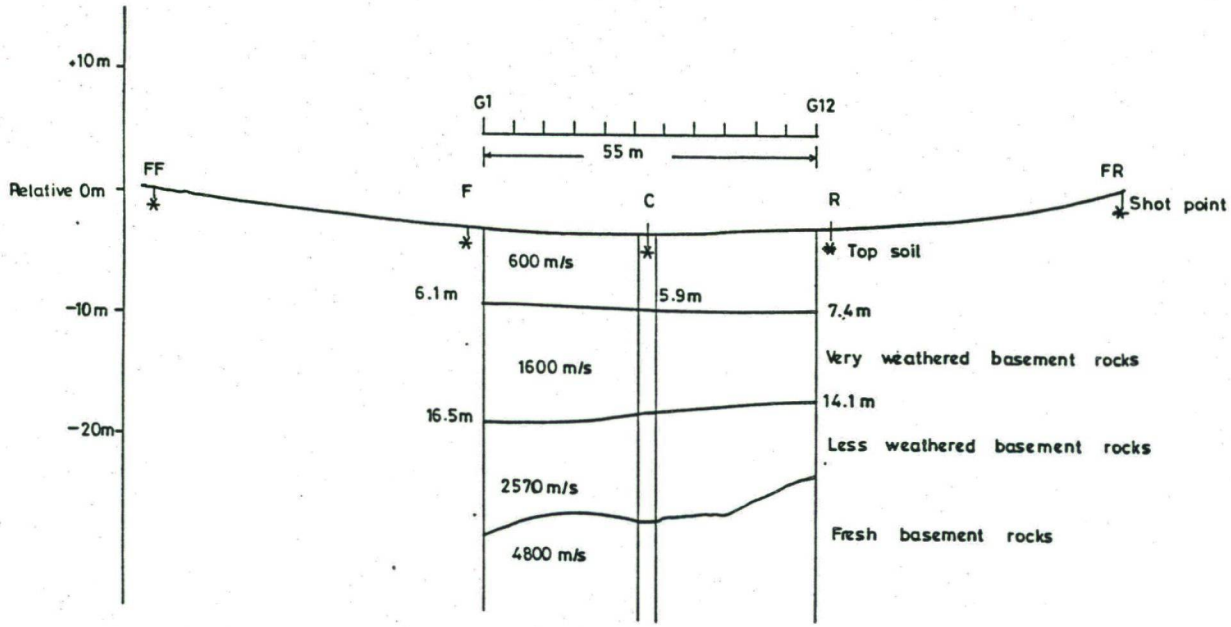


Fig 3.6.4 (a) seismic spread Nr 1, Tura.
(Geophone spacing = 5m)

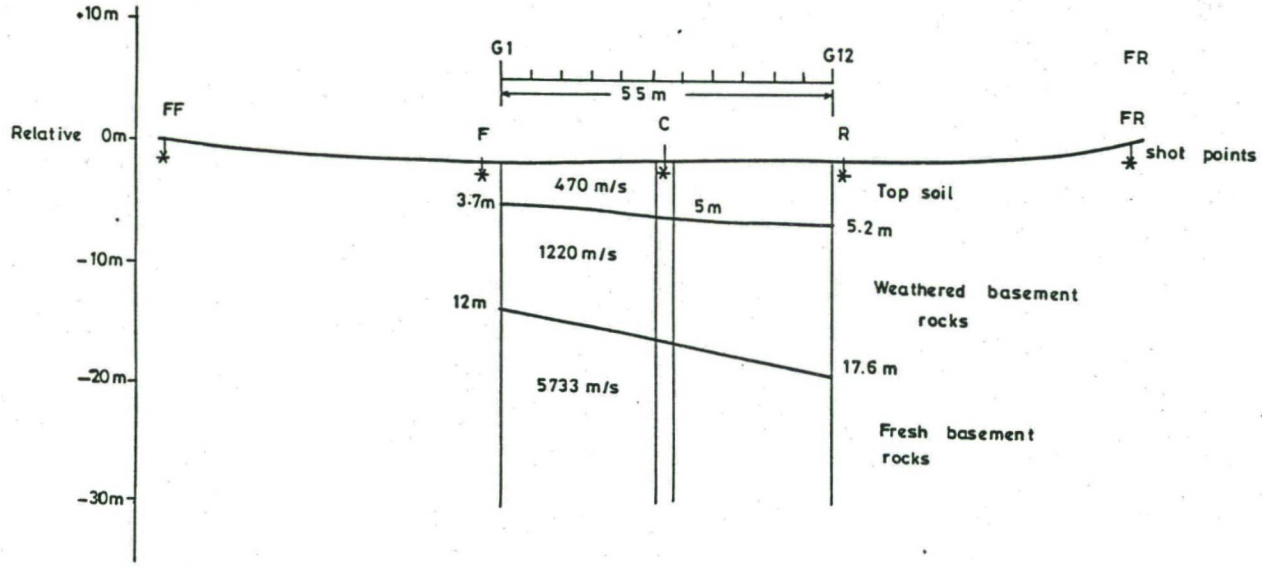


Fig. 3.6.4 (b) seismic spread Nr. 2, Tura

(Geophone spacing = 5m)

Table No. 3.6.4 (c) First Arrival Times for Spread No.3 at Tura (OlKimanjo)

Short Point	Distance to nearest Geophone (m)
Far forward (FF)	55.0
Forward (F)	2.5
Centre (C)	2.5
Reverse (R)	2.5
Far Reverse (FR)	55.0
Geophone spacing	5
Depth of Charge	1.2

	First Arrival times (ms)				
Geophone No.	Short Point FF	Short Point F	Short Point C	Short Point R	Short Point FR
1.	62.5	8.5	48	65	80
2.	66	23	44	60.5	79
3.	71	34	39	56	78
4.	75	38.5	34.5	52	77
5.	79.5	43.5	22	48	76
6.	81	48	9	42.5	73
7.	82	54	9	41	70
8.	83.5	57.5	24	36	66
9.	84	60	35	33.5	62
10.	83	62.5	38	29	58
11.	83	64	39.5	22	56
12.	84	66.5	42	9	54

Table No. 3.6.4 (d) First Arrival Times for Spread No. 4 at Tura

Short Point	Distance to nearest Geophone (m)
Far forward (FF)	55.0
Forward (F)	2.5
Centre (C)	2.5
Reverse (R)	2.5
Far Reverse (FR)	55.0
Geophone spacing	5
Depth of Charge	1.2

	First Arrival times (ms)				
Geophone No.	Short Point FF	Short Point F	Short Point C	Short Point R	Short Point FR
1.	46.5	11	29	43	54
2.	47.5	15.5	25	42	52.5
3.	48	21	21	40	50
4.	48.5	24	17	36.5	49.5
5.	49	28.5	14.5	33.5	49
6.	49.5	31	5.5	31.5	48
7.	50	33	5.5	29	47.5
8.	51	35	13.5	28	47
9.	51.5	37	19	24	46.5
10.	52	39	22	18.5	46
11.	53	41	25	14	45.5
12.	54	43	29	8	44

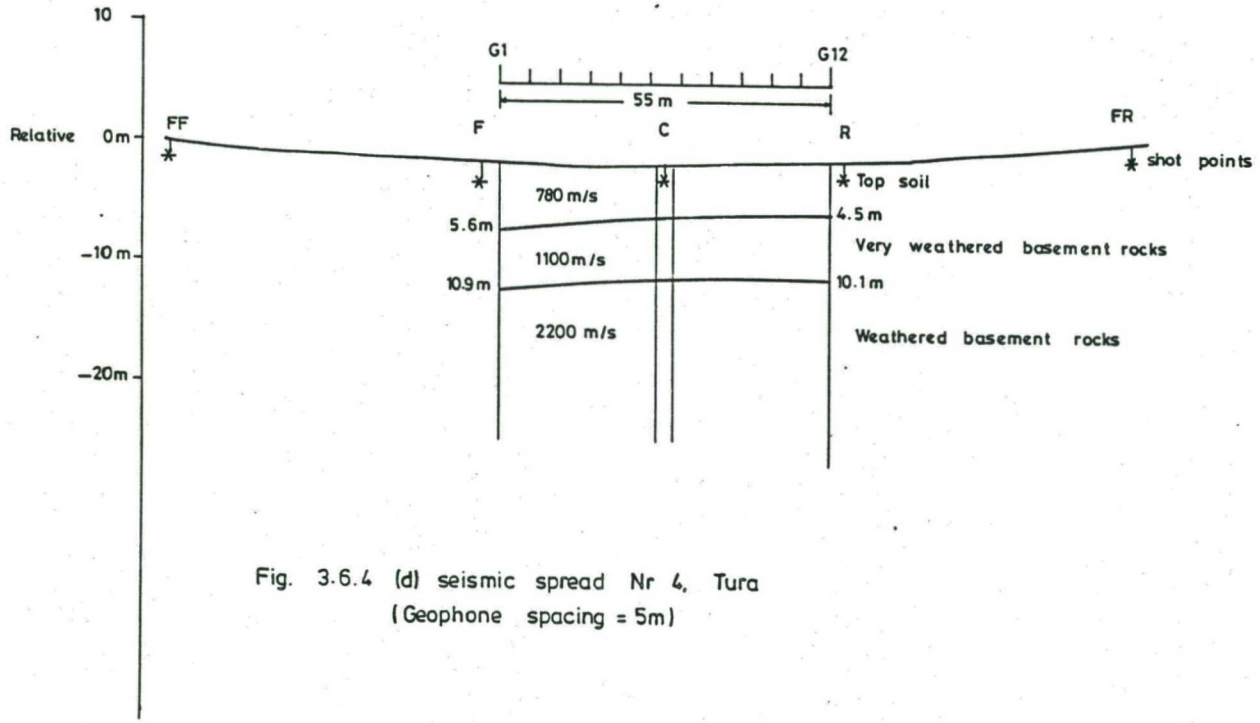


Fig. 3.6.4 (d) seismic spread Nr 4, Tura
(Geophone spacing = 5m)

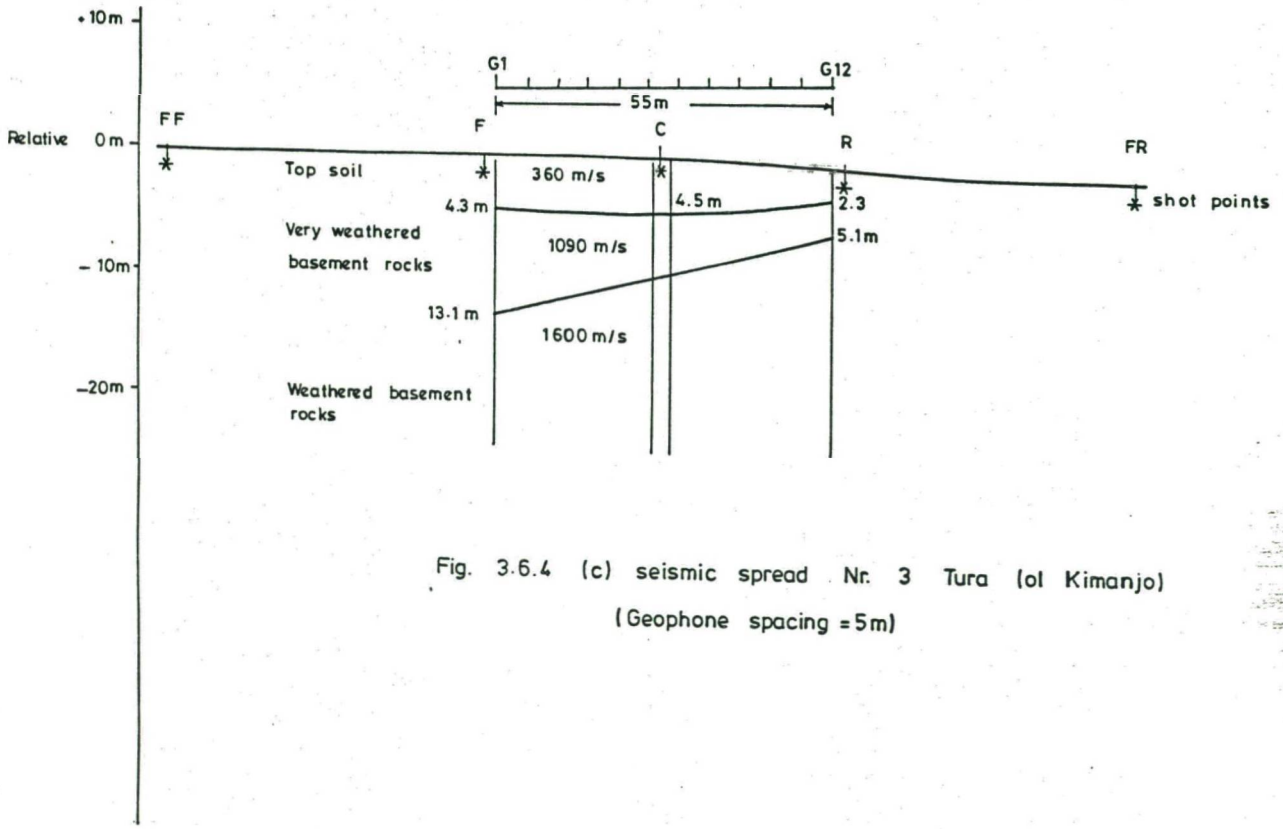


Fig. 3.6.4 (c) seismic spread Nr. 3 Tura (ol Kimanjo)
(Geophone spacing = 5m)

Table No. 3.6.5 First Arrival Times for Spread No. 1 at Musul

Short Point	Distance to nearest Geophone (m)
Far forward (FF)	55.0
Forward (F)	2.5
Centre (C)	2.5
Reverse (R)	2.5
Far Reverse (FR)	55.0
Geophone spacing	5
Depth of Charge	1.2

	First Arrival times (ms)				
Geophone No.	Short Point FF	Short Point F	Short Point C	Short Point R	Short Point FR
1.	42	8	34	45	58
2.	43.5	21.5	33	44	57
3.	45	23.5	31	43	56
4.	46	27	30	42	55
5.	48	31	23	41.5	54.5
6.	50	34.5	8	40	54
7.	52	36	8.5	38.5	53.5
8.	53	37.5	23.5	36	52.5
9.	54	40.5	30	34	51
10.	55	42	34	29.5	50.5
11.	56	43	36	23.5	49.5
12.	58	44	39	7	48

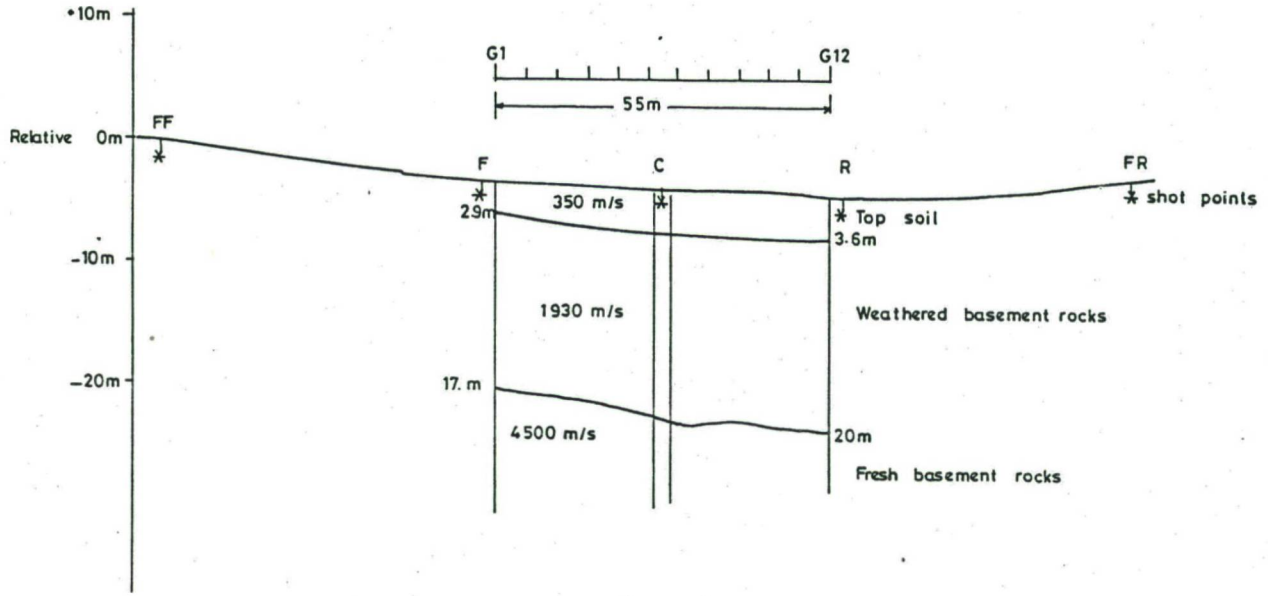


Fig. 3.6.5 seismic spread Nr 1 Musul
(Geophone spacing = 5m)

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4.1 List of Rainfall Stations
4.2 List of Evaporation Stations
4.3 List of Regular Gauging Stations (RGS)
4.4 Rainfall Figures

4.5 Evaporation Figures

4.6 - Description and Analysis of the River Gauging Stations
- Runoff Tables and Figures

4.7 Chemical Data Surface Water

APPENDIX 4.1

List of Rainfall Stations

Appendix 4.1 List of Rainfall Stations

Station Number	Location	Latitude (Northings)	Longitude (Eastings)	Altitude (ft)	Record Period	Remarks
89.36.000	Ol Ng'arua	0 18	36 17'	6200	1920-48	
001	Rumuruti D.O	0 16	36 32'	6090	1906-	
002	Thomson's Falls	0 07	36 24'	7150	1920-56	
003	Nanyuki - Avontuur	0 15	36 53'	6000	1930-59	
004	Ol - Manyatta Estate	0 07	36 15'	5500	1920-65	
005	Laikipia Forest Station	0 13	36 28'	6470	1928-37	
006	Sunguta Naibor	0 27	36 42'	5700	1931-	
007	Chui Farm - Subukia	0 06	36 16'	6000	1932-35	
008	T.H.A. Mills Rumuruti	0 23	36 33'	6000	1934-65	
009	Ol Ngatia Sidai	0 08	36 30'	7000	1933-37	
010	Ol Olara	0 08	36 28'	6900	1934-60	
012	W.M. Williamson - Subukia	0 10	36 15'	5800	1936-37	
013	Mutara Estate	0 09	36 38'	6300	1927-75	
014	Mutara Estate (Managers House)	0 07	36 37'	6000	1936-	
015	Nyahururu K.C.C.	0 12	36 22'	7700	1937-	
016	Nanyuki - Riverdale	0 17	36 55'	5700	1937-54	
019	Tangulbei Dispensary	0 48	36 17'	4200	1939-	
022	Thomson's Falls - W.A. North	0 02	36 21'	7700	1938-	
023	South Marmanet Forest Station	0 03	36 22'	7600	1931-	
024	Thomson's Falls - Lokiteiti	0 01	36 25'	7500	1940-68	
025	Cedaia - Thomson's Falls	0 01	36 16'	8000	1939-59	
027	Leshau Pondo Health Centre	0 06	36 25'	7200	1920-	1920-35 only Annual Totals
028	Marmanet Forest Station	0 10	36 21'	8000	1946-48	
029	Narok Ranch - Rumuruti	0 25	36 34'	6200	1947-	
030	Siron Farm (Marmanet)	0 09	36 24'	7000	1935-	
032	Thomson's Falls - Rooley Limited	0 01	36 30'	7000	1947-64	
034	Kaptarakwa Farm - Subukia	0 05	36 13'	6200	1947-79	
035	Thomson's Falls - W.A. Crowther	0 13	36 22'	6750	1948-67	
036	Ngusero Farm L.Solai	0 10	36 14'	5300	1948-53	
037	Ogaden - Rumuruti	0 16	36 18'	6500	1948-52	
038	Nanyuki - Ol Odin	0 08	36 59'	6200	1949-70	
039	Ol Manyatta	0 08	36 14'	5500	1940-57	
040	Nanyuki - Mpala Farm	0 08	36 55'	5500	1940-57	
042	Thomson's Falls - Olive farms Limited	0 03	36 31'	7000	1950-57	
043	Nanyuki - Ol Jogi farm	0 18	36 57'	5750	1950-52	
044	Nanyuki - Rainbow Vale	0 10	36 53'	5750	1948-63	
045	Nanyuki - Segera Ranch	0 12	36 49'	5900	1951-	
046	Nanyuki - The Venture	0 17	36 54'	5731	1950-62	
047	Nanyuki - Ngari Nyiro	0 02	36 55'	5500	1951-52	
048	Red Oat Farm	0 38	36 30'	6500	1950-52	
049	Rumuruti - Ol Mysor	0 27	36 40'	6248	1928-	
051	Maralol - Ol Joro Losuk	0 58	36 36'	6300	1954-55	
058	Laikipia Police - Divisional Headquaters	0 03	36 24'	7700	1957-64	
059	Rukenya Ranch Limited	0 16	36 47'	5800	1959-	
060	Colcheccio - Sosian Limited	0 38	36 48'	5700	1963-	
061	Samburu Ranch	0 49	36 40'	5200	1959-61	
062	Podo Park - Thomson's Falls	0 12	36 20'	7300	1960	
064	Rumuruti Met Station	0 16	36 33'	5800	1963-	

Cont. Appendix 4.1 List of Rainfall Stations

Station Number	Location	Latitude (Northings)	Longitude (Eastings)	Altitude (ft)	Record Period	Remarks
065	Junction - Rumuruti	0 30	36 51'	5500	1949-	
066	Ol Pejeta Ranch (Kamok)	0 04	36 48'	6000	1940-	
068	Ahiti - Nyahururu	0 02	36 17'	7700	1965-	
069	Ol Pejeta Ranch (Randalls)	0 07	36 53'	6000	1969-	
070	Nyingama Ranch	0 30	36 39'	6000	1973-	
071	Ol Pejeta Ranch (Eland Downs)	0 09	36 48'	6000	1974-	
072	Ol Pejeta Ranch (Ol Elerai)	0 04	36 49'	6000	1974-	
073	Muguru Kieni East Farmers Company	0 10	36 35'	6000	1973-	
074	Suguta Marmar Police Post	0 50	36 41'	6220	1973-	
075	Kisima A.PS Post	0 57	36 46'	5900	1973-75	
077	Kirimun Police Post	0 45	36 53'	5800	1975-	
078	Longewan (Ntim-Nariwo)	0 50	36 33'	6500	1974-	
079	Lodo Kejek Chiefs Camp	0 51	36 52'	5500	1975-	
081	Churo Primary School	0 47	36 24'	6000	1975-	
084	Mukenya Mutara River	0 19	36 47'	5750	1980-	
085	Kaseregei - Serega Ranch	0 12	36 49'	6000	1980-	
086	Ol arabel Forest Station	0 18	36 16'	6600	1979-	
088	Mukutano Shopping Centre	0 38	36 15'	3800	1980-	
089	Ol Pejeta Sweet Water	0 02	36 58'	6000	1981-	
091	Kirimuni Lifestock Holding Ground	0 44	36 53'	5500	1982-	
093	Luonrek Lifestock Holding Ground	0 31	36 42	6500	1952-74 1979-	1975-8 no records
89.37.001	View Point Farm - Timau	0 08	37 15'	7200	1928-50	1936-7 no data
002	Marania - Timau	0 06	37 28'	8450	1925-	
003	Isiolo Dio	0 22	37 35'	3600	1930-	
004	Ngare - Unga	0 10	37 20'	6400	1930-41	
008	Marula - Timau	0 13	37 24'	5700	1933-39	
009	Ndaiga Valley - Nanyuki	0 09	37 09'	6100	1933-39	
010	Impala Farm - Timau	0 09	37 12'	6800	1933-39	
012	West Loldaigas	0 09	37 07'	6100	1937-44	
018	Wamba - Uaraguess	0 56	37 23'	6000	1938-	
022	Nanyuki Met station	0 01	37 03'	6400	1939-	
025	Nanyuki K.C.C.	0 01	37 04'	6400	1946-69	
028	Inghi Farm - Timau	0 04	37 17'	8000	1946-64	
030	Timau Settlement Scheme	0 04	37 14'	7400	1944-64	
032	Kilimara Farm - Timau	0 03	37 12'	7000	1947-58	
033	Dol Dol D.O	0 25	37 10'	6000	1948-	Replaced old gauge in May,85
034	Ardencaple Farm - Timau	0 05	37 16'	7600	1933-	
035	Archer's Post	0 38	37 40'	2800	1946-	
036	Magwooni Estate	0 13	37 01'	5700	1948-53	
039	Nanyuki - Umande	0 06	37 09'	6500	1948-63	
040	Ontulili Forest Station	0 01	37 11'	7400	1948-	
042	Nanyuki - Murwa	0 05	37 03	6000	1950-54	
043	Sirimon - Nanyuki	0 05	37 10'	6900	1926-	
044	Salmon's Farm	0 10	37 17'	7500	1950-68	
045	Dol Dol Forest Guard Post	0 23	37 11'	6100	1950-	Poor records

Cont. Appendix 4.1 L ist of Rainfall Stations

Station Number	Location	Latitude (Northings)	Longitude (Eastings)	Altitude (ft)	Record Period	Remarks
048	Lolpoto Farm	0 10	37 01'	5900	1950-	
050	Nanyuki Pyramid	0 19	37 05'	6300	1950-65	
061	Anandanguru Forest Station	0 22	37 18'	6000	1960 -	Poor records
064	Kimagandura Farm	0 10	37 03'	6000	1966-	
067	Nanyuki Water Division	0 01	37 05'	6300	1965-	
074	Kimanjoi Chiefs Camp	0 28	37 00'	6000	1973-	
075	Nanyuki M.O.W.	0 01	37 05	6500	1954-	
077	Ngare Ndare West	0 11	37 20	6300	1973-	
103	Longopito Holding Ground	0 42	37 08	3800	1978-	
		(Southings)				
90.36.005	Ngobit - Angata Ndare	0 02	36 44	6400	1926-55	
014	Kenya Park - Naro Moru	0 05	36 58	6000	1914-39	
028	Karemeno - Naro Moru	0 08	36 45	6900	1929-34	
032	Bahati Forest Station	0 10	36 11	7900	1931-	
040	Sirrima - Ngobit	0 03	36 46	6200	1933-53	
046	Kahoreru Estate - Nyeri	0 18	36 49	7200	1934-48	
047	Ol Viron - T. Falls	0 01	36 16	8400	1935-56	
055	Ol Kalou Railway Station	0 16	36 22	7800	1935-	
056	Slains Farm - Ol Kalou	0 19	36 32	7300	1935-71	
072	Mweiga Estate	0 21	36 55	6200	1936-	
085	Karemeno Estate	0 08	36 46	6800	1938-	
099	Ngobit - Suguroi Estate	0 02	36 37	6700	1937-	
101	Four Winds Farm - Thomson's Falls	0 07	36 32	8800	1939-64	
112	Ol Joro Orok - Mutarakwa	0 03	36 17	8000	1939-64	
116	Deighton Downs - Ngobit	0 08	36 36	7000	1927-	
117	Ngobit Farm	0 10	36 39	8000	1940-34	
123	Mweiga - Talau	0 18	36 49	7400	1941-62	
133	Oleomoto Farm - Ol Joro Orok	0 08	36 22	8600	1945-51	
134	Ndaragwa Forest Station	0 07	36 33	8000	1945-	no data 1952-72
135	Ol Joro Orok Agromet Station	0 02	36 21	7800	1921-	
137	Manyatta Farm - Ol Joro Orok	0 06	36 22	7800	1946-64	
138	Ol Bolossat Forest Station	0 03	36 20	7800	1946-	
144	Monte Carlo Ranch - Mweiga	0 20	36 57	6300	1946-	
149	Ngobit - Ndaragwa	0 03	36 33	7400	1939-62	
151	Subukia Agriculture Export Farm	0 02	36 09	7000	1947-	
157	Kiandongoro Met	0 27	36 51	7800	1948-	
182	Uaso Nyiro farms - Naro Moru	0 17	36 46	8500	1949-62	
187	Thomson's Falls - Podo	0 02	36 23	7700	1949-58	
192	Nairutia - Naro Moru	0 03	36 49	6300	1928-56	
193	Nanyuki - Barn house	0 03	36 59	6000	1951-56	
209	Ngobit - Ndaragwa	0 02	36 33	7000	1951-69	
213	Lamuria - Naro Moru	0 09	36 52	6100	1926-55	
215	Ol Chani L'engai - Thomson's Falls	0 03	36 18	8200	1948-64	
226	Ol Awai - Naro Moru	0 08	36 58	6500	1954-64	
237	Ngobit Estate	0 06	36 40	6800	1961-	
245	Dimilil - Narok Moru	0 09	36 59	6200	1959-69	
246	Zaina Forest Station	0 23	36 49	7800	1959-	

Cont. Appendix 4.1 List of Rainfall Stations

Station Number	Location	Latitude (Northings)	Longitude (Eastings)	Altitude (ft)	Record Period	Remarks
260	Lamuria Met Station	0 08	36 52	6100	1959-	
268	Mweiga Settlement Scheme	0 20	36 53	6600	1966-	
269	Gatarakwa Settlement Scheme	0 17	36 43	8400	1965-	
273	Ruhuruini Gate (A.N.P)	0 23	36 38	8200	1960-	
274	Tree Tops Gate (A.N.P.)	0 21	36 54	6400	1961-	
275	Mweiga Headquater (Mt. National Parks)	0 20	36 55	6300	1950-	
289	Wanjohi Chief's Office	0 21	36 32	8100	1969-	
290	Malewa Scheme	0 21	36 27	8200	1969-	
295	Miogo River (A.N.P.)	0 20	36 43	9900	1970-	Long - term
296	Kurase Hill (A.N.P.)	0 20	36 40	11200	1970-	Long - term
297	Ark Gate (A.N.P.)	0 20	36 51	7000	1970-	
298	Wandare Gate (A.N.P.)	0 19	36 46	8000	1970-	
300	Ngobit Police Post	0 03	36 47	6500	1971-	
304	Mirangini Chief's Office	0 10	36 14	8800	1970-	
305	Silibwet Settlement Scheme	0 03	36 16	8500	1971-	
307	Kangui Secondary School	0 07	36 20	8500	1971-	No data 80-3
311	Ol Pejeta Ranch - Loidien	0 02	36 52	6000	1974-	
312	Shamata gate (A.N.P)	0 12	36 32	9300	1973-	
313	Chebuswa Hill	0 14	36 36	11000	1973-	Long-term
319	Mugunda primary School	0 10	36 42	7500	1974-	
326	Ol Joro orok Farmers Training Centre	0 01	36 23	7800	1979-	
90.37.023	Ol Tarakwai - Naro Moru	0 09	37 02	6700	1927-55	
060	Kangaita Forest Station	0 06	37 07	7600	1945-	
070	Kangaita Farm	0 01	37 01	6800	1948-71	
071	Timsales - Nanyuki	0 04	37 12	7400	1948-64	
081	Burguret River (Blue Lodge)	0 06	37 00	6300	1949-53	
097	Gathiuru Forest Station	0 05	37 07	7500	1951-	No data 1955-64
120	Kabaru Forest Station	0 17	37 07	7500	1959-	
125	Burguret Forest Guard Post	0 06	37 02	6400	1960-	
138	Naro Moru Forest Station	0 12	37 08	7300	1965-	
139	Naro Moru Settlement Scheme	0 12	37 04	6700	1965-	
149	Naro Moru Gate Mt. Kenya N.P.	0 10	37 09	7200	1968-	
155	Sirimoni Gate Mt. Kenya N.P.	0 02	37 17	8500	1970	
156	Nanyuki Forest Station	0 05	37 06	7600	1962	
208	Upper Naro Moru F.G.P.	0 09	37 08	7600	1976	
		Rainfall Stations With MOWD Number				
WD 232	Ngorare Ranch	0 19N	36 39	6000	1950-59	
241	Esperanza farm	0 03N	36 57	6000	1927-59	
263	Ontulili farm	0 04N	37 08	6700	1932-59	
279	Lintin goddard	0 15N	36 26	7600	1957-59	
285	Melwa Dykes	0 14N	36 26	6800	1938-59	
288	Gasson	0 11N	37 01	5800	1947-59	
289	Hinde, Loldaika Hills	0 13N	37 07	6900	1932-58	
290	Moyo, Outspan	0 16N	36 51	6700	1940-59	
308	Lesirko - White	0 10S	36 20	8300	1940-59	
309	Thorndale Farm	0 03N	37 03	6200	1930-59	

Cont. Appendix 4.1 List of Rainfall Stations

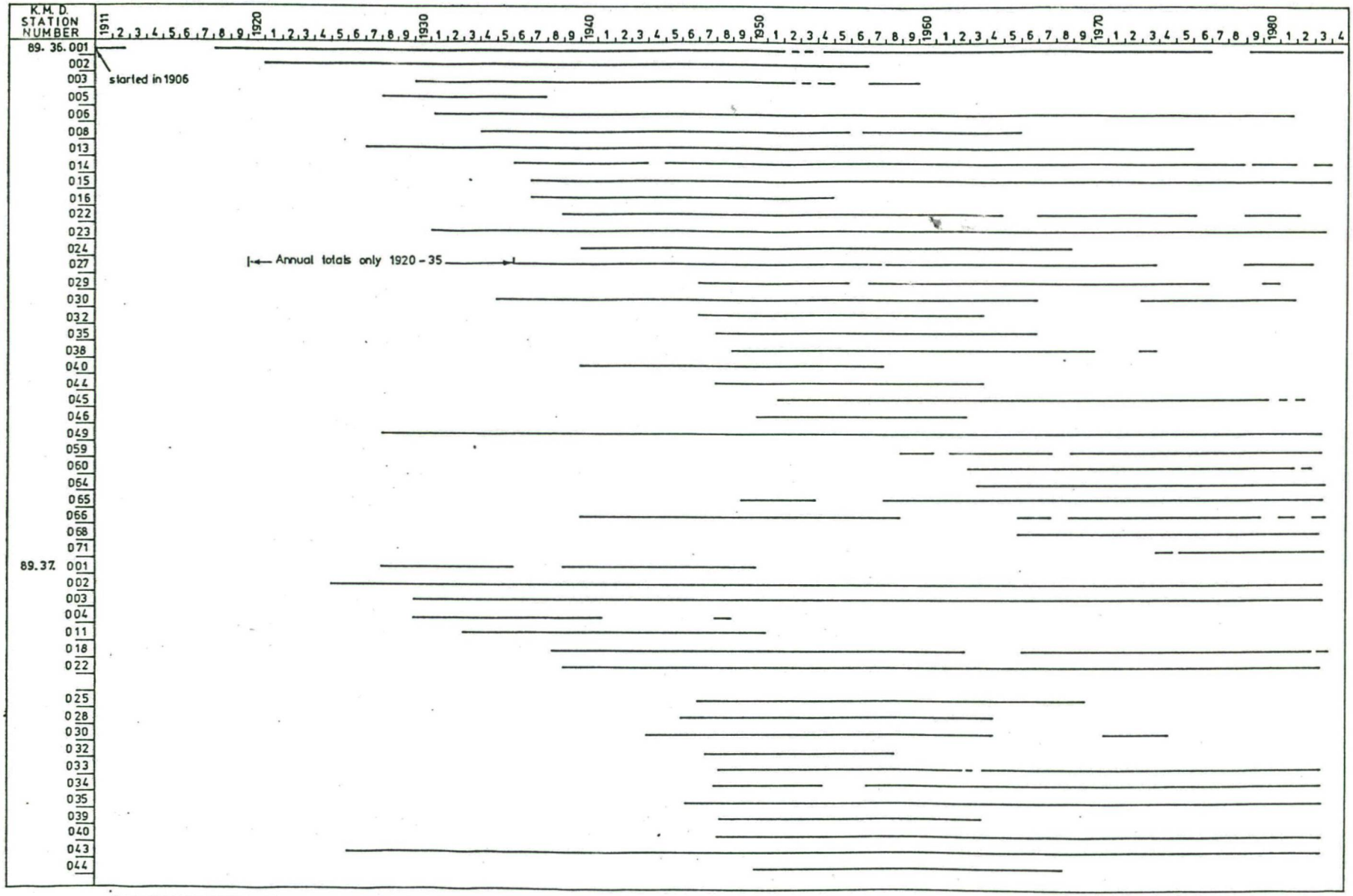
Station Number	Location	Latitude (Northings)	Longitude (Eastings)	Altitude (ft)	Record Period	Remarks
312	Kisima Limited	0 07N	37 25	7800	1929-60	
314	Loigululu - Nanyuki	0 02S	37 03	6300	1934-59	
315	Endarasha	0 18S	36 48	7800	1946-58	
316	Pura Milk - Mweiga	0 19S	36 47	8200	1931-59	
318	Supuko - Augerand	0 04S	36 30	7800	1926-61	
390	Lariak - Thomson's Falls	0 17N	36 22	6800	1957-61	
391	Sipili	0 25N	36 23	6600	1957-61	
392	Ol Morani	0 33N	36 29	6400	1957-61	
393	Laikipia Ranching Company	0 33N	36 24	6000	1953-61	
396	Luoniek Ranch	0 45N	36 33	6500	1952-60	
751	Kinamba Agriculture Office	0 25N	36 20	6800	1984-	
281	Wangu Embori Farm	0 05N	37 21	8700	1959-	
		New Rainfall Stations				
774	Ol Morani Chief's Office	0 33N	36 28	6500	1985	] Installed
780	Sipili D.O	0 23N	36 22	6700	1985	] by WRAP
779	Ngari Nyiro Police Post	0 06N	36 54	6000	1985	]
777	Gitundaga Forest Station	0 09N	36 19	7600	1985	re-habilitated
		From rainfall stations in Kenya as in the 1982 register				
		(Northings)				
89.37.015	Mago - Timau	0 14	37 15	5800	1937-38	
020	Runnymede Estate	0 07	37 17	7600	1938-39	
023	Selemani Farm	0 04	37 14	7300	1939-39	
024	Ndaiga Valley No. 2	0 08	37 10	6000	1939-39	
026	B.C.M.S. Wamba	0 55	37 20	4000	1940-40	
027	West Kenya Forest Station	0 11	37 09	7600	1945-45	
029	Anandanguru	0 22	37 18	6000	1946-47	
046	Marania Forest Station	0 05	37 29	8000	1951-53	
049	Tura - Mukogodo Reserve	0 31	37 02	6000	1950-50	
052	Ol Donyo Nyiro	0 36	37 00	5800	1955-55	
054	Lugilada farm - Timau	0 03	37 17	7000	1953-57	
057	Timau Taraquet	0 04	37 15	7300	1954-63	
058	R.H. Mackidonald - Nanyuki	0 02	37 13	7800	1954-56	
069	Wamba - Maralal Game Office	0 59	37 20	4800	1968-	
070	Timau Settlement Scheme	0 03	37 13	7600	1970-	
073	Mukima Estate	0 05	37 03	5000	1973-	
076	Rugutu Mutirithia Estate	0 09	37 01	6200	1948-	
079	Lerata Borehole	0 50	37 30	3000	1973-	
093	Lodungukwe games Camp	0 52	37 00	4300	1974-	
094	Ngutukongironi Nursery School	0 41	37 19	3000	1975-	
095	Nanyuki Sports Club	0 01	37 05	6400	1976-	
102	Kipsing livestock Holding Ground	0 37	37 15	3400	1980-	
104	Marania Forest Station	0 03	37 23	9400	1981-	

Cont. Appendix 4.1 List of Rainfall Stations

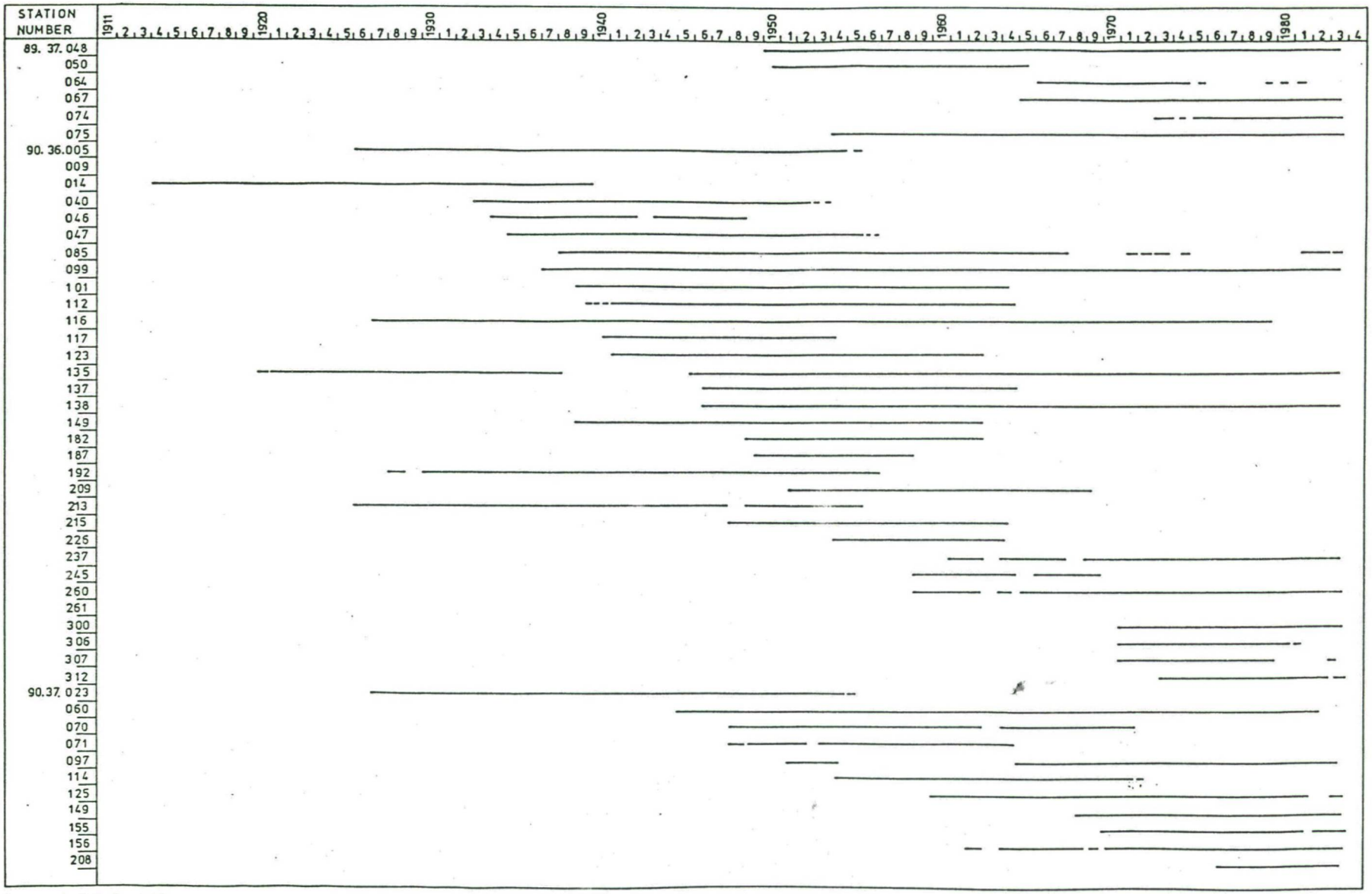
Station Number	Location	Latitude (Northings) (Southings)	Longitude (Eastings)	Altitude (ft)	Record Period	Remarks
90.36.000	Subukia Ol Momoi Estate	0 01	36 15	6750	1922-	
049	Chumuga - Ol Joro Orok	0 11	36 19	8600	1934-	
050	Loguru Estate	0 12	36 24	8700	1935-	
051	Boughton Farm	0 14	36 18	9000	1935-49	
057	Robert Hall, Gilgil	0 17	36 17	8400	1935-51	
068	Croust - Naivasha	0 05	36 33	8400	1936-49	
069	Olegojera Farm	0 13	36 29	7800	1936-40	
071	Ol Tuara - Subukia	0 01	36 15	6700	1936-38	
078	Brooke Farm - Ol Kabu	0 16	36 29	8000	1936-56	
091	Kiborok - Thomson's Falls	0 03	36 17	8200	1938-40	
113	Ketai - Ol Kalou	0 20	36 32	8200	1939-55	
114	Kiriundu - Gilgil	0 17	36 17	8000	1940-51	
115	The highland - Ol Kalou	0 19	36 21	8000	1940-62	
118	Maluera Farm - Ol Kalou	0 19	36 24	7000	1940-53	
120	Nakuru Constantia	0 15	36 15	8000	1941-63	
122	Ol Kalou - Leweston	0 19	36 26	7500	1941-64	
126	Greenhill - Ol Joro Orok	0 03	36 16	8900	1942-64	
000	Subukia, Ol Momoi Estate	0 01	36 15	6750	1922-	
153	Ongatabus Estate	0 13	36 26	7700	1947-62	
158	Serenguet Limited	0 07	36 17	8900	1948-52	
173	Long term raingauge	0 22	36 35	8000	1948-52	
177	Excelsior Farm - Ol Kalou	0 11	36 24	7800	1947-49	
186	Mirangini - Ol Joro Orok	0 11	36 15	9100	1949-58	
189	Chartley Farm - Nakuru	0 12	36 14	8600	1949-59	
190	Nakuru Bryn glass (Dundari)	0 09	36 14	8300	1949-64	
199	Bucksteep Limited Nakuru	0 02	36 12	7300	1944-60	
204	Rayeta Estate Limited, Ol Kalou	0 19	36 32	8400	1951-62	
229	Ol Kalou Flaxlands	0 19	36 25	7500	1954-67	
231	Sidai Subukia	0 00	36 12	7000	1955-59	
232	G.L. P.F.ing station - Thomson's Falls	0 07	36 16	8700	1955-62	
243	Dundori Forest Station	0 15	36 14	7400	1958-	
256	Avondale Estate - Subukia	0 02	36 13	7000	1948-63	
270	Uaso Nyiro Settlement Scheme	0 17	36 51	6800	1965-	
306	Kanyagia Settlement Scheme	0 05	36 28	8500	1970-	
321	Ndunyu Gwathi Market	0 16	36 51	6800	1975-	
338	Uhuru Primary School - Bahati	0 08	36 18	8500	1982-	
90.37.006	Thogo River Estates	0 17	37 08	7200	1920-	
009	Silverbeck Hotel - Nanyuki	0 00	37 04	6400	1929-54	
012	Waraza Farm - Naro Moru	0 16	37 08	7500	1930-36	
020	Kirinyaga - Naro Moru	0 12	37 06	7400	1935-59	
035	Ol Tarakwai (Race Course)	0 09	37 03	6700	1938-41	
040	K.A.R. Nanyuki	0 00	37 08	6500	1939-40	
041	Thaga, Farm - Nyeri	0 15	37 07	7000	1939-47	
048	Kimahuri Primary School	0 17	37 07	6800	1941-76	
087	Mawingo Home Farm	0 02	37 08	6700	1950-57	
088	Naro Moru Agricultural Export Station	0 11	37 01	6500	1950-51	

Cont. Appendix 4.1 List of Rainfall Stations

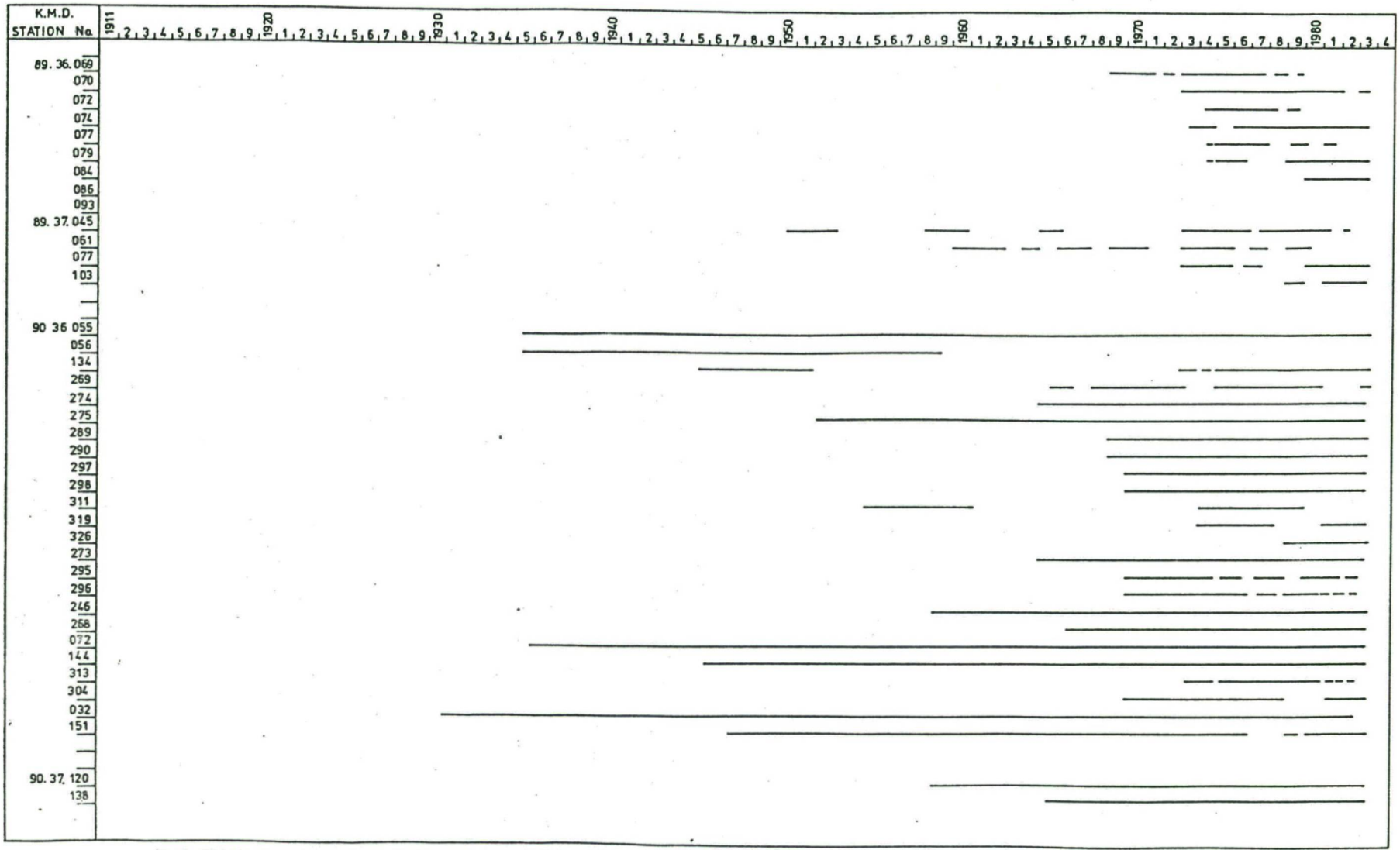
Station Number	Location	Latitude (Northings)	Longitude (Eastings)	Altitude (ft)	Record Period	Remarks
095	Naro Moru Kambura-ini	0 14	37 05	7000	1950-63	
128	Nanyuki D.O.	0 00	37 05	6500	1961-62	
211	Naro Moru Girls Secondary School	0 15	37 05	7000	1976-	
217	Meteorological Station Lodge	0 10	37 13	10000	1978-	
218	Teleki Camp	0 10	37 18	14000	1978-	
219	Austrian Hut	0 10	37 19	16000	1978-	



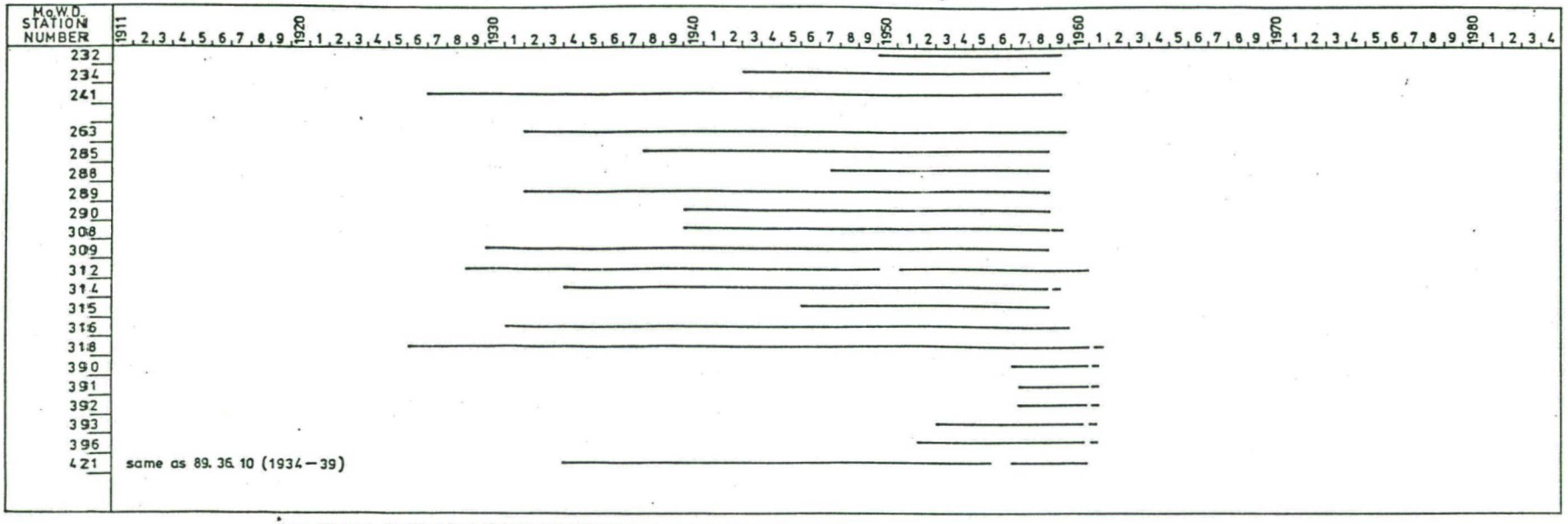
BAR GRAPH SHOWING PERIOD OF RECORD OF RAINFALL STATIONS
IN UPPER EWASO NGIRO BASIN (MAINLY LAIKIPIA DISTRICT)



Annex 4. 1. 2 (contd.) BAR GRAPH SHOWING PERIOD OF RECORD OF RAINFALL STATIONS



BAR GRAPH SHOWING PERIOD OF RECORD OF RAINFALL STATIONS
(ADDITIONAL STATIONS)



BAR GRAPH SHOWING PERIOD OF RECORD OF RAINFALL STATIONS

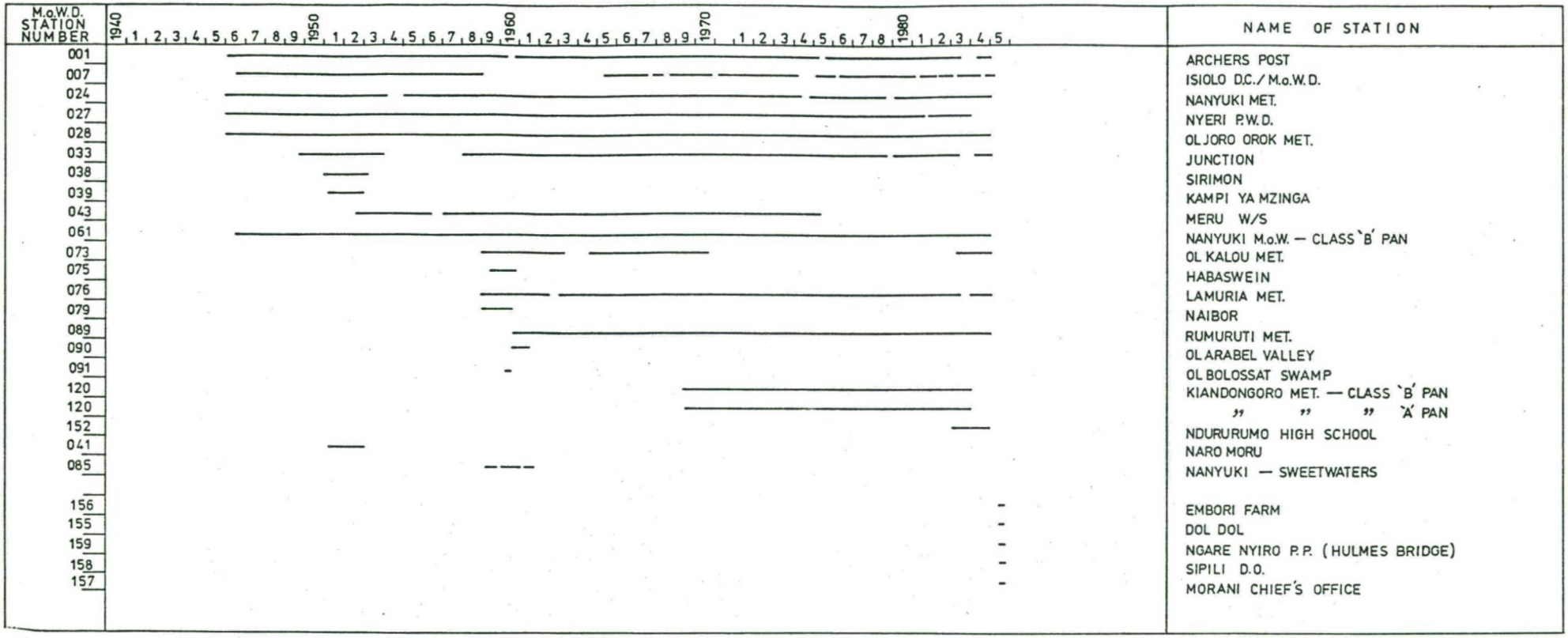
(Data copied from Evaporation files)

APPENDIX 4.2

List of Evaporation Stations

Appendix 4.2 List of Evaporation Stations

Station Number	Location	Latitude	Longitude	Altitude (ft)	Record	Remarks
1	Archer's Post met Station	0 37N	37 40	2800	1946-	
7	Isiolo Dic/MOWD Yard	0 21N	37 35	3600	1946-	
24	Nanyuki Met Station	0 01N	37 04	6400	1946-	
27	Nyeri M.O.W.	0 25S	36 57	5800	1946-	
28	Nyandarua Agromet Station	0 03S	36 21	7800	1946-	
33	Ewaso Narok/Nyiro Junction	0 30N	36 51	5500	1949-	
38	Sirimoni	0 02S	37 16	9500	1951-52	
39	Kampi ya Mzinga	0 15S	36 34	10000	1951-52	
41	Narok Moru	0 11S	37 11	9700	1951-52	
43	Meru water Supply	0 03N	37 38	5200	1952-76	
61	Nanyuki M.O.W. yard	0 01N	37 05	6500	1956-	Class B pan
73	Ol Kalou Water Supply	0 16S	36 23	7800	1959-70	Reopened 1983 (Class B pan)
75	Habaswein	1 02N	39 30	650	1959-60	
76	Lamuria Met Station	0 08S	36 52	6200	1959-	
79	Naibor	0 16N	36 56	5600	1959-60	
85	Nanyuki - Sweet Waters	0 00	36 57	6000	1959-61	
89	Rumuruti met Station	0 16N	36 32	6000	1960-	
90	Ol Arabel				1960-61	
91	Ol Bolossat Swamp	0 11S	36 25	7600	1960-60	only November data
120B	Kiandongoro Met Station	0 27S	36 51	7800	1969-	Class B pan
120A	Kiandongoro Met Station	0 27S	36 51	7800	1969-	Class A pan
152	Ndururumo High School met Station	0 04N	36 22	7700	1983-	
156	Wangu Embori Farm	0 05N	37 21	8700	1985-	}
155	Dol Dol D.O.	0 25N	37 10	6000	1985-	}
159	Ngari Nyiro P.P. (Hulmes Bridge)	0 06N	36 54	6000	1985-	} installed
158	Sipili D.O.	0 23N	36 22	6700	1985-	} by WRAP
157	Ol Morani Chief's Office	0 33N	36 28	6500	1985-	}



BAR GRAPH SHOWING PERIOD OF RECORD OF EVAPORATION STATIONS
IN UPPER AND MIDDLE EWASO NGIRO BASIN

APPENDIX 4.3

List of River Gauging Stations

Appendix 4.3 List of River Gauging Stations

Station Number	River	Latitude	Longitude (Eastings)	Type	Date Open	Date Closed	Rated	Catchment Areas (Km2)
5AA1	Ewaso Narok	0 02' 20"N	36 22 30	SWA	01/45		R	577 e)
5AA2	Equator	0 01 26 N	36 22 09	SW	04/50		R	251
5AA2(A)	Equator			S	04/78		N/R	
5AA3	L.Ol Bolossat	0 09 27 N	36 25 49	S	01/52	05/62		
5AA4	Equator	0 01 21 N	36 21 00	S	12/58		N/R	60
5AA5	Equator	0 01 12 N	36 21 48	S	12/58		R	157
5AA6	Oramutia	0 01 56 S	36 21 12	S	12/58		R	70 a)
5AA7	Nyahururu Dam	0 02 06 N	36 19 07	W	02/59	08/61	N/R	52
5AA10	Nyahururu Trib	0 01 36 N	36 21 02	W	12/58	02/67	N/R	26
5AA11	Ewaso Narok	0 01 12 N	36 24 00	SW	03/60	03/64	N/R	
5AA12	L. Ol Bolossat	0 00 30 N	36 23 48	SW	04/60	02/67		
5AA13	L. Ol Bolossat							
5AA14	Oramutia	0 07 30 S	36 18 35	W	06/60		R	
5AA16	L. Ol Bolossat	0 02 28 S	36 25 00	S	09/60			
5AB1	Pesi	0 08 06 N	36 36 19	SW	02/45	09/58	R	
5AB2	Pesi	0 12 01 N	36 36 00	S	11/58		R	412
5AB3	Pesi	0 05 43 N	36 34 53	SA	11/58		R	319 e)
5AB4	Pesi	0 03 47 S	36 31 37	S	11/58		R	109
5AB5	Pesi	0 08 15 N	36 35 45	S	05/59		N/R	307
5AC1	Ewaso Narok	0 15 36 N	36 32 24	W	10/44	09/60	N/R	
5AC2	Ewaso Narok	0 15 43 N	36 22 28	SW	12/44		N/R	
5AC3	Ewaso Narok	0 16 00 N	36 32 48	SW	01/45		R	878
5AC4	Ewaso Narok	0 22 39 N	36 38 50	SW	03/45		R	2,403
5AC6	Ewaso Narok (Pesi)	0 16 42 N	36 35 28	SW	03/45		R	448
5AC7	Ewaso Narok (Pesi)	0 22 24 N	36 39 20	SW	02/45	12/63	R	
5AC8	Ewaso Narok	0 30 30 N	36 50 45	SWA	04/51		R	3,290
5AC9	Ewaso Narok	0 31 35 N	36 51 30	S	03/50	10/58	N/R	
5AC10	Ewaso Narok	0 26 15 N	36 43 26	S	10/58		R	2,590
5AC11	Ewaso Narok	0 15 29 N	36 32 23	S	11/58		R	868
5AC12	Aiyam	0 19 25 N	36 34 05	S	11/58		N/R	466
5AC13	Melwa	0 19 25 N	36 34 05	S	03/59		N/R	
5AC14	Muruku	0 14 20 N	36 33 52	S	05/59		N/R	285
5AC15	Ewaso Narok	0 15 25 N	36 32 12	S	03/82		N/R	
5AD1	Mutara	0 04 00 S	36 33 00	SW	02/51	01/63	N/R	13
5AD2	Mutara	0 04 50 N	36 39 48	S	11/58		N/R	65 a)
5AD3	Mutara	0 27 00 N	36 47 40	SW	02/59	05/77	N/R	453
5AD4	Mutara	0 04 49 N	36 39 48	S	09/81		N/R	
5BA1	Engare Moyok	0 15 05 S	36 52 55	SW	11/31	07/63	R	58 a)
5BA2	Engare Moyok	0 08 12 S	36 55 24	SW	02/59	02/62	N/R	
5AB3	Engare Moyok	0 15 48 S	36 52 14	S	09/80		N/R	
5BB1	Ewaso Ngiro	0 08 00 S	36 52 06	S	03/44	12/47	R	
5BB2	Ewaso Ngiro	0 08 00 S	36 52 00	SWA	12/47		R	405 e)
5BB3	Lughunya	0 08 45 S	36 51 10	SW	11/58	09/63	N/R	52
5BB4	Karameno	0 08 10 S	36 50 55	SW	01/59	09/69	R	83
5BB5	Karemeno	0 08 00 S	36 46 24	SW	01/59		R	49
5BC1	Burguret	0 06 34 S	37 02 07	S	03/44	04/49		b)
5BC2	Naromoru	0 09 55 S	37 01 30	SWA	07/31		R	83
5BC3	Engare Ngobit	0 03 20 S	36 46 57	S	03/44	02/48	R	

Cont. Appendix 4.3 List of River Gauging Stations

Station Number	River	Latitude	Longitude (Eastings)	Type	Date Open	Date Closed	Rated	Catchment Areas (Km2)	
5BC5	Rongai	0 02 30 S	37 04 00	SW	01/48	07/63	R	41	b)
5BC6	Burguret	0 06 34 S	37 02 15	SWA	01/48		R	98	
5BC7	Engare Ngobit	0 10 00 S	36 41 00	SWA	03/47	08/58	R		
5BC8	Engare Ngobit	0 03 00 S	36 47 00	SWA	11/48		R	256	
5BC11	Ewaso Ngiro	0 14 15 N	36 54 15	S	10/52	05/53	N/R	2,830	
5BD1	Suguroi	0 04 00 N	36 40 20	S	11/58		R	197	a)
5BD2	Suguroi	0 04 35 N	36 36 10	S	11/58	06/73	R	124	
5BD3	Segara	0 04 54 N	36 43 48	S	12/58	04/61	N/R	109	
5BD4	Suguroi	0 13 48 N	36 52 20	S	01/59		N/R	389	a)
5BD5	Segara Suguroi	0 13 30 N	36 53 36	S	01/59		R	725	a)
5BE1	Nanyuki	0 01 15 N	37 04 38	SWA	07/30		R	68	
5BE2	Ontulili	0 02 25 N	37 08 20	SWA	03/31		R	64	
5BE3	Kongoni	0 03 20 N	37 11 10	SW	03/31		R	14	
5BE4	Sirimon	0 03 40 N	37 12 00	SWA	07/31		R	62	
5BE5	Teleswani	0 04 57 N	37 13 49	SWA	01/44		R	36	
5BE6	Timau	0 05 18 N	37 14 30	SWA	12/43		R	64	
5BE7	Liki	0 01 15 N	37 05 13	SA	01/44		R	176	
5BE10	Timau	0 03 30 N	37 18 00	SW	03/48	08/53	R		
5BE11	Liki (Centre)	0 02 00 S	37 08 35	SW	02/51		R	41	
5BE12	Liki (South)	0 02 55 S	37 08 50	SW	02/51		R	26	
5BE14	Nanyuki	0 11 00 N	37 00 30	S	10/52	05/59	N/R		
5BE15	Liki (Main)	0 00 00	37 06 30	S	12/58	05/59	N/R		
5BE16	Nanyuki	0 08 00	37 01 48	S	03/59	05/65	R	329	
5BE17	Liki (North)	0 01 20 S	37 08 44	S	01/59	07/61	R	62	
5BE18	Nanyuki	0 10 53 N	37 01 00	S	04/59	07/63	N/R		
5BE19	Ngushishi	0 06 00 N	37 15 40	W	01/59	07/63	R	13	
5BE20	Nanyuki	0 08 50 N	37 01 47	SR	12/59		R	860	
5BE21	Nanyuki	0 07 55 N	37 01 40	SR	01/65		R	329	
5D1	Ngare - Ndare	0 11 27 N	37 20 50	S	03/44	07/67	R	140	
5D2	Ngare - Nything	0 10 53 N	36 25 22	S	03/44	11/61	R	34	
5D3	Ngare - Narok			W	/55		N/R		a)
5D4	Ngare - Ndare	0 11 10 N	37 20 40	SW	01/48	07/63	R	137	
5D5	Ewaso - Ngiro	0 31 45 N	36 52 00	SA	08/49	-	R	4,561	e)
5D7	Isiolo	0 33 50 N	37 35 15	S	01/53	07/63	N/R	596	
5D8	Isiolo	0 20 00 N	37 34 00	S	03/54		R		c)
5D9	Lewa Springs	0 11 36 N	37 27 30	W	01/59	01/62	N/R		
5D10	Western Marania	0 11 36 N	37 28 28	W	01/59	01/62	N/R	65	
5D11	Eastern Marania	0 12 02 N	37 29 27	W	01/59	01/62	N/R	83	
5D12	Ngare - Unga	0 10 55 N	37 25 00	W	03/59	01/62	N/R	21	
5D13	Tributary of Ngare - Unga	0 10 50 N	37 25 12	W	03/59	01/62	N/R		
5E2	Ewaso Nyiro, Archer's Post	0 33 34 N	37 37 06	SW	03/44	05/59	R		
5E3	Ewaso Nyiro, Archer's Post	0 38 30 N	37 40 40	SWA	03/49		R	15,300	
5E4	Ewaso Nyiro, Habaswein	1 00 00 N	39 28 00	S	10/51	/59	R		

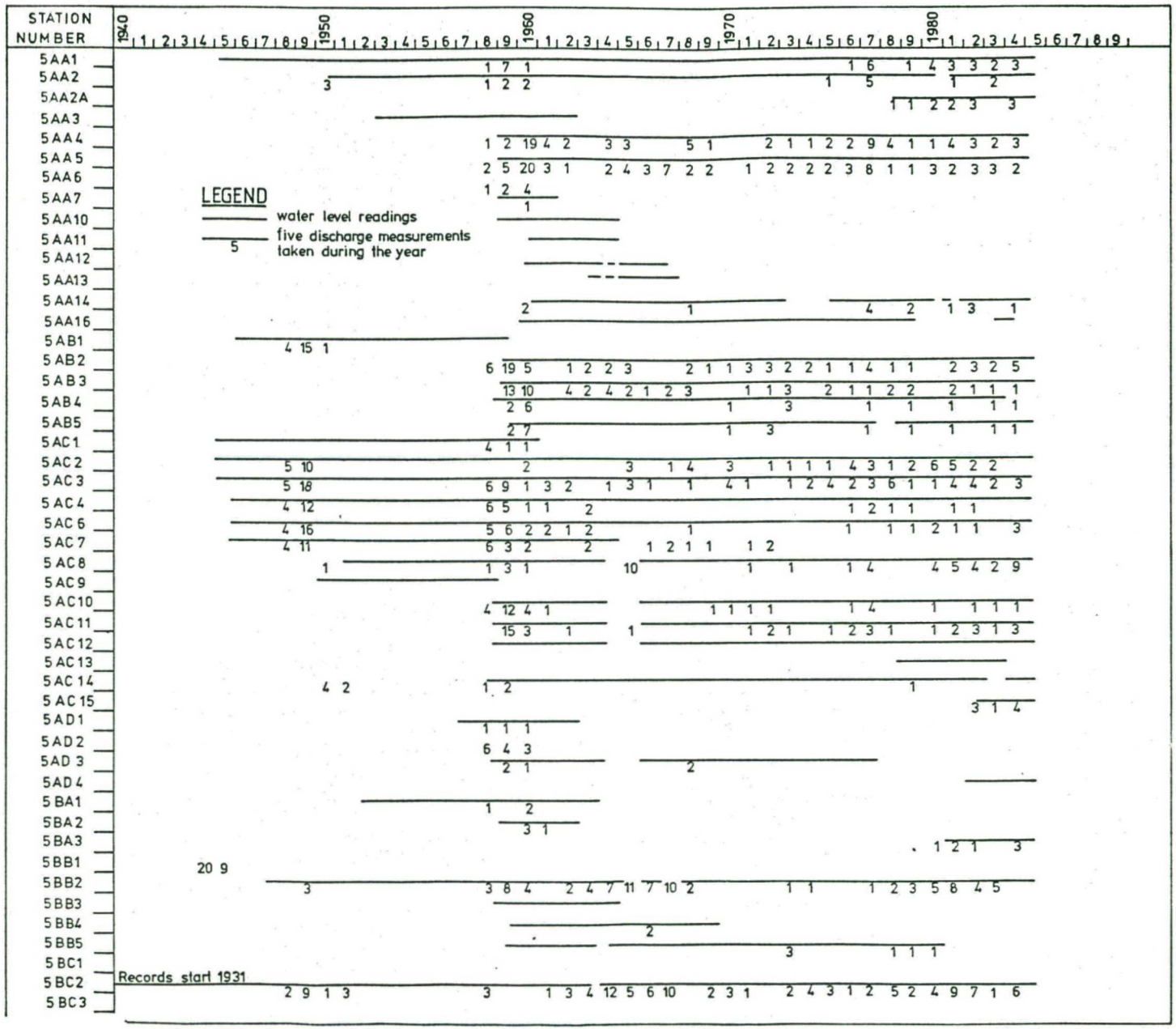
CONT. APPENDIX 4.3 LIST OF RIVER GAUGING STATIONS

LEGEND

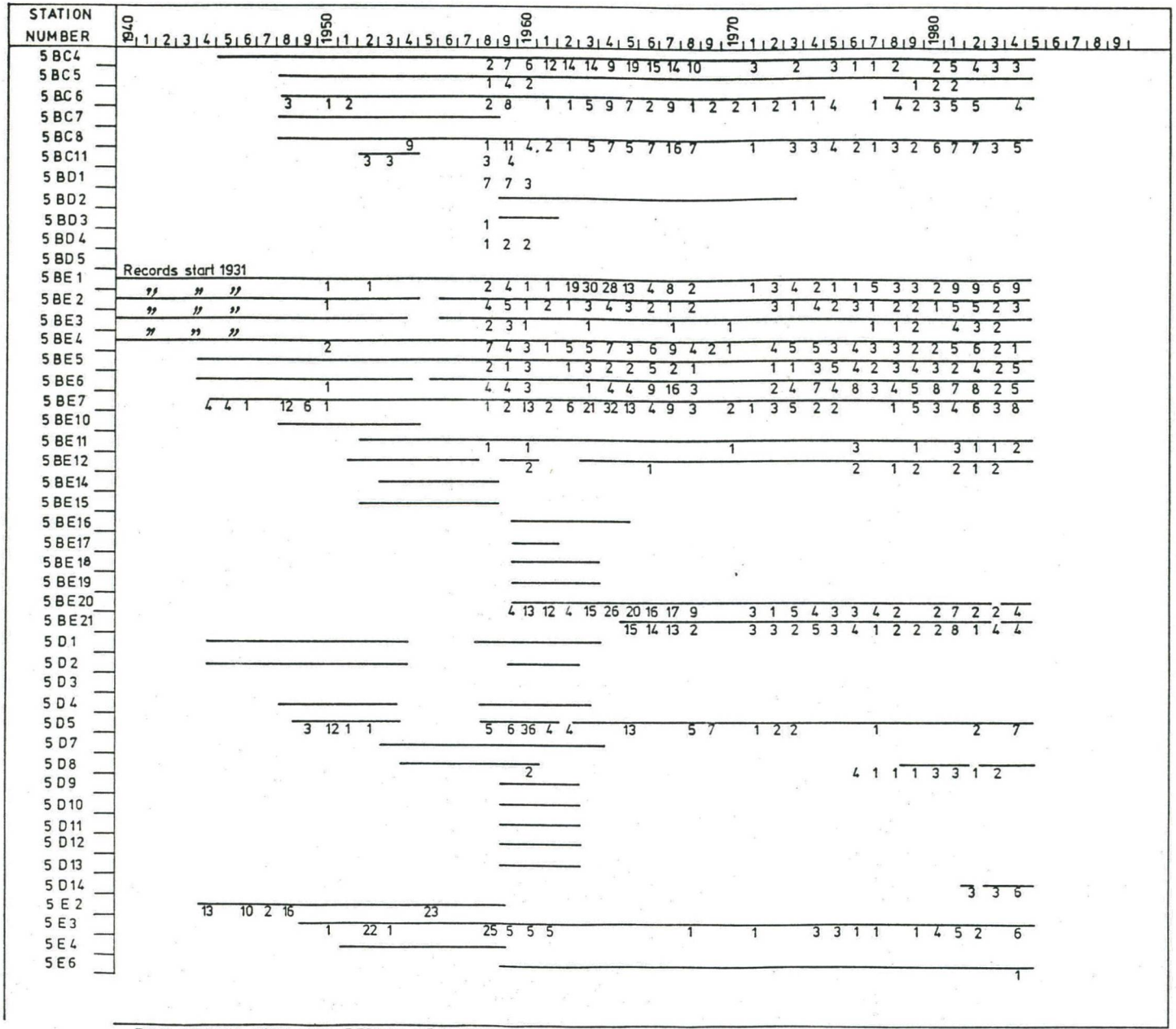
"Type" S = Staff Gauge
W = Weir
A = Automatic Water Level Recorder.

"Rated" R = Rated
N/R = Not Rated

"Note" a = Station abandoned on unknown date
b = Station re-opened on 3-9-79
c = Station re-opened on 13-10-76
d = Station replaced by 5BC6
e = Solid state water level recorder installed by WRAP in April 1986



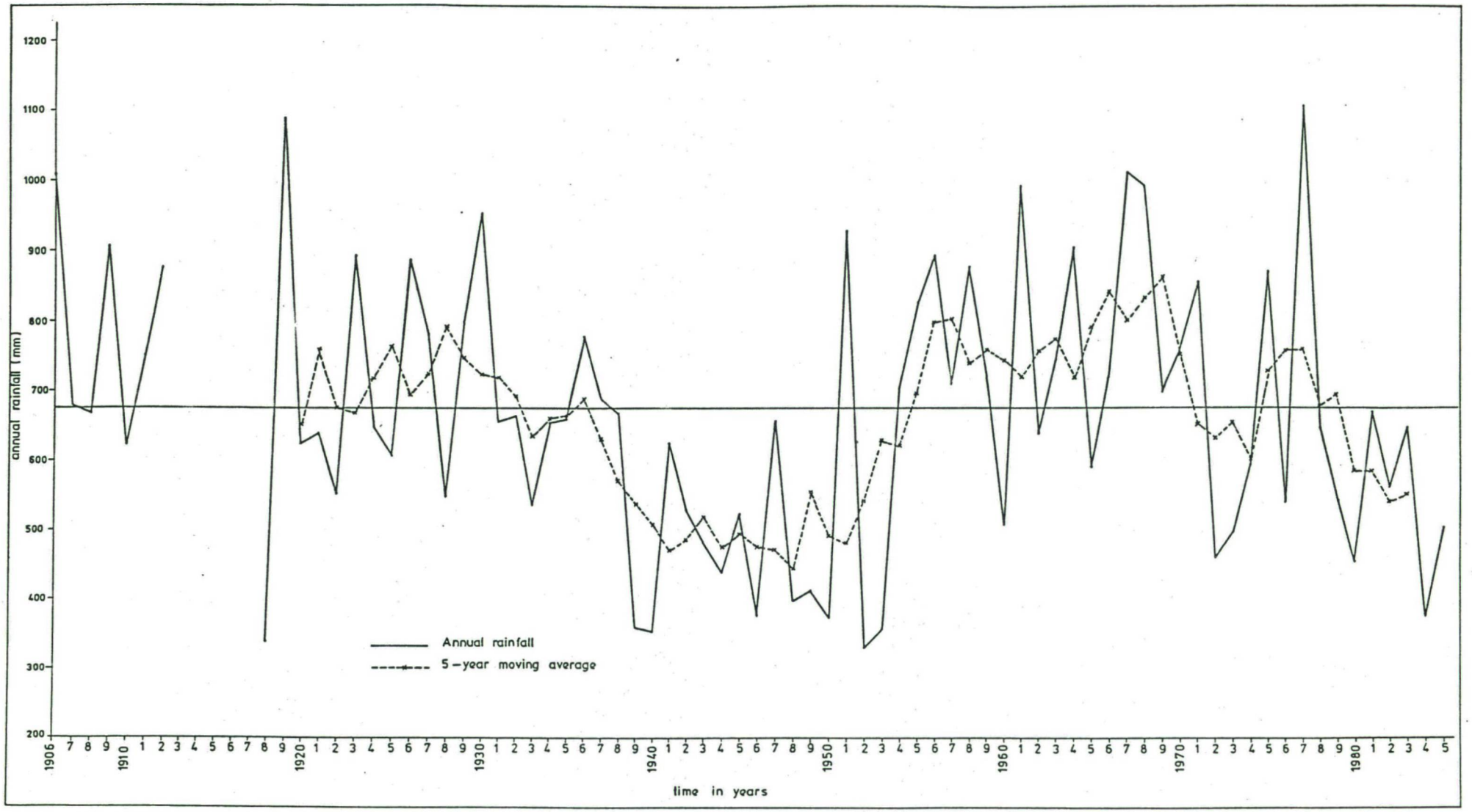
BAR GRAPH SHOWING PERIOD OF RECORD OF RIVER GAUGING STATIONS IN UPPER EWASO NGIRO BASIN (MAINLY LAIKIPIA DISTRICT)



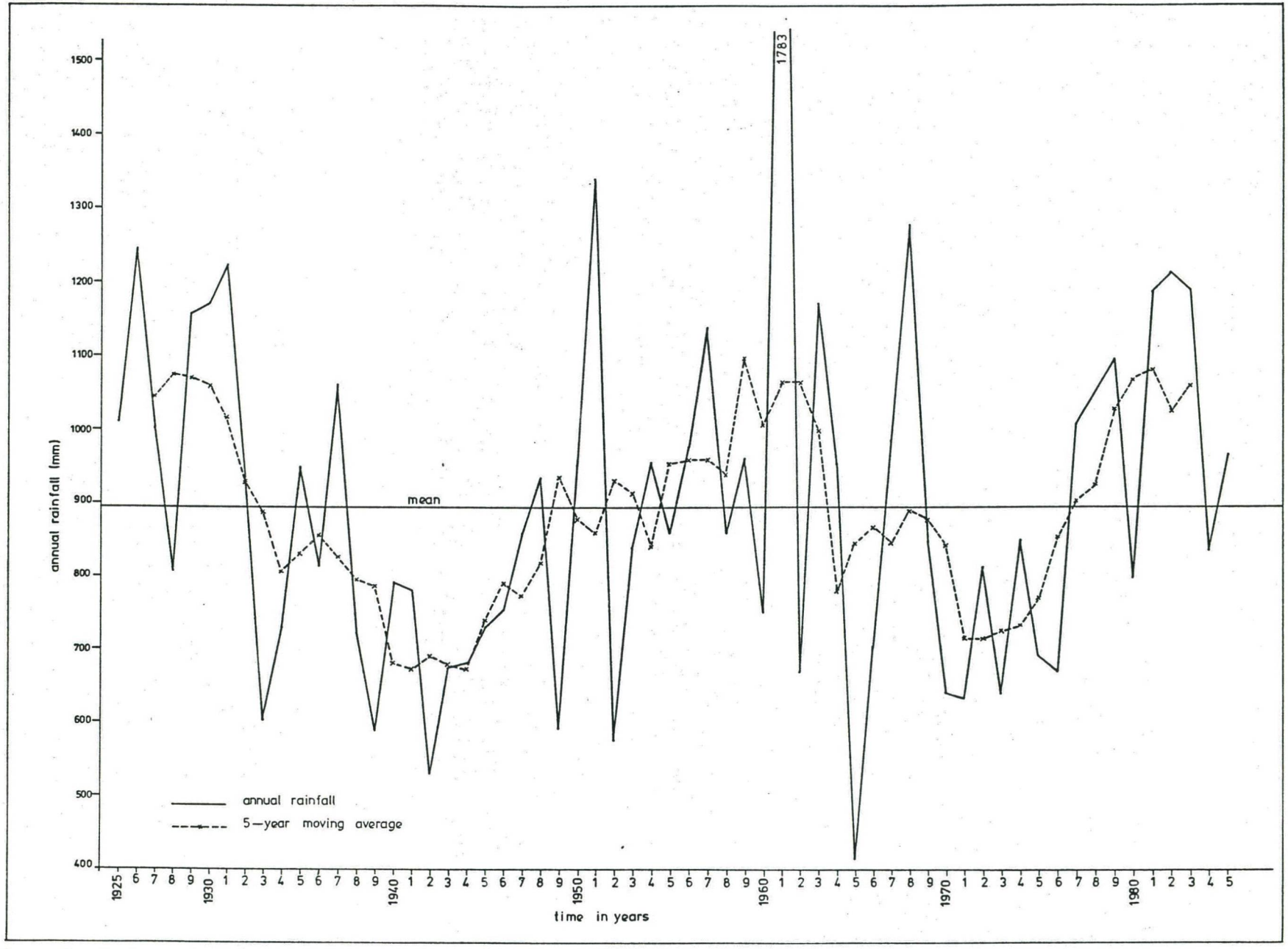
BAR GRAPH SHOWING PERIOD OF RECORD OF RIVER GAUGING STATIONS
IN UPPER EWASO NGIRO BASIN (MAINLY LAIKIPIA DISTRICT)

APPENDIX 4.4

Rainfall Figures

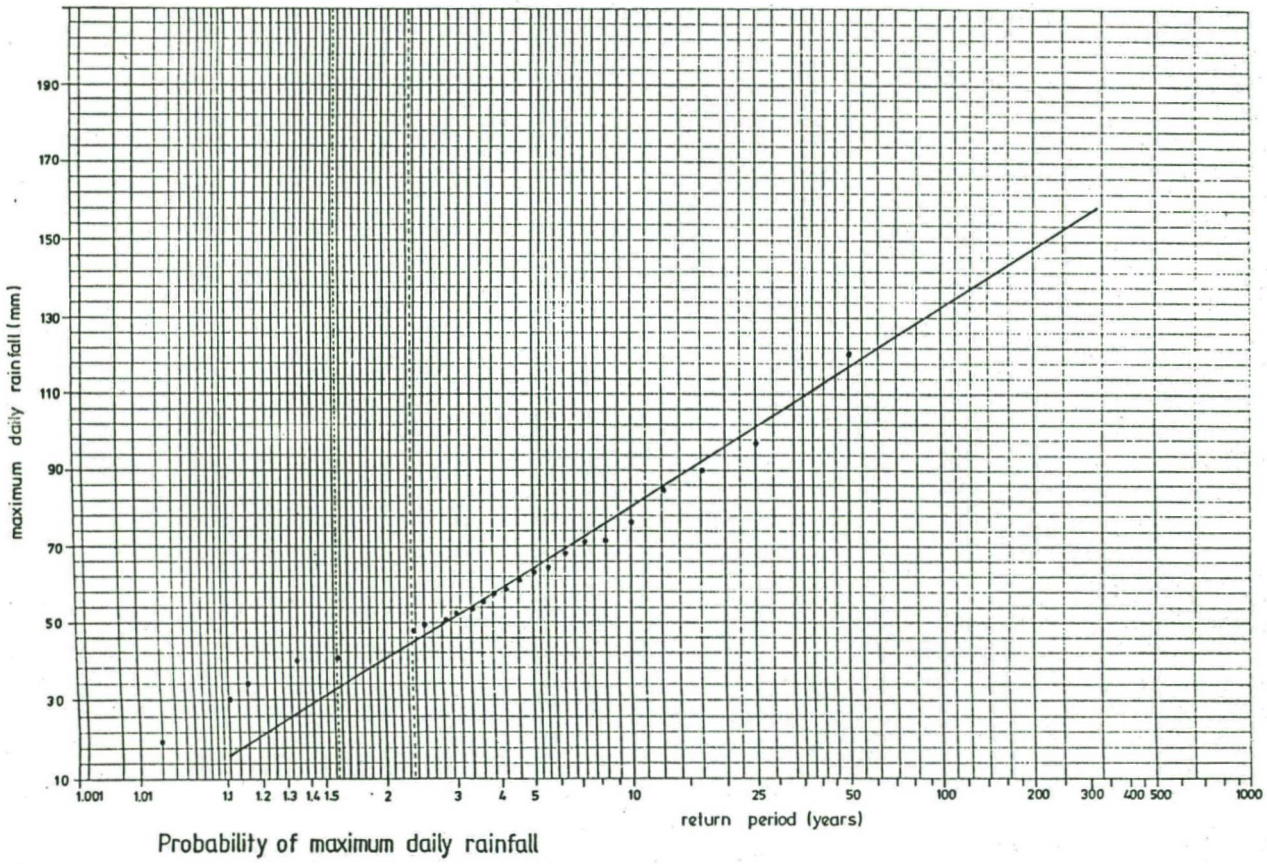


Trend of annual rainfall — RUMURUTI 89. 36. 001



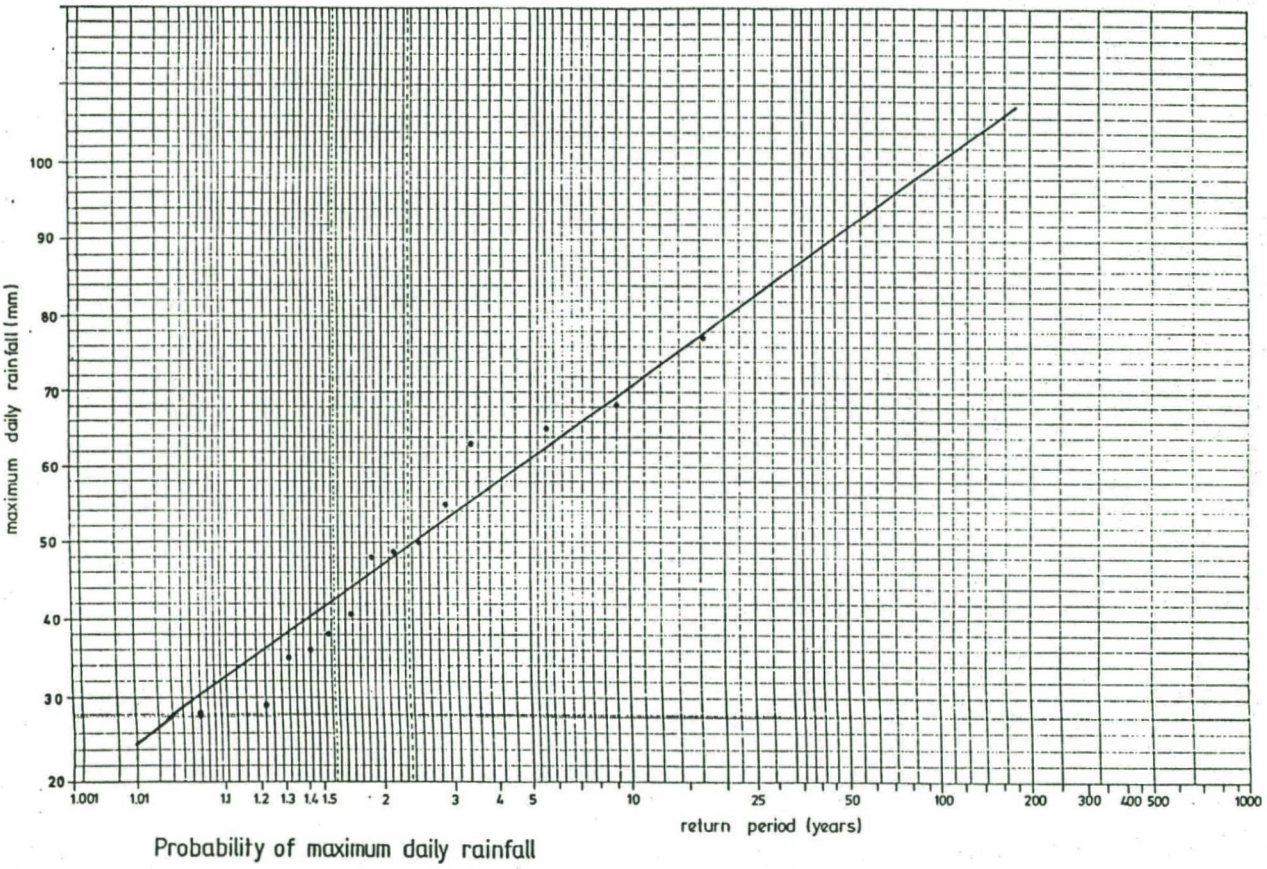
Trend of annual rainfall — TIMAU MARANIA 89. 37. 002

RUMURUTI 89. 36. 001



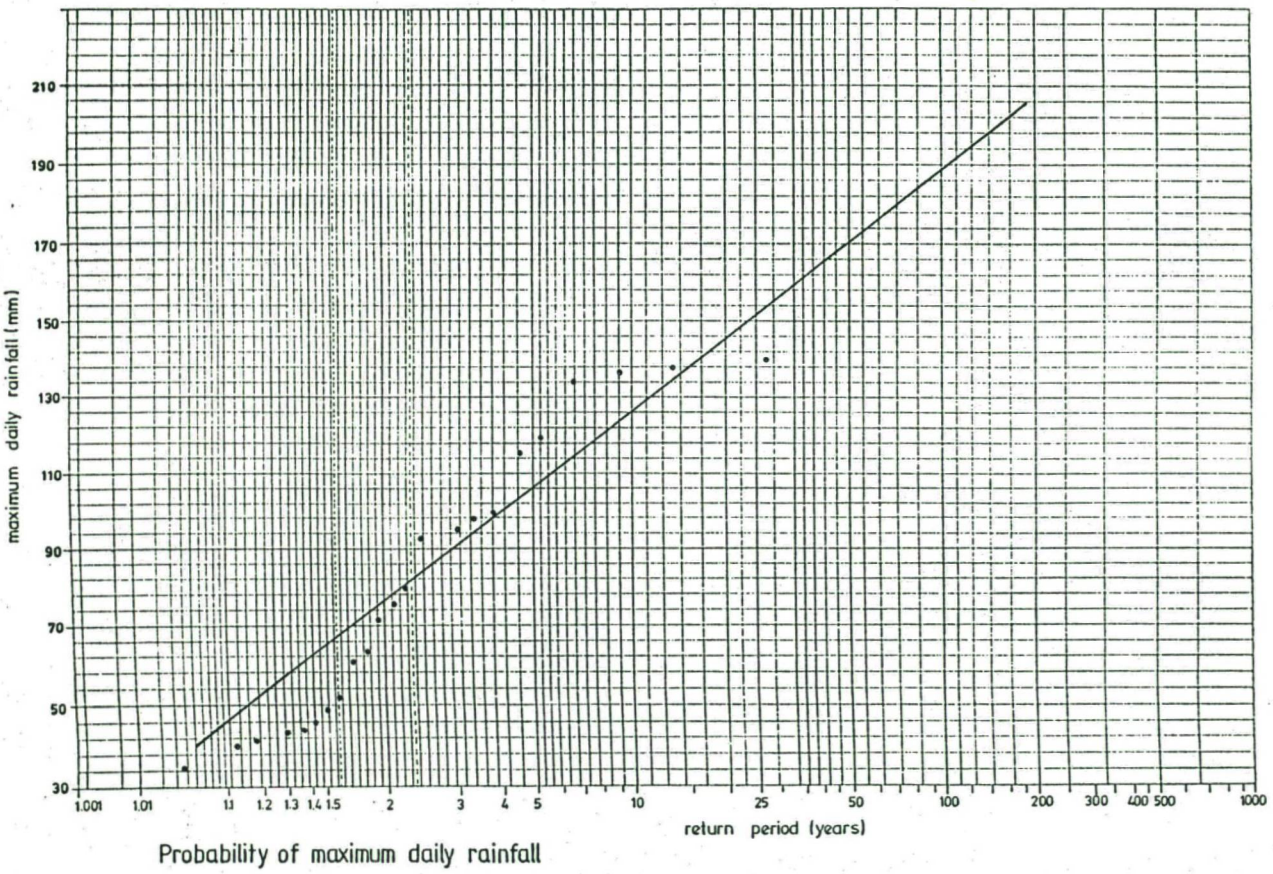
Probability of maximum daily rainfall

JUNCTION 89. 36. 065



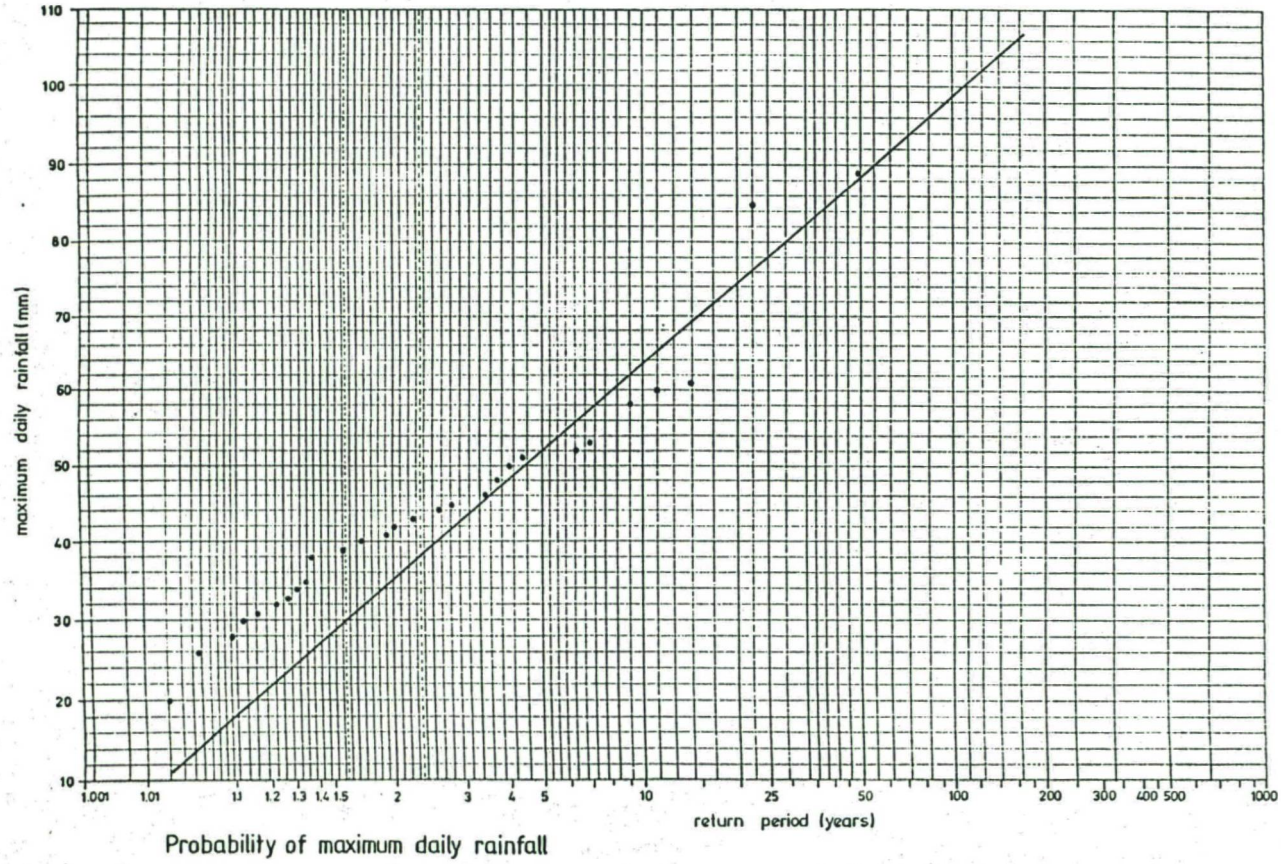
Probability of maximum daily rainfall

WAMBA 89. 37. 018



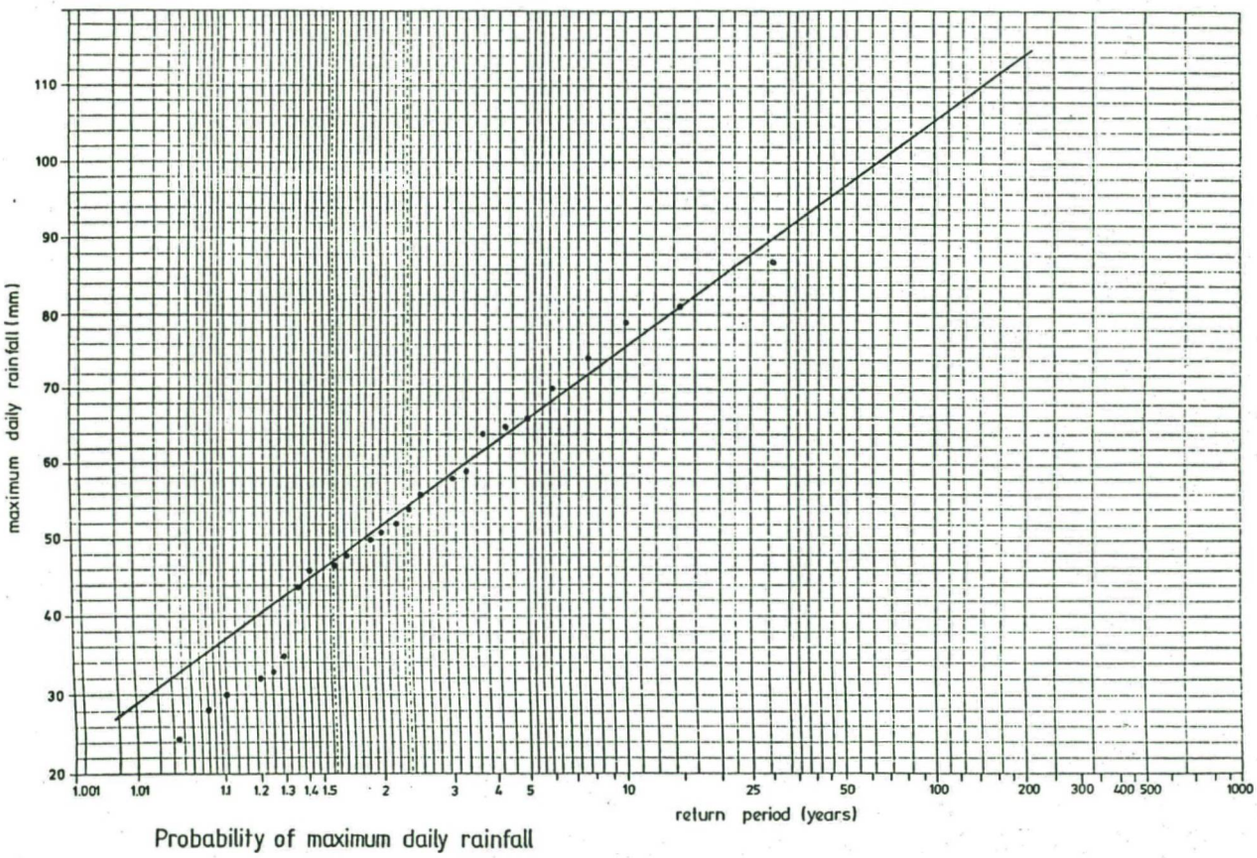
Probability of maximum daily rainfall

NANYUKI 89. 37. 022



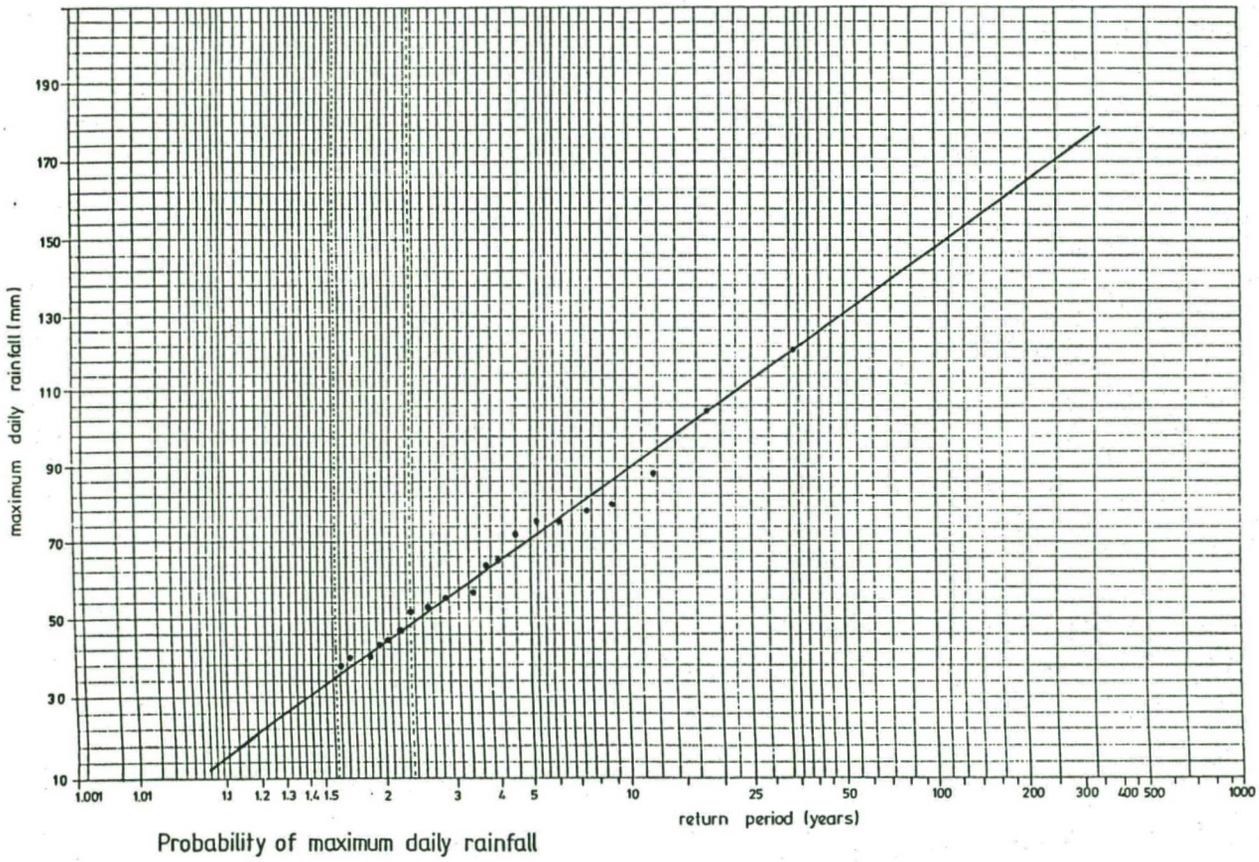
Probability of maximum daily rainfall

DOL DOL 89. 37. 033



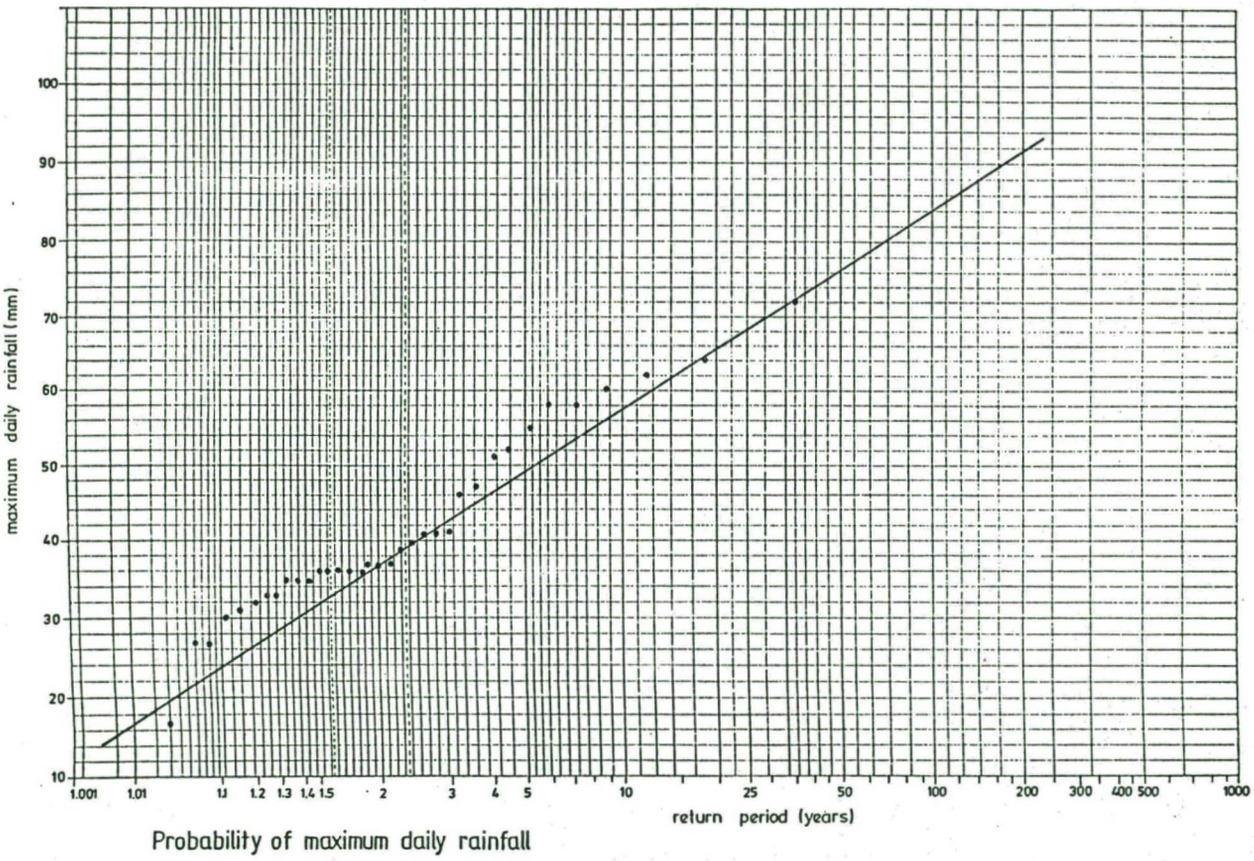
Probability of maximum daily rainfall

ARCHER'S POST 89. 37. 035



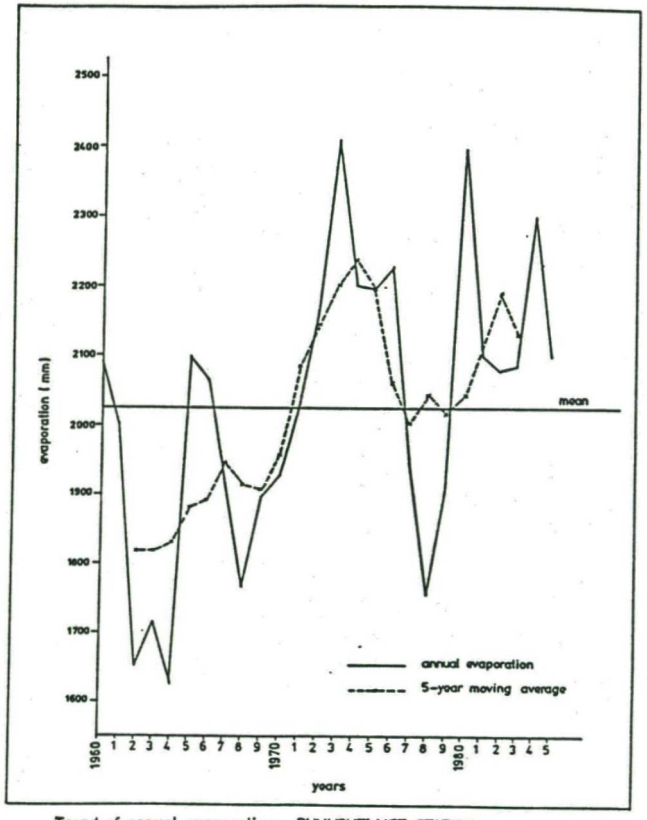
Probability of maximum daily rainfall

KANGAITA FOREST 90. 37. 060

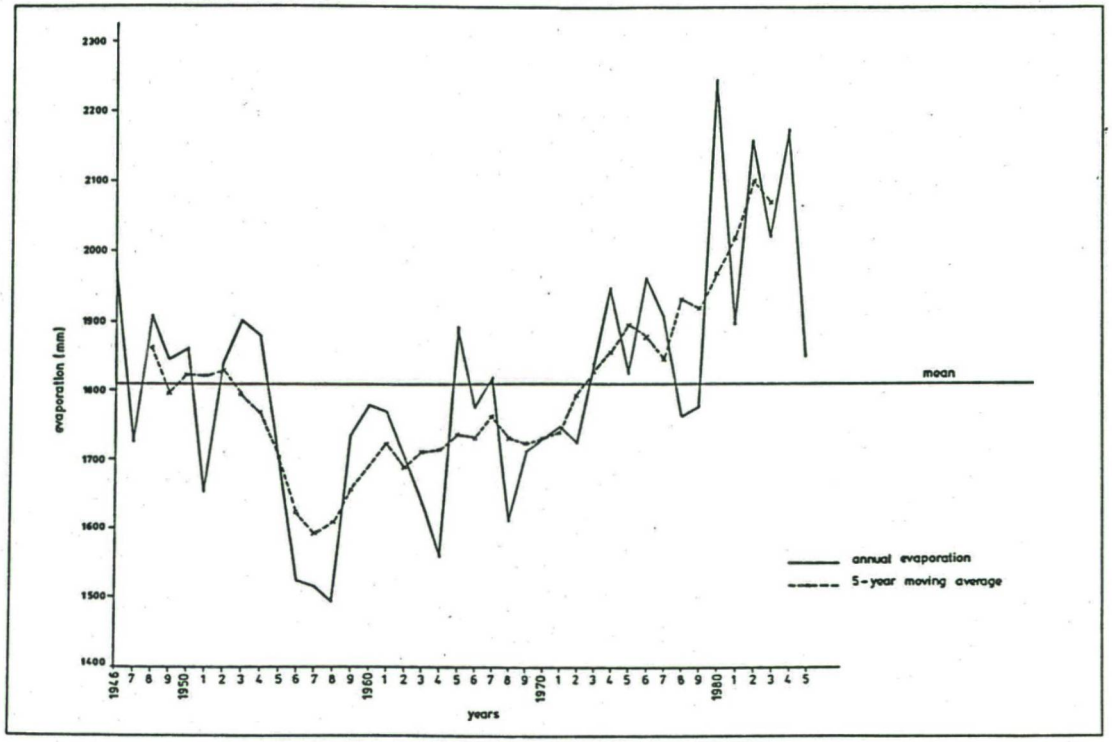


Probability of maximum daily rainfall

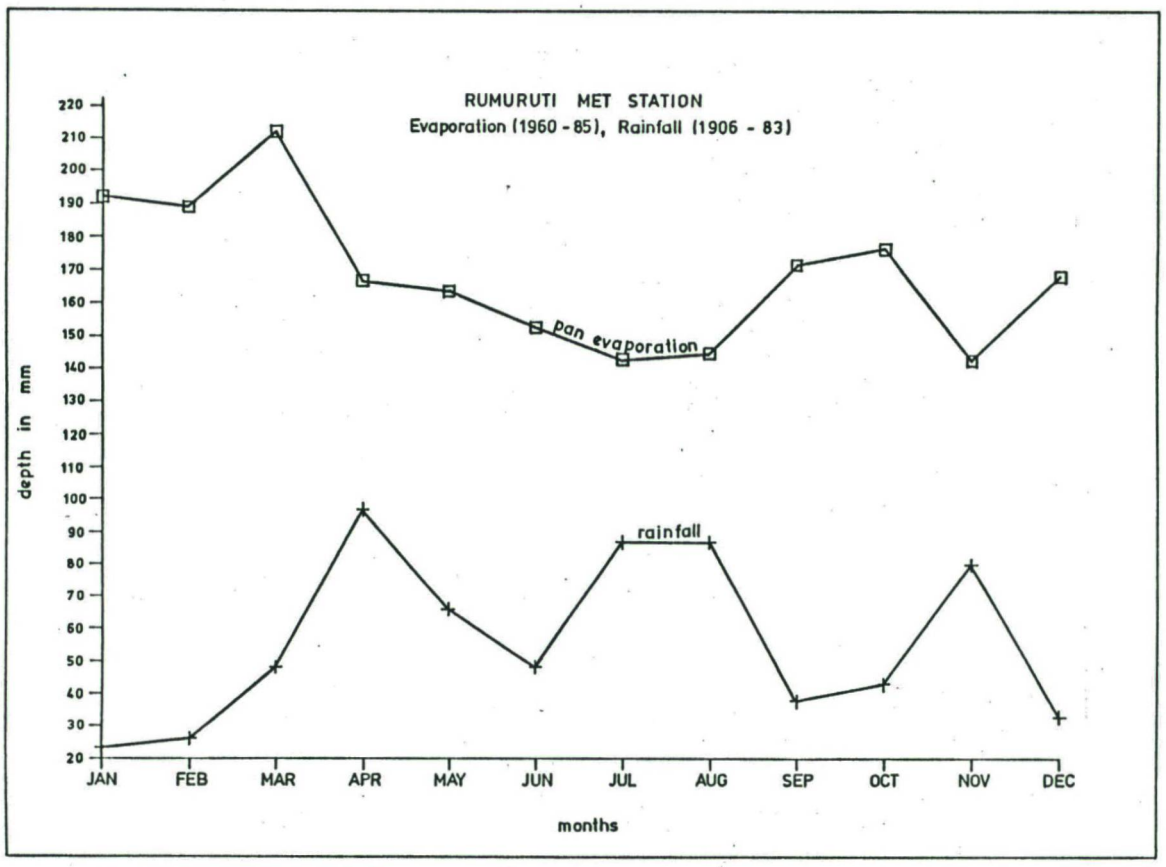
APPENDIX 4.5
Evaporation Figures



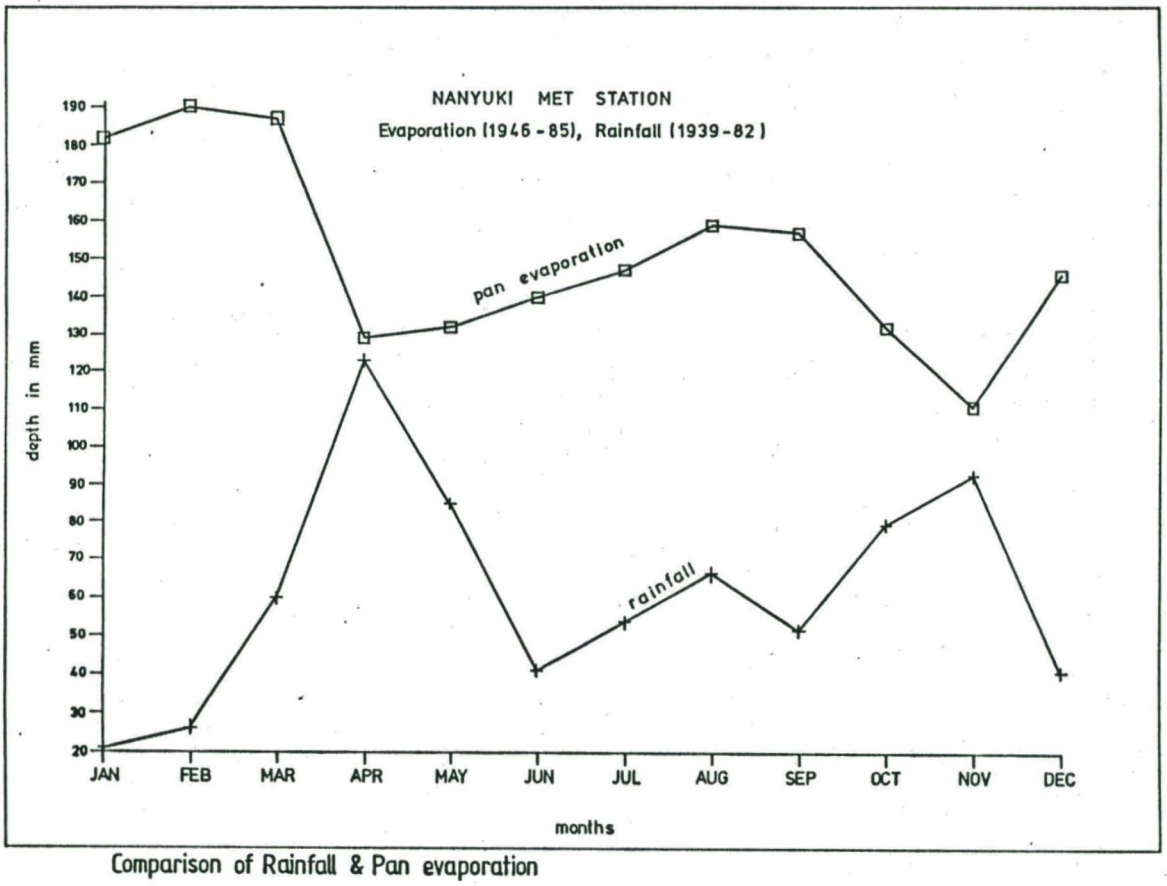
Trend of annual evaporation — RUMURUTI MET. STATION



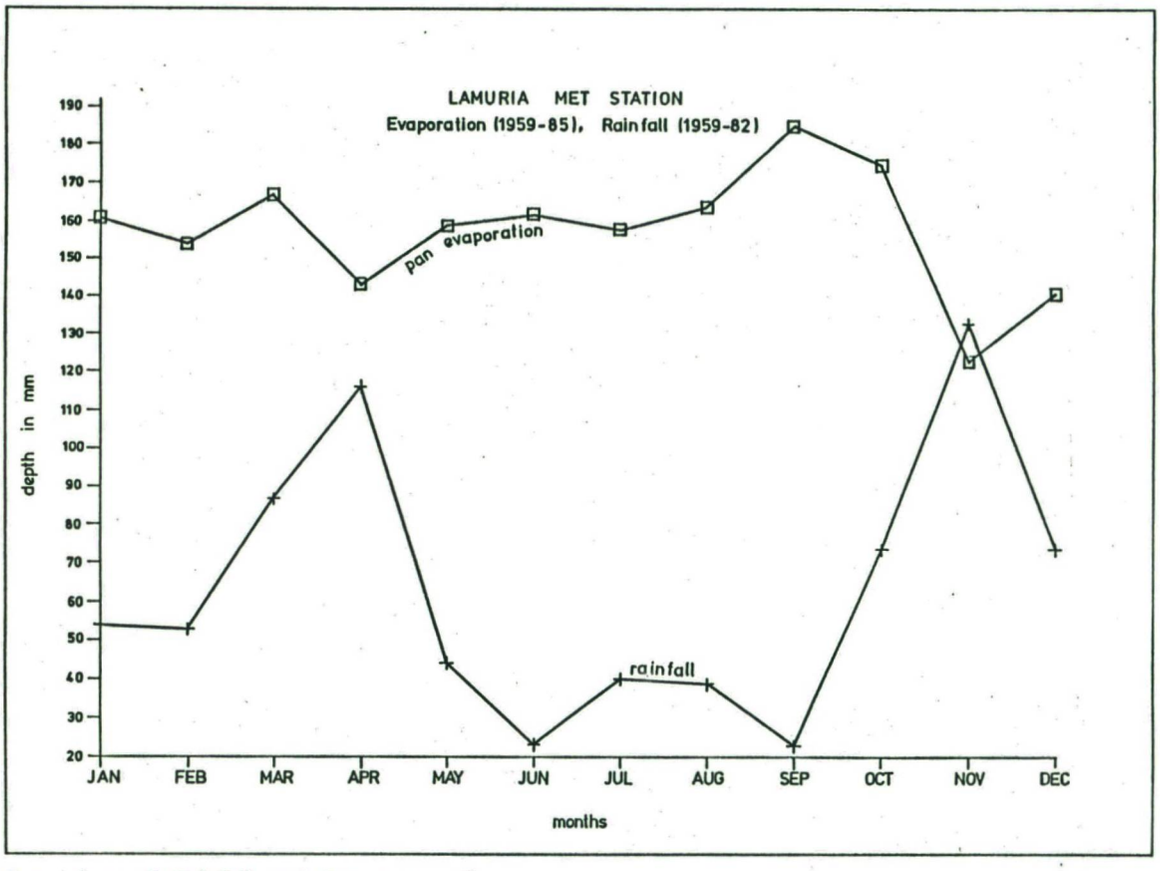
Trend of annual evaporation — NANYUKI MET STATION



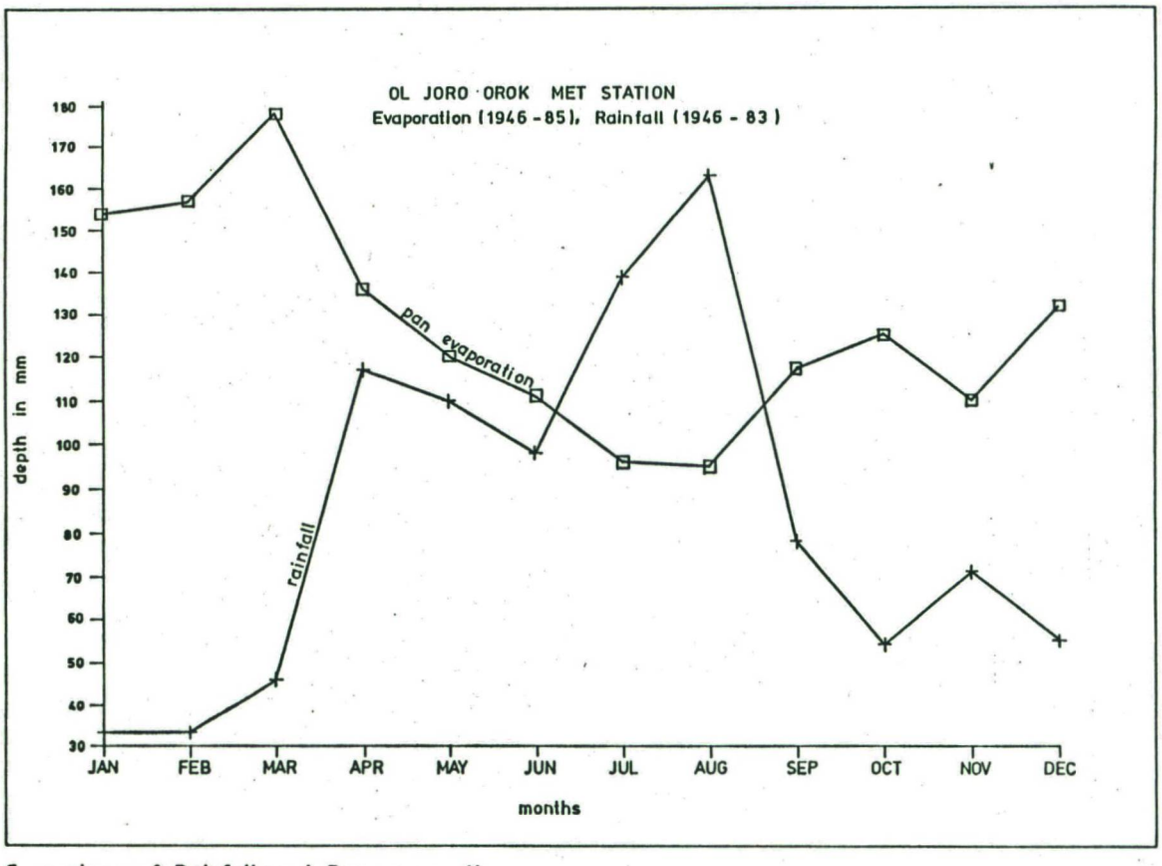
Comparison of Rainfall & Pan evaporation



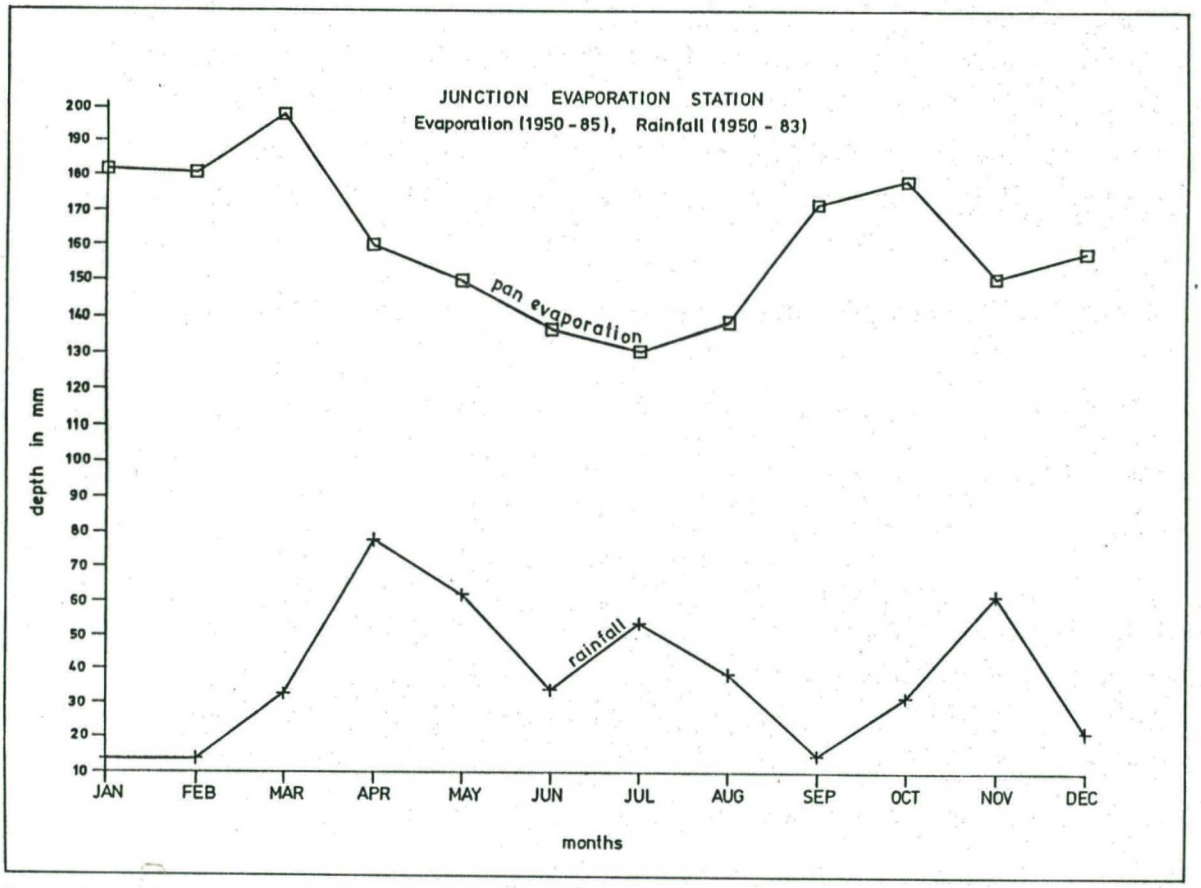
Comparison of Rainfall & Pan evaporation



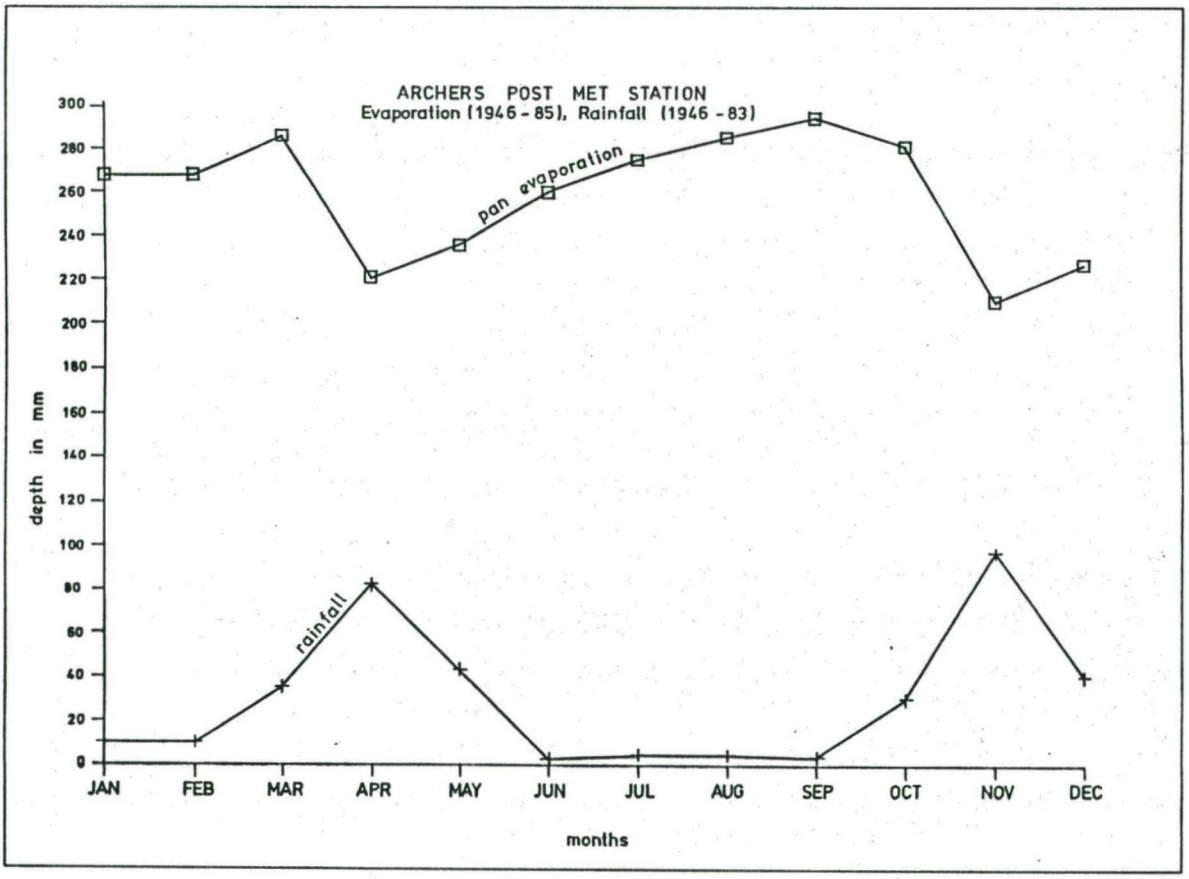
Comparison of Rainfall and Pan evaporation



Comparison of Rainfall and Pan evaporation



Comparison of Rainfall and Pan evaporation



Comparison of Rainfall and Pan evaporation

APPENDIX 4.6

-Description and Analysis of the River Gauging Stations
-Runoff Tables and Figures

- Description and Analysis of the River Gauging Station

4.6.1 Ewaso Narok River at Nyahururu RGS 5AA1

This RGS covers the sub-catchment area of 5AA and monitors a catchment area of 577 km². It is about 500 m upstream of the Nyahururu water falls.

The main source of Ewaso Narok river is a major spring some 2-3 km upstream of the RGS at the foot of the north western edge of the Nyandarua mountain ranges. The Equator stream, originating from Dundori ridge is a fairly minor source. The catchment area of 5AA1 receives fairly high rainfall amounts of over 1,000 mm per year.

The Ol Bolossat swamp at the foot of the mountains was thought to contribute water to Ewaso Narok but this was observed to occur very rarely, only during high swamp water levels. The swamp itself is mainly fed by several springs originating from the foot of the mountains including a minor contribution from surface runoff during the rains.

Records at this RGS started in 1945 and the station is equipped with staff gauges, a compound weir and an autographic water level recorder. Due to operational problems, the float type recorder was removed in February 1980. A solid state water level recorder was installed in April 1986. This is located about 200 m downstream of the RGS and is fixed to the bridge abutment. The station has been rated to cover discharges in the range 0.5 to 17 cumecs.

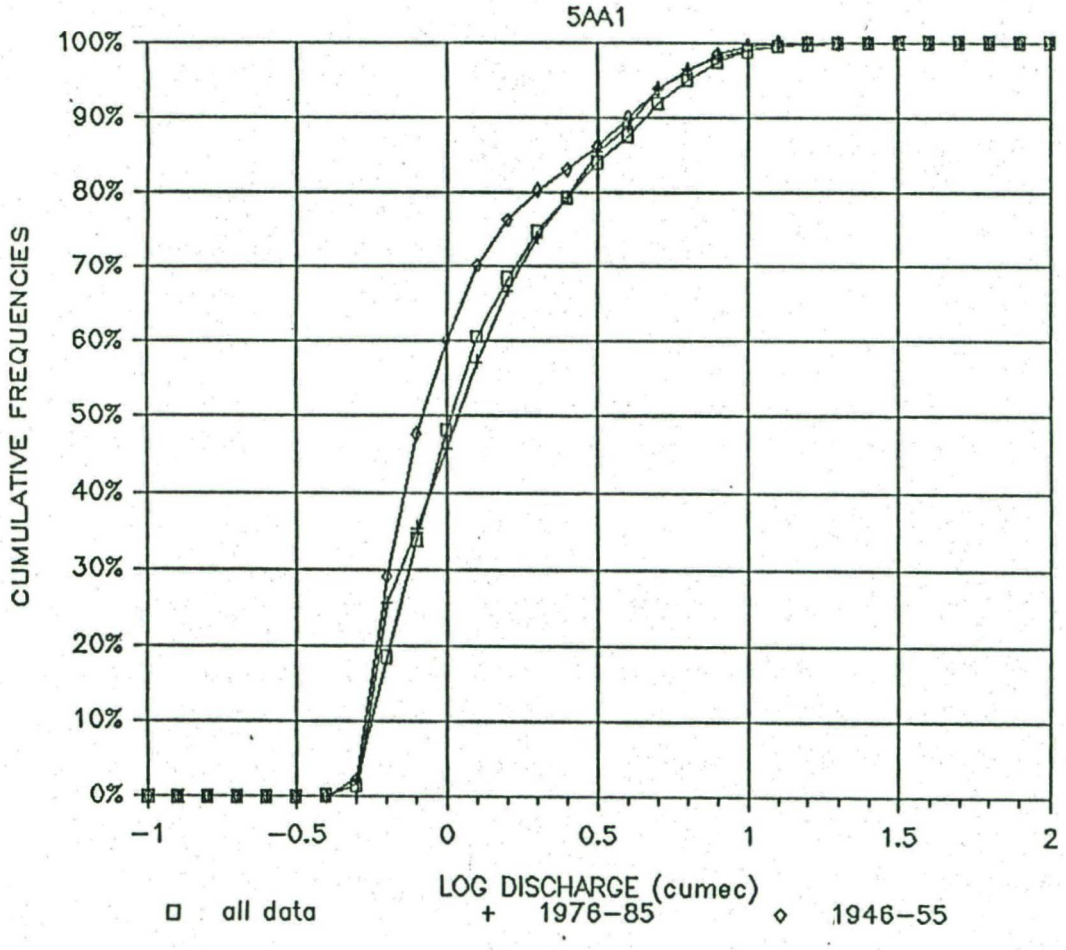


Fig. 6.1 Frequency Distribution of Daily Flows at RGS 5AA1

Daily discharge data for the period 1945-85 have been computed from which the lowest flow recorded is 0.39 cumec in March 1973, maximum flow is 36 cumecs in December 1961 and the overall mean monthly flow is 1.91 cumecs. The minimum mean monthly flow is about 0.591 cumec (Table 4.6.1). Most of the surface runoff from this area is brought by the continental rains in the months of June - August (Appendix 4.3).

A daily flow duration curve for the period of record has been prepared and the 95 and 90% duration flows are estimated as 0.519 and 0.556 cumec respectively. The latter is the available flow 9 out of 10 days on long-term average (Figure 4.6.1). A lot of this available flow is however abstracted just downstream of the station for a couple of water supply schemes including Nyahururu municipality.

Flood flow analysis has been carried out using both the recorder data and staff gauge readings. The maximum discharges plotted very well on the log-normal probability paper (using Weibull's plotting position) and the 50 and 100 - year design floods are estimated at 39 and 48 cumecs respectively (Figure 4.6.2).

4.6.2 Ewaso Narok at Rumuruti RGS 5AC15

The RGS is about 35 km downstream of 5AA1 and consists of only a staff gauge fixed to the bridge abutment of the Nanyuki - Rumuruti road. It covers a catchment area of 860 km^2 and monitors the river flows before entering the Narok swamp. A lot of dry season flow is however abstracted between the two river gauging stations.

Water level observations started in May 1982 and the station has been rated for discharges between 0.45 and 4.5 cumecs. The lowest flow recorded between May 1982 and July 1986 is 0.36 cumec in both 1984 and 1986 while the highest is 21.6 cumecs in December 1982.

The minimum mean monthly flow is 0.54 cumec while the overall mean daily flow is 1.696 cumecs.

Due to its short period of record (only 4 years), the flow characteristics at this station cannot be compared with those at RGS 5AA1.

4.6.3 Pesi River Upstream of the Pesi Swamp at RGS 5AB3

This station which covers a catchment area of 319 km^2 is just upstream of the Nanyuki - Nyahururu road bridge at Pesi shopping centre and monitors river flows before entering the swamp.

The RGS consists of a staff gauge installed in December 1958 and a solid state water level recorder installed by WRAP in April 1986. Water level observations have been made wholly from staff gauges with the result that peak water levels have been missed due to lack of an autographic recorder. Two readings per day were taken between May 1979 and December 1983 otherwise only one reading daily.

Rating of the station has been done for discharges below 3 cumecs but discharges as high as 350 cumecs have been computed by extrapolation. This calls for an urgent campaign to rate this station to cover medium and high flows.

Table 4.6.1 Mean Monthly Discharge Data at RGS 5AA1

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment Division Hydrology Division

MONTHLY AND ANNUAL DISCHARGE DATA

River: EWASO NAROK
R.G.S: 5AA1
Area (km2): 577

The flows are in: CUMEC
except when otherwise stated.

YEAR	J	F	M	A	M	J	J	A	S	O	N	D	YEAR	DAILY MAX	DAILY MIN	Days without readings
1944																366
1945	0.65				0.62	0.98	2.19	6.75	6.88	2.40	1.00	0.72				103
1946										1.53	1.00	0.74				316
1947									5.65	2.52	1.03	0.91				244
1948	0.65	0.68	0.61	0.65	0.79	1.25	1.58		4.33	1.23	1.22	0.81				11
1949	0.61	0.55	0.55	0.58			1.29			1.70	0.89	0.77				22
1950	0.65	0.58	0.58	0.71		0.68	1.59	4.35	3.80	1.48	0.81	0.64				28
1951	0.58	0.56	2.64	4.69	5.22	2.75	1.68	6.01	3.29	1.66	1.84	5.62	2.90	12.23	0.50	40
1952	1.76	0.86	0.66	0.70	1.27	0.80	0.99	2.23	1.57	0.83	0.71	0.65	1.09	4.04	0.63	1
1953	0.58	0.56	0.58	0.64	0.71	0.85	0.99	1.42	0.92	0.66	0.66	0.68	0.77	2.08	0.56	91
1954	0.54	0.52	0.54	0.62	0.91	1.16	2.97	4.97	7.01	2.80	1.03	0.90	2.01	9.60	0.50	39
1955	0.63	0.67	0.61	0.65	0.67	0.66	0.85	3.13	5.67	2.37	0.93	0.73	1.46	10.45	0.50	126
1956	0.98	1.75	0.83	0.71	1.07	1.16	2.68	5.93	4.47	1.90	1.01	0.77	1.94	10.44	0.63	64
1957	0.65	0.67	0.61	1.27	1.70	2.25	2.64	2.44	2.14	0.77	0.84	1.02	1.42	5.75	0.56	73
1958	0.74	2.03	1.08	0.68	0.88	1.78	8.53	7.23	5.54	2.06	1.11	1.61	2.78	19.29	0.63	0
1959	0.92		0.67	0.69	0.81		1.01	1.84	3.13	1.20	0.88	1.11				75
1960			0.59	0.67	0.88	0.82	1.07	2.98	4.13	1.32	1.04	0.79				13
1961	0.69	0.63	0.65	0.74	0.90	0.84	0.97	3.51	2.97	3.40	13.46	14.25	3.60	57.88	0.63	0
1962	11.21	3.42	1.77	1.38	2.19	1.59	2.70	4.61	5.63	2.55	1.42	1.22	3.31	31.58	1.03	40
1963	1.04	0.87	1.12	1.47	4.99	3.38	1.63	4.20	3.58	1.20	1.06	4.46	2.40	9.33	0.69	12
1964	2.32	1.04	0.95	1.30	1.21	1.48	3.42	8.05	7.35	5.09	2.35	1.74	3.04	13.51	0.75	2
1965	1.66	1.06	0.90	1.05	0.83	0.72	0.77	0.89	0.83	0.84	1.30	0.94	0.98	2.54	0.69	4
1966	0.69	0.68	0.70	0.84	0.86	1.02	1.37	2.81	5.85	1.39	1.68	0.97	1.57	11.02	0.63	35
1967	0.71	0.65	0.73	0.81	2.82	1.44	6.18	7.23	4.90	1.81	2.39	3.01	2.74	11.32	0.63	47
1968	1.18	1.17	3.19	8.08	7.51	6.37	5.09	8.60	4.55	2.30	2.25	3.58	4.50	19.29	0.96	60
1969	1.32	1.32	1.03	0.83	0.92	0.76	0.96	1.31	2.56	1.12	1.00	0.86	1.16	5.35	0.69	53
1970	0.85	0.79	0.73	0.97	0.83	1.00	1.10	3.69	4.12	1.81	1.21	0.94	1.50	7.92	0.66	64
1971	0.75	0.70	0.77	0.80	1.54	3.00	5.91	7.27	4.85	2.70	1.25	1.22	2.58	12.39	0.69	55
1972		1.00	0.66	0.62	0.78	1.12	2.61	2.34	1.28	0.83	1.00	0.72				56
1973	0.66	0.53	0.45	0.47	0.54	0.63	0.85	2.96	2.58	1.49	0.77	0.58	1.04	4.76	0.39	45
1974	0.51	0.56	0.63	0.73	0.98	1.14	2.29	2.85	2.75	0.89	0.69	0.61	1.22	5.96	0.50	64
1975																361
1976																359
1977	0.69	0.61	0.58	0.71		2.05	3.66	5.96	2.68	2.01	10.09	4.78				57
1978	1.78	1.22	2.18	2.08	2.45	1.63	5.19	4.48	4.40	2.77	2.64	1.76	2.73	7.79	0.82	24
1979	1.29	3.98	1.11	1.09	1.31	1.24	1.38	2.14	1.26	0.83	0.76	0.66	1.41	14.69	0.63	51
1980	0.64	0.64	0.63	0.63	1.38	1.30	1.29	1.33	1.47	0.88	0.94	0.88	1.00	2.35	0.56	64
1981	0.71	0.63	0.67	3.66	2.84	1.09	2.47	6.42	4.26	2.62	1.07	0.76	2.28	11.62	0.56	62
1982	0.66	0.62	0.64	0.74	1.14	1.53	1.27	4.08	2.08	1.38	3.54	6.55	2.03	21.75	0.56	66
1983	1.28	0.85	0.65	0.66	0.76	0.97	1.91	5.48	5.67	2.16	1.32	0.91	1.89	10.44	0.50	97
1984	0.74	0.63	0.63	0.63	0.63	0.64	0.67	0.78	0.68	0.63	0.63	0.63	0.66	1.03	0.63	115
1985	0.63	0.63	0.64	0.70	1.25	1.51	2.67	3.72	2.65	0.87	0.72	0.58	1.39	6.18	0.50	115
1986																
Maximum	11.21	3.98	3.19	8.08	7.51	6.37	8.53	8.60	7.35	5.09	13.46	14.25	14.25	57.88	1.03	
Minimum	0.51	0.52	0.45	0.47	0.54	0.63	0.67	0.78	0.68	0.63	0.63	0.58	0.45	1.03	0.39	
Mean	1.20	0.99	0.91	1.23	1.59	1.47	2.34	4.11	3.72	1.74	1.78	1.82	1.91	11.81	0.63	
Runoff (mm)	6.28	5.04	4.88	6.62	8.11	7.72	12.94	21.56	20.58	10.18	10.42	10.64	18.71	51.30	2.73	

Daily discharge data for the period 1959-85 have been computed using the inadequate rating curve and the lowest flow recorded is 0.006 cumec in January 1967. This very low flow is inaccurate due to rating curve limitation to flows less than 0.2 cumec.

From the daily discharge data the overall minimum mean monthly flow is 0.202 cumec, and the longterm mean monthly discharge is 1.26 cumecs. On a daily basis, the 95 and 90% duration flows are 0.204 and 0.219 cumec respectively (Figure 4.6.3), which compares well with the minimum mean monthly flow.

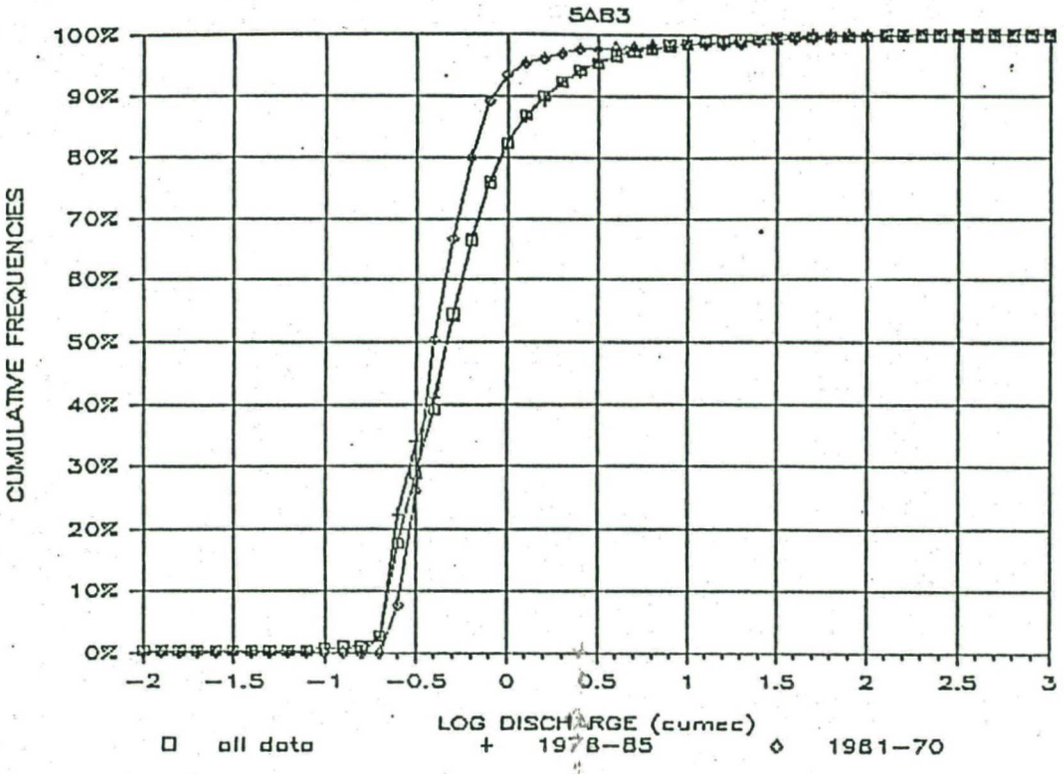


Figure 4.6.3 Frequency Distribution of Daily Flows at RGS SAB3

Flood Analysis

High water levels have been recorded using manual staff gauges which do not give instantaneous peak water levels as they occur mostly at night. This problem is coupled by the use of an inadequate rating curve which covers a maximum flow of 3 cumecs. Despite these difficulties, a Gumbel analysis has been subjected to the data and the 50 and 100 year design floods estimated at 405 and 450 cumecs respectively. These flows appear to be too high for this catchment area. These are however provisional results which should be confirmed with more data collection.

4.6.4 Pesi river downstream of the swamp at RGS SAB2

The RGS is located downstream of the Pesi swamp on the Nanyuki - Rumuruti road bridge and covers a catchment area of 412 km^2. The swamp has a by-pass canal on the left side which diverts some river water for domestic and irrigation purposes. The remainder of this water is returned back to the

river and monitored by RGS 5AB2.
Water level observàtions started in February 1959 from staff gauges and the station has been rated for discharges between 0.14 and 1.7 cumecs.

Daily discharge data for the 1959 - June 1986 period have been computed and the lowest flow recorded is 0.039 cumec in November 1962 while the highest is 27 cumecs in February 1979. The mean monthly flow for the whole period is 0.736 cumec while the minimum mean monthly flow is 0.158 cumec. The daily flow duration curve of this RGS estimates the 95 and 90% duration flows as 0.162 and 0.182 cumec respectively (Figure 4.6.4).

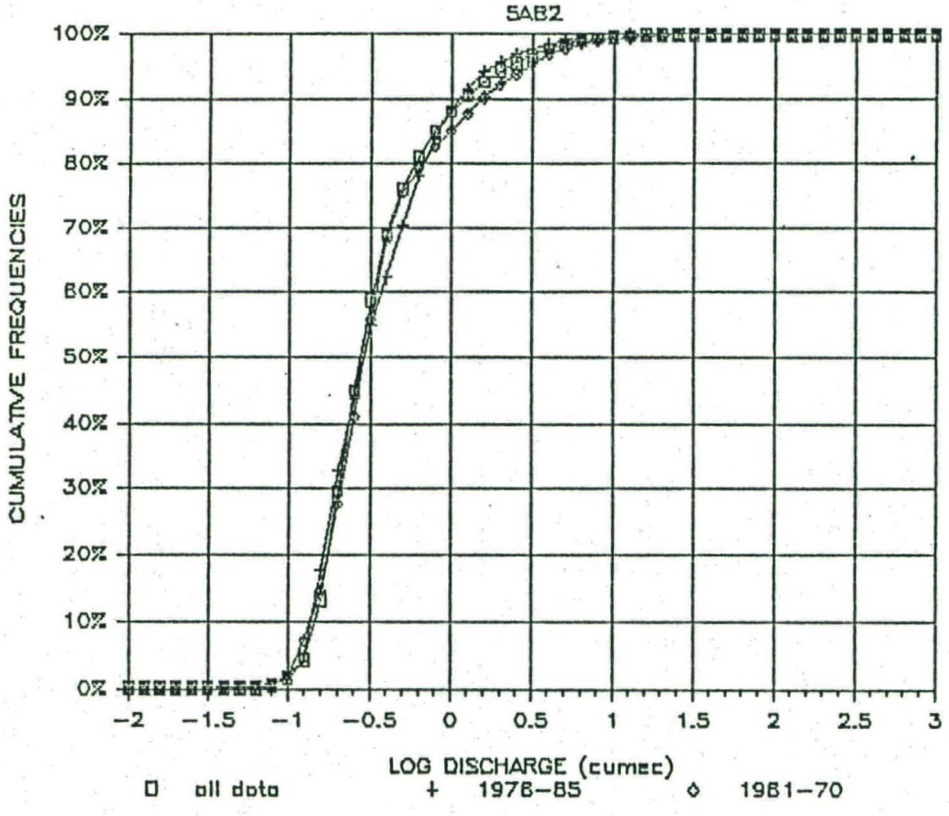


Figure 4.6.4 Frequency Distribution of Daily Flows at RGS 5AB2

High water level observations have not been properly made at this station as the highest flow realised is only 27 cumecs. It is difficult to evaluate what effect the Pesi swamp has had on high water levels as no autographic water level recorder has been installed.
Taking the available records and subjecting them to the Gumbel analysis gives the 50 and 100 year design floods as only about 32 and 35 cumecs respectively. These are rather extremely low flood flows of a catchment area of its size and should be treated as provisional results until more flood data is collected.

4.6.5 Ewaso Narok at the Junction RGS 5AC8

This is the most downstream station of the Ewaso Narok system and monitors the surface water resources of the whole system. All flow contributions of the perennial and seasonal tributaries are monitored here and the RGS therefore covers an area of 3,290 km².

The station is equipped with staff gauges, a compound weir and a float type autographic water level recorder since 1951. The functioning of the recorder has been off and on due to operational problems but some important high water levels have been obtained from the recorder.

Rating curve for this station has been established to cover discharges in the range 0.17 - 45 cumecs. Due to lack of flood gauging equipments like the cable ways and winch, the station has not been rated to cover most of the peak flows.

Daily discharge data for the period 1951-85 (with a gap in 1954-7) have been computed mainly from twice daily staff gauge readings from which daily flow hydrographs have been drawn. The driest years have been recorded as 1953, 1974, 1984 and 1985 when the lowest flow was 0.078 cumec. 1951 and 1961 recorded the highest flows of 498 and 544 cumecs respectively. These maximum flows are based on single water level observations while the daily discharge values are based on a mean of two observations. The minimum mean monthly flow for the period of record is 0.184 cumec while the overall mean monthly flow is 3.84 cumec.

The tri-modal runoff distribution pattern, caused by the long, continental and short rains is shown in Figure 4.6.5 in which the months of April, August and November contribute 12, 14 and 17 % of the mean annual flow respectively.

Low flow analysis

Flow recession curves for the driest months of 1984 (January-May) and 1985 (September - December) have been plotted in which the discharge decreased from 2.2 to 0.19 cumec in 60 days in 1984 and took only 5 days to drop from 0.23 to 0.078 cumecs in May of the same year. In 1985 however, discharge decreased from 2.4 to 0.078 cumecs in about 90 days.

These recession curves however are not natural as they are greatly affected by heavy water abstractions and the presence of the Narok swamp upstream.

Minimum flows for 1 day and 7 consecutive days have been analyzed using Weibull's plotting position and Gumbel's paper from which flows equal to or greater than 0.075 and 0.095 cumec are possible 9 out of 10 days respectively. These flows do not take into account the abstractions made upstream of the RGS.

For the planning and design of water development projects like water supply schemes, sanitation and irrigation projects, the daily flow duration curve is an important tool to determine the available flow on a daily basis. Figure 4.6.6 is such a curve and it indicates that flows equal to or greater than 0.240 and 0.302 cumec are possible 95 and 90% of the times respectively.

Flood analysis

Water level observations used for flood analysis have been recorded both manually and by the water level recorder.

Due to lack of flood gauging equipments, the station has only been rated for a maximum discharge of 45 cumecs, but the rating curve has been extrapolated upto to a discharge of 544 cumecs.

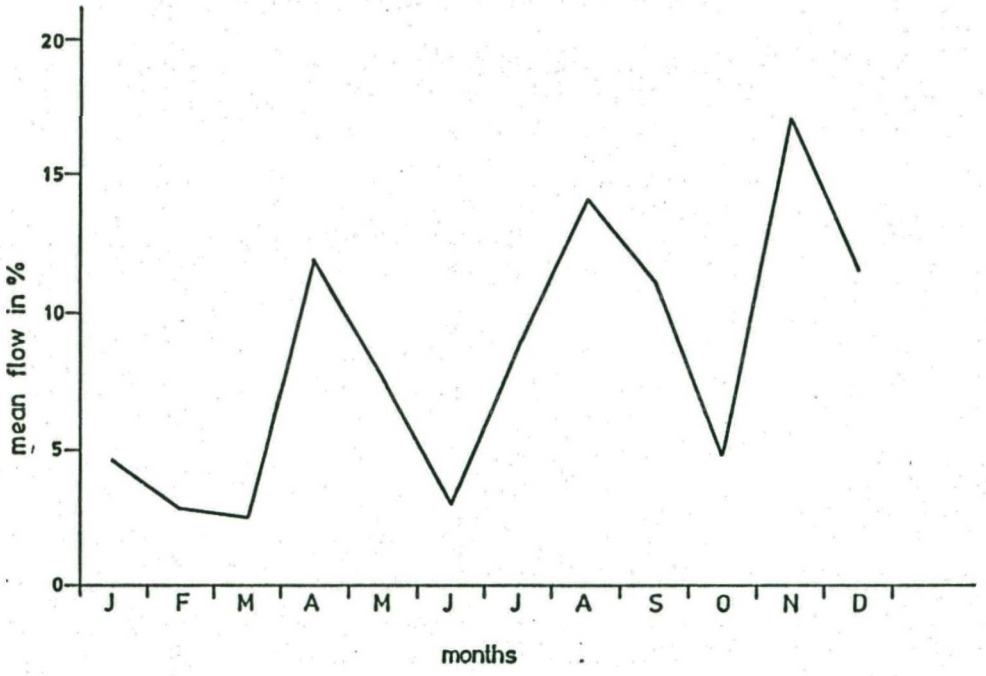


Fig. 4.6.5 Mean Monthly Flow Distribution at RGS 5AC8

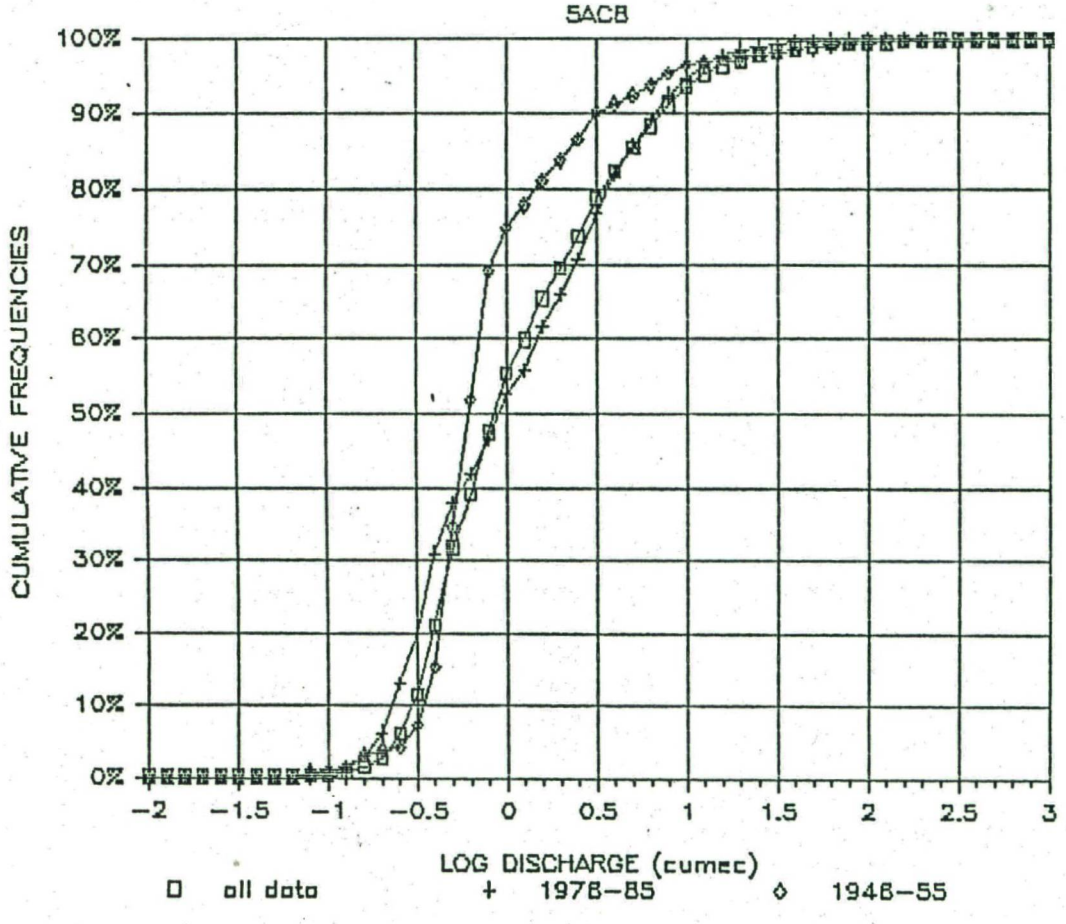


Figure 4.6.6 Frequency Distribution of Daily Flows at RGS 5AC8

Despite these limitations, annual maximum flows have been plotted in the log-normal probability paper using Weibull's plotting position and a log-pearson type III distribution has been fitted into the data (Figure 4.6.7). From this figure, the 50 and 100 year design floods are estimated at 860 and 1300 cumecs respectively. Such flows are very important in the design of dams and spillways.

Rainfall - Runoff Relation

For this relationship, mean annual rainfall for four stations distributed in the catchment area, is plotted against mean annual runoff monitored at RGS 5AC8. This relationship is fairly good and it shows that rainfall amounts greater than 700 mm produce substantial amounts of runoff. This could be due to the high daily maximum rainfall amounts common in this catchment particularly in the Nyahururu - Leshau area (Table 4.4).

The rainfall - runoff relation is not a simple linear regression analysis due to the varied climatological, topographic, vegetation and soil moisture conditions of the basin and this has the effect that equal rainfall amounts do not produce equal amounts of runoff. Inspite of this problem, the relationship can be used as a first approximation of missing runoff data where rainfall data is available or vice versa.

4.6.6 Ewaso Ng'iro at RGS 5BC4

This station monitors river flows originating from both northern Nyandarua Mt. ranges and the western slopes of Mount Kenya. From the former are rivers Ngobit, Ewaso Ng'iro itself and Moyo while Naro Moru, Burguret and Rongai are from the latter. These cover the minor sub-catchment areas of 5BA, 5BB and a large portion of 5BC which totals to an area of 1870 km^2.

There are 11 RGSs in the catchment area of 5BC4, 8 of which are equipped with autographic water level recorders. 5 of these recorders are on Naro Moru and Burguret rivers and were installed by the Swiss project, 2 by Ministry of Water and 1 solid state recorder by WRAP in April 1986.

RGS 5BC4 is presently equipped with staff gauges which were installed in 1944 and a recorder installed in 1959. Prior to installation of recorder, water level observations were made once per week after which daily readings were started until April, 1983. From this date onwards, one observation has been made every two days but gaps of 4 to 6 days (or more) can be seen in the records when the recorder is out of order. The performance of the recorder however has been very poor.

The station has been rated for discharges between 0.27 and 50 cumecs, but discharges as high as 244 cumecs have been extrapolated from the rating curve.

Discharge data for the period 1950-July 1986 (with a gap in 1954-59) have been computed on a daily basis and daily flow hydrographs plotted for each year. The lowest flow recorded is 0.0065 cumec in 1985 while the highest is 244 cumecs in 1961. These extreme flows may be inaccurate due to the extrapolation of the rating curve.

From the daily discharge computations the overall mean monthly flow for the period of record is 3.28 cumecs. For the same period, the minimum mean

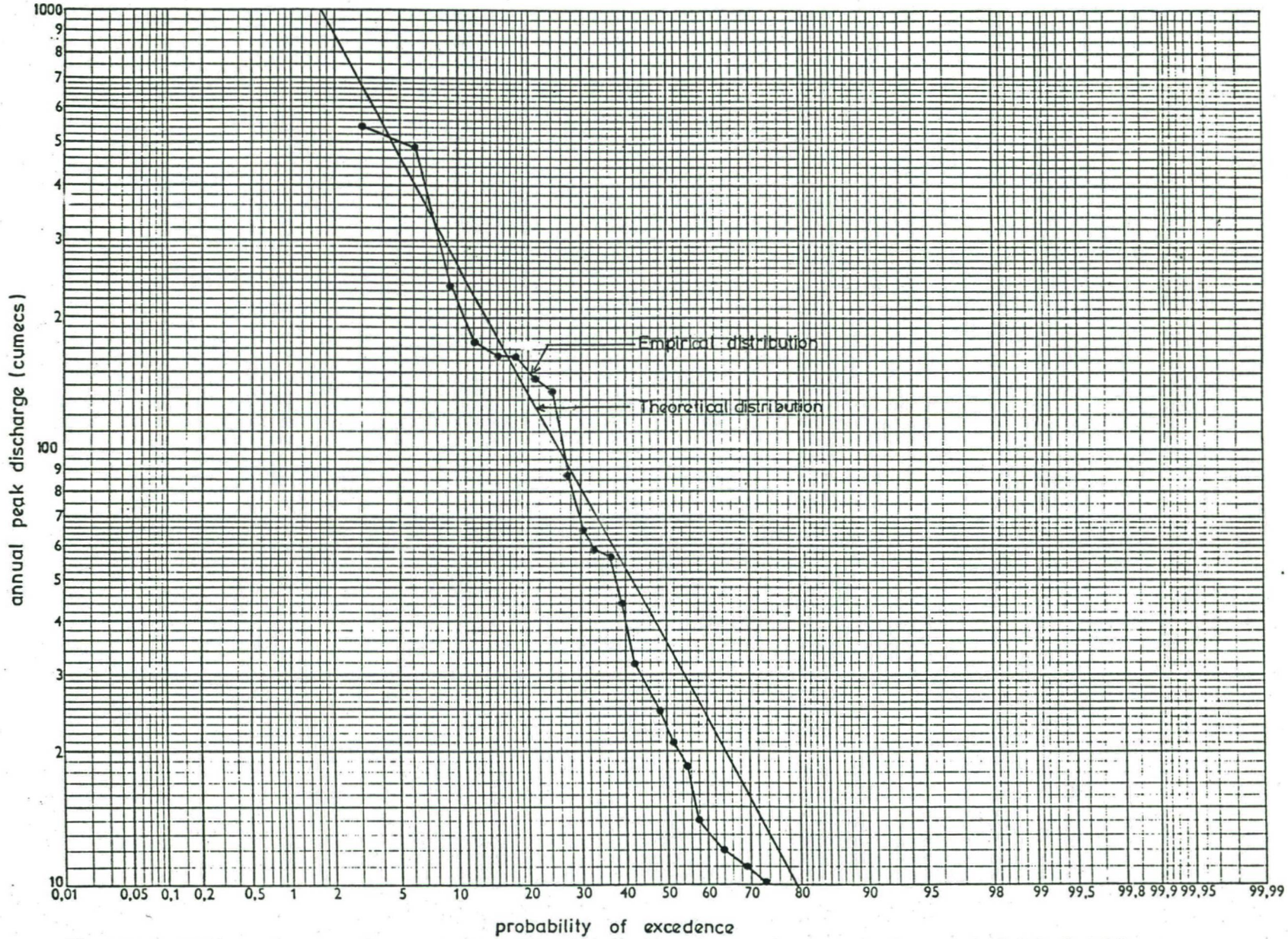


Fig.4.6.7 Fitting the Log Pearson type III distribution to peak annual flows at RGS 5 AC 8

monthly flow is only 0.404 cumec which is comparable with the 95 and 90% daily duration flows of 0.347 and 0.468 cumec respectively (Figure 4.6.8).

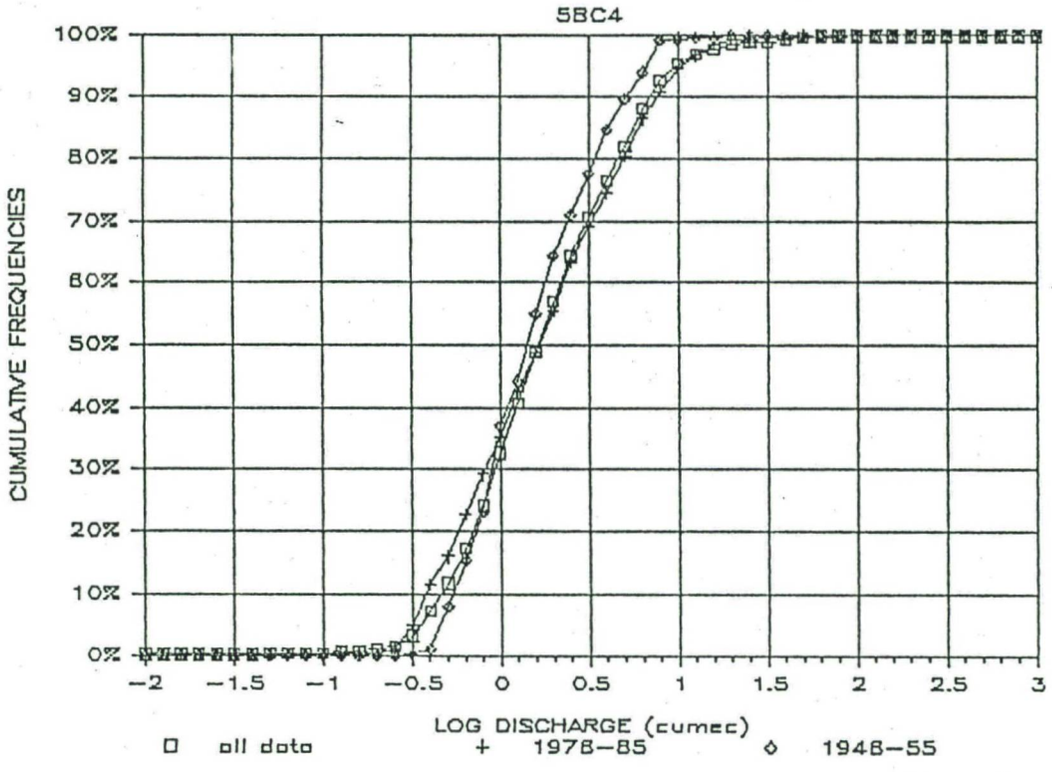


Fig. 4.6.8 Frequency Distribution of Daily Flows at RGS 5BC4

Flood analysis

Although the RGS has been equipped with a water level recorder since 1959, it appears that the recorder's performance during high water levels has always been poor since only in 1961 was flow more than 100 cumecs i.e at 244 cumecs. Most of the annual maximum discharges used (which range from 8 to 92 cumecs in 1984 and 1968 respectively) have been obtained from staff gauge readings which under estimate peak flows. The data has been plotted in the Gumbel paper and the 50 and 100-year design floods are estimated at 310 and 380 cumecs respectively. These should be treated as provisional results until more flood data becomes available.

4.6.7 Nanyuki at RGS 5BE20

This covers the Nanyuki - Timau river system which drains the north-western slopes of Mount Kenya and includes the rivers and streams within the minor sub-catchment area 5BE covering an area of 860 km^2. There are 11 RGSs in the system, 6 of which are equipped with water level recorders. These recorders were installed in 1985 by the Swiss project to monitor the tributaries of Nanyuki river which include Nanyuki itself, Liki, Ontulili, Sirimon, Teleswani and Timau.

Water level observations at the station started in December 1959 from staff

gauges and a water level recorder. The latter was in operation until 1972 when it was removed to another area. From 1973 onwards, a single reading of the water level has been made every two days but data gaps of 2 or more days can be observed now and then due to operational problems of this station from Nanyuki water office.

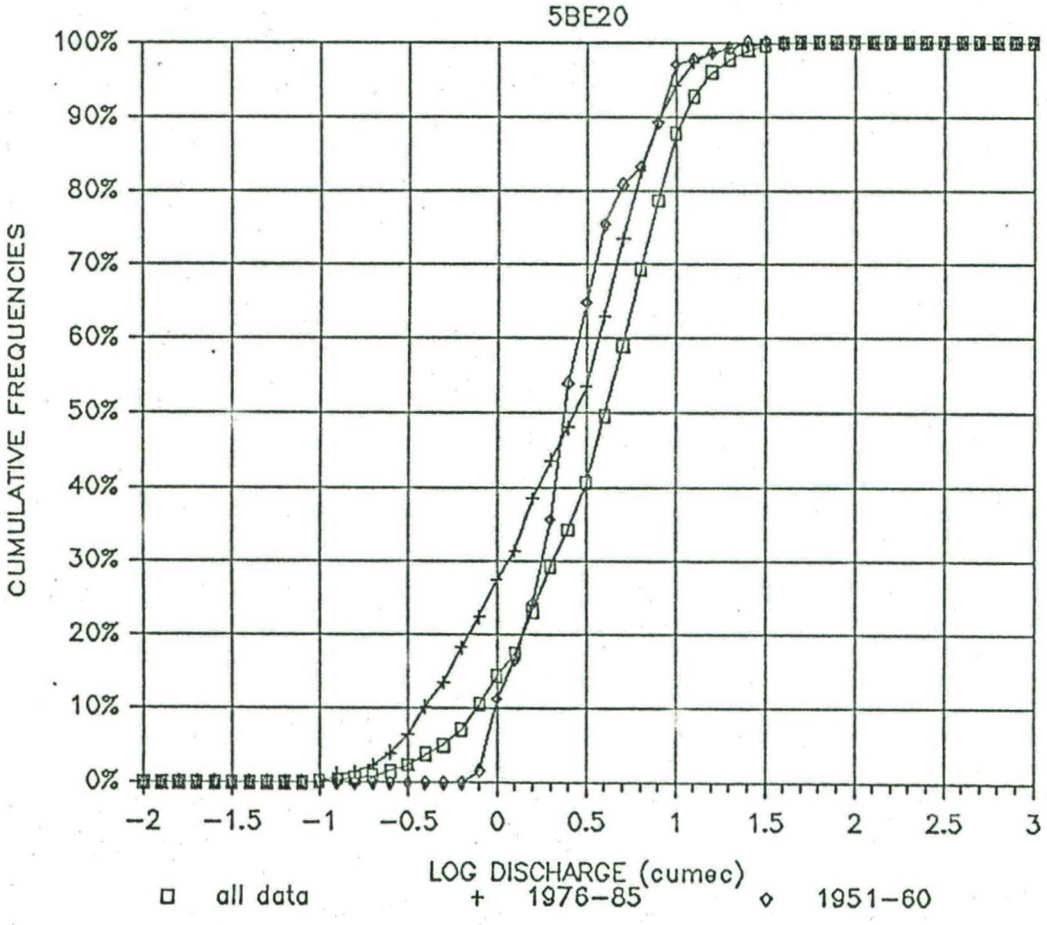


Fig. 4.6.9 Frequency Distribution of Daily Flows at RGS 5BE20

The station has been rated to cover discharges between 0.62 and 85 cumecs for the 1960-69 period and 0.45 and 54 cumecs for the 1970-86 period.

Daily discharge data for the 1960- July 1986 period have been computed showing the lowest flow recorded as 0.1 cumec in both 1984 and 1985 while the highest is 107 cumecs recorded in 1961. The mean monthly flow for the period is 5.8 cumecs while the minimum mean monthly flow reduces to 0.740 cumec. This can be compared with the 90% daily duration flow of 0.794 cumec which decreases to 0.436 cumec with a 95% reliability, (Figure 4.6.9).

Flood analysis

During the sixties, high water levels were recorded by the existing autographic water level recorder which was removed from the station in March 1973. From 1960-69, floods of between 60-107 cumecs were observed but very low floods of between 12-50 cumecs were observed from 1970 onwards due to use of staff gauge readings.

Despite this shortcoming, maximum annual flows have been analyzed using Gumbel paper and the estimated 50 and 100-year floods are 130 and 144 cumecs respectively. These floods are low because about a half of the catchment area is in the forested slopes of Mount Kenya and again the area receives relatively low maximum daily rainfalls.

4.6.8 Ewaso Ng'iro before the Junction RGS 5D5

This RGS monitors the combined flows of the stations 5BC4 and 5BE20 plus the wet season contribution of the seasonal rivers and streams. It is located some 60 km down stream of 5BC4 and about 50 km down stream of 5BE20 and monitors a catchment area of 4561 km^2.

The RGS was started in September 1949 equipped with staff gauges only. In 1966 an autographic water level recorder was installed and operated until April 1973. In April, 1986, WRAP installed a solid state water level recorder whose records have not been obtained due to operational problems.

It then follows that most of our runoff data have been obtained from staff gauge readings. Two readings daily were made from 1949 to February 1959 and thereafter one reading daily.
The station has been rated for discharges in the range 1.0 - 68 cumecs but extrapolation of the rating curve has been done to cover all possible flows.

Daily discharge data for the period September 1949 - May 1986 (with a gap in 1954 - 57 and 1963) have been computed and flow hydrographs plotted for each year. The lowest flow recorded was 0.067 cumec in 1967, 1971, 1973, 1974 and 1975 while the highest flows were 255 and 378 in 1961 and 1962 respectively. The mean monthly flow for the whole period is 7.88 cumecs while the minimum mean monthly flow is 1.017 cumecs.

The bimodal runoff distribution pattern of this catchment shows that the months of April/May and November produce most of the flood runoff (Figure 4.6.10.

Low flow analysis

As we have observed in the Ewaso Narok system, low flow analysis is hampered by heavy river water abstractions which take place during the dry seasons. An additional problem to RGS 5D5 is that the zero of the 0-1.5 m staff gauge was installed above minimum water level and in March 1971, 1974 and 1975, the water levels were observed to be below zero of the gauge which means that such levels cannot be converted into flows. Inspite of these problems, the flow recession curve for the driest period (20/12/74 to 14/2/75) has been drawn and it indicates that discharge decreased from 2.6 to 0.07 cumec in about 40 days. Discharge was constant at 0.07 cumec for 9 consecutive days in February 1975.

The minimum 1 day and 7 days consecutive flows have been plotted on Gumbel paper, and the 9 out of 10 days flows are 0.075 and 0.12 cumec respectively.

On the other hand, the daily flow duration analysis (Fig. 4.6.11) gives the 95 and 90% duration flows as 0.661 and 0.955 cumec respectively. These flows are about 3 times greater than those at RGS 5AC8 while the mean monthly flow is only 2 times greater.

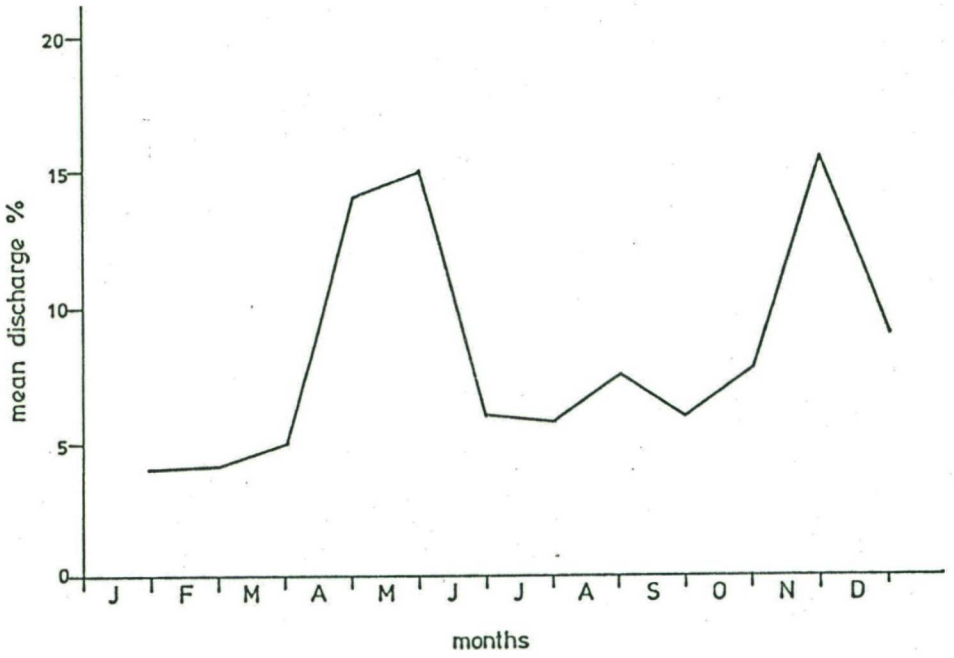


Fig. 4.6.10 Mean Monthly Flow Distribution at AGS 5D5

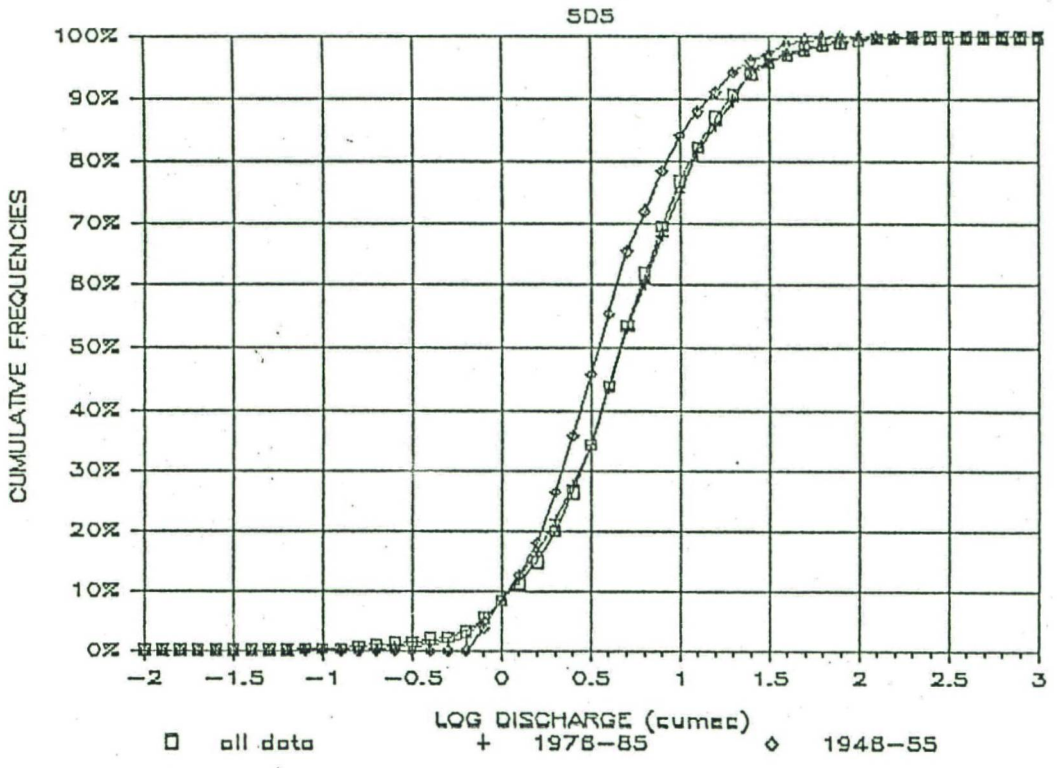


Fig. 4.6.11 Frequency distribution of daily flows at AGS 5D5

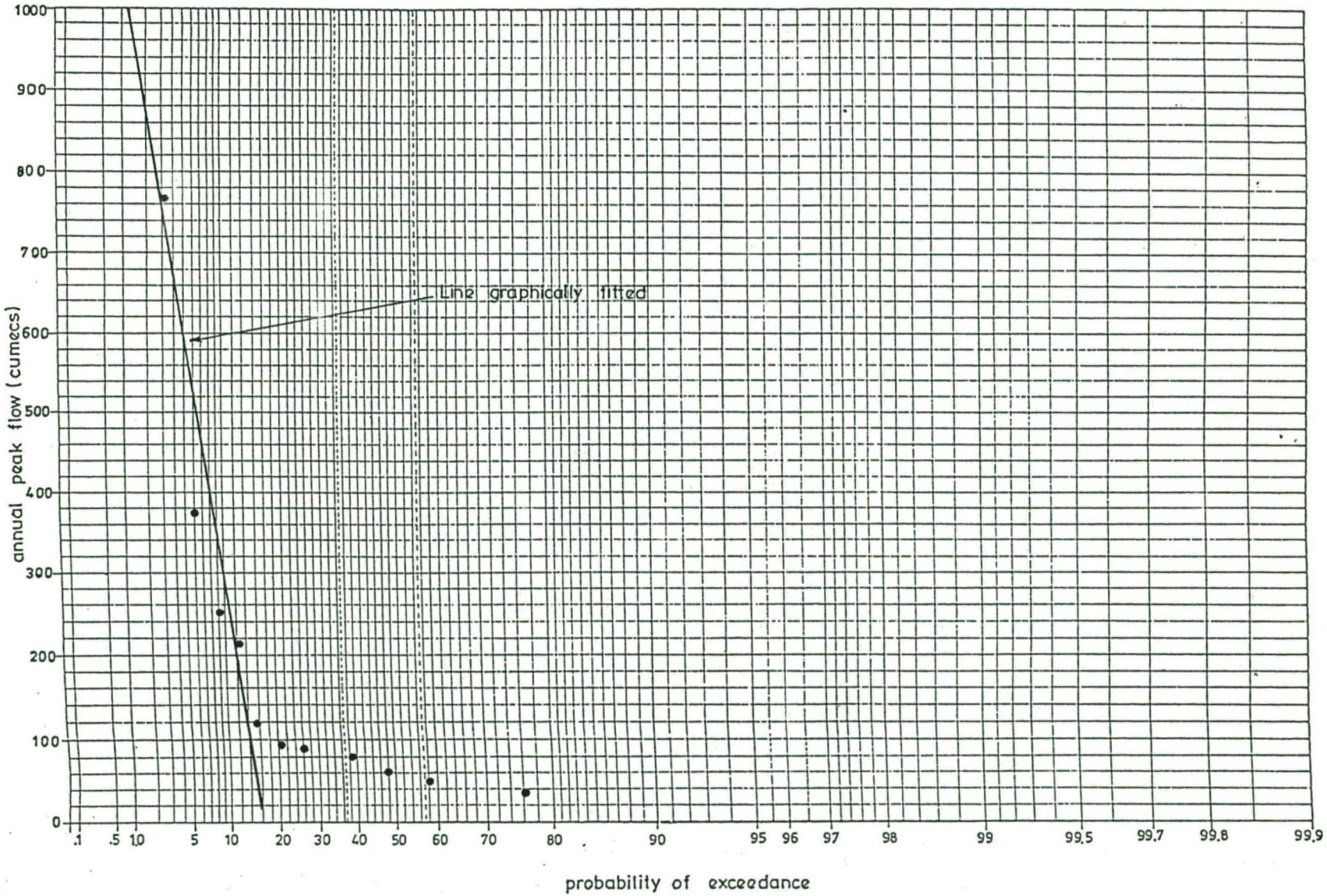


Fig. 4.6.12 Peak flow analysis at RGS 5 D 5

Downstream of the Junction, the conditions there are semi-arid with sparse vegetation cover which is as a result of low annual rainfall (450 - 350 mm)

RGS 5E3 was opened in April 1949 and was equipped with staff gauges, a compound weir and a less sensitive silt free air flow autographic water level recorder. This recorder operated until 1952 and was removed due to operational problems. A second recorder was installed in May 1959 and was in operation upto 1961. A third recorder, a pneumatic type was installed in March 1980 but its delicate operational procedures makes it unoperational most of the times. Water level observations have been made twice daily from 1949 to present due to the presence of a full time employee at the station.

The RGS is rated to cover discharges in the range 0.6 to 1,900 cumecs. Thus the station is well covered for high flows but not so for low discharges.

Daily discharge data for the period April 1949 - 1985 (with a gap in 1975-80) have been computed and flow hydrographs drawn for each year. From the latter, one can tell the periods of low and high flows recorded.

The years 1981, 1984 and 1985 are observed to have experienced various degrees of water shortages during the early months of 1981 and 1985 and in the middle months of 1984.

Wet years were experienced in 1951, 1961, 1968 and 1977 but 1961 was however the wettest.

In Appendix 4.6 is a summary of the mean monthly flow data for the period of record in which the overall mean monthly flow is 21.04 cumecs, the minimum mean monthly flow is 1.613 cumecs, the lowest flow is 0.10 cumec in both 1981 and 1985 and highest flow equal to 1835 cumecs in 1961.

The bimodal runoff distribution pattern of this station is shown in Figure 4.6.13 in which most of the flood flows are generated by the long and short rains.

Low flow analysis

From Appendix 4.6, we find that the lowest flow recorded is 0.10 cumec in March 1981 and 1985. Investigations carried out in March 1985 indicated that this flow was due to the contribution of Isiolo tributary as upstream of their confluence the Ewaso Ng'iro was found to be completely dry. The drying up of the river was explained to be due to heavy water losses caused by seepage and evaporation below the Junction. This is because, alot of dry season flow is abstracted for irrigation purposes upstream of the Junction and the little flow left in the river cannot reach Archer's Post.
Two flow recession curves for the driest months of 1980/81 and 1984/85 show that discharge decreased from 20 to 0.19 cumecs in 67 days in 1980/81

period and took another 10 days to drop to 0.10 cumec. For the 1984/85 period, discharge took 40 days to fall from 16 to 0.55 cumec.

As we have seen before, natural recession curves are difficult to draw because of the increased water abstractions from the rivers during periods of low flows.

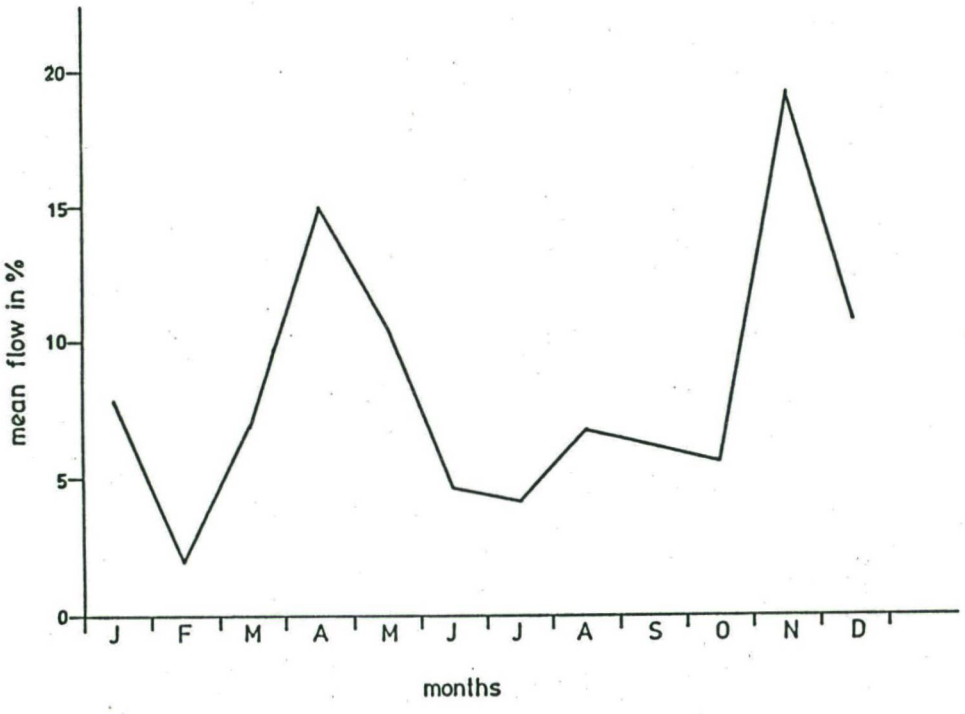


Fig. 4.6.13 Mean monthly flow distribution at RGS SE3

The minimum 1 day and 7 days consecutive flows have been analysed in which flows equal to or greater than 0.3 and 0.4 cumec are possible 9 out of 10 days respectively. As before, these flows do not take into account water abstractions upstream.

Water availability on a daily basis for various water development projects is determined from the flow duration curve in which the 95 and 90% duration flows are 1.12 and 1.73 cumecs respectively (Figure 4.6.14).

Flood analysis

Flood flows at SE3 were estimated using floats and a temporary cable way during the 1958-61 investigation period and such data were used to rate the station upto a maximum flow of about 1900 cumecs. A lot of hard work was actually put into rating this station as the existing (1961) rating curve is still valid to low stages. But unfortunately, due to lack of flood gauging equipments, the validity of this rating curve at medium and high water levels cannot be confirmed now.

The present pneumatic water level recorder installed in 1980 has been out of order most of the times due to its delicate operational requirements which demand frequent maintenance visits.

Except for the 1949-52 and 1959-61 periods, most of the peak water levels have been manually read from staff gauges in which the actual water levels have been underestimated.

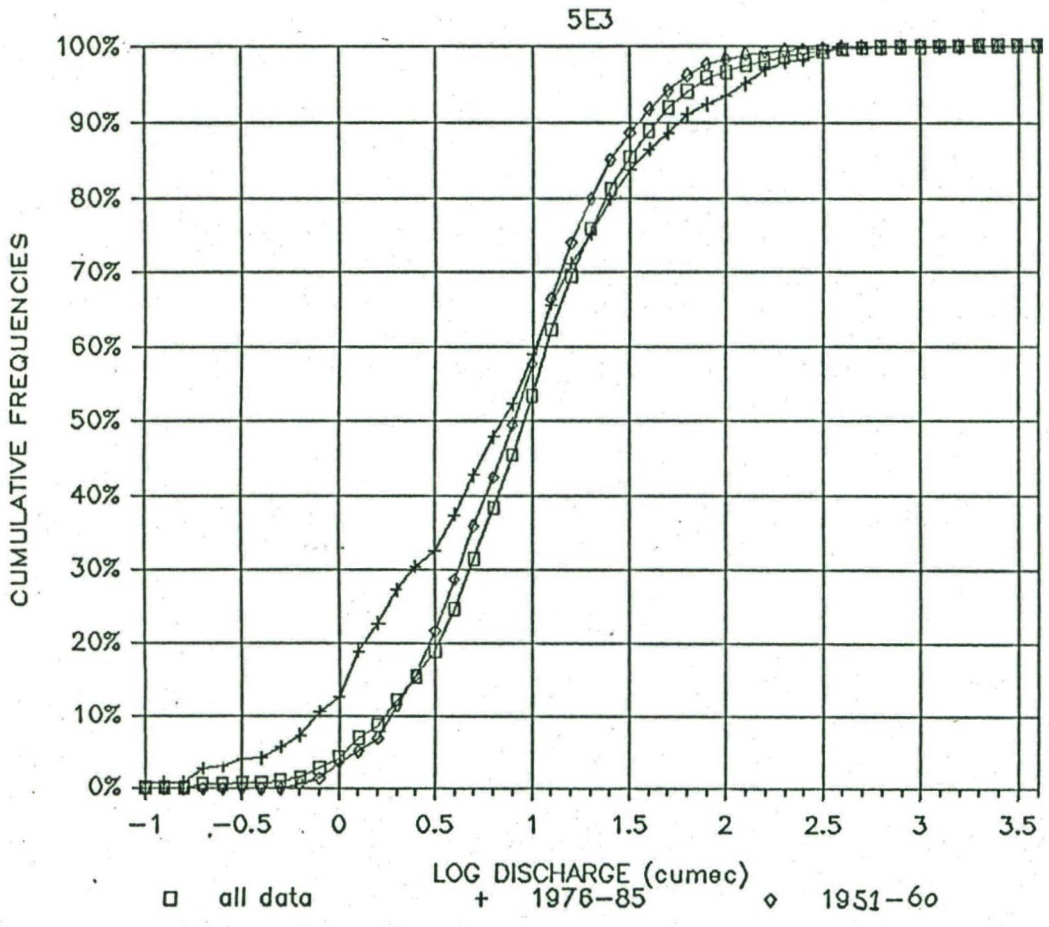


Fig. 4.6.14 Frequency Distribution of Daily Flows at RGS 5E3

The 1961 flood was the highest at 1897 cumecs followed by the 1951 and 1968 floods of 660 and 646 cumecs respectively. The lowest flood for the 33 years of record is 104 cumecs observed in 1955.

Weibull's plotting position has been used to plot the flood flows data in the log-normal probability paper (Fig. 4.6.15). These data are then fitted with the log-pearson type III distribution which gives the 100-year flood as about 1780 cumecs. The 1961 flood of 1897 cumecs has a return period of about 150 years.

Rainfall - Runoff Relation

This relationship is a plot of mean annual rainfall for 11 rainfall stations in the catchment versus mean annual runoff at RGS 5E3. A fairly good relation is obtained for rainfall amounts less than 750 mm while higher amounts show a lot of scatter.

Good rainfall - runoff correlations are rare to come by due to the many factors which play part in runoff generation. This is particularly so for large catchment areas like 5E3.

As mentioned before, a rainfall - runoff relation becomes very handy when a

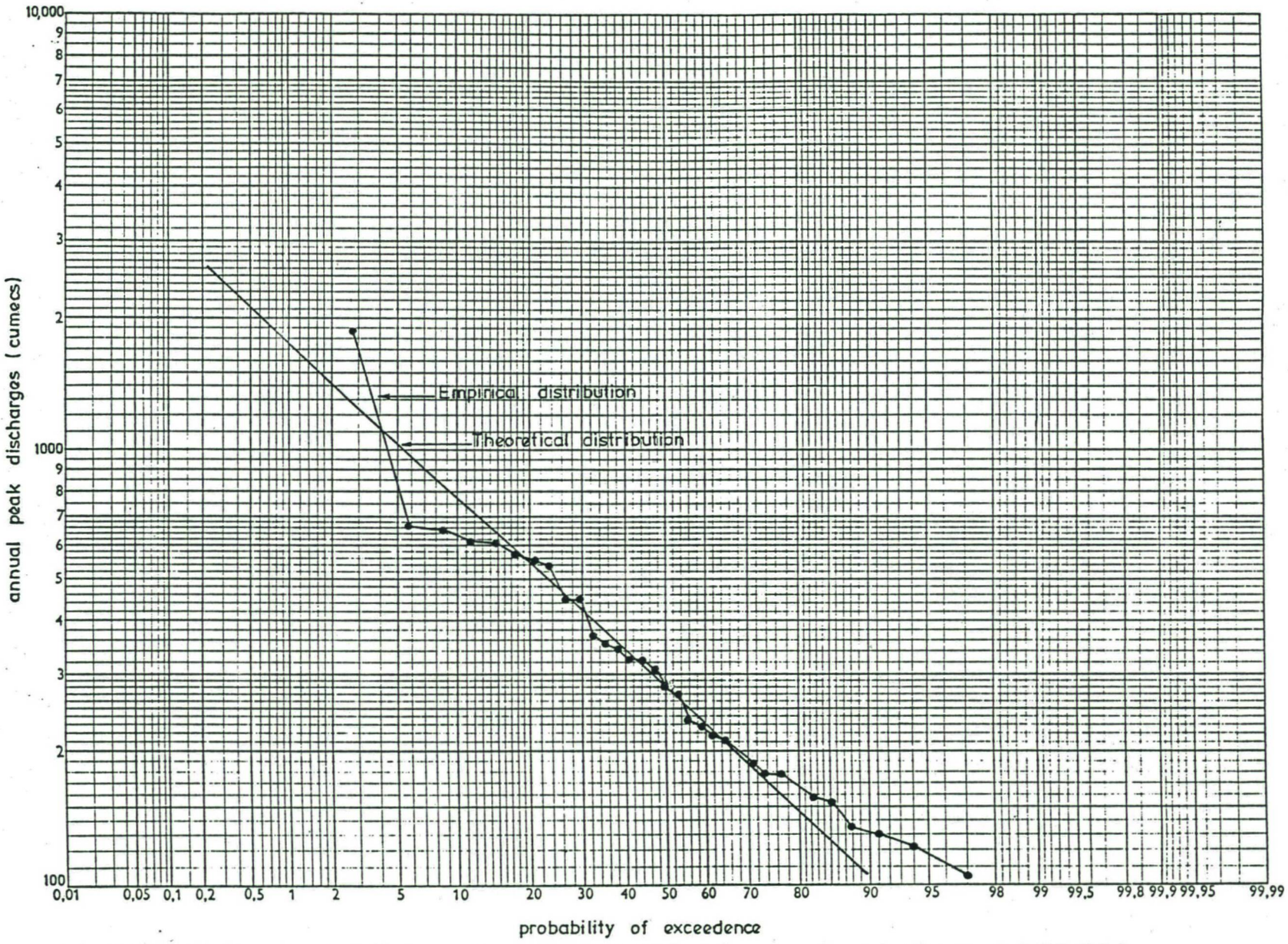


Fig. 4.6.15 Fitting the Log Pearson type III distribution to annual peak flows at RGS 5E3

first approximation of missing discharge data is sought where rainfall data is available.

4.6.10 Comparison of flow characteristics at the Junction and Archer's Post

The MoW report of 1962 on the "investigation of the water resources of the Ewaso Ng'iro basin" has shown that more than 50% of the flood flows at Archer's Post (RGS 5E3) originates from the middle catchment area below the Junction. This area is known to receive intense high maximum daily rainfall amounts which falling on nearly bare soil produces the observed flash floods.

A break down of flows (in %) passing through Archer's Post for a wet year (1951), dry year (1952) and average year (1960) was done in 1962 and these are reproduced below in Table 4.6.2.

It is evident that the Ewaso Ng'iro system contributes equal flow to Ewaso Narok system during wet years but this phenomena is drastically changed in dry and average years when Ewaso Ng'iro contributes 4 and 6 times more flow than Ewaso Narok respectively.

Table 4.6.2 Breakdown of flows at RGS 5E3 in percent

System	1951 (wet)	1952 (dry)	1960 (average)
Upper (Ewaso Narok) basin	22	18	11
(Ewaso Ng'iro)	22	75	67
Middle (Below Junction) basin	56	7	22
Total at RGS 5E3	100	100	100

In Table 4.6.3 is a summary of flow characteristics at the three key monitoring stations based on nearly the same period of record.

It will be seen that the 95 and 90% duration flows for Ewaso Ng'iro (5D5) are about 3 times greater than those of Ewaso Narok (5AC8). Runoff generation per square kilometre are of the same order of magnitude for all stations with that of Ewaso Ng'iro being only 1.4 times greater than that of Ewaso Narok. Surprisingly, the 50 - year floods for the two river systems are estimated to be equal although the catchment areas are of different sizes.

Table 4.6.3 **Comparison of flow characteristics at the Junction and Archer's Post (cumecs)**

		RGS	5AC8 (1951-85 with gap 1954-7)	5D5 (1950-85 with gap 1954-7 and 1963)	5E3 (1949-85 with gap 1975-80)
Catchment area (km²)			3290	4561	15,300
Minimum	-1 day (9 out)		0.075	0.075	0.3
	-7 days (of 10 days)		0.095	0.12	0.4
Mean	-Minimum monthly		0.184	1.017	1.613
	-Monthly		3.84	7.88	21.04
	-per km²		0.0012	0.0017	0.0014
Daily flow duration	-95%		0.240	0.661	1.12
	-90%		0.302	0.955	1.73
Maximum flow			544	766	1897
Floods	50 - year		860	870	1400
	100 - year		1300	1500	1800

- Runoff Tables and Figures

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment Project Hydrology Section

MONTHLY AND ANNUAL DISCHARGE DATA

River: EWASO NAROK
R.G.S: 5AC15
Area (km2): 860 0

The flows are in: CUMEC
except when otherwise stated.

YEAR	J	F	M	A	M	J	J	A	S	O	N	D	YEAR	DAILY MAX	DAILY MIN	Days without readings
1900																365
1980																366
1981																365
1982						1.08	0.93	4.68	1.86	1.48	4.30	9.01				159
1983	1.07	0.92	0.81	0.79	0.77	0.82	1.94	8.39	8.22	3.15	1.17	0.90	2.42	20.51	0.708	90
1984	0.83	0.68	0.61	0.68	0.65			0.58	0.45	0.40	0.48	0.46				132
1985	0.41	0.51	0.51	0.75	1.01	1.21	2.86	4.37	2.99	0.75	0.71	0.60	1.40	7.63	0.406	113
1986	0.602	0.558	0.468	0.488	0.512	2.085										224
Maximum	1.068	0.919	0.811	0.786	1.011	2.085	2.856	8.385	8.220	3.145	4.300	9.014	2.420	20.510	0.708	
Minimum	0.414	0.507	0.468	0.488	0.512	0.816	0.928	0.580	0.445	0.401	0.481	0.463	1.396	7.630	0.406	
Mean	0.729	0.667	0.600	0.676	0.734	1.297	1.909	4.503	3.378	1.444	1.665	2.746	1.696	14.070	0.5570	
Runoff(mm)	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment Project Hydrology Section

MONTHLY AND ANNUAL DISCHARGE DATA

River: PESI
R.G.S: 5AB3
Area (km2): 319

The flows are in: CUMEC
except when otherwise stated.

YEAR	J	F	M	A	M	J	J	A	S	O	N	D	YEAR	DAILY MAX	DAILY MIN	Days without readings
1900																365
1956																366
1957																365
1958																343
1959		0.555	0.394	0.438	0.575	0.389	0.422	0.664	1.800	0.436	0.793	0.951				44
1960	0.395	0.278	0.308	0.305	0.247	0.253	0.311	0.547	0.542	0.359	0.351	0.794	0.392	1.310	0.236	69
1961	0.729	0.703	0.700			0.956	0.977	1.914	1.215							134
1962							0.462	0.627	0.798	0.581	0.776	1.154				194
1963	1.185	1.055	0.938	1.098	1.084	0.310	0.124	0.545	0.331	0.124	0.263	10.167	1.449	47.700	0.043	66
1964	2.640	0.365	0.506	1.058	0.496	0.436	1.373	7.148	2.501	1.223	0.669	0.611	1.597	23.560	0.207	68
1965	0.766	0.407	0.357	0.321	0.329	0.269	0.319	0.297	0.272	0.363	0.505	0.302	0.376	2.150	0.246	65
1966	0.211	0.227	0.225	0.332	0.288	0.315	0.347	1.371	1.486	0.423	0.540					73
1967	0.201	0.196	0.195	0.264	1.014	0.667	2.766	2.786	1.082	0.790	3.303	6.812	1.689	113.900	0.005	63
1968	0.423	0.369	2.377	8.475	3.964	1.413	1.467	2.458	0.753	0.500	1.408	19.306	3.600	350.300	0.290	65
1969	0.630	0.629	0.605	0.554	0.564	0.409	0.498	0.479	0.782	0.388	0.427	0.502	0.538	1.680	0.292	63
1970	0.540	0.376	0.355	0.446	0.398	0.444	0.478	0.981	0.674	0.546	0.437	0.292	0.498	2.580	0.290	68
1971	0.322	0.252	0.272	0.399	1.209	1.920	1.515	10.497	2.419	0.906	0.651	1.611	1.849	37.360	0.246	70
1972		1.839	0.504	0.325	0.389	0.486	0.489	0.895	0.434	0.352	0.475	0.368				73
1973	0.357	0.346	0.330	0.344	0.346				0.473	0.310	0.285	0.234				109
1974	0.230	0.246	0.304	0.359	0.246	0.326	1.085	1.634	2.103	0.451	0.383	0.256	0.637	6.000	0.173	73
1975	0.219	0.213	0.217	0.305	0.262	0.371	2.135	9.339	9.355	1.745	0.571	0.372	2.101	53.060	0.173	69
1976	0.258	0.289	0.284	0.320	0.342	0.313	0.740	1.007	1.568		0.304	0.326				81
1977	0.312	0.222	0.235	1.431	0.975	0.601	1.313	2.110	0.985	0.628	2.177	2.327	1.115	15.700	0.207	81
1978	1.386	0.687	1.254	1.227	0.596	0.507	1.651	6.941	1.057	0.672	0.886	2.977	1.669	86.860	0.292	73
1979	8.773	19.485	0.842	1.244	0.620	0.535	0.565	0.704	0.486	0.341	0.441	0.417	2.759	182.700	0.173	60
1980	0.336	0.272	0.279	0.344	0.895	0.404	0.472	0.320	0.327	0.252	0.306	0.256	0.373	1.910	0.119	62
1981	0.214	0.207	0.364	4.480	6.813	0.502	5.671	18.435	1.369	0.716	0.623	0.488	3.366	162.100	0.170	62
1982	0.282	0.225	0.189	0.445	0.742	0.564	0.393	1.010	0.751	0.520	6.514	22.472	2.872	235.300	0.163	60
1983	0.842	0.551	0.339	0.425	0.497	0.486	1.245	9.988	1.702	0.643	0.616	0.751	1.522	113.700	0.292	87
1984	0.619	0.299	0.246	0.246	0.206	0.174	0.230	0.238	0.223	0.243	0.351	0.237	0.276	0.989	0.173	112
1985	0.202	0.301	0.226	0.545	0.508			0.529	0.388	0.256	0.285	0.249				133
1986	0.246	0.202														325
Maximum	8.773	19.485	2.377	8.475	6.813	1.920	5.671	18.435	9.355	1.745	6.514	22.472	3.600	350.300	0.2920	
Minimum	0.2009	0.1956	0.1895	0.2460	0.2065	0.1738	0.1239	0.2385	0.2226	0.1244	0.2631	0.2337	0.2762	0.989	0.0050	
Mean	0.893	1.141	0.494	1.029	0.944	0.544	1.082	3.210	1.329	0.551	0.936	2.969	1.260	75.73	0.1995	
Runoff(mm)	7.50	8.73	4.15	8.36	7.93	4.42	9.08	26.95	10.80	4.62	7.61	24.93	10.58	20.51	0.0540	

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment Project Hydrology Section

River: PESI

MONTHLY AND ANNUAL DISCHARGE DATA

R.G.S: 5AB2

Area (km2): 412

The flows are in: CUMEC
except when otherwise stated.

YEAR	J	F	M	A	M	J	J	A	S	O	N	D	YEAR	DAILY MAX	DAILY MIN	Days without readings
1900																365
1956																366
1957																365
1958																365
1959			0.225	0.191	0.279	0.258	0.252	0.380	0.554	0.268	0.290	0.762				97
1960	0.393	0.279	0.306	0.268	0.237	0.222	0.275	0.425	0.526	0.343	0.349	0.310	0.328	0.834	0.1570	72
1961	0.296	0.243	0.276	0.373	0.337	0.245	0.269	1.164	0.724	1.977						125
1962		0.458	0.302	0.379	0.588	0.371	0.357	0.453	0.488	0.371	0.247	0.308				74
1963	0.367	0.248	0.145	0.253	0.574	0.278	0.159	0.410	0.286	0.128	0.230	4.787	0.663	16.620	0.0650	66
1964	1.589	0.239	0.372	1.067	0.441	0.361	0.720	5.680	2.229	1.047	0.555	0.479	1.239	15.380	0.2020	68
1965	0.576	0.256	0.235	0.250	0.285	0.221	0.251	0.250	0.222	0.274	0.375	0.284	0.290	1.990	0.0510	64
1966	0.227	0.247	0.262	0.382	0.343	0.386	0.384	0.680	1.478	0.511	0.623	0.444	0.497	2.990	0.2130	63
1967	0.367	0.347	0.314	0.359	1.222	0.611	2.401	3.222	1.361	0.963	2.875	3.133	1.442	9.110	0.2910	63
1968	0.786	0.684	2.648	8.594	4.435	1.277	1.183	2.692	0.753	0.383	0.945	3.819	2.353	25.680	0.3310	64
1969	0.399	0.411	0.424	0.359	0.383	0.230	0.275	0.288	0.454	0.206	0.218	0.214	0.321	1.460	0.0790	68
1970	0.214	0.172	0.175	0.211	0.175	0.189	0.195	0.515	0.499	0.290	0.259	0.173	0.256	1.560	0.0850	68
1971	0.164	0.143	0.138	0.175	0.722	1.460	1.861	8.192	3.094	0.699	0.400	1.323	1.545	19.040	0.1380	71
1972				0.173	0.203	0.268	0.314	0.534	0.307	0.255	0.318	0.333				73
1973	0.367	0.344	0.324	0.340	0.437		0.575		0.730	0.473	0.428	0.335				107
1974	0.306	0.303	0.258	0.385	0.298	0.363	1.515	2.995	2.888	0.630	0.493	0.413	0.907	5.980	0.2130	68
1975	0.370	0.282	0.245	0.284	0.223	0.409	2.389	5.891	5.365	1.845	0.418	0.276	1.509	15.400	0.1610	67
1976	0.210	0.195	0.188	0.211	0.228	0.215	0.545	1.016	1.546		0.237	0.249				82
1977	0.264	0.212	0.219	0.809	1.275	0.496	0.970	1.789	1.017	0.521	2.184	2.317	1.011	6.240	0.2000	78
1978	1.284	0.645	1.128	1.041	0.592	0.393	1.182	3.608			0.873	2.315				95
1979	0.958			1.095	0.548	0.380	0.399	0.491	0.330	0.255	0.217	0.176				78
1980	0.138	0.107	0.107	0.148	0.500	0.296	0.333		0.270	0.194	0.232	0.181				70
1981		0.185	0.346	1.242	1.029	0.461			1.452	0.805	0.579	0.398				166
1982			0.291		0.762	0.755	0.556	1.157		0.705	2.989					232
1983	1.138	0.404	0.196	0.214	0.266	0.265	0.433	2.546	1.446	0.435	0.410	0.472	0.689	15.230	0.1590	120
1984	0.407	0.198	0.169	0.182	0.174	0.171	0.187	0.209	0.168	0.160	0.253	0.225	0.209	0.891	0.1370	119
1985	0.166	0.201	0.197	0.271	0.341	0.243	0.315	0.492	0.322	0.261	0.307	0.307	0.286	1.130	0.1520	117
1986	0.248	0.236	0.237	0.284	0.447	0.542										226
Maximum	1.589	0.684	2.648	8.594	4.435	1.460	2.401	8.192	5.365	1.977	2.989	4.787	2.353	25.680	0.3310	
Minimum	0.1378	0.1072	0.1071	0.1480	0.1741	0.1712	0.1586	0.2090	0.1677	0.1278	0.2167	0.1734	0.2088	0.834	0.0510	
Mean	0.488	0.293	0.374	0.724	0.619	0.421	0.704	1.878	1.140	0.560	0.665	0.961	0.736	8.72	0.1646	
Runoff(mm)	3.18	1.74	2.43	4.55	4.03	2.65	4.57	12.21	7.17	3.64	4.19	6.25	4.78	1.83	0.0345	

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment Project — Hydrology Section

MONTHLY AND ANNUAL DISCHARGE DATA

River: EWASO NAROK
R.G.S: 5AC8
Area (km2): 3290

The flows are in: CUMEC
except when otherwise stated.

YEAR	J	F	M	A	M	J	J	A	S	O	N	D	YEAR	DAILY MAX	DAILY MIN	Days without readings
1951				84.43	19.96	3.89	1.84	8.70	5.23	6.58		16.58				109
1952	3.28	0.67	0.37	0.41	0.88	0.55	0.59	0.36	2.12		0.65	0.62				39
1952	3.28	0.67	0.37	0.41	0.88	0.55	0.59	0.36	2.12		0.65	0.62				39
1953	0.37	0.16	0.45	0.61	0.79	0.76	0.68	0.89	0.64	0.55	0.54	0.53	0.58	2.30	0.078	15
1953	0.37	0.16	0.45	0.61	0.79	0.76	0.68	0.89	0.64	0.55	0.54	0.53	0.58	2.30	0.078	15
1954	0.40															317
1954	0.40															317
1955																365
1955																365
1956																366
1957																365
1958			2.12	0.80	1.91	2.11	57.71	34.60	10.38	3.23		3.02				67
1959	1.14	0.44	0.31	0.31	1.38	2.23	0.65	1.57	3.30	2.47		1.01				42
1960	0.68	0.38	0.30	0.51	0.37	0.33	0.43	1.94	5.14	1.42	0.72	0.69	1.07	10.33	0.229	11
1961	0.50	0.39	0.40	0.61	0.52	0.45	0.53	3.07	2.80	2.71	170.68	62.11	20.31	436.70	0.350	3
1962	30.53	4.34	1.53	1.03	7.63	1.49	2.25	4.03	5.33	3.08	1.38	0.93	5.34	146.00	0.672	22
1963	0.89	0.71	0.77	1.04	6.52	4.47	1.23	3.14	5.13	1.16	0.81	13.73	3.30	38.89	0.375	5
1964	6.82	1.16	0.96	2.39	2.28	0.90	2.16	22.54	12.24	7.46	3.29	2.22	5.40	42.02	0.672	0
1965	2.05	0.76	0.39	0.46	0.51	0.40	0.42	0.38	0.33	0.38	0.50	0.41	0.58	3.30	0.275	0
1966	0.43	0.29	0.23	1.01	0.34	0.39	0.61	3.69	10.63	1.55	2.05	0.88	1.84	28.87	0.186	5
1967	0.43	0.37	0.59	0.75	12.47	2.50	9.88	10.28	6.79	2.15	5.00	6.95	4.88	61.28	0.324	0
1968	1.33	1.35	7.76	41.82	20.73	7.30	5.61	10.96	5.29	2.67	3.21	12.26	10.02	140.70	0.672	0
1969	1.91	1.26	1.15	0.97	1.11	0.65	0.60	0.66	1.58	1.22	0.82	0.76	1.05	6.67	0.487	0
1970	0.98	0.87	0.53	0.77	1.12	0.74	0.79	2.29	5.16	2.20	0.95	0.61	1.42	9.02	0.430	0
1971	0.43	0.38	0.47	0.56	1.53	3.80	7.58	17.71	11.80	3.87	7.18	19.52	6.28	58.76	0.324	2
1972	1.53	1.31	0.81	0.44	1.65	0.55	1.44	2.07	1.45	0.68	0.91	0.58	1.12	14.43	0.375	0
1973	0.42	0.36	0.24	0.24	0.25	0.27	0.70	1.38	3.12	1.90	0.77	0.42	0.84	7.80	0.147	4
1974	0.29	0.26	0.46	0.34	0.35	0.25	0.91	3.78	5.24	0.97	0.60	0.50	1.17	12.00	0.078	0
1975	0.32	0.31	1.93	3.63	1.85	2.18	11.88	25.38	23.22	6.93	1.24	0.67	6.53	136.90	0.186	0
1976	0.39	0.27	0.24	0.31	0.58	0.31	0.95	3.32	5.67	0.86	0.46	0.36	1.14	12.30	0.186	0
1977	0.48	0.33	0.31	3.71	10.78	1.90	6.01	9.96	3.77	1.87	20.38	10.18	5.83	62.56	0.229	0
1978	4.87	2.32	6.29	5.14	3.34	1.60	7.11	9.33	6.46	4.24	3.83	3.39	4.85	16.90	0.950	0
1979	1.93	18.20	2.70	2.40	2.44	1.51	1.36	2.08	1.34	0.78	0.71	0.42	2.91	159.40	0.375	1
1980	0.40	0.33	0.31	0.32	1.89	0.90	0.71	0.53	0.53	0.39	0.39	0.31	0.59	5.71	0.229	1
1981	0.26	0.23	3.17	21.39	8.85	1.06	2.52	11.51	4.71	3.64	1.16	0.62	4.94	134.40	0.186	0
1982	0.39	0.32	0.25	0.48	0.77	1.49	0.85	2.80	2.94	1.59	4.06	13.31	2.46	24.21	0.147	4
1983	2.42	0.77	0.60	0.68	0.72	0.43	1.21	10.15	9.79	2.86	1.45	1.12	2.69	27.34	0.229	0
1984	1.08	0.34	0.23	0.22	0.17	0.16	0.20	0.25	0.23	0.17	0.26	0.30	0.30	2.17	0.078	0
1985	0.20	0.25	0.24	2.16	1.92	0.97	2.19	4.13	2.64	0.55	0.25	0.12	1.31	12.29	0.078	0
1986	0.05															325
Maximum	30.53	18.20	7.76	84.43	20.73	7.30	57.71	34.60	23.22	7.46	170.68	62.11	20.31	436.70	0.95	
Minimum	0.051	0.158	0.232	0.223	0.171	0.160	0.200	0.246	0.232	0.171	0.246	0.122	0.302	2.169	0.078	
Mean	2.10	1.29	1.15	5.48	3.55	1.45	4.03	6.51	5.08	2.28	7.85	5.34	3.84	57.70	0.3080	
Runoff(mm)	1.71	0.96	0.94	4.32	2.89	1.14	3.28	5.30	4.01	1.86	6.18	4.35	3.13	1.52	0.0081	

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment Project Hydrology Section

MONTHLY AND ANNUAL DISCHARGE DATA

River: EWASO NGIRO
R.G.S: 5BC4
Area (km2): 1870

The flows are in: CUMEC
except when otherwise stated.

YEAR	J	F	M	A	M	J	J	A	S	O	N	D	YEAR	DAILY MAX	DAILY MIN	Days without readings
1944																330
1945																328
1946																328
1947																317
1948										1.636						318
1949																325
1950				3.411			3.182		3.432	1.051	1.323	1.482				309
1951		0.460	1.132	5.647	4.066	3.105	2.285	1.669	1.792	4.092	8.707					307
1952	3.341	1.040		0.897	2.475	0.824	0.749	1.034	1.109			1.883				312
1953	0.671			0.859	2.502	1.805	0.811	1.343	1.010	2.598	5.067	4.648				278
1954	1.011	0.580	0.465	2.032	4.584	3.143										304
1955																365
1956																366
1957																365
1958																365
1959								2.424	2.246	1.399						224
1960	1.319	0.901	1.489	2.586	1.958	1.266	1.016	0.935	1.423	1.263	2.614	2.383	1.596	9.730	0.5280	39
1961	0.712	0.494	0.528	7.070	4.268	1.266	0.845	3.038	1.370	16.762						92
1962					1.063	0.354	0.175	0.129	0.291	0.419	0.509	0.593				103
1963										1.808	7.316	33.772				216
1964	9.945	2.296	2.911	20.834	6.856	3.006	2.172	5.492	4.004	5.513	5.611	7.513	6.346	56.710	1.4300	22
1965	4.469	1.678	1.063	2.841	3.601	0.881	0.791	0.555	0.508		5.083	2.268				16
1966	0.779	0.724	2.159	7.339	4.616	2.281	1.118	2.954	3.723	1.885	13.142	1.956	3.546	51.630	0.5720	4
1967	0.601	0.385	0.465	3.078	9.887	3.252	3.002	3.906	1.751	4.867	13.500	6.242	4.264	54.850	0.1230	24
1968	0.890	3.414	22.924	26.939	14.067	5.365	2.751	2.059	0.924	1.326	10.659	15.348	8.896	69.710	0.5720	36
1969	2.389	3.416	7.542	4.897	7.743	1.961	1.073	0.783	2.121	0.785	3.306	3.158	3.265	18.980	0.2240	53
1970	3.530	1.903	1.856	8.050	5.281	1.909	1.562	2.231	1.623	2.300	3.342	1.013	2.882	16.230	0.7180	73
1971	0.847	0.409	0.355	3.162	6.957	2.949	3.026	8.066	3.769	2.392	2.909	5.205	3.363	21.430	0.2600	24
1972			1.924	3.806	2.102	3.365	1.806	1.457	0.610	2.370	5.428	2.227				69
1973	1.622	1.058	0.492	1.061	1.768	2.160	1.082	1.853	2.477	2.163	5.562	1.652	1.910	15.800	0.3460	1
1974	0.558	0.364	0.506	5.756	2.175	1.284	3.283	3.185	4.177	1.912	4.615	1.482	2.442	11.830	0.2800	15
1975	0.618	0.405	0.359	2.262	2.192	1.649	3.684	4.941	4.933	5.284	3.960	2.024	2.706	12.870	0.2800	4
1976	0.711	0.567	0.448	1.662	2.872	1.763	3.392	3.236	3.832	1.164	1.322	3.819	2.073	15.050	0.3010	5
1977	2.674	0.792	1.013	14.617	9.843	2.059	3.255	2.810	1.992	1.873	11.928	8.918	5.156	50.840	0.5400	7
1978	4.136	2.891	7.901	10.330	6.968	1.458	1.266	1.937	3.248	3.573	7.008	9.269	5.011	19.570	0.8420	22
1979	6.204	18.964	4.333	6.734	6.514	4.484	1.951	1.208	0.880	1.270	4.345	1.295	4.741	56.290	0.6070	0
1980	0.559	0.522	0.556	2.023	5.543	1.269	0.848	0.505	0.480	0.359	2.803	0.829	1.359	10.580	0.2410	0
1981	0.354	0.324	2.345	8.890	8.328	1.889	2.277	3.604	2.908	2.745	3.995	2.245	3.338	19.450	0.2240	23
1982	1.463	0.539	0.345	3.580	6.982	2.668	1.125	1.687	0.927	3.066	9.695	9.150	3.451	17.350	0.2600	55
1983	1.748	1.098	0.614							4.109	3.836					290
1984		0.560	0.397		0.554			0.279	0.593	.	3.215	1.866				274
1985	0.555			5.880	4.577	2.001					0.905					279
1986				3.141	4.513	3.060										305
Maximum	9.945	18.964	22.924	26.939	14.067	5.365	3.684	8.066	4.933	16.762	13.500	33.772	8.896	69.710	1.4300	
Minimum	0.3537	0.3240	0.3448	0.8587	0.5536	0.3543	0.1748	0.1294	0.2910	0.3588	0.5090	0.5932	1.3593	9.730	0.1230	
Mean	2.07	1.83	2.56	6.05	5.00	2.23	1.87	2.35	2.08	2.86	5.42	5.09	3.28	29.38	0.4638	
Runoff(mm)	2.96	2.39	3.67	8.39	7.15	3.09	2.67	3.36	2.88	4.09	7.51	7.28	4.70	1.36	0.0214	

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment Project Hydrology Section

MONTHLY AND ANNUAL DISCHARGE DATA

River: NANYUKI
R.G.S: 5BE20
Area (km2): 860

The flows are in: CUMEC
except when otherwise stated.

YEAR	J	F	M	A	M	J	J	A	S	O	N	D	YEAR	DAILY MAX	DAILY MIN	Days without readings
1960	1.063	1.335		3.270	3.537	2.003	5.529	5.957		2.586		2.963				48
1961	1.102	0.731	0.862	5.519	4.169	4.117	4.605		7.336							201
1962		4.378						2.819	4.987	7.132	6.529	4.805				211
1963	3.604	1.617	1.758	9.460	19.359			8.948	6.966	7.689	12.932	20.422				110
1964	9.086	4.594	4.652	13.319	8.102	6.812	4.836	12.139	12.981	10.450	8.128	11.745	8.912	24.150	2.600	7
1965	7.231	2.822	1.802	4.223	5.107	2.848	2.127	2.332	3.509	6.506	12.393	5.720	4.723	25.110	0.951	1
1966	2.618	2.206	3.367	9.411	7.493	8.540	6.487	8.636	8.959	7.292	18.873	6.103	7.499	48.500	1.360	13
1967	3.560	2.913	2.986	9.411	13.863	13.588	13.135	12.286	9.295	13.830	17.586	12.032	10.412	35.060	2.470	62
1968	6.407	7.891	12.761	19.180	22.298	17.102	11.332	8.893	7.858	7.463	13.388	13.751	12.363	37.760	5.140	33
1969	7.468	8.096	9.284	7.022	11.337	6.670	5.938	6.655	8.069	6.389	7.607	3.401	7.322	16.060	2.320	127
1970	2.033	1.838	2.230	6.297	5.521	2.958	3.367	5.055	3.865	4.054	4.475	1.684	3.621	20.680	0.981	33
1971	1.266	0.799	0.761	2.532	7.408	5.854	5.826	10.928	8.108	7.632	5.269	4.368	5.093	21.290	0.558	15
1972	2.830	4.172	1.734	1.146	3.650	7.026	3.666	3.323	2.009	4.969	7.965	2.966	3.778	19.340	1.070	43
1973	1.857	1.876	1.074	2.605	4.200	3.721	2.109	5.320	8.297	4.088	7.061	2.077	3.687	30.760	0.677	166
1974	1.063	0.767	0.873	3.067	1.328	2.354	7.254	6.130	5.376	4.341	5.489	1.866	3.339	21.910	0.615	212
1975	1.014	0.795	0.723	3.033	4.923	7.002	12.820	13.470	9.088	7.421	6.237	3.992	5.913	27.800	0.615	217
1976	2.057	1.430	1.114	3.001	6.776	5.598	7.138	5.925	7.012	3.673	4.677	4.254	4.397	14.530	0.896	215
1977	3.547	1.483	1.774					5.592			16.991	8.570				261
1978	4.030	3.876	6.930	6.068	7.210	3.862	4.535	2.986	5.725	6.047	7.437	4.478	5.271	19.770	1.970	209
1979	7.405	5.907	2.565	6.070	6.335	5.617	2.857	2.287	1.830	1.838	7.065	1.689	4.266	49.540	0.014	213
1980	0.902	0.717	0.596	1.465	5.178	1.088	0.729	0.965	1.074	0.783	2.708	1.129	1.447	11.860	0.506	210
1981	0.495	0.397	3.149	8.480	7.938	2.270	2.300	4.508	5.350	4.267	4.930					213
1982		0.452	0.348		8.246	4.030	2.335	2.799	2.063	4.621	9.268	7.105				222
1983	1.925	0.750	0.423							4.913	8.582	4.042				279
1984	1.304	0.391	0.213		0.283	0.507		0.646	0.421	1.141	3.086	0.702				233
1985	0.207	0.388	1.501	9.284	5.571	3.510		2.624			1.915					240
1986				5.131	5.229	7.444										287
Maximum	9.086	8.096	12.761	19.180	22.298	17.102	13.135	13.470	12.981	13.830	18.873	20.422	12.363	49.540	5.140	
Minimum	0.207	0.388	0.213	1.146	0.283	0.507	0.729	0.646	0.421	0.783	1.915	0.702	1.447	11.860	0.014	
Mean	3.087	2.409	2.645	6.318	7.294	5.414	5.446	5.884	5.917	5.614	8.358	5.646	5.336	26.508	1.421	
Runoff(mm)	9.613	6.836	8.238	19.042	22.717	16.317	16.962	18.326	17.834	17.485	25.190	17.584	16.619	2.663	0.143	

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment Project Hydrology Section

River: EWASO NGIRO

MONTHLY AND ANNUAL DISCHARGE DATA

R.G.S: 5D5

Area (km2): 4561

The flows are in: CUMEC
except when otherwise stated.

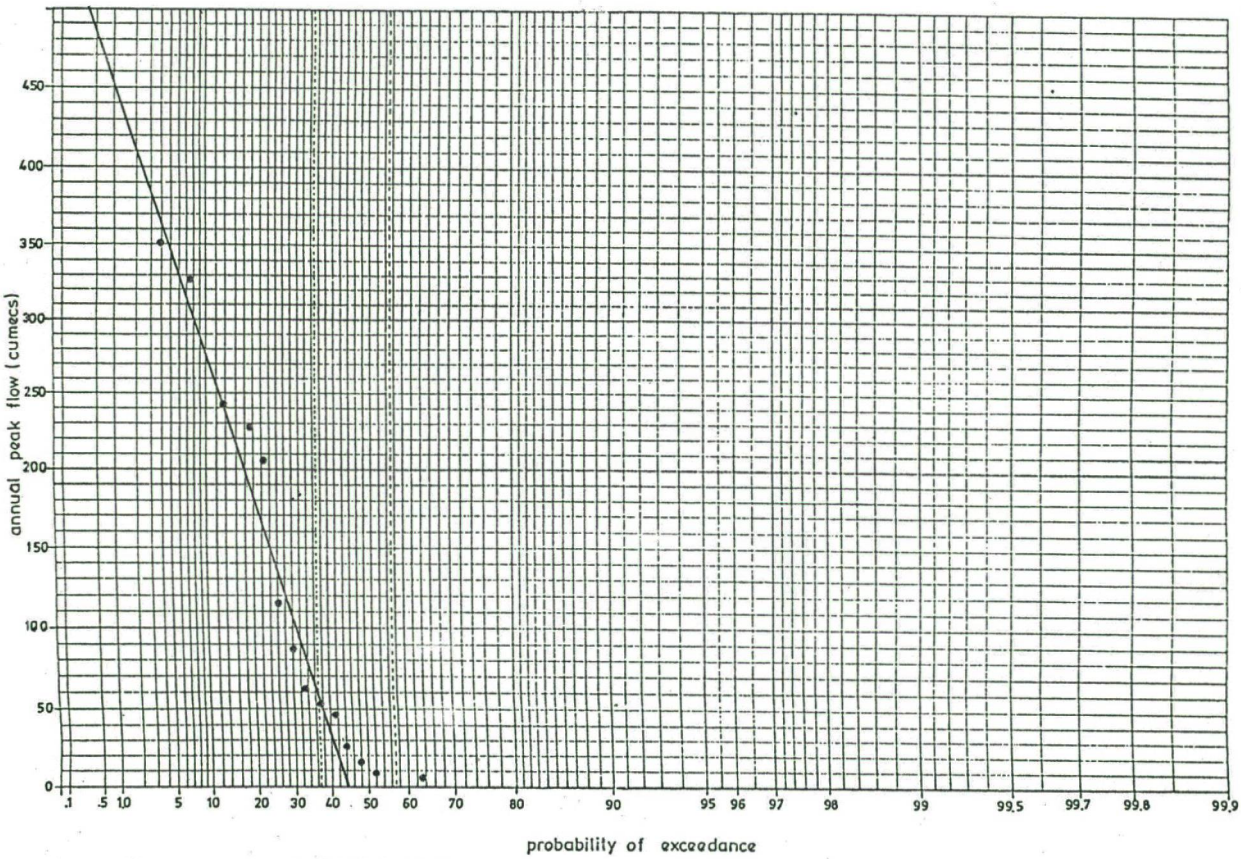
YEAR	J	F	M	A	M	J	J	A	S	O	N	D	YEAR	DAILY MAX	DAILY MIN	Days without readings
1948																364
1949										4.492	5.382	4.458				265
1950	3.316	1.375	2.231	11.795	8.838	4.291	6.445		8.565	3.681	5.099	3.390				33
1951	1.108	0.815	3.300	32.774	17.018	8.013	6.425	6.583	4.204			25.354				43
1952	7.162	2.278	1.361	3.183	9.661	2.256	1.630	2.393	2.686	4.378	6.737	5.435	4.111	21.130	1.120	2
1953	1.838	0.745	1.146	2.779	9.375	6.640	3.472	4.630	2.449	7.034	11.604	8.720	5.062	35.900	0.669	0
1954	1.952															317
1955																365
1956																366
1957																365
1958		13.646	3.815	5.941	19.700	7.584	20.051	10.149	5.798	6.551	6.554	14.784				16
1959	5.201	2.792	1.934	4.168												249
1960										5.947	10.456	5.632				255
1961	2.438	1.417	1.379	11.938	10.487	5.352	5.612	18.064	7.020	38.394	11.772					27
1962				11.669	26.173	5.616	3.965	3.503	6.044	9.211	8.410	8.955				111
1963																359
1964	23.595	6.563	8.146	45.538	14.566	8.238	6.338	22.292	17.199	14.129	12.160	16.652	16.289	129.200	5.080	52
1965	10.043	4.848	3.771	5.999	8.093	3.452	3.205	3.104	3.171	7.170	14.446	5.672	6.084	24.680	2.430	54
1966	2.654	2.255	3.998	18.017	8.521	12.004	3.386	7.002	10.167	6.167	34.177	3.897	9.311	120.000	1.390	56
1967	0.880	0.422	0.694	7.710	31.500	11.262	10.349	9.393	6.720	13.622	34.730	18.874	12.244	194.400	0.067	39
1968	2.408	7.595	37.198	66.044	52.975	19.246	9.019	5.885	2.776	3.160	21.534	31.202	21.600	209.100	1.000	50
1969	4.122	6.985	12.482	7.036	13.397	3.246	2.138	2.154	4.106	1.971	8.070	4.345	5.830	42.370	1.050	39
1970	3.847	2.370	3.523	13.805	9.559	3.199	2.876	5.036	3.673	4.338	5.103	1.350	4.894	32.580	0.754	42
1971	0.748			3.890	14.595	7.012	5.626	22.291	9.598	7.199	4.970	7.275				91
1972	4.952	9.397	1.905	0.646	4.267	6.049	3.096	2.408	0.678	4.861	11.737	2.820	4.370	35.200	0.239	43
1973	2.073	1.644	0.412	1.670	3.926	3.611	1.972	6.052	6.893	4.546	11.011	2.365	3.845	48.840	0.067	42
1974	0.641			6.793	2.356	2.517	8.714	8.274	7.795	3.594	7.108	2.182				77
1975	0.527				7.780	10.235	13.994	16.620	15.747	12.118	8.408	3.874				88
1976	1.382	0.695	0.463	2.450	9.175	5.036	9.204	7.037	10.235	2.722	3.512	6.524	4.888	43.210	0.126	53
1977	4.546	1.053	1.395	45.872	34.541	5.403	7.425	8.144	6.837	5.748	40.980	21.656	15.313	121.400	0.704	53
1978	8.252	6.169	15.223	18.627	15.755	4.228	5.106	4.625	6.644	10.720	16.231	14.766	10.555	44.910	2.170	53
1979	8.976	36.270	8.764	12.650	13.535	8.838	3.781	2.528	2.069	2.181	9.083	2.040	9.016	92.690	1.100	55
1980	0.603			4.067	12.342	3.160	2.308	1.847	1.740	1.156	6.636	2.127				89
1981	0.898	0.858	11.608	35.611	29.744	5.649	6.516	10.985	10.235	8.008	10.596	5.149	11.362	95.140	0.604	54
1982	3.473	1.634	1.218	11.307	21.932	8.844	4.693	6.418	4.278	15.406	29.647	24.615	11.174	79.180	0.900	56
1983	5.055	3.442	2.227	9.053	11.372	5.501	6.688	12.999	12.241	12.587	16.232	13.312	9.256	47.069	1.586	54
1984	5.830	2.170	1.588	1.949	1.465	2.072	1.950	1.763	2.286	6.401	8.077	6.373	3.500	24.358	0.625	55
1985	1.029	1.875	1.504	23.149	19.877	4.790	4.988	4.152	4.197	5.568	7.005	3.352	6.798	90.254	0.215	56
1986	0.777	0.140	0.305	11.763	19.080											239
Maximum	23.595	36.270	37.198	66.044	52.975	19.246	20.051	22.292	17.199	38.394	20.522	31.202	21.600	209.100	5.0800	
Minimum	0.5274	0.1397	0.3052	0.6456	1.4650	2.0717	1.6297	1.7630	0.6777	1.1558	3.5120	1.3497	3.4998	21.130	0.0670	
Mean	4.01	4.59	5.06	14.60	15.39	6.32	5.90	7.73	6.42	7.77	16.18	9.24	8.60	76.58	1.0948	
Runoff(mm)	2.36	2.46	2.97	8.30	9.04	3.59	3.46	4.54	3.65	4.56	9.20	5.43	5.05	1.45	0.0207	

MINISTRY OF WATER DEVELOPMENT
Water Resources Branch Hydrology Section

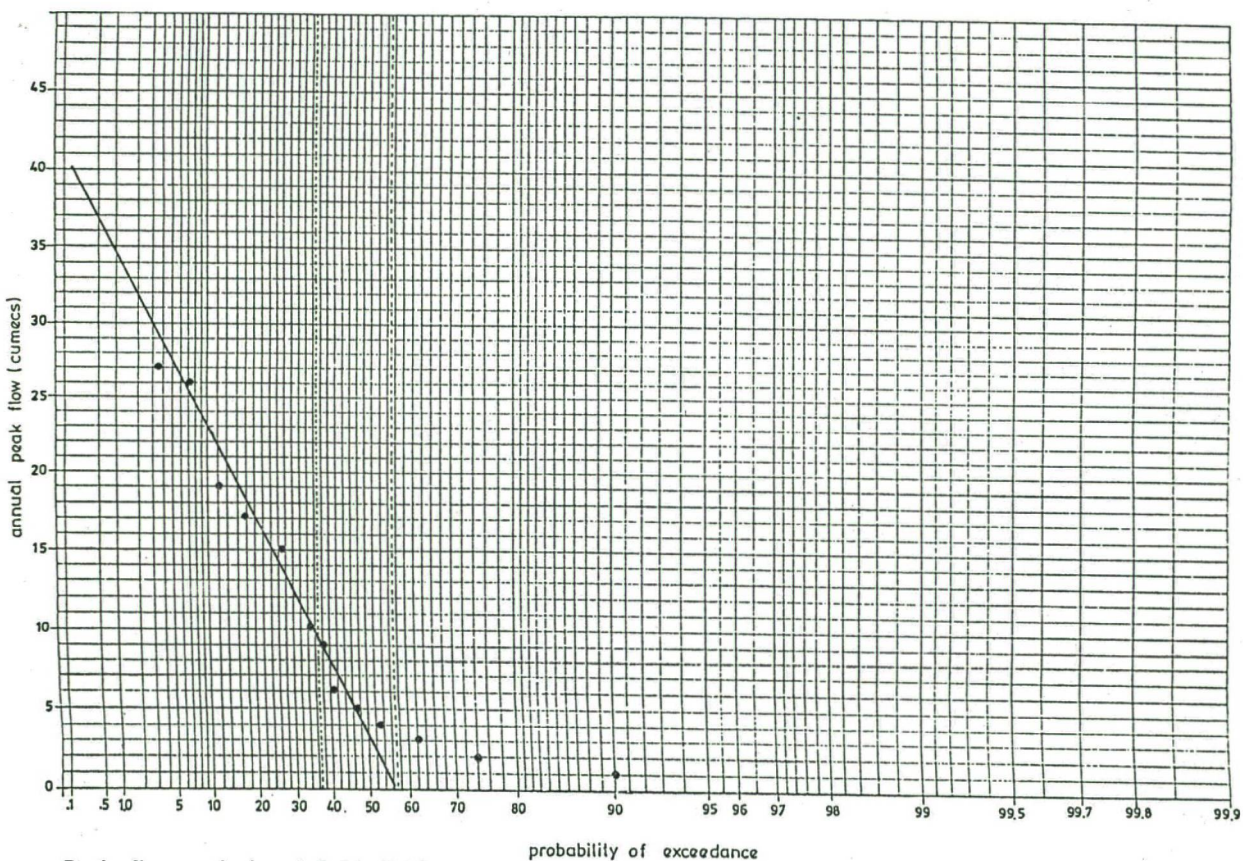
MONTHLY AND ANNUAL DISCHARGE DATA River: EWASO NGIRO
R.G.S: 5E3
The flows are in: CUMEC Area (km2): 15300

YEAR	J	F	M	A	M	J	J	A	S	O	N	D	YEAR	DAILY MAX	DAILY MIN	Days without readings
1949				7.74	6.00	9.17	6.65	10.23	19.72	6.25	9.18	9.87				68
1950	3.88	2.17	9.33	40.96	11.52	7.24	10.60	11.54	14.04	5.33	5.98	4.52	10.59	211.40	1.04	1
1951	1.11	0.90	154.90	270.24	46.83	17.49	12.77	16.69	11.58	10.24	42.59	52.13	43.72	658.60	0.64	0
1952	12.15	2.86	1.71	3.16	12.81	2.68	1.96	2.47	3.86	3.88	7.36	7.03	5.18	28.25	1.23	5
1953	2.15	0.65	1.31	10.56	12.08	11.92	3.92	5.51	2.63	5.73	25.27	10.69	7.70	121.40	0.55	0
1954	2.23	0.99	0.80	26.69	28.47	8.40	30.79	23.82	39.26	17.02	12.25	25.75	18.14	178.00	0.48	0
1955	5.33	4.60	10.21	18.72	7.78	2.96	3.23	20.90	27.04	23.71	16.09	17.06	12.47	103.00	1.42	0
1956	19.21	7.68	7.34	26.27	25.95	7.68	9.22	22.41	24.65	13.52	18.92	10.24	16.10	127.60	2.59	0
1957	4.48	3.39	5.84	30.62	44.12	29.60	10.05	8.11	8.62	5.36	21.27	40.46	17.73	223.20	1.85	0
1958	7.53	21.71	12.29	14.59	37.47	14.08	47.75	44.90	21.52	12.65	9.66	22.38	22.29	126.20	3.21	0
1958	7.53	21.71	12.29	14.59	37.47	14.08	47.75	44.90	21.52	12.65	9.66	22.38	22.29	126.20	3.21	0
1959	9.41	3.91	4.66	6.55	28.62	12.77	7.12	8.12	11.42	5.71	30.36	14.77	11.83	195.30	1.23	23
1960	4.47	2.16	16.01	23.88	8.15	4.37	5.47	5.74	13.24	7.25	23.00	11.17	10.39	267.10	1.23	35
1961	2.81	1.43	10.11	37.16	16.07	6.65	7.32	41.95	13.29	60.70	724.00	141.42	88.12	1835.00	0.70	35
1962	95.26	18.27	12.81	19.24	38.48	10.48	8.23	10.01	14.79	23.68	12.49	19.22	23.73	321.10	6.67	49
1963	13.43	4.83	19.82	34.74	56.66	28.43	8.39	16.23		7.99	59.13	151.18				66
1964	46.64	15.03	15.18	76.20	29.30	14.57	9.59	47.63	39.58	32.58	23.60	35.42	32.13	352.90	6.67	55
1965	20.59	9.37	6.00	17.82	14.75	5.83	5.24	4.13	4.61	16.80	30.17	10.93	12.18	84.36	3.21	54
1966	4.86	8.71	7.86	53.35	18.00	16.48	10.08	15.72	25.86	24.53	58.73	6.93	20.83	332.60	3.54	56
1967	2.27	1.53	25.72	43.40	89.92	28.75	29.67	27.87	17.95	22.27	86.55	35.30	32.97	485.50	1.04	58
1968	7.17	10.98	61.63	165.09	89.47	42.19	23.68	24.91	12.69	9.49	66.24	97.97	50.95	598.70	3.88	65
1969	18.27	17.81	28.46	17.20	28.18	8.59	6.31	5.66	10.26	5.99	19.95	10.85	14.78	87.16	4.24	58
1970	8.65	6.69	5.33	19.56	18.03	6.40	5.34	8.93	11.26	8.85	9.42	3.80	9.35	44.30	1.85	59
1971	2.17	1.14	15.75	31.17	26.12	14.40	18.38	39.89	30.46	17.23	17.24	16.70	18.06	165.80	0.70	57
1972		13.69	4.93	2.31	12.18	17.74	7.43	7.48	4.09	24.57	39.61	9.38				63
1973	11.61	2.54	1.81	4.32	4.58	6.47	4.02	14.57	11.80	9.65	26.97	4.91	8.61	165.90	1.04	57
1974	1.70	0.98	6.78	21.81	5.14	4.19	15.73	16.46	17.76	6.25	22.55	5.54	10.42	129.70	0.70	55
1975																365
1976																360
1977	124.13															285
1978																328
1979	164.05															328
1980	1.72							1.52	1.87	0.90	14.79	2.06				182
1981	0.56	0.26	60.27	93.42	38.72	7.35	8.95	24.14	15.74	12.54	12.45	5.22	23.40	390.20	0.10	6
1982	3.15	1.23	0.89	22.55	26.55	12.81	5.62	9.34	7.43		50.04	47.83				39
1983	11.30	4.07	5.72	9.78	14.69	5.34	6.89	32.84	28.23	16.16	13.66	26.01	14.31	143.30	1.23	0
1984	7.38	1.68	1.17	5.00	1.73	0.42	1.05	1.42	2.50	13.26	26.92	9.38	5.99	143.30	0.19	0
1985	1.35	2.28	5.49	34.44	23.67	8.71	7.94	8.98	7.18	6.05	18.29	5.65	10.84	143.30	0.10	0
Maximum	164.05	21.71	154.90	270.24	89.92	42.19	47.75	47.63	39.58	60.70	724.00	151.18	88.12	1835.00	6.67	
Minimum	0.56	0.26	0.80	2.31	1.73	0.42	1.05	1.42	1.87	0.90	5.98	2.06	5.18	28.25	0.10	
Mean	19.41	5.78	17.34	38.34	26.52	12.07	10.95	16.88	15.32	14.07	48.58	27.24	252.50	283.82	1.90	
Runoff (mm)	3.40	0.91	3.04	6.50	4.64	2.04	1.92	2.95	2.60	2.46	8.23	4.77	43.46	1.60	0.01	

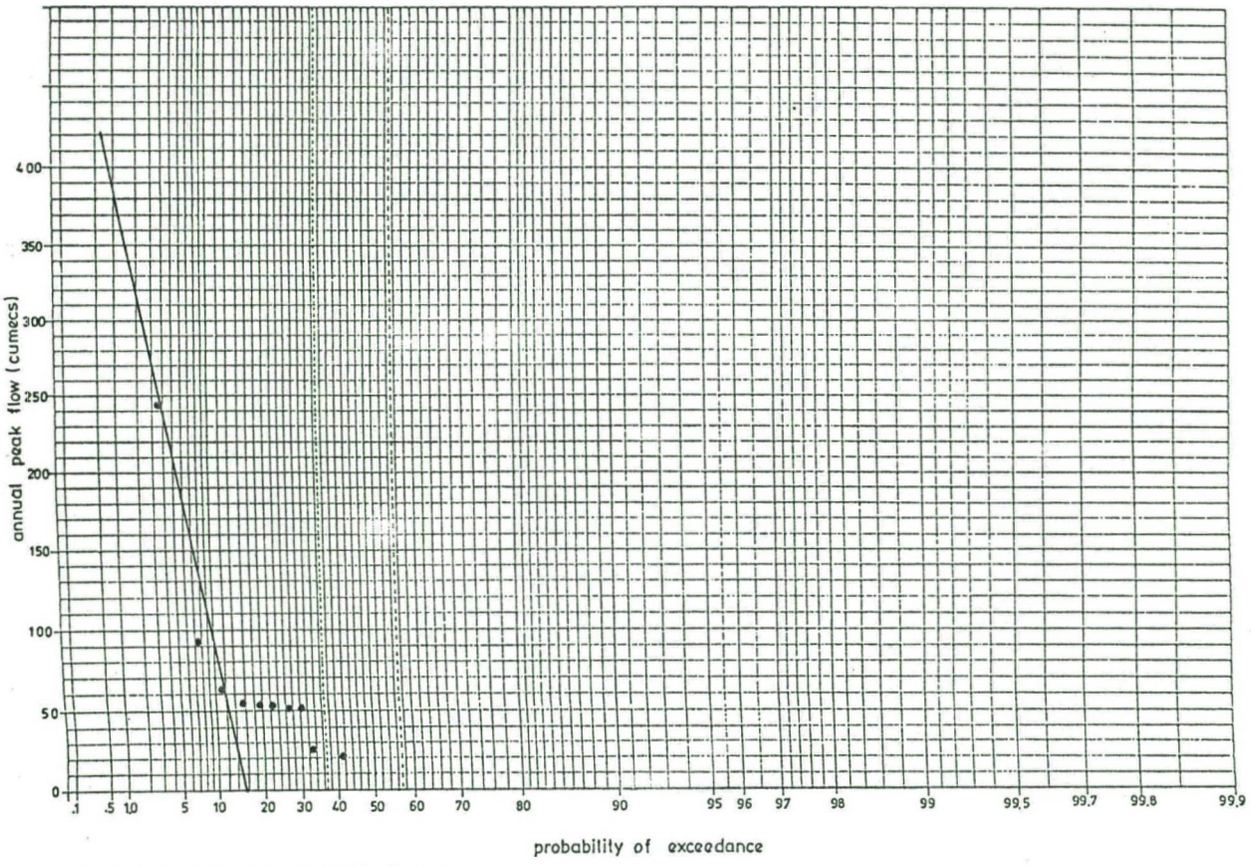
NB For the following summary, datagaps of up to 6 days were bridged by interpolation.
Records with datagaps of more than 6 days are indicated by NA



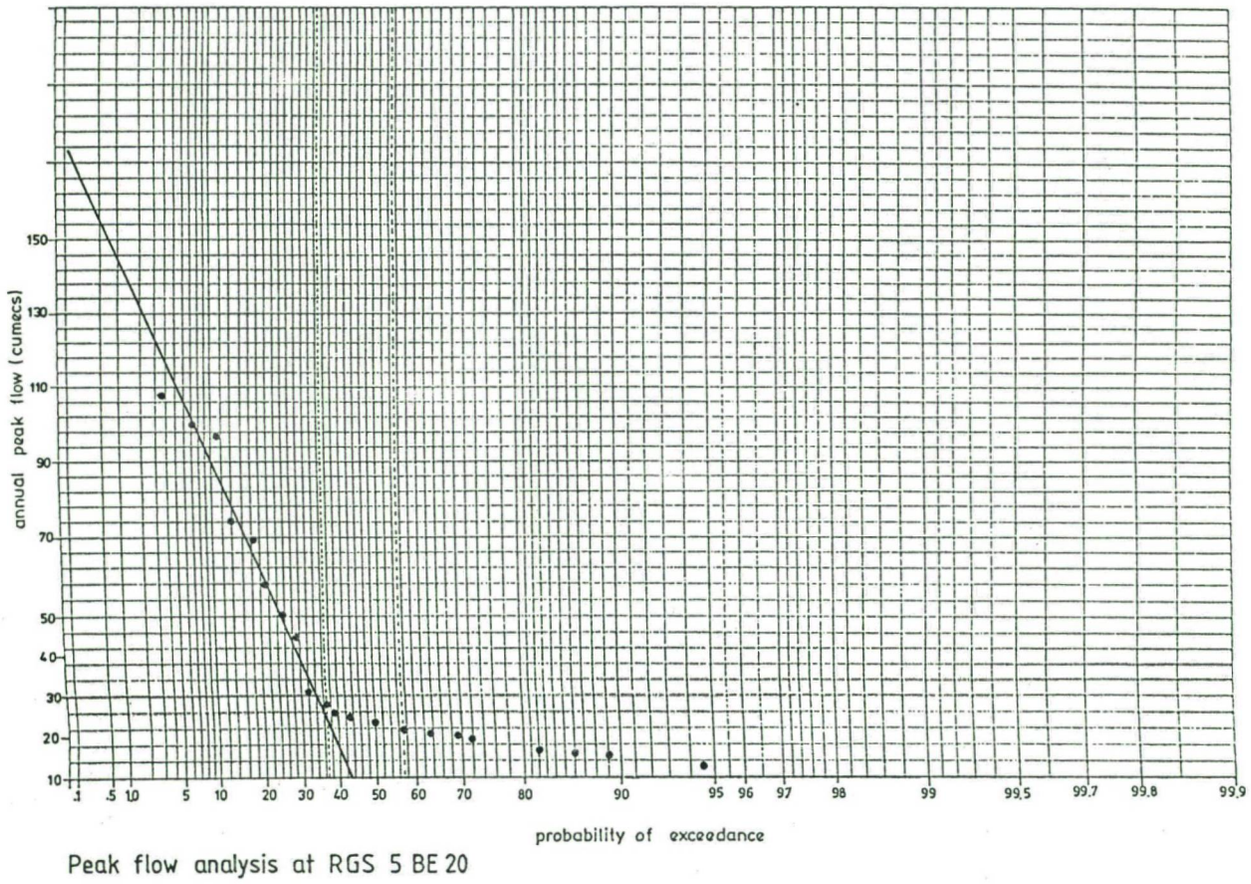
Peak flow analysis at RGS 5 AB 3



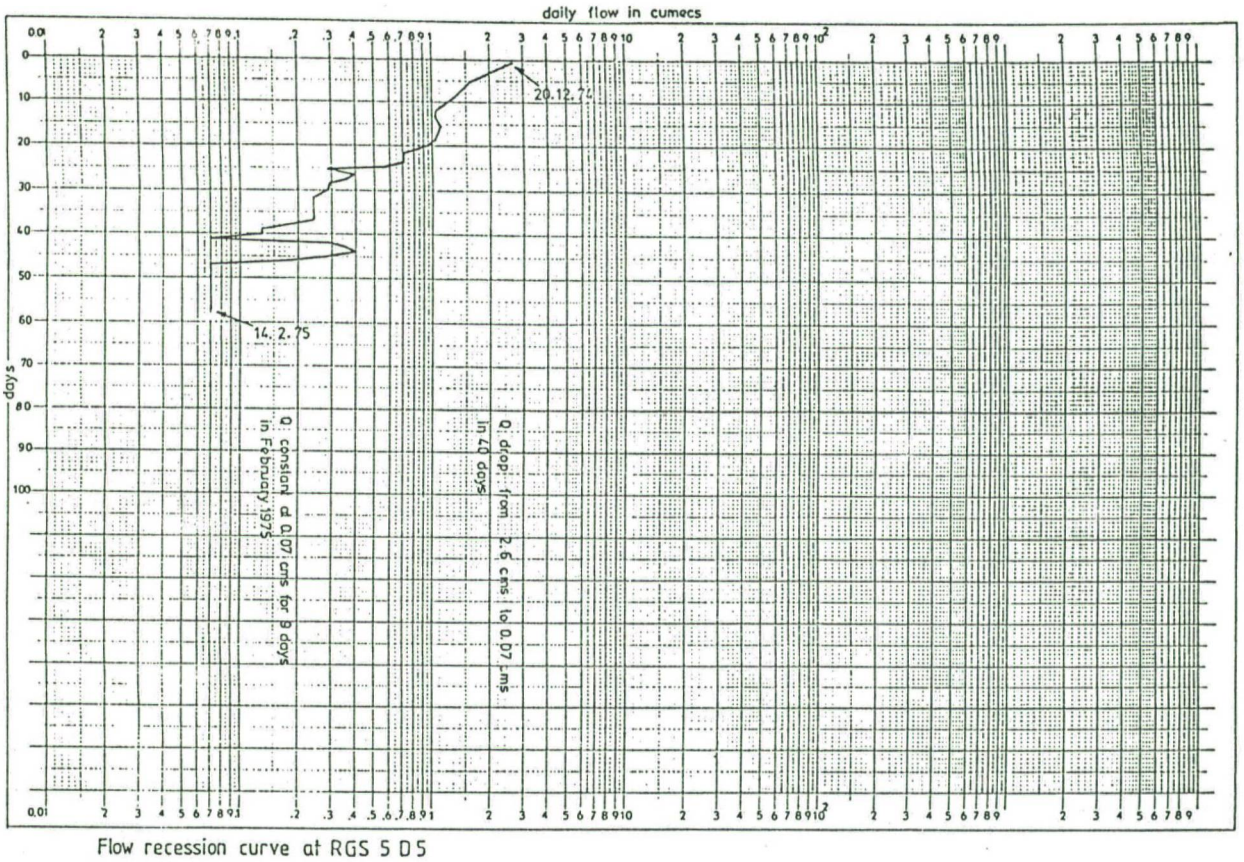
Peak flow analysis at RGS 5 AB 2



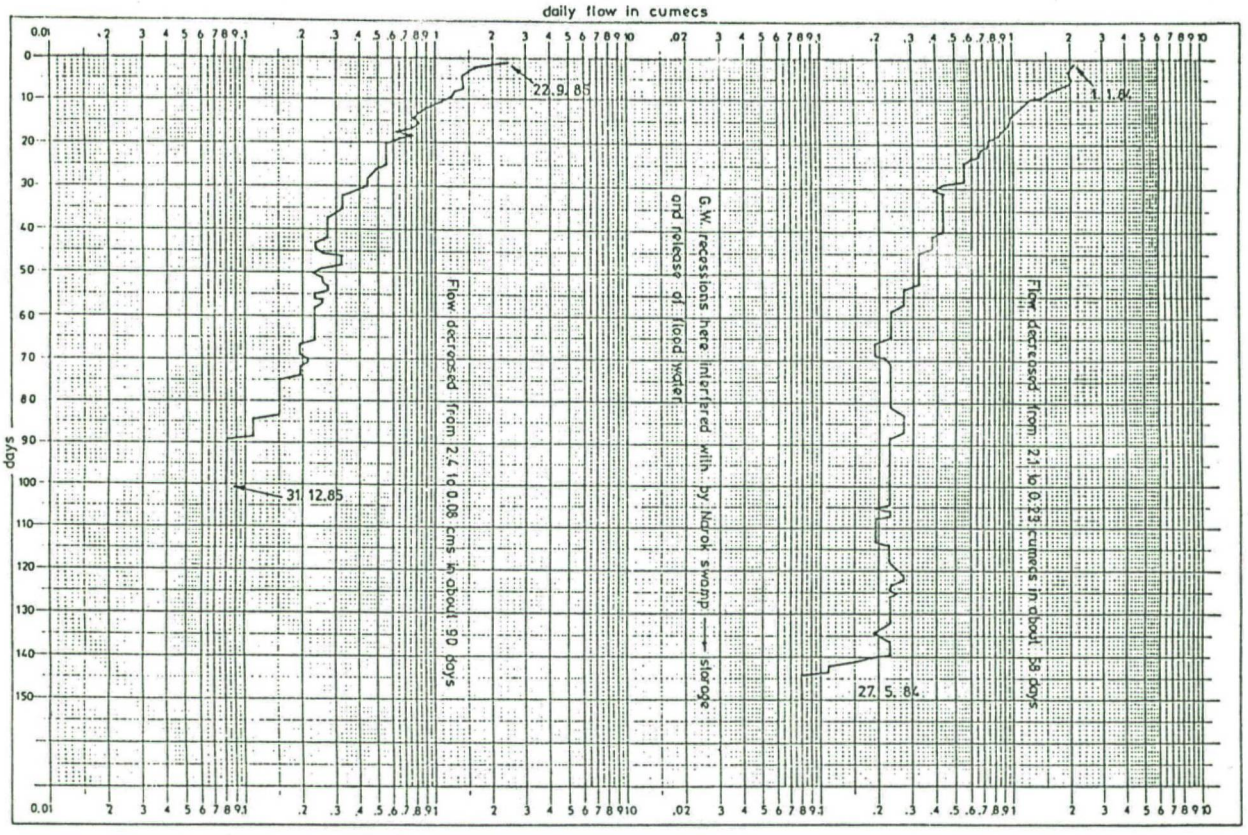
Peak flow analysis at RGS 5 BC 4



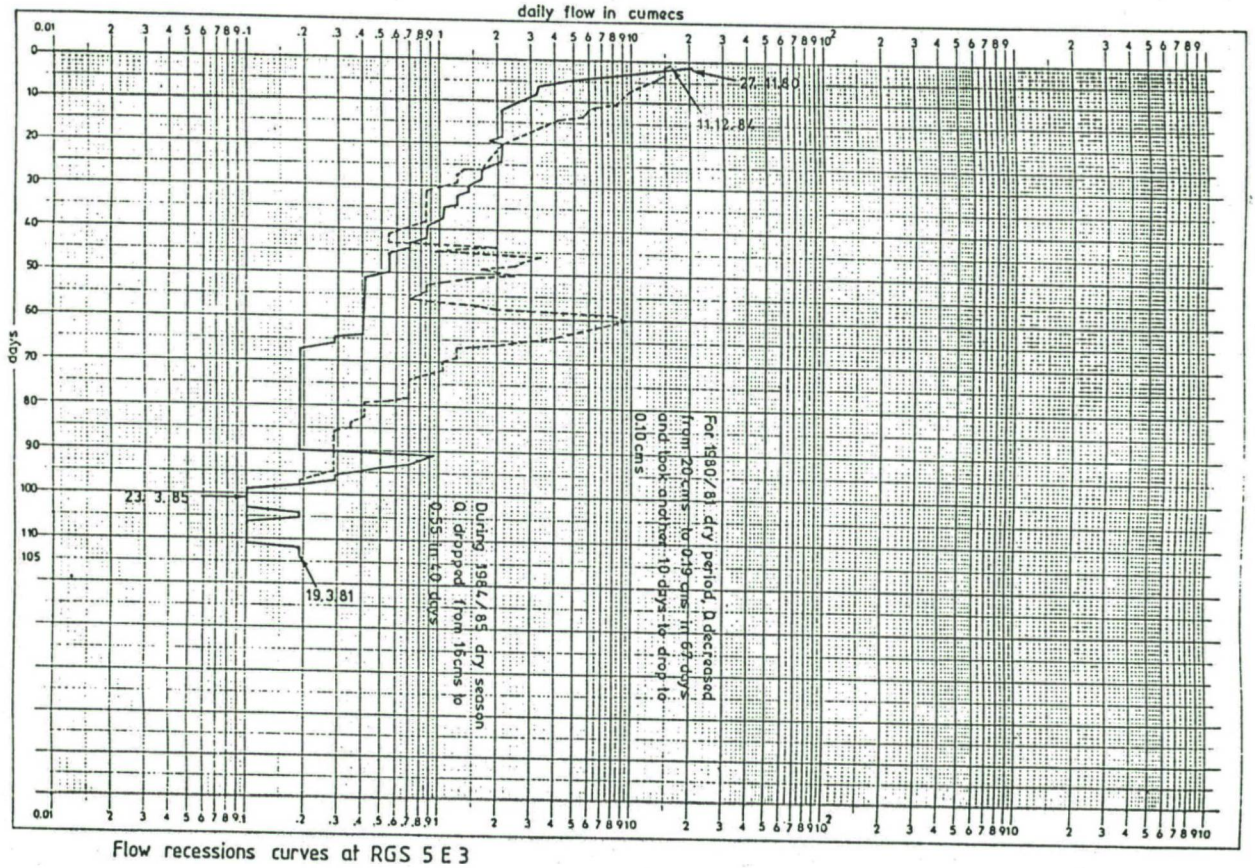
Peak flow analysis at RGS 5 BE 20



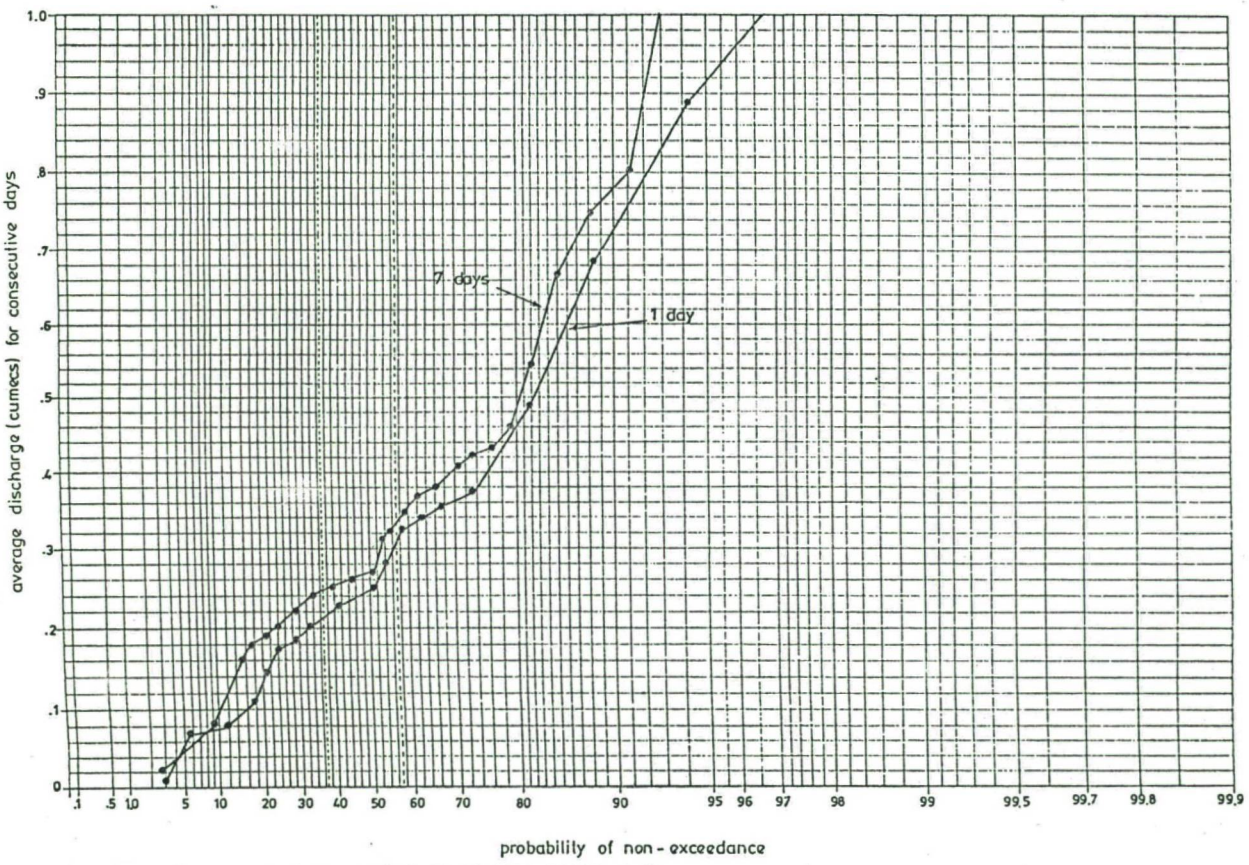
Flow recession curve at RGS 5 D5



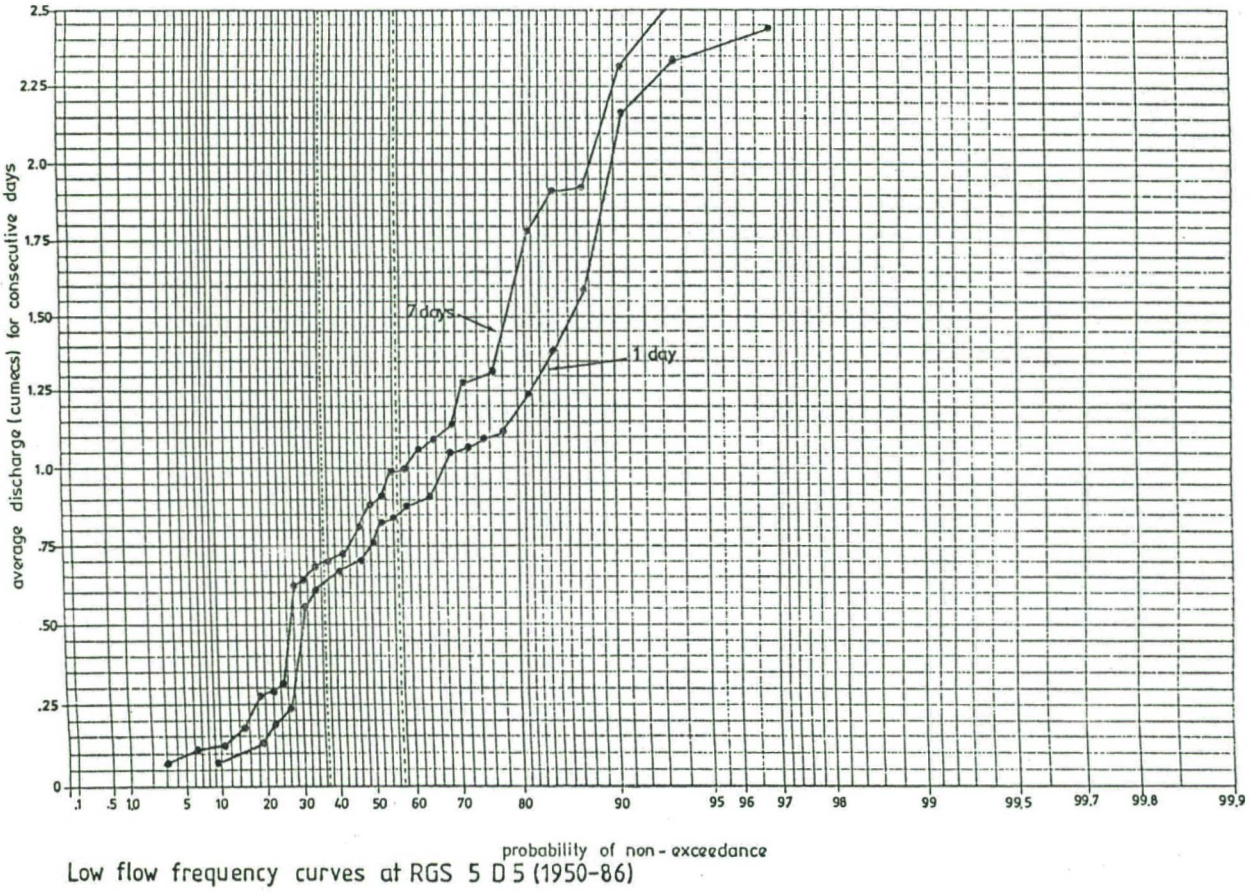
Flow recession curves at RGS 5 AC8



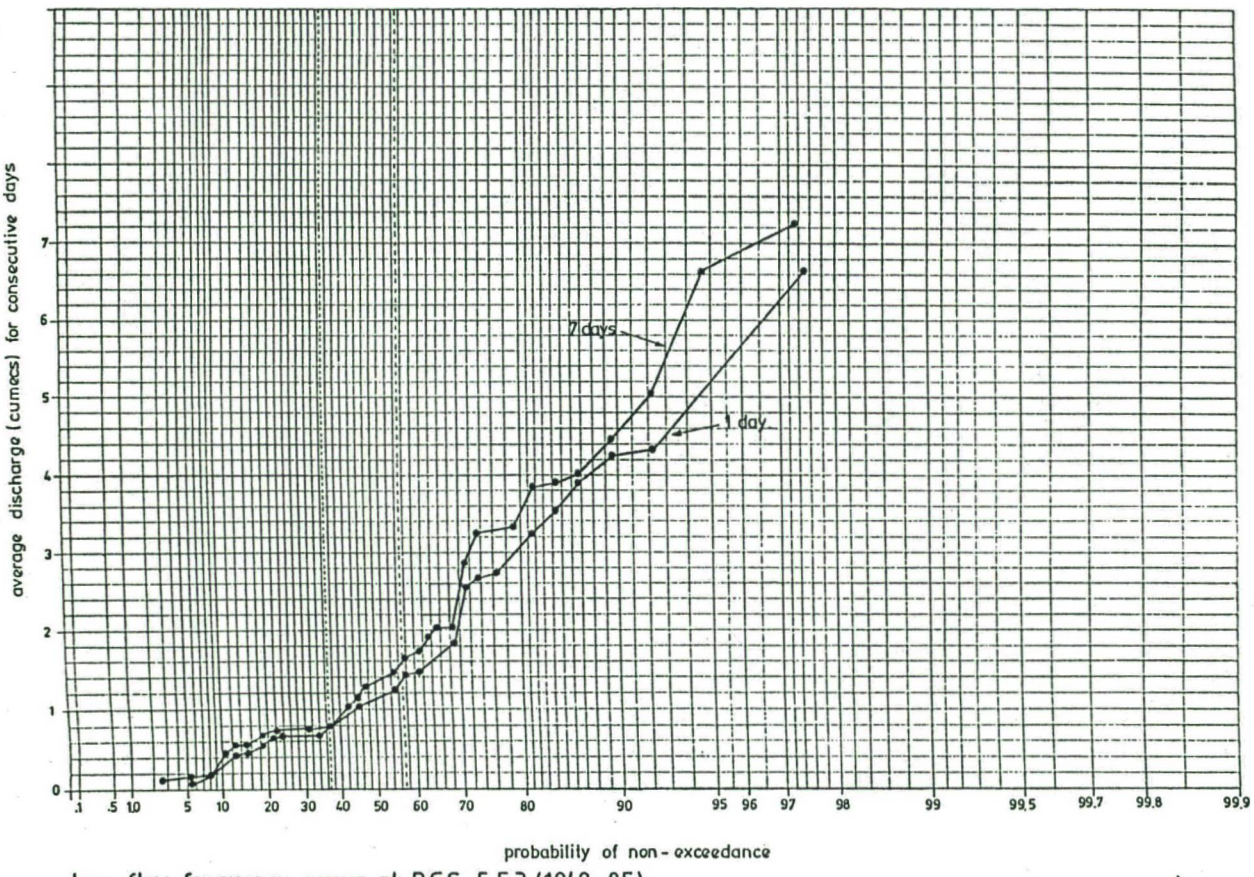
Flow recessions curves at RGS 5 E 3



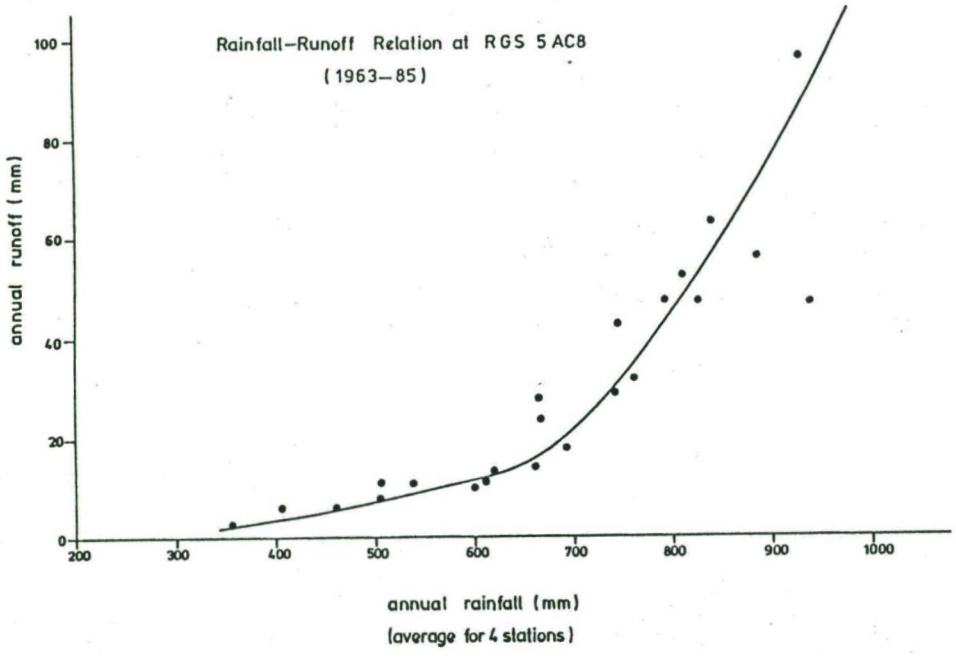
Low flow frequency curves at RGS 5 AC 8 (1951-86)

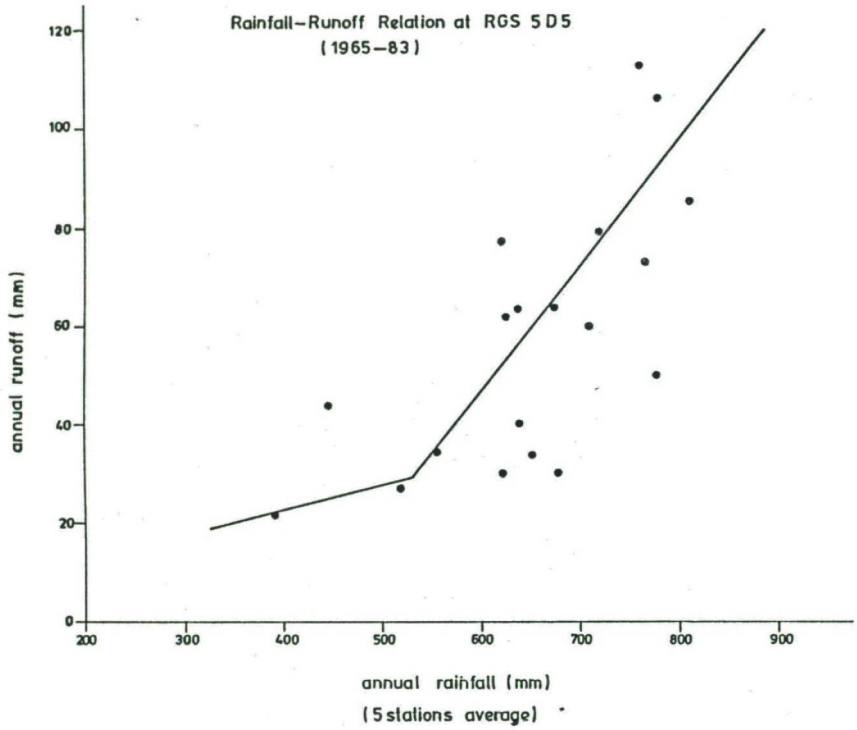


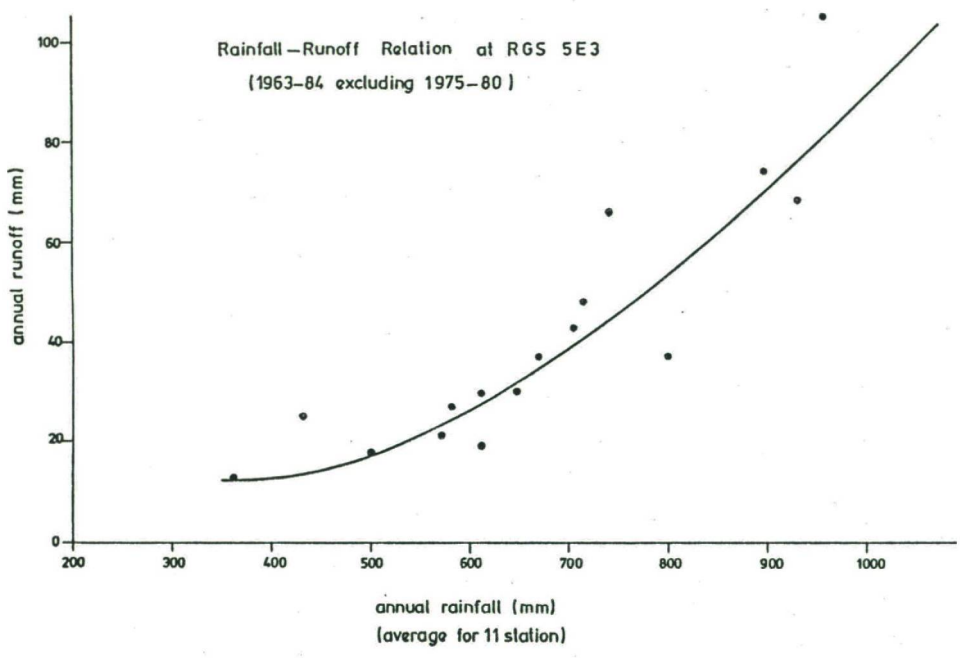
Low flow frequency curves at RGS 5 D 5 (1950-86)



Low flow frequency curves at RGS 5 E 3 (1949-85)




Rainfall–Runoff Relation at RGS 5D5
(1965–83)
annual runoff (mm)
0
20
40
60
80
100
120
200
300
400
500
600
700
800
900
annual rainfall (mm)
(5 stations average)


Rainfall–Runoff Relation at RGS 5E3
(1963–84 excluding 1975–80)
annual runoff (mm)
0
20
40
60
80
100
200
300
400
500
600
700
800
900
1000
annual rainfall (mm)
(average for 11 station)

APPENDIX 4.7

Chemical Data Surface Water

Appendix 4.7 Chemical Data Surface Water

SOURCE	RGS	Stream flow cumec	DATE	pH	O mS/cm	TDS mg/l	Cl mg/l	SO4 mg/l	HCO3 mg/l	Fe mg/l	Mn mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	F mg/l	NO3 mg/l	SiO2 mg/l	CaCO3 Hard	Colour Hazen Units	TURBIDITY F.T.U	Sum Cations meq	Sum Anions meq	%Dif	SAR	Potable?
Lake Ol Bolossat**			29/10/85	8.4	3.20	1920	58.0	450	70.7	0.37	<0.01	8.8	8.8			3.60			58		1650					NO
Ewaso Narok	5AA 1		13/04/86	7.5	0.13	79	8.0	2.10	17.1	1.10	0.07	1.5	0.5	20.0	3.0	1.20	0.03	20.0	14	5	22.0	1.10	0.61	28.6	1.8	yes
Ewaso Narok	5AA 1		21/12/85	7.4	0.14	81	4.0	1.80	24.4	1.40	0.03	1.6	0.6	21.0		0.31			20	5	14.0					yes
Pesi	5AB 2		14/04/86	7.7	0.11	66	4.0	<0.30	43.9	1.40	0.01	3.6	2.4	11.0	2.0	0.50	<0.01	37.0	36	5	18.0	0.96	0.87	5.1	0.6	yes
Pesi	5AB 2		24/10/85	7.9	0.40	240	4.0	1.30	70.7	1.70	<0.01	9.6	8.3			0.30			58	30	12.0					yes
Pesi	5AB 2	0.287	19/12/85	7.7	0.11	66	4.0	<0.30	56.1	2.90	<0.01	9.6	2.9			0.15			46	5	23.0					yes
Pesi	5AB 3		13/04/86	7.7	0.13	75	5.0	0.35	48.8	1.20	0.04	3.9	2.4	10.0	5.0	0.47	0.02		40	5	15.0	1.00	0.97	1.3	0.5	yes
Pesi	5AB 3	0.289	20/12/85	8.2	0.11	66	4.0	0.85	68.3	0.79	0.01	9.6	7.8			0.20			56	5	56.0					yes
Pesi	5AB 4		21/12/85	8.0	0.10	60	3.0	0.60	53.7	0.40	<0.01	8.8	5.3			0.16			44	5	3.6					yes
Narok channel	5AC 3		14/04/86	7.9	0.15	90	7.0	0.71	22.0	1.70	0.05	1.7	0.7	20.0	5.0	0.65	0.01	42.0	18	5	22.0	1.20	0.61	33.0	1.6	yes
Narok channel	5AC 3	0.228	20/12/85	7.8	0.15	90	8.0	3.30	58.5	0.60	0.03	5.6	8.3			0.20			48	5	7.2					yes
Pesi channel	5AC 6	0.085	19/12/85	8.2	0.12	69	4.0	<0.30	46.3	1.20	0.03	9.6	3.4			0.22			38	70	33.0					yes
Ewaso Narok	5AC 8	0.195	05/12/85	8.0	0.17	102	5.0	<0.30	46.3	3.00	0.03	10.0	2.9			0.30			38	20	3.6					yes
Ewaso Narok	5AC 8		17/04/86	7.9	0.14	84	9.0	<0.30	39.0	5.80	0.26	3.2	2.7	20.0	9.0	0.75	0.01	26.0	32	50	16.0	1.70	0.94	28.8	1.0	yes
Ewaso Narok	5AC 8		04/07/86	7.1	0.14	84	8.5	0.00	17.1	7.50	0.19	0.2	0.7	23.0	8.5	0.30	0.01	19.0	14	50	67.0	1.56	0.54	48.9	2.7	yes
Ewaso Narok	5AC10		17/04/86	8.0	0.20	120	14.0	0.71	31.7	5.20	0.35	2.7	1.5	34.0	8.0	0.97	<0.01	33.0	26	50	32.0	2.14	0.98	37.2	2.1	yes
Ewaso Narok	5AC10		20/12/85	7.9	0.17	102	6.0	0.30	43.9	2.40	0.02	4.6	5.8			0.36			36	70	24.0					yes
Ngare Narok	5AC10		24/07/86	6.7	0.18	108	18.0	0.00	87.8	4.00	0.29	19.0	1.5	35.0	4.7	0.35	0.03	24.0	24	50	52.0	2.87	1.97	18.7	1.0	yes
Ewaso Narok	5AC15		14/04/86	7.9	0.13	78	8.0	0.71	22.0	1.70	0.02	1.7	0.7	23.0	4.0	0.65	0.01	42.0	18	10	24.0	1.31	0.63	34.6	1.9	yes
Ewaso Narok	5AC15	0.559	19/12/85	8.2	0.15	90	7.0	3.40	28.0	0.76	0.01	8.0	0.7			0.27			23	5	4.8					yes
Mutara	5AD 4		13/04/86	8.0	0.21	128	7.0	<0.30	87.8	3.10	0.11	8.2	5.5	14.0	2.0	0.85	<0.01	40.0	72	10	37.0	1.64	1.69	1.5	0.5	yes
Mutara	5AD 4	0.073	19/12/85	8.4	0.19	114	4.0	1.50	84.1	3.40	0.05	17.0	6.7			0.26			69	80	57.0					yes
Naru Moro	5BA 2		18/04/86	7.0	0.05	32	4.0	0.35	12.2	1.50	<0.04	1.5	0.5	4.0	1.0	0.38	<0.01	19.0	10	5	16.0	0.37	0.34	4.3	0.4	yes
Ngare Moyok	5BA 3		24/06/86	7.0	0.30	177	21.0	16.0	136.6	1.70	0.52	8.7	9.7	23.0	4.3	0.65	<0.01	28.0		5	33.0	2.42	3.20	13.8	0.6	yes
Ngare Moyok	5BA 3		22/10/85	8.0	0.25	150	18.0	5.00	165.9	1.20	<0.01	24.1	18.5			0.27			136 <	5	17.0					yes
Ngare Moyok	5BA 3	0.109	21/02/85	8.2	0.26	156	12.0	<0.30	141.5	2.90	0.01	26.0	13.0			0.21			116 <	5	33.0					yes
Ewaso Ngiro	5BB 2	0.383	16/12/85	8.0	0.13	78	5.0	0.30	65.9	2.20	0.02	15.0	3.9			0.17			54	15	18.0					yes

* after treatment

** the quality of this water is not good for domestic use or irrigation

+downstream of the station

Cont. Appendix 4.7 Chemical Data Surface Water

SOURCE	RGS	Stream flow cumec	DATE	pH	EC mS/cm	TDS mg/l	Cl mg/l	SO4 mg/l	HCO3 mg/l	Fe mg/l	Mn mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	F mg/l	NO3 mg/l	SiO2 mg/l	CaCO3 Hard	Colour Hazen Units	TURBIDITY F.T.U	Sum Cations meq	Sum Anions meq	%Dif	SAR	Potable?
Lamuria	5BB 2		24/06/86	7.8	0.10	60	8.5	0.00	47.6	11.0	1.05	1.6	2.8	11.0	4.3	0.55	0.02	17.0	39	160	89.0	1.33	1.05	11.9	0.6	yes
Ewaso Ngiro	5BB 2		22/10/85	7.9	0.14	81	5.0	0.30	109.8	3.60	0.09	16.0	12.0			0.24			90	175	82.0					yes
Naru Moru	5BC 2		22/10/85	7.0	0.17	102	4.0	0.32	31.7	0.57	<0.01	1.6	5.3			0.12			26	70	3.5					yes
Naru Moru	5BC 2		29/07/86	6.6	0.04	24	8.5	1.90	19.5	0.20	0.05	1.1	0.3	7.0	0.5	0.17	0.01	13.0	12	5	4.2	0.41	0.61	20.0	0.8	yes
Ewaso Ngiro	5BC 4	1.752	17/12/85	8.2	0.10	60	6.0	0.90	50.0	2.20	0.05	10.0	3.6			0.18			41	50	25.0					yes
Ewaso Ngiro	5BC 4		10/04/86	8.1	0.38	225	36.0	12.0	131.7	5.70	0.17	10.6	9.1	40.0	5.0	0.80	0.01	16.0	108	50	56.0	3.36	3.47	1.6	1.1	yes
Rongai	5BC 5		18/12/85	7.4	0.05	27	4.0	0.30	24.4	1.80	0.02	3.2	2.9			0.14			20	< 5	18.0					yes
Rongai	5BC 5		18/04/86	7.1	0.09	52	6.0	<0.30	17.1	7.20	0.16	0.9	0.6	8.0	5.0	1.20	<0.01	17.0	14	75	67.0	0.83	0.52	23.3	0.8	yes
Burguret	5BC 6		18/06/86	6.9	0.03	15	5.6	0.00	2.4	2.40	0.56	0.8	0.4	5.0	1.7	0.41	0.01	9.8	2	50	31.0	0.44	0.22	33.4	0.6	yes
Burguret	5BC 6		29/07/86	6.4	0.04	21	8.5	1.40	24.4	0.50	0.03	1.3	0.3	5.0	0.7	0.19	0.01	12.0	10	10	9.5	0.34	0.68	32.7	0.5	yes
Burguret	5BC 6		18/04/86	6.6	0.05	27	7.0	3.60	8.5	2.10	0.04	0.7	0.4	8.0	2.0	0.43	0.01	15.0	7	15	14.0	0.54	0.44	11.1	0.9	yes
Burguret	5BC 6	0.499	18/12/85	7.6	0.04	24	5.0	0.55	12.2	0.69	0.01	2.4	1.0			0.12			10	5	3.2					yes
Ngobit	5BC 8		22/10/85	8.0	0.16	93	8.0	1.10	117.1	1.50	<0.01	14.0	15.0			0.22			96	< 5	14.0					yes
Ngobit	5BC 8	0.401	16/12/85	8.0	0.11	66	6.0	0.42	56.1	0.81	0.01	12.0	3.9			0.16			46	20	7.5					yes
Nanyuki	5BE 1		18/04/86	5.7	0.07	43	6.6	<0.30	23.2	15.0	0.24	0.4	1.1	9.0	2.0	1.20	0.03	11.0	19	80	140.0	1.10	0.64	26.7	0.8	yes
Nanyuki	5BE 1		23/12/85	7.5	0.04	24	5.0	0.36	29.3	0.45	<0.01	2.4	4.4			0.11			24	15	2.6					yes
Nanyuki	5BE 1		26/06/86	7.2	0.03	18	5.6	0.40	1.8	0.20	0.43	0.5	0.3	5.0	1.1	0.54	<0.01	11.0	1.5	20	3.6	0.32	0.22	17.2	0.7	yes
Ontulili	5BE 2		18/04/86	7.5	0.07	44	5.0	0.30	20.7	2.70	0.14	1.3	1.9	10.0	3.6	0.55	0.02	20.0	17	30	25.0	0.85	0.52	24.4	0.7	yes
Ontulili	5BE 2		18/12/86	7.6	0.05	27	4.0	<0.30	26.8	1.60	<0.01	4.0	2.9			0.13			22	45	11.0					yes
Kongoni	5BE 3		18/04/86	7.3	0.10	60	7.0	1.40	43.9	4.80	0.06	1.7	2.8	11.0	7.0	0.60	0.01	16.0	36	70	47.0	1.15	0.98	7.9	0.6	yes
Kongoni	5BE 3		18/12/85	7.6	0.08	48	4.0	1.50	29.3	1.60	0.01	4.6	2.9			0.15			24	60	17.0					yes
Sirimon	5BE 4		18/12/85	7.8	0.05	30	4.0	0.64	14.6	0.50	<0.01	4.0	0.5			0.13			12	5	2.1					yes
Sirimon	5BE 4		18/04/86	7.4	0.06	34	6.0	1.40	17.1	0.40	0.03	1.5	1.2	9.0	2.6	0.48	<0.01	13.0	14	5	3.1	0.65	0.50	12.5	0.7	yes
Sirimon	5BE 4		26/06/86	6.3	0.03	18	5.6	0.33	2.4	0.30	0.54	1.3	0.6	8.0	1.5	0.48	<0.01	14.0	2	5	0.3	0.53	0.23	39.5	0.7	yes
Teleswani	5BE 5	0.129	18/12/85	7.5	0.07	42		<0.30	26.8	1.80	0.06	4.6	2.4			0.15			22	< 5	17.0					yes
Teleswani	5BE 5		18/04/86	7.7	0.07	44	4.0	0.71	22.0	0.70	0.05	1.6	0.5	6.0	1.0	0.45	0.01	35.0	18	5	10.0	0.43	0.51	8.1	0.5	yes
Timau	5BE 6	0.081	18/12/85	8.1	0.08	48		1.40	29.3	1.60	0.01	4.0	3.4			0.19			24	5	6.4					yes

* after treatment

** the quality of this water is not good for domestic use or irrigation

+downstream of the station

Cont. Appendix 4.7 Chemical Data Surface Water

SOURCE	RGS	Stream flow cumec	DATE	pH	Ø mS/cm	TDS mg/l	Cl mg/l	SO4 mg/l	HCO3 mg/l	Fe mg/l	Mn mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	F mg/l	NO3 mg/l	SiO2 mg/l	CaCO3 Hard	Colour Hazen Units	TURBI DITY F.T.U	Sum Cations meq	Sum Anions meq	%Dif	SAR	Potable?
Timau	5BE 6		18/10/85	7.6	0.07	42	8.0	2.70	48.8	0.23	<0.01	6.4	5.8			0.20			40	5	9.0					yes
Timau	5BE 6		18/04/86	7.9	0.07	42	7.0	<0.30	24.4	3.30	0.12	1.6	1.4	7.0	2.0	0.58	<0.01	23.0	20	5	23.0	0.67	0.63	3.0	0.5	yes
Timau	5BE 6		26/06/86	6.8	0.09	54	8.5	0.00	2.4	5.00	0.51	1.0	1.1	17.0	3.9	0.64	0.03		20	100	51.0	1.18	0.31	57.9	1.4	yes
Liki	5BE 7		26/06/86	6.3	0.03	18	7.1	0.67	6.1	1.30	0.43	0.7	0.4	10.0	1.8	0.49	0.01	15.0	5	30	16.0	0.61	0.34	28.5	1.2	yes
Liki	5BE11	0.179	23/12/85	7.6	0.05	27	3.0	0.74	9.8	0.24	<0.01	1.8	0.9	12.0		0.12			8	30	16.0					yes
Liki	5BE12		25/06/86	6.3	0.03	15	5.6	0.10	2.4	0.90	0.37	0.5	0.3	3.0	1.7	0.40	<0.01	9.9	2	20	6.9	0.27	0.22	9.8	0.4	yes
Liki	5BE12	0.106	23/12/85	7.2	0.04	24	4.0	0.85	12.2	0.40	<0.01	1.6	1.5			<0.10			10	< 5	1.4					yes
Nanyuki 12km+	5BE20		17/04/86	7.4	0.08	50	7.0	<0.30	22.0	15.0	0.28	0.6	1.2	10.0	5.0	0.48	0.02	26.0	18	280	145.0	1.24	0.59	35.5	0.9	yes
Nanyuki 5km+	5BE20		04/11/85	7.3	0.05	27	5.0	9.00	51.2	2.80	<0.01	3.2	8.3			0:17			42	300	78.0					yes
Nanyuki	5BE20	0.901	17/12/85	7.4	0.06	36	4.0	0.90	22.0	1.00	<0.01	2.4	2.9			0.10				30	8.0					yes
Nanyuki	5BE21	0.579	17/12/85	7.5	0.05	27	3.0	0.73	19.5	0.80	<0.01	2.8	2.2			<0.10			16	5	4.8					yes
Ewaso Ngiro	5D 5		17/04/86	7.9	0.16	56	12.0	<0.30	51.2	11.0	0.19	2.6	3.5	14.0	4.0	0.62	0.01	17.0	42	50	67.0	1.53	1.22	11.4	0.7	yes
Ewaso Ngiro	5D 5		05/12/85	7.8	0.10	95	57.0	6.00	1.1	32.0	1.60	0.1	7.2	3.4		0.16			32	70	58.0					yes
Archer's Post	5E 3		03/12/86	7.0	0.16	93	8.5	0.00	82.9	13.0	0.80	4.8	4.1	15.0	6.7	0.68	0.02	10.0		brown	235	1.90	1.64	7.4	0.6	yes
Ewaso Ngiro	5E 3		11/04/86	8.1	0.31	186	29.0	<0.30	268.3	100	1.90	18.0	25.0	17.0	27.0	0.80	0.06	13.0	220		2250	8.03	5.26	20.8	0.3	yes*
Ol-Arabel	Karandi		17/04/86	8.0	0.33	198	30.0	5.00	70.7	2.50	0.23	6.3	3.7	45.0	14.0	0.55	0.01	36.0	58	5	24.0	3.03	2.14	17.3	1.8	yes
Ol-Arabel	Karandi		28/10/85	8.1	0.25	150	28.0	1.70	85.4	1.30	0.03	14.0	8.5			0.28			70	30	15.0					yes

* after treatment

** the quality of this water is not good for domestic use or irrigation

+downstream of the station

LIST OF APPENDICES, CHAPTER 5

5.1 Borehole Data from MoWD Files

5.2 Test Pump Data

APPENDIX 5.1

Borehole Data from MoWD

Appendix 5.1 Borehole data from M.O.W.D Files

BOREHOLE (Ref.No.)	LOCATION LON/LAT (degrees-minutes)	MAP SHEET 1:50,000 (Ref.No.)	TOTAL DEPTH (m)	DEPTH TO WATER LEVEL STRUCK (m)	DEPTH TO WATER LEVEL REST (m)	TESTED YIELD m^3/h	DATE OF COMPLETION (day-mo-yr
P125	3643 N13	106/3	66	23,66	15	1.64	20-01-31
P126	3708 N12	107/3	84	59	43	0.10	16-01-30
P137	3647 N22	106/2	76	40,76	27	1.64	27-06-31
P141	3648 N15	106/2	67	62	14	11.36	16-05-31
P144	3716 N12	107/4	50	-	-	-	10-06-31
P145	3628 N08	105/4	34	26	8	1.36	17-06-30
P152	3658 N04	106/4	70	46,57	43	5.45	18-07-31
P155	3647 N24	106/2	98	88	56	0.11	21-06-32
P158	3658 N02	106/4	76	58	47	-	11-08-31
P163	3703 N02	107/3	34	18	15	5.68	18-09-31
P164	3701 00	121/1	87	46,84	46	1.09	07-10-31
P167	3700 S01	121/1	64	52	43	6.55	29-10-31
P171	3649 N12	106/4	121	91	64	0.46	11-06-32
P172	3649 N25	106/2	81	50	44	4.18	03-03-32
P175	3651 N23	106/2	66	39	32	3.03	19-04-32
C0022	3707 N12	107/3	52	-	-	0.42	03-37
C0023	3707 N13	107/3	32	-	-	-	03-37
C0024	3707 N13	107/3	51	-	-	-	04-37
C0025	3708 N12	107/3	22	-	-	-	04-37
C0026	3709 N10	107/3	37	-	-	-	05-37
C0027	3708 N11	107/3	54	-	-	3.60	05-37
C0028	3708 N12	107/3	69	-	-	6.78	05-37
C0037	3628 N19	105/2	158	66	46	2.70	09-38

BOREHOLE (Ref.No.)	LOCATION LON/LAT (degrees-minutes)	MAP SHEET 1:50,000 (Ref.No.)	TOTAL DEPTH (m)	DEPTH TO WATER LEVEL STRUCK (m)	DEPTH TO WATER LEVEL REST (m)	TESTED YIELD m³/h	DATE OF COMPLETION (day-mo-yr
C0038	3630 N24	106/1	186	101,165	23	5.94	10-38
C0039	3639 N12	106/3	69	56	56	6.78	10-38
C0040	3638 N13	106/3	152	63	57	3.30	11-38
C0042	3644 N04	106/3	85	75	34	4.86	12-38
C0047	3631 N07	106/3	85	76,84	18	0.90	20-03-39
C0065	3629 N07	105/4	119	-	76	0.57	-34
C0101	3631 N11	106/3	112	111	55	9.00	06-40
C0139	3709 N09	107/3	53	32	29	2.34	06-41
C0149	3704 00	107/3	122	101	55	3.24	02-41
C0150	3717 N13	107/4	27	24	8	3.64	07-41
C0153	3714 N14	107/3	107	51,93	48	3.84	07-41
C0154	3718 N16	107/2	43	35	19	0.78	05-41
C0158	3716 N15	107/2	60	-	-	-	07-41
C0159	3712 N14	107/3	74	49	26	0.12	09-41
C0160	3712 N13	107/3	67	64	23	10.86	10-41
C0187	3705 N10	107/3	70	-	-	-	-
C0193	3707 N17	107/1	85	38,69	34	0.48	06-42
C0195	3707 N17	107/1	73	39,69	31	0.54	07-42
C0207	3710 N12	107/3	110	88	27	0.84	01-43
C0221	3714 N14	107/3	122	55,85	52	6.54	05-43
C0228	3709 N19	107/1	95	88	34	1.56	11-42
C0233	3712 N09	107/3	91	79	27	5.10	08-43
C0235	3713 N09	107/3	66	-	-	-	06-43
C0237	3640 S01	120/1	107	27,61	9	0.24	09-43

BOREHOLE (Ref.No.)	LOCATION LON/LAT (degrees-minutes)	MAP SHEET 1:50,000 (Ref.No.)	TOTAL DEPTH (m)	DEPTH TO WATER LEVEL STRUCK (m)	DEPTH TO WATER LEVEL REST (m)	TESTED YIELD m^3/h	DATE OF COMPLETION (day-mo-yr
C0241	3716 N08	107/4	122	82	21	1.08	10-43
C0244	3642 S01	120/1	131	-	7	0.54	11-43
C0283	3643 S02	120/1	58	20,49	23	12.00	12-55
C0289	3710 N14	107/3	76	37,61,73	32	3.66	11-43
C0296	3645 N06	106/3	66	66	18	5.22	04.44
C0297	3643 N12	106/3	308	59,244	50	1.14	09-44
C0308	3649 00	120/2	51	-	-	-	04-44
C0309	3649 00	120/2	134	68,72,110	17	3.54	11-46
C0337	3642 N18	107/1	236	56,186	64	1.60	27-04-45
C0342	3634 N26	106/1	111	49,110	37	13.62	04-45
C0346	3703 N17	107/1	36	7	7	0.24	06-45
C0371	3707 N23	107/1	35	18	12	1.80	06-45
C0372	3705 N23	107/1	33	17,30	16	0.48	08-45
C0373	3659 N05	106/4	59	50	50	0.54	08-45
C0382	3641 N01	106/3	152	40,97,147	66	4.80	11-45
C0395	3655 00	106/4	61	42	32	1.56	02-46
C0396	3650 00	106/4	19	9	7	0.30	02-46
C0453	3652 N07	106/4	26	18,25	13	1.62	08-46
C0490	3658 00	120/2	38	32	30	7.56	12-46
C0508	3658 S12	120/2	92	72,85	42	16.32	02-47
C0515	3645 N07	106/4	105	30,98	34	4.32	03-47
C0522	3645 S07	120/2	46	30,38	25	8.58	04-47
C0523	3707 N02	107/3	79	56,70	40	9.06	04-47
C0527	3701 N03	107/3	105	54	50	0.66	04-47

BOREHOLE (Ref.No.)	LOCATION LON/LAT (degrees-minutes)	MAP SHEET 1:50,000 (Ref.No.)	TOTAL DEPTH (m)	DEPTH TO WATER LEVEL STRUCK (m)	REST (m)	TESTED YIELD m^3/h	DATE OF COMPLETION (day-mo-yr
C0539	3658 N06	106/4	48	40	40	6.42	05-47
C0555	3649 N09	106/4	76	26,70	16	3.60	06-47
C0571	3719 N17	107/2	78	29,67	49	4.08	02-53
C0593	3652 N08	106/4	122	41,119	35	2.76	07-47
C0596	3716 N16	107/2	76	21,43,59	6	2.94	10-47
C0599	3718 N14	107/4	56	36,45	15	2.28	10-47
C0600	3718 N15	107/4	20	-	-	-	09-47
C0611	3641 N45	92/1	72	55,67	18	13.50	11-47
C0674	3710 N08	107/3	69	47	29	1.08	05-48
C0690	3655 N07	106/4	40	37	32	5.64	11-44
C0694	3705 N04	107/3	108	107	52	6.78	06-48
C0715	3658 N09	106/4	63	44	41	0.48	05-48
C0718	3658 N08	106/4	132	69,119	50	0.90	07-48
C0859	3659 S13	120/2	76	69	55	0.35	07-05-49
C0876	3647 N07	106/4	177	174,177	19	0.24	06-49
C0884	3647 S06	120/2	85	55,67	59	0.55	14-06-49
C0887	3653 S11	120/2	126	64	49	0.95	26-05-49
C0913	3622 N24	105/2	244	92,158, 239	46	2.76	04-51
C0922	3701 00	107/3	110	95	48	6.00	08-49
C0932	3643 N02	106/3	183	43,155	45	3.48	09-49
C0951	3624 N28	105/2	285	-	-	-	07-49
C0954	3650 N05	106/4	102	66,93	49	8.64	08-49
C0957	3651 N09	106/4	156	34,154	2	8.22	09-49
C1008	3638 N07	106/3	203	149	40	5.46	12-49

BOREHOLE (Ref.No.)	LOCATION LON/LAT (degrees-minutes)	MAP SHEET 1:50,000 (Ref.No.)	TOTAL DEPTH (m)	DEPTH TO WATER LEVEL STRUCK (m)	REST (m)	TESTED YIELD m^3/h	DATE OF COMPLETION (day-mo-yr
C1015	3653 S05	120/2	140	60,102,133	49	4.62	11-49
C1018	3628 N33	91/4	251	142,198,230			
				247	115	4.68	11-49
C1124	3657 S13	120/2	104	92	82	4.50	06-05
C1139	3718 N13	107/4	48	-	-	-	-50
C1140	3655 S15	120/4	122	98,119	52	6.78	07-50
C1143	3638 N05	106/3	208	131	48	2.94	08-50
C1164	3652 S12	120/2	92	44,85	37	2.63	-50
C1168	3651 S13	120/2	126	85,127	84	5.45	-50
C1217	3617 N18	105/2	111	107	98	6.82	-50
C1224	3618 N17	105/2	122	52	-	0.10	-50
C1230	3720 N12	107/4	122	58	49	1.18	-50
C1237	3630 N45	92/3	139	104,128,139	98	2.28	12-50
C1262	3720 N13	107/4	122	2.7	11	-	-50
C1360	3718 N14	107/4	81	-	-	-	09-50
C1381	3630 N08	105/4	213	31,85	30	0.48	05-51
C1397	3631 N43	92/3	259	94,106,206,			
				216,245,255	123	1.98	05-51
C1473	3632 N45	92/1	134	122	46	1.98	07-51
C1498	3705 N15	107/1	92	52,77	49	14.16	08-53
C1562	3652 S04	120/2	121	111	50	8.52	09-51
C1563	3700 S03	120/2	154	114,152	67	3.78	10-51
C1565	3644 N46	92/1	137	82	64	2.04	10-51
C1600	3646 N50	92/2	84	67	35	5.46	11-51

BOREHOLE (Ref.No.)	LOCATION LON/LAT (degrees-minutes)	MAP SHEET 1:50,000 (Ref.No.)	TOTAL DEPTH (m)	DEPTH TO WATER LEVEL STRUCK (m)	DEPTH TO WATER LEVEL REST (m)	TESTED YIELD m³/h	DATE OF COMPLETION (day-mo-yr
C1609	3631 N35	92/3	153	-	-	-	11-51
C1646	3637 N33	92/3	90	-	-	-	-
C1649	3641 N04	106/3	116	-	-	6.90	01-52
C1663	3636 N33	92/3	133	76	47	11.40	02-52
C1679	3709 N06	107/3	66	59,62	53	6.72	02-52
C1684	3643 N20	106/1	123	91,96,112	35	6.84	01-52
C1696	3649 N15	106/2	91	-	-	-	04-50
C1697	3648 N15	106/2	65	55	9	7.08	05-50
C1698	3636 N18	106/1	76	52	6	7.08	09-50
C1699	3636 N18	106/1	85	70	7	7.08	01-51
C1700	3645 N15	106/1	183	177	54	3.66	05-59
C1701	3651 N13	106/4	52	-	-	-	05-51
C1702	3649 N15	106/4	61	55	8	4.56	05-51
C1703	3650 N12	106/4	172	85,98,151,170	59	2.28	08-58
C1705	3638 N18	106/1	62	49	39	3.90	10-51
C1706	3645 N04	106/4	161	85,146	82	7.98	01-52
C1752	3643 N33	92/3	119	49,113	46	3.30	04-52
C1767	3638 N09	106/3	127	107	24	10.02	05-52
C1785	3633 N43	92/3	179	21,174	69	4.32	06-52
C1791	3646 N06	106/4	176	36	29	2.34	06-52
C1792	3638 N12	106/3	101	63,98	56	16.38	06-52
C1813	3710 N24	107/1	53	24,50	19	3.30	08-52
C1819	3637 N27	106/1	180	142,174	76	4.14	08-52
C1832	3634 N31	92/3	250	32,227	31	1.38	04-53

BOREHOLE (Ref.No.)	LOCATION LON/LAT (degrees-minutes)	MAP SHEET 1:50,000 (Ref.No.)	TOTAL DEPTH (m)	DEPTH TO WATER LEVEL STRUCK (m)	REST (m)	TESTED YIELD m^3/h	DATE OF COMPLETION (day-mo-yr
C1845	3641 N30	92/3	177	59,174	50	4.09	-52
C1882	3630 N36	92/3	264	122,262	94	4.32	11-52
C1884	3648 N48	92/2	183	100,144,155	67,85	2.52	12-52
C1895	3625 N28	105/2	239	76	63	0.90	01-53
C1896	3643 N46	92/1	104	27,99	24	11.10	01-53
C1899	3622 N14	105/4	135	64,122	48,39	3.06	01-53
C1918	3719 N15	107/2	168	85	55	0.12	02-53
C1921	3635 N21	106/1	220	30,99,119, 189,	28	6.30	03-53
C1953	3623 N02	105/4	78	63,76	27,25	1.14	04-53
C1957	3643 N22	106/1	137	136	50	3.60	01-53
C1977	3617 N23	105/2	165	127,156	79	9.54	06-53
C1980	3716 N15	107/4	107	59	57	40.62	11-54
C1984	3643 S01	120/1	70	24,55,63	18,12	5.88	06-53
C2003	3646 N02	106/4	183	46,99,157,177	24,53	3.18	08-53
C2014	3704 N15	107/1	70	65	34	0.06	-
C2023	3639 S04	120/1	55	50	43	6.48	09-53
C2027	3641 S01	120/1	211	57	-	0.36	03-53
C2036	3641 S04	120/1	61	28,116	19	0.60	09-53
C2037	3644 N29	106/1	30	-	-	-	-53
C2135	3705 N21	107/1	71	24,63	26	4.08	08-53
C2142	3647 N36	92/4	247	145,220,230	133,126	0.60	26-01-54
C2144	3617 N26	105/2	244	31,119,123, 233	44	0.90	01-54
C2188	3701 N22	107/1	153	109,142	43	3.24	03-54
C2189	3659 N10	106/4	98	76	-	0.36	04-54

BOREHOLE (Ref.No.)	LOCATION LON/LAT (degrees-minutes)	MAP SHEET 1:50,000 (Ref.No.)	TOTAL DEPTH (m)	DEPTH TO WATER LEVEL STRUCK (m)	DEPTH TO WATER LEVEL REST (m)	TESTED YIELD m^3/h	DATE OF COMPLETION (day-mo-yr
C2190	3619 N27	105/2	244	93, 156	-	-	04-54
C2218	3616 N03	105/4	213	34,168,204	35	1.98	05-54
C2249	3654 00	106/4	212	152,204	43	13.62	08-54
C2258	3623 N13	104/4	68	49	26	3.60	06-09-54
C2259	3648 N37	92/4	110	90,110	73	2.70	08-54
C2277	3700 N03	107/3	148	88,99,148	81,66,83	5.94	10-54
C2280	3636 N31	92/3	110	98	49	13.08	10-54
C2285	3623 N13	105/4	165	7,73,110,152	53	5.50	15-10-54
C2314	3715 N07	107/4	92	31,85	31,27	1.44	11-54
C2315	3713 N05	107/3	71	46,65	32	10.92	11-54
C2316	3715 N07	107/4	46	24	14	14.52	12-54
C2318	3626 N31	91/4	152	109,137	70	13.20	01-55
C2328	3658 S11	120/2	113	76	67	12.73	-55
C2345	3657 S14	120/2	114	76	73	10.91	-55
C2349	3647 S04	120/2	107	24,59	17	6.37	-55
C2354	3630 N40	91/4	158	79,137	61	6.84	03-55
C2363	3650 N01	106/4	164	67,128	67,65	0.84	02-55
C2369	3648 S06	120/2	157	79,120,133	53	5.68	-55
C2375	3657 N09	106/4	128	69,72	61	1.68	01-55
C2381	3624 N08	105/4	160	82,142	24	5.50	16-06-55
C2400	3641 N39	92/3	155	58,143	50,67	5.46	06-55
C2401	3625 N06	105/4	106	-	0	-	09-06-55
C2405	3625 N05	105/4	72	-	0	-	05-07-55
C2414	3650 N02	106/4	317	77	72	0.12	08-55

BOREHOLE (Ref.No.)	LOCATION LON/LAT (degrees-minutes)	MAP SHEET 1:50,000 (Ref.No.)	TOTAL DEPTH (m)	DEPTH TO WATER LEVEL STRUCK (m)	DEPTH TO WATER LEVEL REST (m)	TESTED YIELD m^3/h	DATE OF COMPLETION (day-mo-yr
C2446	3656 N08	106/4	144	-	-	-	11-55
C2463	3650 N45	92/4	107	67,99	46	-	10-55
C2479	3640 S01	120/1	142	55	23	0.30	02-56
C2506	3645 N01	106/4	244	97	89	0.84	04-55
C2509	3648 N02	106/4	119	24,70	17	14.04	03-56
C2561	3646 N10	106/4	92	37,81	37	9.06	06-56
C2562	3648 N11	106/4	213	52,146,202,204	45,62	13.62	09-56
C2574	3627 N24	105/2	279	266	73	2.82	10-56
C2576	3702 N02	107/3	146	52, 63,75,128	40	9.06	10-56
C2594	3650 N07	106/4	84	51,76	41	9.06	10-56
C2595	3645 N02	106/3	172	27,38,164	20,44	10.92	11-56
C2597	3712 N10	107/3	107	52,59	44	0.60	11-56
C2633	3656 N26	106/2	61	55	26	1.14	11-56
C2634	3647 N06	106/4	283	44,277	51	1.56	02-57
C2676	3652 N40	92/4	125	27,116	-	2.40	05-57
C2691	3623 N14	105/4	76	70	0	4.50	03-07-57
C2727	3631 N21	106/1	179	73,104,176	60	3.78	11-57
C2750	3652 N41	92/4	160	73,116,133	49,44	3.00	05-58
C2803	3659 N07	106/4	92	35,58	32	1.32	05-58
C2805	3635 N29	106/1	194	58,140,172	49,40,55	11.88	07-58
C2816	3624 N02	105/4	18	18	5	4.60	16-07-58
C2833	3630 N25	105/2	282	76,256	85	9.48	10-58
C2844	3630 N38	91/4	286	152,165,196,275	143, 135, 141,162	6.72	12-58

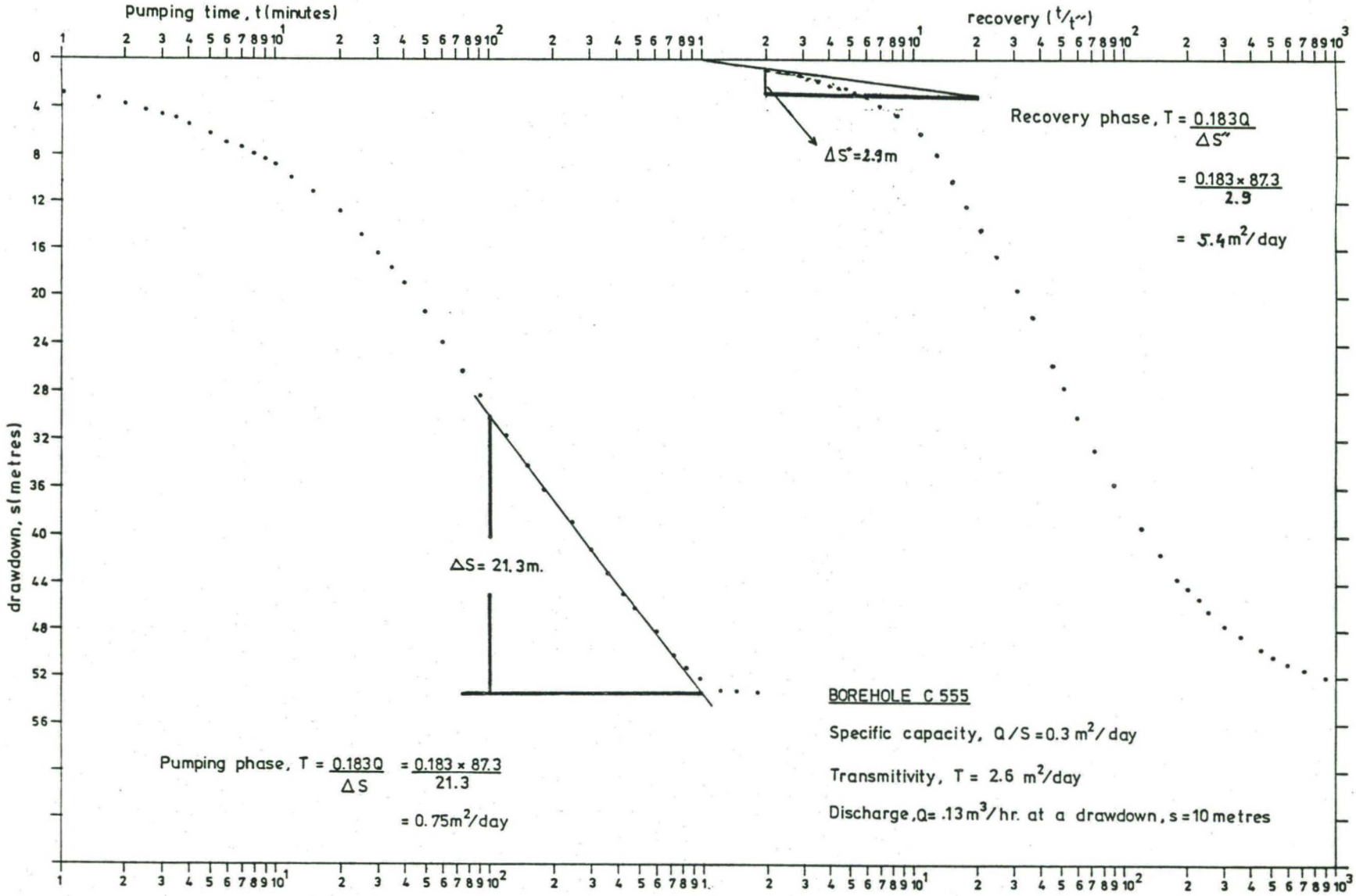
BOREHOLE (Ref.No.)	LOCATION LON/LAT (degrees-minutes)	MAP SHEET 1:50,000 (Ref.No.)	TOTAL DEPTH (m)	DEPTH TO WATER LEVEL STRUCK (m)	REST (m)	TESTED YIELD m³/h	DATE OF COMPLETION (day-mo-yr
C2854	3621 N12	105/4	96	43,79	40	8.60	12-12-58
C2858	3624 N13	105/4	107	17,41,50,105	12	9.00	02-59
C2889	3634 N13	106/3	238	123,214	80,69	10.14	03-59
C2895	3636 N24	106/1	122	37,105	46,49	5.64	04-59
C2898	3651 N11	106/4	182	39	38	-	03-59
C2904	3628 N29	105/2	118	24	12	0.12	04-59
C2969	3623 N02	105/4	34	-	4	-	
C2998	3657 N27	106/2	123	-	-	0.12	02-60
C3014	3656 N26	106/2	43	34	34	5.40	02-60
C3022	3715 N16	107/2	98	56,58	75,56	1.20	04-60
C3023	3721 N16	107/2	78	36,52	27	4.50	04-60
C3054	3624 N12	105/4	92	18,85	15,21	2.94	08-60
C3055	3636 N47	92/1	92	31,79	27	14.16	08-60
C3057	3635 N35	92/3	196	99,193	54,64	5.94	02-60
C3077	3717	107/4	99	13,96	7,6	1.23	28-07-60
C3078	3617 N14	107/4	126	-	-	-	-60
C3098	3631 N26	106/1	244	76,238	56,101	11.28	12-60
C3115	3624 N27	105/2	305	183	122	0.24	03-61
C3119	3629 N33	91/4	235	76,152,221	61,68	5.52	04-61
C3122	3633 N35	92/3	155	96,149	24,15	11.70	05-61
C3200	3640 N34	92/3	138	59,122	35	12.60	07-62
C3201	3645 N32	92/3	159	91, 122, 155	73,46	2.58	10-62
C3215	3642 N29	106/1	198	69,183	3,9	2.28	12-62
C3310	3714 N13	107/3	152	79,95,110	76,79,69	8.88	09-64

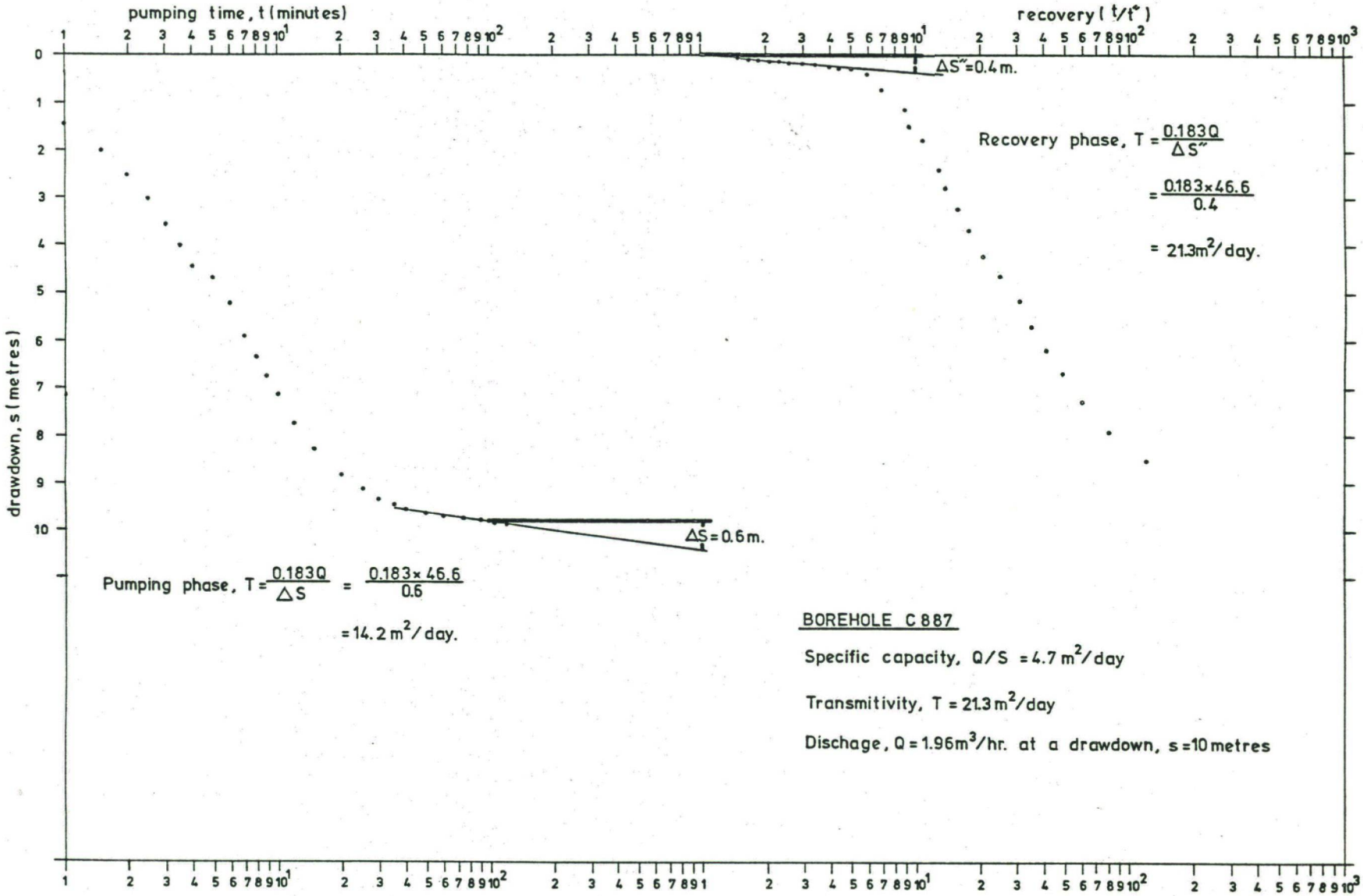
BOREHOLE (Ref.No.)	LOCATION LON/LAT (degrees-minutes)	MAP SHEET 1:50,000 (Ref.No.)	TOTAL DEPTH (m)	DEPTH TO WATER LEVEL STRUCK (m)	REST (m)	TESTED YIELD m^3/h	DATE OF COMPLETION (day-mo-yr
C3316	3712 N12	107/3	64	27	-	0.12	10-64
C3413	3643 N42	92/3	177	79,146	24,37	4.50	10-66
C3420	3701 N29	107/1	119	95	23	4.32	-
C3430	3659 N32	92/4	168	46,152	30	0.42	03-67
C3434	3658 N30	106/2	91	46,67,88	39	3.66	04-67
C3450	3712 N29	107/1	100	58,82	47	8.16	06-67
C3533	3641 N44	92/3	125	20,113	6,12	8.16	12-68
C3555	3704 N18	107/1	148	61,91,140	24,22	2.58	03-69
C3563	3648 N18	106/2	68	42,58,63,67	33,34	9.12	04-69
C3670	3640 S01	120/3	213	56,234,243,268	66,127, 82	0.03	29-04-70
C3672	3617 N19	105/2	104	21,43	4	-	06-70
C3704	3641 S02	120/1	33	7,14,22	3	0.76	-
C3761	3629 N26	105/2	258	128,223	115	-	07-71
C3857	3700 N01	107/3	152	61,121	59	-	08-72
C3916	3617 N20	105/2	132	22,87,101,119,	50	5.45	30-08-70
C4180	3619 N03	105/4	107	84	19.4	13.2	29-10-75
C4683	3651 N01	106/4	213	47,199	37	5.46	-70
C4684	3645 00	106/3	165	70,97	50.4	10.91	28-09-79
C4724	3648 N05	106/4	250	50,110	36,74	6.82	16-01-80
C4725	3649 N06	106/4	286	110,266	74.91	2.73	15-01-80
C4726	3651 N05	106/4	90	58,85	50,44	12.55	07-02 80
C4727	3658 N04	106/4	82	68,78	51.2	4.55	24-02-80
C4737	3648 N05	106/4	230	74,184	70,87.3	3.60	29-03-80

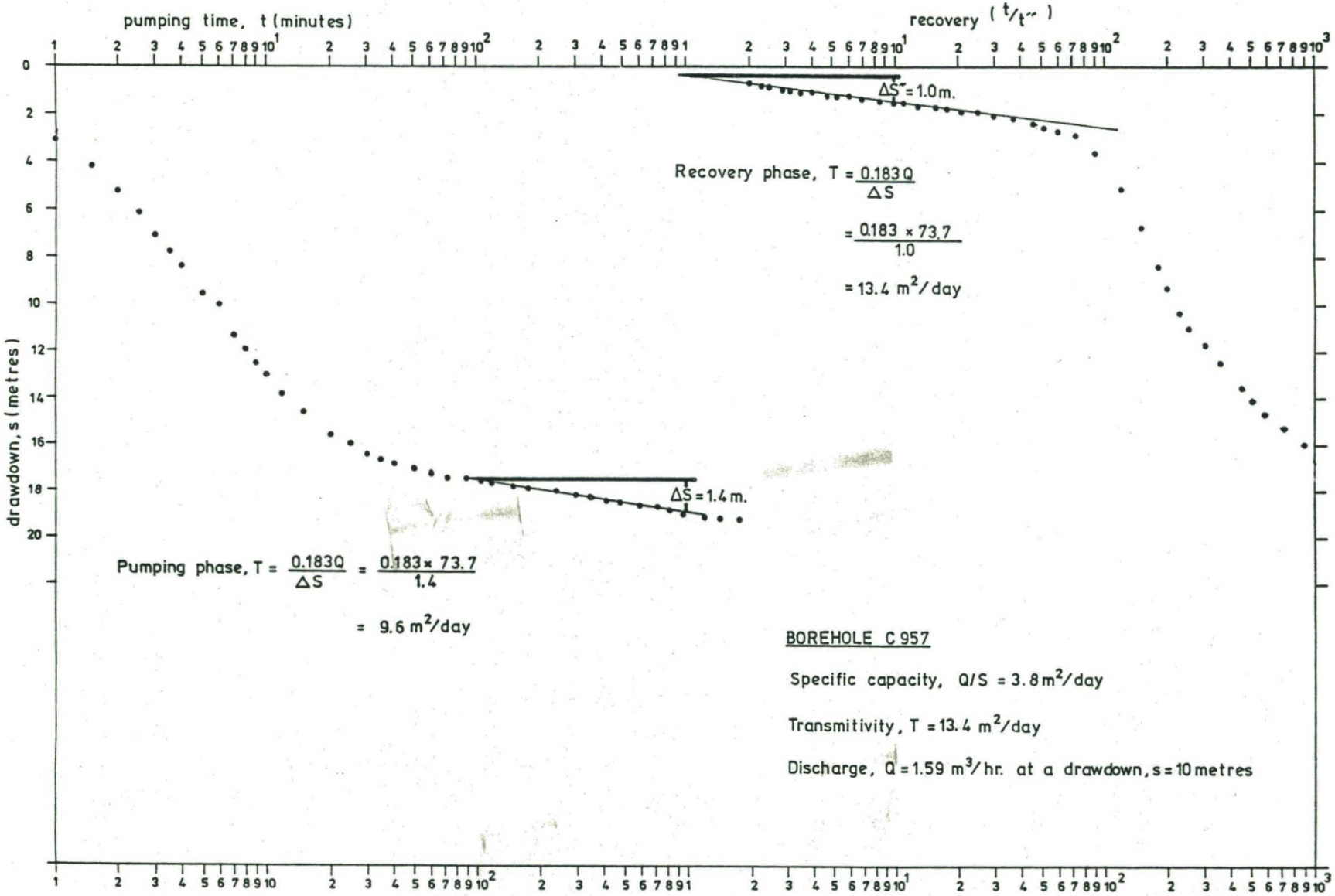
BOREHOLE (Ref.No.)	LOCATION LON/LAT (degrees-minutes)	MAP SHEET 1:50,000 (Ref.No.)	TOTAL DEPTH (m)	DEPTH TO WATER LEVEL STRUCK (m)	REST (m)	TESTED YIELD m^3/h	DATE OF COMPLETION (day-mo-yr
C5019	3702 N02	107/3	180	40,100	40.42	0.05	11-11-80
C5069	3619 N27	105/2	154	20,128	1.95	9.86	30-04-82
C5139	3718 N21	107/1	100	85	6.4	0.48	17-11-82
C5140	3717 N18	107/1	72	42,46,50	?		
C5197	3710 N22	107/1	NO INFORMATION HAS BEEN RECEIVED				
C5360	379 N24	107/1	63	20	5.9	5.94	28-06-83

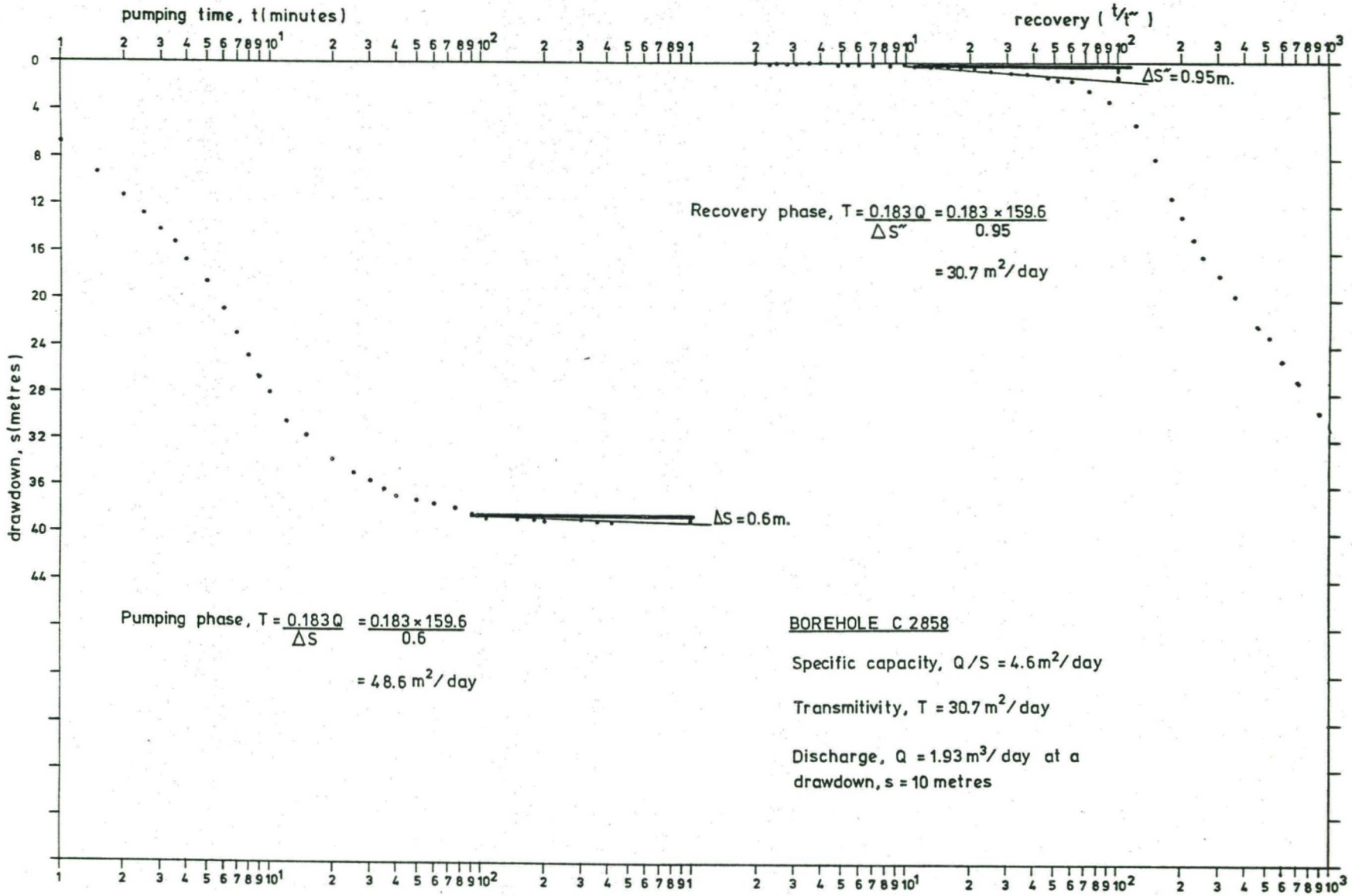
APPENDIX 5.2

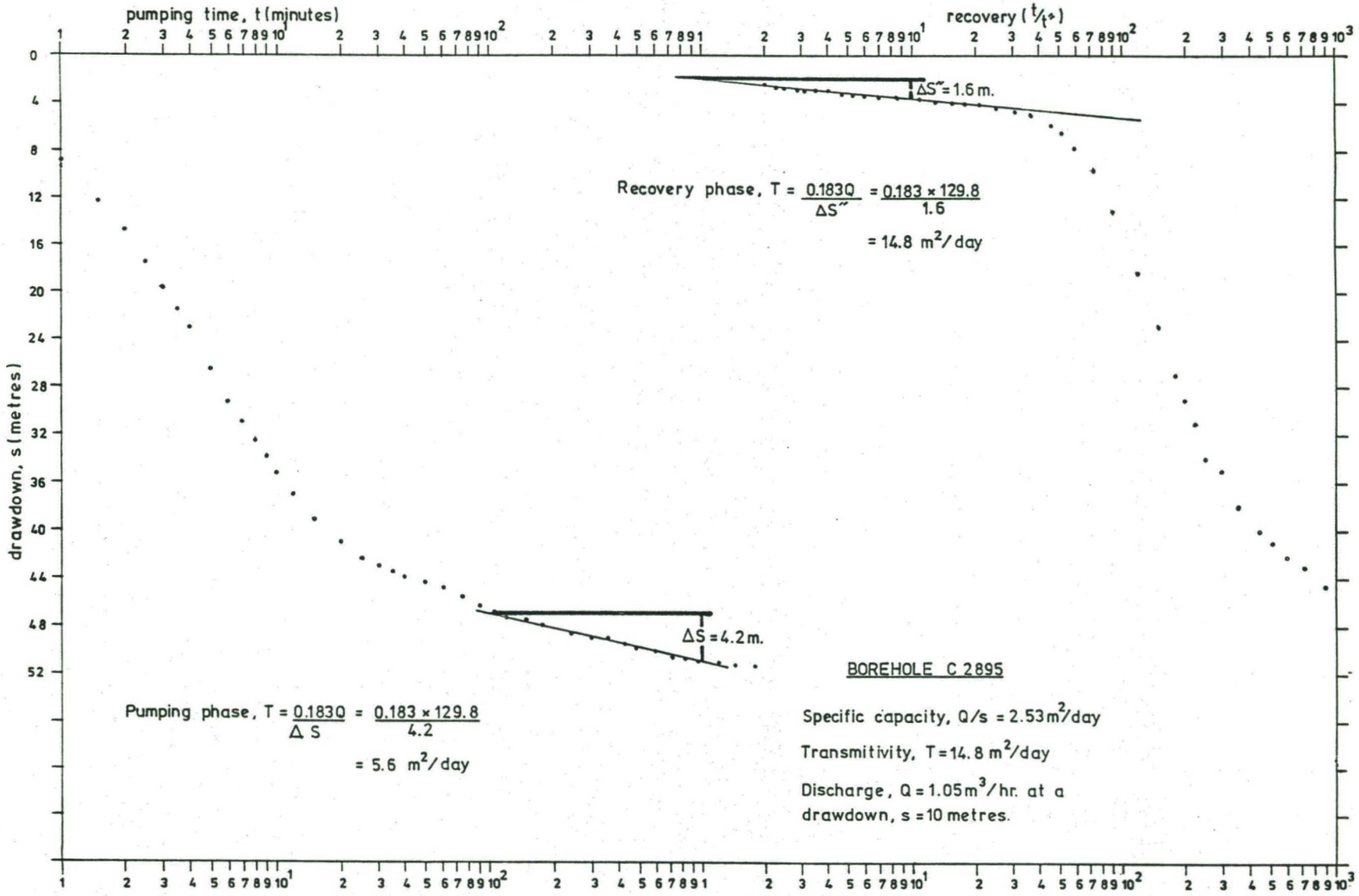
Test Pump Data


Pumping time, t (minutes)
recovery (t/t')
drawdown, s (metres)
Recovery phase, $T = \frac{0.183Q}{\Delta S'}$
$= \frac{0.183 \times 87.3}{2.9}$
$= 5.4 m^2/day$
$\Delta S' = 2.9m$
$\Delta S = 21.3m.$
Pumping phase, $T = \frac{0.183Q}{\Delta S} = \frac{0.183 \times 87.3}{21.3}$
$= 0.75 m^2/day$
BOREHOLE C 555
Specific capacity, $Q/S = 0.3 m^2/day$
Transmitivity, $T = 2.6 m^2/day$
Discharge, $Q = .13 m^3/hr.$ at a drawdown, $s = 10$ metres


pumping time, t (minutes)
recovery (t/t')
drawdown, s (metres)
ΔS''=0.4 m.
Recovery phase, T = 0.183Q / ΔS''
= 0.183×46.6 / 0.4
= 21.3 m²/day.
ΔS = 0.6 m.
Pumping phase, T = 0.183Q / ΔS = 0.183×46.6 / 0.6
= 14.2 m²/day.
BOREHOLE C 887
Specific capacity, Q/S = 4.7 m²/day
Transmitivity, T = 21.3 m²/day
Dischage, Q = 1.96 m³/hr. at a drawdown, s = 10 metres


pumping time, t (minutes)
recovery (t/t')
drawdown, s (metres)
ΔS = 1.0 m.
ΔS = 1.4 m.
Recovery phase, T = 0.183Q / ΔS
= 0.183 × 73.7 / 1.0
= 13.4 m²/day
Pumping phase, T = 0.183Q / ΔS = 0.183 × 73.7 / 1.4
= 9.6 m²/day
BOREHOLE C 957
Specific capacity, Q/S = 3.8 m²/day
Transmitivity, T = 13.4 m²/day
Discharge, Q = 1.59 m³/hr. at a drawdown, s = 10 metres


pumping time, t (minutes)
recovery (t/t')
drawdown, s (metres)
ΔS' = 0.95m.
ΔS = 0.6m.
Recovery phase, T = 0.183 Q / ΔS' = 0.183 × 159.6 / 0.95
= 30.7 m²/day
Pumping phase, T = 0.183 Q / ΔS = 0.183 × 159.6 / 0.6
= 48.6 m²/day
BOREHOLE C 2858
Specific capacity, Q/S = 4.6 m²/day
Transmitivity, T = 30.7 m²/day
Discharge, Q = 1.93 m³/day at a drawdown, s = 10 metres


pumping time, t (minutes)
recovery (t/t')
drawdown, s (metres)
ΔS" = 1.6 m.
Recovery phase, T = 0.183Q/ΔS" = 0.183 × 129.8/1.6
= 14.8 m²/day
ΔS = 4.2 m.
Pumping phase, T = 0.183Q/ΔS = 0.183 × 129.8/4.2
= 5.6 m²/day
BOREHOLE C 2895
Specific capacity, Q/s = 2.53 m²/day
Transmitivity, T = 14.8 m²/day
Discharge, Q = 1.05 m³/hr. at a drawdown, s = 10 metres.

LIST OF APPENDICES, CHAPTER 6

6.1 Water Supplies in Laikipia District

APPENDIX 6.1

Water Supplies in Laikipia District

APPENDIX 6.1 WATER SUPPLIES IN LAIKIPIA DISTRICT.

NR	RANCH OR WATER SUPPLY	DIVISION	WATER SOURCE(S)	ABSTRACTION		NO OF PEOPLE	CATTLE HEADS	SHEEP & GOATS	DEMAND M³/DAY	EXPANSION PLANS	PROBLEMS & REMARKS
				M³/DAY	METHOD						
1	Marmanet W/S (MoWD)	Ng'arua	Ewaso Narok	2055	Gravity	50,000			3,000	Minor	Under Staffing
2	Naibor Springs	Rumuruti	1 spring (21/sec) = (173 M³/day)								
			3 boreholes	173	Gravity: Pumps	50	7,000	5,000		None	None
			6 dams								
3	Mugie Ltd (Suguta Mugie (18,225 Ha)	Rumuruti	1 spring (0.05 l/s)	4.32	Pumps	200	4,500				
			3 other springs	3.24	Gravity		(currently only 2,000)	1000		None	Improvement on wells did not improve yield
			1 borehole								
4	Luoniek LMD Holding ground		C1237 depth-138.68m Yield-3.64 m³/hr	43.6	Pump		5,000			None	No treatment
	(21,060 Ha)	Ng'arua	C1473 depth - 134.1m yield - 319m³/hr	38.2	Pump	140	currently 2,000				of water necessary
			C1785 depth - 178.9m yield-2.73m³/hr	32.7	Pump						
5	Ngarua Spring	Ng'arua	Spring well			30	10	30		Replacement of pump necessary	No pump

NR	RANCH OR WATER SUPPLY	DIVISION	WATER SOURCE(S)	ABSTRACTION		NO OF PEOPLE	CATTLE HEADS	SHEEP & GOATS	DEMAND M³/DAY	EXPANSION PLANS	PROBLEMS & REMARKS
				M³/DAY	METHOD						
6	Ng'arachi farmers scheme - Ngarua	Ng'arua				5000	1500	5000		None	silting at the intake water not treated
7	Kinamba (police station & Kinamba Health Centre)	Ng'arua	Borehole C5069		Electric pump	30 (Health centre and 50 police station			0.1 (for Health centre)	Bigger storage tanks in construc-tion but expansion is not in the near future Replace-ment of one generator necessary	Lack of piping net-work water goes to police stan. and Kinamba Health Centre One generator not working. A second one working but rather too small.
8	Sipili (Mutukanio Farming co.)	Rumuruti	Borehole C913	10 (during dry weather) but 12 on average	pump	400	1000	3000		Extensions: Kaharati, Lereshwa and Line Nursery School	Salinity of water and difficulty in pumping due to air during the dry season
9	Ndurumo/ minjore (Ndurumo centre Minjore centre Mithuri Centre)	Rumuruti	C2574 TD-279M WSL-266M WRL-73M pump intake-195 capacity-2.8 m³/hr Head-207m	55.2 and 124.8	pump					Project still under construc-tion	

NR	RANCH OR WATER SUPPLY	DIVISION	WATER SOURCE(S)	ABSTRACTION		NO OF PEOPLE	CATTLE HEADS	SHEEP & GOATS	DEMAND M^3/DAY	EXPANSION PLANS	PROBLEMS & REMARKS
				M^3/DAY	METHOD						
	C3761 TD - 258m WSL - 128m WRL - 115m pumpintake -193 capacity -5.2 m^3/hr Head-27m										
10	Ol Maran Water Supply (Ol Maran centre Merg-wet settlement	Ng'arua	Borehole	68.25	pump	2000	4000	12,000		None	Frequent pump break-down and lack of diesel, water treat-ment not necessary
11	Nyahururu Town Water Supply (Nyahururu Municipal Council The town supplies Maina village and Ndurumo Secondary School which are in Laiki-District)	Rumuruti	Ewaso Narok River			10,000			16.7 for (Ndurumo Sec. School)	None	Frequent disconnec-tions due to inability of the maina village residents to pay for water. Forest Station water not treated but that of maina village treated
12	Well mount spring (Lashou-Pondo Self Help Project	Rumuruti	Spring							None	

NR	RANCH OR WATER SUPPLY	DIVISION	WATER SOURCE(S)	ABSTRACTION		NO OF PEOPLE	CATTLE HEADS	SHEEP & GOATS	DEMAND M³/DAY	EXPANSION PLANS	PROBLEMS & REMARKS
				M³/DAY	METHOD						
13	AHITI Nyahururu (AHITI-Ministry of Agriculture and Livestock Development)	Rumuruti	Spring		Gravity then Pumping to houses	500	200	200 (50 pigs 500 hens 50 rabbits)		Another spring to be tapped to supplement present resources	During drought water shortage occur
14	Njonjo Girls High School (30.4 Hectre, 6.08 Hectres in use currently	Rumuruti	Spring		Pump (diesel)	330	25			School to be included in Nyahururu water supply scheme	Pump breaks down after due to its small size water not treated
15	Nyahururu settlement scheme water project (49 km²)	Rumuruti	Equator River Dam - 2 big - 2 small (seasonal)	3	Gravity then pump	6350	2200 (1979) 1600 (1973)	4000 (1973)	485	None	Number of users in 1975 the figure is expected to rise to 8500. The water demand in 1979 was 395 m³/day. It is expected to be 590 M³/day by the year 1995.
16	Nyakairu Water Project (25km²)	Central	Ontulili River		Pump		4000 animals			None	Project when complete will serve 10,000 people

NR	RANCH OR WATER SUPPLY	DIVISION	WATER SOURCE(S)	ABSTRACTION		NO OF PEOPLE	CATTLE HEADS	SHEEP & GOATS	DEMAND M^3/DAY	EXPANSION PLANS	PROBLEMS & REMARKS
				M^3/DAY	METHOD						
17	Tigithi Water Project		Naro Moru River		Pump	2460	300	100	151	None	Ultimate water demand expected to rise to about 201 m^3/day.
18	Rumuruti Water Supply (Rumuruti Town)	Rumuruti	Ewaso Narok River		Pump					Extension anticipated and to be merged with marmanet W/S	Water partially treated serves for domestic use and live-stock
19	Sosian Farm (Suguta Naibor farm) (12, 150 Ha)	Rumuruti	Narok River Spring Furrow (MoWD) 3 dams 2 boreholes C ..... depth-79.3M yield-2.28m^3/hr		Pumps	600-650	2000	2000		None	Furrow is bushy and boreholes need atten. water not treated
20	Ol Maisor Ranch	Rumuruti	Narok River Narok Channel = 50 small dams Boreholes (3) only one in use	1820m^3 (from river) 1820m^3 (from channel	pumps	500 (1979)	2500	5,000 (500 camels) (15 horses)	9.1 (domestic from river)	None	Water for domestic use is from the river; permits only allow 1820m^3 from river 1820m^3 from the channel for irrigation water is insufficient only during dry season pump thefts is also another problem

NR	RANCH OR WATER SUPPLY	DIVISION	WATER SOURCE(S)	ABSTRACTION		NO OF PEOPLE	CATTLE HEADS	SHEEP & GOATS	DEMAND M^3/DAY	EXPANSION PLANS	PROBLEMS & REMARKS
				M^3/DAY	METHOD						
22	Narok Ranch (12,555 Ha)	Rumuruti	3 boreholes but only 2 are working Narok channel 1 small dam operational		pumps	60	3000-4000	800		Expansion plans under way	Blockages and sedimentation in the dam and also weeds, bush in furrow
21	Maundu ni meri Ranch	Rumuruti	Aiyam River Narok Furrow Dam (not used often 2 B.Hs		Pump (missing from 1 Bh) small containers		300	1500		Expansion plans anticipated in the near future	One borehole lacks a pump while the other has a pump but pipes are spoilt water is not treated. The Water from Aiyam is brackish used for livestock only
22	Kiyo Ranch (752 Ha	Rumuruti	Narok furrow	0.75 for cattle dip per week 3m^3 per week for domestic use toal about 0.54 m^3/day	pump	30	500	850		Expansion plans for irrigation are underway (81hectres	The furrow gets silted
23	Two Rivers Ranch (7290 Ha)	Rumuruti	2 dams (1 big) 1 small) 2 small permanent streams 2 boreholes		Pumps (not from dams)	30	730	650		None	One borehole not operating but could be repaired water is abit salty Boreholes pumped 3 days aweek for

NR	RANCH OR WATER SUPPLY	DIVISION	WATER SOURCE(S)	ABSTRACTION		NO OF PEOPLE	CATTLE HEADS	SHEEP & GOATS	DEMAND M³/DAY	EXPANSION PLANS	PROBLEMS & REMARKS
				M³/DAY	METHOD						
	Two Rivers Ranch (continued)										about 2 hrs. per day On dry years the pumping is for 10hrs /day throughout the week
24	Ol Doinyo Lemboro (4050 Ha)	Rumuruti	Engare Narok River	21.84	pump	70	1000	2000			During dry weather water is pumped daily for about 6 hours on other days its pumped for 1 hour every 3 days water-not treated we have minor irrigations for fruits and vegetables
25	Kisima Farm Ltd. (17,820 Ha)	Rumuruti	Ewaso Narok River =15 dams 2275 Boreholes	982.8	pump	115	2800	6000 (150 camels)		None	Ewaso Narok river almost dries during dry season. The dams vary in capacity from 22750m³- 227500m³ All the boreholes are in working condition
26	Colcheccio Ranch (6885 Ha)	Central	Narok Channel 5 Dams 3 boreholes		Gravity Pumps	400	3361 (9horse)			Expansion for irrigation planned	Water slightly brackish but not treated

NR	RANCH OR WATER SUPPLY	DIVISION	WATER SOURCE(S)	ABSTRACTION		NO OF PEOPLE	CATTLE HEADS	SHEEP & GOATS	DEMAND M^3/DAY	EXPANSION PLANS	PROBLEMS & REMARKS
				M^3/DAY	METHOD						
27	Swamp Farm (1814.4 Ha)	Rumuruti	Narok River Pesi River Water holes in swamp		Pumps	60	575 (normally 750)	400		Expension for irrigation for farming	No treatment people beginning to cultivate in swamp interfering with the water resource
28	Thome 4 (14175 Ha)	Rumuruti	Pesi furrow 5 Dams 4 boreholes	small containers						None	All the 4 BHs in the area not being used (but not broken down. Water not treated.
29	Lombala Farm (3240 Ha)	Rumuruti	Pesi River 2 Dams (Roof Catchment)	Pumped into 2 tanks of 45.5 m^3 12hrs. each day: about $13m^3$/day: for some days of week							
30	Agricultural Developed Cooperation (ADC) Mutara Ranch (25656.8 Ha)	Rumuruti	Mutara River Pesi River Suguroi River (seasonal) Dam 13 Boreholes (3 wind pump) (10 diesel engine)		Pump	350	7000	1000		None	No pump for dam and it dries in dry weather BH water brackish irrigation upstream needs checking
31	Kiamariga (101.3 Ha)	Rumuruti	Mutara River		gravity for irrigation	=560				There is room for expansion of irrigation scheme	Domestic water is in plan stage with a pump already acquired.

NR	RANCH OR WATER SUPPLY	DIVISION	WATER SOURCE(S)	ABSTRACTION		NO OF PEOPLE	CATTLE HEADS	SHEEP & GOATS	DEMAND M^3/DAY	EXPANSION PLANS	PROBLEMS & REMARKS
				M^3/DAY	METHOD						
32	Wiyumiririe Farmers Cooperative Society (former Deigitton Down Farm)	Central	Suguroi River 10 dams (3 large ones, 7 small ones) A few springs pesi River		small containers	12500	=7200	14000		None	There are 3 cattle dips in operation but one more to be built in near future. about Ksh.100,000 already collected for a water project. Available water is seasonal and polluted water not treated
33	Nanyuki Town Water Supply (Owned by Nanyuki Municipal council)	Central	Nanyuki River	2836 m^3/day (of this 1256 m^3/day for Army 250 m^3/day Airforce	gravity pump (to Army camp)	18000			3,000	None	The projected population is 41,000 by the year 1995 For storage we have mountex having 45m^3 Army reservoir 1490m^3
34	Kuri kuri well	Mukogodo	Well		Handpump					None	Pump is out of order removed by ministry staff. The well has water but its dirty water is not treated
35	Lariakorok Dam	Mukogodo	surface catchment							None	The dam is dry due to erosion of the spill way causing draining of the

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				M³/DAY	METHOD						
	Lariakorok Dam (continued)										water. The dam is reparable
36	Lariakorok wells	Mukogodo	well							None	Burried by the recent rains. People get water by scooping in the sands
37	Aljijo supply	Mukogodo	Borehole C5140		Pump					None	The water supply under construction but almost complete livestock not using the water at present.
38	Upper Sepeyo Dam (0.1 Ha in size)	Mukogodo	Dam		Drawing contains (local)	50 manyatas about 500 people	3000 (500 donkeys)	6000		None	Dam is not fenced hence animals get in. The water only lasts about 4 months whereby the people scoop in the sand for water. Water quality not satisfactory and is not treated

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				M³/DAY	METHOD						
39	Anandanguru	Mukogodo	Borehole C5139 Hand-dug well nearby Depression in the sandy riverbed nearby		Hand-pump local drawing material (pots)	=500	=1000	=7140		Plans to improve the borehole to pump water to the camp are underway	Handpump is broken down. Well water is dirty. Tank for forestry staff under construction by their Ministry. capacity 1365m³ Animals get water directly from river bed
40	Alkinyei	Mukogodo	Well, Borehole (C5197)		Pump	120	100	1000		None	Well drilled in 1982 but equiped with an electric diesel pump in 1986. The cattle herds rises to about 300-400 during a good year while goats and sheep rise to about 3000 well water is dirty and the borehole is yet to be completed 9.1m³ tank constructed
41	Dol Dol Dam (MoWD)	Mukogodo	Dam			1500	10,000	18,000		None	Water is not treated and its dirty, the dam is seasonal 6-9 months since its heavily

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				M³/DAY	METHOD						
	Dol Dol Dam (continued)										silted and and bushy
42	Dol Dol BH	Mukogodo	Borehole C1813		Pump	3500	500	2,000		None	Water is brackish water level in borehole goes very low during very dry season.
43	Mukima Farm (Nanyuki) (1935.9 Ha)	Central	Liki River and Ontulili River		gravitational (furrow) local/ drawing material (pots) pipes (few areas)	220	800	1600		Water Project proposed and to be implemental in 2-3 years time	Water is not treated. Water from furrow is not enough but it could be increased
44	Kimuri Farm (2025 Ha)	Central	Nanyuki River		Pump	60	400	250		extension possibility for irrigafter subdivision of land	Water is not treated

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				M³/DAY	METHOD						
45	Naibor shopping Centre (Primary school) (121.5 Ha)	Central	Nanyuki River		local drawing materials (pots)	50				Proposed extension of School into out-span but not the market	Water is dirty and better abstraction methods required water used by school only Market has a projected population of about 10,000 in the next 20 years.
46	Loldoto Farm (1458 Ha)	Central	Nanyuki River 2 boreholes (not working)		Pump	30	400			None	The water is not treated and the level is usually very low pumping is not done continuously but every other day.
47	Druids Osoitoitashe Dam under construction by MoWD Nanyuki)	Mukogodo	Sinyai River bed		Gravity					None	Dam under construction is meant to reduce the nomadic movements of the people. It will cover 6 km²
48	Musul Rock Catchment	Mukogodo	Rock catchment and masonary storage tank (MoWD)	15.93m³ for cattle dip, filled once a							

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				M^3/DAY	METHOD						
	Musul Rock catchment (continued)			week storage tank holds 273 m^3 (still small)	pump	over 500	1000	4000		None in 6 km	Water used radius and is not treated storage not sufficient
49	Ol Kimanjo water supply (Laikipia county council)	Mukogodo	Borehole C3420	Pumped 8hrs. a day into two tanks 136.5m^3 891m^3 cattle dip uses 36.4m^3 per week	Pump	2000	9000 (300 donkeys)	20,000		None	Water used in 10 km radius its brackish no treatment necessary Kijabe dam dries after 3 months. So the borehole helps the people from near the dam
50	Lobor Soit Dam (On Tiamomut River) (0.203 Ha)	Mukogodo	Dam (On Tiamoumut River)	Water drawn in contai-ners							
51	Tura rock catchment	Mukogodo	Rock Catchment		Water drawn in con-tainer	200	300	1000		None	The water supply not popular maybe due to broken tap handle Tanks retain-ing wall is 3.05m and has capacity of 91m^3 Tank about 1/10full
52	Tiamamut Rock Catchment	Mukogodo	Rock Catchment		Water drawn in con-tainers	=30	= 500	=1500		None	Storage tank about 182 m^3 (constructed 1976). Rock catchment sufficiently large.

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				M³/DAY	METHOD						
53	Osoit Oudo Rock Catchment	Mukogodo	Rock Catchment		Water drawn in containers	20 manyattas 200 people				None	Storage about 182 m³ Water not treated and dries up
54	Makulian	Mukogodo	Borehole C2135		Pump					None	Had a wind pump but broken down There is a masonary water tank nearby
55	Daraja ya Mungu sub-surface Dam (1m high)	Mukogodo	Dam		containers (pots) water is from the sand		300 50 donkeys	2000		None	Dam filled with sand. people scoop out the sand to get water both for livestock and domestic use. Better wells can be dug along the banks and culvert linings. No suitable method for abstraction
56	Catholic Mission Dol Dol	Mukogodo	Borehole C5360 depth 61.5m water rest level 5.5m Dynamic level -13-14m (pumped at 60l/min) pump:3.7m³/h head 90m	10.8	Pump (submersible electric	250				None	The water is slightly alkaline and organically polluted. No treatment done water is pumped for 3 hours each day. In 1987, 50 more

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	Catholic mission Dol Dol (continued)										students. In four years time 200 students and 15 teachers more expected the Alkalinity causes corrosion of metal parts.
57	Impala farm (20250 Ha)	Central	Ngare Ngiro R. (main) Ewaso Ngiro R. 4 Dams (2 permanent)	54.6 (from Ngare Ngiro River)	Pump	250	4000 (20 horse) (=750 elephants 1000 buffalos 2000-3000 other wild animals			None	Water is not treated. water has become scarce hence there is need to control water usage upstream
58	01 Jogi Ranch Ltd (21465 Ha)	Central	Nanyuki River Ewaso Ngiro 2 boreholes (poor yields) several Dams (=18, target 36) (largest about 2.43 Ha)	68.3 one pump for livestock and domestic)	Pumps (3 working 1broken down)	800	1100 (53 camels) (6000 wild animals)			Irrigation expansion for cattle food and subsistance crops proposed	Water treated at main pumping complex water level at times very low due to illegal abstraction
59	Mogwooni Ranch	Central	Nanyuki River 2 dams	49-57	Pump	177	1500-1600 (12 horses)	900		Expansion plans for irrigation (30.4 Ha)	The dams dry up during severe dry weather. The water is not treated and is usually very low

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60	Naibor Farm (2673 Ha)	Central	Nanyuki River Ewaso River	45.5 m³ week; tank filled once per week	pump	30	600	1000		No major expansion plans underway but may be irrigation for about 3 acres for vegetables (domestic) in 2-3yrs.	Water is not treated and gets low during the dry weather storage tank of a capacity of 45.5 m³ and is filled once a week
61	Suguroi Ranch (4009.5 Ha)	Central	Suguroi River (seasonal) Ngare Ngiro R. Ewaso Ngiro R. 2 average size dams 1 dam under construction one dry borehole	87.4	Pump	20-30	600 (5-6 horses)	600		Plan for small irrigation scheme suggested	water is not treated storage is done in a masonary tank of capacity about 91 m³
62	Kihoto Farm	Central	Ewaso Ngiro River Several Dams		small containers	10	200	500			Water is not treated and is also not piped
63	Kariunga (Lairagwan) Farm (1903.5 Ha)	Central	Nanyuki River Nyarigima River (ontilili River) 2 boreholes (1 not working)	3.6 m³ per week for domestic use	Pump (from Nanyuki River)	2500	1000	2000		None	Water not treated and is not sufficient due to lack of piping
64	Kimugandura Farm (6885 Ha)	Central	Timau River Nanyuki River 8 medium size Dams (2.03 Ha, 4.6 m deep)	Storage tanks masonry 3.6 m³ iron sheet- 5.5 m³	Pump (small)	400	2000	5000		Increasing herds and irrigation for folder & wheat underway	No water treatment problem of lack of piped water

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65	Rugutu (Mutirithia) Farm (1822.5 Ha)	Central	Nanyuki River One Dam (temporary) One borehole	storage in 100m³ tank	Pump (under repair)	50 currently in the farm	100 10 donkeys	800		None	None
66	Enasoit Ranch (4050 Ha)	Central	Several Dams (1 large) 2 boreholes C2014 and C1498	storage in two tanks 288 m³ & 273m³	Pump	=15	1500 (over 500 elephants)			None	Borehole water has high fluoride content C1498 has better water while C2014 has highly mineralized water
67	Chololo Ranch (5973.8 Ha)	Central	6 Dams (2m deep) Ewaso Ngiro River One borehole	River water pumped out 4.6m³ storage tank 5 hours a day every	Pump (from river and BH)	30	750			Irrigation expansion plans in near future for beans	No piped water Dams well scattered in farm. Water not treated Domestic water got from Ewaso Ngiro River Roof catchment water used for cooking and drinking.
68	Ol Pejeta Ranching Ltd. (42525 Ha)	Central	Ngobit River =12 Dams (2 or 3 serviceable 20 boreholes (10 wind pumps 10 engine)	576m³ (from river)	Pump	1200	10,000 5 horses 3 donkeys) 200 elephant (10,000-15000) heads of assorted wild animals	8,000		None	Water is highly mineralized and is not treated level of water in the rivers decreasing year after year wild animals destroy the pipes.

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69	Northern Approaches Ranching (Zawadi Farm) (5265 Ha)	Central	Ewaso Ngiro River; 4 dams (2 medium size 2 small ones; one is perennial; 4 boreholes (3 working)		Pumps	=40	1500 (currently 1200) (several assorted wild animals)	1230		None	Water is not treated wild animal (elephants causing concern
70	Mukenya and Segera Ranch 20250 Ha	Central	Ewaso Ngiro R. Suguroi River Mutara River One dam One spring (=4.6m³/day) 4 boreholes all working.	2184 (91m³/hr once a week for 1 hour from Ewaso Ngiro R. for domestic use	pump	200	4000 (30 horses) (wild animals)	1000		Expansion plans are there for the number of animals and the irrigation area covered in 2-3 years time	Suguroi and Mutara Rivers are seasonal Water is not treated. The animals get water direct-ly from the rivers. Water from boreholes has high fluoride content (6ppm)
71	Osoitoitashe Rock catchment	Mukogodo								None (the Druids dam is just a few hundred metres downstream)	The catchments dam broken down due to water pressure (wall was too thin)
72	Magutu Farming Company (712.8 Ha)	Central	Nariginu (Sirimion river) Theta stream (seasonal) one dam is perennial (others are seasonal)		Pumps (now small con-tainers used for drawing water as pump is not working)	200-300	300	600		None	Water is not treated Umande Primary School (400 pupils) have their own pump drawing water from Sirimon River (pumped 2 times aweek) Cattle dip also served

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73	Upepo (Ngenia) Settlement Scheme (891Ha)	Central	Sirimion River Timau River 2 Major Dams (permanent) one borehole (out of order but could be serviced) 2 semi permanent springs		gravity	2000	3000	10000		Project still under construction	Sirimion self help project under construction covering Kalalu farm, Gikaria farm and Ngenia. Dam water polluted, There is no water treatment
74	Kirimun Holding Ground LMD (38070 Ha)	Ng'arua & Rumuruti	Kirimun stream One Dam (big) 5 boreholes (3 working)	68.3m³ storage tank (pumped 2 times a week for 5-6 hrs)	Pumps	380 (230 NYS)	10,000 (currently 1500) (28 horses) 36 camels)	1000 currently; capable of having 30,000		None	Dam dries up during acute dry weather
75	N.Y.S Kirimun	Ng'arua & Rumuruti	2 boreholes	3 tanks with capacities of 91 m³ each pumping for 8hrs daily	Pumps	230	1500	230		Increase the cattle herd to 20,000	Water slightly saline no treatment
76	Mathira-Kihindui Gitaaraga Kahonoki Co. Ltd. (9010.4 Ha)	Rumuruti	Pesi furrow 6 Dams 1 borehole	2 storage tanks 45.5 m³ and 91m³ pumped daily for 12 hours	Pumps	100 (currently)	1800 (currently 510)	2000 (currently 1150)		None	Furrow has many illegal abstractions upstream. There is no piped water.

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80	Kijabe Dam (Ngobit area) (Simina Farm)	Central	Dam (Kamok valley)								Supposed tobe rehabilitated by ASAL, LRDP team (Laikipia Rural Development Programme
81	Withare Dam	Central	Dam								To be rehabilitated
82	Murera Farm (607.5 Ha)	Central	Ewaso Ngiro R.	6.8 m³ (in normal year) much more on dry year	Pump	150	350	800		None	Water not treated and insufficient. In dry weather: Water used for irrigation: livestock and domestic needs:
83	Tharua farm (Co) (4252.5 Ha)	Central	Ewaso Ngiro River Ngobit River Moya River 2 boreholes (one under drilling)	91m³ in 3-4 days a week for 67 hrs a day from borehole: 45.5m³ 91m³ and 22.8m³ from rivers for same duration:	Pumps	150	1500	1700		None but new BH to replace the Ngobit R. which is liable to drying up	None

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81	Withare Dam	Central	Dam								To be rehabilitated
82	Murera Farm (607.5 Ha)	Central	Ewaso Ngiro R.	6.8 m³ (in normal year) much more on dry year	Pump	150	350	800		None	Water not treated and insufficient. In dry weather Water used for irrigation livestock and domestic needs
83	Tharua farm (Co) (4252.5 Ha)	Central	Ewaso Ngiro River Ngobit River Moya River 2 boreholes (one under drilling)	91m³ in 3-4 days a week for 67 hrs a day from borehole 45.5m³ 91m³ and 22.8m³ from rivers for same duration	Pumps	150	1500	1700		None but new BH to replace the Ngobit R. which is liable to drying up	None

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84	Solio Ranch Ltd. (24300 Ha)	Central	Moyok River 8 boreholes (only 1 is being used) C1168 Depth 126.5m WRL 77.4 m Yield 4.3 m³/hour	328 m³ to 502m³	Pump	150	6000 (40 horses)			Plans for irrigation expansion have been shelved Treffers settlement scheme have applied to be connected =227.5 m³ per month	Water stored into 2 big tanks of capacity 6825 m³ water is not treated. During acute dry weather illegal water diversion done by people upstream
85	Carissa Farm (3.24 Ha)	Central	Naro Moru River	9.1	Pump	7	2			None	Water is not treated but drinking water is boiled. Level of water in the river going down water is dirty and a dam is being constructed upstream.
86	Tigithi Location Formerly Matanya Farm (olechugul Weruini Ranch (Tegess) Thome Farmers Mwiremia Farmers Kafanga Farmers (2612.7 Ha)	Central	Tigithi River (Naro Moro) Waguthero (Barguret) River	2238.3 from Naro Moru River	Furrow (from Naro Moru) small containers (from both rivers Pump (Muirenio Farm)	2136 (2016 shareholders) (107 students 7 teachers 6workers				Expansion on furrow network under construction Additional 2 Primary Schools planned.	Water is not treated Water is insufficient