REPUBLIC OF KENYA

MINISTRY OF WATER DEVELOPMENT

WATER RESOURCES ASSESSMENT STUDY

IN

BARINGO DISTRICT

APPENDICES

MAY 1987

WATER RESOURCES ASSESSMENT DIVISION
NAIROBI, KENYA

TNO-DGV INSTITUTE OF APPLIED GEOSCIENCE
DELFT, THE NETHERLANDS

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APPENDIX 1.1

Kenyan & Netherlands Staff
Involved in the WRAP investigation

Kenyan and Netherlands Staff Involved in the WRAP Investigations

KENYA TEAM

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---

* = people employed in more than one discipline or study
** = Project Manager is also Geohydrologist in Laikipia Study
*** = Not employed in the WRAP team, but in district

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N.N. Ndirangu (October 1986)
M.N. Musyoka

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Assistant Hydrologists	C.G. Gitonga
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	D.W. Mwangi
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Support Staff

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Secretary for Project Manager	Mrs. M.W. Mwaniki
Messenger for CTA	Miss Hellen Wangenzi
Messenger for Project Manager	Mr. M. Safina
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	A.N. Muchiri KXG 550
	J.M. Maina KXG 549
	J.K. Kibara KXJ 811
	A.O. Ohanya KXG 516
	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

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3.1 Discussions on Each Site
3.2 Location Maps and Photogeological Map
3.3 Vertical Electrical Soundings (VES)
3.4 Resistivity Profiles (RP)
3.5 Electromagnetic Profiles (EM)

APPENDIX 3.1

Discussions on Each Site

3.1 Discussions on Each Site

3.1.1 Salabani

Expected groundwater occurence: in sedimentary deposits of the Loboi Alluvium.

Completed Geophysical fieldwork:

15 soundings. (Appendix 3.3.1a-h)
4 resistivity profiles (Appendix 3.4.1a-d)
Map showing geophysical sites (Appendix 3.2.1)

The soundings were aimed at finding sedimentary deposits saturated with fresh water; the profiles were carried out to locate buried channels filled with coarse grained sediments could be potential shallow aquifers.

Almost all soundings - except no. 10, 11, and 15 indicate the presence of saline water at a depth varying between 7m (sounding no. 4) and 35m (sounding no. 12). In formations saturated with saline water no resistivity difference can be measured between sandy and clayey deposits. In soundings no. 10, 11, and 15 the very low resistivity layer is absent; here the groundwater is expected to be less saline or fresh.

Above the saline water level the deposits have mainly a clayey composition. Medium to coarse grained sediments can be expected on the sites of soundings:

no. 5 : between a depth of 6.5 and 30m (25 ohmm);
no. 10: between a depth of 4.5 and 27m (77 ohmm);
no. 11: between a depth of 4.4 and 23m (45 ohmm);
no. 15: between a depth of 1.5 and 31m (38 ohmm).

From the soundings it cannot be inferred whether these layers are saturated with groundwater or not.

Below the level of the groundwater on the sites of soundings no. 10, 11, and 15, deposits of mainly fine grained or clayey deposits are expected.

Above the saline water level the layer resistivity model of sounding no. 3 agrees well with the presence of clayey deposits found in borehole C6362 drilled on the same site. The water struck level was at 48m; the conductivity of the water is very high 14.0 mS/cm.

At great depths (i.e. > 130m) several soundings show a slight increase in resistivity values; see soundings no. 1, 2, 6 and 15. A satisfying explanation for this feature cannot be given; probably it is caused by less accurate instrument performance under the prevailing hydrogeological conditions.

Resistivity profiles no. 2 and 3 show an increase in resistivity values over the southeastern section which can be correlated with changes in near surface (i.e. <10m) layer resistivities as can be inferred from nearby soundings. This can be correlated with changes in composition of the top soil from clayey to sandy. Borehole C6362, drilled at a site on profile no. 3 (see Appendix 3.2.1) where the apparent resistivities show high

values, was aimed to check the presence of a presumed buried channel. However, such a channel was not found.

Note: In borehole C 6362 warm groundwater is found. The temperature at the static water level (15.7m) is 37.4°C; at maximum depth (60m) it is 47.1°C. The higher temperature of the groundwater decreases the electrical resistivity of saturated deposits. If a sounding in a warm groundwater area is to be correlated with other soundings, a temperature correction on the measured values must be applied. Different temperature correction factors are in use. Generally the assumption is made that the resistivity decreases with temperature at a rate of approximately 2% per °C.

3.1.2 Ng'ambo

Expected groundwater occurrence: in sedimentary deposits of the Loboi Alluvium.

Complete Geophysical fieldwork:

6 soundings (Appendix 3.3.2a-c)
4 resistivity profiles (Appendix 3.4.2a-d)
Map showing geophysical sites (Appendix 3.2.2)

All soundings indicate the presence of saline water at a depth varying between 16m (soundings no. 2 and 6) and 40m (sounding no. 5). In formations saturated with saline water no resistivity differences can be measured between sandy and clayey deposits. Above the saline water level the alluvium consists mainly of clayey deposits.

The resistivity profiles were aimed to locate a presumed buried channel; see Location and Photo-geological Map, Appendix 3.2.2. The profiles confirm the presence of mainly clayey deposits at shallow depth. Borehole C6365, drilled at a site on profile No. 4 where the apparent resistivity values are somewhat higher, was aimed at verifying the presence of the presumed buried channel. However, it penetrated mainly through clayey and fine grained deposits. The water struck level was at 42 m; the water quality is brackish (5.6 - 5.9 mS/cm).

3.1.3 Logumukum

Expected groundwater occurrence: in sedimentary deposits of the Loboi Alluvium.

Completed geophysical fieldwork:

5 soundings (Appendix 3.3.3a-c)
Map showing geophysical sites (Appendix 3.2.3)

No information is available about the level, the conductivity and temperature of the groundwater in the area of Logumukum; therefore the following results of the geophysical survey can only be tentative.

All soundings show very low layer resistivities (<2 ohmm) indicating the presence of saline water at a depth varying between 2m (sounding no. 2) and 28m (sounding no. 5) . Above the saline water level it is not expected to

find fresh water. A shallow well (with a total depth of 12m) did not reach the groundwater level. The location of the well is indicated in Appendix 3.2.3.

The higher layer resistivity values found below the saline water layer are probably caused by trachytes. In trachyte formations weathered zones can be present; however they cannot be detected by the geophysical methods used. On the site of sounding no. 3 the depth of 30m to the higher resistivity layer is much less than the depths found on the sites of the other soundings; there depths range between 80 and 135m.

From the soundings no conclusion can be drawn about the location of the inferred major fault along the river Molo.

3.1.4 Sandai

Expected groundwater occurrence: in sedimentary deposits of the Loboi Alluvium.

Completed geophysical fieldwork:

4 soundings (Appendix 3.3.4a-b)
Map showing geophysical sites: (Appendix 3.2.4)

No information is available about the level, the conductivity and temperature of the groundwater in the area of Sandai; therefore the results of the geophysical survey can only be tentative.

Medium to coarse grained sediments are expected on the sites of soundings:

no. 1: between a depth of 11 and 72 m (60 ohmm);
no. 2: between a depth of 2.7 and 31 m (75 ohmm);
no. 3: between a depth of 16 and 130 m (40 ohmm).

Below these layers, sedimentary deposits ranging from medium grained to clayey are expected to be found with a layer resistivity ranging from 18 ohmm (sounding no. 1) to 9 ohmm (sounding no. 3).

At sounding no.4 saline groundwater is expected at a depth of 40m; above the saline water level, a layer resistivity of 23 ohmm is found indicating either the presence of medium to fine grained sediments saturated with fresh water, or unsaturated clayey deposits.

3.1.5 Loboi

Expected groundwater occurrence: (1) in sedimentary deposits of the Loboi Alluvium or of more recent age, or (2) in weathered or fractured zones in the underlaying volcanic rocks (Lake Hannington Trachyphonolites).

Completed geophysical fieldwork:

4 soundings (Appendix 3.3.5a-b)
1 resistivity profile (Appendix 3.4.5)
Map showing area covered (Plate 3.1)

From the soundings the thickness of the sedimentary deposits cannot be inferred. The resistivity layer models can only be used qualitatively because no much information is available concerning the lithology, level and temperature of the groundwater. Saline water is not expected on the four sounding sites.

Borehole C 6652 near sounding no.1, struck water at 12 and 21 m depth. The conductivity of the water was 0.66 - 0.815 mS/cm; see Table 5.4 No geological log is available. On the same sounding a layer resistivity of 6 ohmm is found between a depth of 40 and 110 m; in sedimentary deposits this low value usually correlates with clayey sediments.

Both the resistivity and the EM profile indicate the presence of a major fault at the crossing between the profile-line and the river Loboi. Other anomalies such as in the western section of the five frequency EM profiles are probably caused by minor faults of limited depth or extent.

The water of the hot spring in Loboi area has a conductivity of 0.6 mS/cm.

3.1.6 Chesirimion

Expected groundwater occurrence: (1) in shallow local alluvial deposits, or (2) in weathered or fractured zones in volcanic rocks of various formations.

Completed geophysical fieldwork:

5 soundings (Appendix 3.3.6a-c)
2 resistivity profiles (Appendix 3.4.6a-b)

Map showing geophysical sites (Appendix 3.2.5)

The soundings were aimed at finding the thickness of the alluvium and of the first weathered zones of the volcanic formations. The profiles were aimed at determining the presence of faults or fractured zones.

The depth of 25m to the high resistivity layer of 3,000 ohmm of sounding no. 4 agrees well with the depth of 29.5m to the first fresh basalts found in borehole C 6364 which later was drilled at the same location; see geological log in Appendix. Water was struck at a depth of 105.5m; no water was found in the alluvium.

The calculated depths to the high resistivity layer of 200 ohmmeter or more on the other soundings varies between 21m (sounding no. 5) and 40m (sounding no. 1). These depths will probably coincide with the depth to the first zone of fresh volcanic rocks.

The resistivity profiles don't show any indication for the presence of a major fault or fractured zone in the volcanics. The section with low values (<50 ohmm) corrrelates with the presence at alluvial deposits.

Notes

1. sounding no.3 is measured in an area underlain by tuffs according to information from the field recording sheet. This is not indicated on the location and photo-geologic map of Appendix 3.2.6

2. the decrease in layer resistivity at greater depth on soundings no. 2 (at 160m) and no. 5 (at 83m) are probably caused by weathered volcanics.

3.1.7 Kositei

Expected groundwater occurrence: (1) in local fluvial deposits (if they extend deep enough), or (2) in weathered or fractured zones in volcanic rocks (basalts and trachytes).

Completed geophysical fieldwork:

5 soundings (Appendix 3.3.7a-d)

Map showing geophysical sites (Appendix 3.2.6)

The interpreted layer model of sounding No. 2 does not correlate with the hydrogeological features realized after drilling borehole C6363 on the same site because:

(i) water was struck at a depths of 93 and 97 m, a possible case of suppression as these small weathered zones are not reflected in the interpretation model.

(ii) the conductivity of the water is only 0.81 - 0.92 ms/cm; see Table 5.4. The very low layer resistivity at a depth of only 3.3 m is normal for blackish or saline water which would be expected to have higher resistivity

On the aerial-photograph an ENE - WSW running lineament is visible north of sounding No. 5; see location map Appendix 3.2.7. This sounding - which has been measured near an outcrop of basalts - has a pronounced different curve type compared with other soundings in the area. Because of this it is expected that the lineament can be correlated with a fault or fractured zone.

The sounding performed in Nginyang near borehole C3868 for correlation purposes turned out to be of less use because the geological log of the borehole differs considerably from the log of the recently drilled borehole C6363 in Kositei. Furthermore the conductivity of the groundwater in Nginyang (3.4 mS/cm) is much higher than the values found in Kositei (0.81 - 0.92 mS/cm)

3.1.8 Marigat

Expected groundwater occurrence: in sedimentary deposits of the Kapthurin formation or in more recent alluvial deposits.

Completed geophysical fieldwork:

6 soundings (Appendix 3.3.8a-d)
Map showing geophysical sites (Appendix 3.2.7)

No information is available about the level, the conductivity and tempera-

ture of the goundwater in Marigat area. Therefore the results of the geophysical survey can only be tentative.

The most promising site for founding shallow groundwater is near sounding:

no. 1. Between a depth of 10 and 40m a layer resistivity of 45 ohmmeter is found which can be caused by medium to coarse grained saturated sediments.

Finer grained sedimentary deposits can be expected on the sites of sounding:

no. 3: between a depth of 25 and 90 m (22 ohmm);
no. 4: between a depth of 9 and >100 m (19.5 ohmm);
no. 5: between a depth of 13 and 65 m (20 ohmm).

On sounding no.6 a layer resistivity of 50 ohmm at an estimated depth of 120m is found; in sedimentary deposits this can be correlated with coarse grained material saturated with fresh water. However, not much is known about the depth to volcanic rocks in Marigat area; the layer resistivity of 50 ohmmeter also can be caused by partly weathered volcanics.

Note. The above mentioned layer resistivities can also be caused by dry clayey deposits. Knowledge of the groundwater levels in Marigat area can be diagnostic for a correct interpretation of the soundings.

3.1.9 Kimalel (includes also Koriema and Egerton)

Expected groundwater occurrence: in weathered or fractured zones in volcanic rocks of differert formations.

Completed geophysical fieldwork:

9 soundings (Appendix 3.3.9 a-e)
3 resistivity profiles (Appendix 3.4.9 a-c)
Map showing area covered (Plate 3.1)

The quality of soundings no. 6, 7 and 8 and the final parts of soundings no. 1, 2 and 3 is unacceptable for a layer model interpretation. The soundings can only can be used qualitatively. This feature has been experienced also in other areas underlain by volcanic rocks.

Sounding no.5 is sited near borehole C 5072 at Egerton; no geological log is available. The water is slightly saline (information from the geophysical field recording sheet). No other soundings in the area has a similar curve type.

The layer model interpretations of the other soundings probably don't correlate with the expected weathered zones in the volcanic rocks.

The resistivity profiles do not show any feature of direct interest for groundwater occurences. Profile no. 3 and the southern section of profile No. 2 indicate the presence of clayey deposits at shallow depths.

3.1.10 Mukutan

Expected groundwater occurrence: (1) in recent alluvial deposits, or (2) in weathered or fractured zones in volcanic rocks (Rumuruti Phonolites ???).

Completed geophysical fieldwork:

6 soundings (Appendix 3.3.10a-c)
Map showing geophysical sites (Appendix 3.2.8)

No information is available about the lithology, the level and temperature of the groundwater in Mukutan area. Therefore the results of the geophysical survey can only be tentative.

All soundings indicate the presence of brackish to saline water at a depth varying between 0.8m (sounding no. 6) and 80m (sounding no. 3).

Above the saline water level medium to coarse grained sediments or partly weathered volcanics are expected on the site of soundings:

no.2: between a depth of 6 and 45m (42 ohmm);
no.3: between a depth of 3 and 15m (60 ohmm);
no.4: between a depth of 3.5 and 30m (75 ohmm);
no.5: between a depth of 10 and 18m (30 ohmm).

Other layers above the saline water level are expected to be mainly of clayey composition.

The conductivity of the water of the springs in Mukutan area ranges between 0.7 mS/cm and 1.7 mS/cm, see Table 5.4.

3.1.11 Kabarnet

Expected groundwater occurrence: in weathered or fractured zones in volcanic rocks (Kabarnet Trachytes).

Completed geophysical fieldwork:

12 soundings (Appendix 3.2.11a-f)

Map showing geophysical sites (Appendix 3.2.9)

The quality of the soundings no. 1, 7 and 11 and the final part of most other sounding curves in Kabarnet area are generally unacceptable for a layer model interpretation. The measured apparent resistivity values can only be used qualitatively. This feature has been experienced also in other areas underlain by volcanic rocks.

All soundings indicate the presence of at least a zone of weathered volcanic rocks. Depths to the formation below the Kabarnet Trachytes could not be determined; however, it is expected that the trachytes extend until a depth of several hundred meters.

No correlation can be found between the (poor) geological log of the productive borehole C 3506 and sounding no.6 measured at the same site.

However, the curve type can be used to trace other sites for groundwater resources; similar curve types are found on the sites of sounding no. 3 and 10. Sounding no. 1 has been measured near boreholes no. C 4780 (yield: 13.5 m3/h) and no. C 6089 (yield: ???); similar sounding curves have not been measured elsewhere.

The presence and the exact location of faults or fractured zones could not be inferred from the soundings.

3.1.12 Talai

Expected groundwater occurrence: in weathered or fractured zones in volcanic rocks (Kabarnet Tracytes).

Completed geophysical fieldwork:

3 soundings (Appendix 3.3.12a-b)
Map showing area covered (Plate 3.1)

The quality of the curve of sounding no.3 is unacceptable for a layer model interpretation; the measured apparent resistivity values can only be used qualitatively.

All soundings indicate the presence of weathered or partly weathered zones in the volcanic rocks; however, no estimate can be made about depths and thicknesses of these zones.

3.1.13 Tangulbei (includes Orus)

Expected groundwater occurrence: (1) in sedimentary deposits of the Tangulbei Alluvium, or (2) in weathered or fractured zones of volcanic rocks of different formations.

Completed geophysical fieldwork

10 soundings (Appendix 3.3.13a-e)
1 EM profile (Appendix 3.5.13a-c)
Map showing geophysical sites (Appendix 3.2.10)

The quality of the final part of most sounding curves is unacceptable for a layer model interpretation. This is a commmon feature in areas underlain by volcanic rocks.

The thickness of the alluvial deposits cannot be determined from the soundings alone since the resistivity contrast with the partly weathered volcanic rocks is not big enough.

Sounding no. 5 was done near the existing, productive borehole no. C3437. The water struck levels in the borehole were at 99, 107 and 148 m (see Table 5.1), the conductivity of the water is 0.9 mS/cm (see Table 5.4). The interpretation does not directly compare with the interpreted layer model. It is however evident that water was struck at different zones in the high resistivity (70 ohmm) layer. This is a possible case of suppression where the thin water bearing zones could not be realized within the thick layer.

The conductivity of the water in the borehole near Orus is about 0.5 mS/cm. Neither a geological log nor information on water level(s) are available.

Sounding No. 6 and 9 are less promising sites for groundwater occurrences because here relatively high apparent resistivity values have been measured.

On the sites of the other soundings, weathered zones in volcanic rocks can be expected; however, no estimate can be made about depths and thicknesses of these zones.

The EM profiles of all three operating frequencies do not show features of direct interest for groundwater occurrences. In the eastern section of the profile a good conductor - probably existing of clayey deposits - at shallow depth can be inferred.

3.1.14 Molos

Expected groundwater occurrence: in weathered or fractured zones in volcanic rocks of different formations.

Completed geophysical fieldwork:

2 soundings (Appendix 3.3.14)
1 resistivity profile (Appendix 3.4.14)
1 EM profile (Appendix 3.5.14a-c)
Map showing geophysical sites (Appendix 3.2.11)

Zones of weathered volcanic rocks are expected on both sounding sites. On the site of sounding no. 2 a layer of either clayey material or highly weathered volcanics is expected until a depth of 35m.

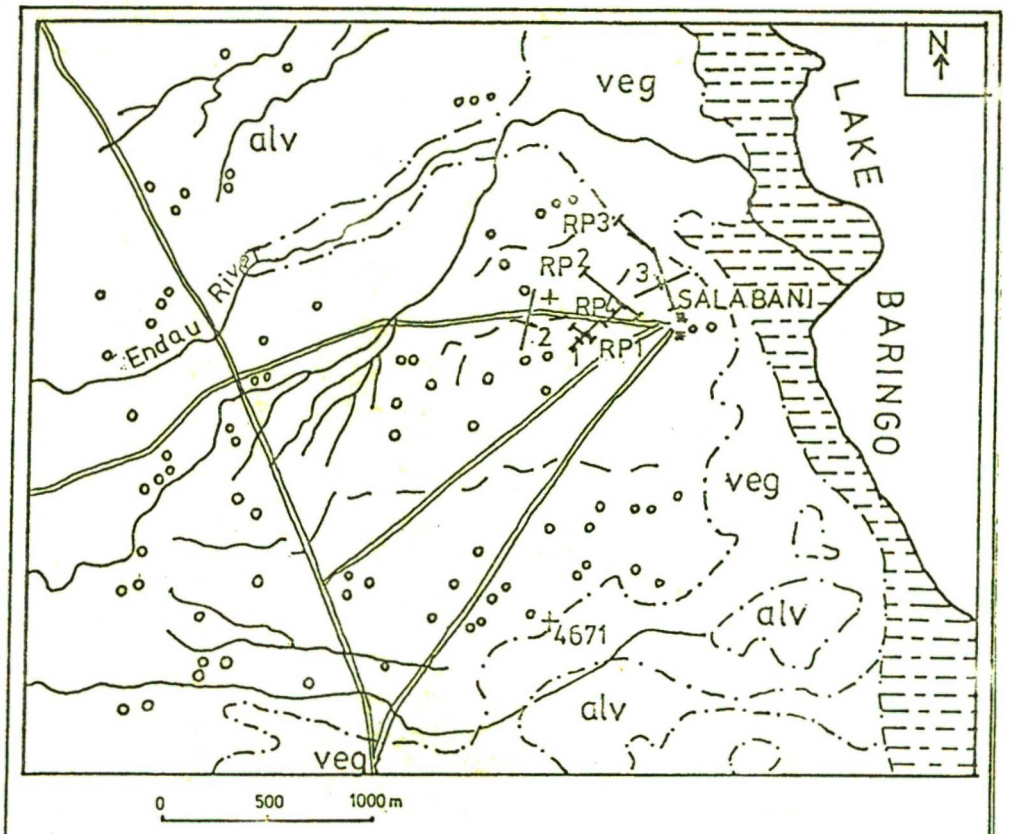
The resistivity profile shows a steeply decreasing curve with a central minimum value of 10 ohmm over the section between 175m from the beginning and the far eastern end . It is caused by a shallow conductor, probably of clayey material. This is also inferred from the EM profile measured at three operating frequencies. At the highest frequency the response of the quadrature (Q) component is lower than the in-phase (IP) component response over the corresponding section of the resistivity profile; at the lowermost frequency the Q response is higher than the IP response.

The peak minimum on the EM profile at 75m from the western end at the higher operating frequency represents a shallow lateral inhomogeneity of unknown character.

APPENDIX 3.2

Photogeological and Location Maps

3.2.1 Salabani
3.2.2 Ng'ambo
3.2.3 Logumukum
3.2.4 Sandai
3.2.5 Chesirimion
3.2.6 Kositei
3.2.7 Marigat
3.2.8 Mukutan
3.2.9 Kabarnet
3.2.10 Tangulbei
3.2.11 Molos



LEGEND

alv ------ alluvial sediments (mainly light brown silts forming the flood plain)

veg ----- vegetation (thick vegetation of acacia trees)

---- Perkera irrigation scheme

----- swamp

------ homesteads, round huts

------ roads

+-------- photo centre

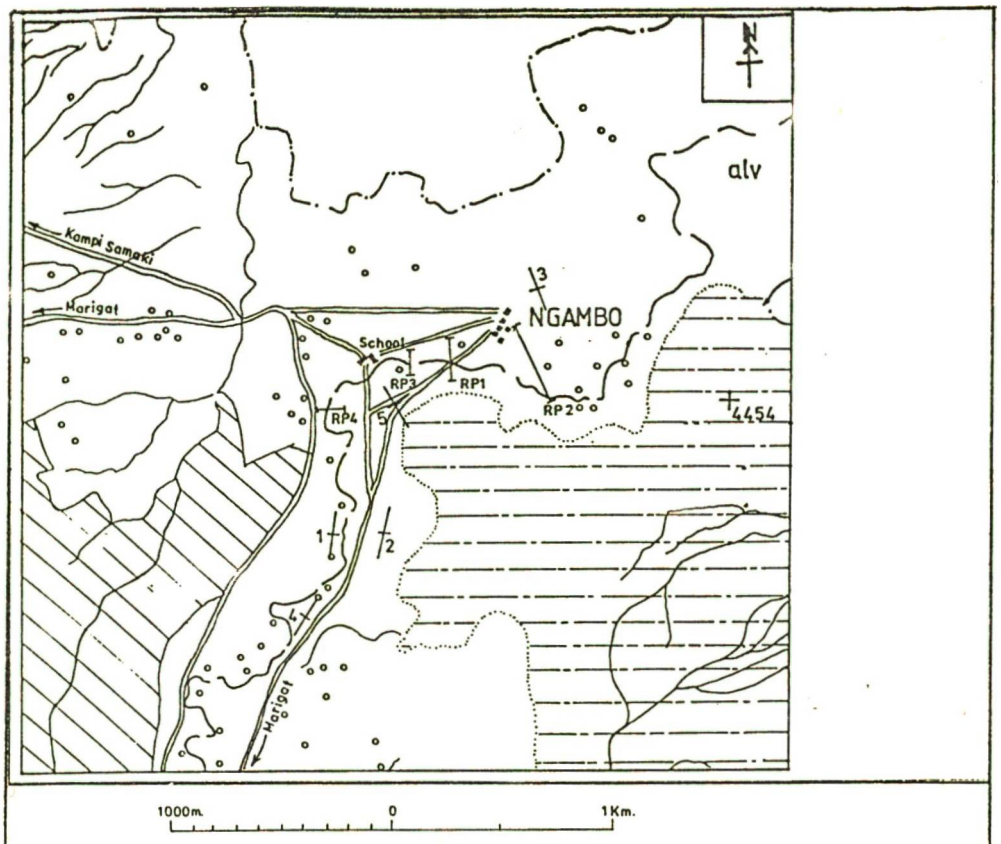
------ main river and tributary

------ old river course (best sites for geophysical investigation)

$\frac{1}{2}$ ------ vertical electrical sounding 2

RP1 ------ resistivity profile 1

APPENDIX 3.2.1 Photogeological and Location Map of Salabani



1000m. 0 1Km.

LEGEND

alv ------alluvial sediments (mainly light brown silts forming the flood plain)

veg -----vegetation (thick vegetation of acacia trees)

-----Perkera irrigation scheme

-----swamp

------homesteads, round huts

-------roads

+-------- photo centre

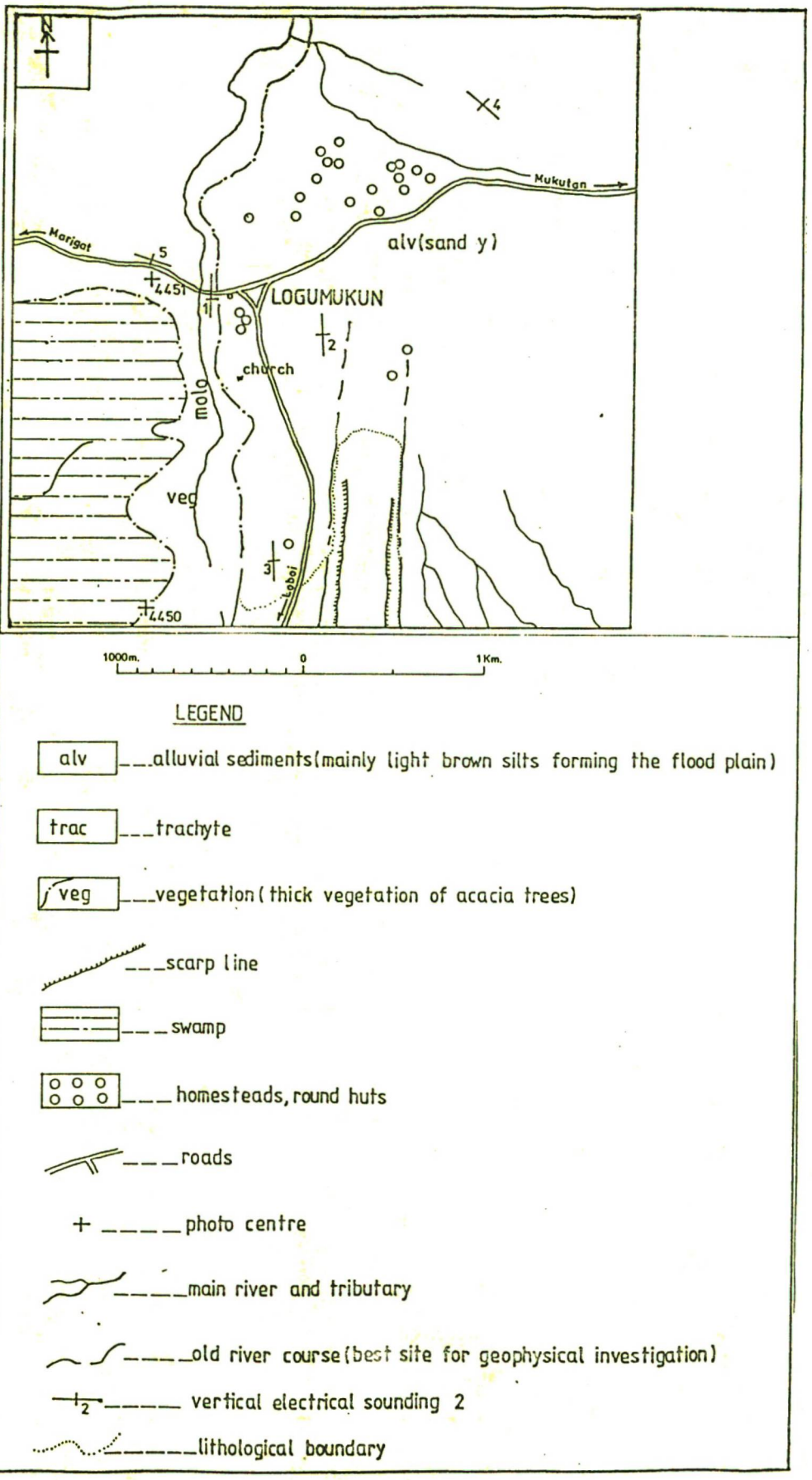
-------main river and tributary

------old river course (best sites for geophysical investigation)

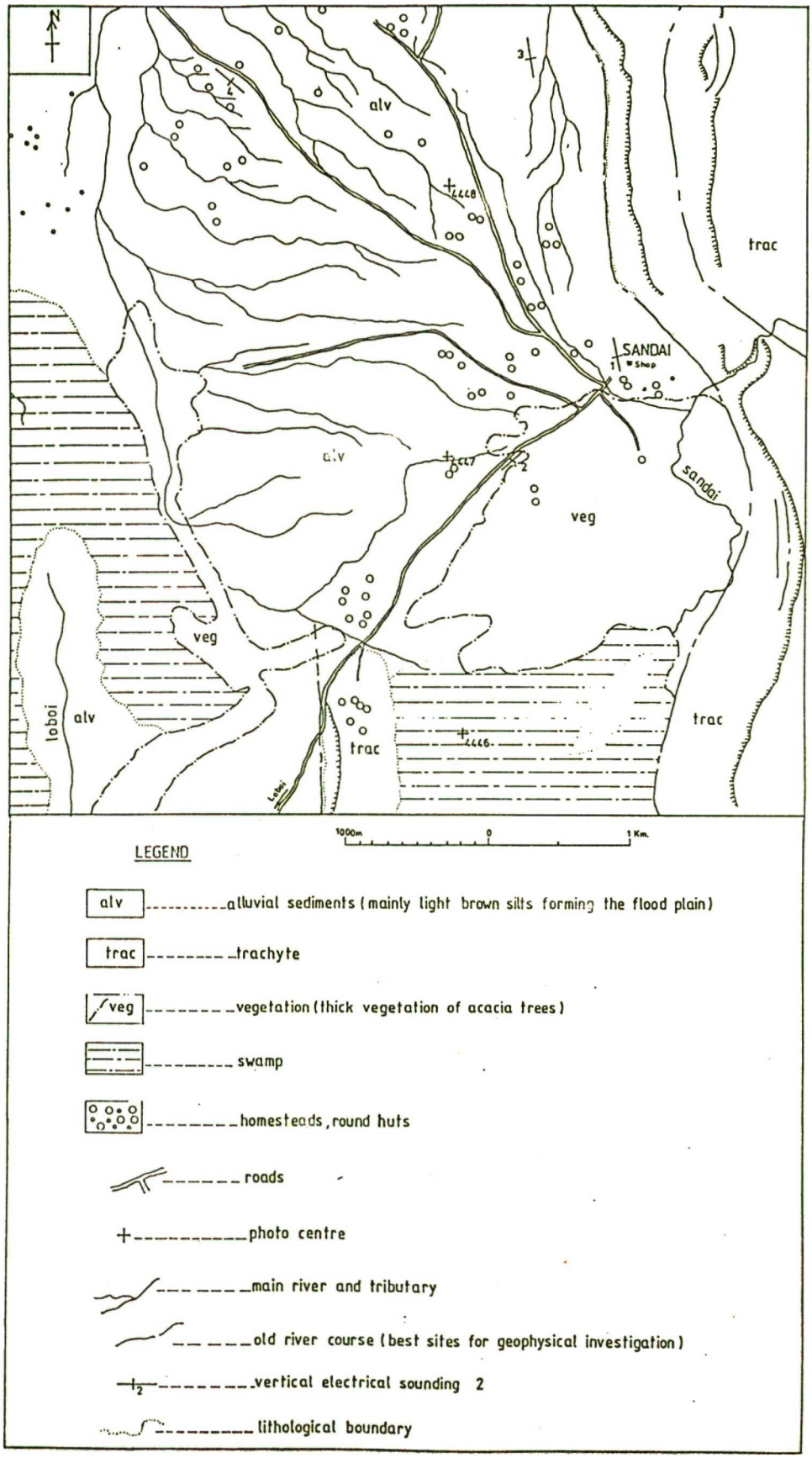
2 -------vertical electrical sounding 2

RP1 -----resistivity profile 1

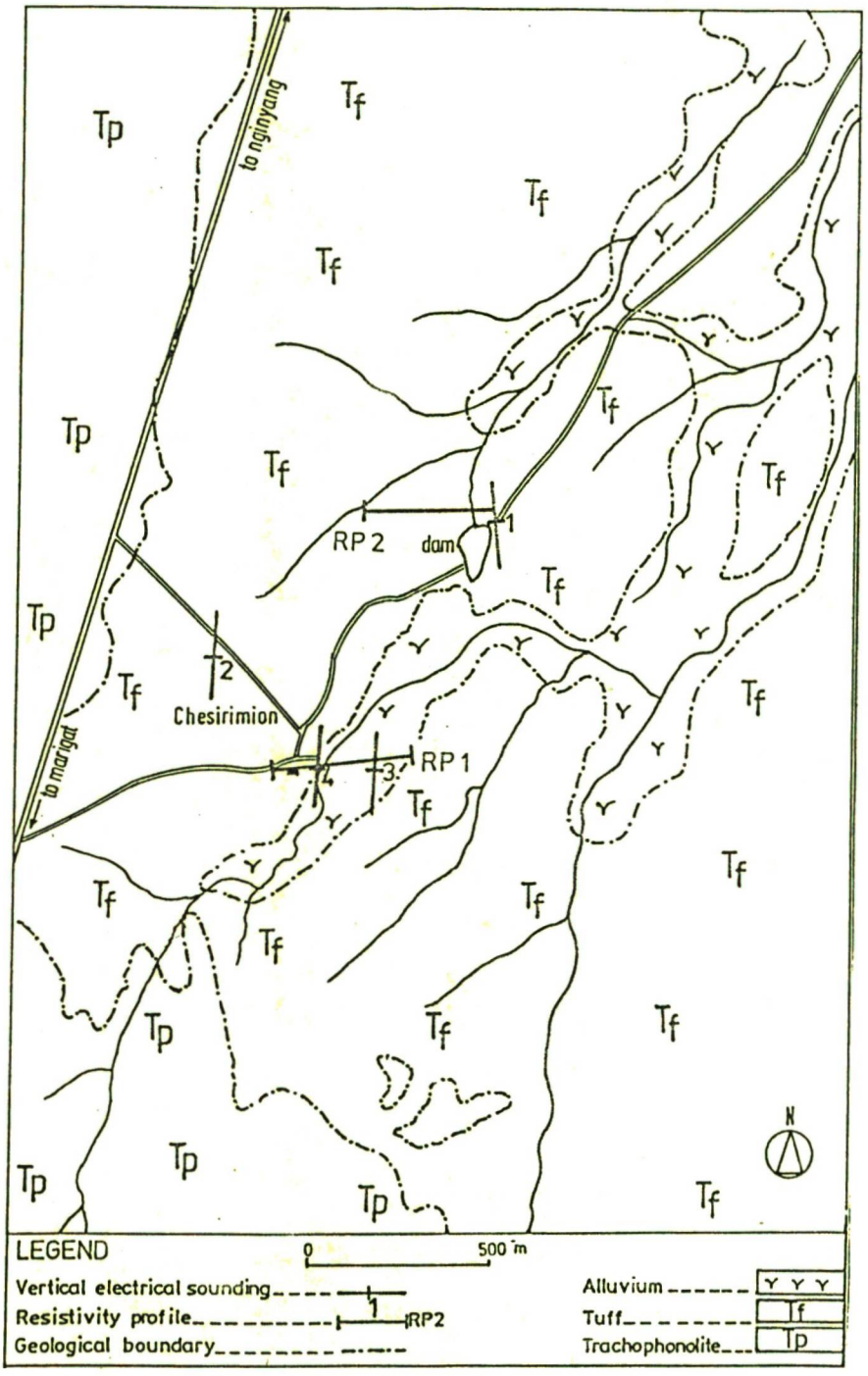
APPENDIX 3.2.2 Photogeological and Location Map of Ng'ambo



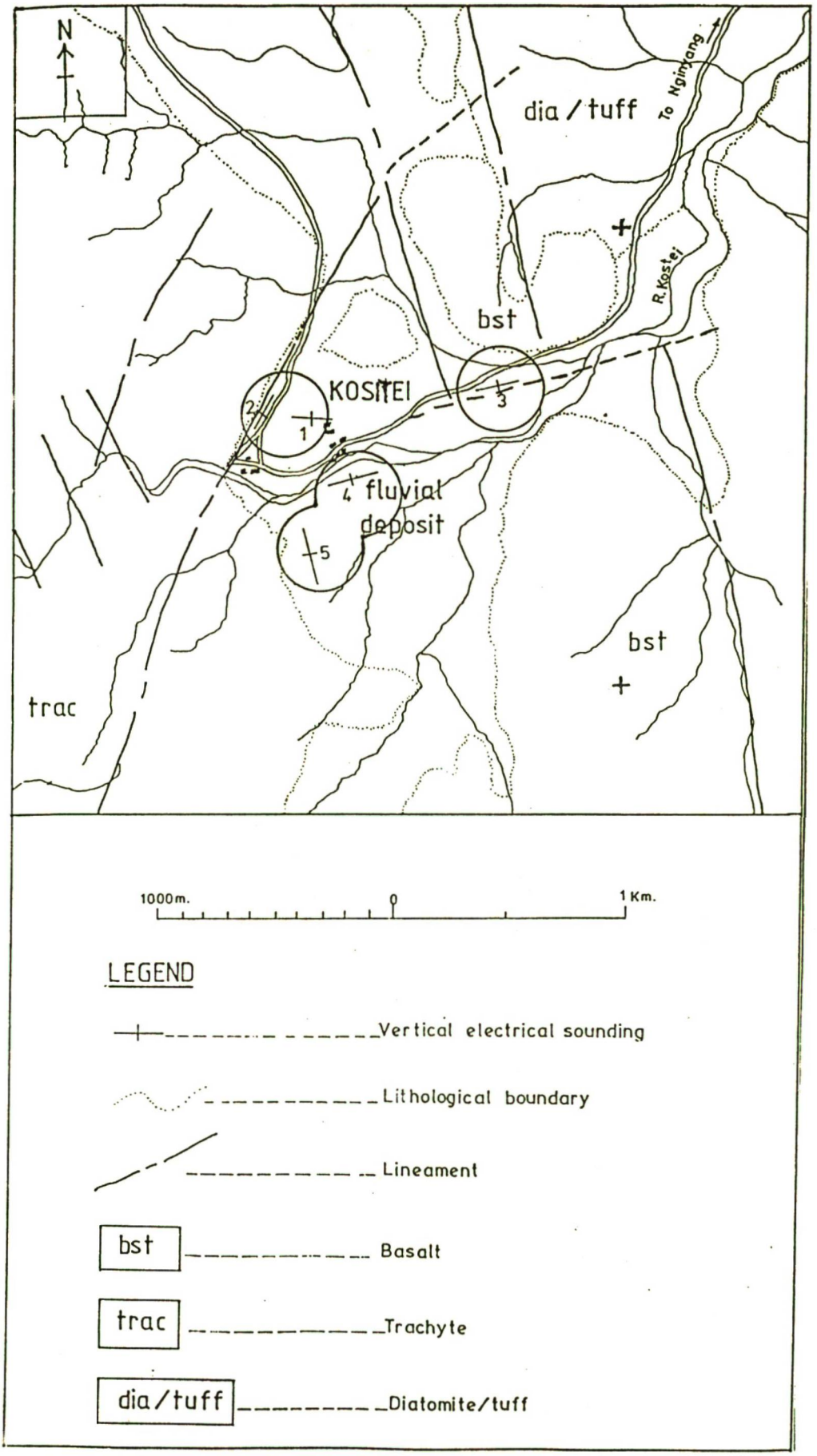
APPENDIX 3.2.3 Photogeological and Location Map of Logumukum



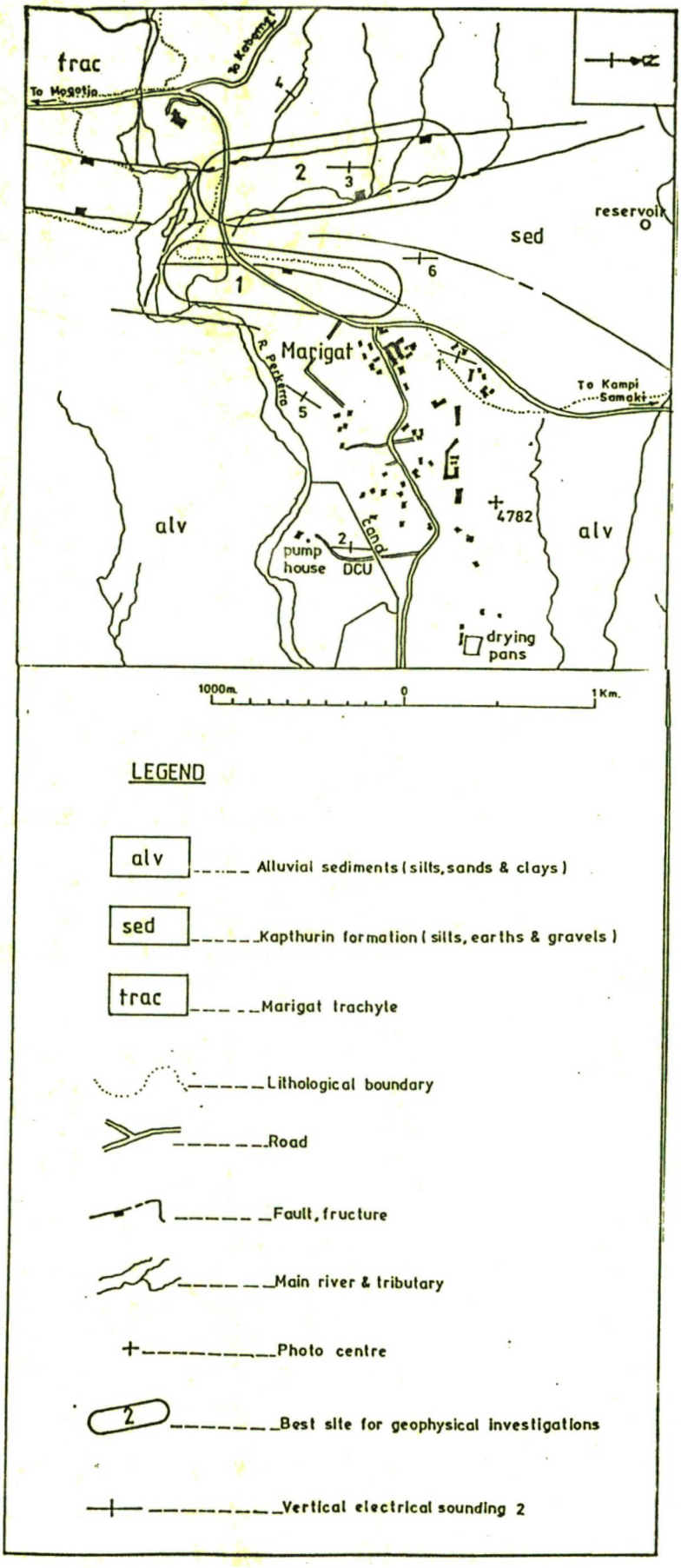
APPENDIX 3.2.4 Photogeological and Location Map of Sandai



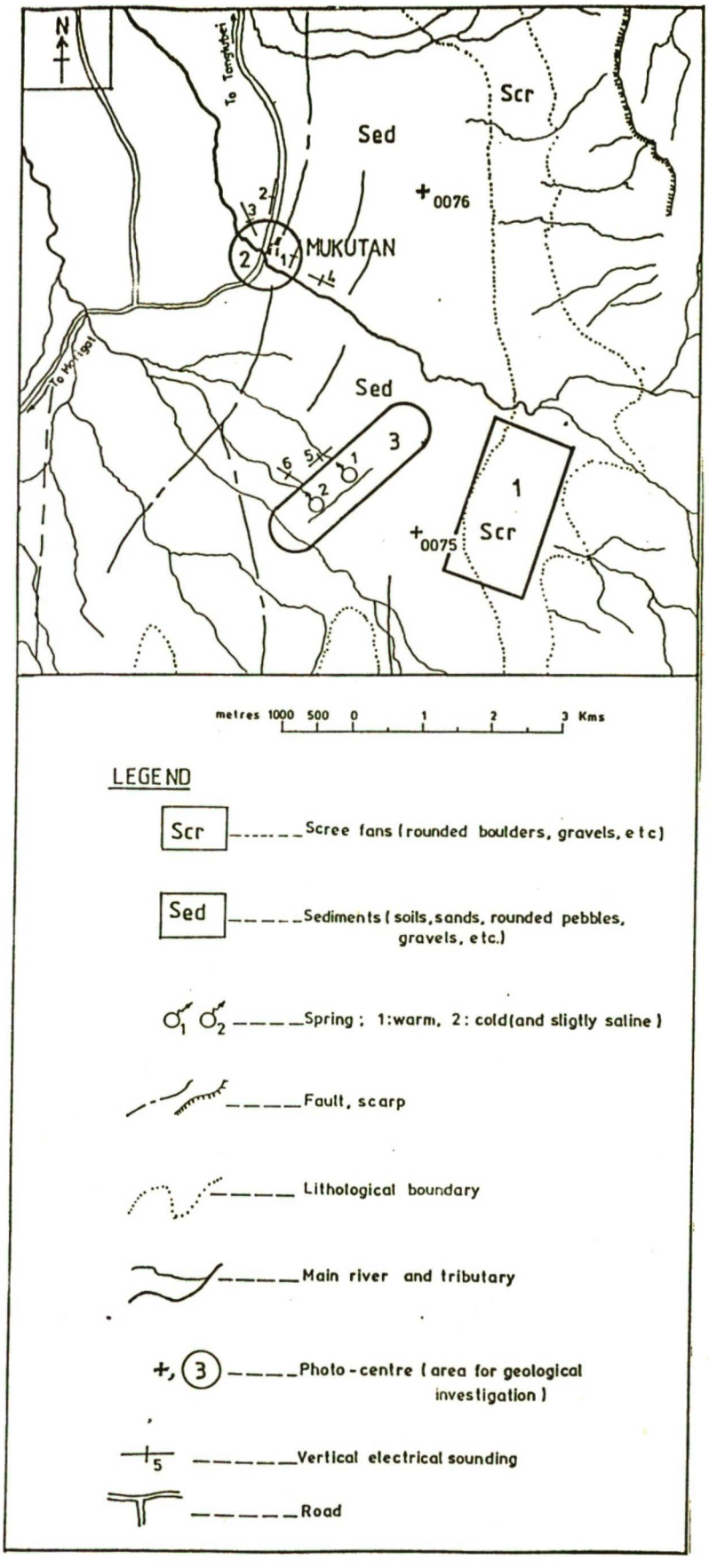
APPENDIX 3.2.5 Photogeological and Location Map of Chesirimion



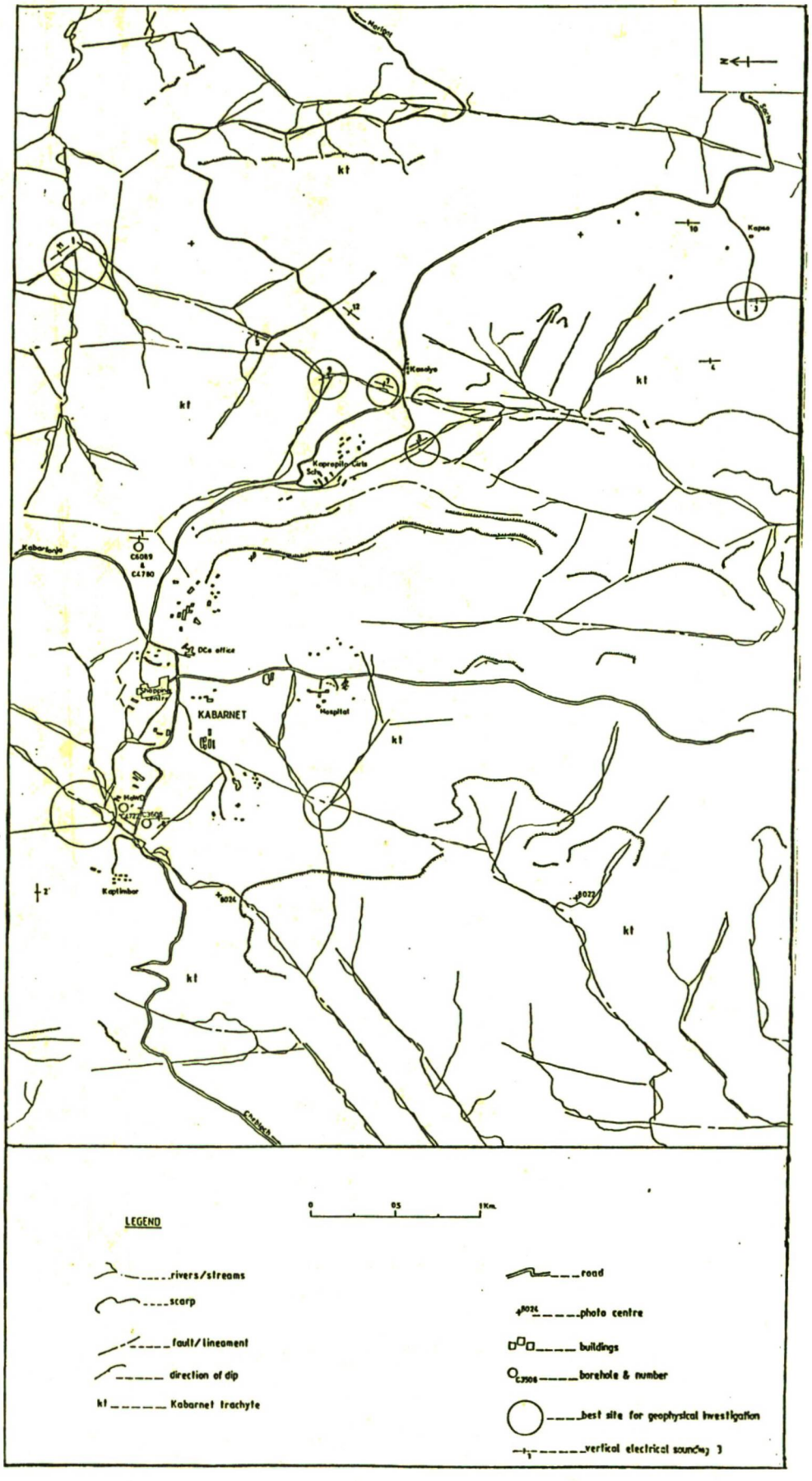
APPENDIX 3.2.6 Photogeological and Location Map of Kositei



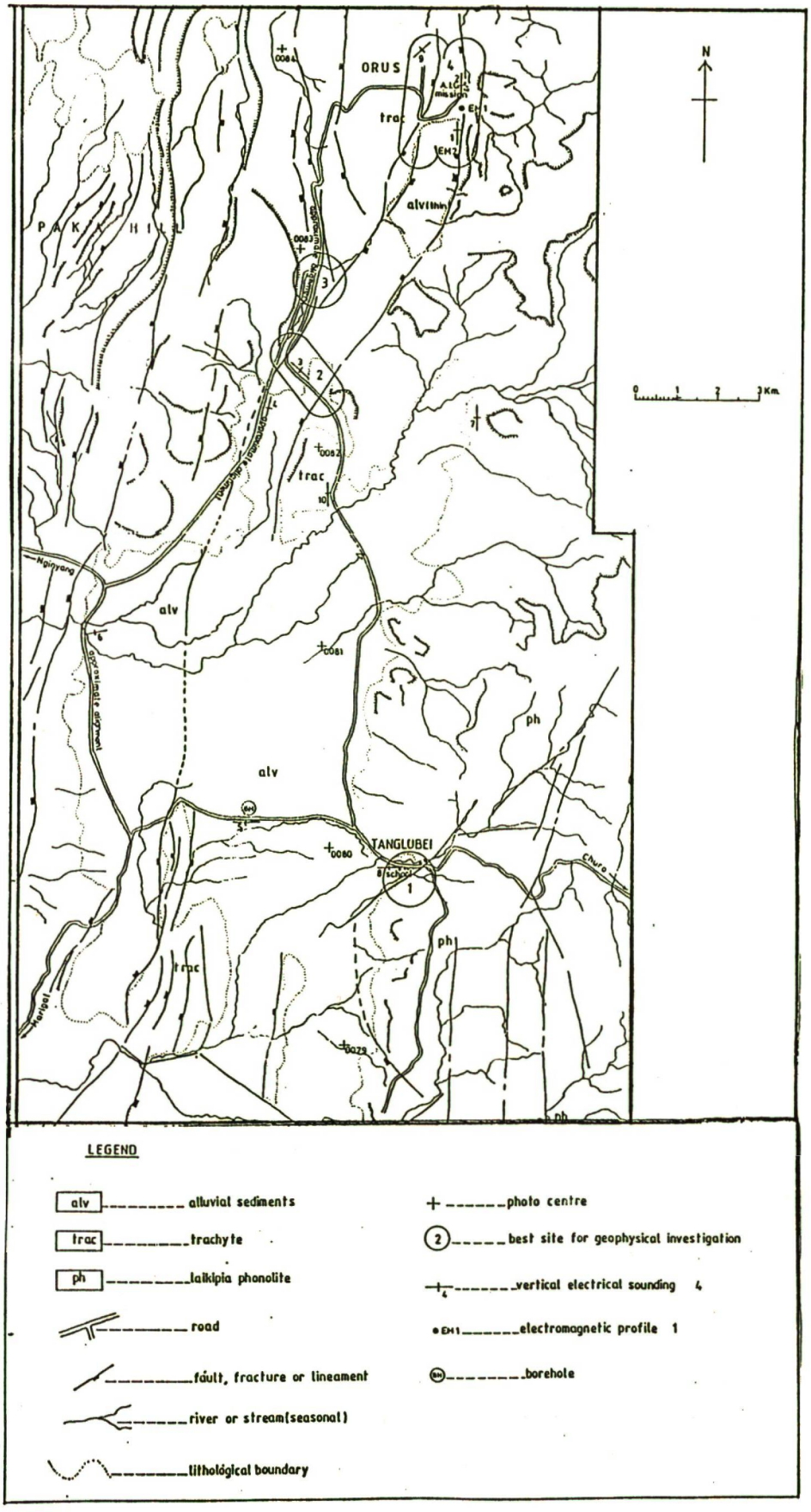
APPENDIX 3.2.7 Photogeological and Location Map of Marigat



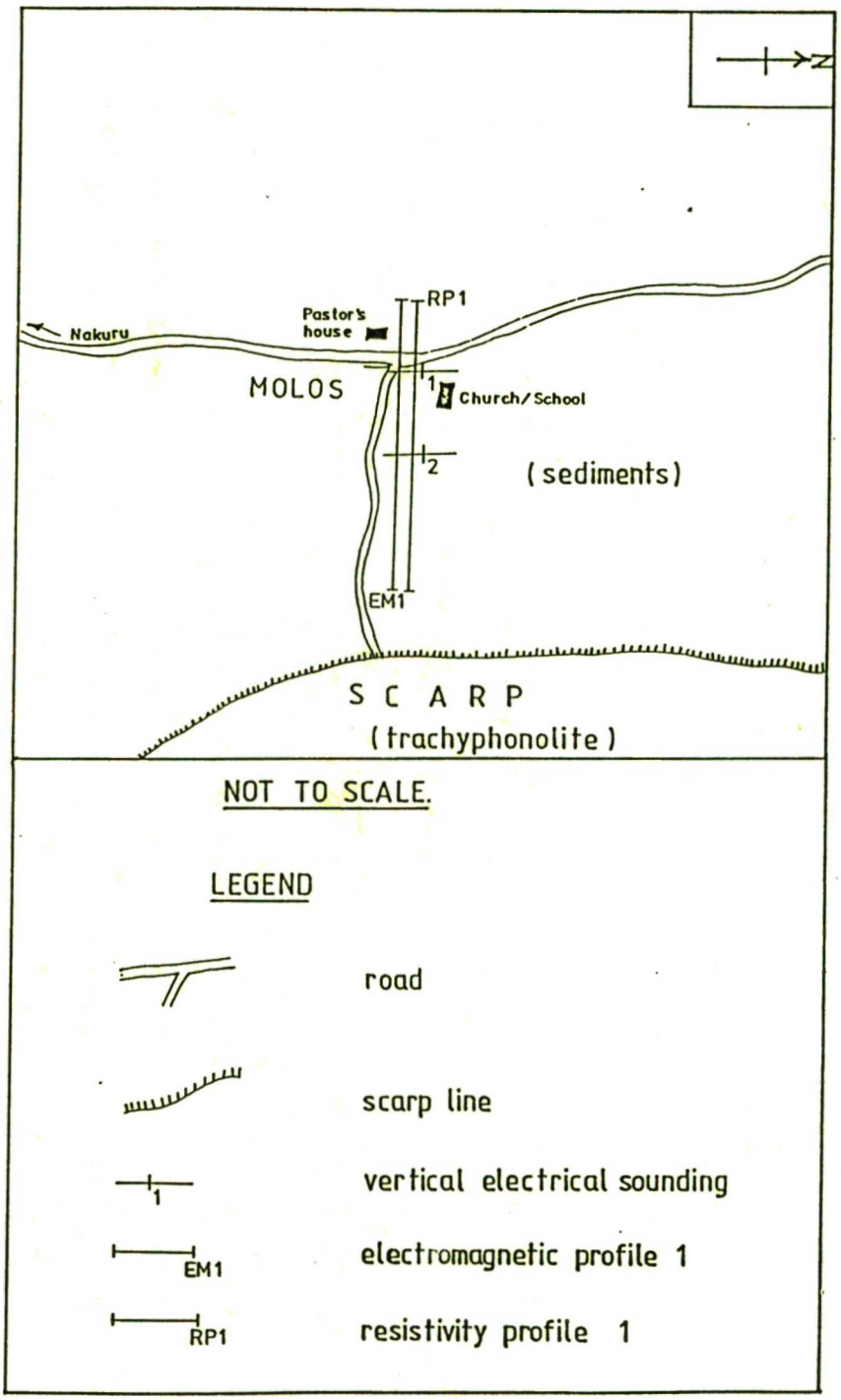
APPENDIX 3.2.8 Photogeological and Location Map of Mukutan



APPENDIX 3.2.9 Photogeological and Location Map of Kabarnet



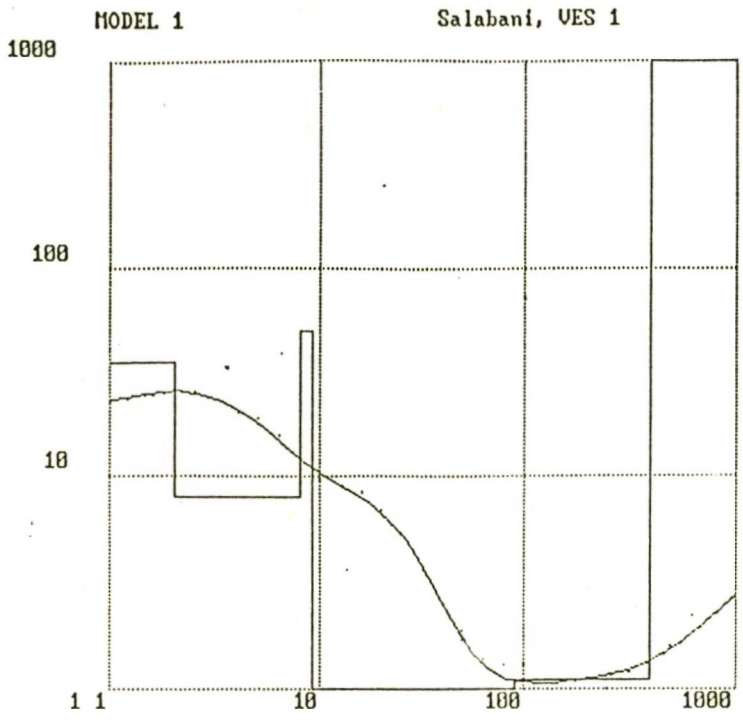
APPENDIX 3.2.10 Photogeological and Location Map of Orus-Tangulbei

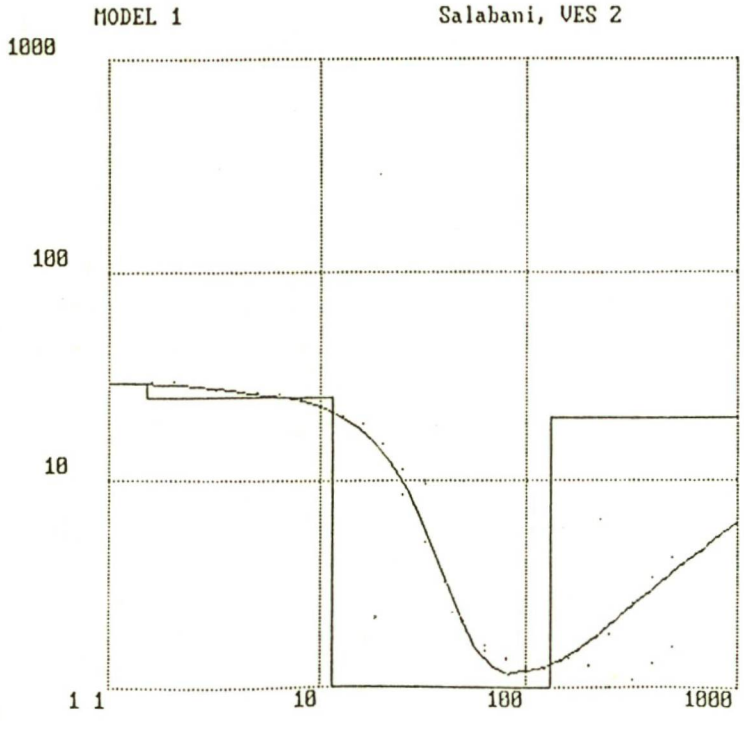


APPENDIX 3.2.11 Location Map of Molos

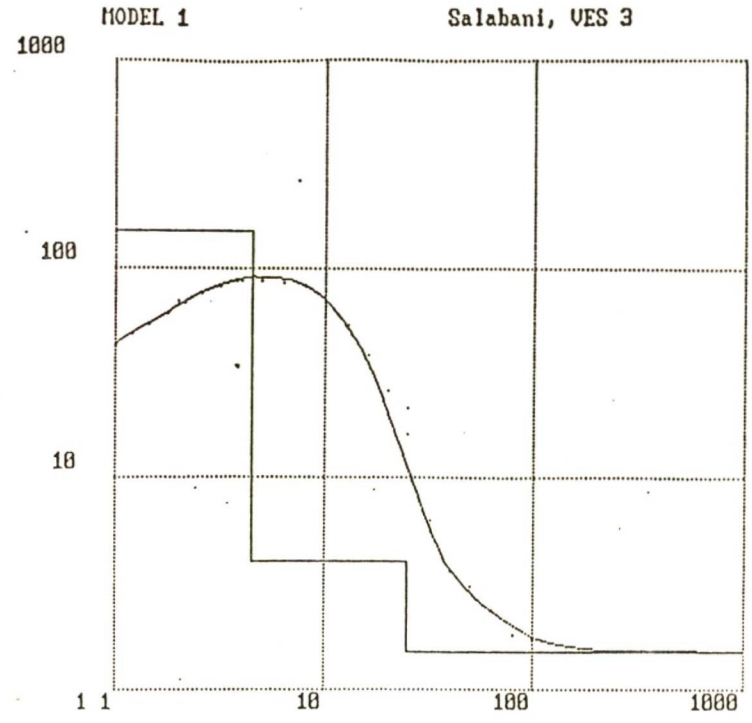
APPENDIX 3.3

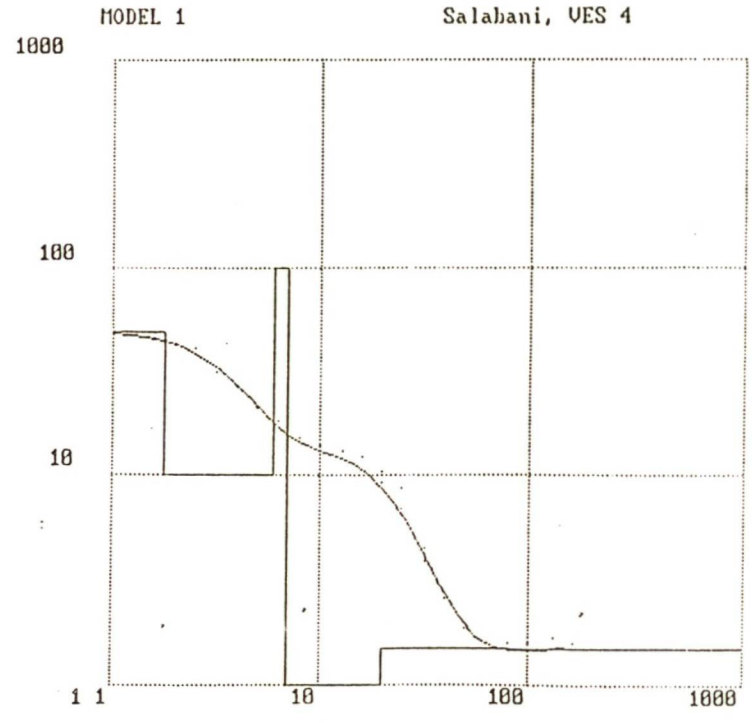
Vertical Electrical Soundings



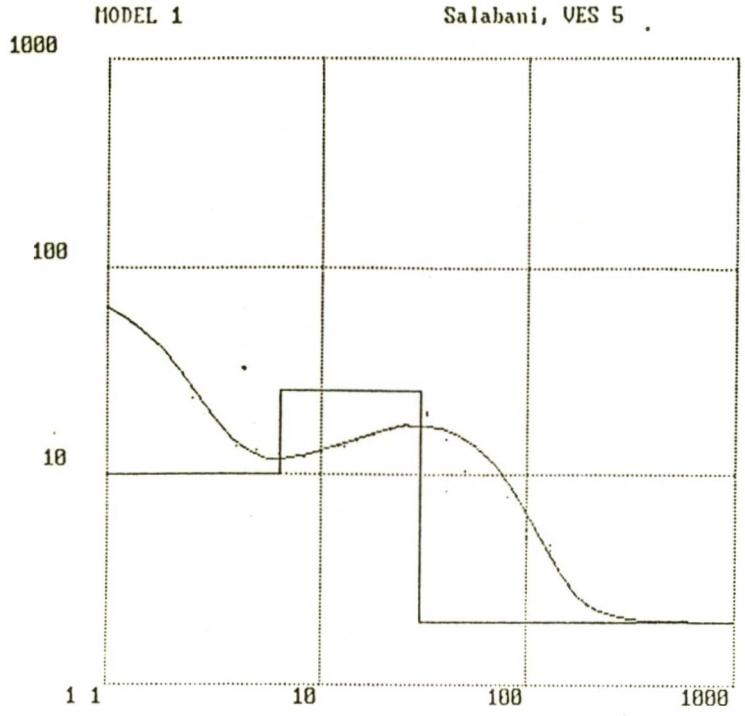


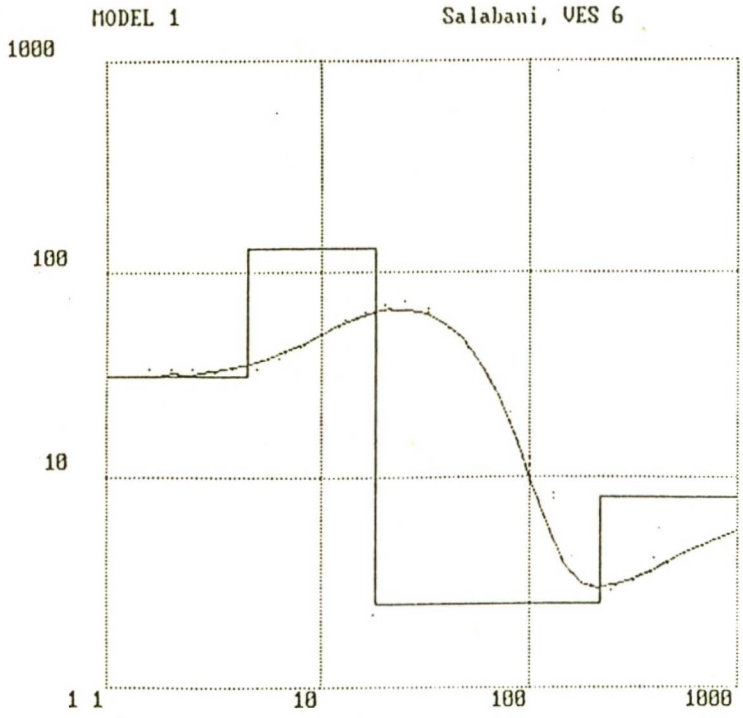
Appendix 3. 3. 1a



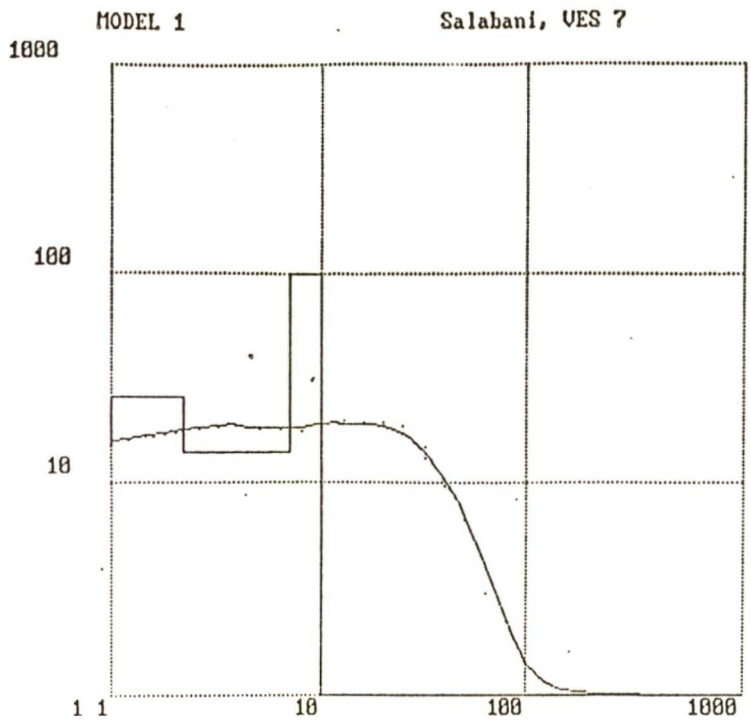


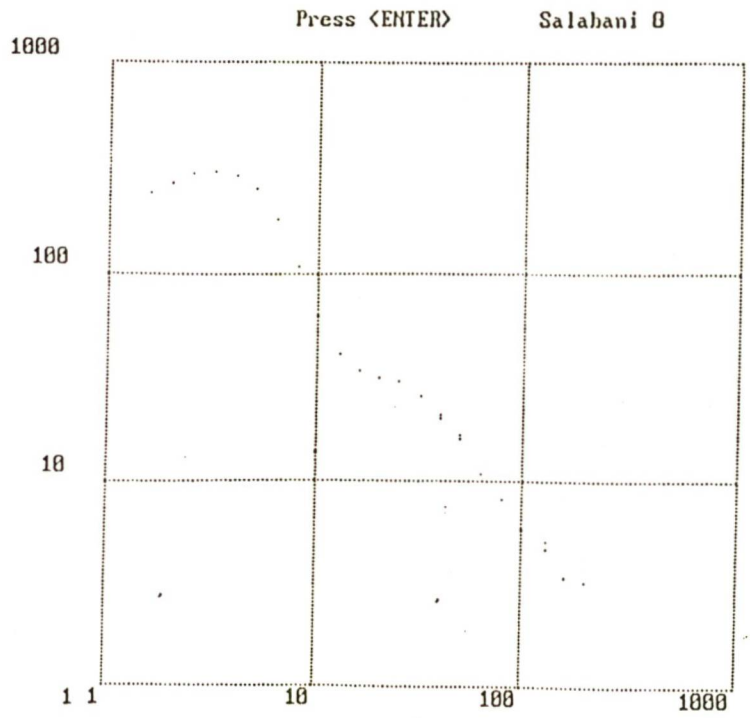
Appendix 3. 3.1b



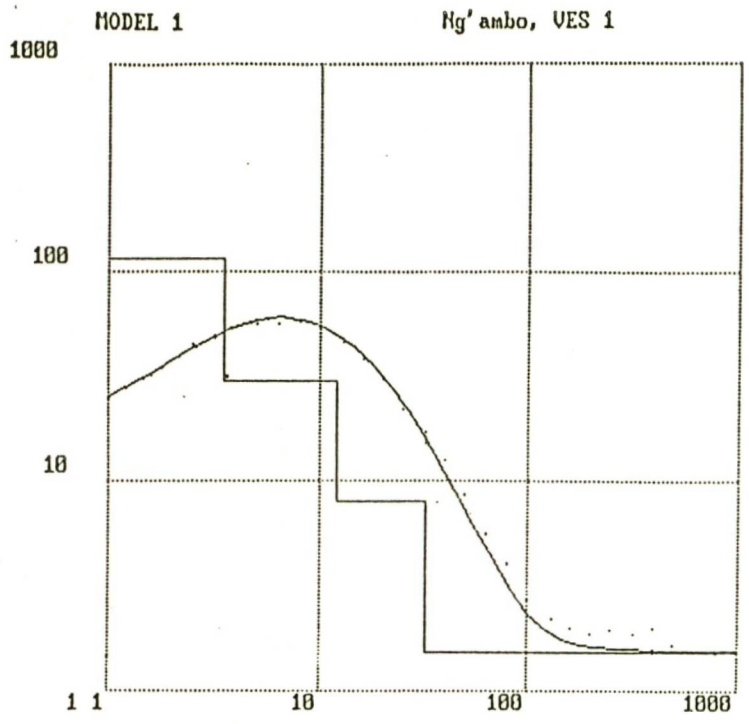


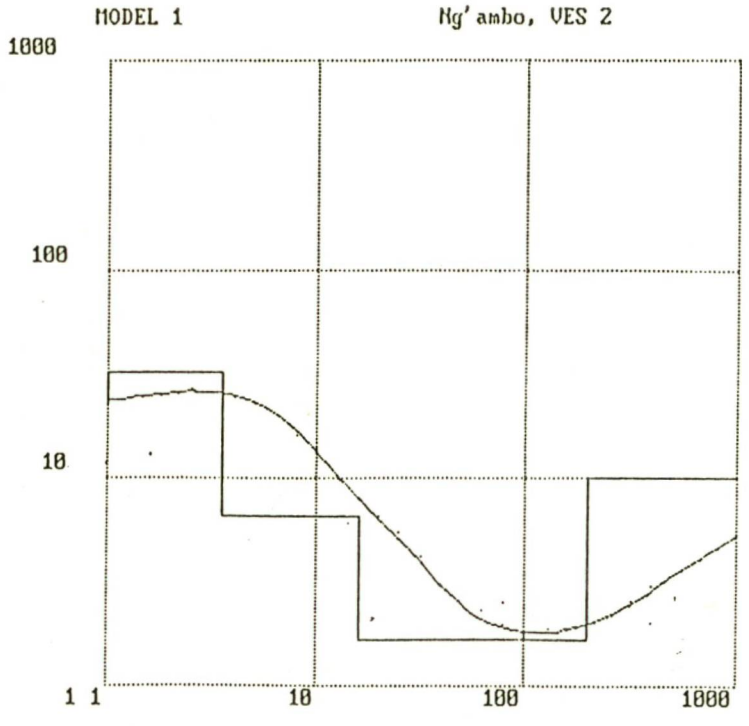
Appendix 3. 3. 1c



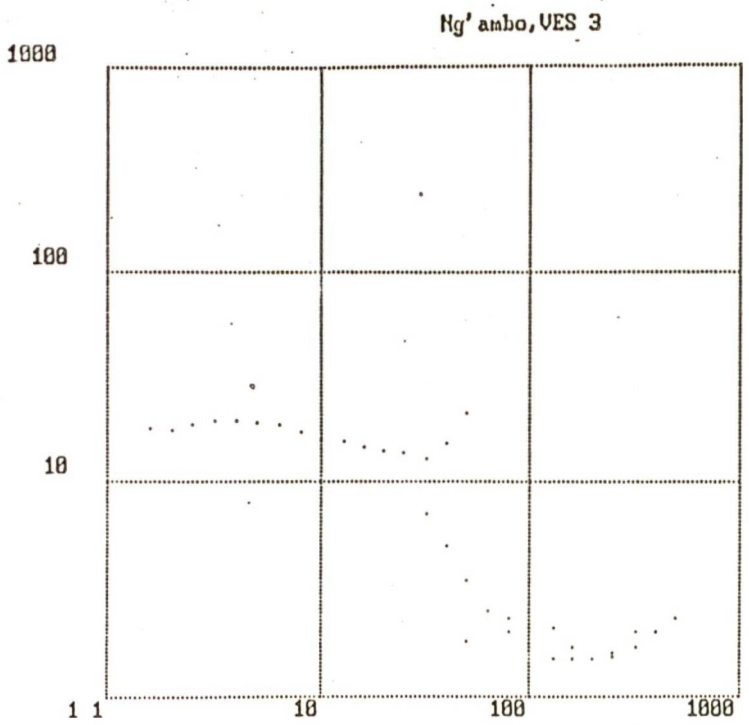


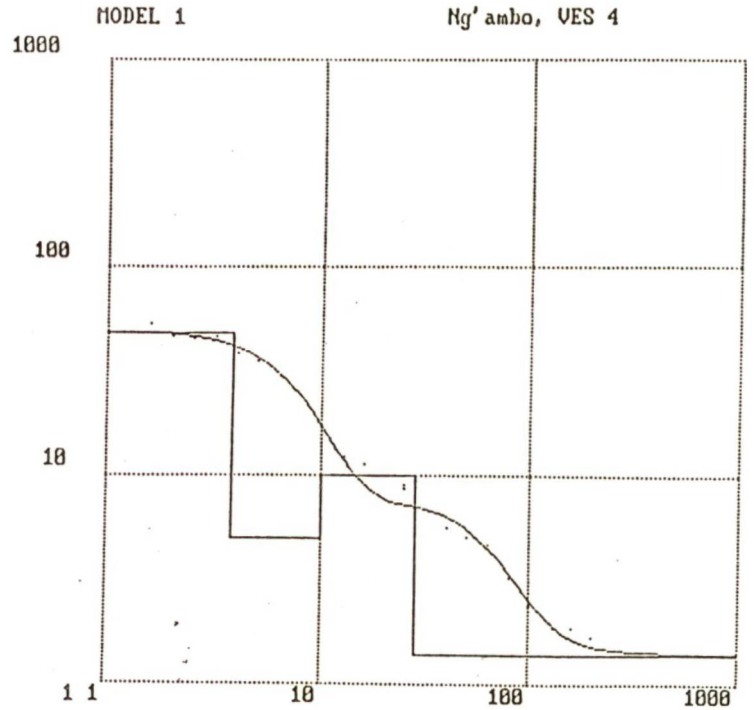
Appendix 3. 3. 1d



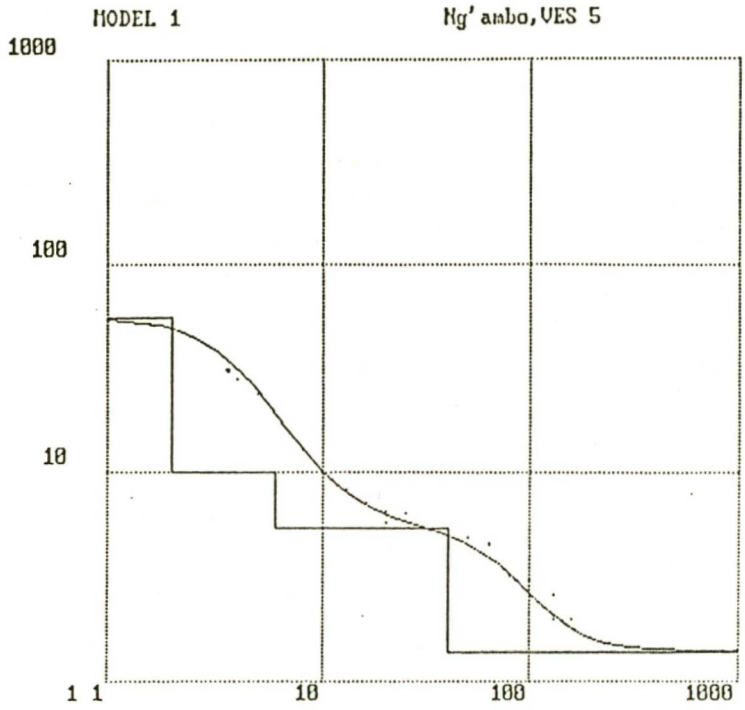


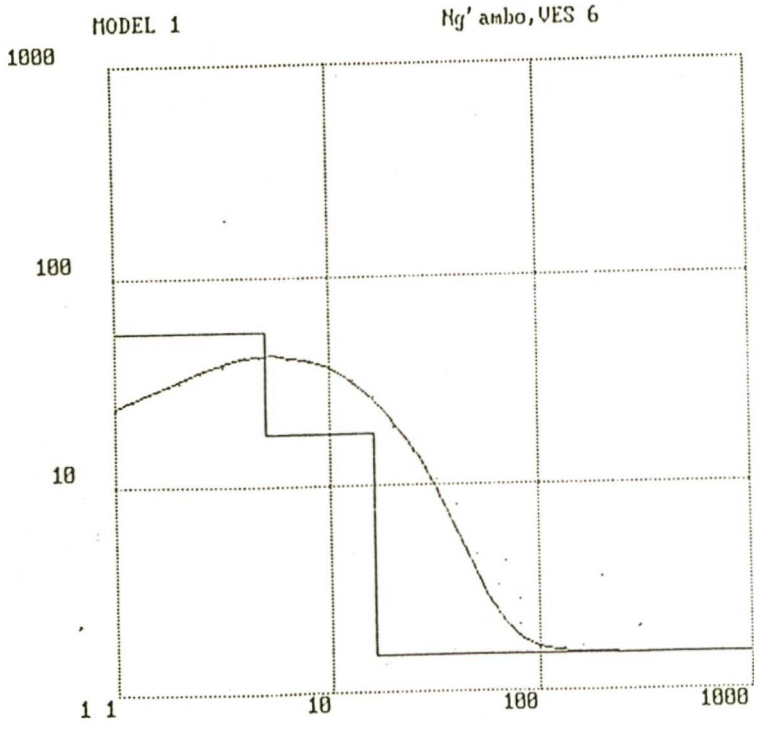
Appendix 3. 3. 2a



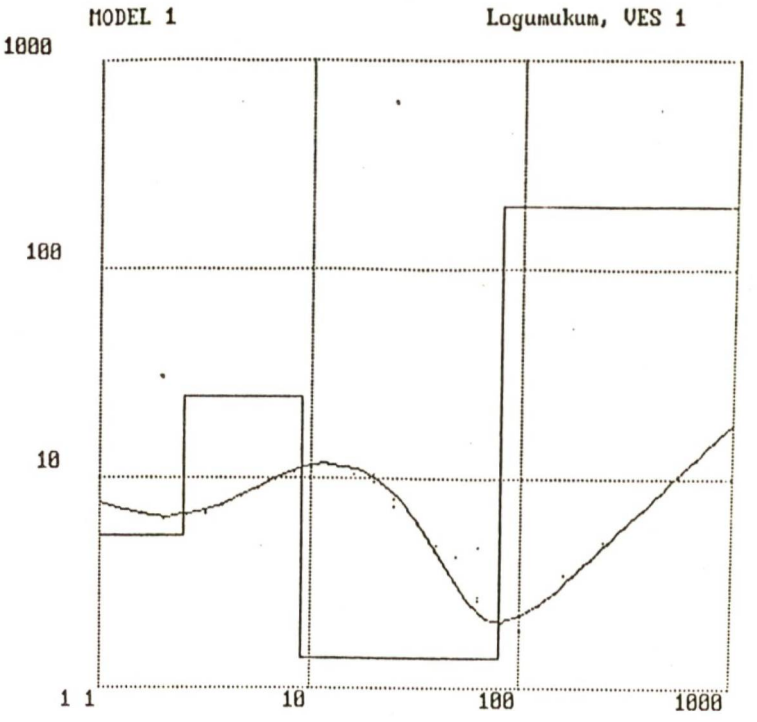


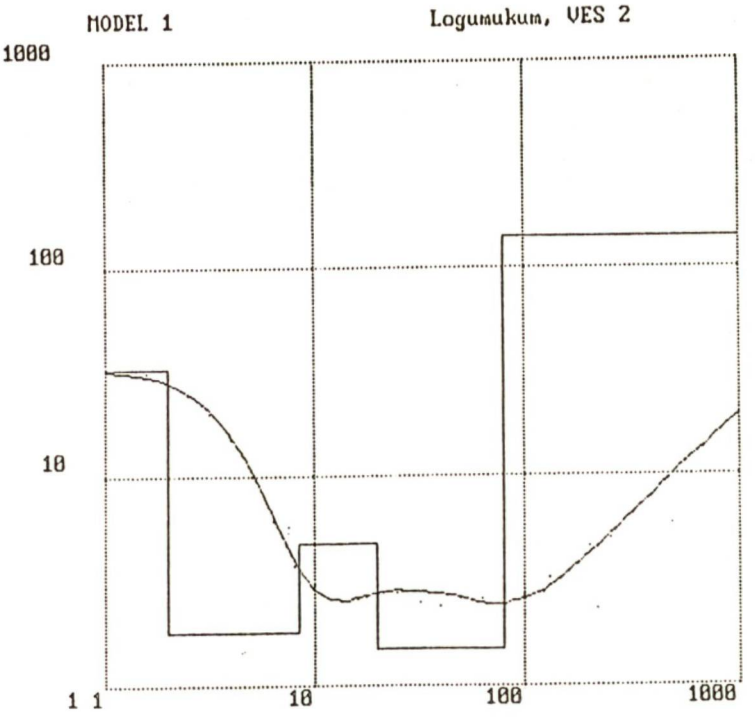
Appendix 3 3 2b



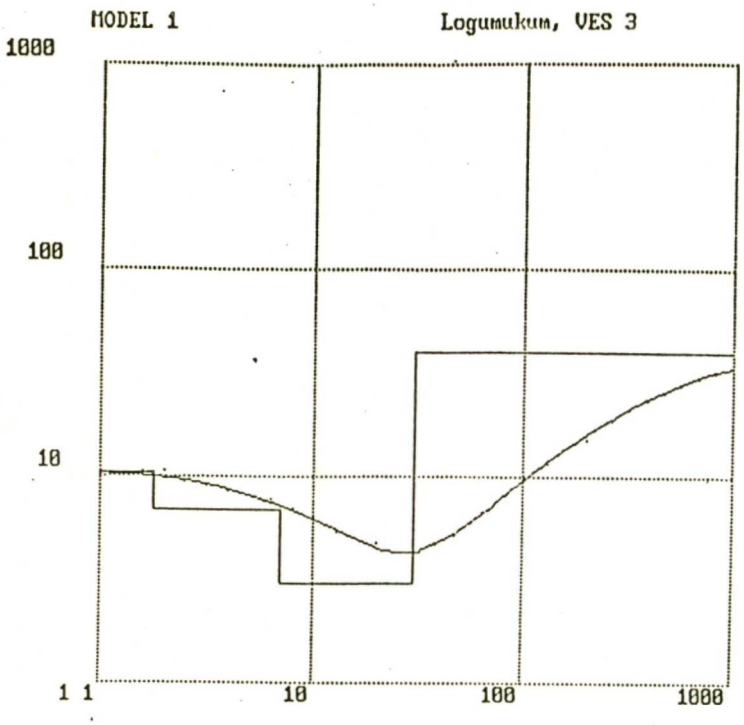


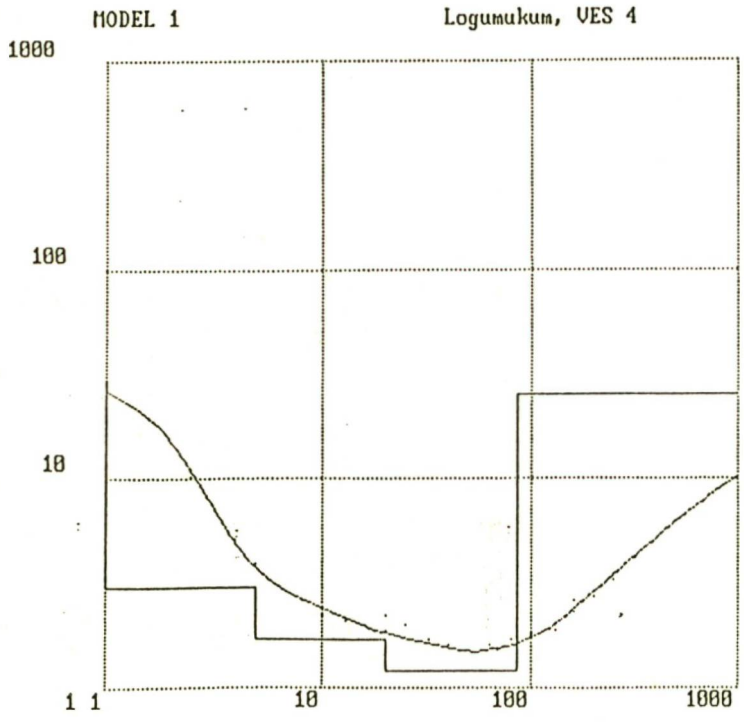
Appendix 3 3 2c



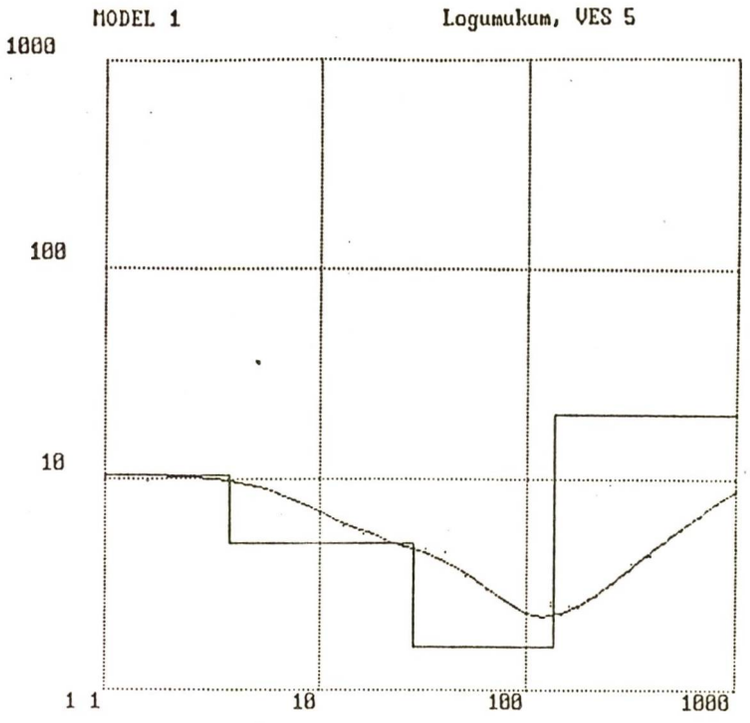


Appendix 3.3.3a

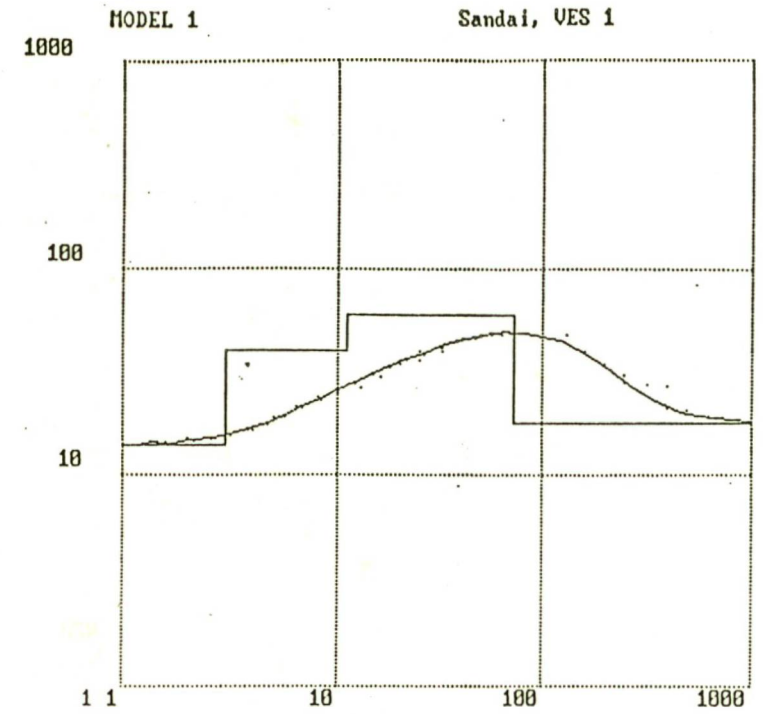


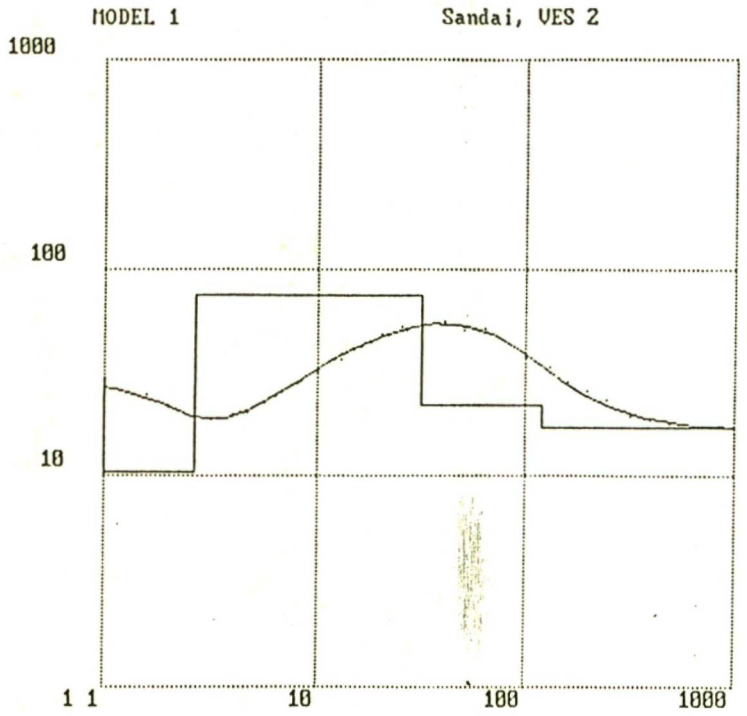


Appendix 3. 3. 3b

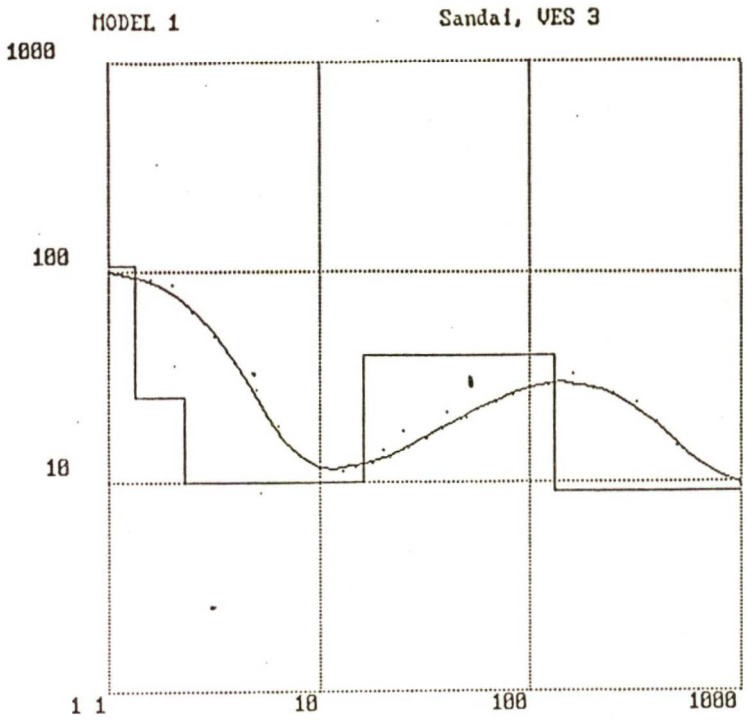


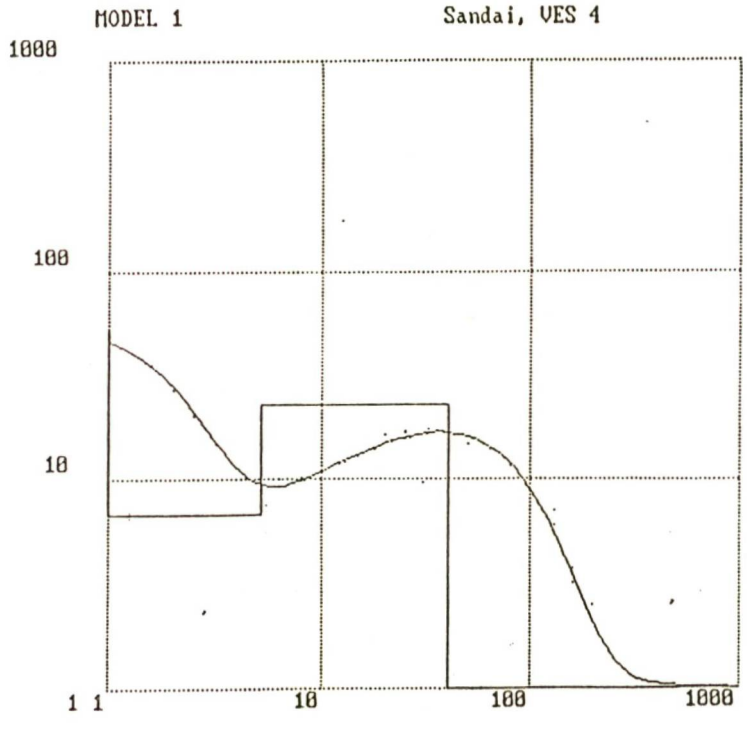
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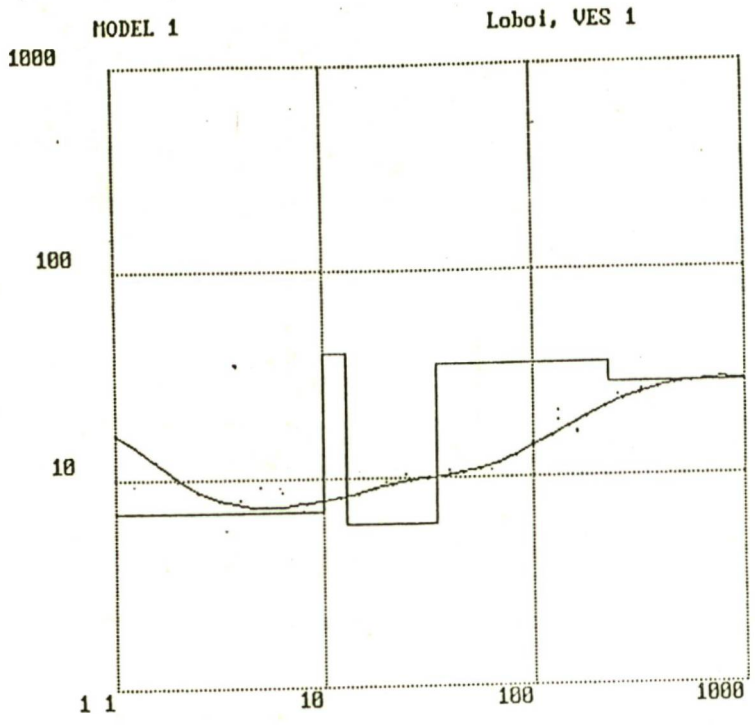


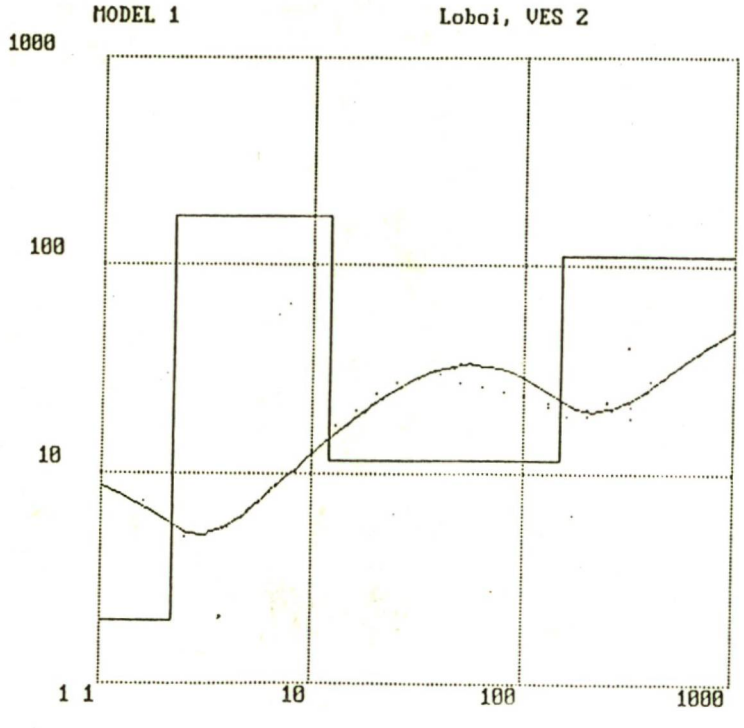
Appendix 3. 3. 4a



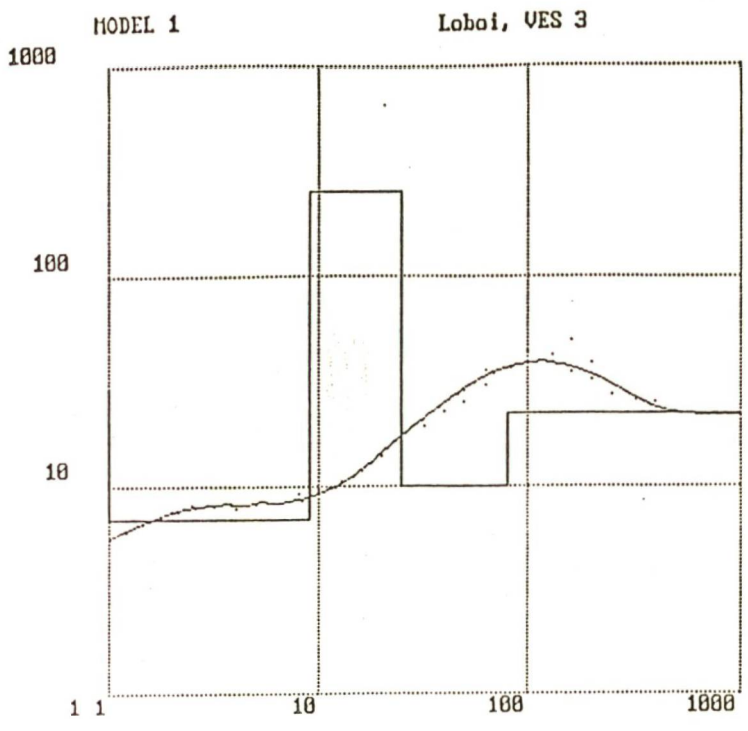


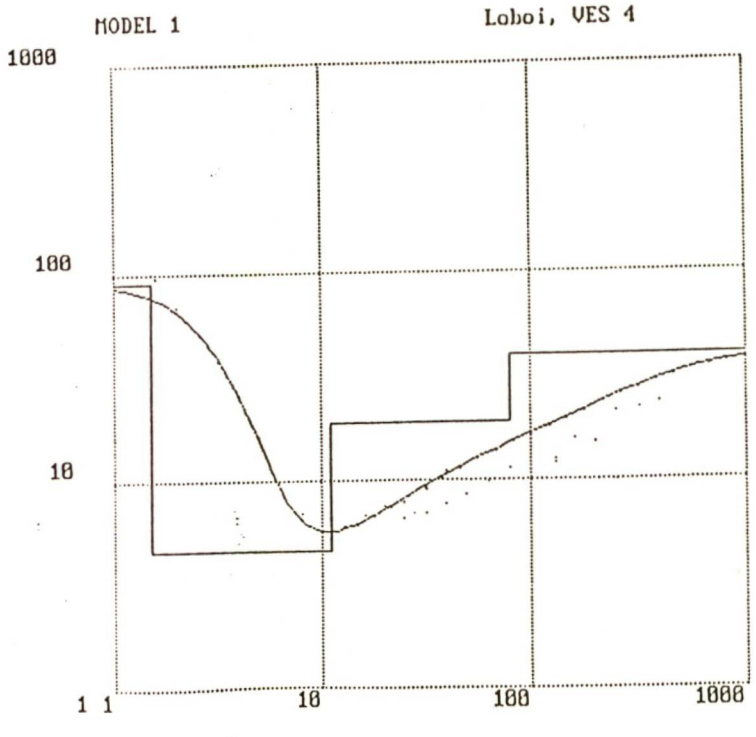
Appendix 3.3.4b



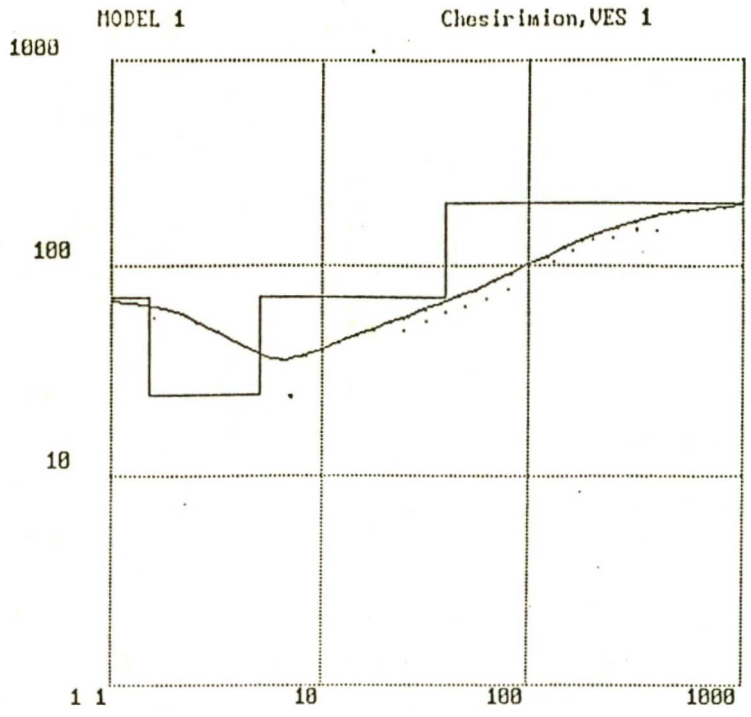


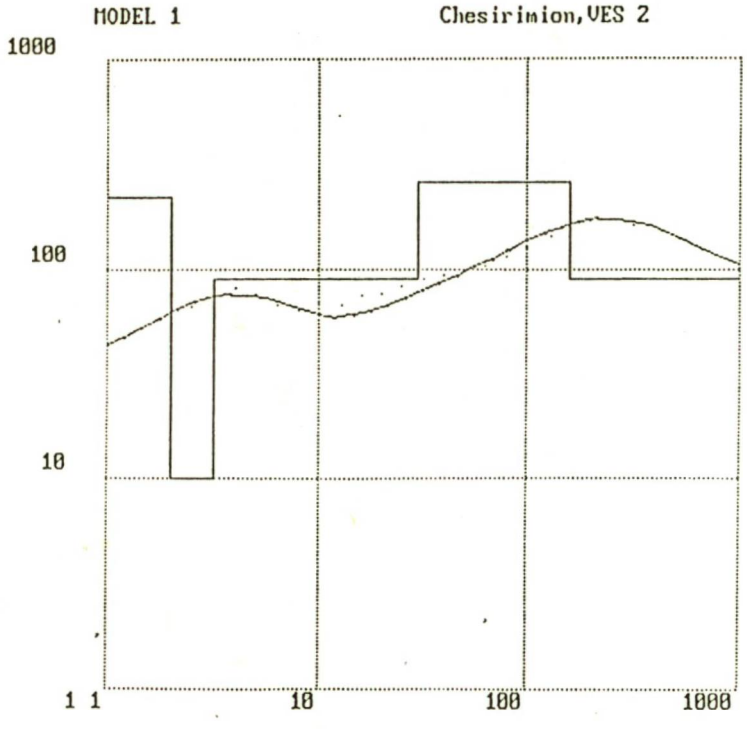
Appendix 3. 3. 5a



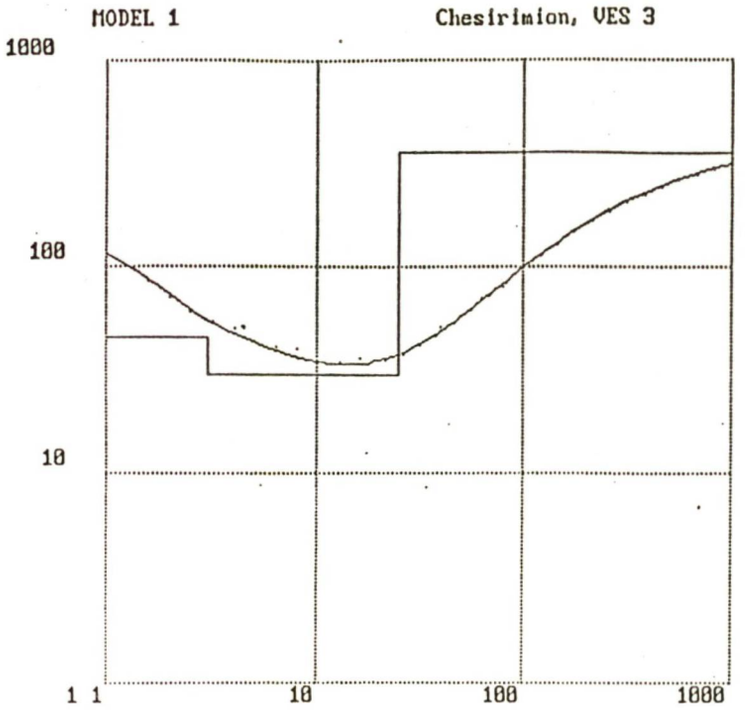


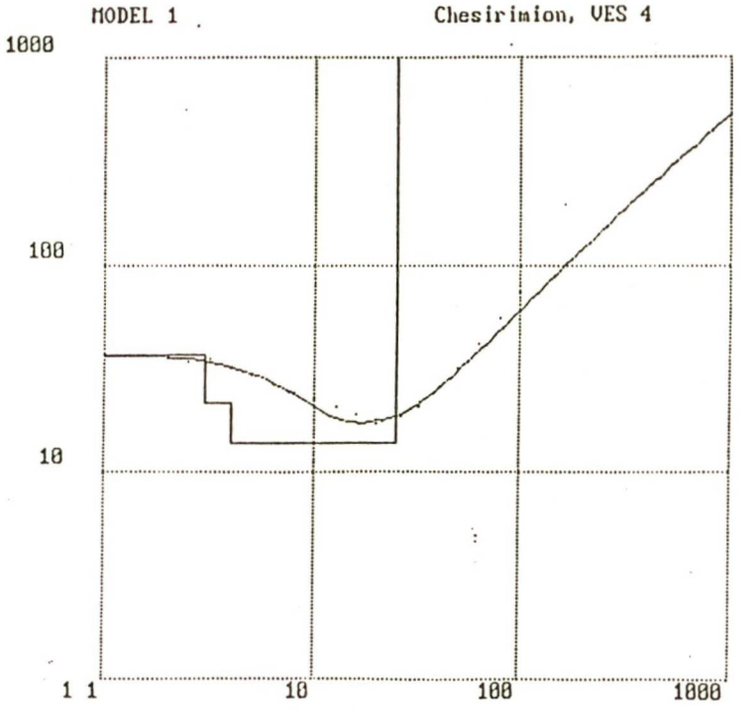
Appendix 3. 3. 5b



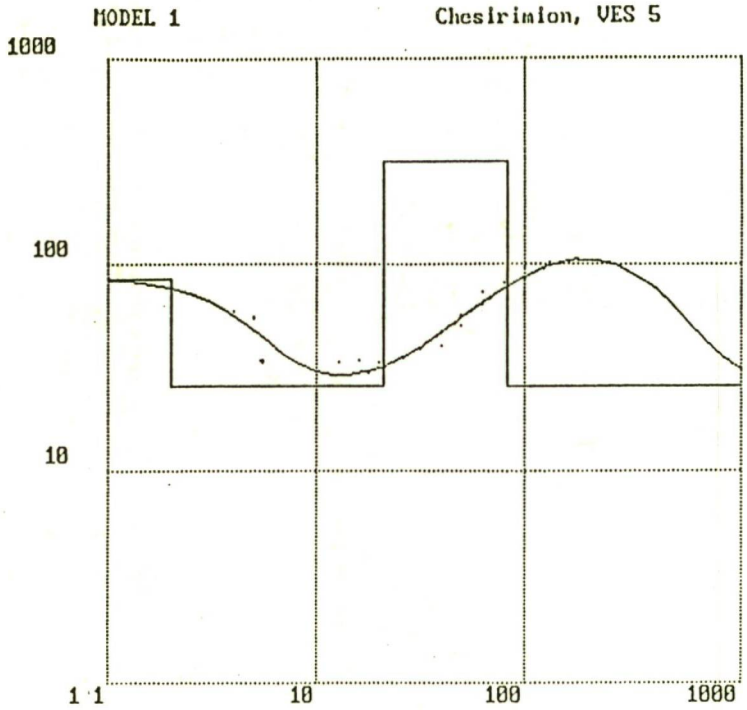


Appendix 3. 3. 6a

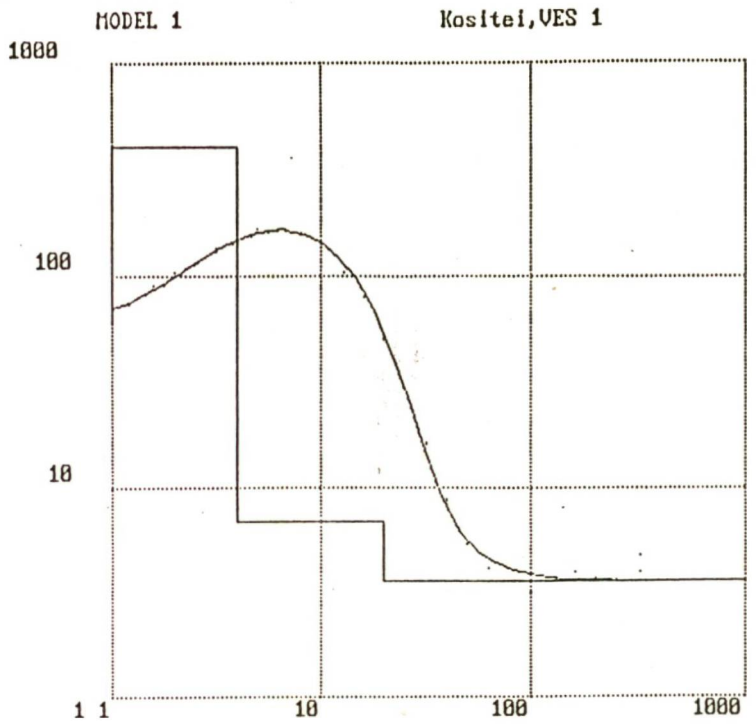


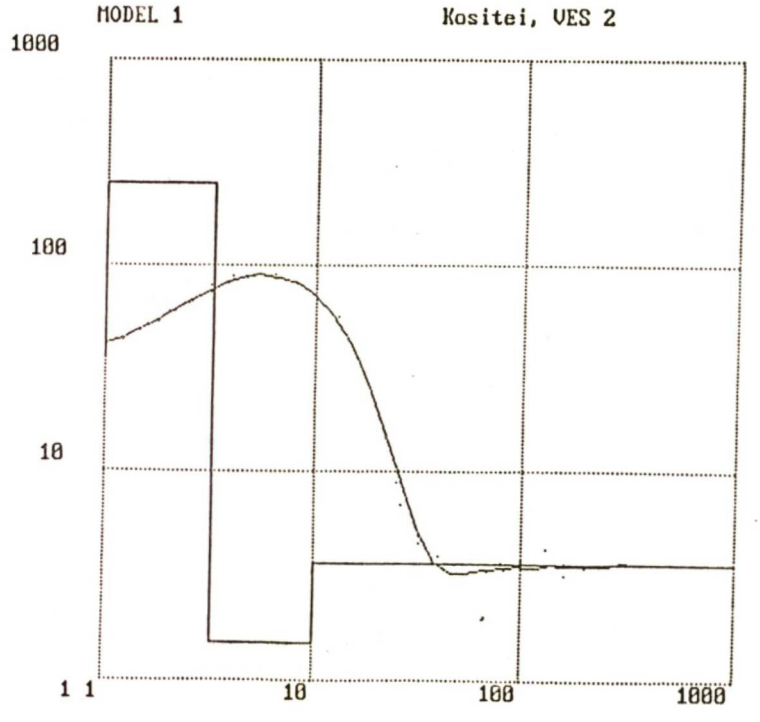


Appendix 3. 3. 6b

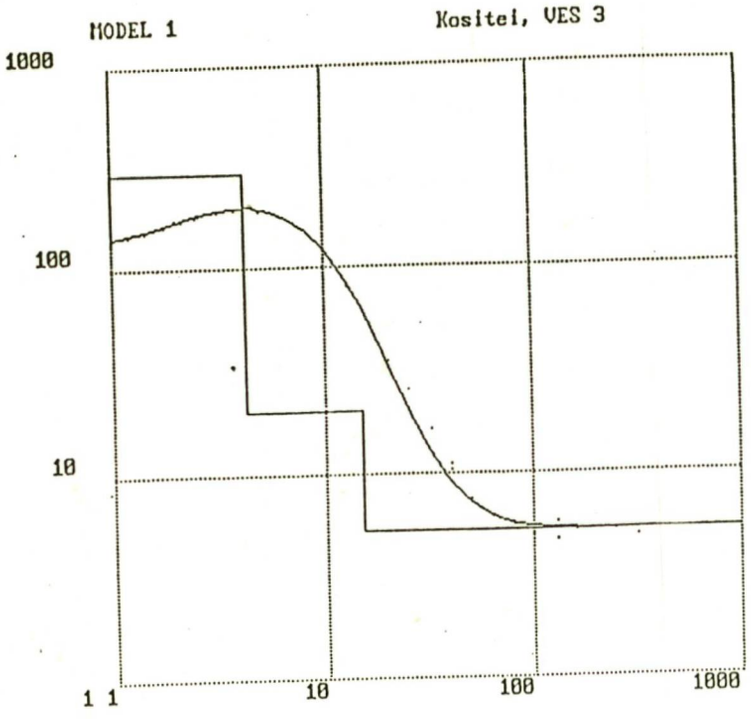


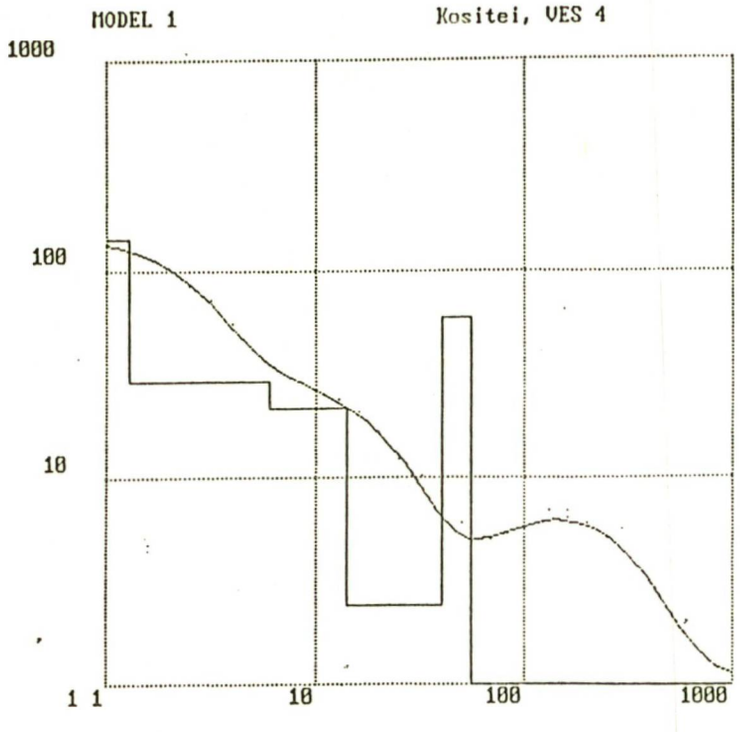
Appendix 3. 3. 6c



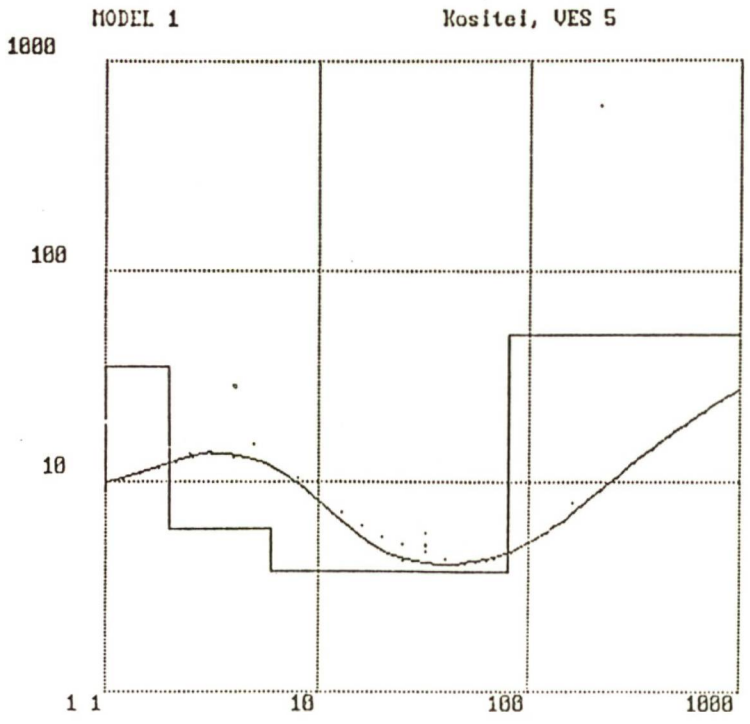


Appendix 3. 3. 7a

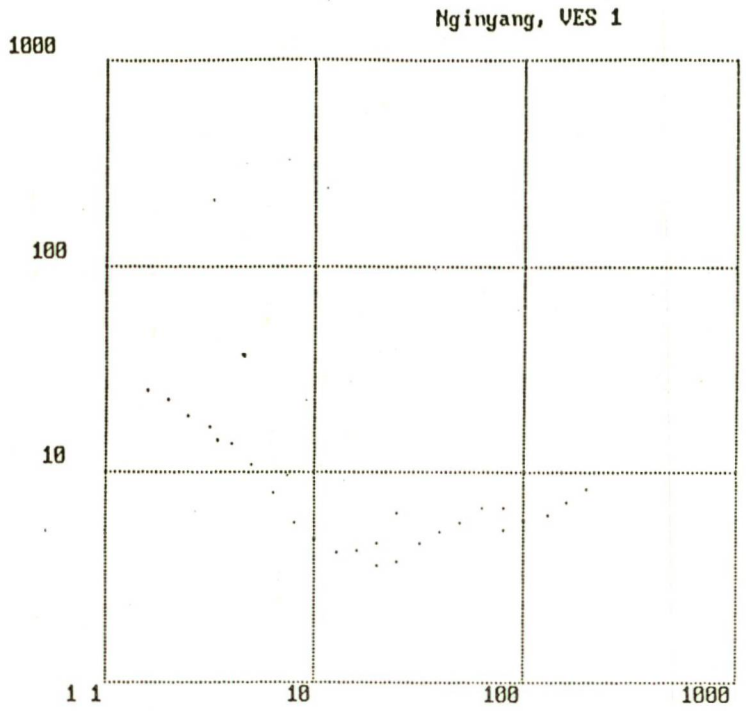




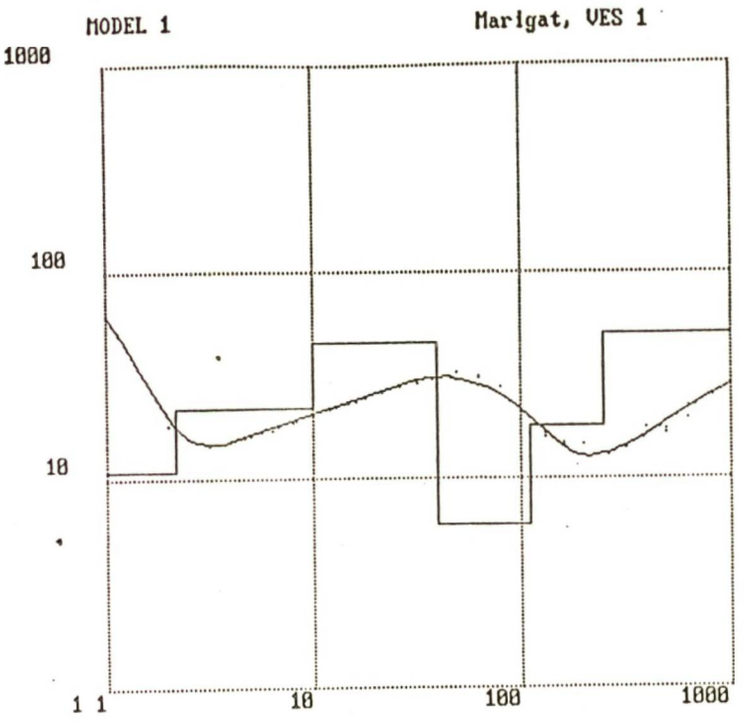
Appendix 3. 3. 7b

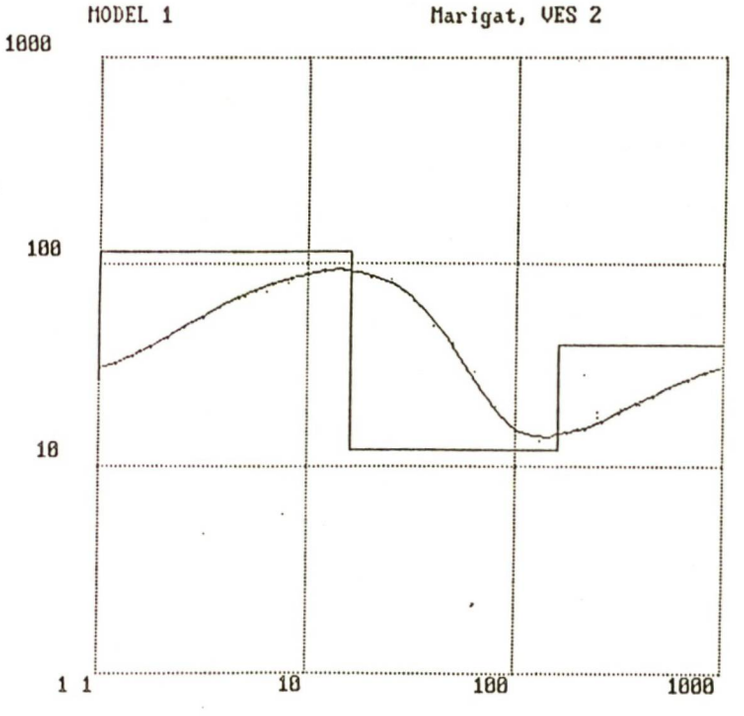


Appendix 3. 3. 7c

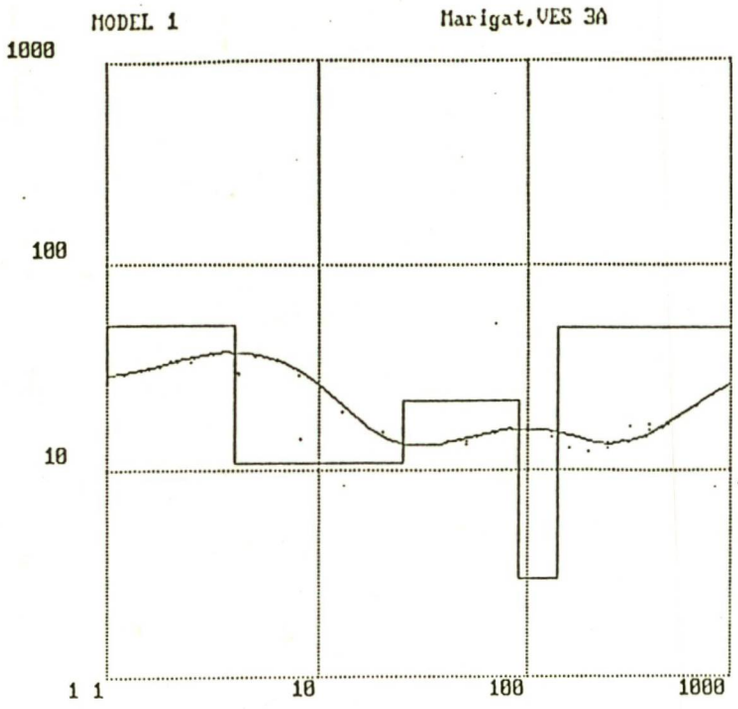


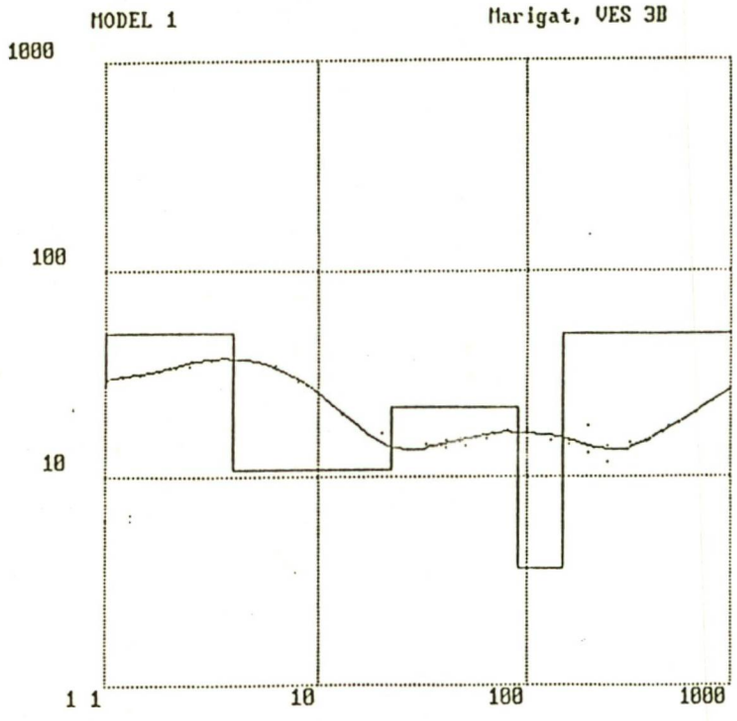
Appendix 3. 3. 7d



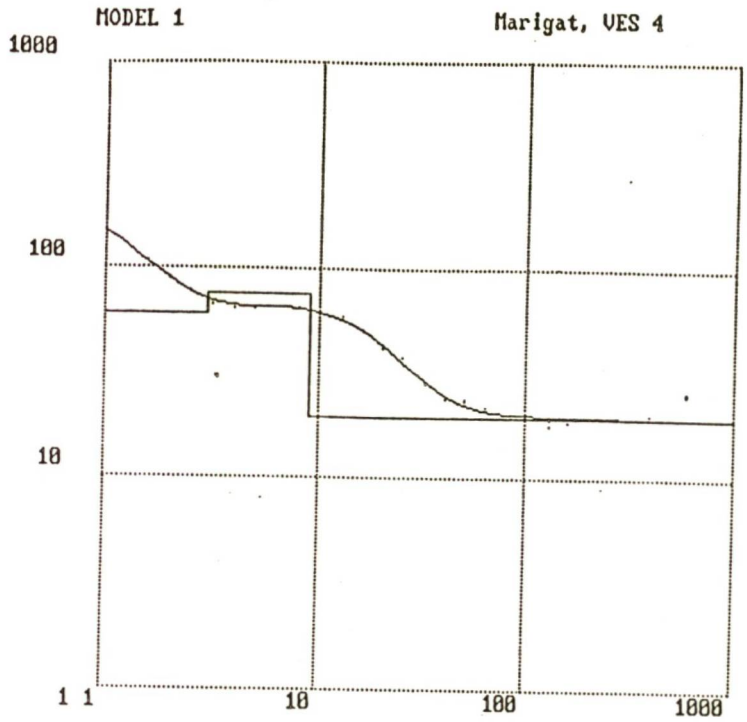


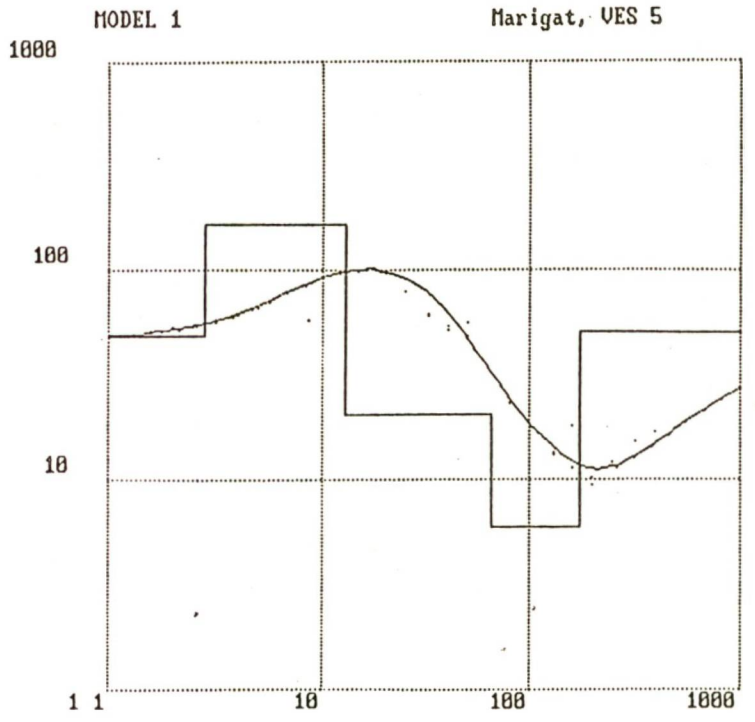
Appendix 3. 3. 8a



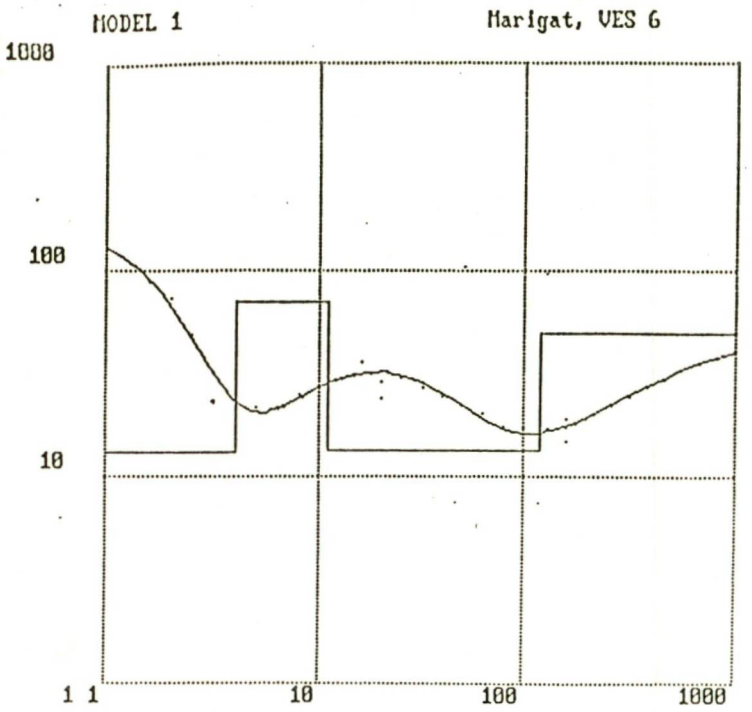


Appendix 3. 3. 8b

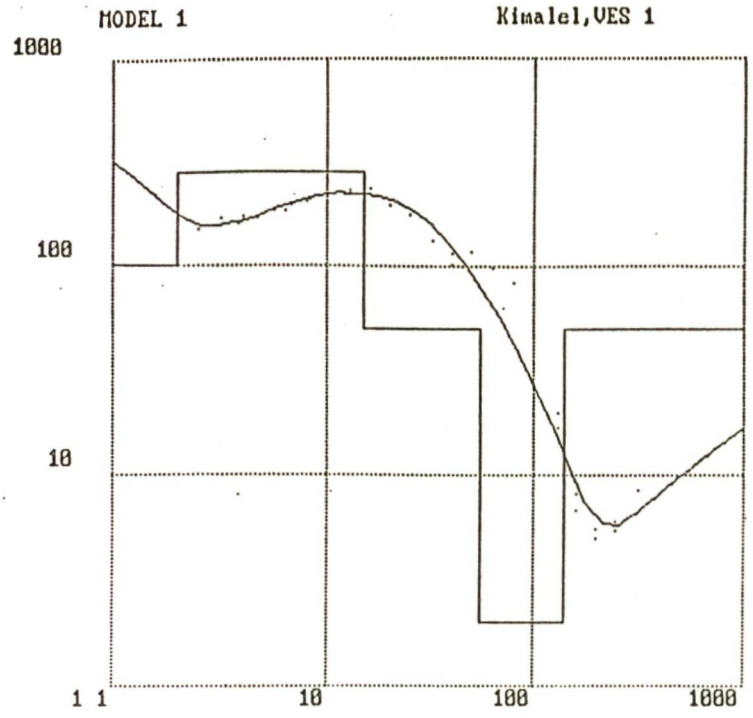


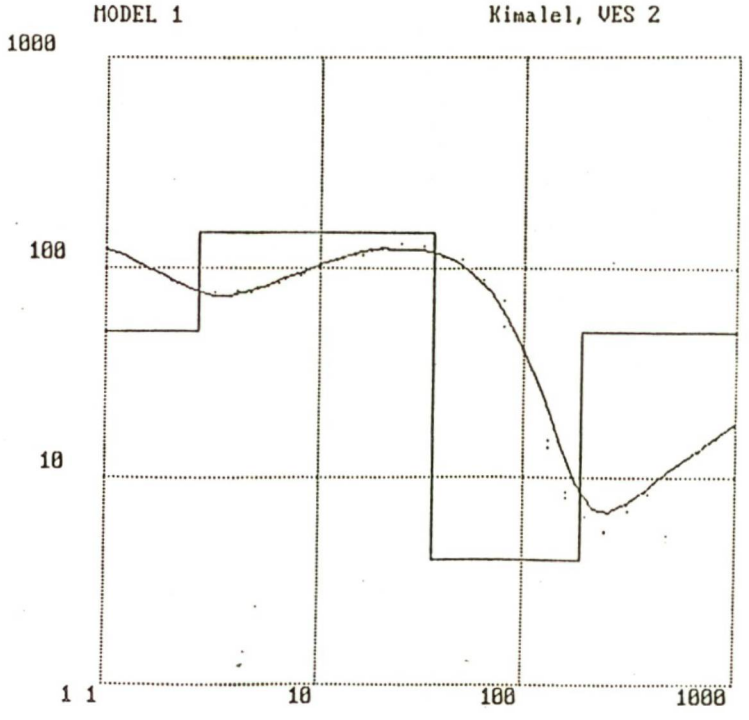


Appendix 3. 3. 8c

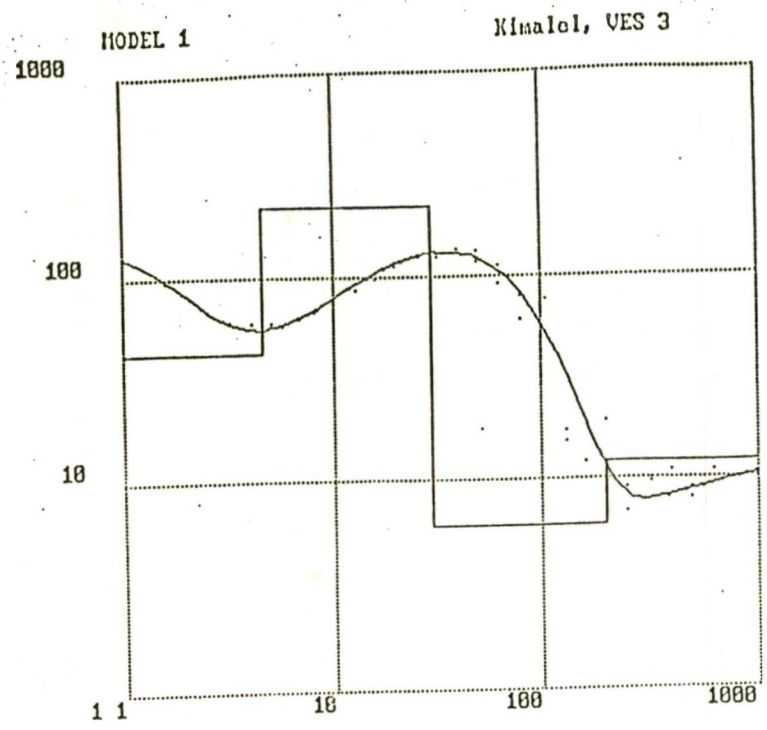


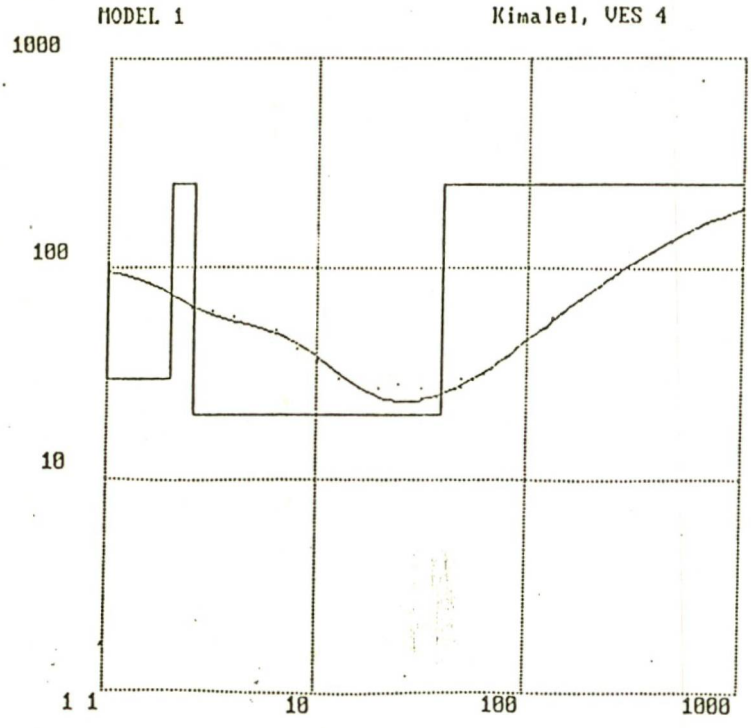
Appendix 3. 3. 8d



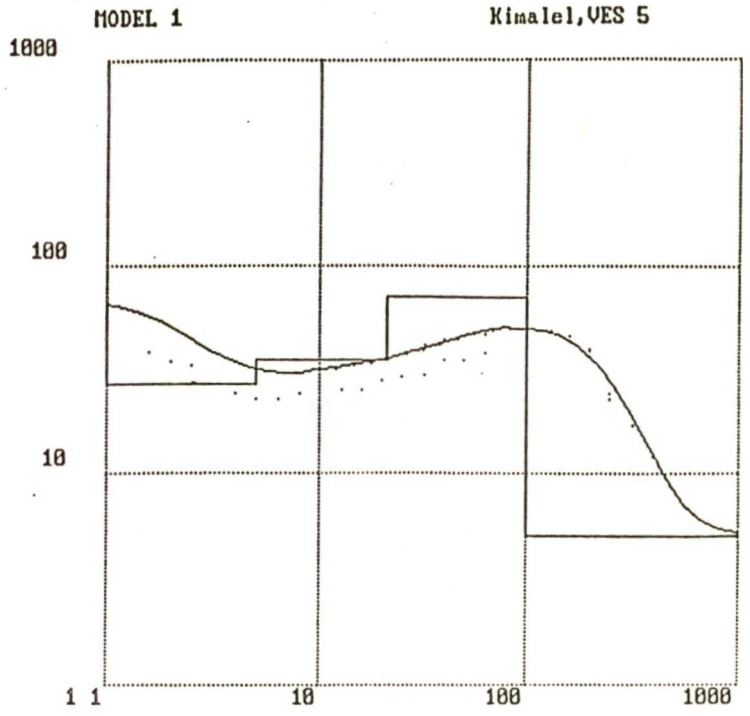


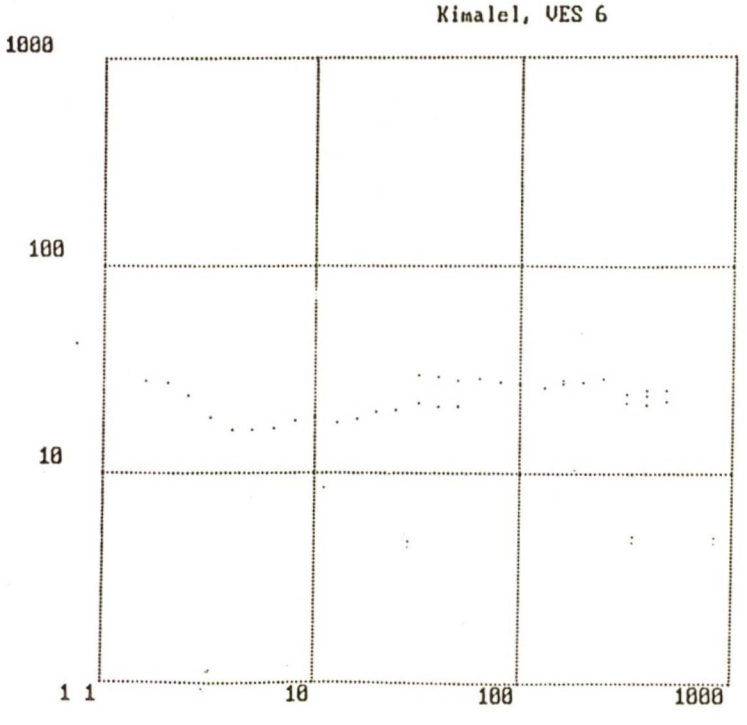
Appendix 3. 3. 9a



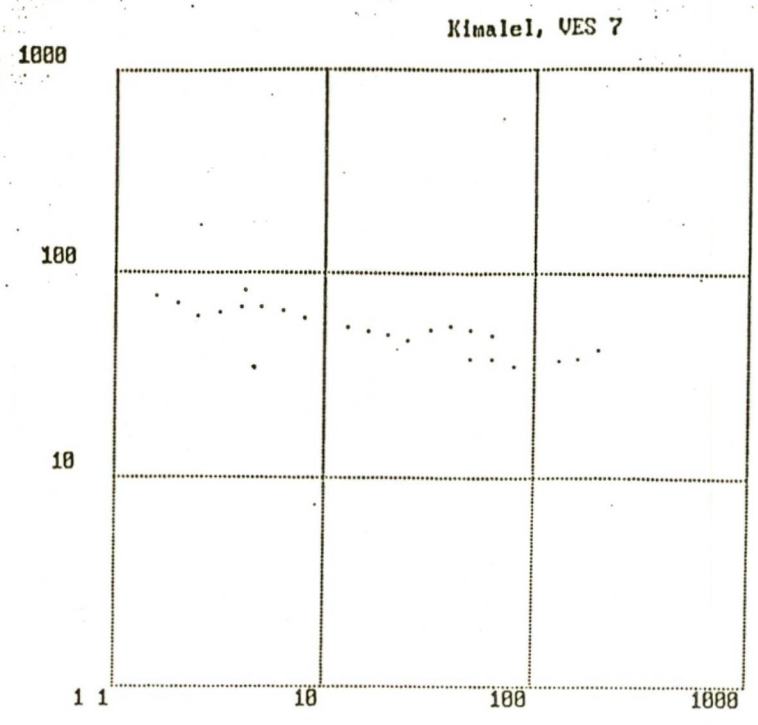


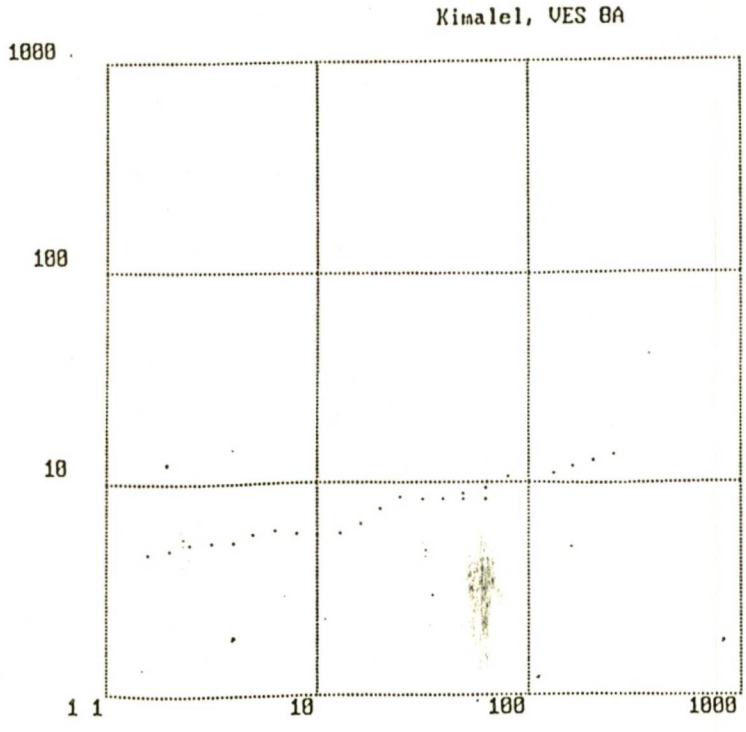
Appendix 3. 3. 9b



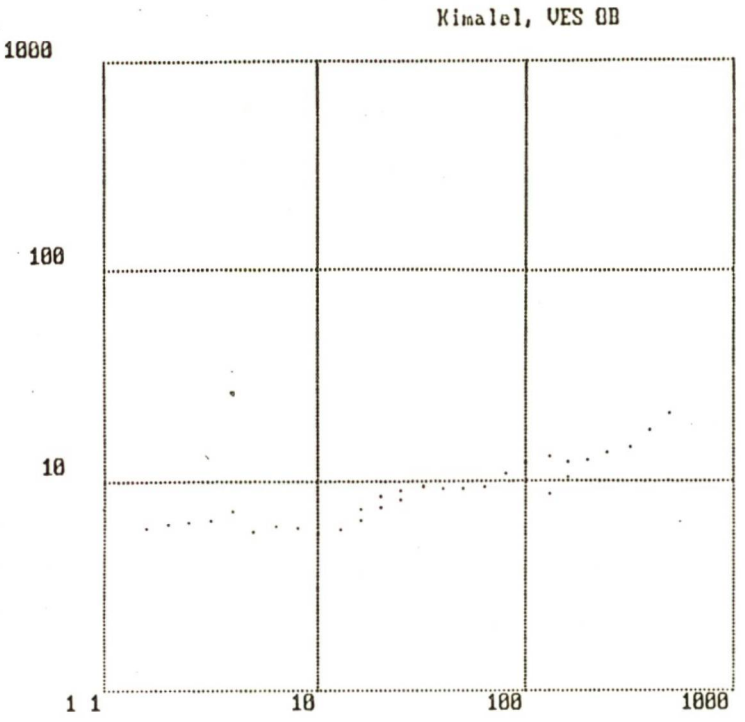


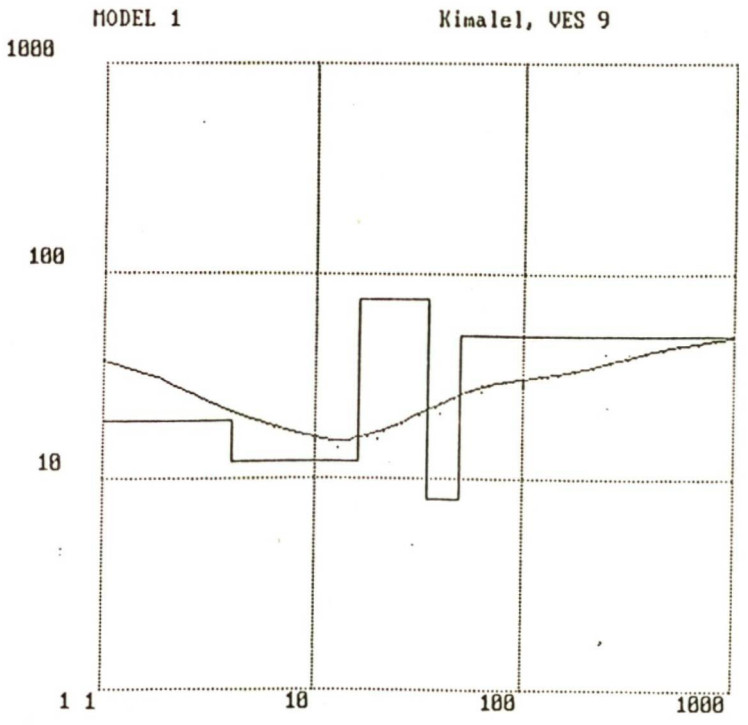
Appendix 3. 3. 9c



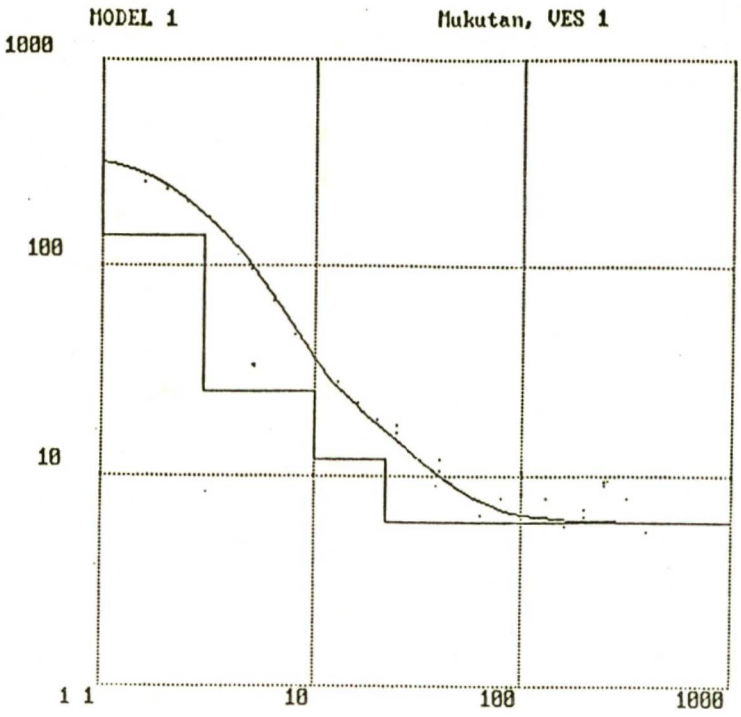


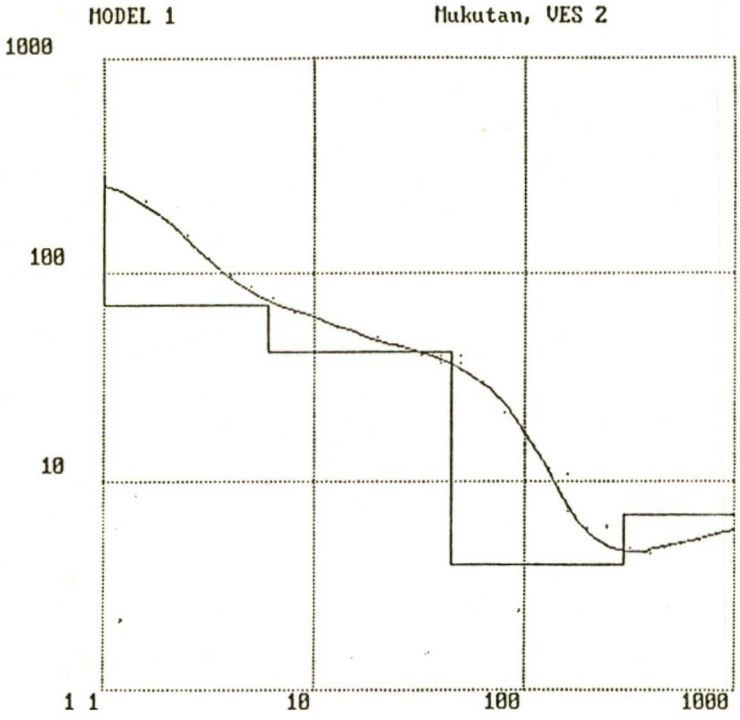
Appendix 3. 3. 9d



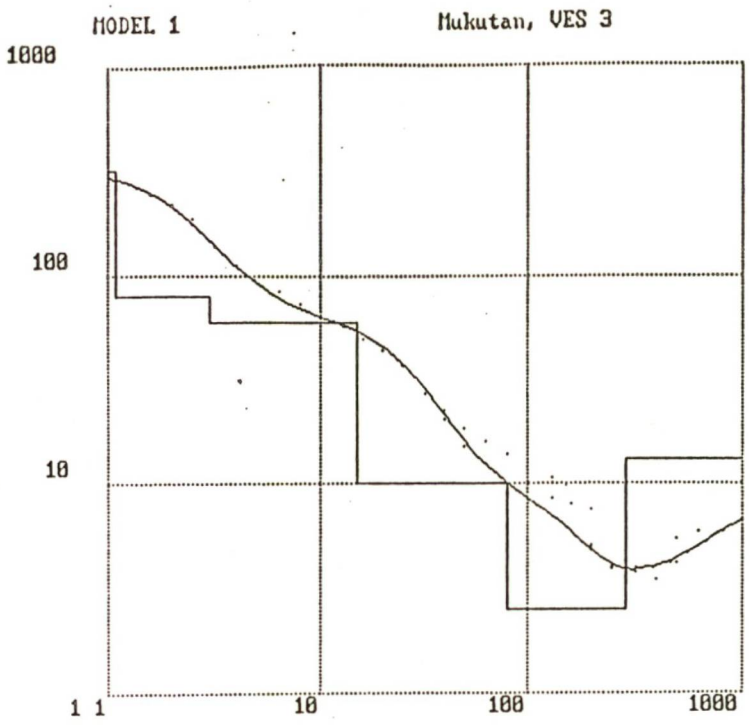


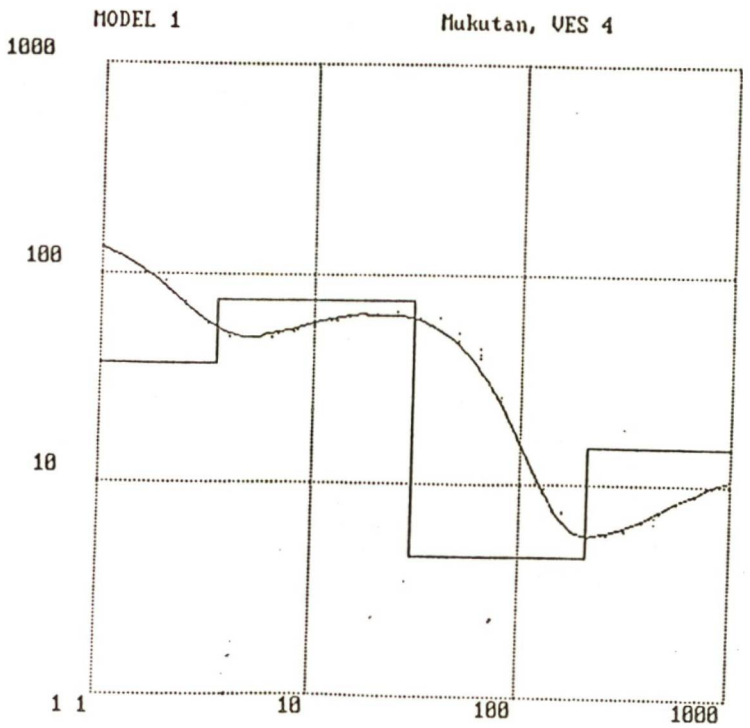
Appendix 3 3 9e



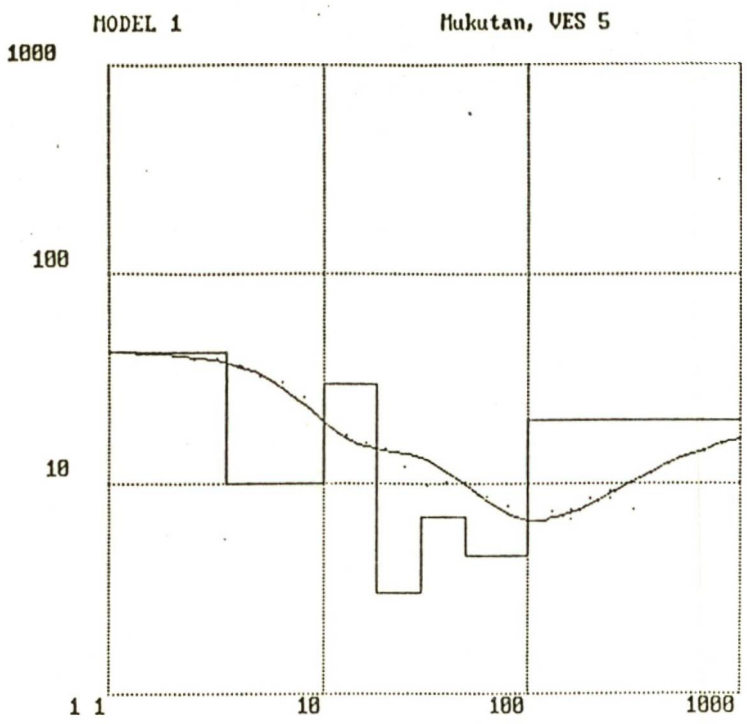


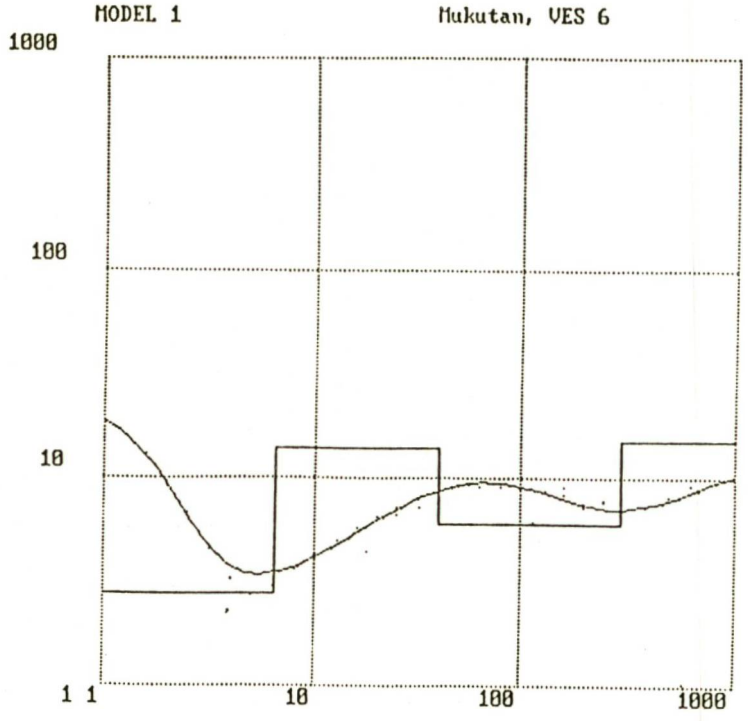
Appendix 3. 3. 10a



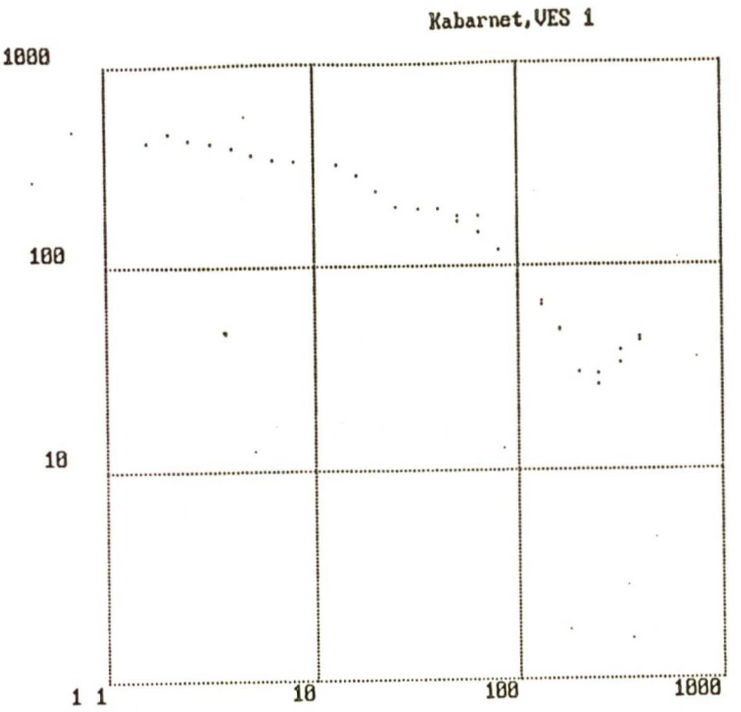


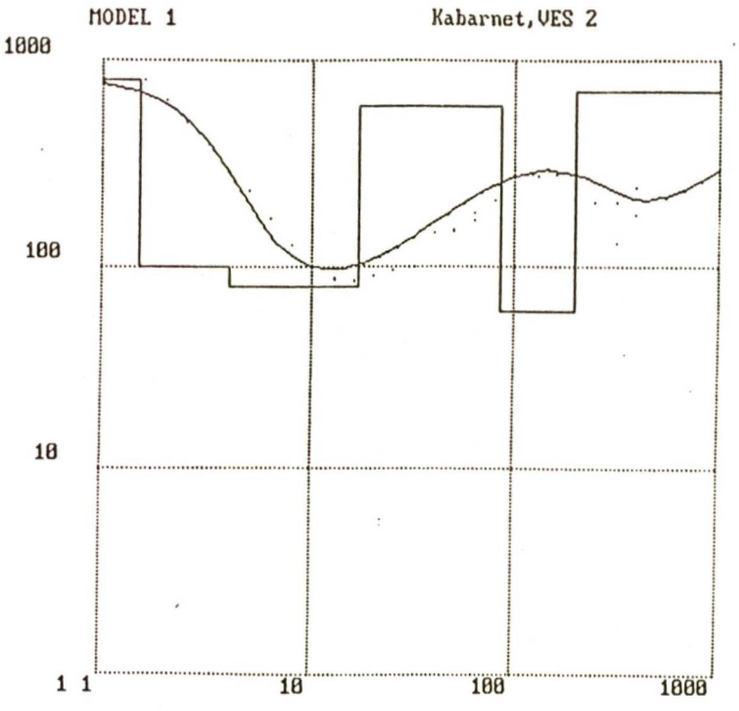
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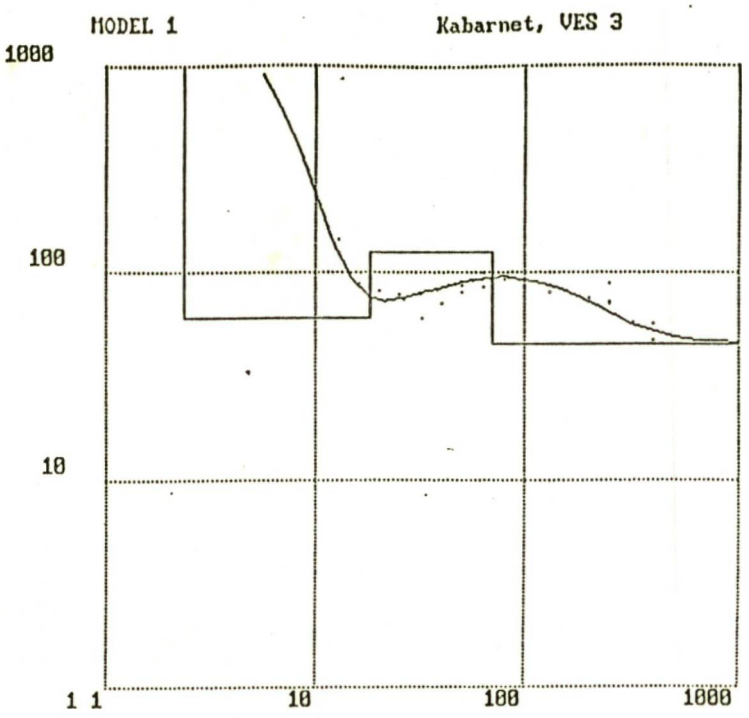


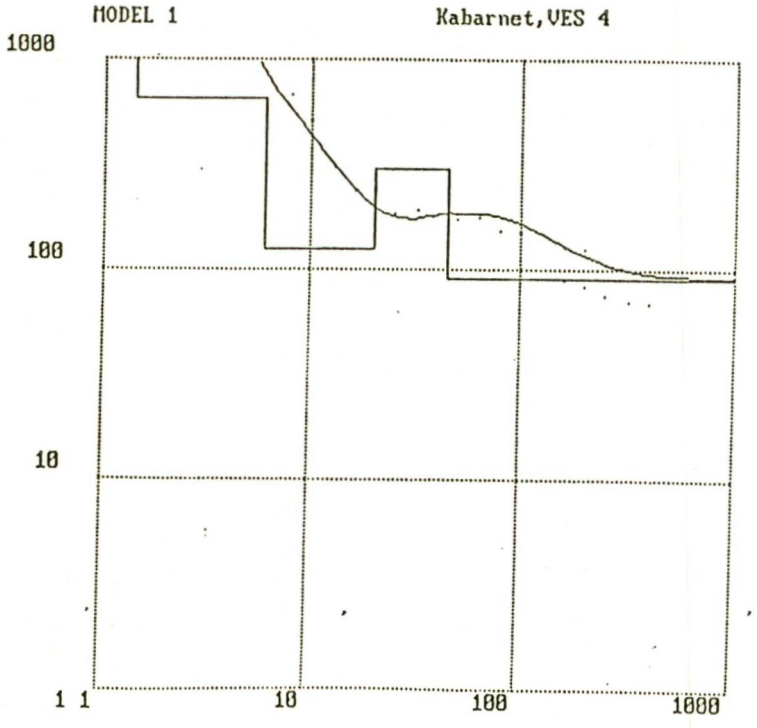
Appendix 3. 3. 10c



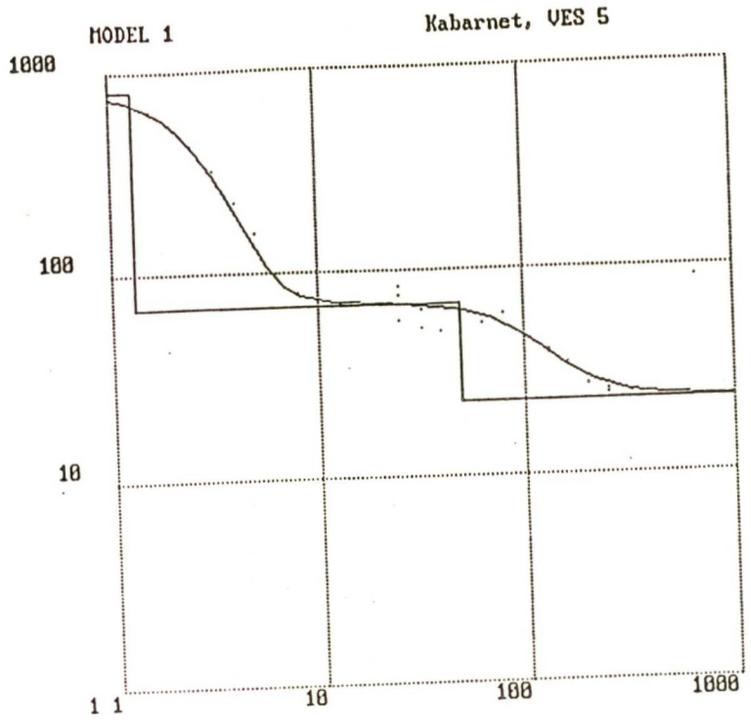


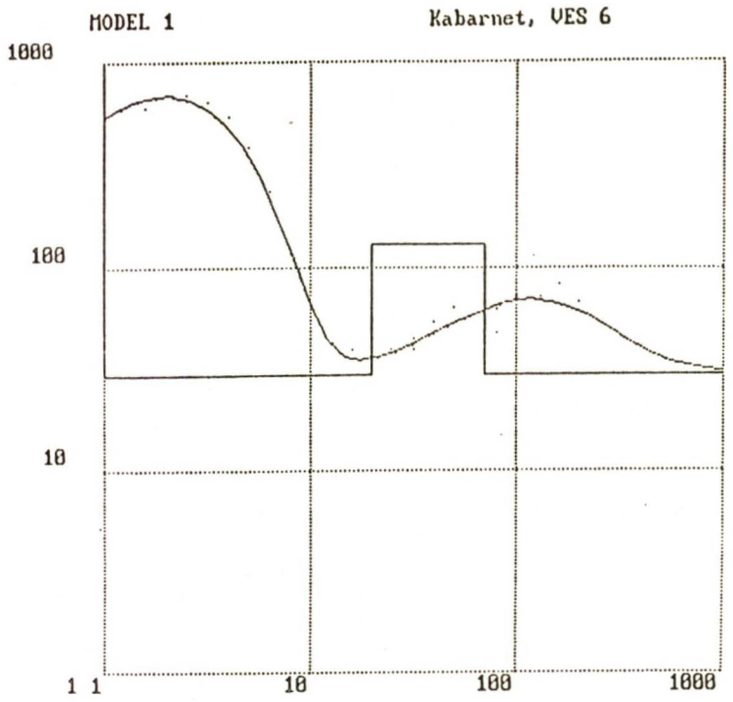
Appendix 3. 3. 11a



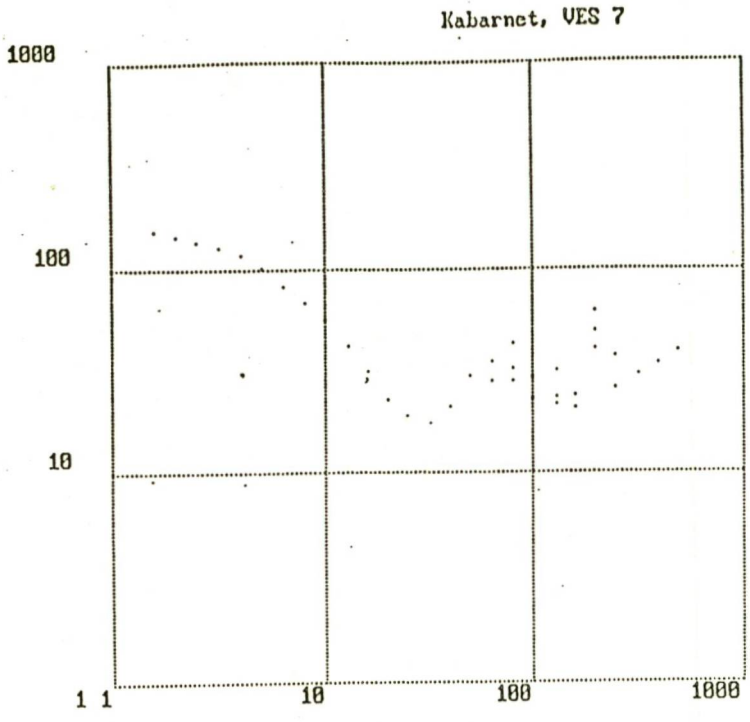


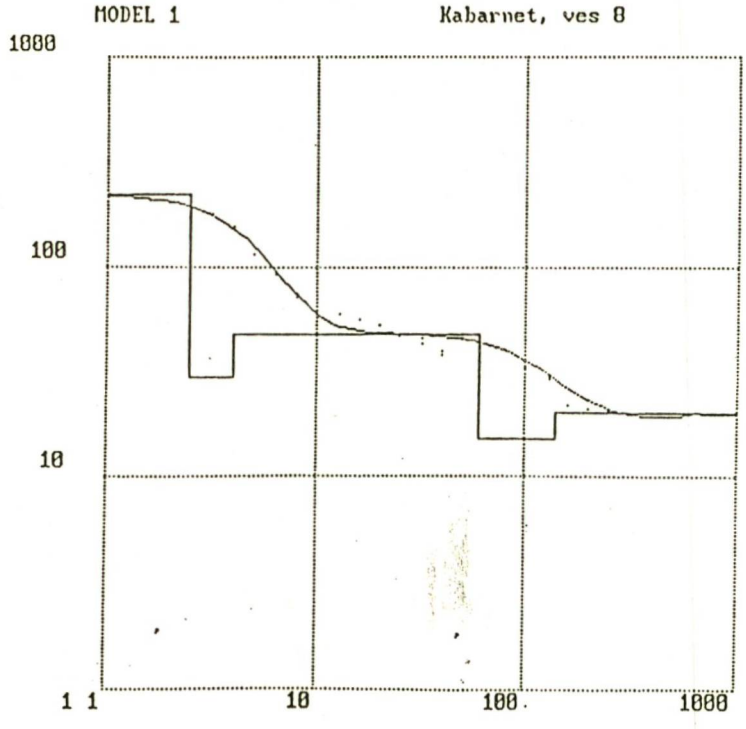
Appendix 3. 3. 11b



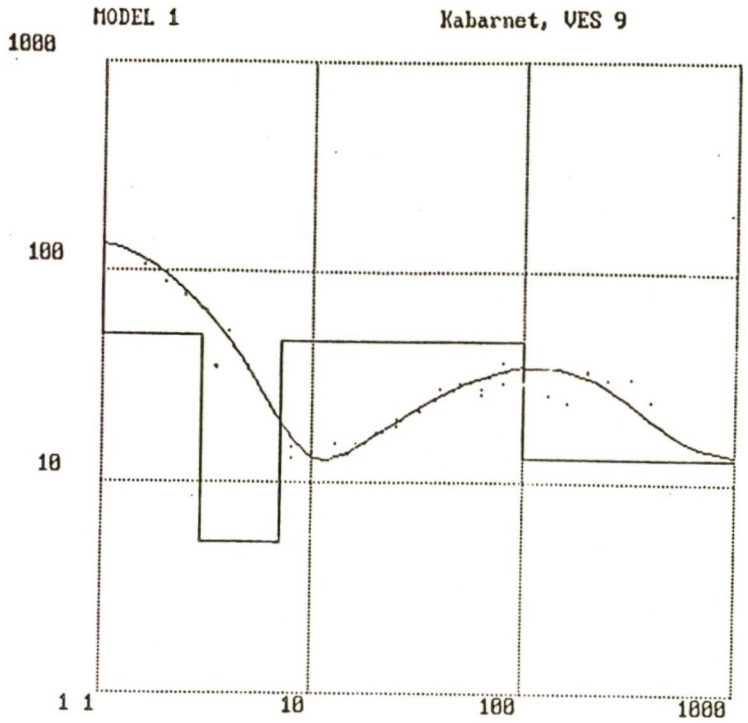


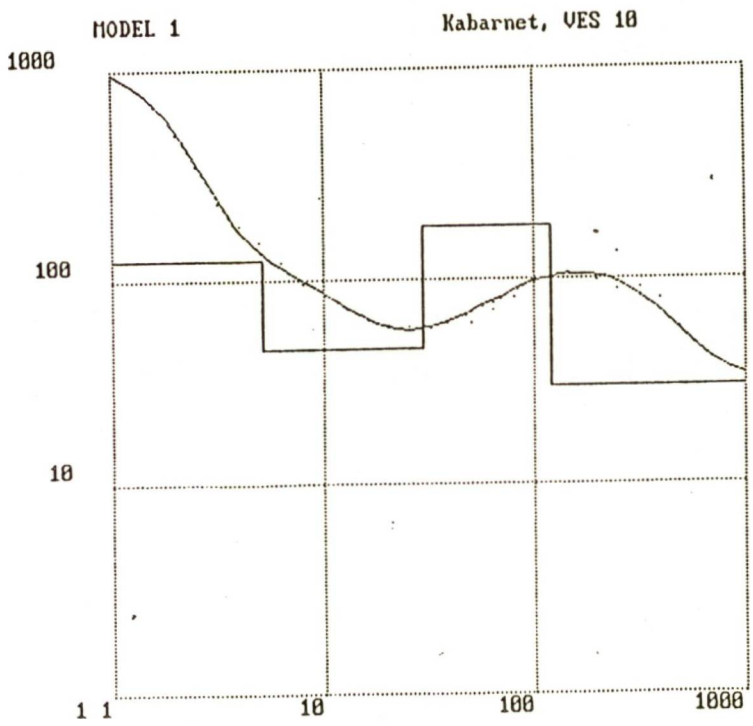
Appendix 3. 3. 11c



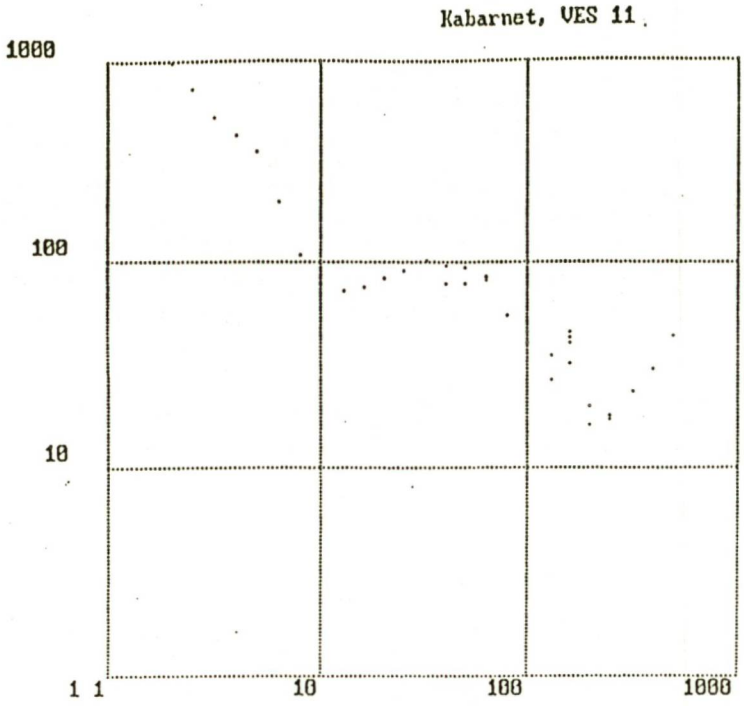


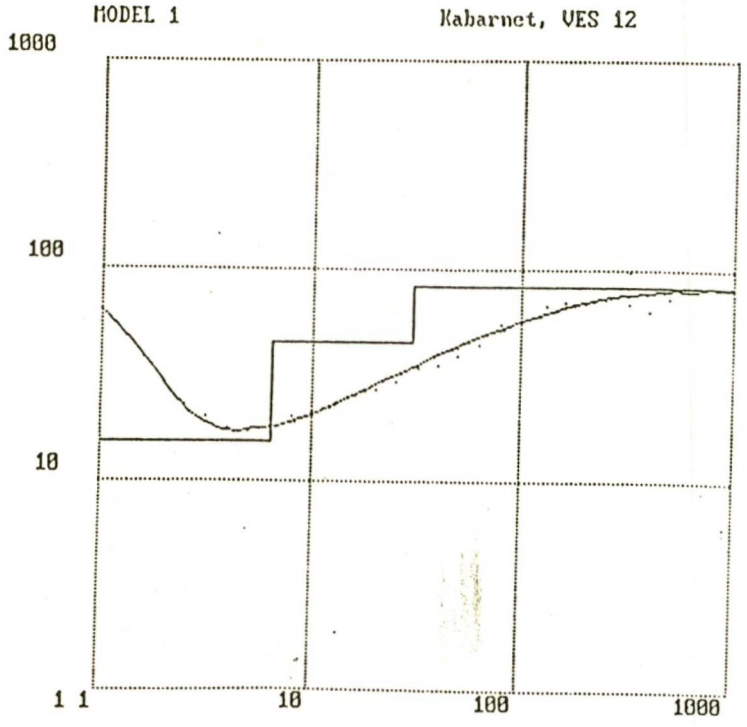
Appendix 3. 3. 11d



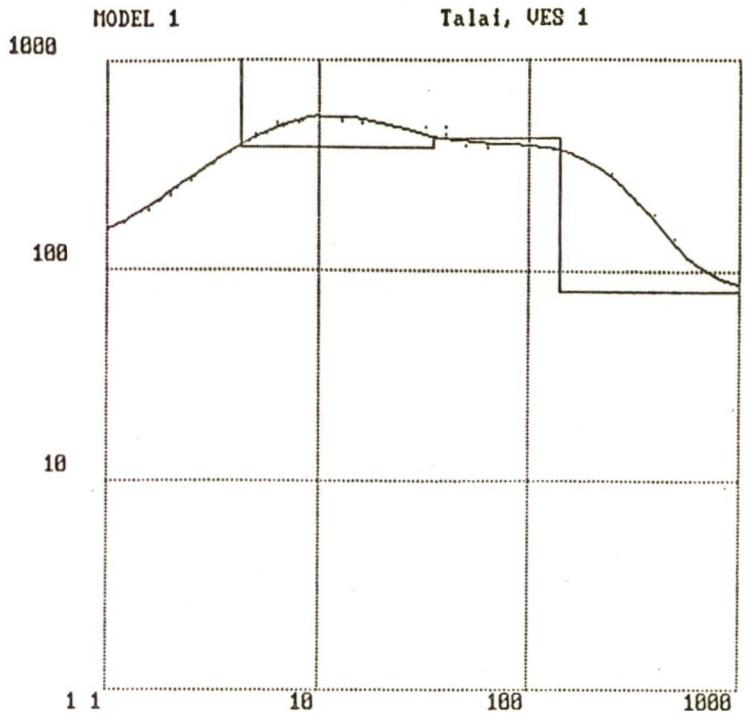


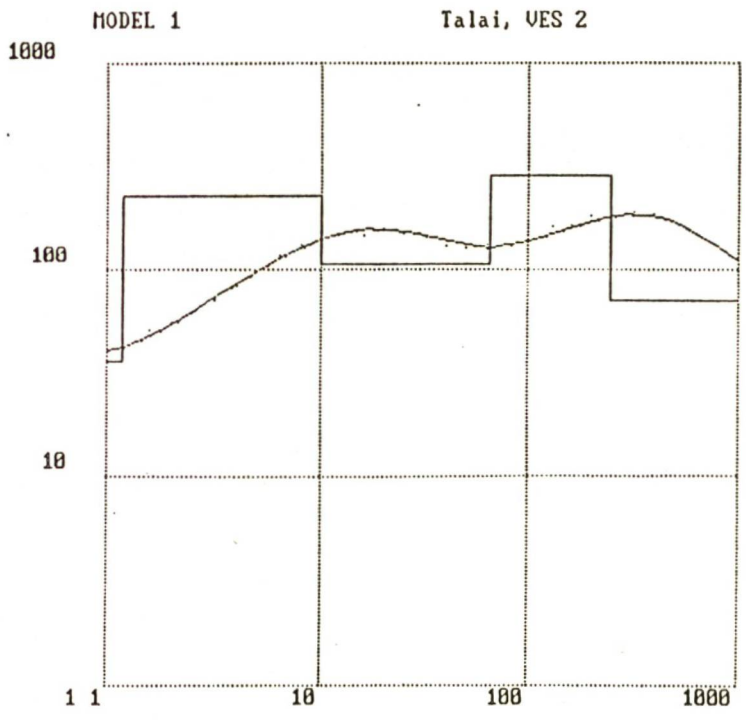
Appendix 3. 3. 11e



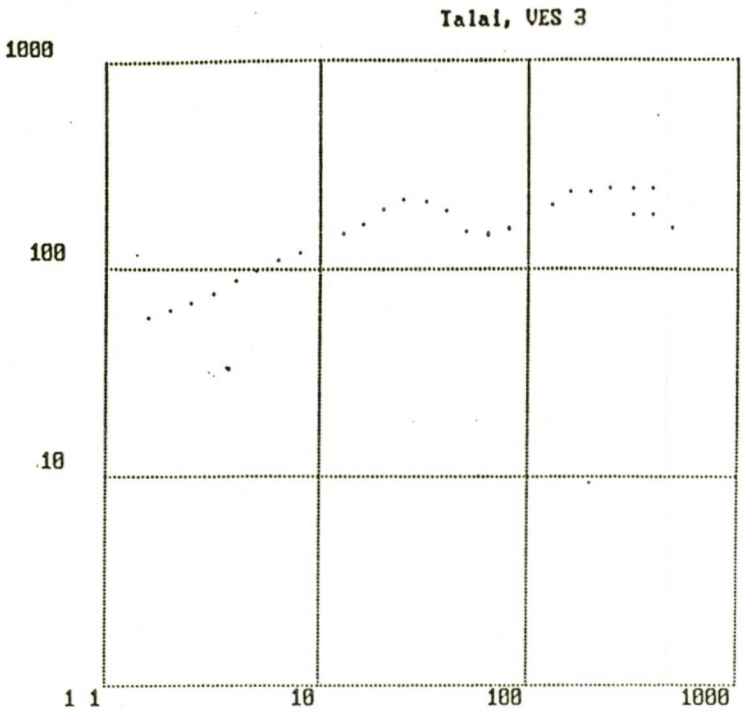


Appendix 3. 3. 11f

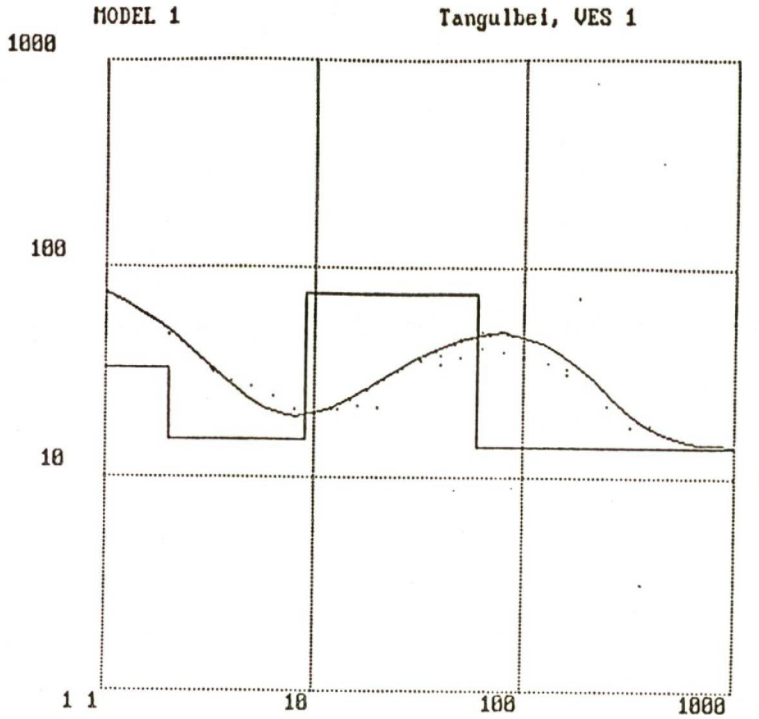


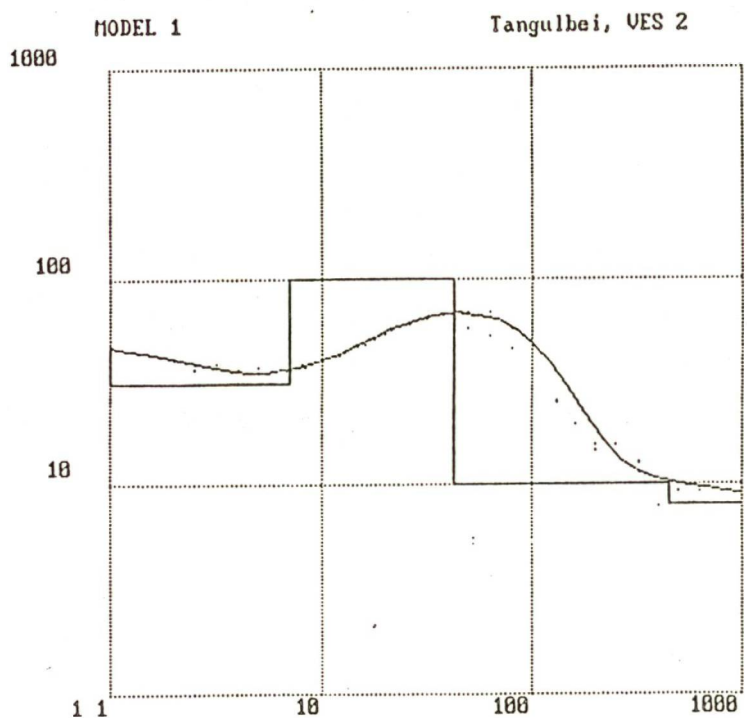


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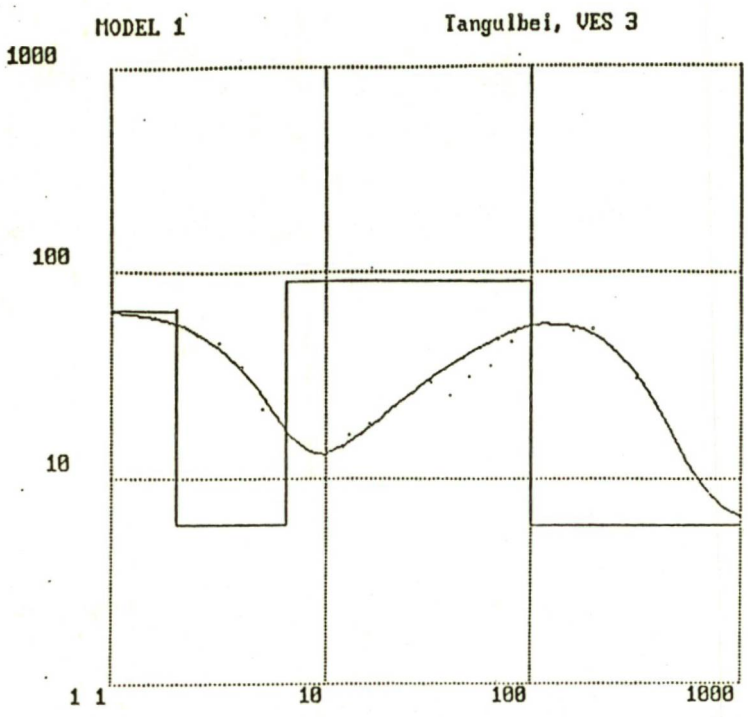


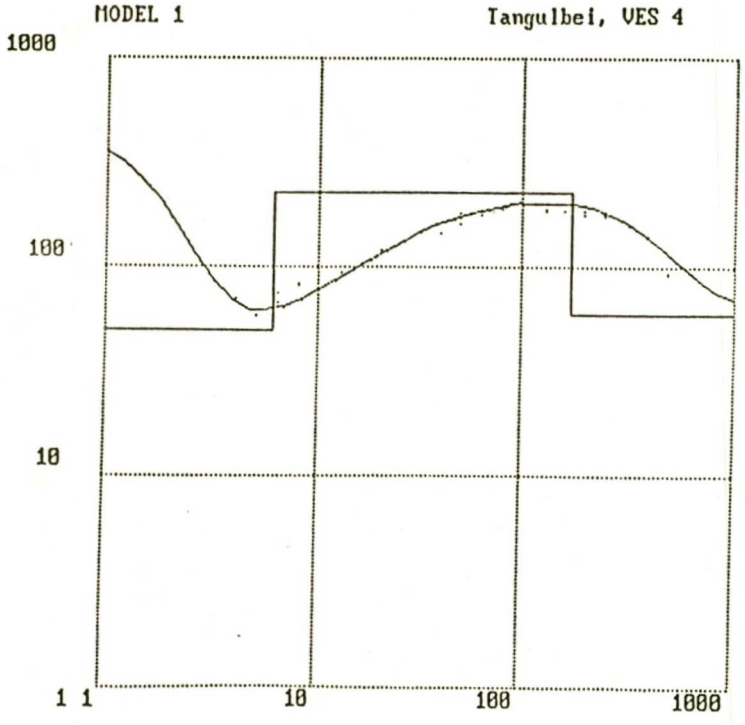
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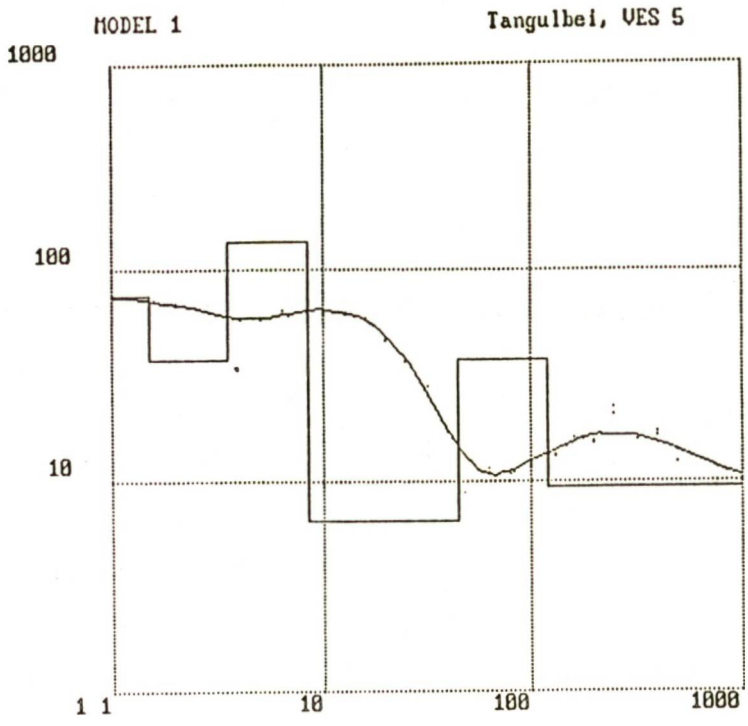


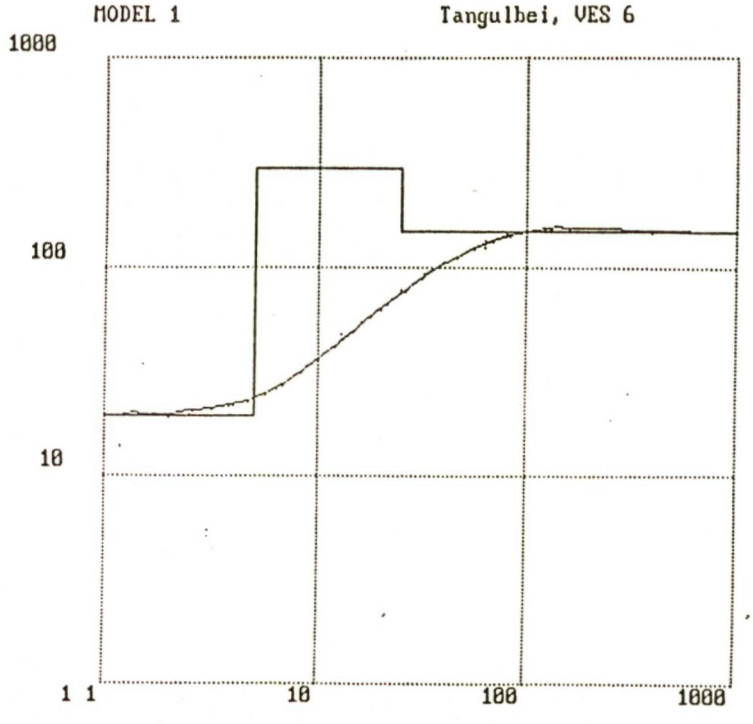
Appendix 3. 3. 13a



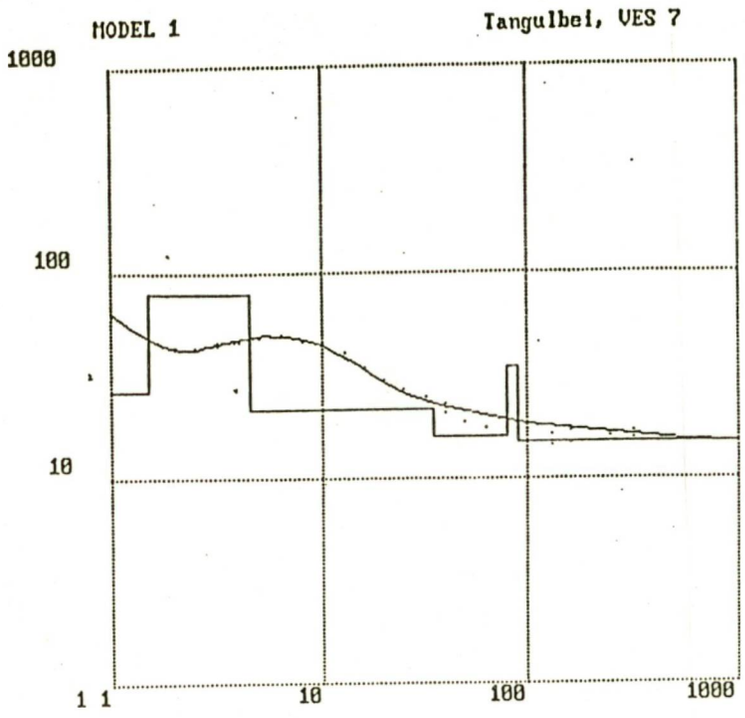


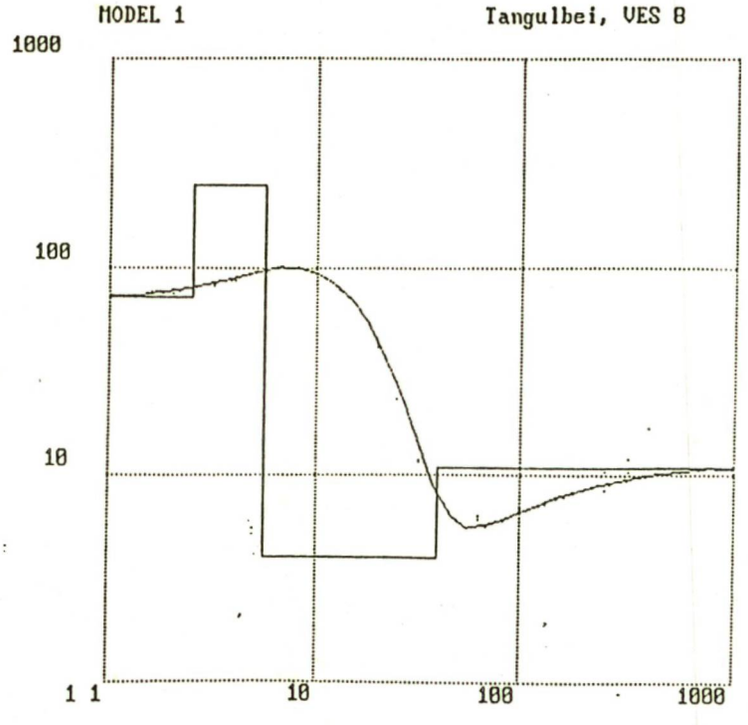
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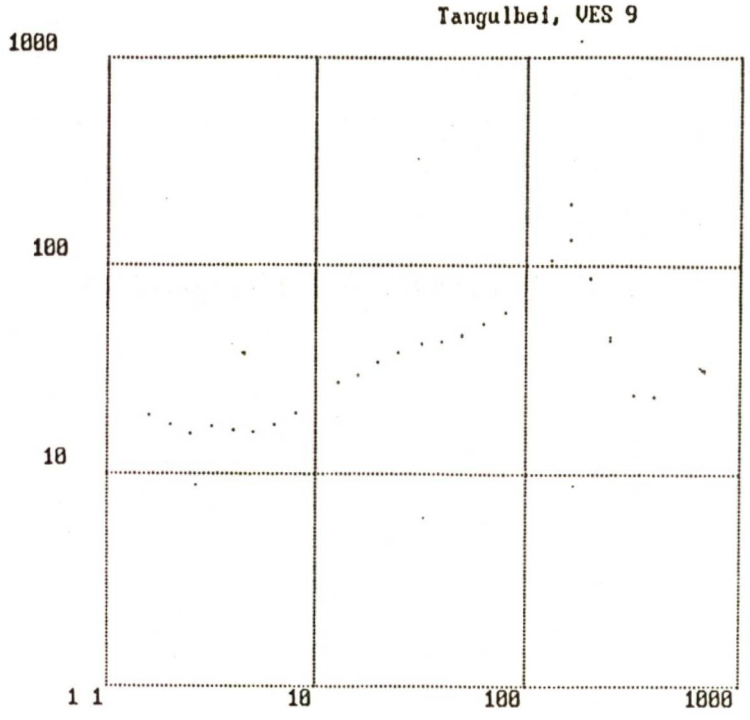


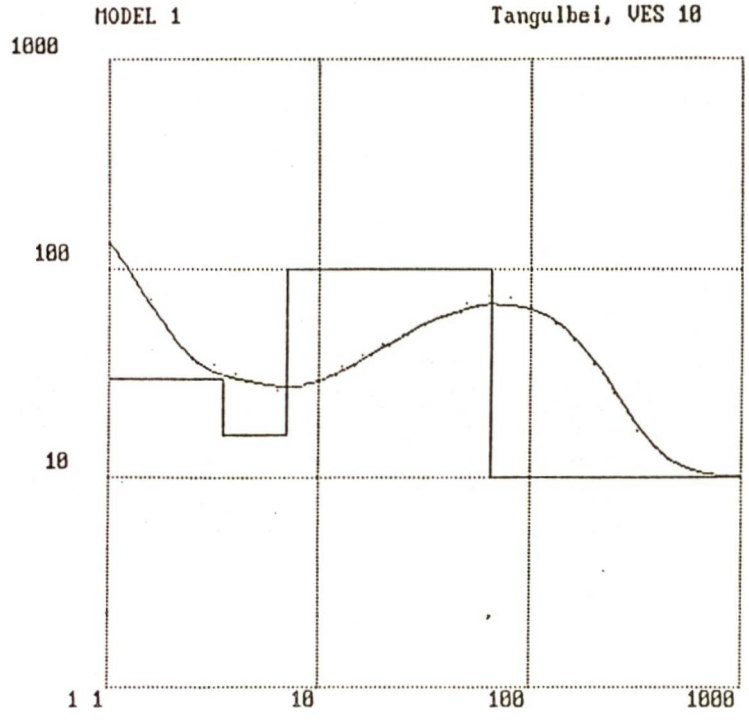
Appendix 3. 3. 13c



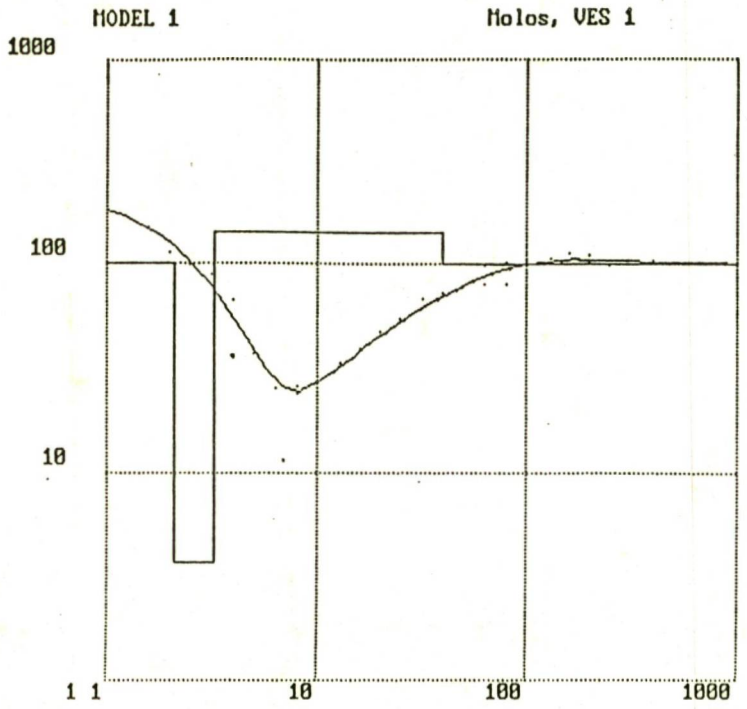


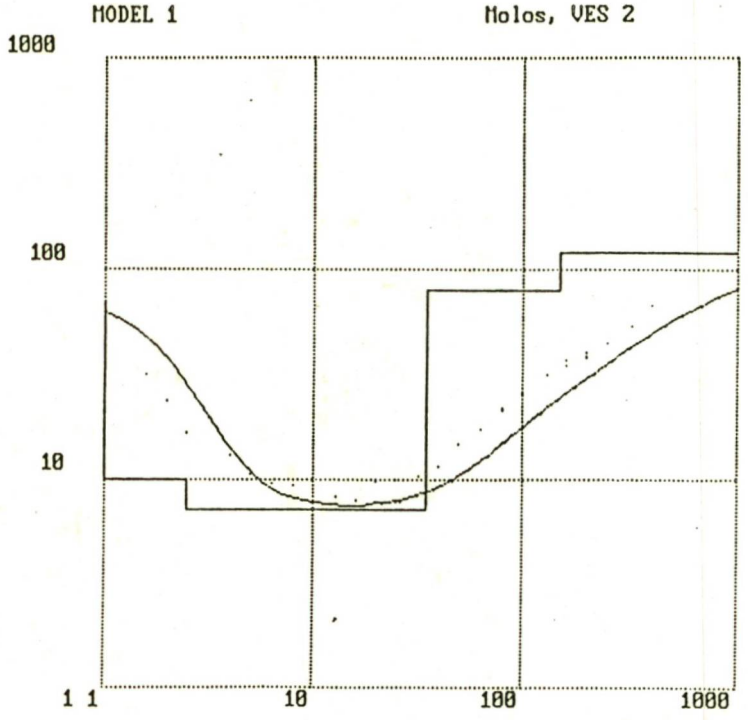
Appendix 3. 3. 13d





Appendix 3. 3. 13e

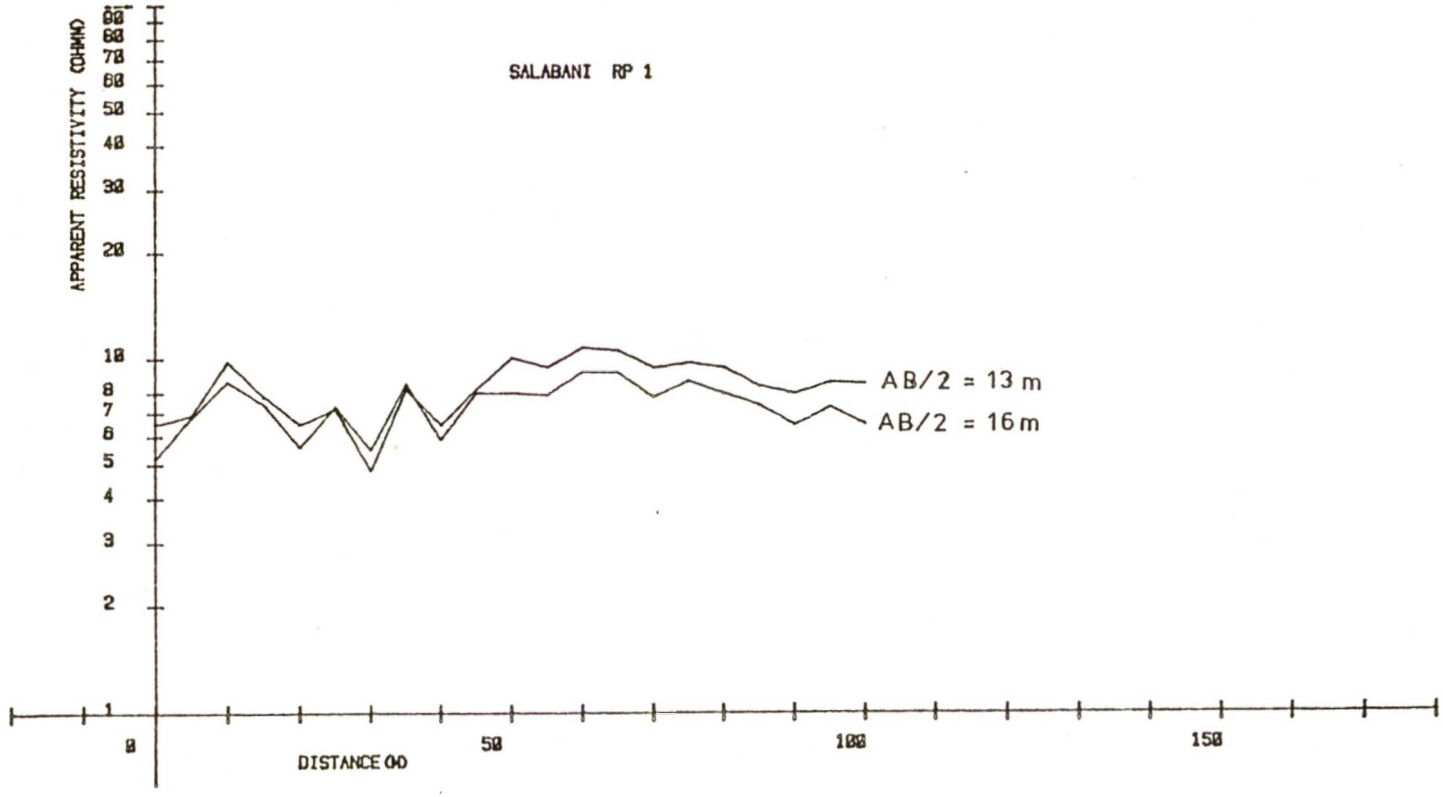




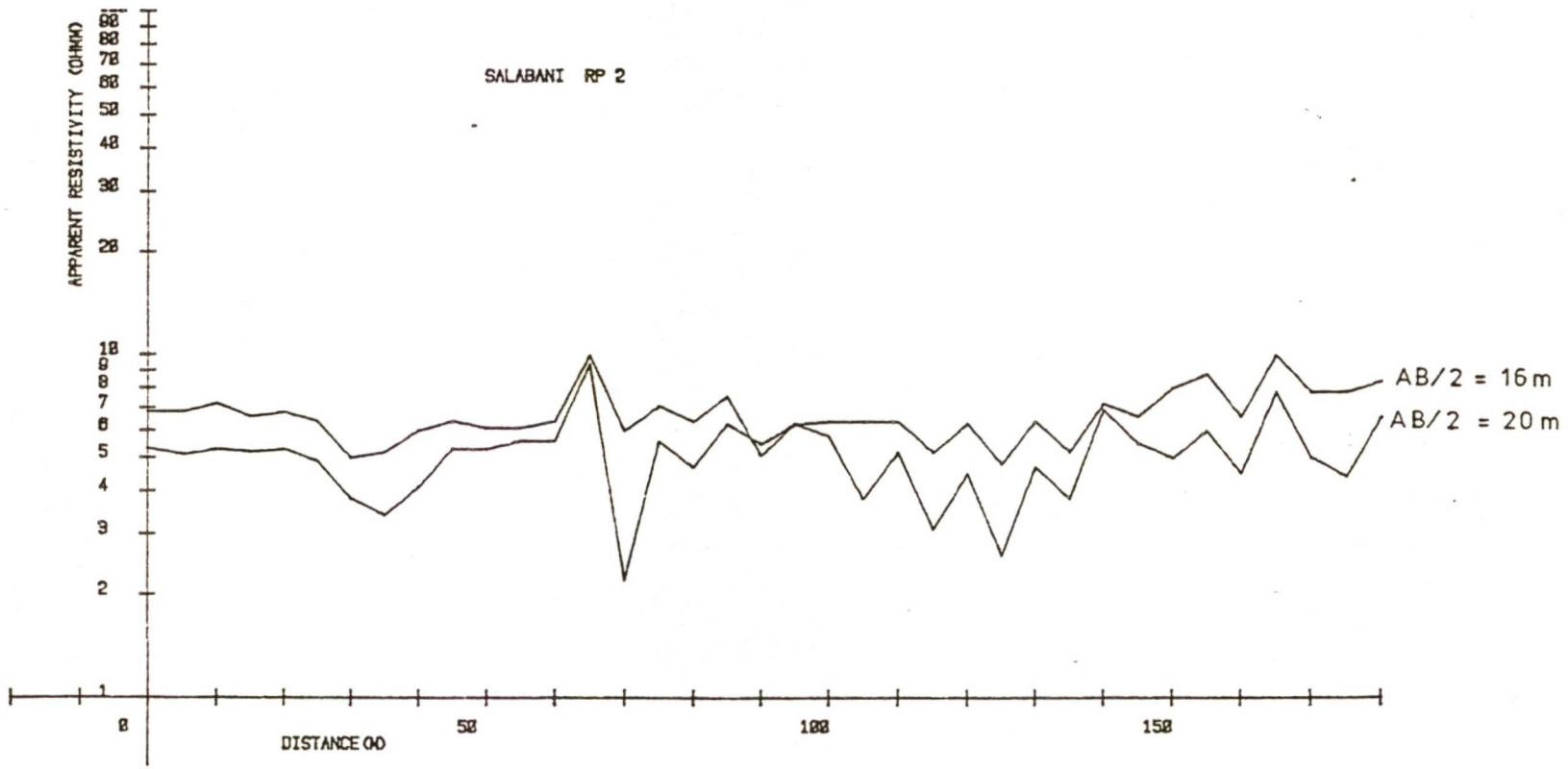
Appendix 3. 3. 14

APPENDIX 3.4

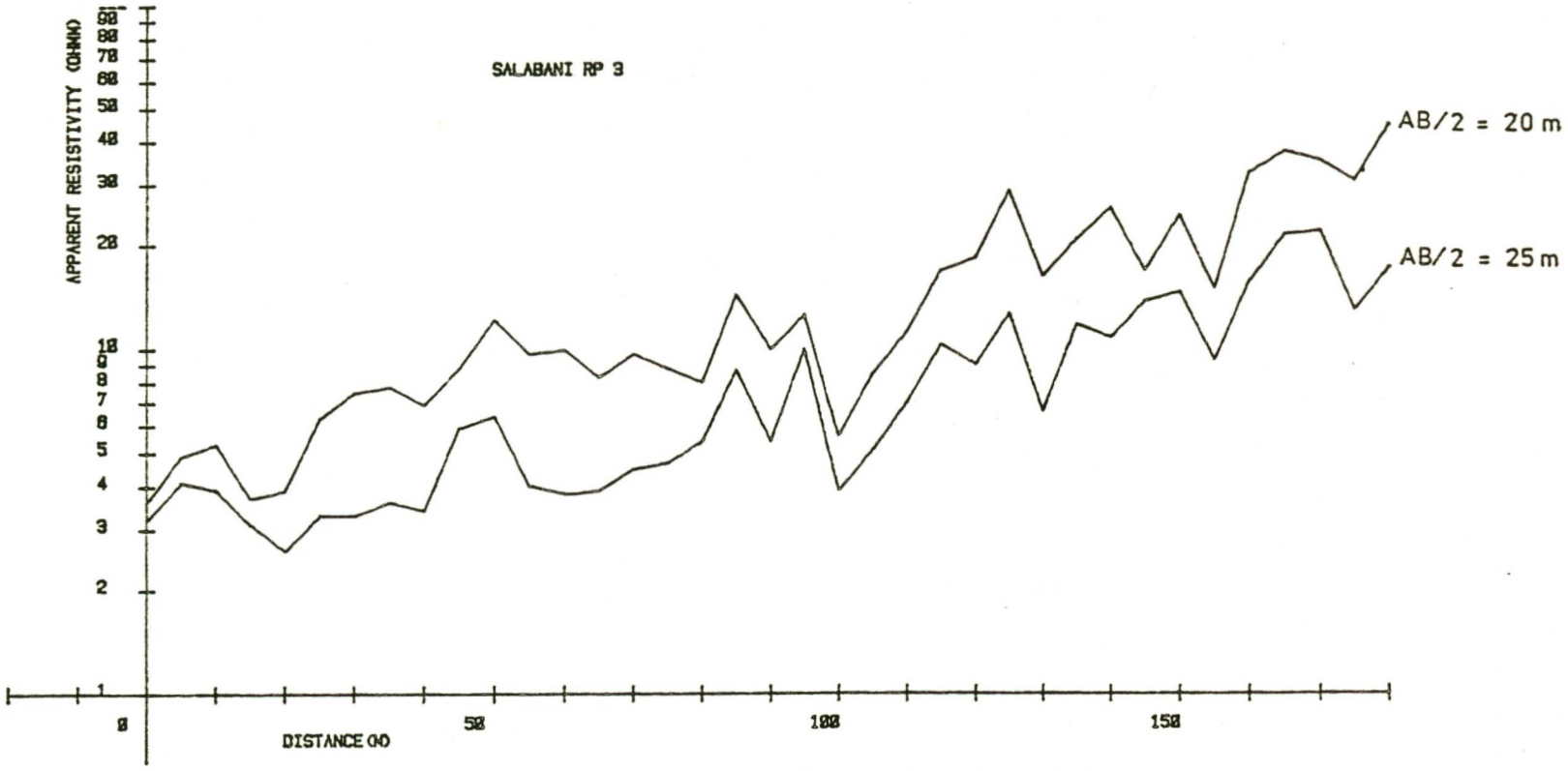
Resistivity Profiles



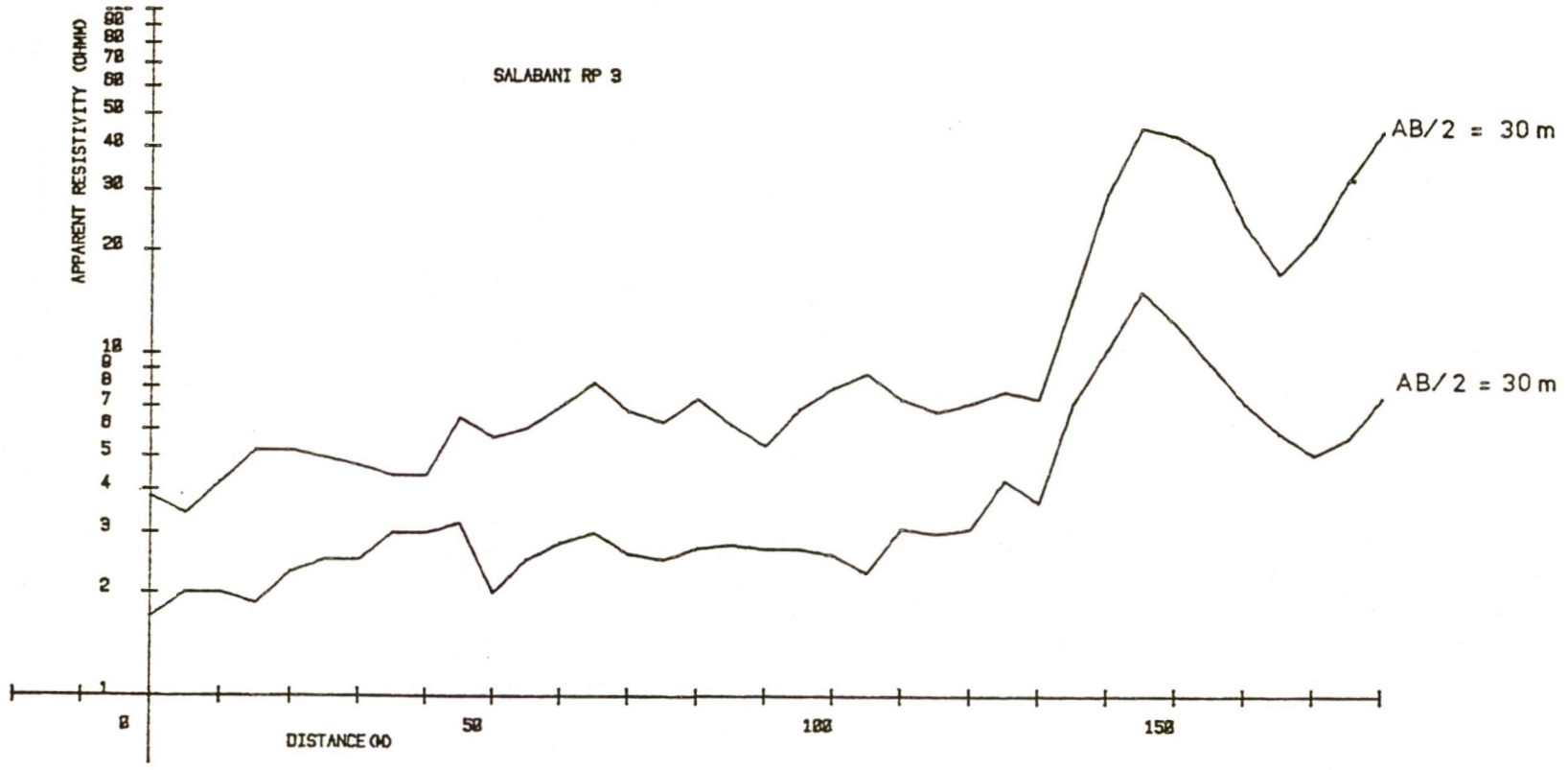
Appendix 3. 4. 1a



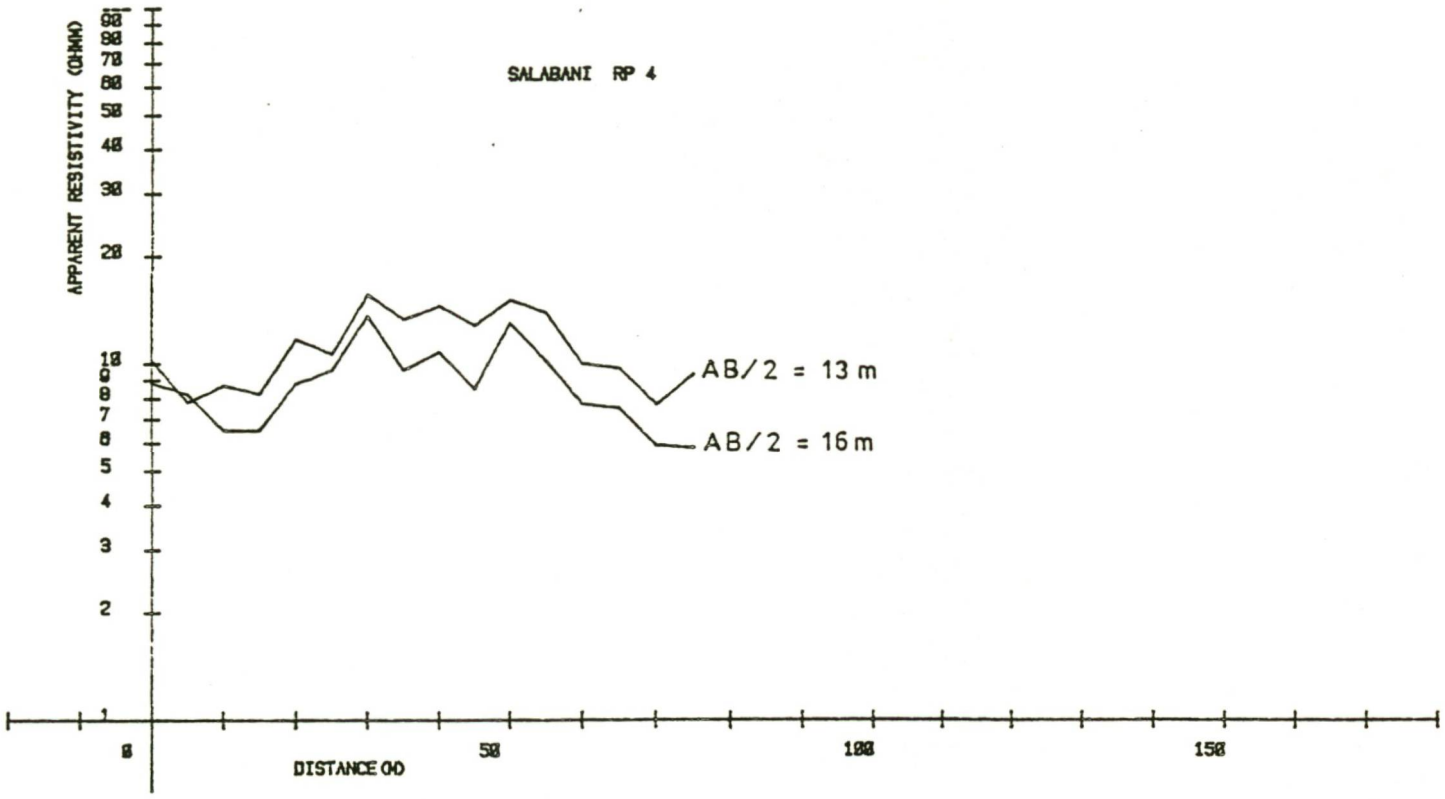
Appendix 3. 4. 1b



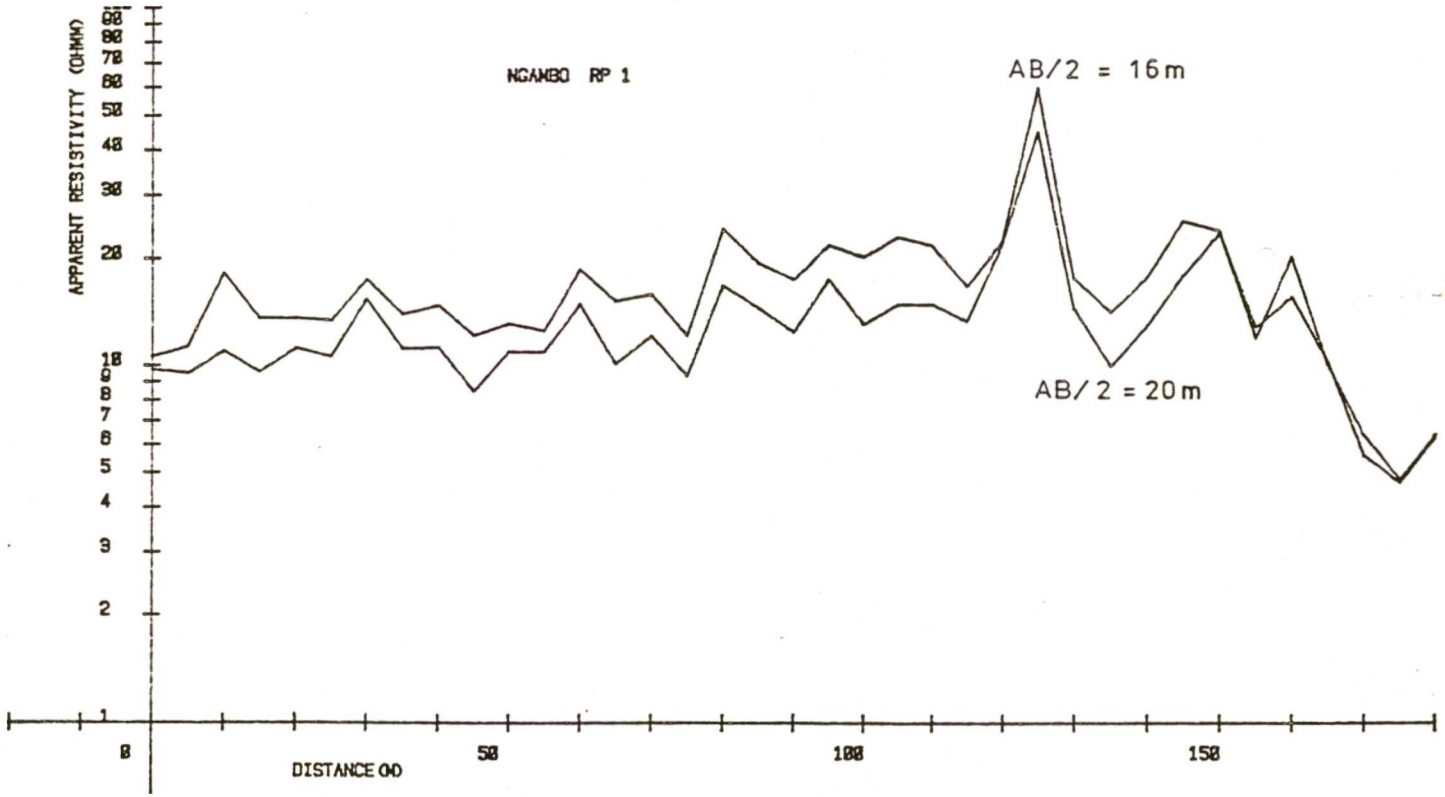
Appendix 3. 4. 1c1



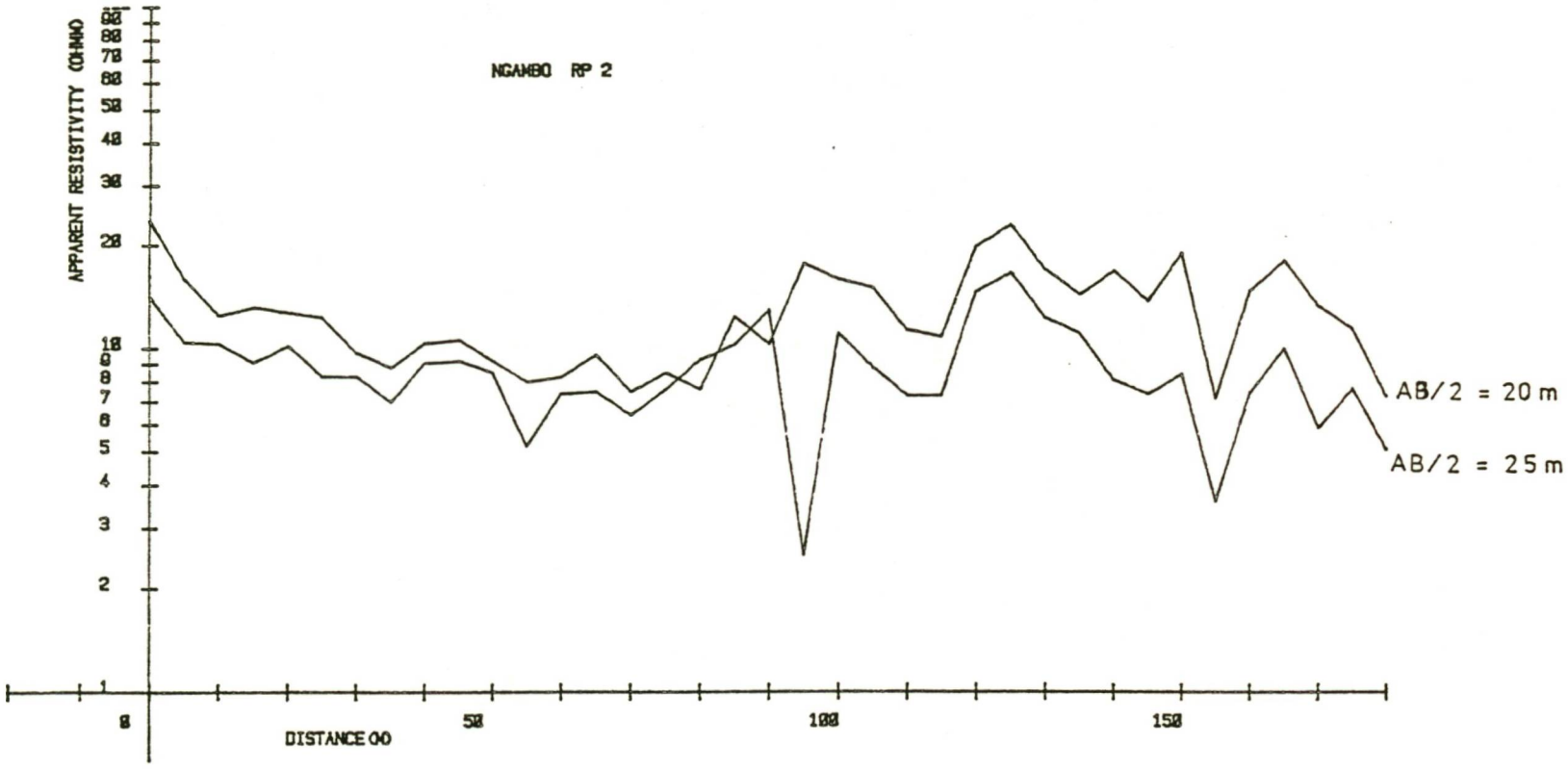
Appendix 3. 4. 1c2



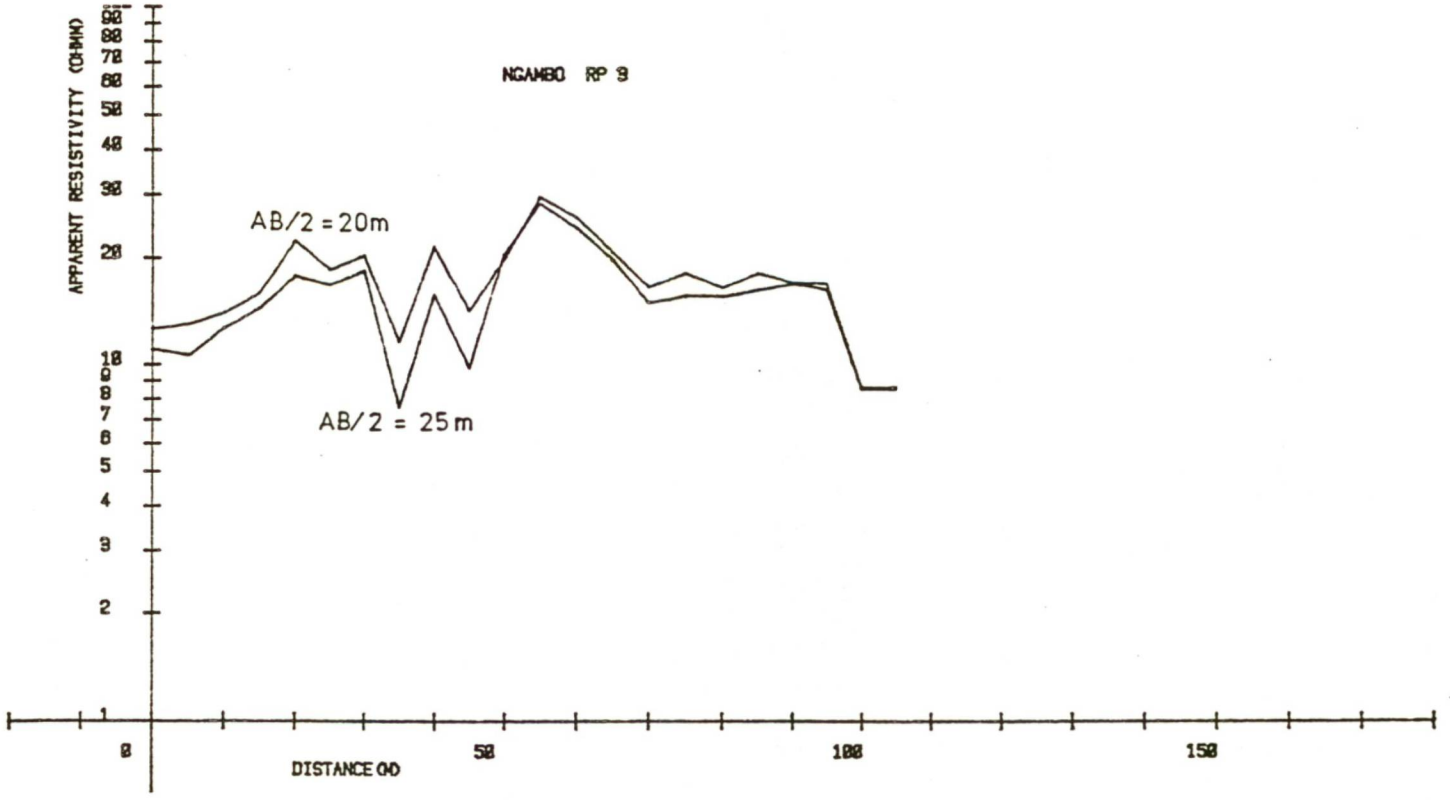
Appendix 3. 4. 1d



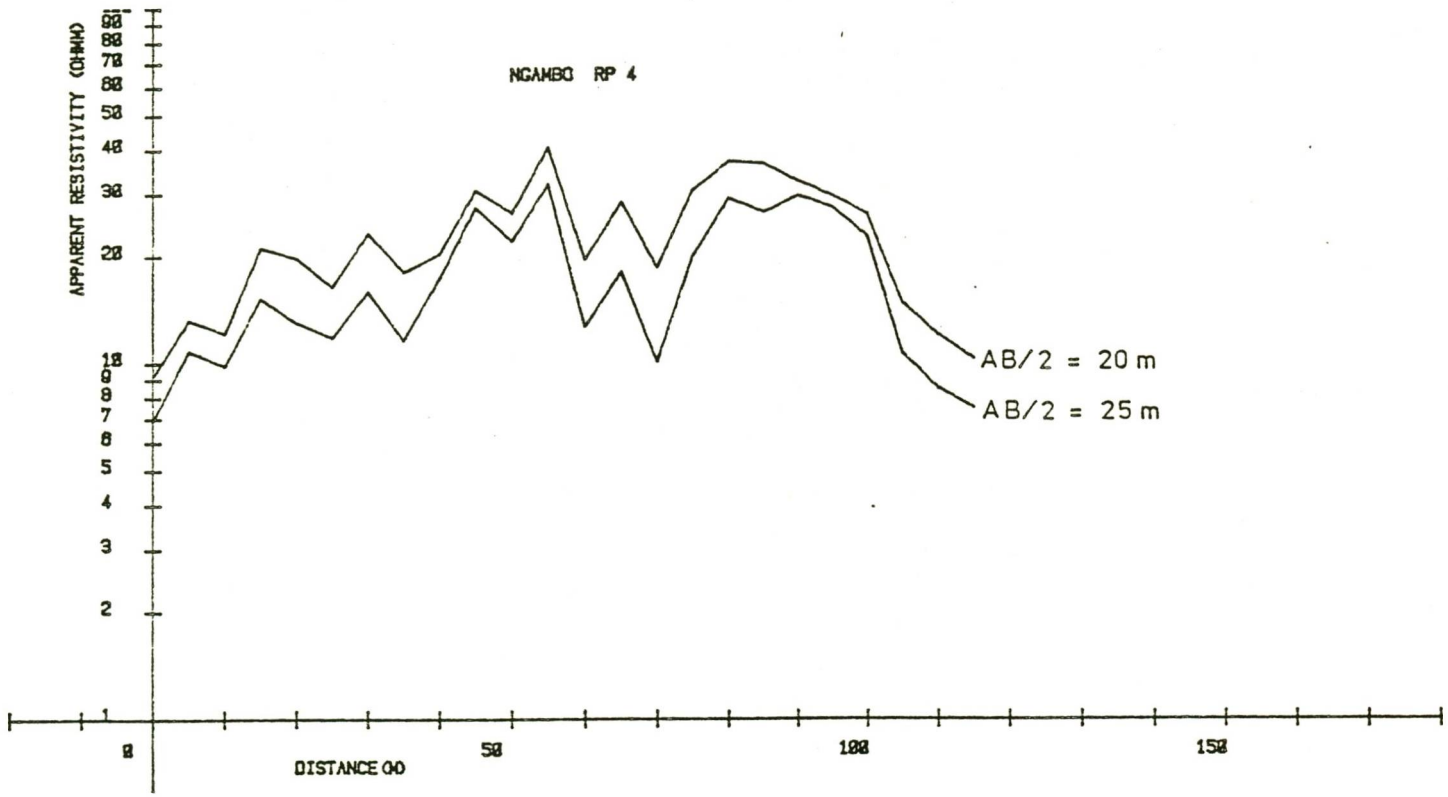
Appendix 3. 4. 2a



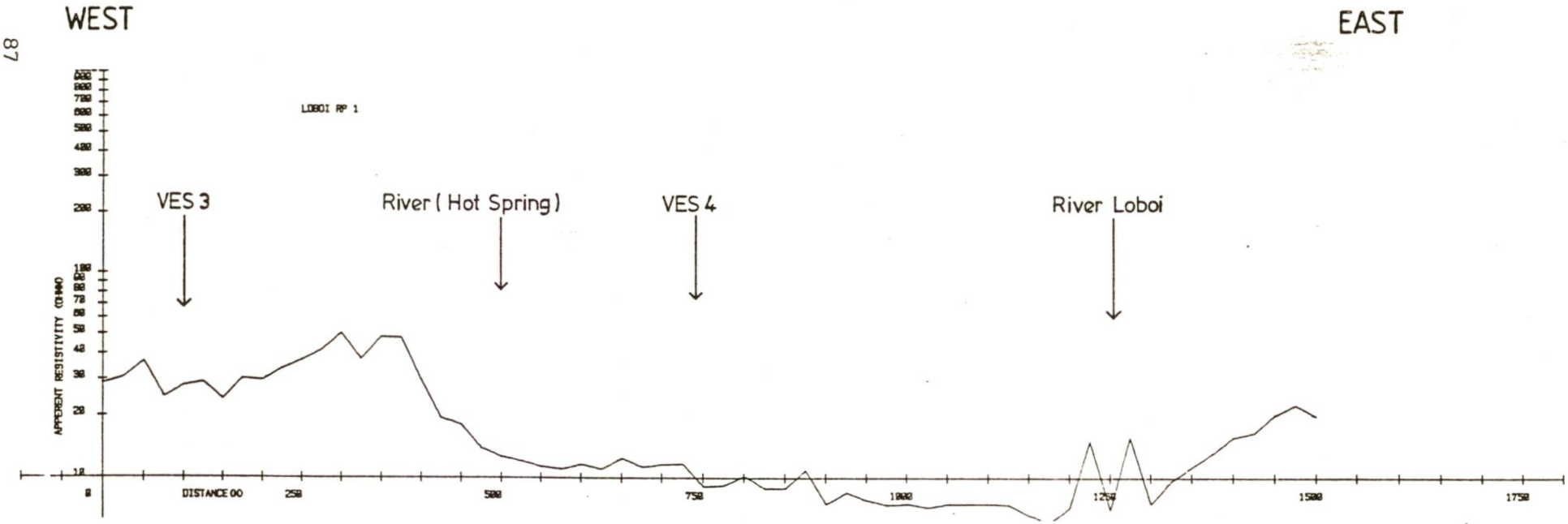
Appendix 3. 4. 2b



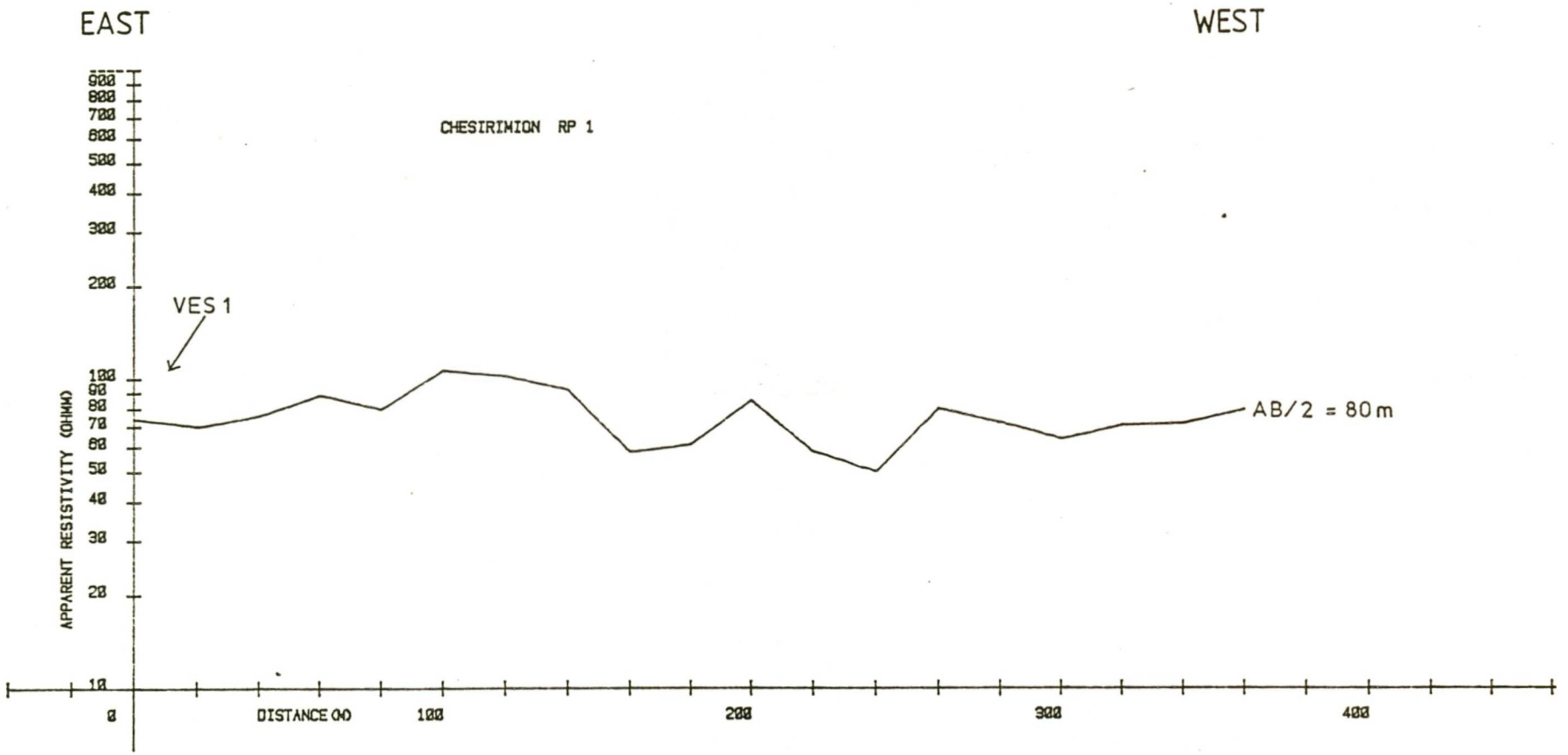
Appendix 3. 4. 2c



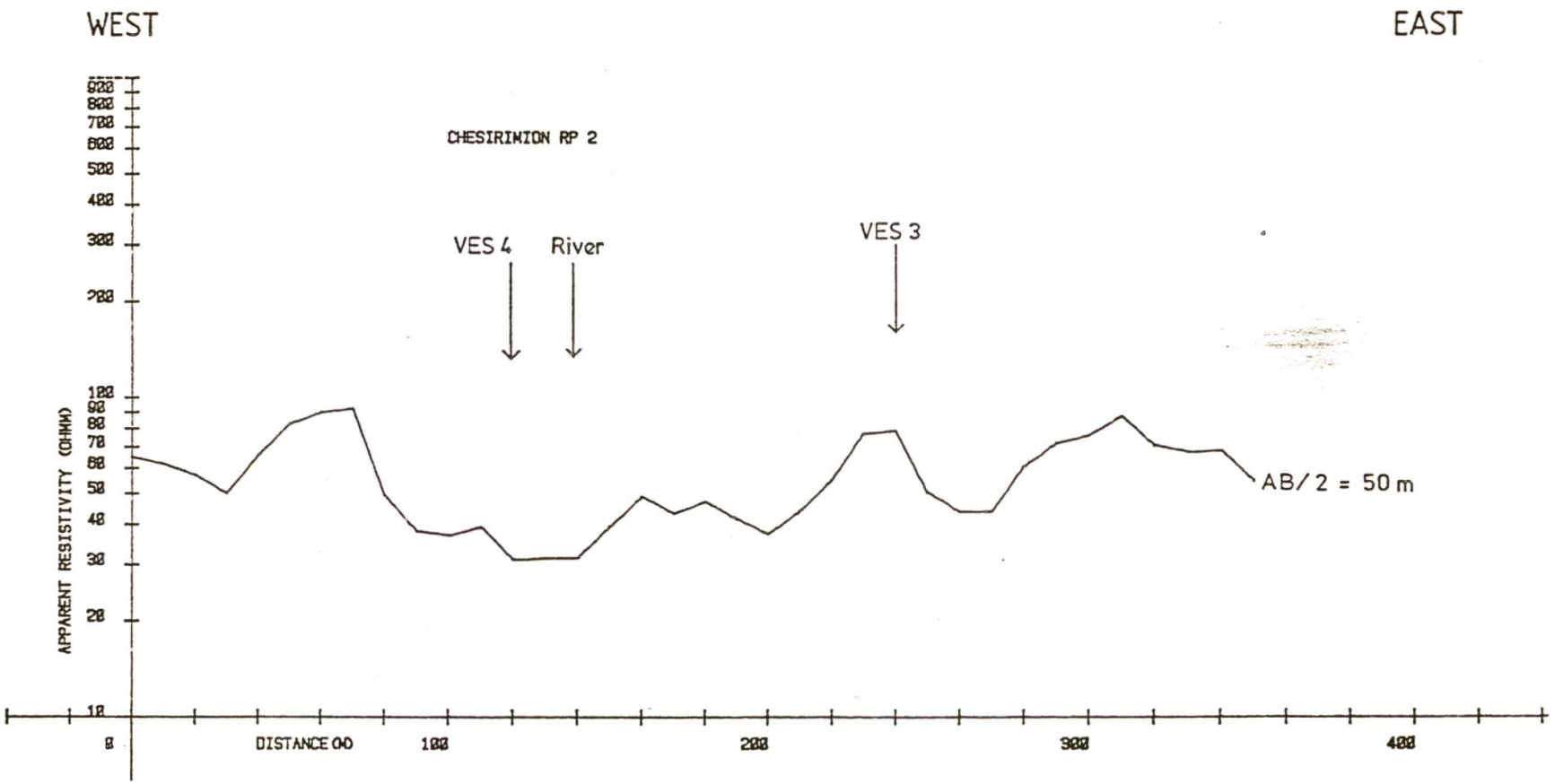
Appendix 3. 4. 2d



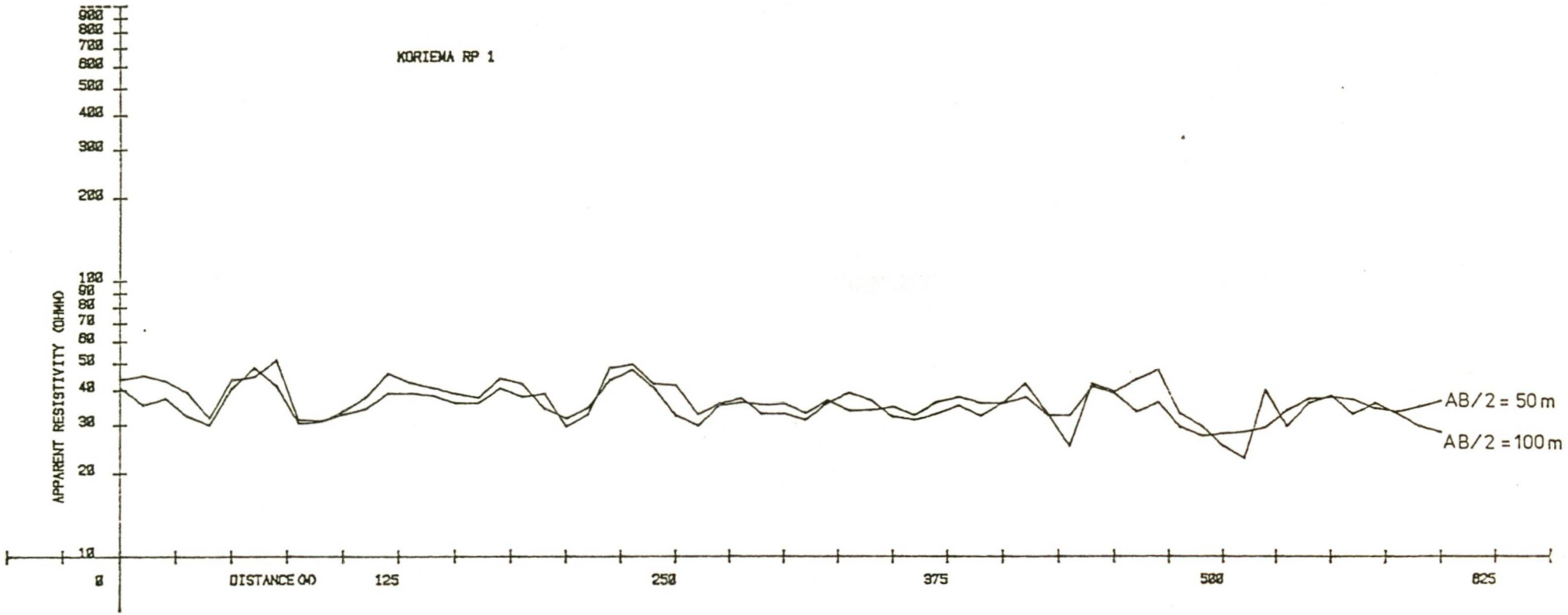
Appendix 3. 4. 5



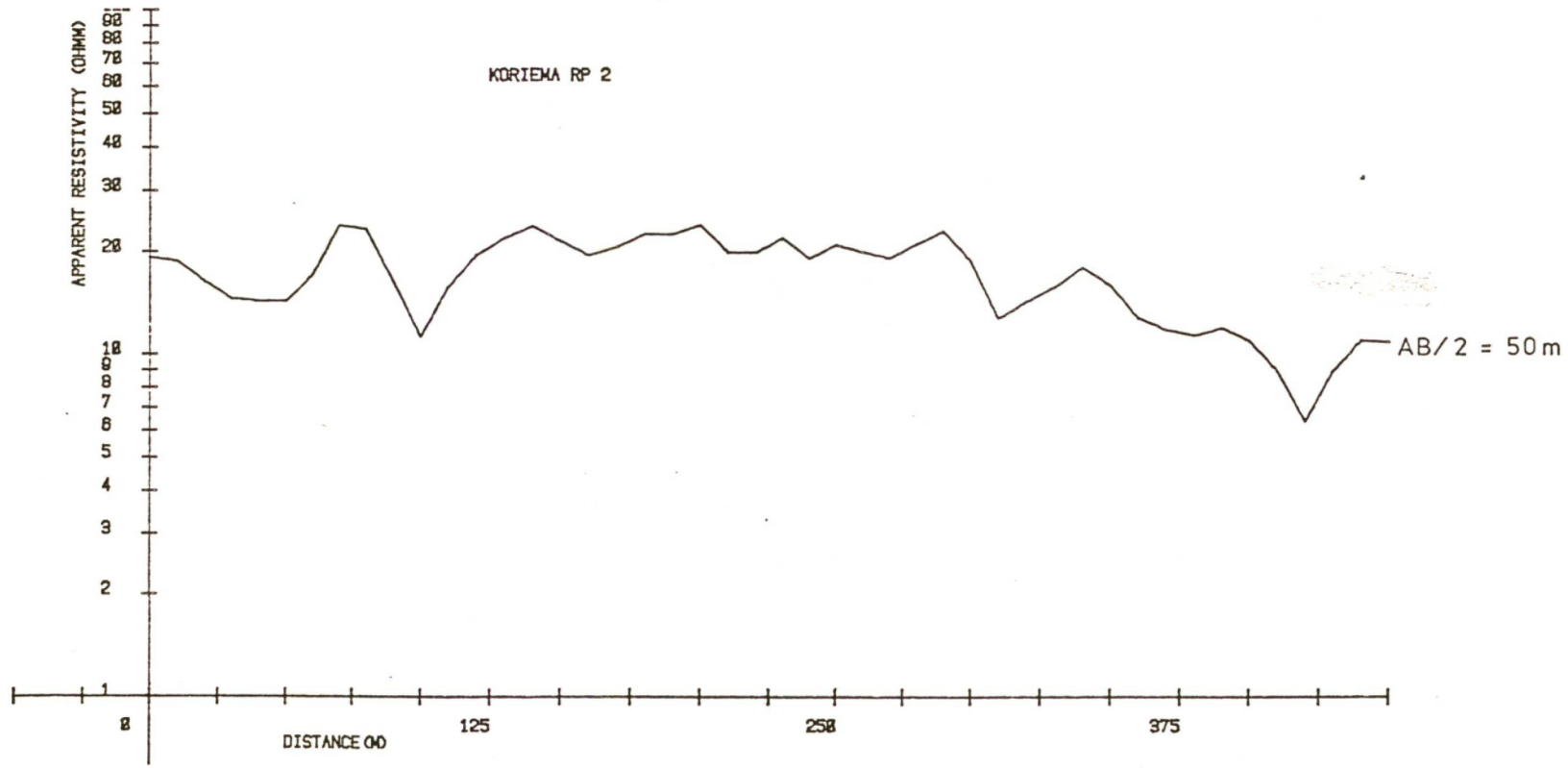
Appendix 3. 4. 6a



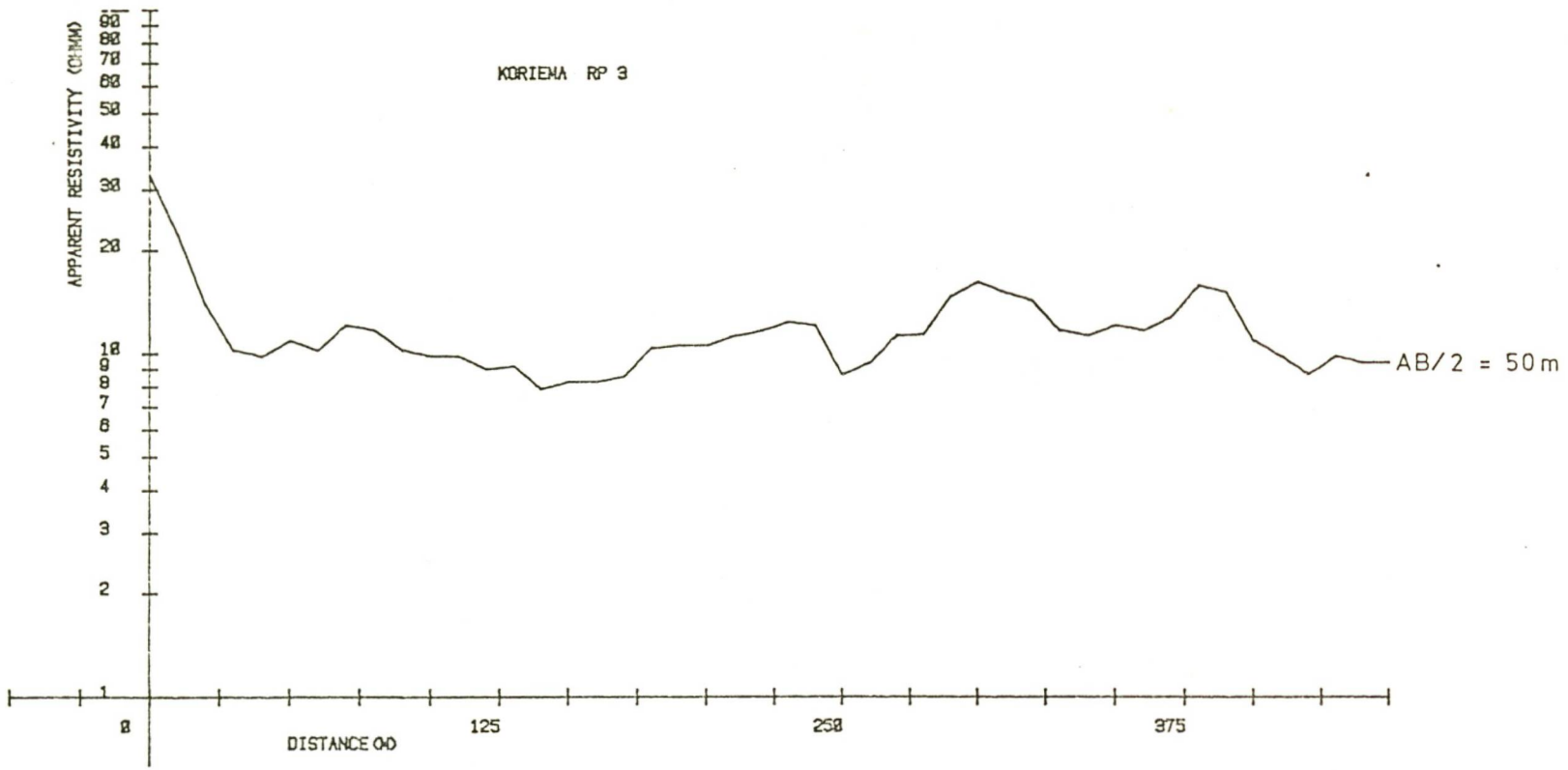
Appendix 3. 4. 6b



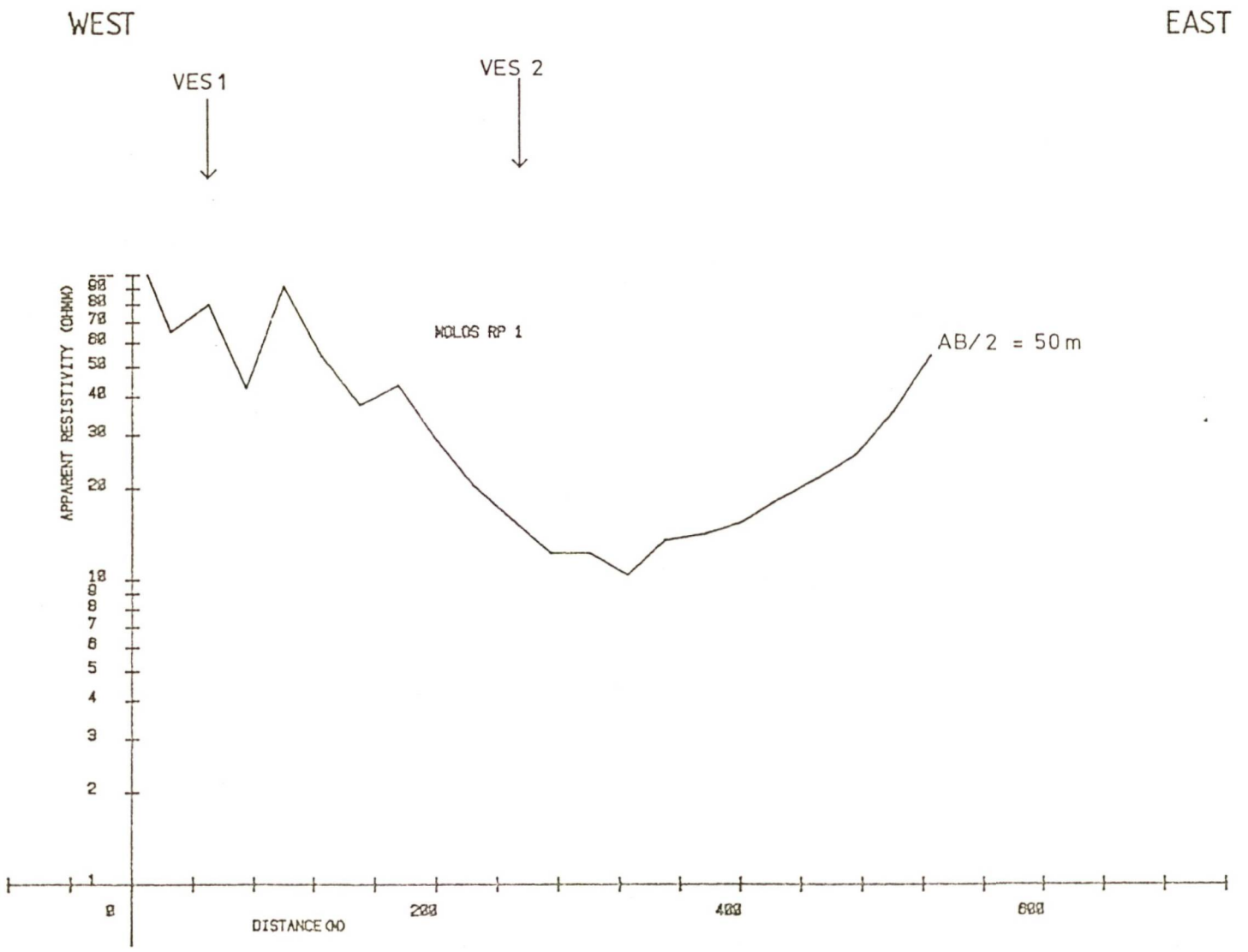
Appendix 3. 4. 9a



Appendix 3. 4. 9b



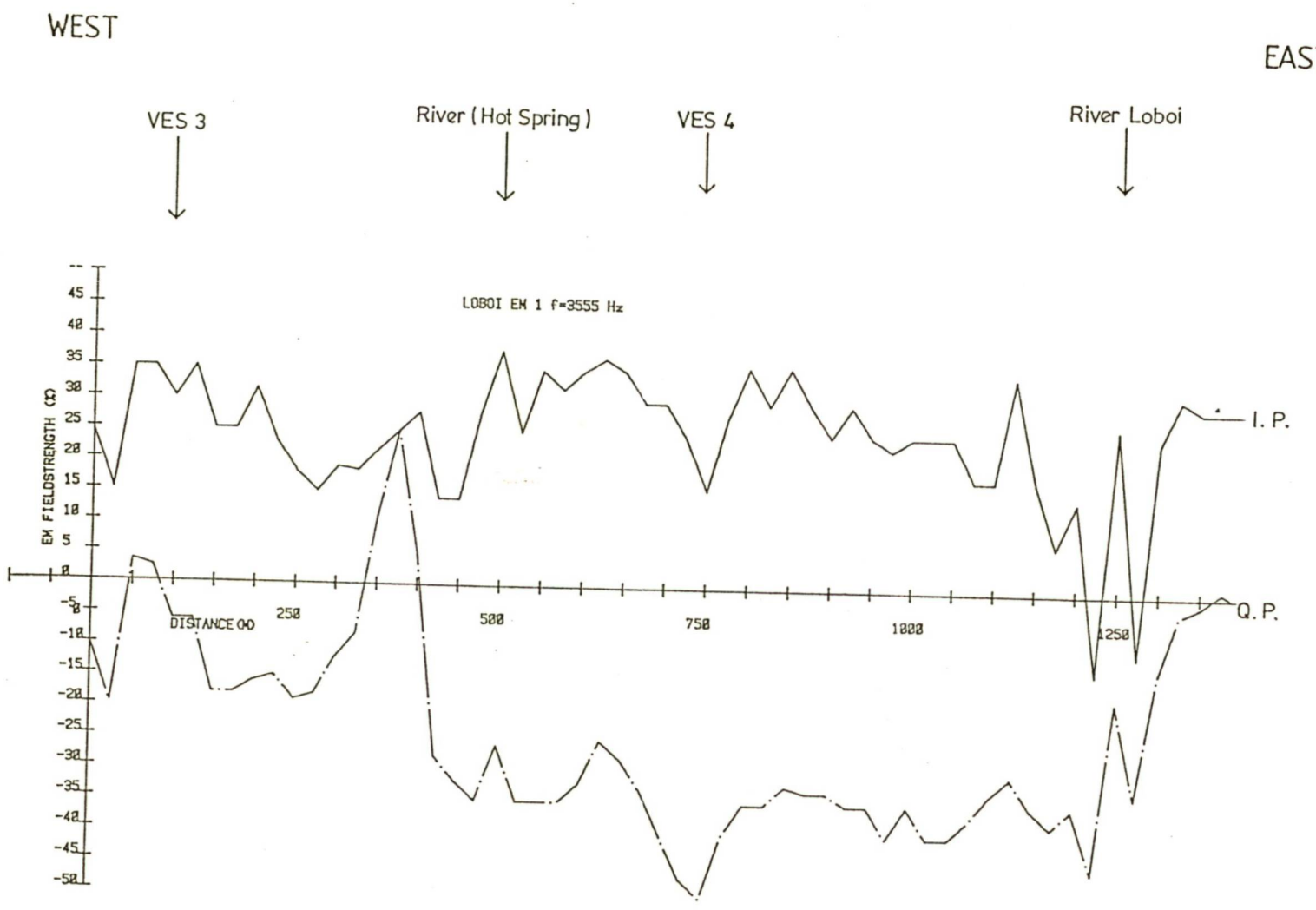
Appendix 3. 4. 9c



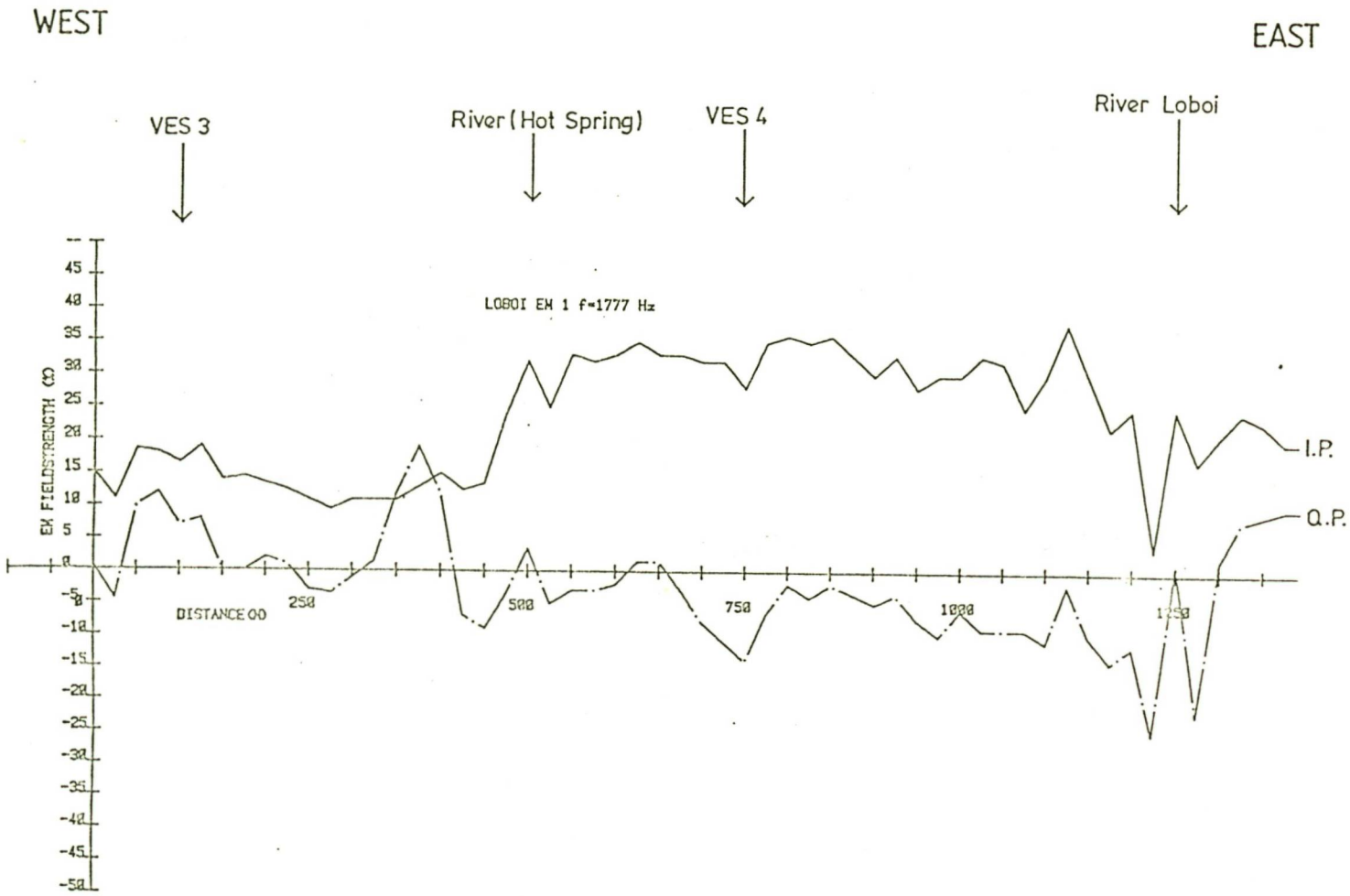
Appendix 3. 4. 14

APPENDIX 3.5

EM - Profiles



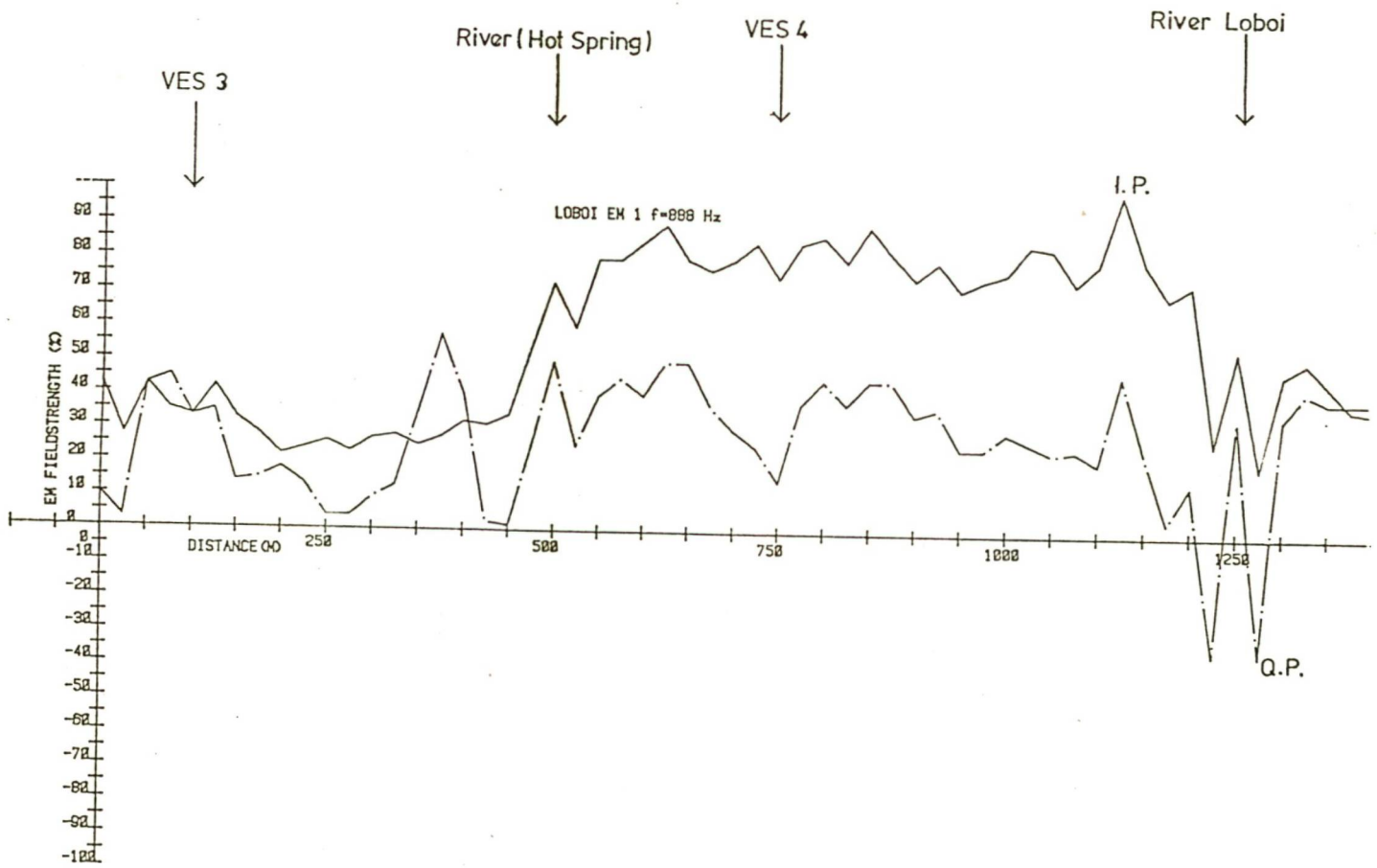
Appendix 3. 5. 5a



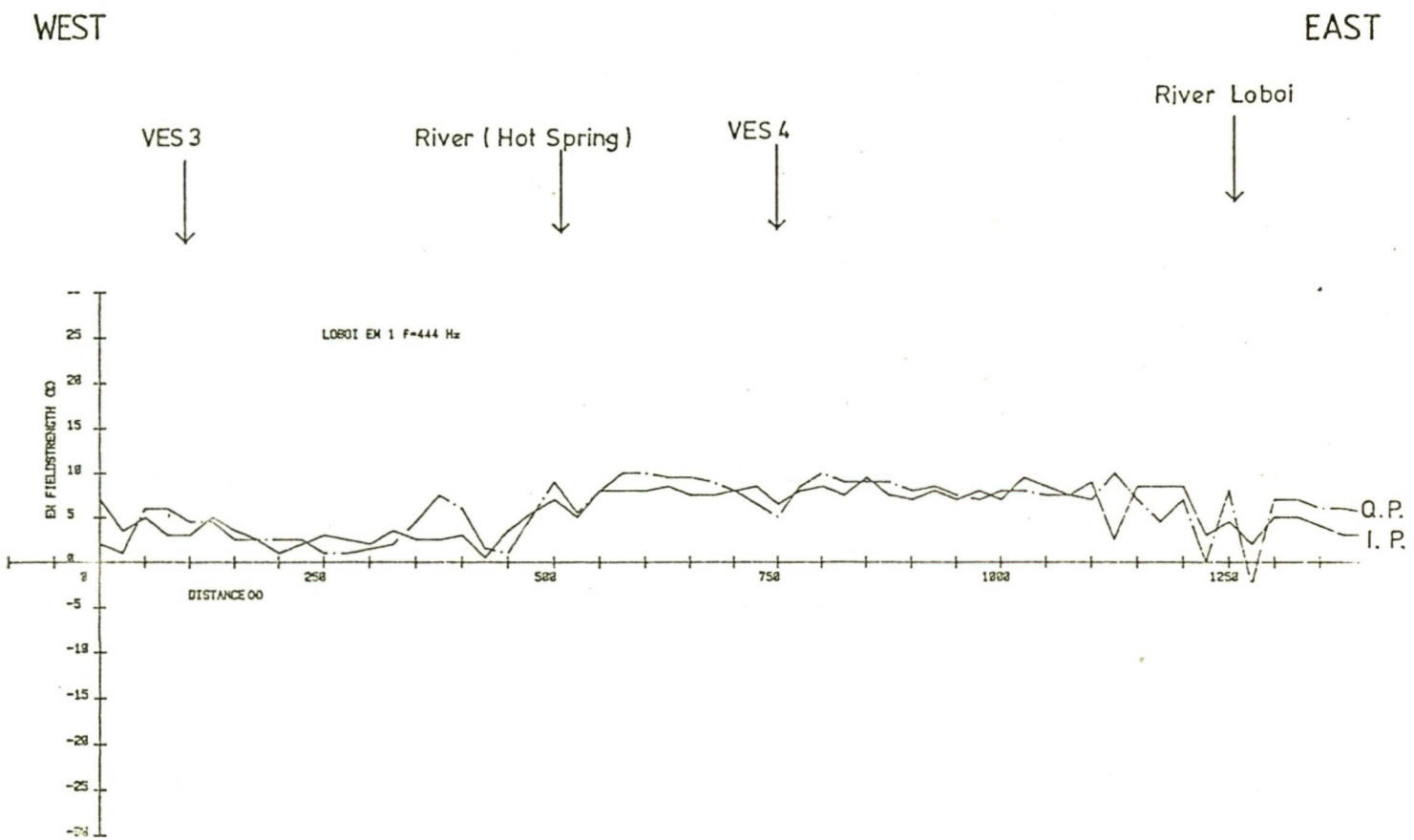
Appendix 3. 5. 5b

WEST

EAST



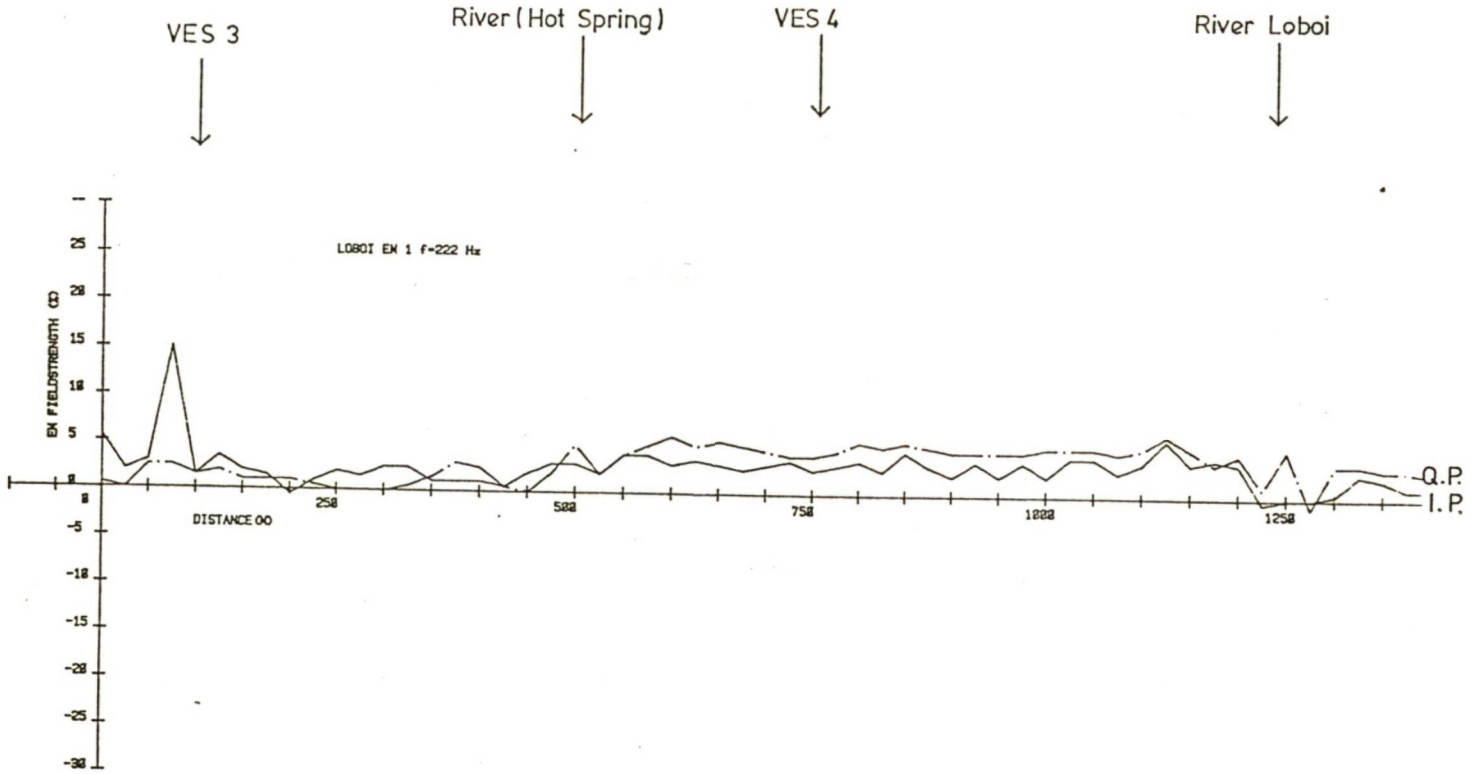
Appendix 3. 5. 5c



Appendix 3. 5. 5d

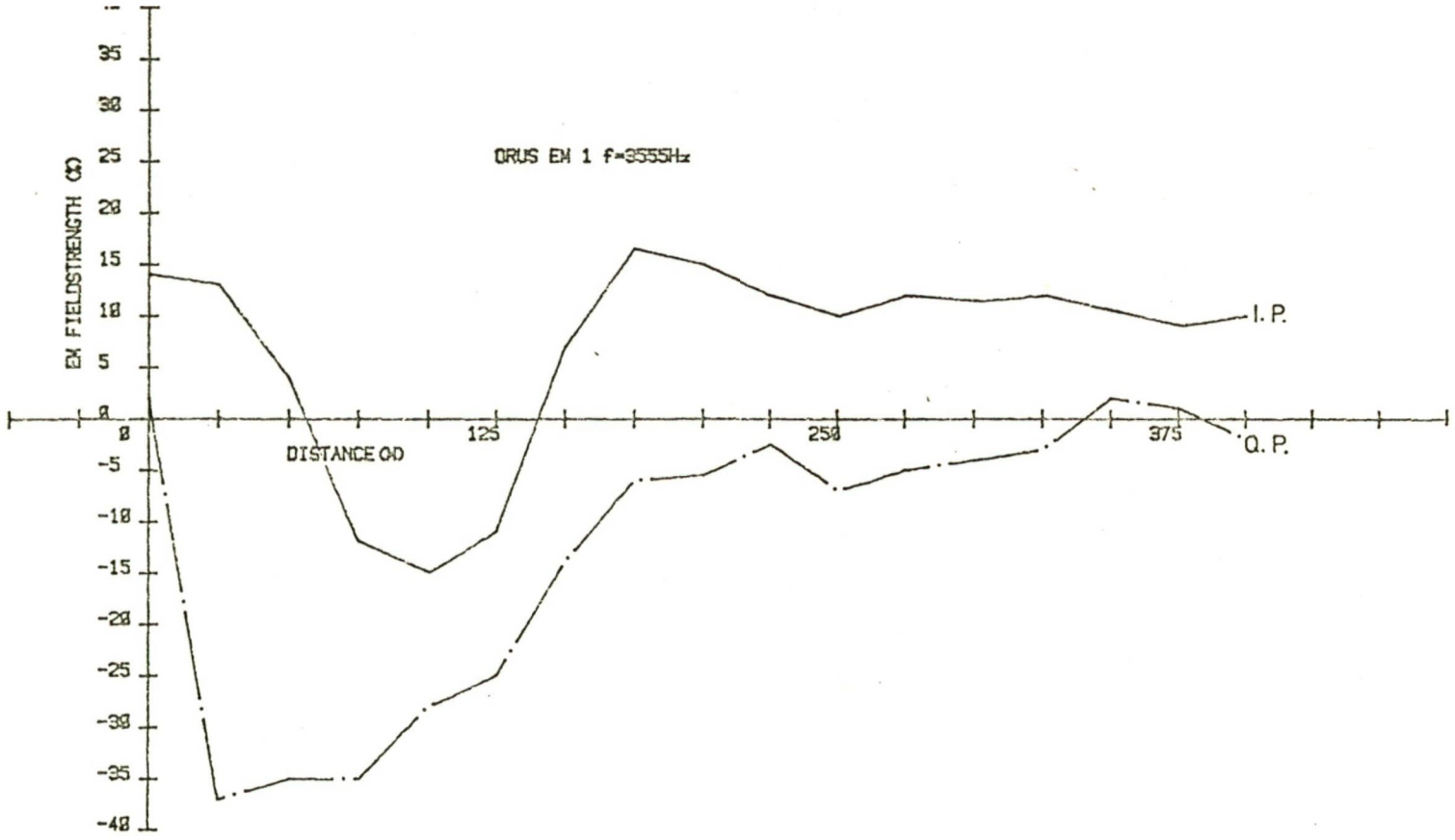
WEST

EAST

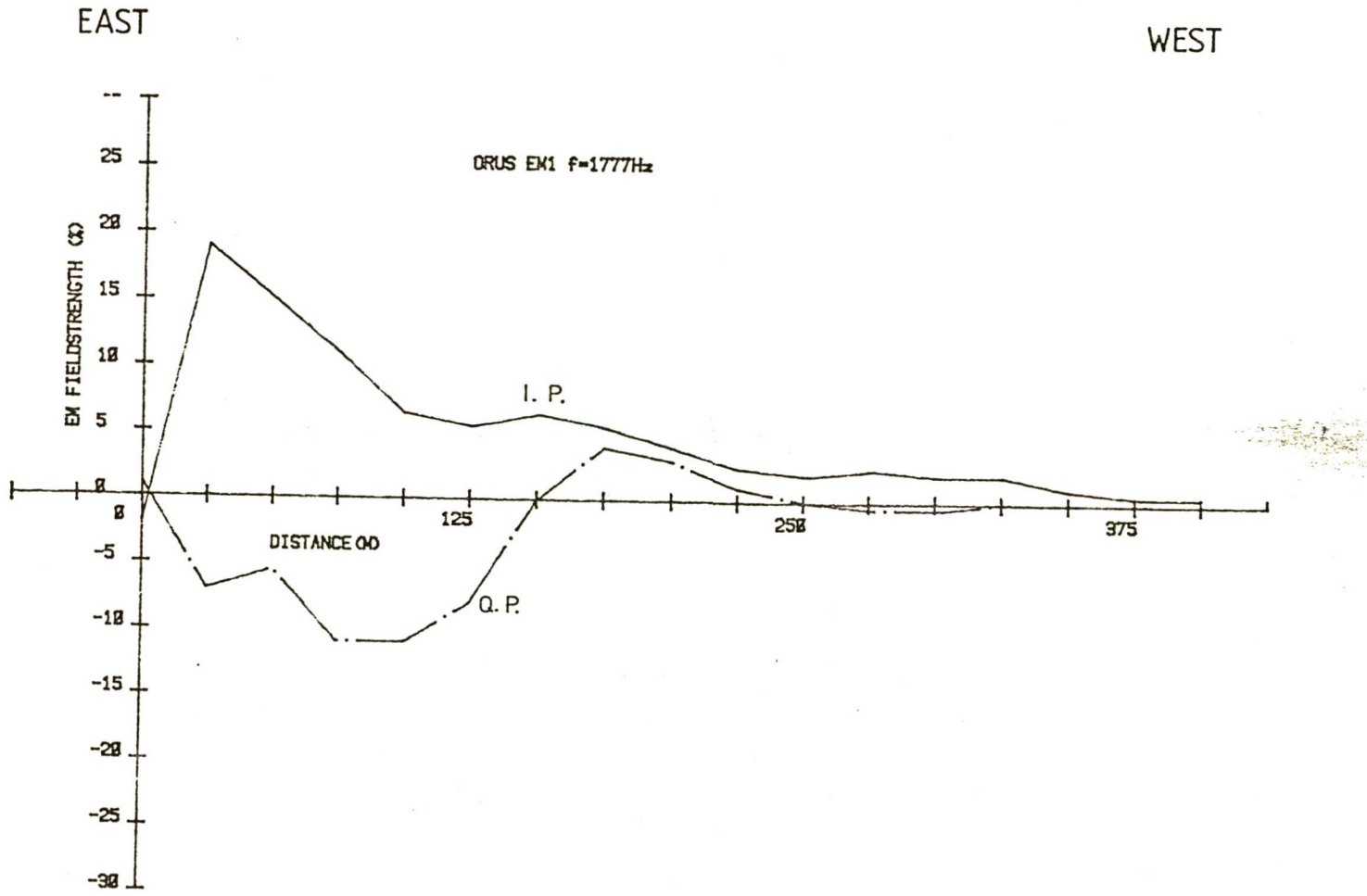


Appendix 3. 5. 5e

EAST WEST



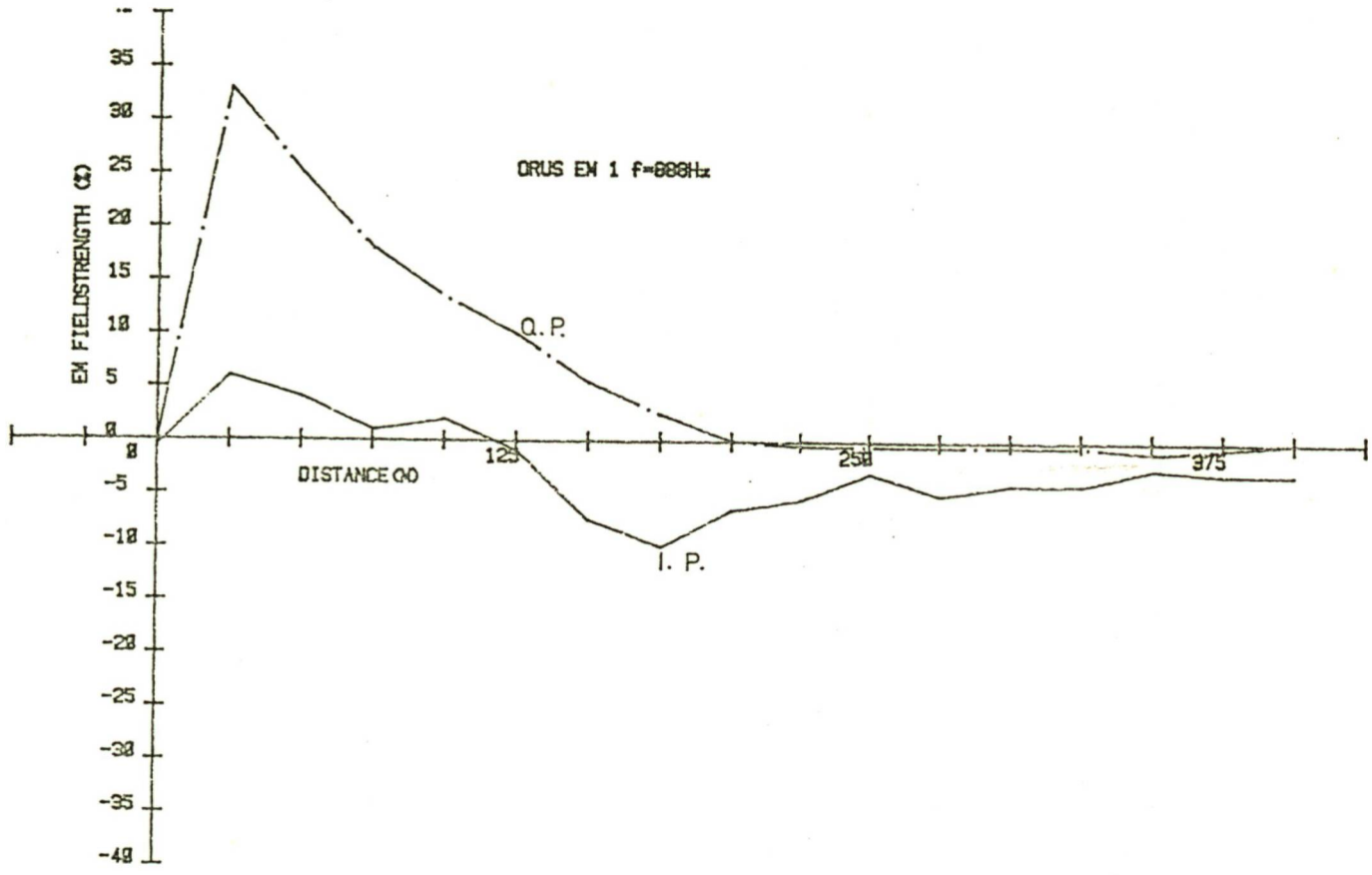
Appendix 3. 5. 13a



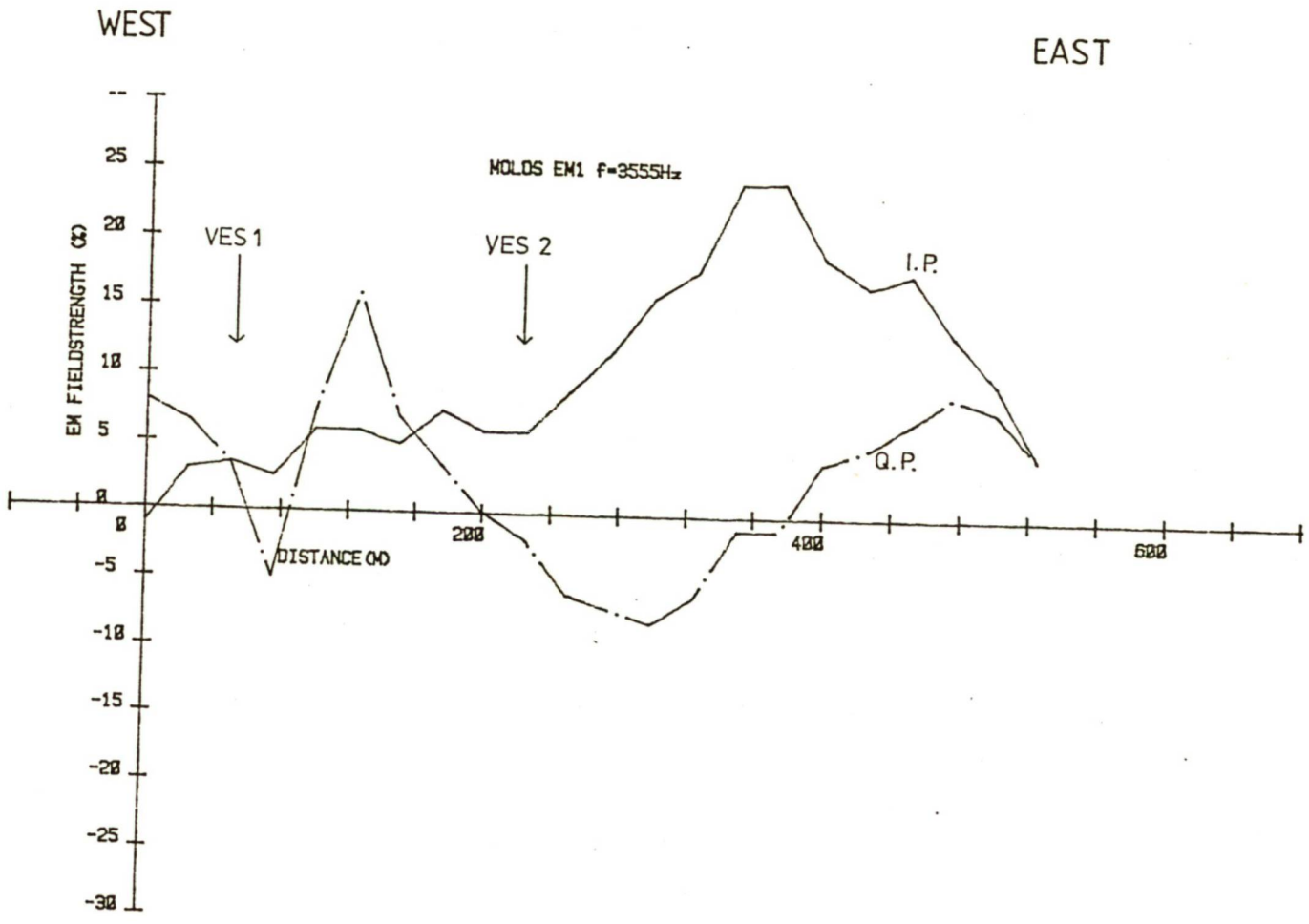
Appendix 3. 5. 13b

EAST

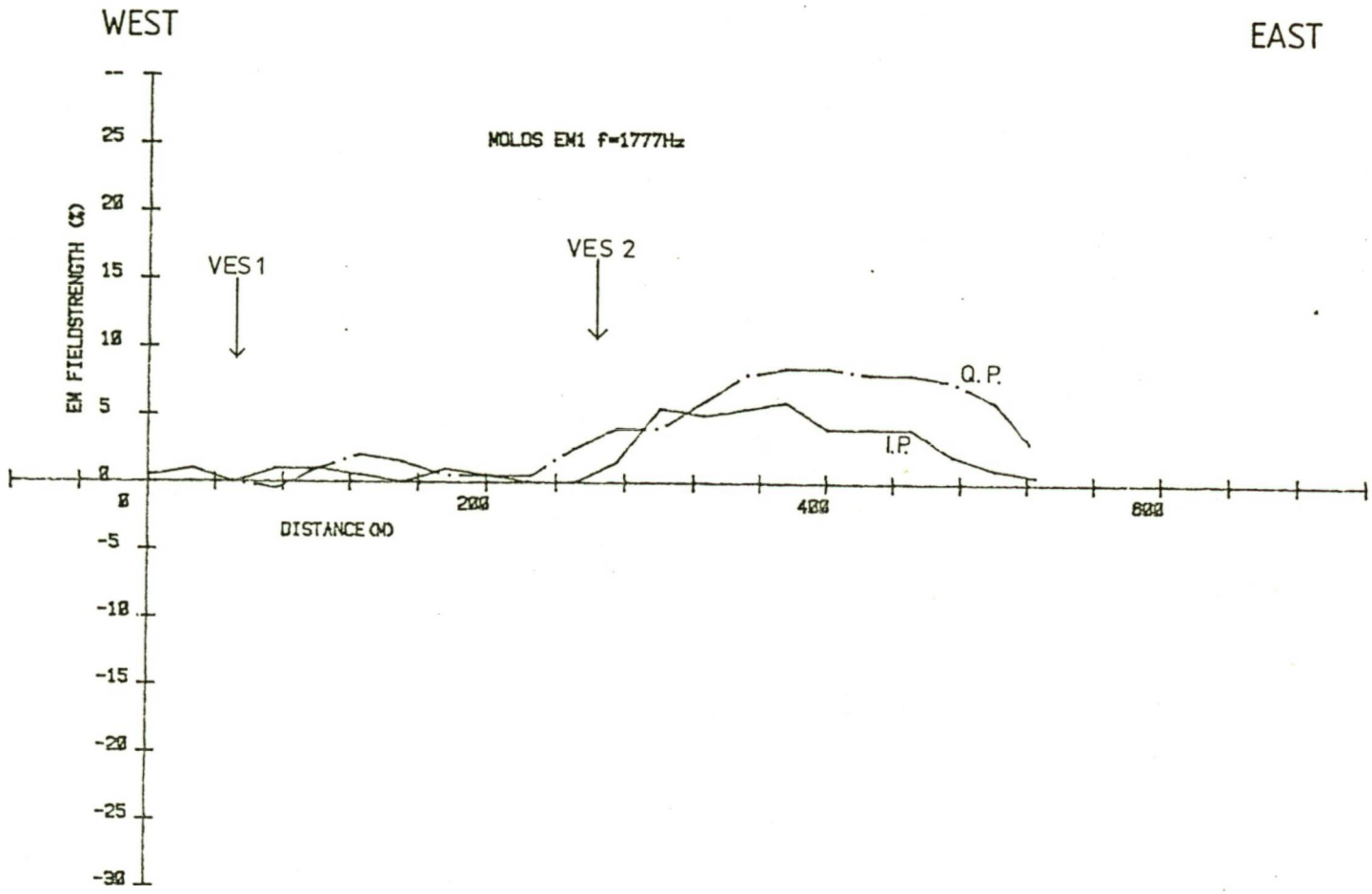
WEST



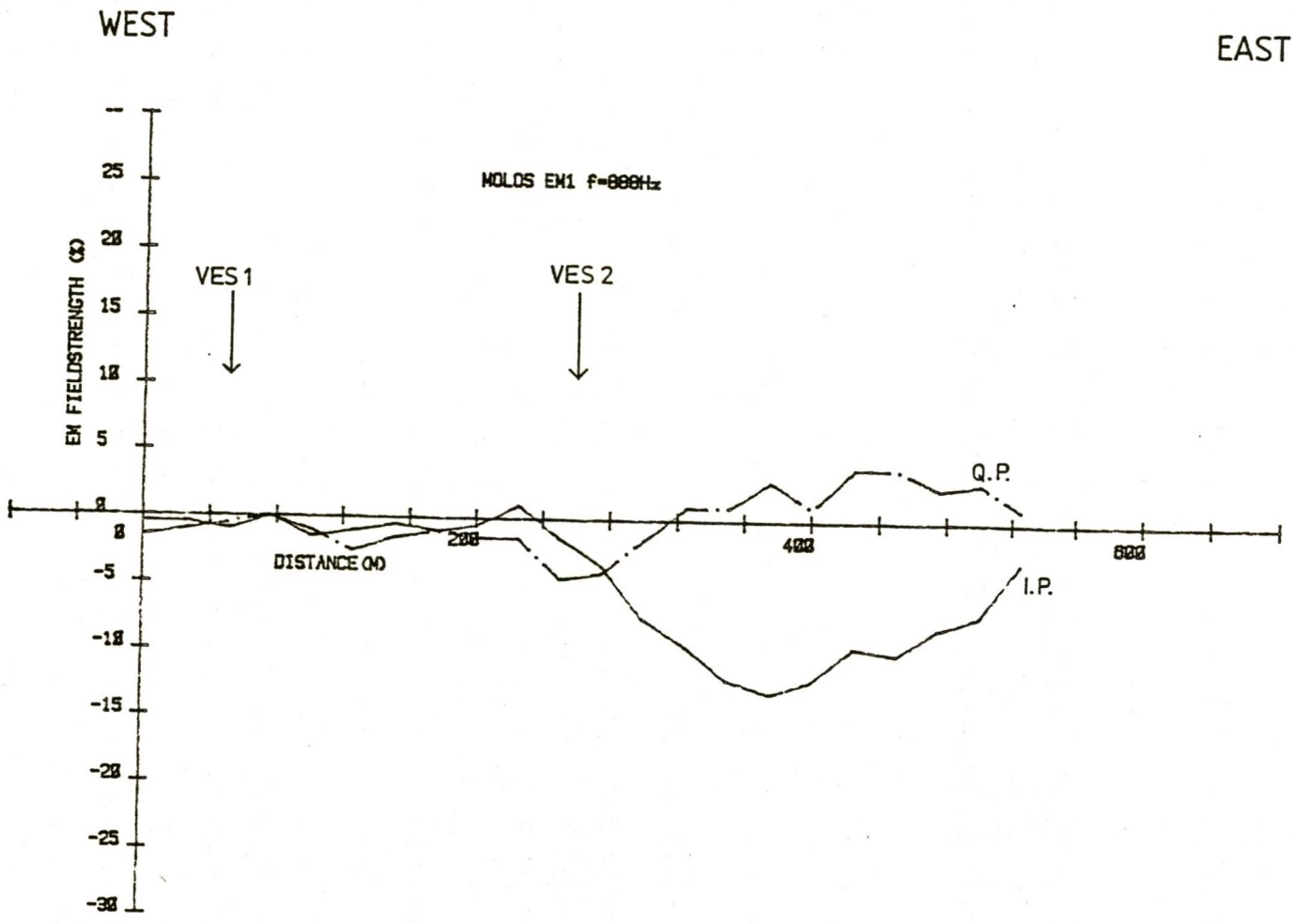
Appendix 3. 5. 13c



Appendix 3. 5. 14a



Appendix 3.5.14b



Appendix 3. 5. 14c

LIST OF APPENDICES, CHAPTER 4

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APPENDIX 4.1

List of Regular River Gauging Stations

List of Regular River Gauging Stations

No.	RGS	RIVER	LATITUDE	LONGITUDE	TYPE	OPEN	CLOSED	AREA km²	RATED
1.	2D1	Suguta	1 10 55N	36 06 20E	S	10/68	-	3497	No
2.	2EB1	Wards Stream	0 03 20N	36 14 15E	W	02-48	-	46	Yes
3.	2EB2	Subukia							
4.	2EB3	Subukia	0 11 10N	36 12 40E	W	02-48	-	331	Yes
5.	2EB4	Lesser Subukia	0 08 40N	36 14 49E	S	04-59	-	23	Yes
6.	2EB5	Waseges	0 23 26N	36 05 18E	S	09-73	-	528	Yes
7.	2EC1	Olobonaita	0 07 45S	36 07 38E	W	10-31	07-59	68	Yes
8.	2EC2	Rongai	0 06 20S	35 55 50E	W	10-31	-	288	Yes
9.	2EC3	Rongai	0 18 48S	35 50 50E	W	10-31	-	48	Yes
10.	2EC4	Swamp Canal	0 12 20S	35 51 40E	W	03-48	-	32	Yes
11.	2EC5	Rongai	0 24 02S	35 50 20E	W	03-49	09-64	17	Yes
12.	2EC6	Rongai	0 22 06S	35 49 40E	W	04-49	09-64	27	Yes
13.	2EC7	Rongai	0 23 20S	35 50 08E	W	12-49	09-64	19	Yes
14.	2EC8	Rongai Tunnel	0 23 20S	35 50 08E	W	02-52	09-64	19	Yes
15.	2ED1	Tiggeri	0 06 10N	35 41 28E	S	05-56	-	135	Yes
16.	2ED2	Lelgel	0 03 48N	35 42 05E	S	05-56	-	108	Yes
17.	2ED3	Eldama	0 03 03N	35 43 18E	S	05-56	-	14	Yes
18.	2EE1	Perkera							
19.	2EE2	Perkera							
20.	2EE3	Perkera	0 27 23N	35 57 55E	S	01-55	03-06	1181	Yes
21.	2EE4	Perkera	0 27 33N	35 58 08E	S	06-55	05-68	1334	Yes
22.	2EE5	Perkera				09-58	01-59		No
23.	2EE6	Perkera							
24.	2EE7	Perkera	0 27 23N	35 57 55E	S	07-62	-	1181	Yes
25.	2EE8	Perkera	0 09 54N	35 49 10E	S	10-63	-	500	Yes
26.	2EE9	Perkera	0 14 30N	35 52 28E	S	02-64	-	580	Yes
27.	2EE10	Perkera	0 27 33N	25 58 18E	S	06-68	10-69	1329	No
28.	2EF1	Esageri	0 14 00N	35 52 43E	S	05-56	-	365	Yes
29.	2EF2	Esageri	0 08 08N	35 53 03E	S	06-56	-56	257	No
30.	2EF3	Esageri	0 01 17N	35 49 25E	W	06-56	-	60	Yes
31.	2EF4	Naro-Sura	0 01 32N	35 47 05E	S	06-56	-	90	Yes
32.	2EG1	Molo	0 05 10S	35 54 48E	W	01-26	-	595	Yes
33.	2EG2	Maria-Shoni	0 23 12S	35 48 51E	W	4-49	9-64	8	Yes
34.	2EG3	Molo	0 26 40N	36 00 40E	S	05-56	03-65	2145	No
35.	2EG4	Munji	0 16 28S	35 42 30E	S	10-56	09-62	14	No
36.	2EH1	L. Baringo	0 36 57N	36 01 28E	S	2-50	-		-
37.	2EH2	Kinyo	0 28 50N	35 46 40E	S	-69	-72	5	Yes
38.	2EH3	Endau	0 31 14N	35 51 46E	S	-77		131	No
39.		Lorwai Spring				85			
40.	2EA1	Maji Matamu							
41.		Lake Bogoria				85			

S = Staff Gauge
W = Weir

APPENDIX 4.2

List of Rainfall Stations

List of Rainfall Stations

NAME	METEO. REG. NO.	LATITUDE	LONGITUDE	ALTITUDE METRES	RECORD PERIOD
1. Kolloa	88.35.40	1 15 N	35 45 E		67-68
2. Maron Mission	88.35.145	1 12 N	35 55 E	1488	70-83
3. Kapedo Mission	88.36.10	1 10 N	36 05 E	763	66-83
4. Eldama Ravine	89.35.00	0 04 N	35 44 E	1983	23-42
5. Eldama Ravine	89.35.07	0 05 N	35 45 E	2196	03-82
6. Sabatia Farm	89.35.09	0 01 N	35 46 E	2051	35-36
7. Kabarnet D.C.	89.35.20	0 30 N	35 45 E	2041	15-82
8. Marigat Dispens.	89.35.35	0 26 N	35 56 E	1098	35-53
9. Kabartonjo Mission	89.35.51	0 39 N	35 48 E	2257	35-78
10. Emening Dispens.	89.35.60	0 09 N	35 55 E	1586	39-65,73-80
11. Rongai Esageri	89.35.87	0 03 N	35 53 E	1739	47-82
12. Tenges	89.35.91	0 26 N	35 52 E	1891	48-83
13. Poi	89.35.92	0 43 N	35 42 E	1678	49-62,70-83
14. Chebloch Primary Sch.	89.35.93	0 27 N	35 40 E	1220	49-72
15. Timboiwa	89.35.94	0 26 N	35 47 E	2288	49-76,78-82
16. Narasha Forest	89.35.109	0 01 N	35 41 E	2379	51-83
17. Kabarnet	89.35.128	0 30 N	35 46 E	1952	55-81,83
18. Kituro Dem. Plot	89.35.135	0 30 N	35 50 E	2135	56-71,73
19. Kabimoi	89.35.136	0 03 N	35 49 E	1830	56-83
20. Sirwa Dispensary	89.35.140	0 11 N	35 46 E	2135	75-78,1980
21. Chmogoch	89.35.141	0 01 N	35 58 E	1617	60-78
22. Cheberen	89.35.143	0 14 N	35 53 E	1373	60-69
23. Radad School	89.35.144	0 21 N	35 57 E	1159	61-69,71-75,77-83
24. Torongo	89.35.145	0 06 N	35 36 E	2593	61-65,67-71,73-83
25. Barwesa	89.35.146	0 42 N	35 44 E	1678	58-76,78-83
26. Talai	89.35.149	0 35 N	35 50 E	2135	60-83
27. Bartalimo	89.35.153	0 41 N	35 49 E	1983	64,66,68-69,71-83
28. Ravine School	89.35.155	0 03 N	35 42 E	2196	66-68,70-76,78-79
29. Perkera School	89.35.163	0 28 N	35 58 E	1068	54-83
30. Tenges Forest	89.35.176	0 24 N	35 53 E	1464	69-83
31. Katimok Forest	89.35.177	0 40 N	35 50 E	2288	70-83
32. Chemususu Forest	89.35.187	0 05 N	35 40 E	2318	74-83
33. Sacho Dispensary	89.35.191	0 23 N	35 47 E	2135	75-78
34. Sigoro Primary School	89.35.192	0 08 N	35 44 E	2135	75-80
35. Nara Sura	89.35.193	0 03 N	35 47 E	1952	75-83
36. Bartabwa	89.35.195	0 51 N	35 49 E	1830	76-77,79-82
37. Tiriominin Churon	89.35.196	0 39 N	35 49 E	2135	76-77,79-83
38. Kapkalewa	89.35.197	0 23 N	35 43 E	1373	75-83
39. Mugorwa	89.35.199	0 18 N	35 45 E	1525	75-79
40. Kimose	89.35.200	0 15 N	35 53 E	1525	75-80
41. Tangulbei	89.36.19	0 48 N	36 18 E	1525	39-62,64-71,66-84
42. Kinyang	89.36.20	0 57 N	36 01 E	915	38-39,42-61,66-84
43. Hot Springs	89.36.26	0 15 N	36 03 E	1220	39-82
44. Kamasia Reserve	89.36.31	0 04 N	36 06 E	1678	48-65
45. L. Baringo Fisheries	89.36.41	0 35 N	36 02 E	961	50
46. Mugurin School	89.36.55	0 06 N	36 02 E	1495	75-76,79-82
47. Snake Farm	89.36.67	0 38 N	36 03 E	976	66-81

Cont. List of Rainfall Stations

NAME	METEO. REG. NO.	LATITUDE	LONGITUDE	ALTITUDE METRES	RECORD PERIOD
48. Loboi Disp.	89.36.80	0 21 N	36 04 E	1066	75-80,1982
49. Loruk School	89.36.82	0 43 N	36 02 E	1007	75-82
50. L. Bogoria	89.36.83	0 15 N	36 05 E	564	77-83
51. Maji Mazuri Forest	90.35.28	0 01 S	35 45 E	2333	16-17,23-83
52. Sabatia Railway	90.35.35	0 02 S	35 45 E	2211	31-54,69-73,76-80
53. Sabatia Forest	90.35.229	0 03 S	35 45 E	2211	59-83
54. Esageri Forest	90.35.231	0 04 S	35 47 E	2135	60-83
55. Perkerai	90.35.246	0 05 S	35 47 E	2044	64-72
56. Sabatia Scheme	90.35.247	0 01 S	35 47 E	2166	64-83
57. Lebolos Farm	90.35.272	0 04 S	35 48 E	2013	69-73,76-77
58. Mogotio Police	90.35.293	0 01 S	35 48 E	2013	76-83
59. Nyahururu	89.36.35	0 13 N	36 23 E	2059	48-66
60. Rumuruti	89.36.13	0 09 N	36 38 E	1922	27-75
61. Timboroa	89.35.137	0 13 N	36 23 E	2745	54-83
62. Gwito Co-op	90.35.110	0 05 S	35 35 E	2318	48-68,76-79,82
63. Sorget Forest	90.35.128	0 03 S	35 33 E	2379	51-83
64. Londian Entomology	90.35.151	0 19 S	35 36 E	2318	56-83
65. Londian Training School	90.35.226	0 10 S	35 36 E	2318	57-83
66. Olmanyata Subukia	89.36.04	0 07 N	36 14 E	1754	33-65
67. Kaptarakwa	89.36.34	0 04 N	36 13 E	1891	47-73
68. Emarangishu L. Solai	89.36.63	0 00 N	36 08 E	1562	63-79
69. Olgilgei Farm	90.35.00	0 18 S	35 57 E	2166	22-80
70. Kamara Mau Sumit	90.35.06	0 05 S	35 41 E	2547	21-68, 76
71. Molo	90.35.18	0 15 S	35 44 E	2460	04-83
72. Njoro P B Station	90 35.21	0 20 S	35 56 E	2166	29-83
73. Mau Sumit	90.35.38	0 10 S	35 41 E	2538	32-83
74. Rongai	90.35.64	0 14 S	35 50 E	1983	20-67
75. Rongai (Gogaro)	90.35.73	0 11 S	35 50 E	1891	31-82
76. Elburgon	90.35.90	0 16 S	35 49 E	2318	41-63
77. Molo Pyre. St.	90.35.93	0 14 S	35 44 E	2501	44-83
78. Turi	90.35.99	0 16 S	35 47 E	2355	44-74
79. Turi Highlands	90.35.115	0 19 S	35 45 E	2593	48-77
80. Mariashoni	90.35.117	0 22 S	35 49 E	2684	49-83
81. Nessuit Forest St.	90.35.117	0 22 S	35 49 E	2684	49-83
82. Kiptunga Forest	90.35.228	0 27 S	35 48 E	2955	61-83
83. Elburgon Forest	90.35.237	0 19 S	35 48 E	2562	61-83
84. Kenana Farm (Njoro)	90.35.254	0 18 S	35 55 E	2196	64-83
85. Molo Water Bailif	90.35.266	0 15 S	35 43 E	2440	67-83
86. Molo Forest	90.35.273	0 17 S	35 45 E	2410	69-83
87. Olmomoi Estate	90.36.00	0 01 S	36 15 E	2059	27-77
88. Olbonaita	90.36.10	0 07 S	36 06 E	1830	16-47,76,79-82
89. Nakuru	90 36 21	0 17 S	36 04 E	1851	04-52,56-83
90. Bahati Forest St.	90.36.32	0 07 S	36 12 E	2410	31-81
91. Solai Crater	90.36.84	0 10 S	36 07 E	1891	38-67
92. Subukia Agric.	90.36.151	0 02 S	36 09 E	2135	47-74,76,80-83
93. Nakuru Met.	90.36.261	0 16 S	36 04 E	1873	64-83
94. Mukutan	89.36.088				
95. Churo Primary School	89.36.081	0 47 N	36 24 E		

APPENDIX 4.3

Evaporation Stations Used in Analysis

&

Table of Annual Evaporation

Evaporation Stations Used in Analysis:

STATION NAME	REG. NO.	ALTITUDE (m)	LATITUDE	LONGITUDE	RECORDS
Eldama-Ravine	130	2050	0 03 00N	35 43 45E	1975-85
Perkera Marigat	077	1068	0 16 20S	36 22 50E	1959-83
Kabarnet	063	1908	0 30 00N	35 45 00E	1959-84
Mariashoni	099	2591	0 25 20S	35 50 00E	1962-84
Molo	062	2438	0 14 35S	35 45 40E	1959-83
Nakuru (Show Ground)	026	1870	0 17 00S	36 04 00E	1966-85

Annual Pan Evaporation Data in mm

Station Name	Mariashon	Molo	Eldama Ravine	Kabarnet	Nakuru	Marigat
MoWD No.	99	62	130	63	26	77
Elevation m.s.l	2591	2438	2050	1908	1870	1068
Year						
1959		1282		1711		2612
1960		1154		2036		2986
1961		1128		1873		2828
1962	1235	1075		1786		2587
1963	1109	1253		1711		2552
1964	1212	1266		1639		2439
1965	1191	1466		2037		2765
1966	1326	1384		1930	1791	2620
1967	1231	1376		1696	1942	2523
1968	1115	1241		1710	1561	2453
1969	1256	1403		1976	1879	2625
1970	1237	1341		1868	1779	2665
1971	1284	1350		1946	1881	2870
1972	1236	1379		1992	1900	2884
1973	1276	1419		1993	2040	2775
1974	1223	1331		1930	1829	2514
1975	1446	1345	1845	1976	1765	2304
1976	1422	1487	2074	2268	1684	2553
1977	1227	1306	1918	2020	1521	2344
1978	952	1236	1629	1885	1383	2345
1979	1001	1336	1943	2051	1496	2654
1980	907	1479	2289	2376	1764	2925
1981	1047	1364	1839	1961	1567	2439
1982	1102	1386	1799	1971	1630	2393
1983	1343	1440	1786	1736	1589	2162
1984			2018	2186	1833	
1985			1844		1657	
n	23	25	11	26	20	25
x	1187	1329	1908	1933	1725	2565
s	143	106	174	178	171	191
cv	0.12	0.08	0.09	0.09	0.10	0.07

n = Number of years x = Average s = Standard deviation
cv = coefficient of variation

APPENDIX 4.4

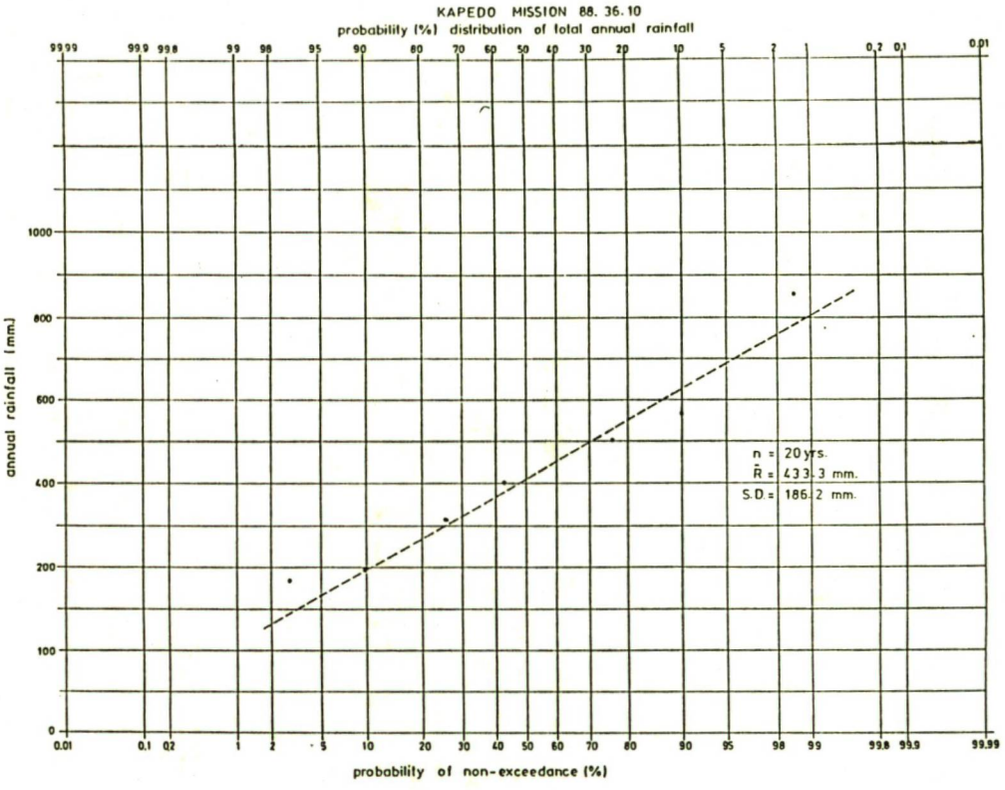
Rainfall Stations Used in Analysis

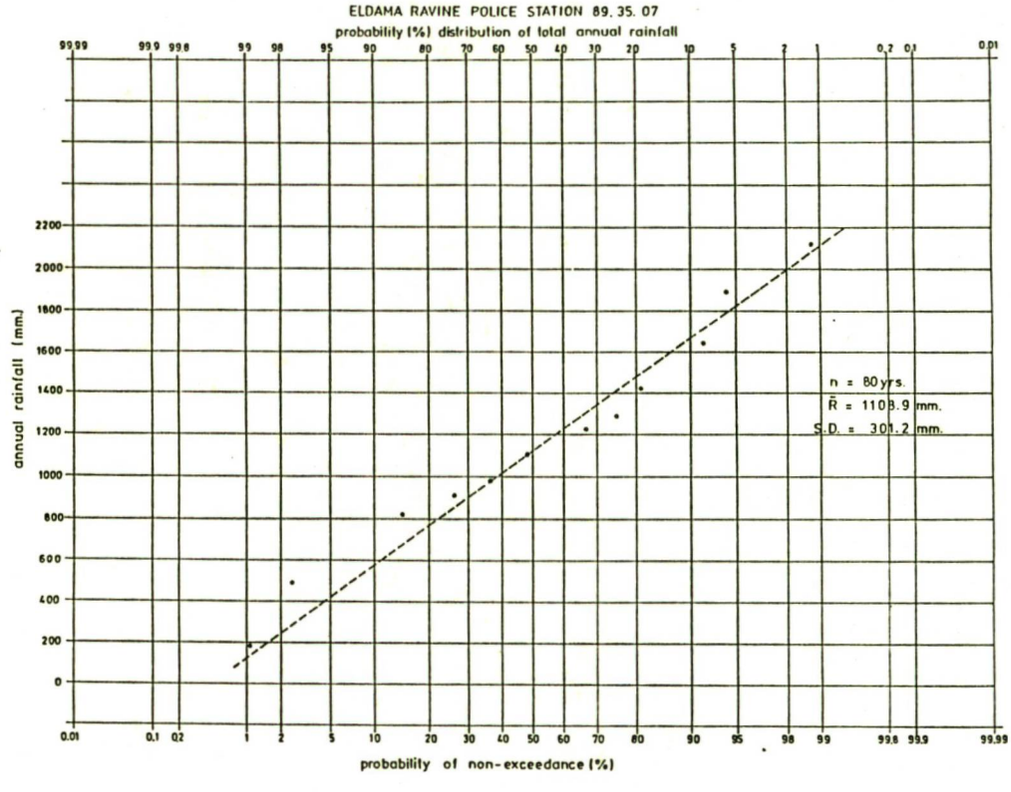
Rainfall Stations Used in Analysis

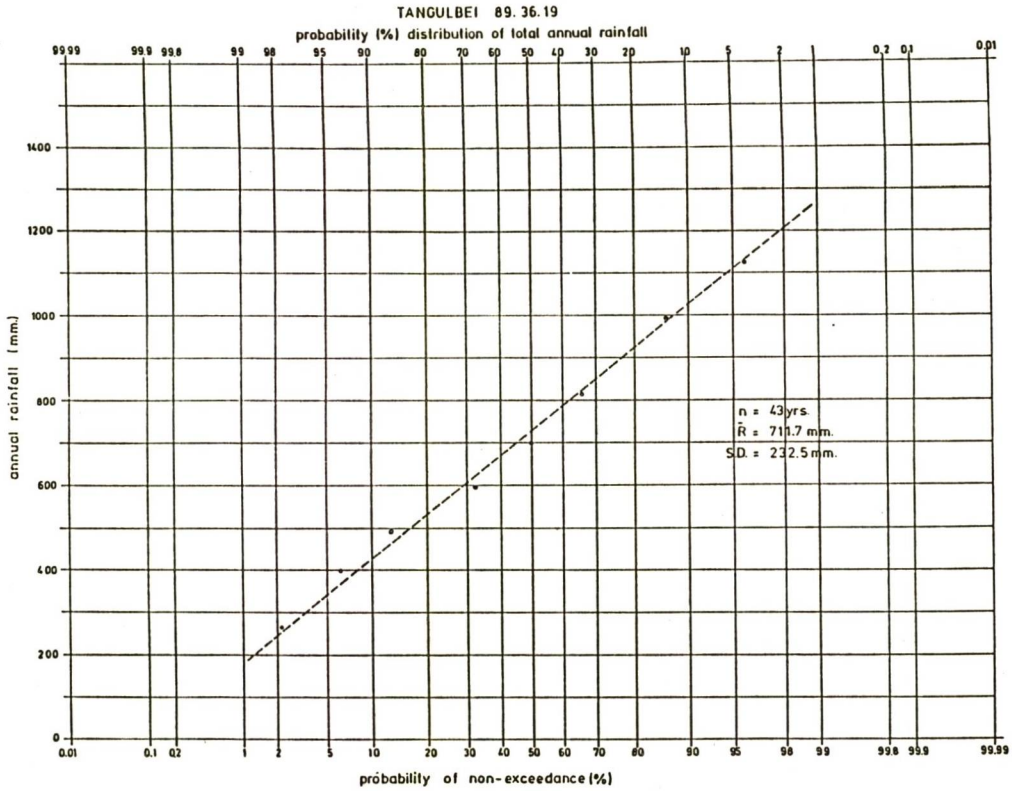
STATION NAME LONGTITUDE	REGISTRATION NO.	ALTITUDE (m)	LATITUDE
Marigat	89.35.163	1068	0 28N 35 58 E
Kaptarakwa	89.36.34	1891	0 04N 36 13E
Subukia (Olmomoi)	90.36.00	2059	0 01S 36 15E
Elburgon-Marishoni Forest Station	90.35.117	2684	0 22S 35 49E
Molo (Railway St.)	90.35.18	2460	0 15S 35 44E
Kapedo Mission	88.36.10	763	1 10N 36 05E
Tangulbei	89.36.19	1525	0 48N 36 18E
Kinyang Hospital	89.36.20	915	0 57N 36 01E
Kabarnet (D.C)	89.35.20	2041	0 30N 35 45E
Eldama Ravine	89.35.07	2196	0 05N 35 45E

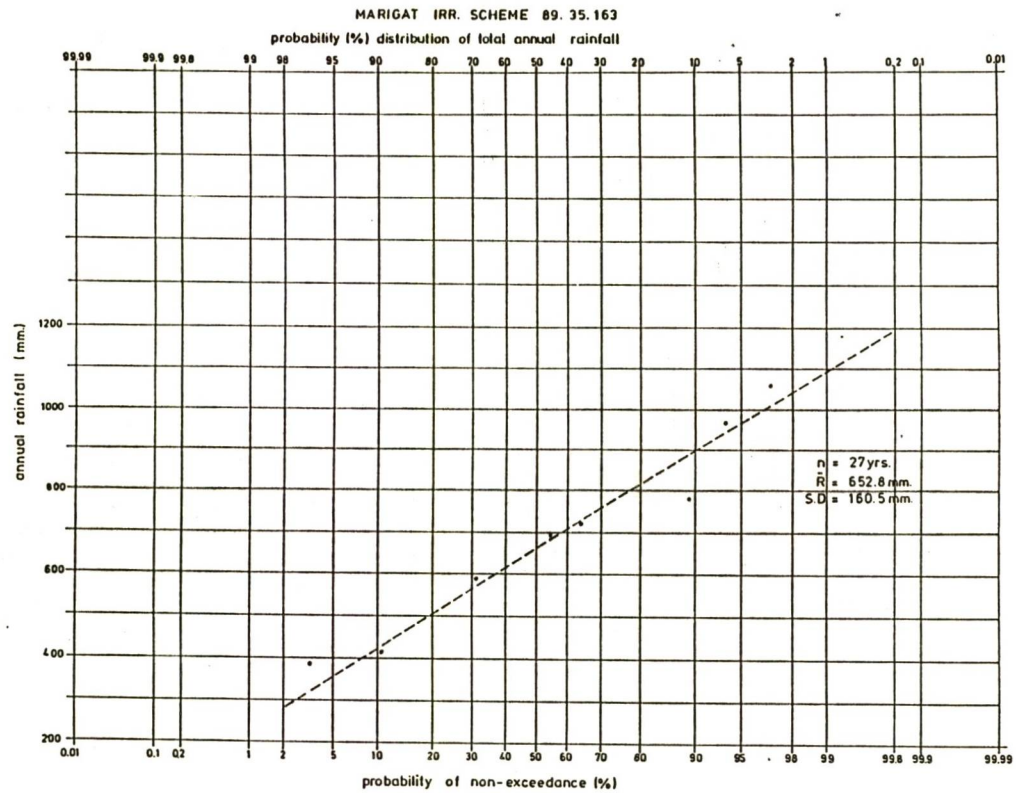
APPENDIX 4.5

Annual Rainfall Probability Graphs


KAPEDO MISSION 88. 36. 10
probability (%) distribution of total annual rainfall
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.2 0.1 0.01
annual rainfall (mm)
0 100 200 400 600 800 1000
0.01 0.1 0.2 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
probability of non-exceedance (%)
n = 20 yrs.
R̄ = 433.3 mm.
S.D. = 186.2 mm.

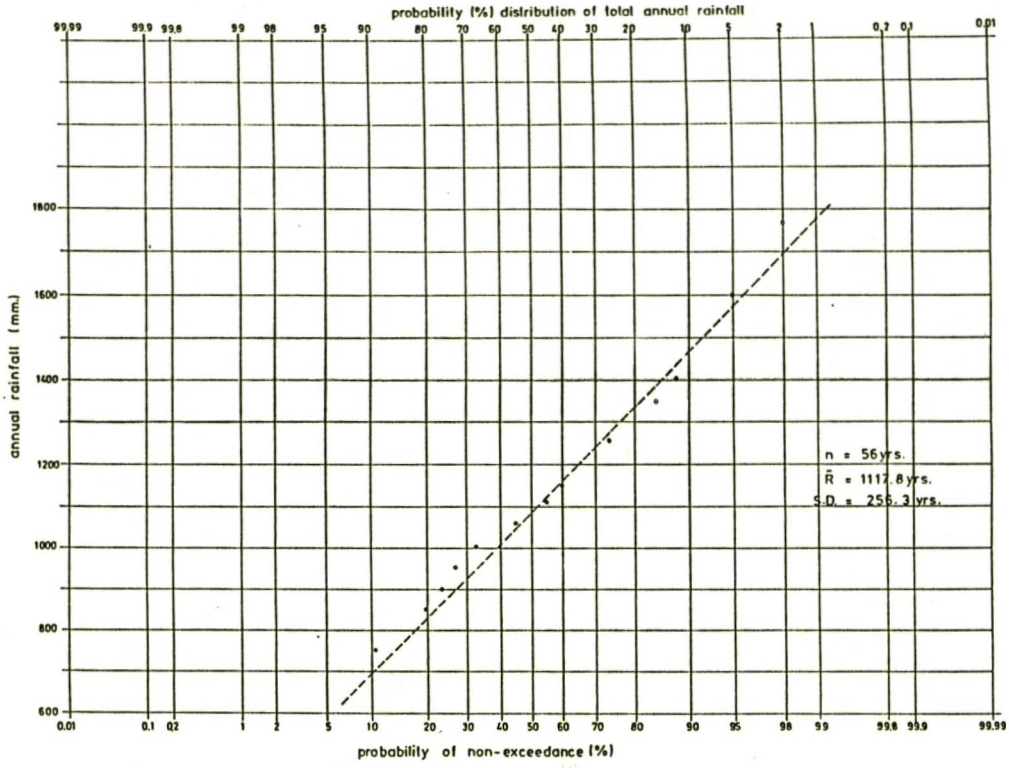

ELDAMA RAVINE POLICE STATION 89. 35. 07
probability (%) distribution of total annual rainfall
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.2 0.1 0.01
annual rainfall (mm)
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200
0.01 0.1 0.2 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
probability of non-exceedance (%)
n = 80 yrs.
R̄ = 1108.9 mm.
S.D. = 301.2 mm.


TANGULBEI 89. 36. 19
probability (%) distribution of total annual rainfall
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.2 0.1 0.01
annual rainfall (mm.)
0 200 400 600 800 1000 1200 1400
0.01 0.1 0.2 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
probability of non-exceedance (%)
n = 43yrs.
R̄ = 711.7 mm.
S.D. = 232.5 mm.


MARIGAT IRR. SCHEME 89. 35. 163
probability (%) distribution of total annual rainfall
99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.2 0.1 0.01
annual rainfall (mm.)
200 400 600 800 1000 1200
0.01 0.1 0.2 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
probability of non-exceedance (%)
n = 27yrs.
R̄ = 652.8 mm.
S.D. = 160.5 mm.

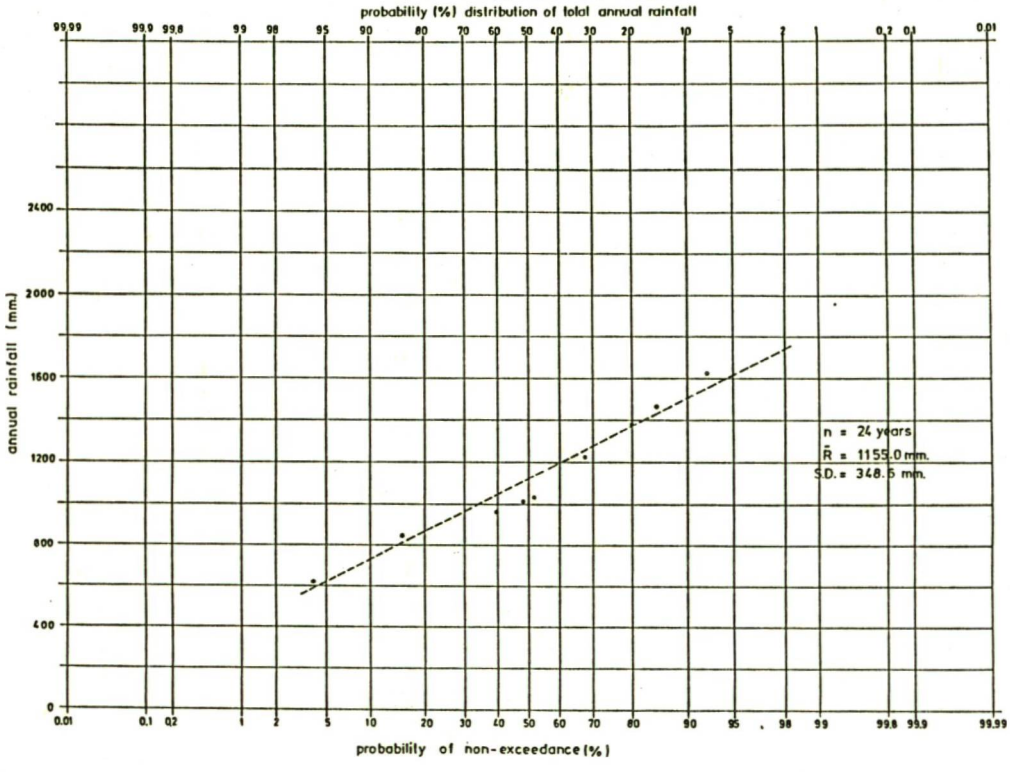
OL MOMOI ESTATE-SUBUKIA 90. 36. 00

probability (%) distribution of total annual rainfall



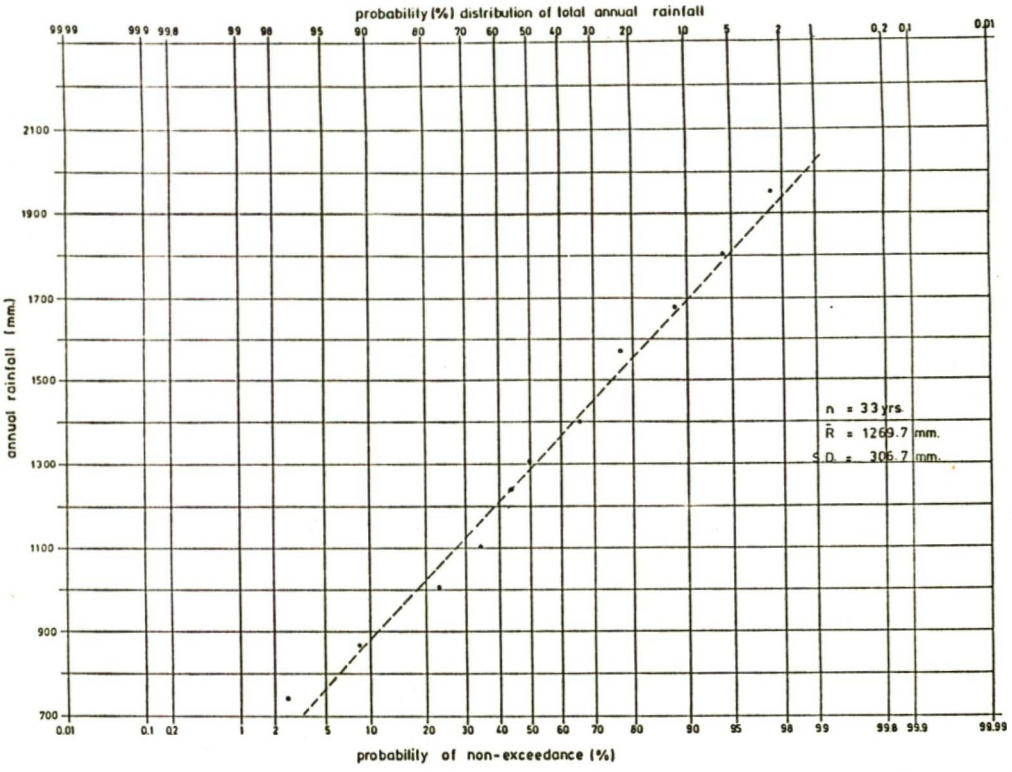
KAPTARAKWA ESTATE SUBUKIA 89. 36. 34

probability (%) distribution of total annual rainfall



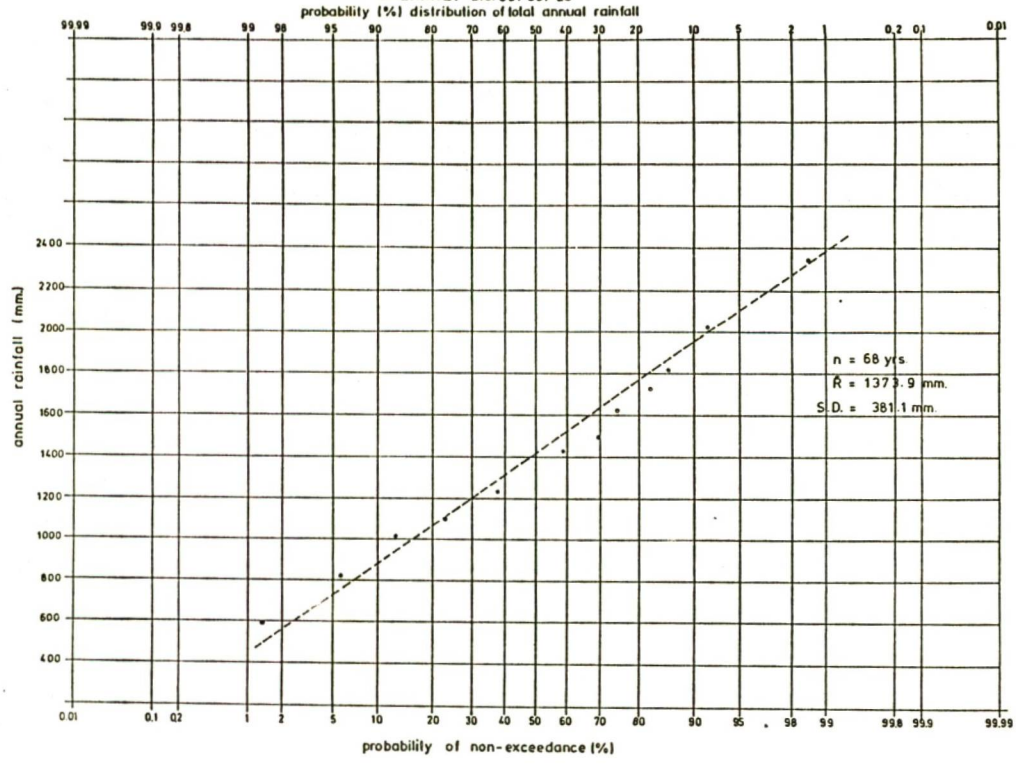
ELBURGON MARIASHONI FOREST ESTATE 90. 35. 117

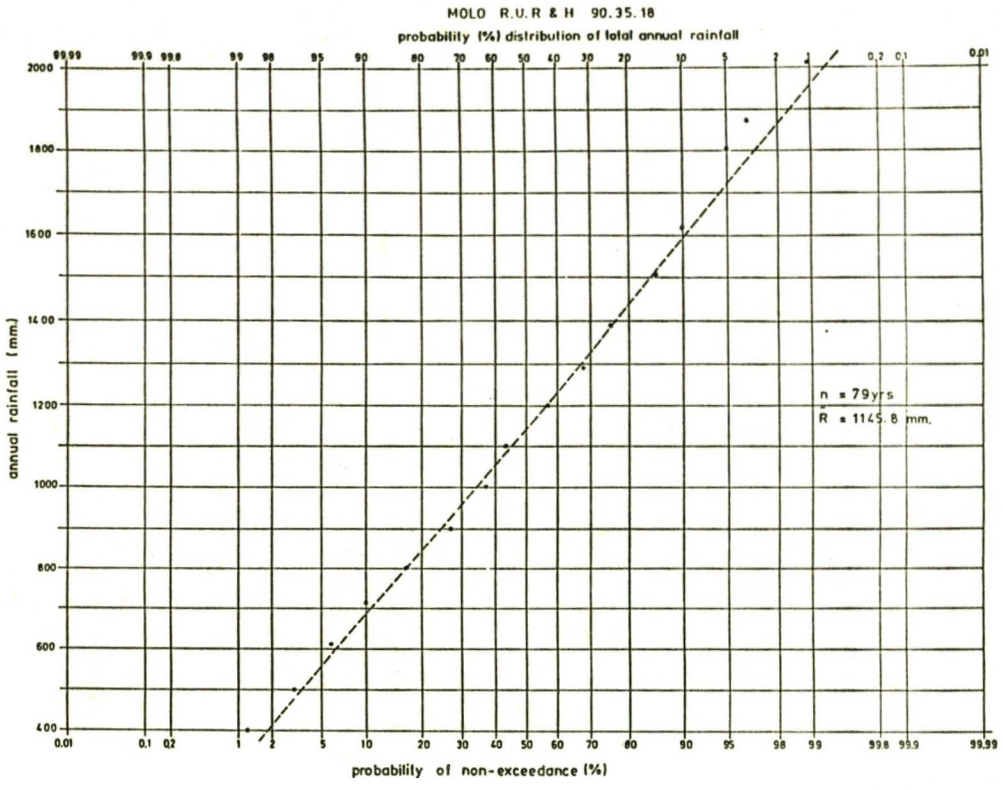
probability (%) distribution of total annual rainfall



KABARNET D.C. 89. 35. 20

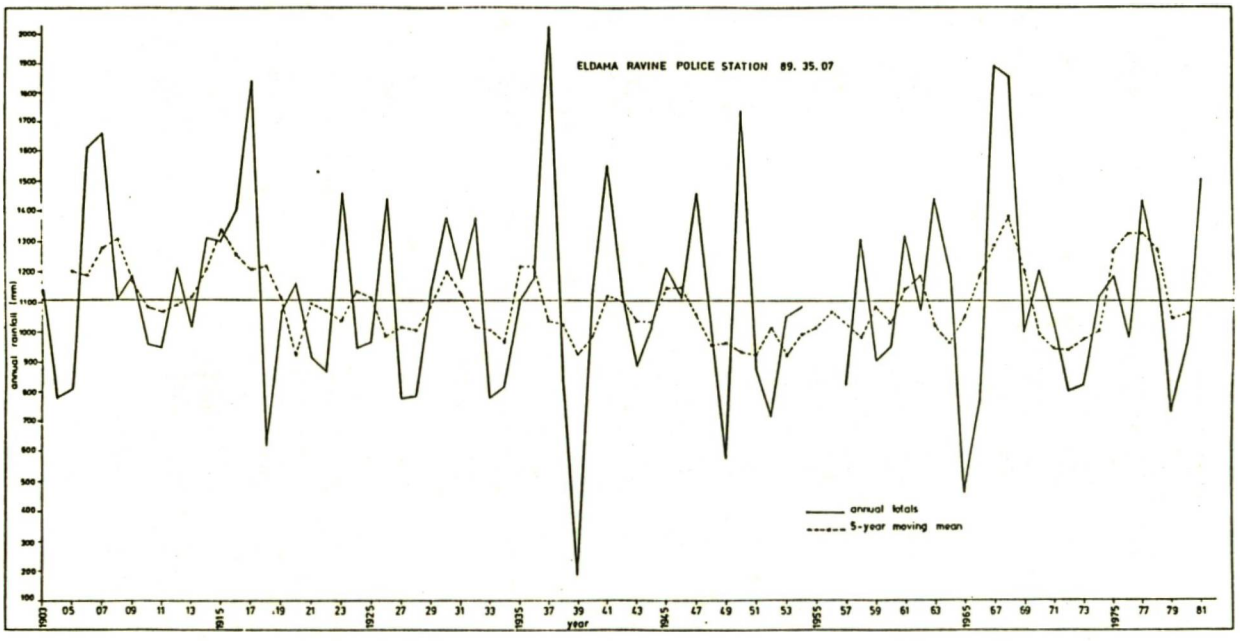
probability (%) distribution of total annual rainfall

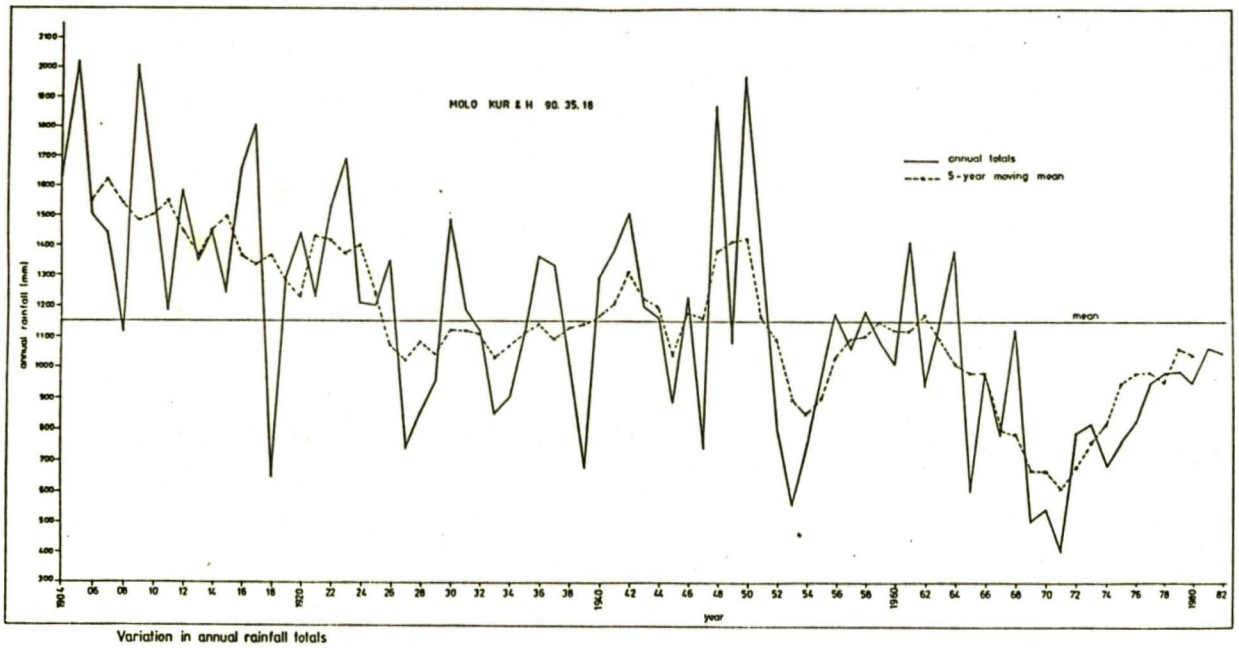



MOLO R.U.R & H 90.35.18
probability (%) distribution of total annual rainfall
annual rainfall (mm)
probability of non-exceedance (%)
n = 79yrs
R = 1145.8 mm.

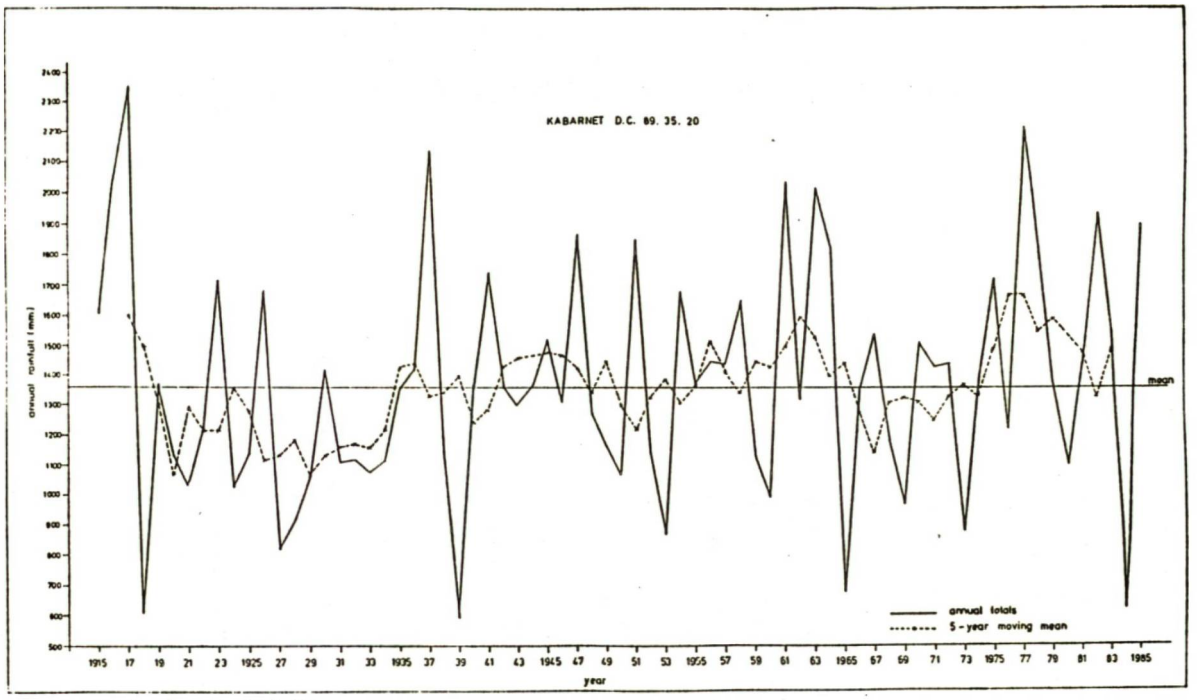
APPENDIX 4.6

Annual Rainfall Variation Graphs

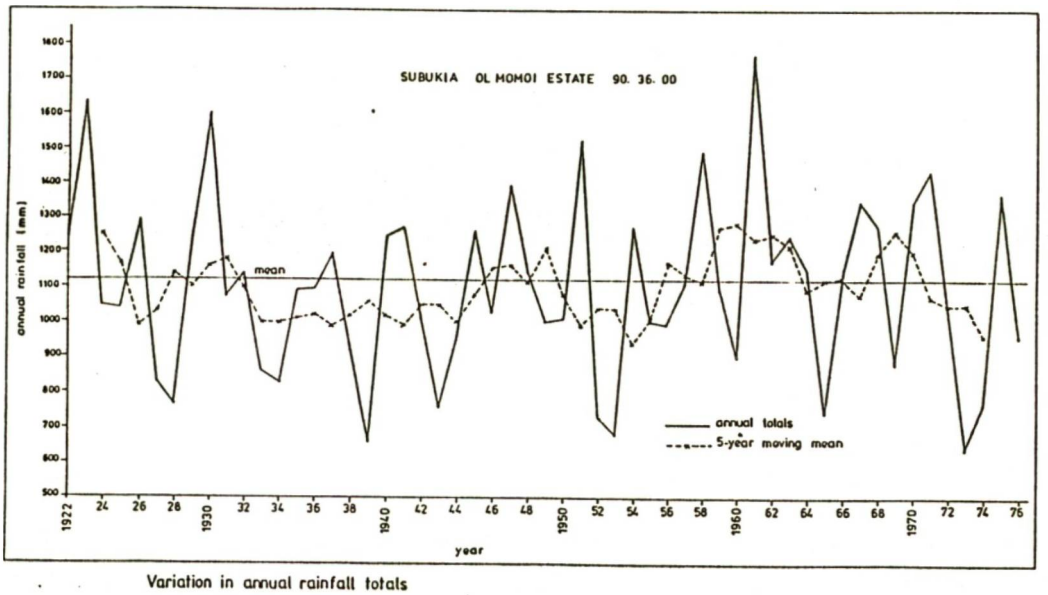




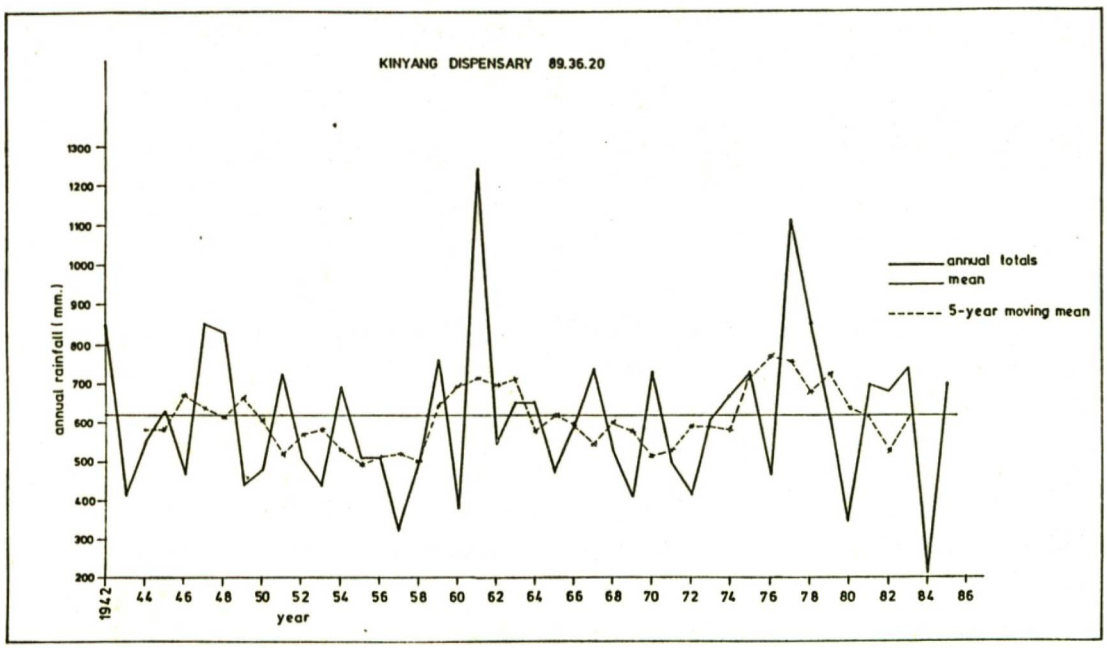
Variation in annual rainfall totals



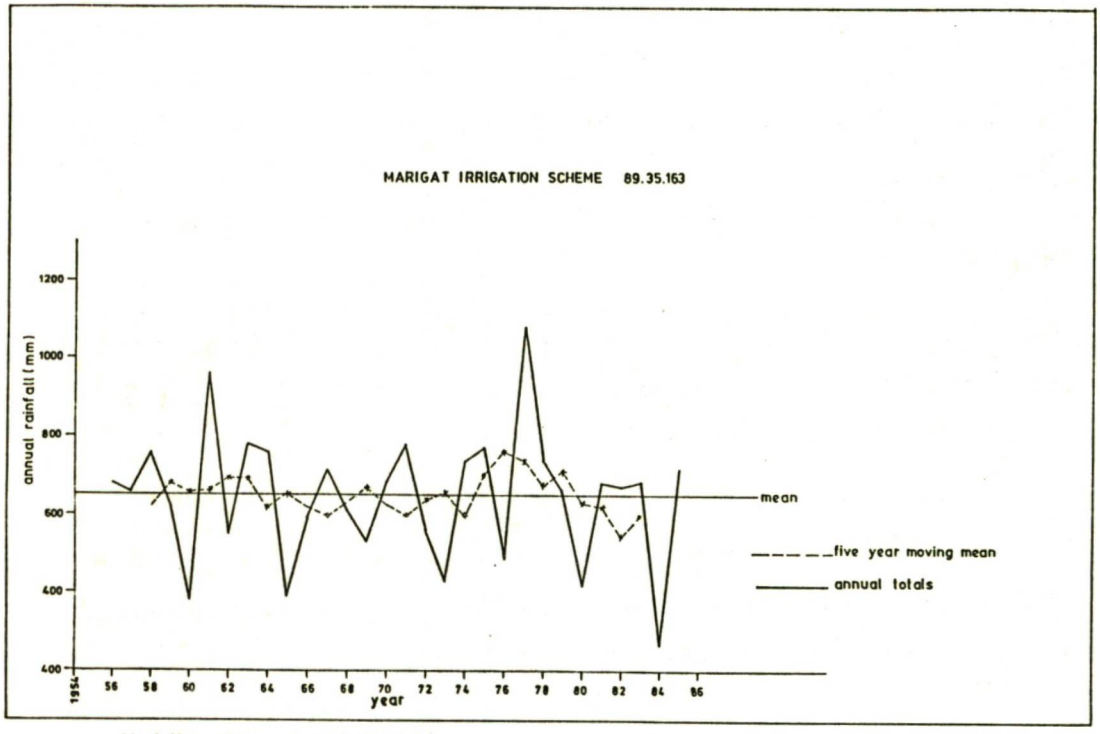
Variation of annual rainfall totals



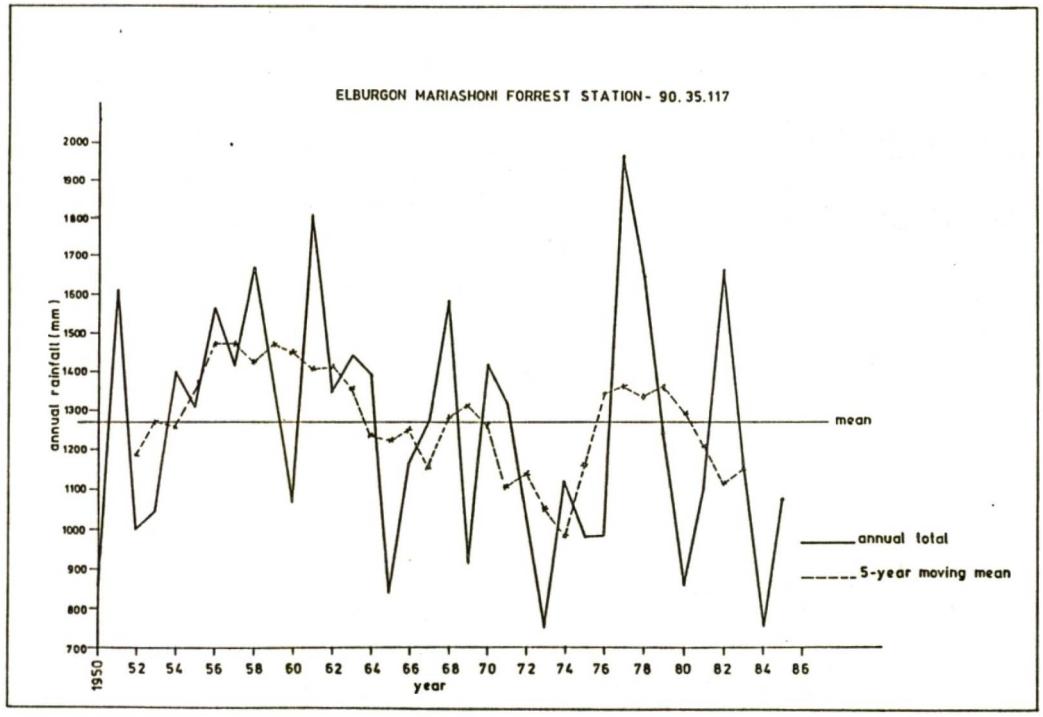
Variation in annual rainfall totals



Variation in annual rainfall totals.



Variation of annual rainfall totals



Variation in annual rainfall totals

APPENDIX 4.7

Gauging Stations Used in Analysis

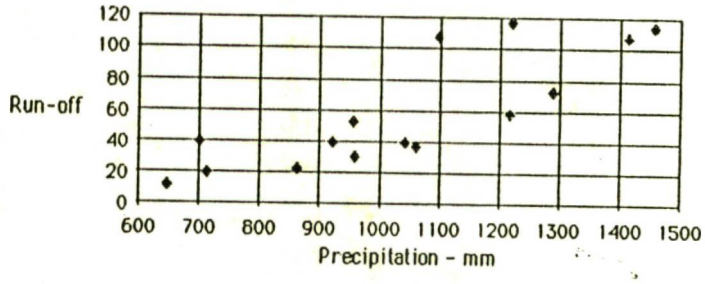
Gauging Stations used in Analysis:

RGS	River	Latitude	Longitude	Open	Area Km²
2EB3	Subukia	0 11 10N	36 12 40E	02/48	331
2ED1	Tiggeri	0 06 10N	35 41 28E	05/56	135
2ED2	Lelgel	0 03 48N	35 42 05E	05/56	108
2EE7	Perkera	0 27 23N	35 57 55E	07/62	1181
2EE8	Perkera	0 09 54N	35 49 10E	10/63	500
2EF3	Esageri	0 01 17N	35 49 25E	06/56	60
2EG1	Molo	0 05 10S	35 54 48E	01/26	595

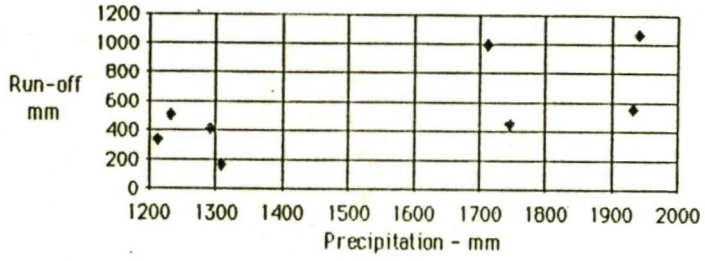
APPENDIX 4.8

Rainfall - Runoff Graphs

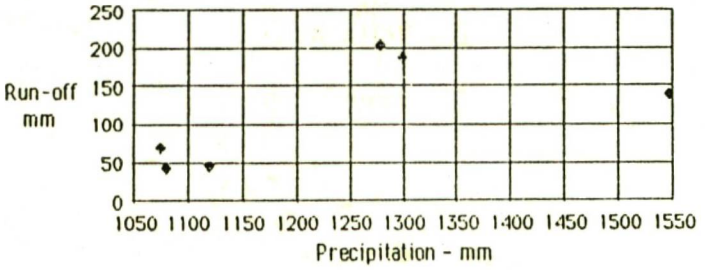
Subukia - 2EB3



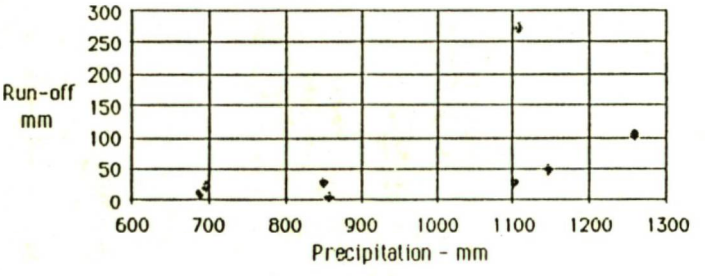
Tiggeri - 2ED1



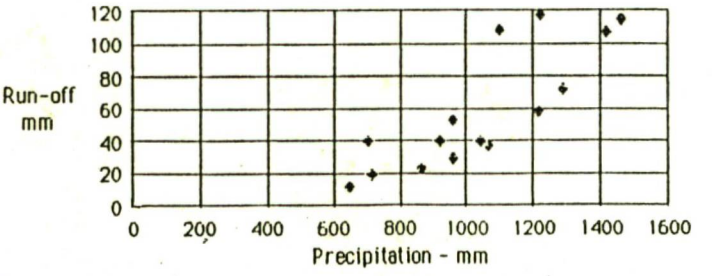
Perkera - 2EE8



Esageri - 2EF3

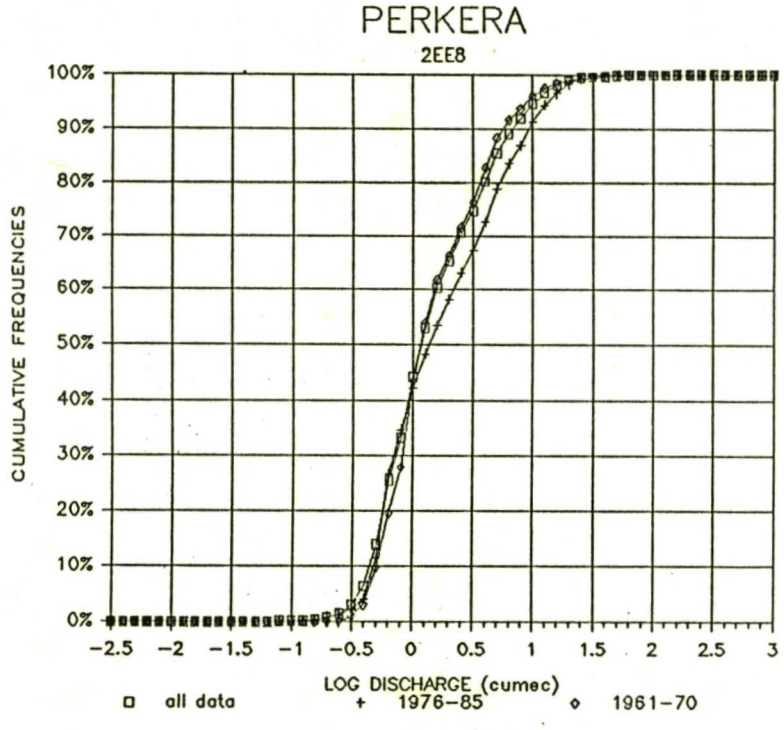


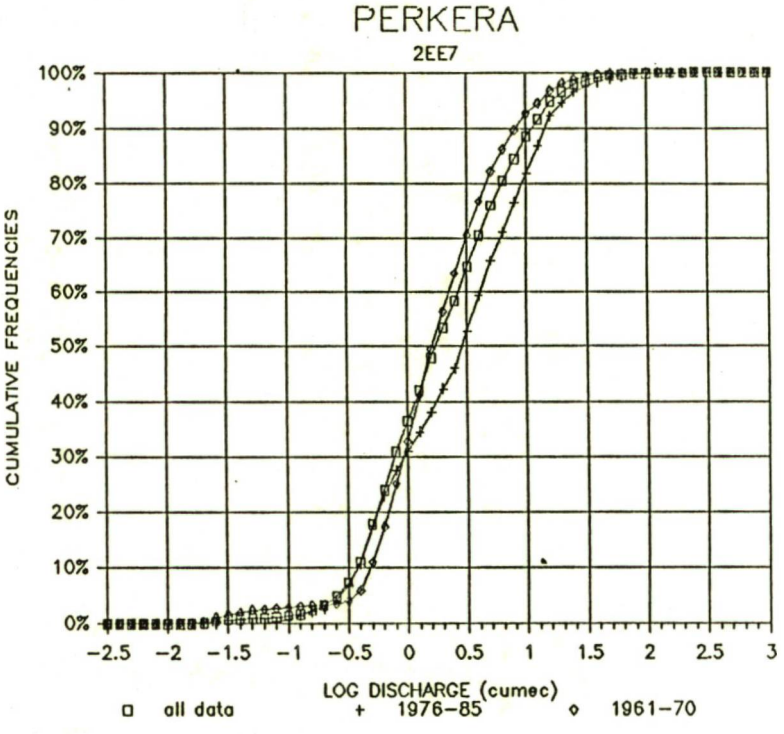
MOLO - 2EG1

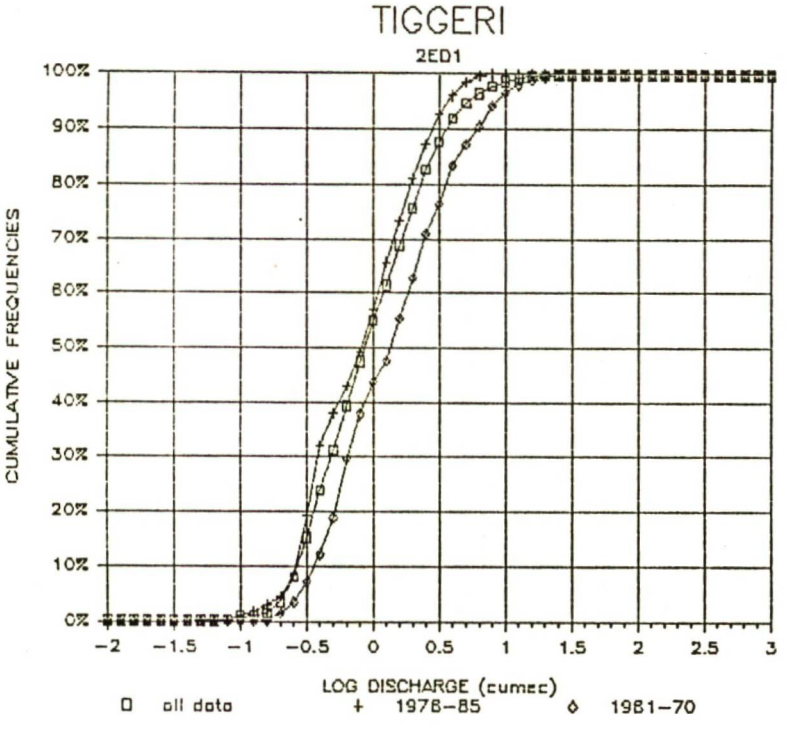


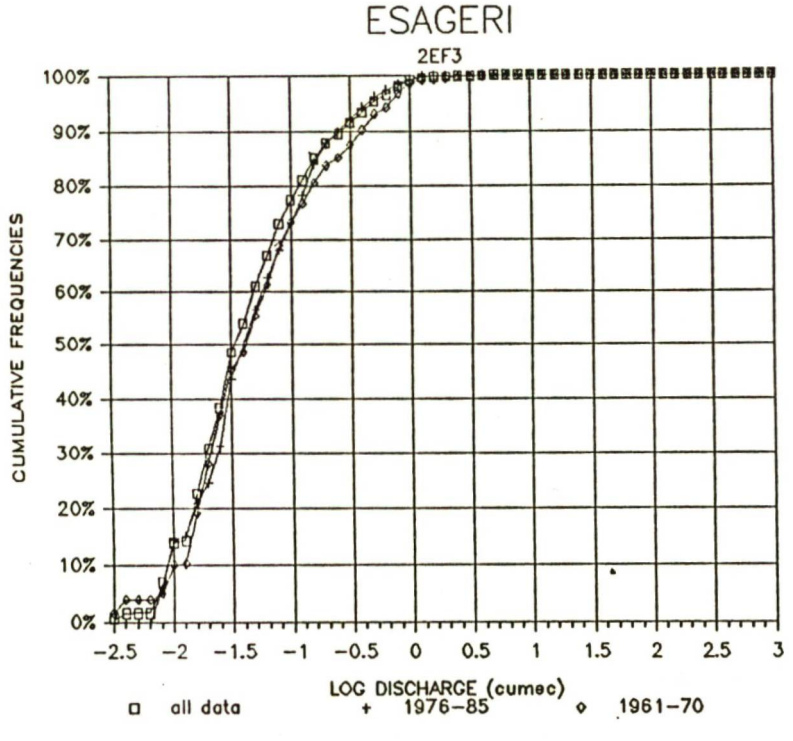
APPENDIX 4.9

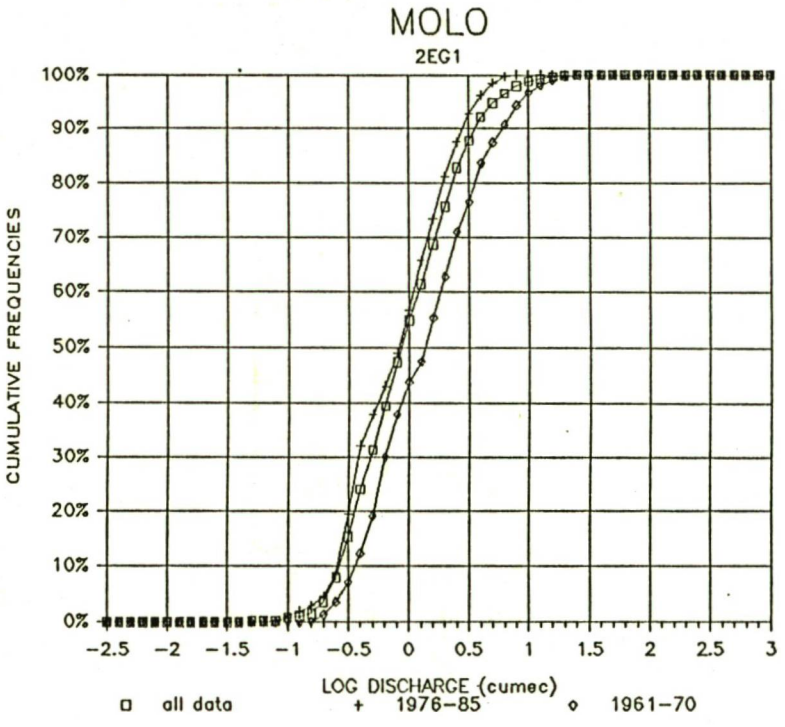
Flow Duration Curves

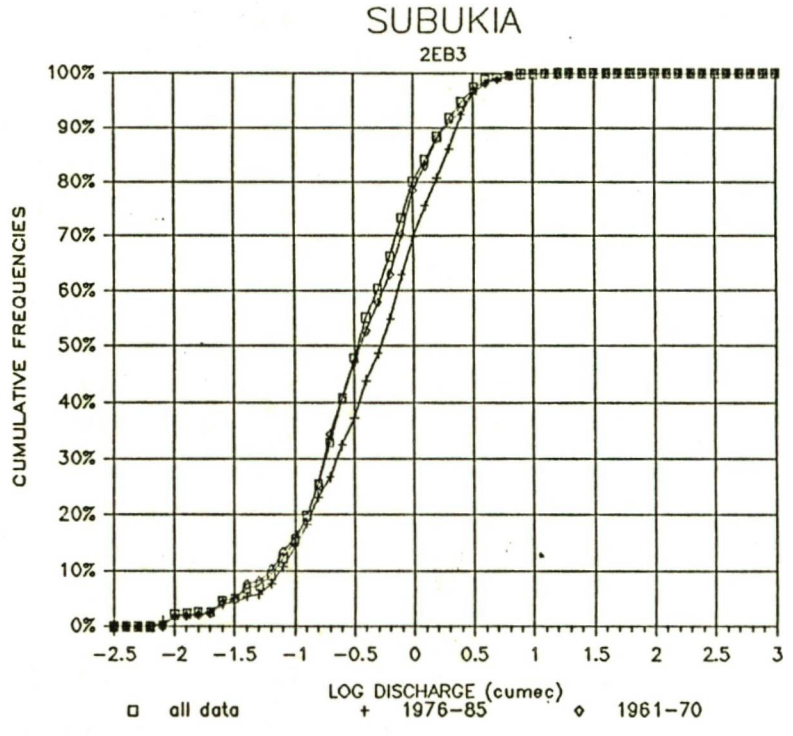

PERKERA
2EE8
CUMULATIVE FREQUENCIES
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
-2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3
LOG DISCHARGE (cumec)
all data
1976-85
1961-70

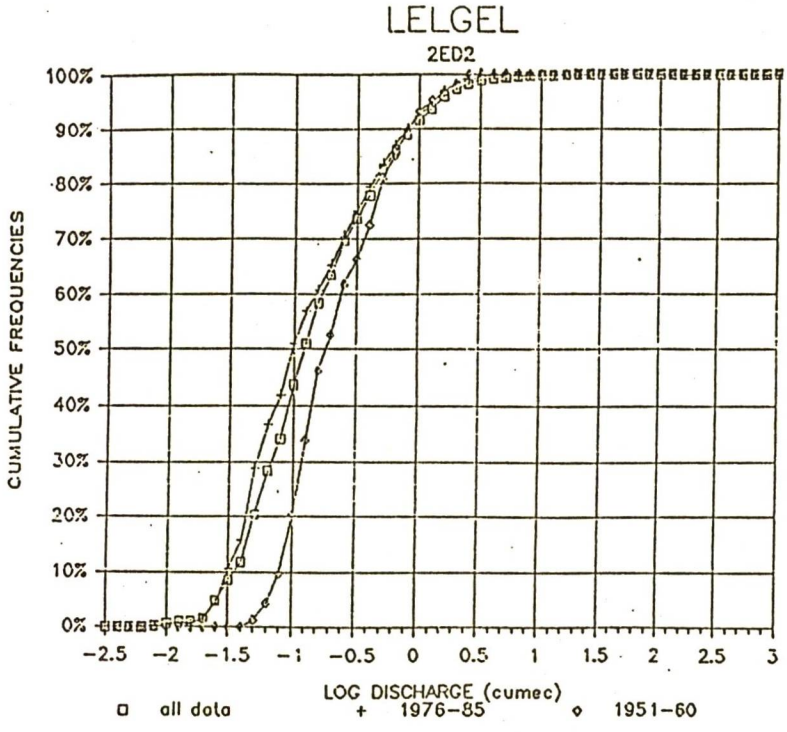

PERKERA
2EE7
CUMULATIVE FREQUENCIES
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
-2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2 2.5 3
LOG DISCHARGE (cumec)
all data
1976-85
1961-70


TIGGERI
2ED1
CUMULATIVE FREQUENCIES
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
−2
−1.5
−1
−0.5
0
0.5
1
1.5
2
2.5
3
LOG DISCHARGE (cumec)
all data
1976−85
1961−70


ESAGERI
2EF3
CUMULATIVE FREQUENCIES
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
−2.5
−2
−1.5
−1
−0.5
0
0.5
1
1.5
2
2.5
3
LOG DISCHARGE (cumec)
all data
1976−85
1961−70


MOLO
2EG1
CUMULATIVE FREQUENCIES
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
−2.5 −2 −1.5 −1 −0.5 0 0.5 1 1.5 2 2.5 3
LOG DISCHARGE (cumec)
□ all data
+ 1976–85
◇ 1961–70


SUBUKIA
2EB3
CUMULATIVE FREQUENCIES
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
−2.5 −2 −1.5 −1 −0.5 0 0.5 1 1.5 2 2.5 3
LOG DISCHARGE (cumec)
□ all data
+ 1976–85
◇ 1961–70


LELGEL
2ED2
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
CUMULATIVE FREQUENCIES
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
LOG DISCHARGE (cumec)
all data
1976-85
1951-60

APPENDIX 4.10

Discussion of Mean and Low Flow Runoff Characteristics

&

Annual Minimum Discharge Frequency Graphs

Discussion of Mean and Low Flow Runoff Characteristics

4.10 Low Flows

4.10.1 Low Flow Frequency Analysis:

In the south of the study area, the rivers are perrennial but the minimum flows are very low. In the northern part of the study area the rivers dry up during dry seasons. Most regular gauging stations on the rivers have recorded minimum flows of less than 100 litres per second.

On the Perkerra river, the lowest minimum flow of 20 litres per second has been recorded at gauging station 2EE7 near Marigat. Its tributaries, (Lelgel, Esageri, Tiggeri) have all recorded the lowest minimum flows of less than 10 litres per second. These results are based on observed minimum daily discharges.

Frequency analysis of annual minimum discharge based on daily records was done. This gives some indication of the reliability of low flows. Only years with complete records were used in the analysis. The data was ranked and plotted on log-normal probability paper.

Curves were fitted through the points graphically. The general aim was to fit straight lines but shallow curves were also used if the data appeared to require so. The plotting positions were calculated from the equation:

$$P = M/n + 1$$

Where:

P = Probability of non-exceedance

M = Position of discharge in ordered sequence of all discharges used in analysis (M = 1 ..... N).

N = Total number of discharge values (= number of years used in analysis)

The graphs for the annual minimum discharge frequency analysis are in the second part of this Appendix.

Results of this analysis are also summarised in Table 4.10.1

Table 4.10.1 Results of Frequency Analysis for Annual Minimum Discharges

AGS	RIVERS	Tr	10	25
			Litres per second	
2ED2	Lelgel		12	8.3
2EE8	Perkera		200	166
2EE7	Perkera		95	67
2ED1	Tiggeri		100	60
2EG1	Molo		60	44
2EF3	Esageri		2	

Tr = Return period in years. For example at Lelgel 2ED2, once in ten years the minimum discharge may be less than 12 litres per second.

Relatively higher minimum discharges are found on the Perkerra at gauging station 2EE8 and Tiggeri at gauging 2ED1. This may be atributed to the high rainfall and good catchment cover.

4.10.2 Mean and Low Flow Runoff Characteristics:

To compare the mean and low flow runoff between different sub-catchments, The following runoff values per unit catchment area (km^2) have been calculated basing on the discharges and catchment area sizes.

The calculated runoff values in $l/s/km^2$ (litres per second per square kilometre) are presented in Table 4.10.2.

Table 4.10.2 Mean and Low Flow Runoff Characterestics: Runoff, $l/s/km^2$

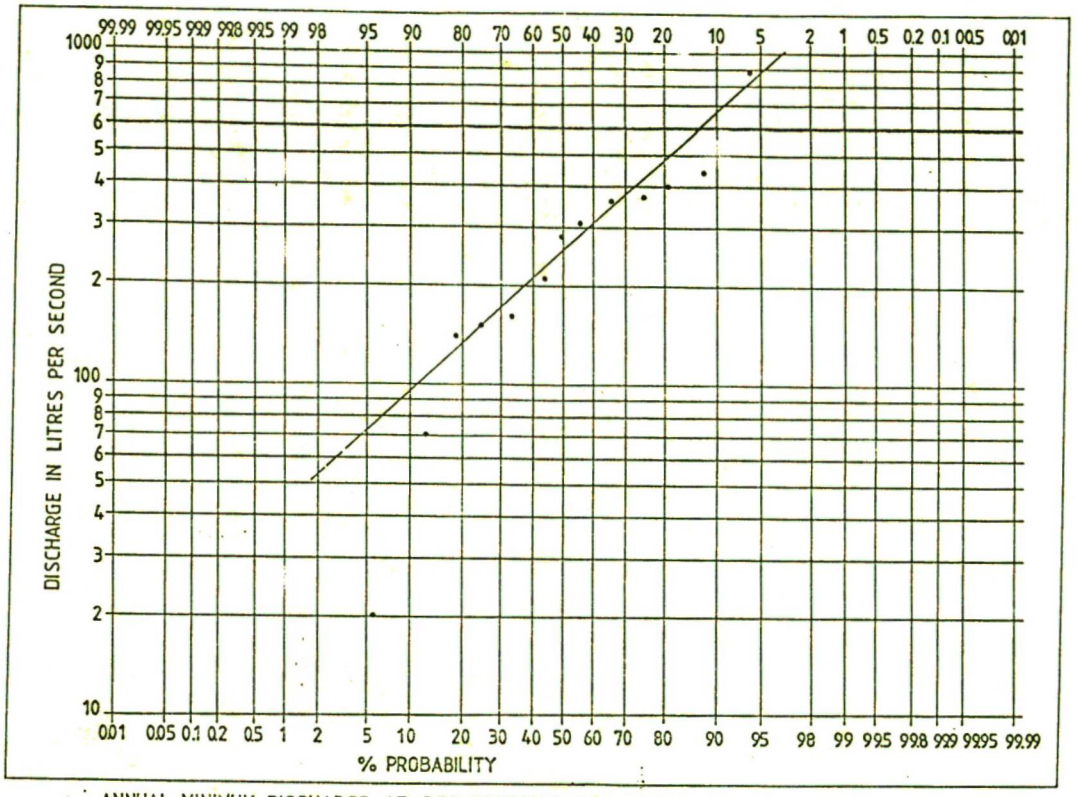
River/Gauging Station	Catchment Area (km^2)	Qm	Q90%	Q95%	Q1 90%
Tiggeri, 2ED1	135	8.81	1.86	1.5	0.74
Leigel, 2ED2	108	3.2	0.36	0.23	0.11
Esageri, 2EF3	60	1.9	0.12	0.10	0.03
Subukia, 2EB3	331	2.1	0.21	0.097	
Perkerra, 2EE7	1180	3.9	0.34	0.21	0.08
Perkerra, 2EE8	500	5.2	0.89	0.662	0.40
Molo, 2EB1	595	3.3	0.45	0.35	0.10

Qm = Mean annual runoff
Q90% = Runoff with 90% duration
Q95% = Runoff with 95% duration
Q1 90% = Minimum daily runoff with 90% reliability (10 year return period).

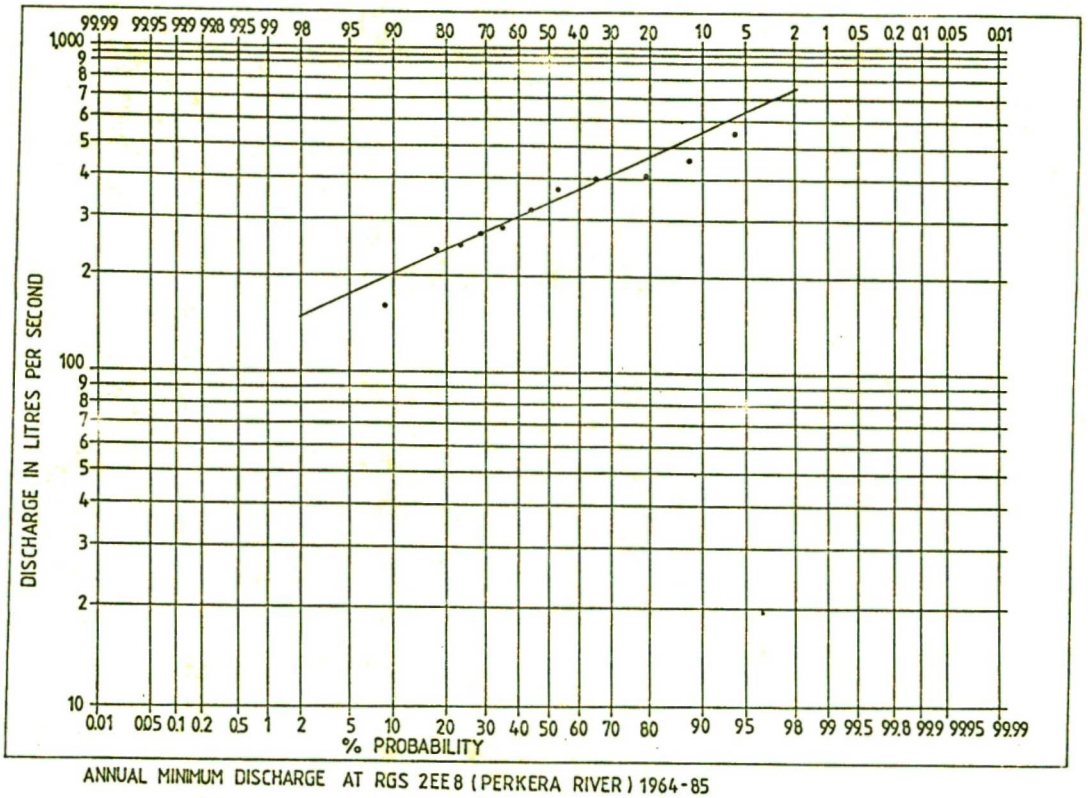
The average values of mean runoff vary between 1.9 - 8.81 $l/s/km^2$. The lowest values are found in the Esageri and Subukia catchments. Generally the mean runoffs are relatively low.

The highest average mean runoff is found in the catchment of Tiggeri river. This is mainly a forested catchment with high rainfall hence the high runoff.
The low flow runoff values may be attributed to extensive abstractions (particulary from the Molo), low groundwater recharge and high evaporation losses.

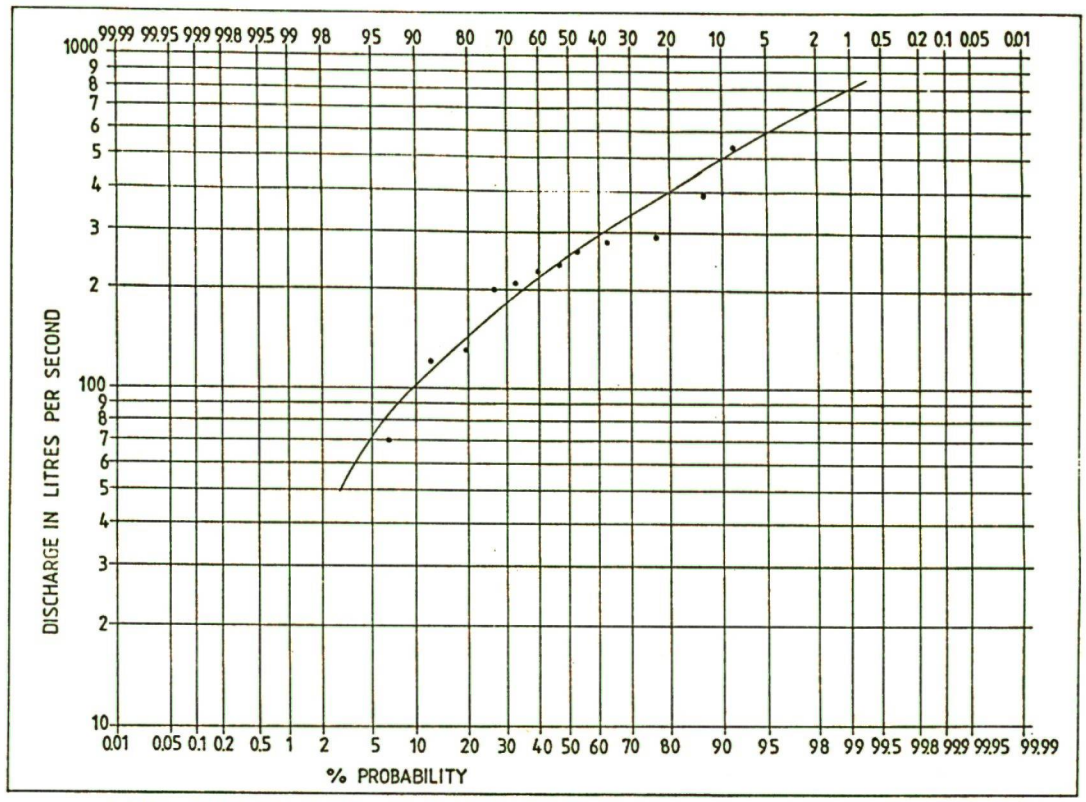
Annual Minimum Discharge Frequency Curves



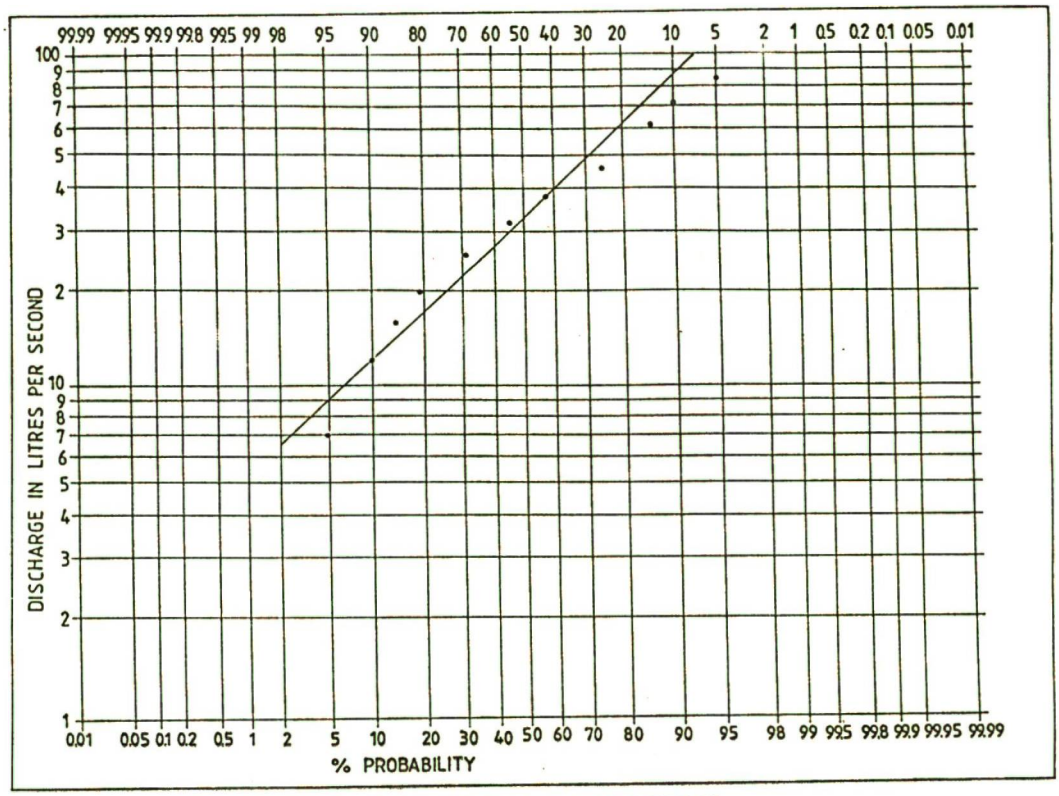
ANNUAL MINIMUM DISCHARGE AT RGS 2EE7 (PERKERA RIVER) 1965-83



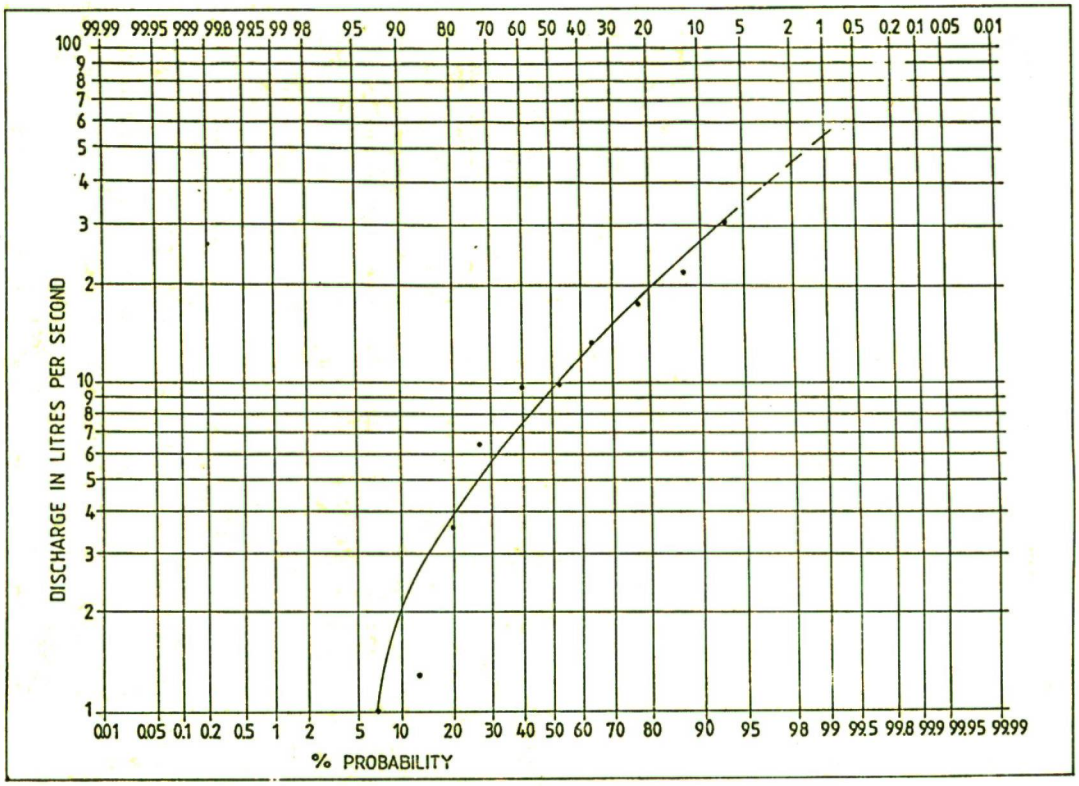
ANNUAL MINIMUM DISCHARGE AT RGS 2EE8 (PERKERA RIVER) 1964-85



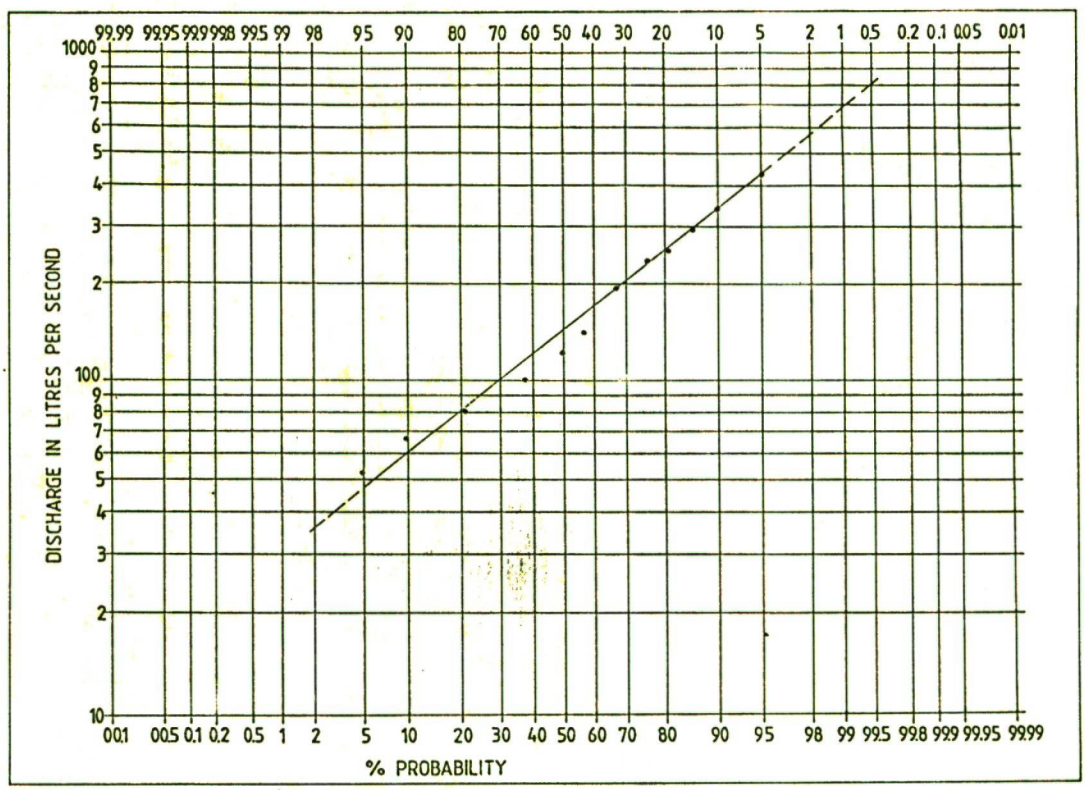
ANNUAL MINIMUM DISCHARGE AT RGS 2ED1 (TIGGERI RIVER) 1960-81



ANNUAL MINIMUM DISCHARGE AT RGS 2ED2 (LELGEL RIVER) 1957-81



ANNUAL MINIMUM DISCHARGE AT RGS 2EF3 (ESAGERI RIVER) 1959-83



ANNUAL MINIMUM DISCHARGE AT RGS 2EG1 (MOLO RIVER) 1958-85

APPENDIX 4.11

Discussion of Baseflow Analysis

&

Groundwater Recession Curves

Discussion of Baseflow Analysis

4.11.1 Baseflow Analysis

Droughtflow analysis has been carried out on the records of five hydrometric stations: the two smaller catchments represent the humid highlands while the larger ones are the main rivers which drain a mixture of highlands and semi-arid midlands. All analysed rivers are perennial. From every decade for which reliable records are available, one or two of the severest droughts were analysed. Master recession curves were constructed by combining individual recessions. Equations were fitted to the data points. Discharge at the beginning of the dry season was estimated by inspecting all available records. These rates of flow are listed under the heading of initial droughtflow (Qo). Results are shown in the second part of this Appendix and in Table 4.11.1.

The only sources of streamflow during droughts are groundwater and soil moisture, which fall within in the same category. In normal years, dry seasons last approximately 3 months. Baseflow volumes after 90 days can be considered as typical amounts of groundwater which flow out of the aquifers and are subsequently recharged when the rainy season sets in. Thus the normal annual recharge varies between 10 and 30 mm, or approximately between 1 and 2% of the mean annual precipitation. However, available records show that, even after more severe droughts lasting approximately 180 days, baseflow recovers to its pre-drought levels. Thus potential recharge varies between 15 and 45 mm, or approximately 1.5 and 3% of the mean annual precipitation.

The severest drought on record, that of 83/84, lasted about 9 months. After the rainy season following this drought, baseflow levels remained lower than normal until the rainy season in 1986. Thus more groundwater was depleted during the 83/84 drought than could be fully recharged in 1985. This confirms that the afore mentioned estimates of potential recharge of 1.5 and 3% represent the maximum recharge.

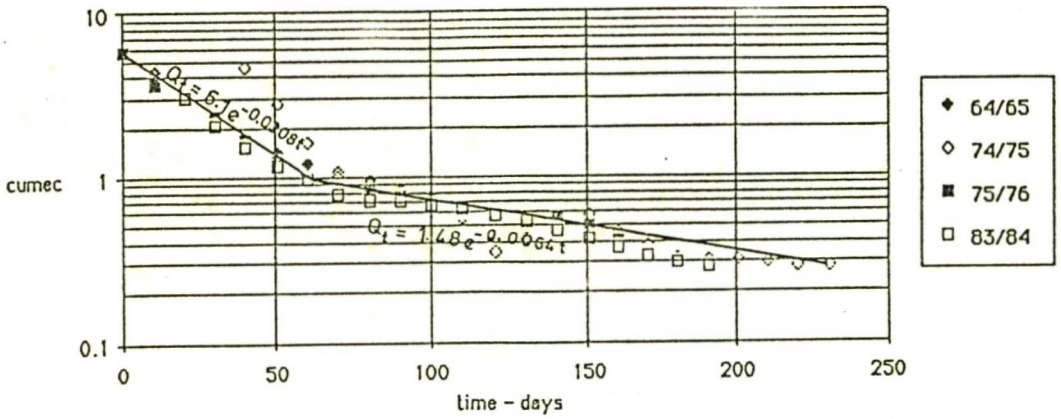
Table 4.11.1 Estimates of Groundwater Depletion from Hydrograph Analysis

River	RGS	Area Km^2	Typical Qo Cumec	Drought Flow Volumes After Days Shown	30	60	90	180	270
				Mm^3	0.4	0.8	0.9	1.2	1.3
Esageri	2EF3	60	0.5	mm	5.2	11.6	14.0	16.8	18.0
				Mm^3	1.1	3.5	4.8	7.1	8.7
Tiggeri	2ED1	135	1.2	mm	7.2	22.1	30.0	45.3	55.9
				Mm^3	2.4	3.9	4.8	5.9	6.1
Subukia	2EB3	331	1.1	mm	6.2	10.0	12.0	15.4	15.8
				Mm^3	3.5	5.7	7.6	11.4	13.6
Perkera	2EE8	500	2	mm	6.0	9.9	13.0	19.8	23.5
				Mm^3	1.6	4.8	6.6	8.7	9.4
Molo	2EG1	595	2	mm	2.3	7.0	9.6	12.6	13.7

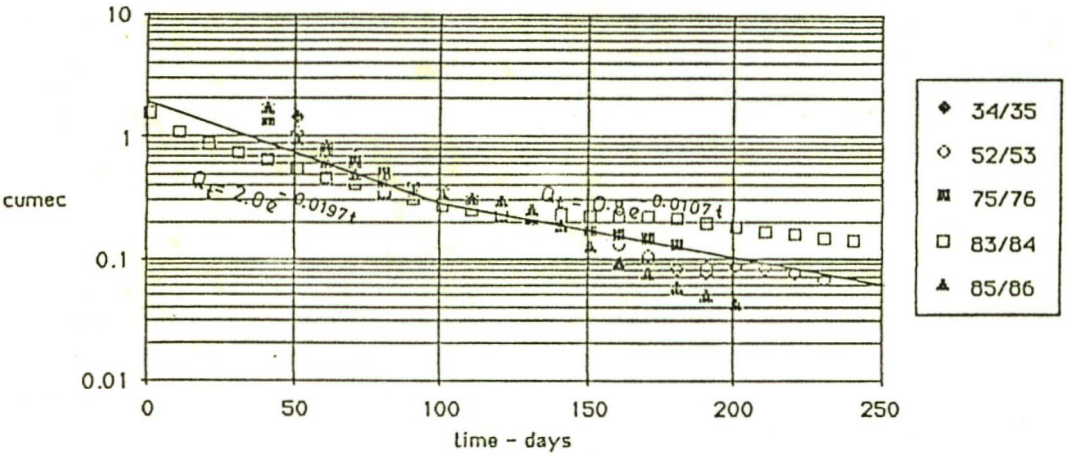
Note: Qo - Typical Baseflow at the Beginning of Dry Season.

Groundwater Recession Curves

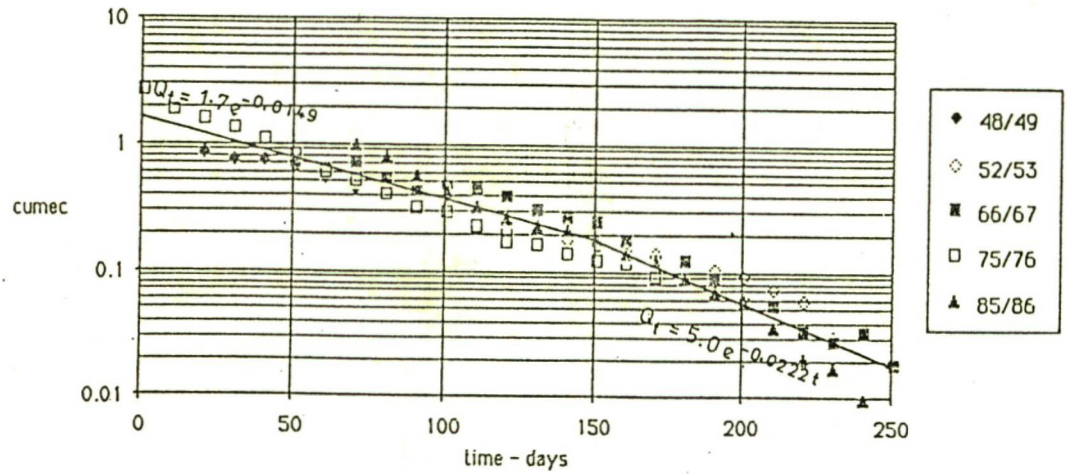
Perkera - 2EE8
baseflow hydrographs



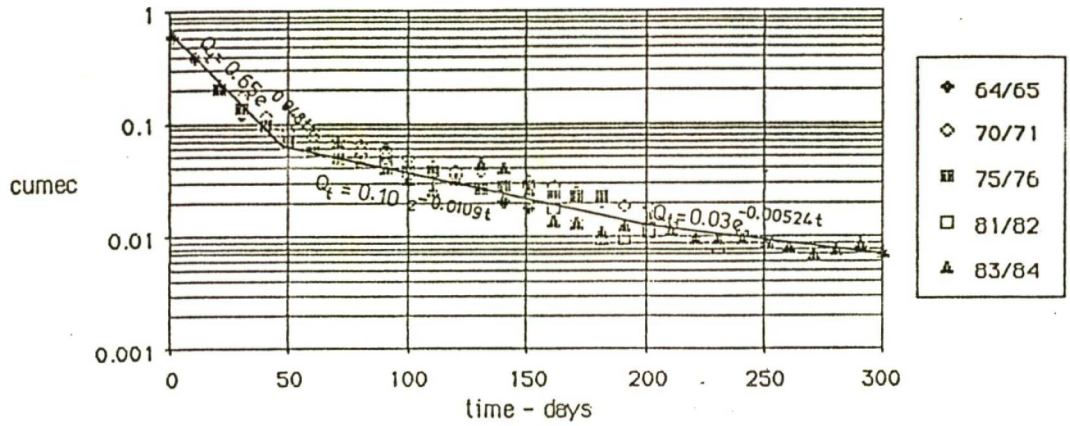
Molo - 2E61
baseflow hydrographs



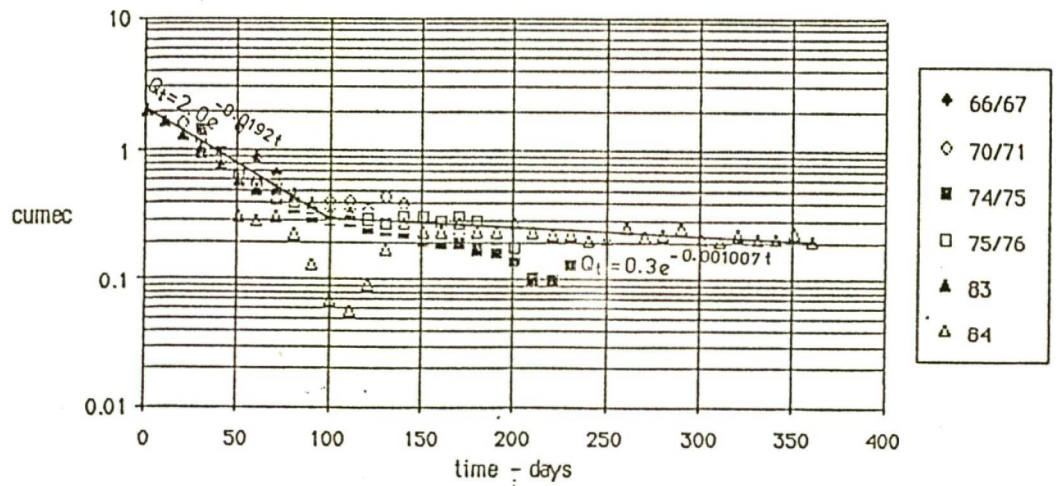
Subukia - 2EB3
baseflow hydrographs



Esageri - 2EF3
baseflow hydrographs



Tiggeri - 2ED1
baseflow hydrographs



APPENDIX 4.12

Miscellaneous Discharge Measurements on Rivers, Streams and Springs-Baringo

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Summary Description

Miscellaneous Discharge Measurements on Rivers, Streams & Springs-Baringo

Table 4.12.1 Miscellaneous Discharge Measurements on Rivers, Streams and Springs- Baringo

Date	Water Source	Location	Discharge in Litres per Second
11.06.86	Chemususu	GR 934101 Sheet 118/1	165
18.03.86	Chemususu	Grid 934101 Sheet 118/1	95
28.03.85	Chemususu	Grid 934101 Sheet 118/1	177
20.03.85	Chemususu	Grid 934101 118/1 (120M u/s of intake)	91
08.03.85	Chemususu	8m u/s of intake	86
01.03.85	Chemususu	10m d/s of intake	116
13.02.85	Chemususu	GR 934101 sheet 118/1	112
26.04.86	Loboi river	Sheet 105/1 Grid 721406-10m u/s of Marigat-Loboi bridge	688
18.09.85	Loboi river	100m u/s of drift Marigat Loboi road	179
07.06.85	Loboi river	GR. 723399 Sheet 105/1	239
22.02.85	Loboi river	2M us Marigat - Loboi drift	178
17.10.84	Loboi river	7m d/s Marigat - Loboi drift	254
25.08.84	Loboi river	Grid 724396 map 105/1	246
22.09.82	Loboi river	GR. 722401	185
27.01.81	Loboi river	Grid 722401 map sheet 105/1	62
27.09.77	Loboi river	Grid 711394 105/1 sheet	90
23.04.86	Emening river	GR. 205149 sheet 104/4	594
22.02.86	Emening river	GR. 205149 sheet 104/4	211
20.09.85	Emening river	GR. 205149 sheet 104/4	128

Date	Water Source	Location	Discharge in Litres per Second
07.05.85	Emening river	GR. 205152 sheet 104/4	1608
22.04.86	Kinyo Stream		1.6
18.02.86	Kinyo stream	2m u/s of bridge	9.8
23.04.86	Kapsokik stream	Grid 124125 sheet 104/	18.5
22.02.86	Kerer Stream	3 km from Chemngorom bridge on Perkerra towards Tenges	5.5
08.08.85	Ol Arabel river	Off Ngarua - Kinamba road 1 km d/s of Kalandini shops.	82
02.03.79	Ol Arabel river	Grid 069175 sheet 105/4	108
30.05.86	Churo Spring	8m d/s of source	4.1
16.02.86	Churo Spring		3.2
17.09.85	Churo Spring		5.2
16.10.84	Churo Spring		2.3
29.04.86	Molo	20m d/s of bridge at Eldume irrigation scheme	3407
18.09.85	Molo	30m u/s of bridge at Eldume	788
08.06.85	Molo	30m u/s of Marigat - Loboi bridge	2345
25.08.84	Molo	100m u/s Marrigat - Loboi bridge	42
10.06.84	Molo	GR 298975 Sheet 118/2	141
09.03.81	Molo		104
27.01.81	Molo	Grid 664490 Sheet 105/1	37
17.12.80	Molo	50m u/s the intake of Soy farmers Water Project	106
16.02.86	Mukutan River	At Mukutan village	5.9

Date	Water Source	Location	Discharge in Litres per Second
17.09.85	Mukutan River	At Mukutan Village	19
16.10.84	Mukutan River	At Mukutan Village	9
21.02.80	Mukutan River	At Mukutan Village	5.8
18.09.85	Lorwai spring	3m u/s of bridge Marigat - Loboi road Grid 715399 sheet 105/1	129
14.09.85	Lorwai spring	3m u/s of bridge Marigat - Loboi road Grid 715399 sheet 105/1	119
01.06.85	Lorwai spring	1m d/s of Marigat-Loboi road bridge	109
22.02.85	Lorwai spring		134
23.03.85	Lorwai spring		107
17.10.84	Lorwai spring	At source	57
25.08.84	Lorwai Spring	Gr. 711394 sheet 105/1	112
01.09.82	Lorwai Spring	715399 sheet 105/1	162
16.09.85	Emsos Spring	In line with gauge plate	58
10.07.74	Emsos Spring	100m from spring source	13.6
10.05.85	Patkawanin	Grid 196557 sheet 90/4	401
21.04.78	Kaplakwa	889119 sheet 104/3	172
21.07.76	Kabartonjo	1500m d/s pemwai - Talai road bridge	13.6
22.01.81	Lelgel	At Arama Centre 963051 sheet 104/3	45
22.04.85	Naro sura	At proposed intake	79
28.03.85	Naro sura	At proposed intake	55
19.03.85	Naro sura	At proposed intake	44
22.02.85	Naro sura	At proposed intake	63

Date	Water Source	Location	Discharge in Litres per Second
05.02.85	Naro sura	At proposed intake	55
22.01.85	Naro sura	At proposed intake	73
17.10.84	Maji Moto river	GR 712296 sheet 105/1	88
27.02.82	Maji Moto	GR 875034 sheet 105/1	13
24.10.77	Maji Moto	GR 711296 sheet 105/1	61
06.03.81	Maji Mazuri	15m d/s Makutano - Eldama Ravine bridge	14
18.10.84	Perkera irrigation Canal	3.6m d/s Water Department camp-Marigat Market bridge	299
15.03.80	Perkera Irrigation Canal	Marigat 338524 sheet 104/2	329
16.10.73	Torongo Spring	889119 Sheet 104/3	64
23.11.73	Torongo Spring	967186 Sheet 104/3	35
22.05.73	Torongo Spring	889119 Sheet 104/3	22
26.03.73	Torongo Spring	889119 Sheet 104/3	18
11.01.73	Torongo Spring	889119 Sheet 104/3	46
	Source: MoWD, surface Water Division		

Summary Description

4.12.2. Summary Description

The main problem in the assessment of surface water resources especially in the semi-arid parts of the country such as is most of the Baringo district is lack of hydrological data. The data on streams and spring flow characteristics is necessary in determining their reliability.

Due to limited resources, it is not possible to maintain a regular network for monitoring the flow characteristics of every known surface water source (streams, springs, rivers).

In the Surface Water Division, there are some records of discharge measurements taken at irregular time intervals on some springs and streams without established regular gauging stations. These kind of discharge data are termed as miscellaneous discharge measurements.

Summaries of some miscellaneous discharge measurements that have been taken on some springs and rivers in Baringo district are in first part of this Appendix.

Basing on this information, the measurements taken during dry periods indicate that most of the streams and springs measured have a dry weather flow of less than 100 litres per second. Extremely low flows are recorded on the small springs such as Churo spring (about 2 litres per second, October 1984), Mukutan stream (about 6 litres per second, February 1986)

In general, it may be observed that the springs and streams have a very low dry weather flow and their reliability as water sources in dry periods may only be limited to small localized areas near these sources.

There are no long regular records for ascertaining their reliability. For development of streams and springs for water supply, continuous discharge measurements are necessary so as to determine their reliability.

Miscellaneous discharge data such as that presented have only gives some rough indication of the amount of water available at the time of measurement. But this kind of data cannot give any indication of the reliability as the discharge measurements are taken at irregular time intervals and are too few for assessment.

APPENDIX 4.13

Discharge Measurements on Sugata River at Kapedo and Summary Description

Table 4.13.1 **Discharge Measurements at RGS 2D1 Suguta River at Kapedo Catchment Area 3497 Km²**

Date	Discharge Measured in LS.
14.09.68	773
22.04.69	903
23.11.72	871
13.06.73	894
15.08.73	2168
17.09.75	988
18.09.75	8900
06.04.76	691
07.09.76	1420
21.10.76	744
23.02.77	931
20.04.79	944
25.01.81	1040
26.10.80	1030
07.05.81	945
23.02.82	966
02.09.82	938
29.02.84	1014
15.10.84	763
24.02.85	997
08.09.85	779
15.02.86	876
25.02.86	879
17.04.86	968
28.05.86	855

Source: MoWD; Surface Water Division

4.13.2 Summary Description on Endo and Sugata Rivers

Some additional information on stream flow data is included in Appendix 4.14, discharge measurements on Endao river near Kibingor.

The regular gauging station at Kapedo (2D1) on Suguta river measures mainly the perennial discharge from the hot saline springs just above this station. The lowest discharge measured at this station has been 0.691 cubic metres per second (cumecs) in April 1976 and the highest 8.91 cumecs in September 1975.

The dry season perrenial discharge of the hot saline springs measured shows. the springs have some regular discharge of between 700-900 litres per second.

Higher discharges occur as a result of rainfall in the upper regions of the catchment. The Nginyang and other tributaries contribute substantially to the discharge during the rain periods. The catchment of the Suguta river upstream of gauging station 2D1 at Kapedo is about 3,500 square kilometres.

The Endao river at Kibingor drains a catchment area of about 131 square kilometres. This river is perennial from the source but some distance downstream of the gauging station (at 2EH3 near Kibingor), it is known to dry up before reaching the lake during dry periods.

Basing on the recorded measured discharge data on this river, the highest discharge measured has been 4.635 cumecs in March 1981. The lowest measured is 5 litres per second in October 1984.

At the time the Pencol report was compiled, the lowest discharge measured had been 19 litres per second in February 1980. Latter on, lower discharges have been measured such as that of March 1981.

This points to the need for continuous discharge measurements in order to get some reliable information on the flow characteristics of rivers. Conclusions based on a few observations may be misleading.

APPENDIX 4.14

Discharge Measurements on Endao River

RGS 2EH3 near Kibigor

Discharge Measurements on Endao River at RGS 2EH3 Near Kibigor.

Date	Discharge in Litres
24.09.77	271
16.03.78	4497
14.08.78	2006
04.11.78	742
24.04.79	721
20.09.79	160
17.01.80	31
20.02.80	18.3
09.05.80	2343
28.01.81	80
27.10.80	19
16.08.80	81
30.03.81	4635
27.07.81	3309
08.05.81	898
27.02.82	1509
18.06.82	504
26.05.82	843
27.07.82	133
19.08.82	1740
31.08.82	777
22.09.82	160
14.10.82	98
22.12.82	1046
09.03.83	63
28.02.84	43
18.04.84	11
23.08.84	27
18.10.84	5
21.11.84	8
19.09.85	67
22.04.86	40

Source: MoWD, Surface water division

APPENDIX 4.15

Chemical Data Surface Water

APPENDIX 4.15a Chemical Data Surface Water (River & Streams)

Site No.	River/ Stream	Location	Date of Sampling	Temp. oC	pH	EC mS/cm	Na	K	Ca	Mg	Fe	Mn	Cl	HCO3	SO4	NO3	F	SiO2	Hardness *	TDS
											-	mg/l	-							
SW 1	Suguta	Kapedo-2D1	14-03-86	30.5	9.0	3.400	1050.0	30.0	0.5	0.4	0.9	0.0	46	2015	84.0	0.0	28.0	54	12	2040
			28-05-86	-	8.6	3.300	870.0	55.0	1.3	0.6	0.2	0.0	252	1458	78.0	-	23.0	59	10	1980
SW 2	Suguta	Kapedo-Bridge	23-12-84	-	8.7	1.800	360.0	11.0	5.8	1.9	0.1	0.1	41	958	25.0	-	11.0	-	12	1080
			18-03-85	30.5	8.5	1.000	210.0	6.0	0.6	0.2	0.1	0.0	16	598	5.0	-	7.0	-	11	550
			18-11-86	-	8.3	1.180	-	-	-	-	-	-	21	690	2.0	0.8	8.5	-	22	710
SW 3	Nginyang	Nginyang	19-05-83	-	8.8	2.100	463.0	9.2	11.0	10.0	0.4	0.3	64	960	14.0	-	12.0	5	72	1300
SW 4	Kositei	Kositei	19-05-83	-	8.4	-	90.0	15.0	45.0	25.0	-	-	38	348	7.0	-	0.8	30	214	-
SW 5	Bartabwa	Bartabwa	21-05-83	-	7.4	0.225	48.0	7.9	4.0	1.9	3.2	0.3	8	120	0.0	-	0.3	40	18	120
SW 6	Kurumboni	Tirimionin	21-05-83	-	6.9	0.100	9.5	3.4	4.0	2.4	0.0	0.2	2	40	0.0	-	0.3	40	20	55
			19-11-86	-	7.5	0.160	-	-	-	-	-	-	9	70	-	0.3	0.2	-	36	95
SW 7	Mukutan	Mukutan	18-05-83	-	7.7	0.610	147.0	4.2	3.2	2.9	0.0	0.0	20	316	7.0	-	3.0	40	20	390
			13-11-86	-	8.2	0.730	-	-	-	-	-	-	30	378	10.0	0.2	2.7	-	20	440
SW 8	Ndau	Kibingor-2EH3	02-08-83	-	7.6	-	15.0	5.0	7.5	1.4	1.0	0.4	2	62	4.8	-	0.6	40	24	120
			13-03-86	-	8.0	0.230	26.0	7.2	4.8	3.1	0.6	0.2	12	131	2.6	0.0	0.9	30	54	140
SW 9	Ol Arabel	Loiminang	18-05-83	-	8.6	0.440	90.0	8.6	7.2	3.4	0.0	0.0	16	216	2.5	-	1.0	20	32	250
SW10	Kirandich	W. of Kabarnet	15-07-83	-	7.5	0.140	13.0	5.2	9.6	11.0	0.0	0.0	10	90	0.0	1.2	0.2	0	70	100
SW11	Kapleel	W. of Kabarnet	23-08-83	-	6.3	-	17.0	3.7	4.8	1.4	0.0	1.2	2	48	6.8	-	0.3	30	18	120
SW12	Perkerra	Marigat - 2EE7	16-07-83	-	7.5	0.305	20.0	6.7	39.0	11.0	0.0	0.1	8	194	0.0	0.5	0.3	0	144	120
			27-05-86		6.6	0.140	12.0	10.0	0.9	1.7	2.6	0.8	8	44	0.0	0.0	0.7	19	35	85
			27-11-86	-	7.9	0.165	-	-	-	-	-	-	7	83	7.0	0.0	0.5	-	68	100
SW13	Perkerra	Ngarua	10-12-86	-	7.6	0.175	-	-	-	-	-	-	8	88	4.1	0.1	0.5	-	48	105
SW14	Molo	Eldume - 2E83	23-05-83	-	6.7	0.175	23.0	13.0	5.8	3.4	1.1	0.4	4	82	0.0	-	1.1	40	28	100
SW15	Waseges	Sandai	27-11-86	-	8.0	0.260	-	-	-	-	-	-	14	130	0.0	0.1	0.6	-	54	155
SW16	Sosion	Kabarak	20-05-83	-	7.6	0.350	32.0	5.1	18.0	15.0	0.2	0.1	8	190	0.0	-	0.7	40	108	200

- not determined * as CaCO3

CONT. APPENDIX 4.15a Chemical Data Surface Water (River & Streams)

Site No.	River/ Stream	Location	Date of Sampling	Temp. oC	pH	EC mS/cm	Na	K	Ca	Mg	Fe	Mn	Cl	HCO3	SO4	NO3	F	SiO2	Hard ness *	TDS
													- mg/l -							
SW17	Loboi	Loboi	23-05-83	-	7.4	0.500	118.0	14.0	6.4	1.0	1.8	0.3	8	272	0.0	-	6.0	8	20	300
			22-08-83	-	6.8	-	123.0	14.0	0.4	1.2	0.0	0.2	10	266	1.5	-	6.2	20	6	350
			27-05-86	-	7.5	0.370	77.0	27.0	1.4	1.8	4.0	1.7	10	157	0.0	0.1	3.0	22	44	220
			01-12-86		7.5	0.615	-	-	-	-	-	-	14	322	13.0	0.9	5.6	-	36	370
SW18	Loboi	Maji Moto	23-05-83	-	7.2	0.470	119.0	14.0	4.0	0.5	0.0	0.0	6	252	14.0	-	8.8	40	12	300
			27-01-86	-	8.9	0.575	-	-	-	-	-	-	13	307	11.0	0.5	4.7	-	26	345
SW19	Perkerra	Kimngor. -2EE8	22-05-83	-	6.6	0.085	9.2	5.3	2.4	2.4	0.4	0.0	4	34	0.0	-	0.2	50	16	50
			29-05-86	20.0	7.1	0.120	11.0	7.0	1.0	1.1	7.4	0.2	6	56	0.0	0.0	0.6	30	24	75
SW20	Subukia	Kirungii -2EB3	13-03-86	-	7.5	0.190	32.0	8.0	1.3	0.9	3.8	0.1	16	98	1.2	1.3	1.3	41	27	115
			19-04-86	21.0	8.0	0.320	56.0	7.8	0.9	1.7	7.8	0.5	22	132	0.3	0.0	1.7	-	30	190
SW21	Subukia	2EB2	19-04-86	21.0	6.8	0.250	39.0	10.0	0.6	1.3	5.5	0.2	22	90	-	0.0	1.6	-	30	150
SW22	Emining	Tigeri	21-08-83	-	6.5	-	13.0	7.0	4.8	1.4	5.6	0.0	10	42	5.8	-	0.9	16	18	60
SW23	Tigeri	Kapchol. -2ED1	29-05-86	17.0	6.5	0.070	9.0	3.4	1.2	0.8	2.3	0.1	8	27	0.0	0.0	0.4	23	10	40
SW24	Lelgel	Simoniu - 2ED2	29-05-86	-	6.7	0.155	67.0	13.0	2.5	1.2	4.7	0.2	10	49	0.3	0.0	1.4	39	25	90
SW25	Chemususu	Chemususu	17-11-86	-	7.0	0.075	-	-	-	-	-	-	6	34	3.1	0.2	0.2	-	12	45
SW26	Esageri	Esageri - 2EF3	29-05-86	-	6.5	0.130	14.0	7.0	1.1	0.8	4.0	0.2	12	29	0.3	0.0	0.9	39	22	70
SW27	Molo	K. ya moto 2EB1	29-05-86	-	7.0	0.235	30.0	20.0	1.9	1.6	5.0	0.2	14	68	0.3	0.0	1.7	36	29	140
SW28	Rongai	Kampi ya Moto	17-11-86	-	7.3	0.205	-	-	-	-	-	-	12	90	5.1	0.7	0.8	-	28	125

- not determined * as CaCO3

APPENDIX 4.15b Chemical Data Surface Water (Lakes & Dams)

Site No.	Lake/dam	Location	Date of Sampling	Temp. oC	pH	EC mS/cm	Na	K	Ca	Mg	Fe	Mn	Cl	HCO3	SO4	NO3	F	SiO2	Hardness *	TDS
												-	mg/l	-						
SW 29	Baringo	S. of Loruk	18-05-83	-	8.7	0.700	171	17.0	3.0	6.4	0.0	0.0	42.0	300	11.0	-	12.0	5	40	450
			14-08-86	30.5	9.1	0.945	200	19.0	11.0	4.6	2.2	0.0	56.0	497	22.0	0.0	24.0	21	-	565
SW 30	Baringo	Kampi ya Samaki	29-05-86	25.0	8.3	1.025	190	41.0	1.3	3.8	15.0	0.2	70.0	519	4.8	0.0	7.7	14	46	615
SW 31	Baringo	E. of Salabani	29-06-83	-	8.2	0.750	128	23.0	11.0	7.7	0.0	0.0	41.0	356	-	3.0	29.0	0	60	450
			14-08-86	27.0	9.0	0.950	218	19.0	11.0	4.4	1.0	0.0	55.0	505	22.0	0.0	21.0	16	-	520
SW 32	Kamnarok	E. Shore	15-11-82	-	6.9	0.080	11	-	0.6	0.4	7.1	0.1	7.0	59	0.0	-	0.6	-	16	48
SW 33	Bogoria	N. end	??-??-??	-	9.6	-		-	22.0	20.0	1.0	-	1437.0	3035	45.0	-	141.0	60	137	12595
SW 34	Bogoria	Kiboriit	??-??-??	-	10.1	-		-	-	0.0	0.0	-	3400.0	5647	181.0	-	491.0	3	90	32000
SW 35	Bogoria	S.W. Corner	??-??-??	-	10.1	-		-	-	-	0.0	-	620.0	7002	3349.0	-	825.0	3	110	63600
SW 36	Bogoria	S. end	??-??-??	-	9.5	-		-	-	-	1.5	-	1750.0	5855	112.0	-	217.0	0	20	16600
SW 37	Chemeron	Chemeron dam	18-03-86	25.0	6.8	0.165	11	3.5	4.8	3.7	7.6	0.1	8.0	124	0.3	0.0	1.3	16	50	95
			20-05-86	25.0	8.2	0.230	18	3.8	16.0	5.9	0.5	0.0	1.7	61	1.3	0.0	1.7	9	72	140
			12-11-86	-	7.8	0.185	-	-	-	-	-	-	6.0	100	1.6	0.1	0.9	-	64	110

- not determined * as CaCO3

LIST OF APPENDICES, CHAPTER 5

5.1 Borehole Data
5.2 Inventory Tugen Hills Springs (Pencol)
5.3 Monitoring of Groundwater Levels
5.4 Analyses of Well Tests
5.5 Chemical Data
5.6 Geological Wells Logs

APPENDIX 5.1

Borehole Data

APPENDIX 5.1 Borehole data

Bh No.	Location	Coordinates X	Coordinates Y	Sheet No	Surface Elevation m + msl	Total Depth (m)	Completion Date	Struck Level depth (m)	Struck Level Elev. m+msl	Rest Level depth (m)	Rest Level Elev. m+msl	Yield (m^3/h)	A	B	C	Present State
P84	Ngendelel	1782	0081	105/3	1540	62	19-04-30	58	1482	43	1497	9.5	X	X	5	In use
P94	Ol Kokwe	1788	0150	105/3	1520	27	18-08-30	dry		dry		dry	X		5	Abandoned
P120	Ol Kokwe	1786	0145	105/3	1520	31	04-11-30	20	1500	13	1507	6.9	X	X	5	In use
P138	Mugurini	1710	0061	105/3	1500	113	09-05-31	110	1390	110	1390	0.3	X	-	4a	Abandoned
P148	Ngubereti	8233	0065	104/4	1630	95	19-09-31	85	1545	79	1551	4.5	X	X	4a	In use
C284	Kisanana	1711	0048	105/3	1600	65	05-10-43	?	?	?	?	2.7	X	-	5	Abandoned
C285	Kisanana	1769	0022	105/3	1600	111	03-12-44	66	1534	53	1547	2.7	X	-	5	Abandoned
C478	Komoi	8224	0045	104/4	1645	123	26-10-46	111, 117	1534 1528	78	1567	7.7	X	-	4a	Not traced
C525	Kiptuim	8190	0040	104/4	1690	182	12-04-47	dry		dry		dry	X	-	4a	Not traced
C526	Kiptuim	8176	0069	104/4	1690	162	16-12-47	107	1583	93	1597	0.9	X	-	4a	Not traced
C576	Kiptuim	8208	0099	118/2	1630	123	16-08-47	dry		dry		dry	X		4a	Not traced
C583	Kamasia	1739	0086	105/3	1600	183	27-09-47	dry		dry		dry	X	-	4a	Not traced
C616	Sagasagik	8185	0092	104/4	1630	96	06-12-47	77 81	1553 1549	46	1630	10.2	X	X	4a	In use
C626	E/Ravine	8091	0095	104/4	2155	152	21-04-48	123 140	2032 2015	121	2032	4.4	X	-	2a	Not traced
C708	E/Ravine	8038	0042	104/3	2155	177	19-08-48	116 125	2039 2030	113	2040	1.4	X	-	2a	Abandoned

A = Geological log available : (x) yes; (-)no B = Chemical analysis of water available : (x) yes ; (-) no
C = Groundwater zone (see plate 5.1)

CONT. APPENDIX 5.1 Borehole Data

Bh No.	Location	Coordinates X	Coordinates Y	Sheet No	Surface Elevation m + msl	Total Depth (m)	Completion Date	Struck Level depth (m)	Struck Level Elev. m+msl	Rest Level depth (m)	Rest Level Elev. m+msl	Yield (m^3/h)	A	B	C	Present State
C711	Kelehun	8240	9972	118/2	1660	141	22-07-48	59, 116 139	1601 1544, 1521	47	1613	5.5	X	X	4a	Cleaned & Capped
C722	E/Ravine	8049	0063	104/3	2155	140	15-09-40	130	2025	50	2103	8.6	X	-	2a	In use
C1280	Esageri	8148	0026	104/4	1660	111	17-10-50	107	1643	69	1681	0.1	X	-	4a	Carbacid
C1406	Legetetwet	8224	0045	104/4	1630	143	??-??-??	87	1543	136	1494	9.1	X	X	4a	In use
C2484	Kisanana	1769	0020	105/3	1600	122	17-03-56	111	1489	102	1492	4.0	X	-	5	Abandoned
C2928	Esageri	8175	0067	104/4	1690	164	26-10-59	110	1690	?	1690	?	-	-	4a	Carbacid
C3433	E/Ravine	8049	0062	104/3	2155	128	28-04-67	127, 116	2028, 2039	36	2119	10.9	X	-	2a	In use
C3437	Tangulbei	1958	0899	91/2	1190	183	29-05-67	99, 107, 148	1091, 1083, 1042	93	1097	9.1	X	X	5	In use
C3466	Nyaunyau	1761	0997	91/1	870	76	27-11-67	40 43	830 827	38	832	12.7	X	-	4c	Servisable
C3470	Chemolingot	8323	1081	90/2	860	122	10-07-67	37, 117	823, 743	30	830	9.1	X	X	3	In use
C3506	Kabarnet	8044	0549	104/1	2000	152	27-07-68	103	1897	26	1974	13.6	X	X	1	In use
C3526	Kabartonjo	8105	0702/4	90/4	2285	166	16-10-68	64, 67	2221, 2218	83	2203	dry	-	-	1	Abandoned

A = Geological log available : (x) yes; (-)no B = Chemical analysis of water available : (x) yes ; (-) no
C = Groundwater zone (see plate 5.1)

CONT. APPENDIX 5.1 Borehole Data

Bh No.	Location	Coordinates X	Coordinates Y	Sheet No	Surface Elevation m + msl	Total Depth (m)	Completion Date	Struck Level depth (m)	Struck Level Elev. m+msl	Rest Level depth (m)	Rest Level Elev. m+msl	Yield (m^3/h)	A	B	C	Present State
C3868	Nginyang	1672	1052	91/1	840	122	11-10-72	14, 41	826, 799	9	840	9.1	X	X	4c	In use
C3935	Chemongoch	8261	0051	104/4	1585	152	11-08-73	128	1457	dry	1584	dry	X	-	4a	Abandoned
C4722	Kabarnet	8044	0551	104/1	2000	155	18-03-80	64, 82	1936, 1918	24	1976	?	X	-	1	Abandoned
C4777	Kisanana	1764	0021	105/3	1600	164	12-07-80	102, 104	1498, 1496	100	1500	?	-	X	5	In use
C4780	Kabarnet	8065	5550	104/2	2090	150	11-07-81	12, 24, 64	2078, 2066, 2026	4.6	2087	13.5	X	-	1	Not equiped
C4786	Koitegan (Tarbunyau)	1673	0053	105/3	1600	41	15-10-81	dry		dry		dry	X	-	4a	Abandoned
C4787	Koitegan (Mugurin)	1701	0114	105/3	1440	200	20-10-81	dry		dry		dry	-	-	4a	Abandoned
C4838	Kabluk	7958	0642	90/3	1110	143	09-01-81	5, 84	1105 1025	4	1106	?	X	-	1	Under construction
C4915	Koitegan (Peterkeber)	1735	0049	105/3	1740	214	30-09-81	192	1548	190.5	150	12.6	X	-	5	Under construction
C4916	Kisanana (Ndabibi)	1768	0002	105/3	1620	100	30-09-81	82	1538	79	1541	3.2	X	X	5	Equiped
C5072	Chemeron (College)	8240	0540	104/2	1220	-	??-??-??	?	?	?	?	?	-	X	3	In use

A = Geological log available : (x) yes; (-)no B = Chemical analysis of water available : (x) yes ; (-) no
C = Groundwater zone (see plate 5.1)

CONT. APPENDIX 5.1 Borehole data

Bh No.	Location	Coordinates X	Coordinates Y	Sheet No	Surface Elevation m + msl	Total Depth (m)	Completion date	Struck Level depth (m)	Struck Level Elev. m+msl	Rest Level depth (m)	Rest Level Elev. m+msl	Yield (m³/h)	A	B	C	Present State
C5170	Kiboino	7988	0514	104/1	1420	120	21-09-82	28, 58	1392 1362	18.7 18.4	1401 1401	12	X	X	1	Under construction
C5333	Kolowa	8067	1354	76/4	960	75	04-08-83	10	950	10	950	1	X	X	1	capped
C5349	Tot Bridge	8003	1343	76/3	940	23	27-07-83	8	932	7	933	44	X	X	1	capped
C5370	Mkorwa	8023	0345	104/1	1400	55	30-08-83	37, 42	1363, 1358	30	1370,	2	X	X	1	capped
C5487	Kinyach	7977	1035	90/1	1070	55	23-11-83	8, 26	1062 1044	10 10	1060 1060	20	X	X	1	capped
C5806	E/Ravine	8033	0063	104/3	2105	187	??-??-??	?	?	108	1997	2.7	X	X	2a	in use
C5883	Mogotio	8295	9982	118/2	1580	226	??-??-84	200	1380	168	1412	7.1	-	-	4a	not visited
C6362	Salabani	1171	0613	91/3	980	60	13-06-85	48	932	15	965	0.7	X	X	4b	capped
C6363	Kositei	8277	1026	90/2	1000	108	29-06-85	93, 97	907	24	976 903	12	X	X	3	equiped
C6364	Chesirimion	1687	0924	91/1	900	120	16-07-85	105	795	85	814	2.5	X	X	4c	capped
C6365	Ngambo	1725	0560	105/1	980	60	10-07-85	42	938	20	960	1.5	X	X	4b	capped
C6652	Loboi	1716	0399	105/3	1000	36	17-02-86	12 21	988 979	7	993	1.4	X	X	4b	equipped
C6970	Kapsoo	8081	0515	104/2	2010	138	07-10-86	106	1904	34	1986	6.0	-	-	1	capped
C7122	Tangulbei	1979	0888	91/2	1220	91	18-11-86	76 85	1144 1135	13	1207	0.5	X	X	5	capped

A = Geological log available : (x) yes; (-)no B = Chemical analysis of water available : (x) yes ; (-) no

C = Groundwater zone (see plate 5.1)

APPENDIX 5.2

Inventory Tugen Hills Springs (Pencol, 1984)

Inventory Tugen Hills Springs (Pencol, 1984)

TUGEN HILLS SPRINGS

Village	Spring or Stream	Regime	Geology	Source	1956 Recommendations
Kituro	Kongmet Pantagnet Pemoi	Perennial Dry Intermittent	Lava rock	 Local or perched water table Run off and Hill	Small Dam on Kongmet River
Kabartonjo	Beptuitock. Kipkotulya Bepyemit Beikoen Mission Well	Intermittent Intermittent Intermittent Perennial Intermittent	Lavas and lava ash	Runoff Hill Seepage Hill Seepage Groundwater Surface Seepage	Investigation to establish groundwater table feeding Beikoen river
Poi	Selanga Luon Poi Lake	Intermittent Perennial Seasonal	Kamasia Lake Beds	Runoff and hill seepage	Borehole in Lake Beds
Bartolimo	East North	Perennial Intermittent	Trachytes	Perched groundwater and hill seepage	Dam, Collecting Trough and Borehole
Cheberen (Kapkein)	Lawina Cheberen	Intermittent Perennial	Volcanic Ash	perched groundwater	Small Dam/Pool
Talai	Kercunin Talai or Kasaawa	Intermittent Intermittent	Trachytes & thick forest soil	Runoff and hill seepage	Dams
Seretunin	East West	Perennial Perennial (both lower down)	Trachytes and bedded volcanics	Hill Seepage	Intake and Borehole
Sirwa	Taktak Kesumone	Perennial Perennial (both lower down)	Trachytes and ashes	Perched water-table	Intake
Pemwai/ Tiriminionin	Pemwai and 2 others	Intermittent Intermittent	Trachytes and ashes	Runoff Groundwater	Dug Well and Shallow Bore-Hole
Kapkiamo	5 points	Perennial	Kamasia Volcanics	Talus seepage	Dug Well or Borehole
Kasisit	North	Perennial	Trachytes and thick soil	Runoff and hill seepage	Intakes
Cheplembus (Emom)	Kipsat	Perennial	Trachytes and tuffs	Groundwater	Intake
Tenges	Two streams	Perennial	Trachytes and thick forest soil	Talus seepage	Resistivity probe to establish groundwater
Sacho	Streams	Perennial	Trachytes and thick forest soil	Talus seepage	Shallow drilling
Timboiwa	Stream	Perennial	Trachytes and thick forest soil	Perched water-table	Shallow drilling

Source: MOWD report

APPENDIX 5.3

Monitoring of Groundwater Levels (June 1985-Sept. 1986)

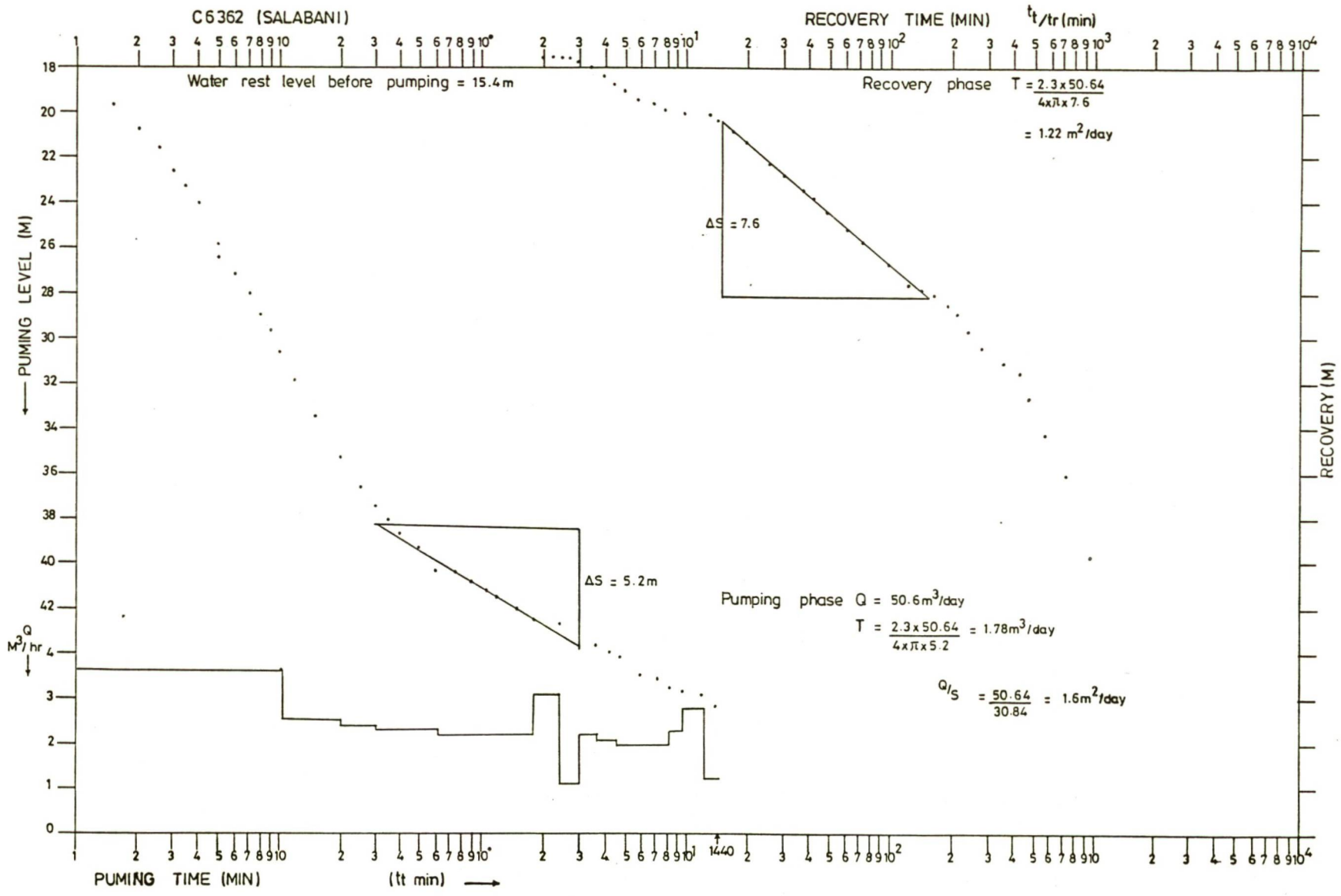
Monitoring of Groundwater Levels (June 1985-Sept. 1986)

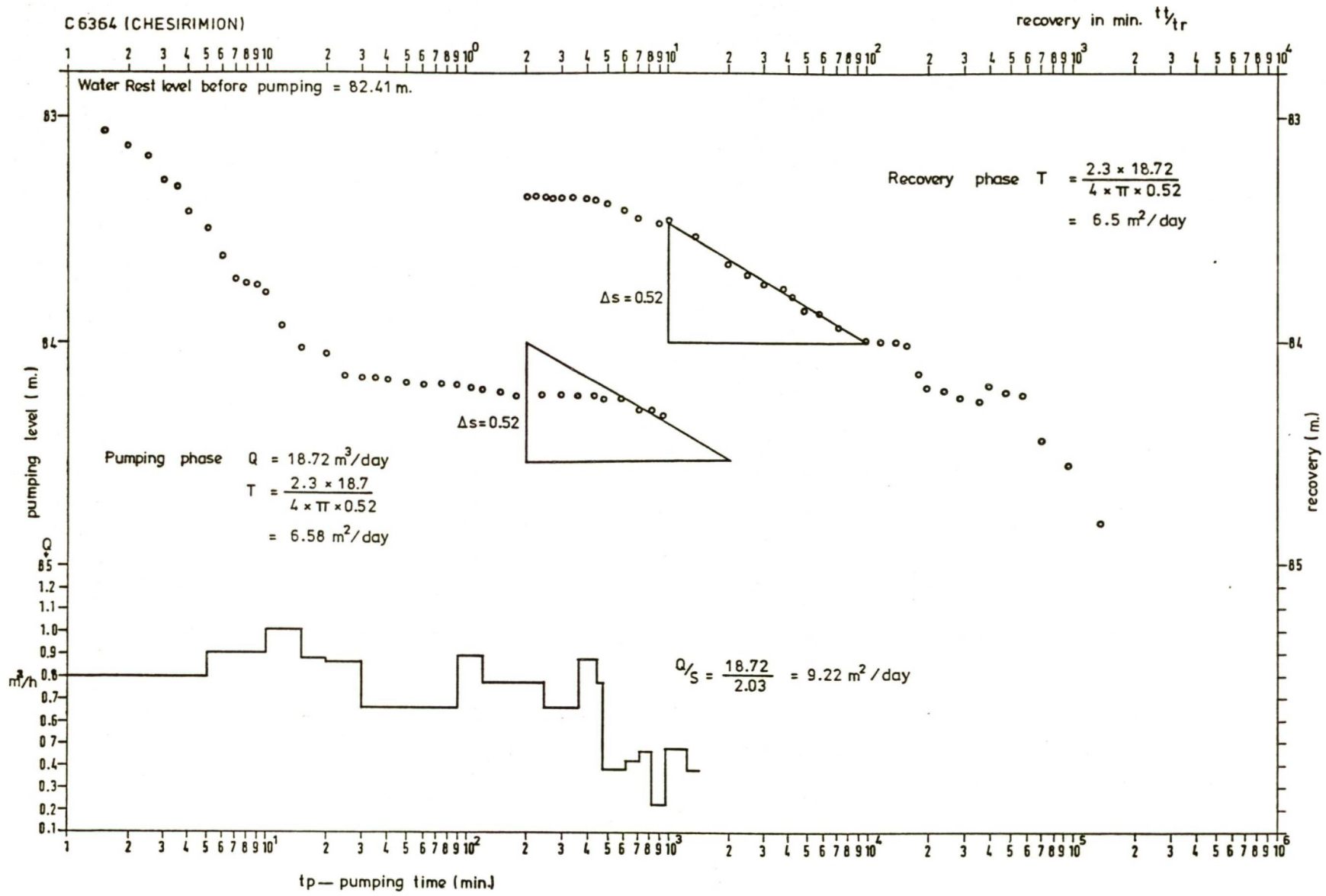
Borehole No.	1985				1986								
	19-06	19-10	08-12	14-12	27-01	05-02	15-02	07-03	17-03	24-03	28-05	12-08	23-09
C5072	-	64.9	-	-	-	75.1	-	-	-	-	-	-	-
C5112*	-	-	-	-	29.4	-	-	-	29.6	-	-	-	-
C5170*	-	20.39	-	20.47	21.7	-	-	-	21.3	-	-	-	-
C5333*	-	9.1	-	-	-	-	-	-	10.9	-	-	-	-
C5370*	-	29.86	-	30.25	-	30.65	-	-	30.9	-	30.39	30.4	
C5487*	-	11.4	-	-	11.5	-	-	-	11.3	-	-	-	-
C5806	-	-	-	-	-	-	-	-	107.53	-	-	-	-
C6362	12.0	15.0	15.10	-	15.10	-	-	15.20	-	-	15.05	-	15.20
C6363	-	19.3	-	-	18.9	-	-	-	20.3	-	19.6	-	19.58
C6364	-	-	84.7	-	-	-	-	-	85.3	-	79.6	82.3	67.88
C6365	-	20.3	20.4	-	20.4	-	-	-	20.4	-	20.3	-	20.39
C6652	-	-	-	-	-	-	6.9	-	-	-	6.95	-	6.65

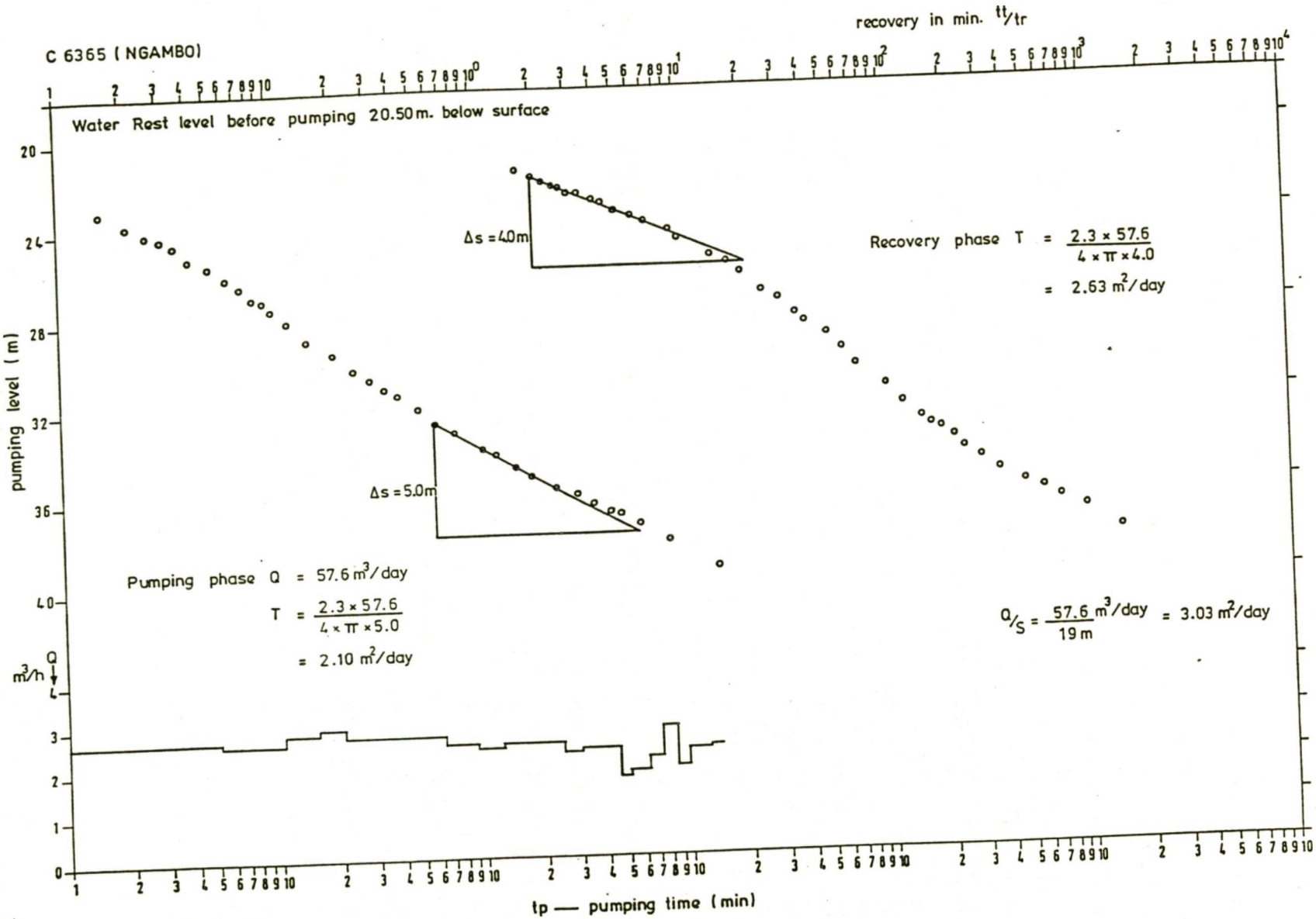
*For the groundwater levels monitoring between 05.11.82 to 07.11.83 see report on Kerio Valley (MoWD, 1984).

APPENDIX 5.4

Analysis of Well Tests


C6362 (SALABANI)
RECOVERY TIME (MIN) $^{t}t/tr$ (min)
Water rest level before pumping = 15.4m
Recovery phase $T = \frac{2.3 \times 50.64}{4 \times \pi \times 7.6}$
$= 1.22\ m^2/day$
ΔS = 7.6
ΔS = 5.2m
Pumping phase $Q = 50.6 m^3/day$
$T = \frac{2.3 \times 50.64}{4 \times \pi \times 5.2} = 1.78 m^3/day$
$Q/S = \frac{50.64}{30.84} = 1.6 m^2/day$
PUMING LEVEL (M)
RECOVERY (M)
M^3/hr Q
PUMING TIME (MIN)
(tt min)
1440


C 6364 (CHESIRIMION)
recovery in min. t/tr
Water Rest level before pumping = 82.41 m.
pumping level (m.)
recovery (m.)
Recovery phase T = 2.3 × 18.72 / 4 × π × 0.52
= 6.5 m²/day
Δs = 0.52
Δs = 0.52
Pumping phase Q = 18.72 m³/day
T = 2.3 × 18.7 / 4 × π × 0.52
= 6.58 m²/day
Q/S = 18.72 / 2.03 = 9.22 m²/day
m³/h
tp — pumping time (min.)


C 6365 (NGAMBO)
recovery in min. tt/tr
Water Rest level before pumping 20.50 m. below surface
pumping level (m)
Δs = 4.0 m
Δs = 5.0 m
Recovery phase T = 2.3 × 57.6 / 4 × π × 4.0
= 2.63 m²/day
Pumping phase Q = 57.6 m³/day
T = 2.3 × 57.6 / 4 × π × 5.0
= 2.10 m²/day
Q/S = 57.6 m³/day / 19 m = 3.03 m²/day
Q m³/h
tp — pumping time (min)

APPENDIX 5.5

Chemical Data Boreholes

Chemical Data Shallow Wells

Chemical Data Springs

APPENDIX 5.5.1 Chemical Data - Boreholes

BOREHOLE NO.	LOCATION	DATE OF SAMPLING	TEMP. °C	pH	EC mS/cm	Na	K	Ca	Mg	Fe	Mn	Cl mg/l	HCO_3	SO4	NO_3	F	SiO_2	HARD* NESS	TDS	G.W ZONE
P84	Ngendalel	17-05-83	-	7.9	0.390	118	9.2	4.0	0.5	5.8	0.0	8	252	2.0	-	3.6	60	-	280	5
		17-08-86	29.5	6.9	0.500	113	11	5.1	1.1	2.1	0.0	14	257	25	0.0	5.5	-	-	300	
P120	Olkokwe	??-05-72	24.0	7.0	0.460	100	10	4.8	1.0	-	-	12	182	56	-	4.4	-	-	275	5
		17-08-86	29.5	7.0	0.505	116	9.8	5.6	1.0	1.2	0.0	13	242	39	4.5	6.2	-	-	300	
P148	Ngubereti	??-06-71	35.0	7.5	0.660	138	27	11	6.8	-	-	27	367	49	-	3.1	60	-	400	4a
C616	Sagasagik	??-06-71	29.0	7.2	0.850	120	22	5.8	33	-	-	12	492	16	-	1.6	82	-	510	4a
C711	Kelelua	??-06-71	36.0	7.3	0.485	108	24	3.9	0.7	-	-	17	259	12	-	2.6	76	-	290	4a
		25-09-86	-	6.9	0.130	-	10	1.2	0.9	5.9	0.1	12	-	1.3	-	0.5	-	18	80	
C1406	Legetetwet	??-06-71	44.0	7.6	0.790	163	33	12	7.4	-	-	23	483	16	-	2.7	64	-	475	4a
C3437	Tangulbei	16-12-85	32.0	7.6	0.800	-	-	20	5.1	1.8	0.0	40	441	13	-	0.6	-	132	510	5
		18-03-86	32.0	7.6	0.800	180	7.3	5.5	13	0.3	0.6	38	-	15	-	1.5	-	111	456	
C3470	Chemoligot	05-07-67	25.0	8.5	-	240	-	4	-	0.3	-	17	-	25	-	2.0	47	16	650	3
		19-05-83	25.0	9.0	1.200	273	4.6	1.6	2.9	0.3	-	28	-	2.5	-	6.8	30	16	700	
		18-11-86	-	8.5	1.100	-	-	-	-	-	-	34	-	40	0.1	2.4	-	-	660	
C3506	Kabarnet	??-??-72	-	6.3	0.112	13	5	12	0.4	0.4	-	16	-	7.0	0.4	0.2	-	-	65	1
		20-05-83	-	7.6	0.090	6.8	4.6	4.0	1.4	0.4	0.0	2	30	0.0	-	0.2	-	16	50	

- not determined * as $CaCO_3$

CONT. APPENDIX 5.5.1 Chemical Data - Boreholes

BOREHOLE NO.	LOCATION	DATE OF SAMPLING	TEMP. °C	pH	EC µS/cm	Na	K	Ca	Mg	Fe	Mn	Cl mg/l	HCO_3	SO4	NO_3	F	SiO_2	HARD* NESS	TDS	G.W ZONE
C3868	Nginyang	10-10-72	-	7.6	7.000	1304	16	12	22	0.3	-	670	-	463	-	18	60	112	3500	3
		19-05-83	-	8.4	3.400	776	5.5	1.2	3.1	0.0	0.0	96	1566	7.3	-	35	-	16	2200	
		28-05-85	35.0	9.0	2.750	-	-	0.7	1.0	1.6	0.2	102	1975	75	-	15	60	-	1650	
		29-05-86	35.0	7.8	2.900	730	9	0.3	1.0	0.7	0.0	148	-	109	-	18	-	14	1740	
		15-08-86	35.0	8.5	2.840	882	5.5	1.5	1.4	0.1	0.0	108	1898	94	0.0	53	-	-	1700	
C4777	Kisanana	17-05-83	-	7.1	0.500	112	12	4.8	1.9	0.0	0.1	30	24	7.8	-	5.8	-	40	300	5
		17-08-86	30.0	6.9	0.520	122	9	2.3	0.5	0.4	0.0	12	291	7.8	5.8	3.6	-	-	310	
C4916	Kisanana	25-09-86	-	7.2	0.460	-	17	4.5	2.3	0.1	0.1	12	-	7		0.1	-	42	275	5
C5072	Chemeron	25-09-86	-	7.9	0.845	-	11	19	7	0.1	0.1	67	-	1.3	-	6.9	-	108	507	3
C5170	Kiboino	07-09-82	-	7.7	0.170	-	-	4.0	2.0	3.5	0.7	8	122	1	-	0.6	-	48	102	1
		24-06-83	-	7.4	0.120	-	-	8.8	4.0	-	-	3	63	2	-	0.3	-	36	70	
C5333	Kolowa	11-08-83	-	7.6	0.460	-	-	18	23	-	-	9	329	7	-	3.4	-	128	275	1
C5349	Tot	28-07-83	-	8.1	0.500	-	-	15	2.3	-	-	7	259	14	-	4.8	-	48	300	1
		28-07-83	-	8.3	0.485	-	-	12	4.6	-	0.0	4	232	5	-	4.8	-	46	290	
C5370	Mkorwa	4-09-83	-	8.0	0.750	-	-	72	50	-	-	6	641	17	-	0.9	-	360	450	1
		6-09-83	-	8.3	0.520	-	-	31	40	-	-	11	284	3	-	1.3	-	220	310	
		7-09-83	-	7.9	0.620	-	-	22	87	-	-	10	566	2	-	0.9	-	360	370	

- not determined * as $CaCO_3$

CONT. APPENDIX 5.5.1 Chemical Data - Boreholes

BOREHOLE NO.	LOCATION	DATE OF SAMPLING	TEMP. °C	pH	EC mS/cm	Na	K	Ca	Mg	Fe	Mn	Cl mg/l	HCO_3	SO4	NO_3	F	SIO_2	HARD-* NESS	TDS	G.W ZONE
C5487	Kinyach	25-01-84	-	7.9	0.570	-	-	8.8	2.9	5.0	0.0	.16	455	19	-	7.4	-	34	340	1
C5806	E/ Ravine	25-09-86	-	7.5	0.320	64	20	3.0	2.7	0.3	0.0	12	180	1.9	0.7	0.9	-	52	192	2a
C6362	Salabani	19-05-85	45.0	9.0	14.400	-	-	5.4	2.3	4.9	0.2	1550	6731	2085	-	36	-	9	8640	4b
		16-07-85	45.0	10.2	15.000	-	-	2.6	2.3	8.0	0.2	2190	5290	3240	-	30	-	12	9000	
		16-07-85	45.0	8.2	14.600	-	-	3.9	2.0	2.4	0.1	1695	6097	2735	-	27	-	8	8760	
		06-10-86	-	8.4	16.640	4750	33	0.6	0.5	0.6	0.1	1850	6420	3563	0.1	34	-	12	9984	
C6363	Kositei	18-05-85	20.0	9.1	0.810	350	-	0.7	2.4	3.4	0.1	23	507	17	-	50	-	486	486	3
		16-07-85	-	9.0	0.920	-	-	2.5	8.4	9.7	1.7	18	500	72	-	11	-	50	552	
C6364	Chesirimi.	16-07-85	26.0	8.3	0.440	-	-	8.0	2.4	2.6	1.1	16	224		-	2.0	-	18	264	4c
		04-12-85	26.0	7.7	0.400	210	-	9.1	12	2.8	0.8	21	481		-	3.3	-	36	240	
		15-08-86	32.2	7.7	0.520	125	7.7	2.2	1.1	6.8	0.2	23	233	12	9.0	8.6	-	-	320	
		30-09-86	-	8.2	0.370	75	6.5	0.1	0.1	7.7	0.0	14	197	0.3	1.5	1.7	-	70	223	
C6365	Ngambo	09-07-85	45.0	9.1	5.900	300	-	0.7	1.3	16	0.5	440	2925	451	-	15	-	40	3540	4b
		16-07-85	45.0	8.6	5.600	-	-	2.0	2.9	11	0.3	295	3602	309	-	35	-	6	3360	
		11-10-86	-	8.7	6.400	1800	16	0.2	0.4	4.5	0.1	370	3457	508	0.1	38	-	14	3840	
C6652	Loboi	15-03-86	32.0	7.4	1.000	200	41	1.1	1.0	17	0.4	-	544	1.7	0.0	20	-	53	490	4a
C7122	Tangulbei	13-03-87	-	8.2	0.820	160	8	5.5	16	9.2	0.0	35	354	3.5	1.5	9.4	36	100	490	5

- not determined *as $CaCO_3$

APPENDIX 5.5.2 Chemical Data - Shallow Wells

WELL NO.	LOCATION	DATE OF SAMPLING	TEMP °C	pH	EC mS/cm	Na	K	Ca	Mg	Fe	Mn	Cl mg/l	HCO_3	SO4	NO_3	F^-	SiO_2	HARD-* NESS	TDS	G.W ZONE
W 1	Ngoron	21-06-83	-	-	-	-	-	-	-	0.0	0.0	-	-	-	-	9.2	-	-	-	1
W 2	Kakabul	21-06-83	-	7.5	0.800	-	-	-	-	0.2	2.1	-	-	-	0.0	8.4	-	-	450	1
W 3	Chepturo	24-03-86	29.5	7.7	0.220	16	19	16	13	46	1.4	8.3	144	0.0	0.0	1.3	-	160	159	1
W 4	Kamnawareng	18-06-83	-	-	-	-	-	-	-	2.0	1.3	-	-	-	0.0	3.2	-	-	-	1
W 5	Parapello	21-06-83	-	-	-	-	-	-	-	0.0	0.8	-	-	-	-	3.9	-	-	-	1
		24-03-86	26.0	8.0	0.400	50	2.3	14	8.0	0.4	0.1	16	246	1.9	0.0	0.7	-	100	225	
W 6	Maron	24-03-86	31.5	7.9	0.160	29	8	0.7	1.2	96?	0.5	17	95	0.3	0.0	0.9	-	30	115	2
W 7	Lowat	17-06-83	-	-	-	-	-	-	-	0.0	0.0	-	-	-	-	7.7	-	-	-	1
W 8	Yoyen	23-06-83	-	7.6	-	-	-	-	-	240?	1.4	-	-	-	2.5	5.6	-	-	-	3
W 9a	Kositei	??-06-83	-	8.4	-	90	15	45	24	-	-	38	430	6.9	-	0.8	-	214	-	3
		18-03-86	21.0	8.4	0.800	140	7.0	11	7.8	0.1	0.1	1.4	502	0.2	0.6	2.0	-	103	485	
W 9b	Kositei	25-06-83	-	-	-	-	-	-	-	0.0	0.0	-	-	-	30	17	-	-	-	
		28-05-85	22.5	8.9	1.550	400	-	11	16	0.3	0.1	38	1090	41	-	2.2	-	192	930	3
W 9c	Kositei	25-06-83	-	8.4	-	-	-	-	-	0.0	0.0	-	-	-	0.8	59	-	-	-	
		28-05-85	29.0	8.7	0.400	200	-	20	7.5	0.8	0.0	10	258	27	-	1.3	-	106	264	3
W 10	Chesoo	22-06-83	-	7.4	0.130	-	-	-	-	1.8	7.5	-	-	-	-	40	-	-	45	3
W 11	Orus	16-12-85	29.5	6.8	0.500	-	-	33	16	0.5	0.0	19	7.6	9.0	-	0.8	-	148	300	5
		29-05-86	28.0	7.9	0.520	63	13	13	8.6	0.3	0.0	3.4	-	9.3	-	1.3	-	-	306	

- not determined *as $CaCO_3$

APPENDIX 5.5.3 Chemical Data - Springs

SPRING NO.	LOCATION	DATE OF SAMPLING	TEMP. °C	pH	EC mS/cm	Na	K	Ca	Mg	Fe	Mn	Cl mg/l	HCO_3	SO4	NO_3	F	SiO_2	HARDNESS*	TDS	G.W ZONE
S 1	Kapuon	29-01-86	21.0	8.6	0.500	143	4.9	5.8	2.6	0.2	0.0	-	26	19	-	8.3	-	70	445	1
		14-03-86	21.5	7.2	0.042	7	2.0	0.4	0.2	5.6	0.5	7.8	17	0.0	-	0.4	-	3	25	
S 2	Ngusuria	14-03-86	24.5	7.4	0.084	9	2.4	0.6	0.4	0.1	0.0	9.7	32	1.5	-	0.5	-	14	45	1
S 3	Kimwemoi	14-03-86	21.0	7.8	0.190	11	2	3.1	3.2	2.4	0.2	12	92	0.31	0.0	0.7	-	66	100	1
S 4	Bartolimo	17-03-86	25.0	8.3	0.400	12	7.1	30	26	7.8	2.2	12	273	0.5	0.0	1.0	-	208	240	1
S 5	Birein	15-03-86	18.5	5.8	0.100	9	26	0.4	0.6	0.8	0.3	5.8	24	1.4	-	0.4	-	13	90	2
S 6	Chebariya.	15-03-86	18.0	7.2	0.083	5	1.5	0.4	0.5	0.7	0.3	16	22	1.1	-	0.4	-	11	45	2
	Talai	21-05-86	22.0	8.0	0.065	7	3.1	0.7	0.4	0.8	0.2	12	12	1.2	-	0.4	-	8	43	
		19-11-86		6.6	0.100	-	-	-	-	-	-	10	-	-	3.4	0.1	-	-	60	
S 7	L.Bogoria	23-12-84	32.0	8.0	0.420	150	15	8.9	1.0	1.0	0.0	32	299	54	-	57	-	4	2880	4a
		03-06-86	-	7.1	0.575	142	23	0.7	0.3	0.4	0.0	14	272	10	0.0	5.6	-	10	345	
S 8	L.Bogoria	23-12-84	85.0	8.8	4.800	1150	30	1.8	1.0	1.0	0.0	32	2480	54	-	57	-	4	2880	4a
		28-11-86	-	9.2	4.290	-	-	-	-	-	-	-	-	75	0.0	67	-	8	2895	
S 9	Maji Moto	??-07-71	33.4	7.3	-	118	15	6.6	1.2	-	-	10	297	10	-	4.1	88	-	-	4a
		??-05-83	-	7.2	0.470	119	14	4.0	0.5	-	-	6	253	14	-	8.8	40	-	280	
		23-12-84	37.0	7.7	0.420	123	15	12	2.3	1.5	0.0	9	394	6.7	-	4.6	-	24	420	
		30-05-86	36.0	7.5	0.520	126	23	1.2	0.7	1.0	0.0	17	240	9.6	-	4.5	-	25	315	
		16-08-86	35.0	7.2	0.520	127	13	5.5	1.1	0.5	0.1	9.1	314	11	0.0	12	-	-	315	

- not determined * as $CaCO_3$

CONT. APPENDIX 5.5.3 Chemical Data - Springs

SPRING NO.	LOCATION	DATE OF SAMPLING	TEMP. °C	pH	EC mS/cm	Na	K	Ca	Mg	Fe	Mn	Cl mg/l	HCO_3	SO4	NO_3	F	SiO_2	HARDNESS*	TDS	G.W ZONE
S 10	Emsos	??-07-71	35.0	7.5	-	105	13	6.3	2.8	-	-	10	245	16	-	4.9	-	-	-	4a
		??-07-74	-	-	0.470	72	12	11	3	0.1	-	30	268	5	-	2.6	-	-	290	
		14-05-85	34.0	7.2	0.420	150	-	0.5	0.5	4.8	0.2	14	280	16	-	2.2	-	40	280	
		16-08-86	34.0	7.8	0.475	104	11	7.8	2.8	0.6	0.0	10	260	16	2.9	6.3	-	-	290	
S 11	Kamar	14-05-85	24.5	7.8	0.065	21	-	0.4	5	2.8	-	4	39	0.5	-	-	-	32	40	4a
S 12 a	N. Nyoka	13-05-85	27.0	8.4	0.220	91	-	6.4	1.0	4.7	0.1	13	90	2.5	-	0.1	-	22	95	4a
S 12 b	N. Nyoka	13-05-85	33.0	8.1	0.360	129	-	1.7	0.9	3.3	0.4	8	83	2.8	-	-	-	32	85	4a
S 13	Loboi	??-07-71	36.0	7.0	-	128	15	2.6	1.1	-	-	11	330	11	-	4.1	89	-	-	4a
		23-05-83	-	6.9	0.490	120	14	12	1.9	0.0	0.0	8	294	0.3	0.0	6.0	50	38	290	
		23-12-84	34.0	8.0	0.480	104	15	8.9	2.1	0.0	0.0	10	299	7.2	-	4.5	-	22	290	
		30-05-86	34.0	6.8	0.600	122	23	1.7	0.6	1.1	0.0	16	246	3.0	-	4.1	-	18	360	
S 14	Sandai	26-10-86	31.0	7.0	0.280	-	-	14	9.7	0.5	0.0	7	168	2.8	-	0.4	-	76	170	4b
S 15	Kapedo	23-12-84	-	8.7	1.800	360	11	5.8	1.9	0.0	0.0	41	958	25	-	11	12	-	1080	4c
		18-03-85	30.5	8.5	1.000	210	6	0.6	0.2	0.0	0.0	16	597	5.3	-	7.0	11	-	550	
		18.11.86		8.3	1.200	-	-	-	-	-	-	21	566	2.1	0.8	-	-	-	700	
S 16	Kapedo	23-12-84	42	9.0	4.000	820	26	2.9	0.9	0.1	-	30	1690	61	-	25	-	6	2400	4c
		29-10-85	42	9.0	3.200	-	-	4.0	13	0.1	0.0	148	2012	58	-	18	-	110	1920	
		14-03-86	30.5	9.0	3.400	1050	30	0.5	0.4	0.9	0.0	46?	2014	84	0.0	28	-	12	2040	
		15-08-86	47.0	8.3	3.800	1026	25	1.6	0.5	0.0	0.0	225	2030	98	1.7	68	-	-	2300	
		18-11-86		9.0	3.800	-	-	-	-	-	-	220	-	78	0.6	24	-	-	2300	

- not determined * as $CaCO_3$

CONT. APPENDIX 5.5.3 Chemical Data - Springs

SPRING NO.	LOCATION	DATE OF SAMPLING	TEMP. °C	pH	EC mS/cm	Na	K	Ca	Mg	Fe	Mn	Cl mg/l	HCO_3	SO_4	NO_3	F	SiO_2	HARD-* NESS	TDS	G.W ZONE
S 17	Kaptunai	16-07-85	18.5	6.4	0.150	-	-	0.9	13	0.2	1.5	2.9	132	1.2	-	5.5	-	10	90	5
S 18	Chebinying	29-05-85	26.5	8.4	0.720	290	-	62	42	1.6	-	29	634	21	-	0.7	-	366	537	5
S 19	Mukutan	23-12-84	25.0	7.8	1.700	110	8	6.4	2.5	0.1	0.0	21	-	2.1	-	0.8		14	1020	5
		28-01-86	22.0	8.4	1.200	143	9.0	5.7	1.3	1.4	0.0	20	400	1.4	-	0.6	-	62	720	
S 20	Mukutan	23-12-84	-	8.6	0.700	54	2	1.1	0.3	0.1	0.1	-	385	4.3	-	1.2	-	-	420	5
		28-01-86	48.0	8.7	1.500	181	1.8	1.1	0.1	0.2	0.1	-	422	5.2	-	0.9	-	10	900	
S 21	Churo	18-03-86	25.0	8.3	0.485	128	5.2	0.4	0.2	0.1	0.0	5.2	-	4.8	0.0	1.6	-	8	290	6
S 22	Nakapuron	09-12-85	62.0	8.8	0.040	-	-	0.0	1.9	1.5	0.0	2.0	27	0.9	-	0.1	-	8.0	25	4c

-not determined * as $CaCO_3$

APPENDIX 5.6

Geological Well Logs

LEGEND TO THE LOGS


unknown


clay


loam


clayey


fine sand


medium sand


coarse sand


sandy


gravel


tuff


volcanic ash


volcanic agglomerate


lava (P=phonolite, T=trachyte, B=basalt)


diatomite


weathered


marble


gneiss


quartzite


pegmatite


schist

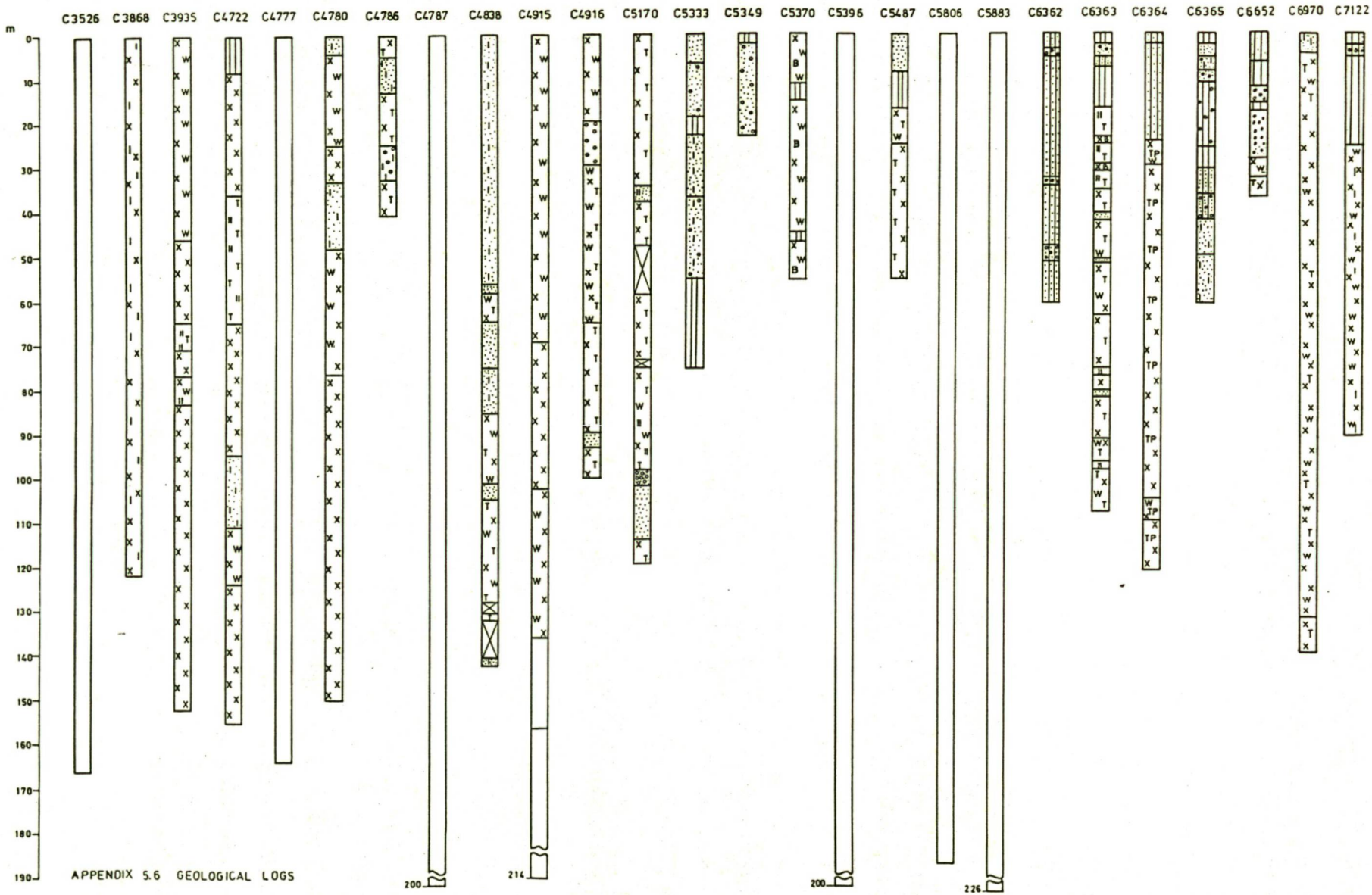

chert, chalcedony


consolidated


metamorphic



APPENDIX 5.6 GEOLOGICAL LOGS



APPENDIX 5.6 GEOLOGICAL LOGS

LIST OF APPENDICES, CHAPTER 6

6.1 Abstracts of Previous Water Resources Assessment Studies in Baringo District.

6.2 Questionnaire Water Survey

6.3 Earth Dams & Pans in Baringo.

APPENDIX 6.1

Abstracts Previous Water Resources Assessment Studies
in Baringo District.

National Master Water Plan (TAMS, 1980) is the first general approach for the assessment of water resources in Baringo. The water resource potential of the Kerio River Basin (2C) and the Perkerra River - Lake Baringo area (2E) is briefly summarized. Several sites are identified for potential storagedams and reservoirs. Water from Lake Baringo is not recommended for irrigation, because of poor chemical quality.
The plan includes also regional maps of mean groundwater rest level and mean borehole yields. According to these maps, the mean groundwater rest level in Baringo (drainage basins 2C, D, E) is between 20 and 80m below surface, and the average tested borehole yields vary between 3 and 11m3/h. These estimates are based however on a few data only.

The Greater Nakuru Water Development Plan 1980 - 2000 by Sir Alexander Gibbs & Partners (1980), is relevant only for the southern parts of Baringo District (Eldama Ravine and Mogotio Divisions). The possibilities for storage in reservoirs in the upper Molo and upper Perkerra chatchment are investigated. It is advised that the exploitation of groundwater resources should only be considered in the areas where surface supply is uneconomic or where limited drawoff is at present evident.

The Water Resources Study for the Kerio Valley Basin by Sogreah (1981), included the whole of Baringo District. This study analysed the available (scanty) hydrological and meteorological records and made recommendations for the large scale development of perennial water resources. The study has concluded that the surface water resources are quite abundant, but unequally distributed in the space and time. Resources appear to be plentiful in the zones which lie above 800mm isohyet. However, the lack of suitable dam site and the heavy sediment transport in the upstreams of main rivers are the major constraints in the regulation of resources.
A hydrological balance of Lake Baringo has been calculated. The annual total inflow to the lake amounts to about 250M m3, which represent only 4% of the average annual rainfall in the catchment area. About 80% of the total inflow is supplied through Molo and Perkerra Rivers. The balance of the lake is based on an assumption that there were no leaks. However, according to Soghreah, it is possible that there is a hydraulic conection between the lake and the hot springs in Kapedo, which are situated some 50 km northwards. These springs discharge 22-28 Mm^3/year.

From the hydrochemical point of view, the water from lake Baringo is not suitable for human or animal consumption. However, it may be used, if care is taken, for irrigation. Lake Bogoria contains saline water. The quality of the river is generally satisfactory for the needs of livestock and irrigation, but Sogreah recommended a chlorine treatment of water when used for human consumption.
In the absence of systematic hydrogeological measurements, the assessment of groundwater resources is based on the geological conditions and estimated recharge. The present WRAP project area coinsides, in greater part, with the hydrogeological unit 2 in Sogreah's report. On the basis of 1% of the average annual depth of rainfall the theoretically exploitable volume of groundwater is equivallent to a continous discharge of 0.5 l/s for km2. The scanty chemical data, available for a few existing wells indicate a good quality groundwater.

Central Baringo Water Development Plan 1983-2003 by Pencol (1984) contains a study of water resources in Central Baringo area, including the Baringo Rift Valley south of Nginyang, the Tugen Hills and the east bank of the Kerio Valley. The Pencol study is mainly based on the analyses of existing

data, supplemented by some additional field measurements.

Pencol concluded that the combined capacity of the present available surface and groundwater sources of the whole area amounts to several times the forecast demand. However these sources are continuously available to only a few people. In order to distribute them more evenly, it will be necessary to provide reservoir storage and/or lengthy pipelines to overcome seasonal and geographical limitations of the central Baringo area. Pencol prepared preliminary designs for four, multi-million shillings, alternative schemes. A water balance study for Lake Baringo indicates that not more than 2.2 Mm3/month can be taken directly from the lake for the irrigation. Lake water is not recommended for human consumption. An evaluation of groundwater based on the available records suggested that boreholes drilled to sufficient depths should yield water almost everywhere but that depth to water, low yields and poor water quality are likely to be the constraining factors.

The quantitative aspects of the groundwater resources are almost unknown. The annual direct groundwater recharge for the central Baringo is estimated at 461 Mm3. About 95% of recharge take place in the sourthern main valley and Tugen Hills, where 10% of annual rainfall is supposed to infiltrate. A part of the infiltrated water may discharge in small cold springs in the Tugen Hills uplands and in the Laikipia Escarpment area. A systematic quantitive survey of cold springs has not yet been carried out. The total annual discharge of all the thermal springs around Lake Bogoria has been estimated to be 6.7 Mm3, including those which are highly mineralized. The estimated total annual abstraction from the boreholes amounts to 0.45.Mm3. From the available chemical data, Pencol concluded that the fluoride and conductivity values increase in the direction of groundwater flow from recharge areas at higher elevation towards the valley centre. In four from 13 tested boreholes, the total dissolved solid contents exceed 500 mg/l, while the WHO - limit for fluoride concentration (1.5 mg/l) was exceeded in 12 wells. Pencol report also deals with rainwater harvesting as an alternative source of water. The availability of water from smaller scale sources, including sand and sub-surface dams, dug wells and cattle pans has also been studied. Pencol study includes a detailed analysis of future water demand for central Baringo upto the year 2003 and cost analysis for proposed schemes.

Interim report of Baringo Pilot Semi Arid Area Project -BPSAAP- (MoA, 1984), deals with the parts of Baringo lying between 35° 30' and 36° 50'E and 0° 15' and 1° 10'N. The project area of approximately 4 600 km² is covered mainly by Marigat and Nginyang Divisions. Chapter 5 in part I, summaries the results of Pencol and Sogreah studies (see above), which are relevant for the water resources assessment. In chapter 14, part II, the water development before and during the project is discussed. It is concluded that over the past 30 years very little has been done to meet the demand for water. Three approaches that could be taken to supply the human and livestock population with water are considered in the development strategy:

1) High cost, large scale, centralised river regulation, treatment and distribution systems.

2) Low cost development of scattered local resources.

3) Medium cost, semi-large scale development of local resources.

The first approach, recomended by Pencol, is considered to be inappropriate because of the extremely high cost involved and the lack of local involvement. The second approach is currently being implemented by BPSAAP, but for organisational and financial reasons, it has been seen to be ineffective. The third approach is being investigated by Pencol.

The Water Resources Assessment study for Kerio Valley (MoWD, 1984) included also a part of Baringo District between western slopes of the Tugen - Tiati Hills and the east bank of the Kerio River.
The study concluded that the existing water supplies are limited in number. There is ample potential for the development of surface water. The total annual surface water outflow from the valley at Tot amounts to about 300 - 500 Mm3. However, the surface water is not evenly distributed over the area. Small-scale irrigation is possible by extending the traditional system of damming small streams, or by constructing sand dams at suitable locations in which shallow wells with handpumps can be installed.
Groundwater resources are limited. From the alluvial aquifer along the Kerio River (both sides) a total of 1.7 Mm3 can be produced yearly, through hand-dug wells with hand-pumps, costing about Kshs. 20,000 each.
Only about 800 km2 of the regional aquifer system, comprising the fractured and weathered volcanics with interbedded sediments and the Kerio Valley sediments, have a high or medium potential for groundwater development. The total yield of this aquifer is estimated to be only 0.2 Mm3/year. Full exploitation would require 100 handpumped wells. The cost of drilling a moderately deep (50m) well and equipping it with a hand-pump is approximately Kshs. 80.000. Detailed site investigations are required for both surface and groundwater development.

A water availability map has been prepared to indicate the regional distribution of the different water resources.

APPENDIX 6.2

Questionnaire Water Survey

WATER RESOURCES ASSESSMENT PROJECT

WRAP-WATER SURVEY BARINGO DISTRICT 1986.

DIVISION: _____

1. Name of supply (site)	:	
2. Location	:	
3. Source	:	☐ borehole ☐ shallow well ☐ spring
	:	☐ river ☐ water hole ☐ lake
	:	☐ dam/pan ☐ other
4. Owner/operating agency	:	
5. Year commissioned	:	
6. Yield/discharge (m3/day)	:	
7. Pumping plant	:	☐ Electr. p. ☐ diesel p. ☐ hand p.
	:	☐ gravity ☐ bucket ☐ other
8. Present extraction (m3/day)	:	
9. Storage (m3)	:	
10. Distribution (km pipes)	:	
11. Water quality	:	☐ good ☐ high TDS ☐ high F
	:	☐ organic pollut. ☐ not known
12. Treatment	:	☐ none ☐ chlorin. ☐ full
13. Population served (number)	:	
14. Metered connections (number)	:	
15. Kiosks/W.P. (number)	:	
16. Area covered by supply (km2)	:	
17. Present water demand (m3/day)	:	
18. Working conditions	:	☐ under construction ☐ good
	:	☐ poor ☐ not working
19. General remarks	:	
20. Date of the last field check:		

APPENDIX 6.3

Earth Dams and Pans in Baringo

Earth Dams and Pans in Baringo.
Source: MoWD & BPSAAP)

Northern Parts (Nginyang Division)

No*	Site**	Capacity (m3)	No*	Site**	Capacity (m3)
1	Kolowa	3 000	15	Seretion	8 000
2	Katowit	8 000	16	Nyanyau	?
3	Aolich	14 000	17	Kaporel	3 000
4	Chesim	?	18	Tangulbei	?
5	Nakoko	?	19	Issaco	8 000
6	Cheboso	10 000	20	Lokot	10 000
7	Loiwat	3 000	21	Chesirimion	5000
8	Togenoi	8 000	22	Noishwa	8 000
9	Chemuningmur.	8 000	23	Churo	?
10	Ngalekan	10 000	24	Namudet	15 000
11	Lamus	5 000	25	Chepkalacha	5 000
12	Korio	2 000	26	Loruk/Chepkal.	?
13	Lokeni	5 000	27	Kalapata	16 000
14	Kadingding	?			

Central Parts (Kabartonjo, Kabarnet & Marigat Divisions)

No*	Site**	Capacity (m3)	No*	Site**	Capacity (m3)
28	Kosile	27 000	41	Tiriongonin	18 000
29	Chepkoi	27 000	42	Koriema	16 000
30	Akoroyan	3 000	43	Kitikibet	8 000
31	Koroto	3 000	44	Kimalel	12 000
32	Karau	16 000	45	Logumukum	18 000
33	Kaplechengei	18 000	46	Kailer	14 000
34	Loperer	3 000	47	Kaptum	10 000
35	Kaplelwo	?	48	Kapkuikui	?
36	Losokoni	15 000	49	Kapkon	14 000
37	Lamalok	6 000	50	Kapngetuny	15 000
38	Kibingor	12 000	51	Kaplel	12 000
39	Ngambo	?	52	Letoi	15 000
40	Syrinyon	12 000	53	Sembele	16 000

* Numbers refer to Plate 6.1
** Spelling of the names may differ from topographical maps

Southern Parts (Eldama Ravine, Tenges & Mogotio Divisions)

No*	Site**	Capacity (m3)	No*	Site**	Capacity (m3)
54	Siewa	12 000	68	Sertonge	6 000
55	Tebei	15 000	69	Oterit	9 000
56	Goiteren	16 000	70	Kapkunyan	8 000
57	Kamarr	12 000	71	Pombo	5 000
58	Nyalilpuch	9 000	72	Oldebes	4 000
59	Lelgut	15 000	73	Tarabunyan	8 000
60	Borokwo	16 000	74	Olobarai	6 000
61	Koitebes	16 000	75	Kisanana	20 000
62	Kabarpesi	18 000	76	Koronionote	3 000
63	Simotwet	8 500	77	Ndabibi	7 000
64	Kiptemeret	20 000	78	Timotin	8 500
65	Cheptant	10 000	79	Muserechi	20 000
66	Tapgurgurwet	16 000	80	Cheptongilo	8 000
67	Kabokanga	10 000	81	Sasurwa	12 000

* Numbers refer to Plate 6.1
** Spelling of the names may differ from topographical maps