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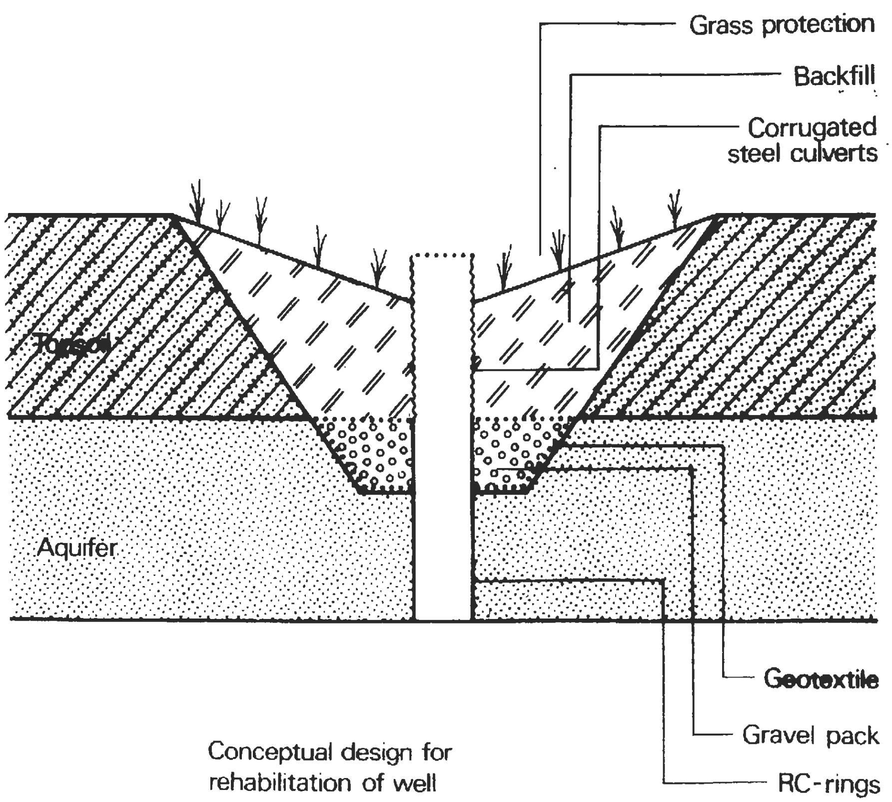
Technical Assistance to North West Agricultural Development Project (II° Phase), Somalia

July 1987

Consultancy Report on Hydrogeological Short Term Mission May - June 1987



Conceptual design for rehabilitation of well

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	provided with infiltration galleries. Farmland needs protection against over land floods.

9: SALEMAN GELLEH.

Structure:	Inland well constructed 1983, right on river-bank, 5*5 m, 12 m deep, 4 m water depth, gneiss in bottom.
Performance:	Pumped dry in 1-2 h, recovers within 4 h, pumped two times per day.
Conductivity	810 microsiemens/cm.
Pump:	Yanmar TS 70
Major problem:	Some aquifer caving.
Recommendation:	Presently there is no need to invest in rehabilitation of well as the existing well performs quite well and is fairly stable. When later this well detoriates, a new RC-ring well in river-bed may be required to superseede existing well.

10: MUSA AW ALI HASSAN.

Structure:	Temporary river-bed well, presently destroyed. Only 2 m depth to gneiss (bedrock)
Performance:	Owner not present, no informations obtained.
Conductivity	
Pump:	
Major problem:	
Recommendation:	New RC-ring well in river-bed, probably provided with infiltration galleries.

TABLE OF CONTENTS

Chapter 1. Introduction and Summary.

Chapter 2. Field Investigations.

Chapter 3. Construction and Rehabilitation of Wells.

Chapter 4. Recommendations.

Appendix A: Terms of Reference.

Appendix B: Reports Studied.

Appendix C: Work Program.

Appendix D: Kalqoray Research Farm.

Appendix E: Well Inventory.

Chapter 1: Introduction and Summary

1. INTRODUCTION and SUMMARY.

1.1 Background.

The North West Agricultural Development Project (NWADP) is the major agricultural project in Northern Somalia. It is operating in the North West Region and the Awdal Region, and has headquarters in Hargeisa. The first phase of the project concentrated mainly on rainfed agriculture, but a start was made on irrigated horticulture. During the second phase, both rainfed agriculture and irrigated horticulture has been continued, the first sector financed by IDA/IFAD and the latter financed by EDF.

Initialy one of the major Phase-2 targets for the horticultural section was to establish 50 new irrigated 1-ha farms, but early 1987 this figure was increased to comprise 150 farms, of which 75 were intended to be new farms and the remaining 75 were existing farms to be rehabilitated. To achieve this increased target, a short term mission by a hydrogeologist was called for to indicate suitable areas for location of wells for new farms and to select existing wells suitable for rehabilitation.

In the course of the mission, a minor extension to TOR was given concerning the possibilities of improving the yield of Borehole 1 at the planned 20 ha. research farm in Kalqoray.

The TOR for the mission is given in Appendix A.

1.2 Comments to Terms of Reference.

In the Terms of Reference a distinction was made between 'new farms' and 'wells to be rehabilitated'. The term 'new farm' has in this context primarily been interpreted with consideration to the present land use, thus indicating arable but presently not cultivated/irrigated land. The mission has identified more than 100 hectars of such suitable virgin land, theoretically sufficient to allow for establishment of 100 new one-ha irrigated farms.

It should be noted that this mission has been dealing with farm-identification mainly from a hydrogeological point of view. Other subjects such as soil suitability, topography etc remains to be evaluated.

A total of 193 existing farms have been visited and described with respect to existing water abstraction facilities. Some 172 of these wells have been deemed suitable for possible

1.4 Work Performed.

Before the departure for Somalia, the following eqipment was purchased for use during the mission and afterwards:

Conductivity meter incl temperature probe and calibration standards.

Ph-meter incl. temperature probe and calibration standards.

Chloride determination kit

Sulphate determination kit

10 meter hand-auger set with soil sampler, spiral auger and transport box.

This equipment was carried to Somalia by the hydrogeologist as luggage except for the Sulphate kit which was brought in by visitors to the project at a late stage of the hydrogeologist's stay.

Initially, existing reports and aerial photos were intended to be studied at the head office in Denmark before the hydrogelogist's departure for Somalia. Due to the rapid mobilisation, this activity was transferred to Somalia and took place during the first days of the mission and on days where field operations were not possible due to logistical constraints such as lack of vehicle, fuel shortage, travel restrictions etc.

The hydrogeologist arrived in Hargeisa on May 8th 1987 and stayed until June 12th 1987, during which time he visited a large number of farms and areas, ranging in status from virtually virgin land without any irrigational or other agricultiural infrastructure, to existing farms having no or only minor problems related to water supply for irrigation. The selection of areas and farms to be visited was performed in close cooperation with and with the kind and willing assistance of the project staff in Hargeisa.

The mainpart of the workload consisted of field trips to visit the specific areas and farms thus selected for investigations. Due to a fairly high density of wells in most of the areas, it proved possible and advantageous to concentrate the efforts on an inventory of existing wells and extrapolate informations from these to cover neighbouring locations. The results of the inventory is presented in Appendix E of this report, and a summary is given below inclusive of a classification with respect to the ease of rehabilitation work.

inclusion to the project under the 'rehabilitation' term and recommendations on work to be performed have been given on each individual well.

The requirements of the Terms of Reference has thus on the average for the two groups been fullfilled by more than 150 percent.

It could be noted that the permanent project staff in general interpretes the term 'new farm' in a wider sence than the one given above, allowing to this category also existing farms, which require major rehabilitation of infrastructure including irrigation structures, extension, farm management etc. This interpretation allows for for a wider geographical distribution of 'new farms' than the interpretation given above, and represents thus no decreased fullfillment of the requirements of the Terms of Reference.

1.3 Previous Studies.

A number of hydrogeological studies has previously been carried out in the involved areas, and the reports from these were made available to the mission. A list of the report titles are given in Appendix B.

A major contribution has been given by Sogreah, who performed a feasibility study in the early 1980'es, but it must be concluded that the knowledge of the hydrogeological conditions is still limited, especially concerning water balances and the magnitude of available ground water resources.

The Sogreah report and the Tams report estimates/reestimates available ground water resources for a number of river valleys. These estimates are mainly based on passive storage within the river-bed aquifers only. These estimates must be considered very conservative, not taking into account any bank storage, which latter is likely to be at least of the same order of magnitude as the storage in the river-bed aquifer itself.

It is outside the scope and the possibilities of this consultancy mission to produce new estimates on available resources, but it can safely be assumed that the available resources in general are much larger than previously estimated. To arrive at a new and better estimate requires monitoring of ground water levels etc. over lenghtly periods of time, observations similar to those presently being performed in Jallelc valley by the project team. Recommendations on such monitoring programme are given in Chapter 4.

		A	B	C	D	NC
DUR-DUR CATCHMENT AREA.						
Qor-Gaab		0	5	0	0	0
Amud		0	7	3	0	0
Ruqi-Baki		1	7	3	0	0
Qabashaarey:		0	5	0	0	0
Dafarorta :		0	10	0	0	0
BIJI CATCHMENT AREA.						
Gebeley		1	0	0	0	0
Elginis		0	13	0	0	0
Hulluq		1	7	2	0	1
Arabsiyo		0	3	1	0	0
Agamso		0	2	2	0	0
Annayo		0	5	6	0	0
Malugta		3	20	0	0	0
Gerdebere		1	6	0	0	2
Agabar		1	4	0	0	2
Kalqoray		7	3	0	0	0
Horohhaddle		0	11	1	0	0
WAHEEN CATCHMENT AREA.						
Halaya		1	4	2	1	3
Aw Barkhaddle:		0	9	0	0	0
Dara Weine		2	10	0	0	2
Xumba Weine		0	2	1	0	0
Grand total	183	18	133	21	1	10.

The categories A to D/NC refers to the ease of rehabilitation and is described in Chapter 3.

A detailed work program is given in appendix C.

1.5 Summary.

The study has identified a total of some 100 hectars of suitable virgin land where irrigated gardens can be developed, inclusive of shallow wells. This land is new, presently uncultivated land. The number of farms which may be developed on the virgin land is strongly dependant on existing, but not clearly visible owership boundaries. The suitability of the land with respect to soil, slope, shelter, climate etc has not been systematicaly investigated and remains to be verified, but this is not believed to pose any serious problems.

Further, some 183 existing farms have been visited. The present status of these farms are highly variable, ranging from farms needing only minor assistance for example on farm management to farms needing major assistance in all respects. The water abstraction structures have been described and recommendations have been given on rehabilitation work to be performed on each individual farm.

The major constraints towards irrigation observed during the study have been:

a: The phreatic aquifers of some river sections are of limited thickness with the consequence that the saturated aquifer thickness towards the end of the dry season is very small for exploitation of sufficient water for irrigation.

b: In a few areas the total salinity of the ground water is fairly high, which may lead to misgrowth of especially citrus, and which on long term may detoriorate the soil structure.

The problems are by far not universal, and may in many instances be solved by carefull selection of well sites and well design as described in Chapter 3.

Generaly it has been found that a great potential exists for inclusion of existing farms and new areas to the horticultural program, regarding both available water resources, suitable land, and human resources. The farmers appear to be very eager to join the project to recieve technical assistance and are willing to invest both capital and effort.

With repect to Borehole 1 at the planned research farm at Kalqoray it has been concluded that theoretically the ground water resources are presently available, but the practical probability for sufficient improvement of the yield must be assessed to 5 to 10 percent.

Chapter 2 : Field Investigations

2. FIELD INVESTIGATIONS.

2.1 General.

The results of the inventory are presented in Appendix E, arranged area by area. A short description of the general conditions and observed constraints in each area are given where appropriate. This is followed by a short desription of each existing well or other intake structure on the farms visited, and giving recommendations on actions to be taken on each individual farm to improve the water supply from wells or from other intake structures.

Most of the information were obtained from interviews with the individual farmers/farm managers and/or a contact farmer for the area. The dephts noted are those given by the farmer in a multitude of different measures ranging from the metric system over imperial system to 'man-heights'. The meassures are not very precise, and in most cases it was not possible to check them.

It is the impression that the information given sometimes were biased by the farmer's wish to receive assistance, eg by omitting or stressing information which the farmer might consider to weaken or strenghthen his possibilities to join the project.

Although great care was taken to obtain sufficient and correct information, some details may possibly be malrecorded. Before actual implementation appropriate action thus has to be taken to avoid mistakes to be carried on.

2.2 Areas for new farms.

Virgin areas for developement of new farms are to some variable extent available over the region, but generaly the most suitable areas are already cultivated and irrigated to some extent. The only region where large virgin areas are presently available is in the Baki-Ruqi region, mainly along the Dibra Weine River.

In this region some 100 hectars of more or less virgin land has been visited and the possibilities and methods for establisment of irrigation wells have been estimated. In general it is believed that the possibilities for withdrawal of ground water are good and that the location of the well within the farm is of minor importance in this respect. The wells should where possible be submerged river bed wells, alternatively the wells should be located on the downslope side of the farm area to reduce the suction lift of the pump, as this is likely to be the most critical parameter. As only minor experience on well digging presently exists in this area it is recommended to proceed in a stepwise manner, so that the project and the farmers may gain a maximum of experience on the conditions in the area.

Two completed boreholes, reportedly reaching the limestone aquifer has recently been drilled in this area. It was not possible during the field mission to gain sufficient information on the quantity and quality of the ground water found in these boreholes, but it might be possible to use the boirehole near the big river junction for irrigation of several farms, which may be developed in this area. The well should in case be equipped with an electric submersible pump, alternatively a diesel driven shaft pump. The required information on water quality and quantity must be assured and the local authorities must be consulted in this respect before proceeding.

2.3 List and classification of existing farms visited.

The general format of information is:

NO. NAME OF FARMER

Structure:	Short description of well, dimension, type, dry season water depht etc.
Performance:	Pumping/Recovery time with actual pump, when not otherwise stated, dry season data are given.
Conductivity:	in microsimens per cm.
Pump:	Nameplate of prime mover/pump.
Major Problem:	Nature and extent of major problems.
Recommendation:	Works to be performed to improve the well(s).

The inventory comprised type and size of existing wells, type and size of existing pump, the performance of the well as described by the farmer, and in most cases the conductivity of the water was meassured. As for the latter the following criteria concerning the suitability of the water for irrigation has been used:

up to 1000 microsiemens/cm : low salinity - excellent for irrigation, normally no problems to be expected.

1000-2000 microsiemens/cm : medium salinity - the suitability is dependent on composition of salts, monitoring of conductivity recommended.

above 2000 microsiemens/cm : high salinity - water may however be suitable for irrigation if a major part of

√ the salinity is due to bicarbonate, close examination and monotoring recommended.

Following areas and farms were visited during the study. The category indicated refers to ease of rehabilitation or construction of wells:

Cat A: Minor or no rehabilitation work required.

Cat B: Some rehabilitation or a new shallow open surface well required.

Cat C: Major rehabilitation or new deep open surface well required.

Cat D: Well rehabilitation/construction cannot be justified.

NC: Not concluded.

DUR-DUR CATCHMENT AREA.

QOR-GAAB	A	B	C	D	NC
1. YUSUF HABANE GAHAYR.		BC			
2. ABDI QALINLEH SHIRWAC.		B			
3. H. NUUR ABDI KAMIC.		B			
4. DAHIR MUMIN WABERI.		B			
5. MOHAMED RABILEH GOOD.		B			
Subtotal Qor-Gaab	0	5	0	0	0

AMUD. near Boroma.	A	B	C	D	NC
1. HUSSEIN NUUR RIALE.			C		
2. ABDI AHMED FAHIYEH.			C		
3. ABRAHAMAN HUSSEIN ARRIH.		B			
4. BARKHAD OMER H. KHAYRE.			C		
5. OMER OSMAN YABEH.		B			
6. EGEH HABANE RAGE.		B			
7. BARKHAD ADAN.		B			
8. FARAH WABERI HUFANE.		B			
9. HUSSEIN DAHIR MOHAMED		B			
10. OMAR EGEH EGAL.		B			
Subtotal Amud	0	7	3	0	0

RUQI-BAKI AREA.	A	B	C	D	NC
1. SH. IBRAHIM BAKAL.		BC			
2. AHMED ABDILAHI OBSIYE.		B			
3. HAGI MOHAMED SULDAN.		B			
4. AW SULEIMAN RAGE EGEH.			CB		
5. SH ABDULAHI HADI TANNY.	A				
6. AHMED DUALEH OBSIYE.		B			
7. HASSAN ABDULAHI MOHAMED			C		
8. OSMAN IBRAHIM BAHAR.		B			
9. HASSAN DHINBIL.		B			
10. BARRE JAMA YOUSUF.		B			
11. IBRAHIM FARAH JAMA.			C		
Subtotal Ruqi-Baki	1	7	3	0	0

futher some 100 hectars inclusive of 7 individual existing were visited.

QABASHAAREY.	A	B	C	D	NC
1. QAWRAH MUSA ELMI.		B			
2. ABDI RABEH WARSAME.		B			
3. HADI RABEH WARSAME.		B			
4. JAMA ABDI KIIRASH.		B			
5. AWALE ABDULAHI URSAD.		B			
Subtotal Qabashaarey:	0	5	0	0	0

DAFARORTA.	A	B	C	D	NC
1. HUSSEIN ELMI SULDAN.		B			
2. MUSA ELMI SULDAN		B			
3. ALI HADDI RABEH		B			
4. HASSAN AWALE FARAH		B			
5. ELMI AYEH DHIDAR		B			
6. AW IBRAHIM ABDIN KIIRASH		B			
7. OSMAN YUSUF CRYEH		B			
8. ARAB ABDULAHI AMUD		B			
9. ADEN SHIRDON BADEED		B			
Further downstream:					
10. ABDILLAHI GEELE BAAB		B			
Subtotal Dafarorta :	0	10	0	0	0

BIJI CATCHMENT AREA.

GEBELEY.

	A	B	C	D	NC
1. H. OMER MOHAMED GEEDI.	A				
Subtotal Gebeley	1	0	0	0	0

ELGINIS.

	A	B	C	D	NC
1. IBRAHIM AW ALI ELMI.		B			
2. ABDI RAGE WAIS.		B			
3. MOHAMED HUDUN KAHIN.		B			
Further some 10 farms further downstream.		10*B			
Subtotal Elginis	0	13	0	0	0

HULLUQ.

	A	B	C	D	NC
1. AHMED DAHIR OMAR.			C		
2. HASSAN YUSUF ALI.		B			
3. AW MOHAMED WARSAME GEELEH.		B			
4. NUUH BATUN GEELEH.		B			
5. OSMAN ASHUR HASSAN.		B			
6. ABDULAHI ALIN GULLED.					NC
7. MUSA ALIN GULEED.		B			
8. MUSA KINAR SUGAL.		B			
9. ALI DAHLEH XERGEEYEH.		B			
10. AW YUSUF ALI HAREED.	A				
11. YUSUF ADAN HUSSEIN.			C		
Subtotal Hulluq	1	7	2	0	1

ARABSIYO.

	A	B	C	D	NC
1. ADEN MOHAMED OLOW.		B			
2. MOHAMED SH. ABDULAHI.		B			
3. HUSSEIN GELEE ALI.			C		
4. ABDI AW FARAH.		B			
Subtotal Arabsiyo	0	3	1	0	0

AGAMSO.	A	B	C	D	NC
1. MOWLID ABDULAHI.			C		
2. AW MUSA YUSUF BILE.		B			
3. MAHDI JAMA SHIREH.			C		
4. MOHAMED OMAR BILE.		B			
Subtotal Agamso	0	2	2	0	0

ANNAYO.	A	B	C	D	NC
1. JAMA MUSA DUALEH.			CD		
2. AHMED HUSSEIN EGAL.			CD		
3. IBRAHIM ABDULAHI ADAN.			CD		
4. MOHAMED ELMI ALIN.			C		
5. MAHAMOUD ELMI ALIN.			C		
6. MAHAMUD ABDULAHI ADAN.		B			
7. MOHAMED OSMAN ADAN.		B			
8. MOHAMED ABDULAHI AHMED.		B			
9. ELMI HANDULE JAMAK.		B			
10. SULEIMAN ADAN NOOR.		B			
11. ALI ABDULAHI NALAYEH.			C		
Subtotal Annayo	0	5	6	0	0

MALUGTA.	A	B	C	D	NC
1. MAHAMOUD IBRAHIM AHMED.		B			
2. HASSAN IBRAHIM FARAH.		BC			
3. ABDI EGEH ALI.		B			
4. MOHAMMED HIRSI WAIS.		B			
5. JIBRIL ALI FARAH.		B			
6. OSMANN MOHAMMED KARIYE.		B			
7. HAYBE MOHAMED SHIRWAC.		B			
8. DAMSITE	-				
9. ALI WARSAME QADUN.		B			
10. ABDULAHI FARAH JIREH.		B			
11. HASSAN SAMATAR JAMA.		B			
12. IBRAHIM OLHAYEH DIRIXIH.		B			
13. HASSAN ESSA YASSIN.		B			
14. HUSSEIN NOOR QADUN.		B			
15. DAHIR HUSSEIN MOHAMED		B			
16. ALI MOHAMED BAHANAN.		B			
17. MOHAMED ABDI GELEH.		B			
18. MOHAMED HUSSEIN.		B			
19. SOULEIMAN ADAN.		B			
20. HAJI SOLEIMAN ADAN.		B			
21. HAJI IBRAHIM HUSSEIN FARAH.	A				
22. MOHAMED OMAR HASHI.	A				
23. SH. MUSA GALELI.		B			
24. MUSA HAJI GABAAX.	A				
Subtotal Malugta	3	20	0	0	0

GERDEBERE.	A	B	C	D	NC
1. AHMED YUSUF BAH.					A-D
2. MOHAMED YUSUF BUH.		B			
3. ABDI HIRSI.					A-D
4. FARAH HIRSI WABARI.		B			
5. MOHAMED WARSAME.		B			
6. MOHANED YUSUF ABDULAHI.		B			
7. BAVARKO COOPERATIVE.	-				
8. ABDI HASSAN ASABLE		B			
9. SALEMAN GELLEH.	AB				
10. MUSA AW ALI HASSAN.		B			
Subtotal Gerdebere	1	6	0	0	2

AGABAR.	A	B	C	D	NC
1. AHMED YUSUF DIRDIR.		B			
2. AYDID ABDULAHI SAMATAR.		B			
3. ABDI ELMI KIBBAR.		B			
4. NUUH OMER HANDULEH, (Dur-Dur).	A				
5. MAHAMOUD OSMAN SULTAN.(- -)		B			
6. NUUR MOHAMED IBRAHIM.					NC
7. H. OSMAN ABLI KAHIN.					NC
Subtotal Agabar	1	4	0	0	2

KALQORAY.	A	B	C	D	NC
1. OSMAN ASKARI.	A				
2. QAMAR EGAL NOOR.	A				
3. LAYLA ABOKOR.	A				
4. MICHER KAADI.	A				
5. IDRIG EGAL NUUX.	A				
6. ADAN JAMA ODAWA.		B			
7. IBRAHIM HEEF.		B			
8. MAHMUD ABDULAHI.	A				
9. MOHAMED HASSAN MOHAMED.	A				
10. AHMED ABDI RAGE.		B			
Subtotal Kalqoray	7	3	0	0	0

HOROHHADDLE.	A	B	C	D	NC
1. MOHAMED MAHAMOUD YOUSUF.		B			
2. AHMED ADEN AHMED.		B			
3. HASSAN QALIB ISMAIL		B			
4. H. HUSSEIN HASSAN.		B			
5. ABDULAHI MUSA DUALEH.		B			
6. MAHAMAD HAJI ISMAIL		B			
7. SALAD ALI IBRAHIM.		B			
8. MAHAMOUD AW FARAH.		B			
9. AHMED ADAN.		B			
10. AHMED OSMAN ALI.		B			
11. ISMAIL AW YUSUF.		B			
12 ASHA ABDULAHI UDUGLEH.			CD		
Subtotal Horohhaddle	0	11	1	0	0

WAHEEN CATCHMENT AREA.

HALAYA.	A	B	C	D	NC
1. AHMED AW HASSAN AWALEH		B			
2. EBLAH RAGE JAMA.		B			
3. AHMED H. HASSAN.	A				
4. ALI MOHAMED ROBLEH					NC
5. MOHAMED JAMA.					NC
6. MOHAMED JAMA OSMAN.					NC
7. ABDI OSMAN ALI.				D	
8. MOHAMOUD JAMA.			C		
9. HASSAN ALI KAHIN.		B			
10. IBRAHIM H. MUSA.		B			
11. H. MOHAMED SH. OMER			CD		
Subtotal Halaya	1	4	2	1	3

AW BARKHADDLE.	A	B	C	D	NC
1. KAAHA MUSSA GEEDI.		BC			
2. ASHA JAMA FARAH.		B			
3. HASSAN NOOR HUSSEIN		B			
4. AHMED DERIA ALI		B			
5. SAFIA ALI HASSAN.		B			
6. AHMED HASSAN FAYAH.		B			
7. HASSAN FARAH JAMA.		BC			
8. MOHAMED ADEN HAKIA.		BC			
9. MOHAMOUD EGAL AWED.		BC			
Subtotal Aw Barkhaddle:	0	9	0	0	0

DARA WEINE	A	B	C	D	NC
1. AIDEED IBRAHIM MOHAMED		B			
2. MUSA FARAH MIREH.					NC
3. MOHAMED AW JAMAH LIBAN		B			
4. MOHAMOUD GEELEH.		B			
5. MOHAMED ABDULAHI ANBUL.		B			
6. ABDI YUSUF SUGULEH.		B			
7. ABDULAHI GULEID OMER.		B			
8. HASSAN OMER ODOWA.		B			
9. AIDEED QUASALIB ALI.		B			
10. ALI H. HASSAN MAGAN.					NC
11. H. ABDI NOOR EGAL.		B			
12. NOOR JAMA ADEN.	A				
13. H. MUSE ABDI ROBLEH.		B			
14. MUSA SOLEIMAN DAHIER.	AB				
Subtotal Dara Weine	2	10	0	0	2

XUMBA WEINE.	A	B	C	D	NC
1. OSMAN JAMA HIRSI.			C		
2. ALI AW ADAN OMAR		B			
3. ABDULAHI ISMAIL JAMA.		B			
Subtotal Xumba Weine	0	2	1	0	0
Grand total 183	18	133	21	1	10

Chapter 3 : Construction and Rehabilitation of Wells

3. CONSTRUCTION and REHABILITATION of WELLS.

3.1 General.

The mainpart of the existing wells in the area are simple 'waterholes', often having very large diameter. A large part of the wells are unlined structures, while most of the remaining wells are lined with undressed timber, both of which designs have serious drawbacks with respect to stability and durability.

Unlined wells are ever when dug in fairly stable formations likely to suffer from surface caving and/or aquifer caving and should not be expected to have a maintenance free lifetime of more than 2 to 3 years. Woodlining have a life expectancy of some 3 to 4 years, after which time the timber is likely to collapse, with subsequent expensive and time consuming repair works.

In many areas the farmers presently have 2 wells: one river-bed well used during the dry season, and one in-land well used during the rainy season. The former is normally destroyed during the first flood of the year, whereas the latter often is dry during the last part of the dry season. Further, in some areas, the inland wells suffers from high salinity of the groundwater.

A serious need thus exists for new procedures and designs for both construction of new wells and for rehabilitation of existing wells to increase life expectancy, and to reduce maintenance costs.

The large number of wells to be installed/rehabilitated in a short period of time with the assistance of a small staff calls for a design based on simple, prefabricated elements, easy to transport to the well site and simple to install.

3.2 Design Criteria.

Evidently the amount of water that within a given time can be pumped from a large diameter well, is the aritmetric sum of the amount of water entering the well from the aquifer during the period of pumping (influx volume), and the amount of water initially stored within the well (storage volume).

To be acceptable, the well design must provide for a reasonable storage volume, eg 25 % of the daily comsumption. This can be achieved by construction of wells having large diameter and/or large depht. A doubling of the diameter provides for a fourfold increase of storage volume, but the construction cost is likely to increase by more than that, as a considerable volume of 'non-productive' overburden also has to be escavated and the banks have to be stabilized. Deepening of the well is - where practicable - a more cost effecient way to increase the storage volume, as no extra overburden has to be escavated.

The well design must allow for a free influx with a minimum of head losses. Under the hydraulic conditions met in the project area, a doubling of well radius will increase the yield by some 35 percent only. Provided that the well has not already reached the bottom of the aquifer, an increase of the yield can thus best be achieved by increasing the depht, allowing for increased drawdown. Furthermore deep wells are less sensitive to descending static water level during the dry season.

Further, the well design must provide for a reasonable maintenance free lifetime as opposed to existing wells, which require frequent maintenace/reconstruction. The total production cost must correspond to expected increase of farm production, so that the farmers will be able to finance the well construction. The design must allow for ease of transportation of prefabricated elements to the well site by lorry or tractor. The wells must be simple to install by the farmers themselves with a minimum of assistance from the project staff.

Proposed Design.

The proposed designs for construction and rehabilitation of existing wells are presented in figs 2.1 to 2.3 behind. The designs are to a large degree equivalent, using the same design elements.

One of the basic design elements (RC-rings) has been adopted from UNICEF, which agency has used it successfully for rural water supply purposes in this and other areas. The design has been further developed during this mission with the aim to reduce construction/transportation cost and to improve yield. The design comprises following elements:

1. Reinforced porous concrete rings (RC-rings) to function as intake and storage structure
2. Corrugated steel culverts to function as caving protection.
3. Gravel Pack.
4. Geotextile lining.
5. Grass protection.
6. PVC drainage pipes to improve yield where required.

Recently the horticultural section has produced moulds for production of such concrete rings with,a diameter of approximately 1.6 meter. The project commenced early 1987 the construction of one such well for irrigation purposes, but the construction was interrupted by the first flood of 1987.

To determine the required average depht of such installations, the following considerations have been used:

1. Required amount of irrigation water is approximately 30 cum per day.
2. Pumping is performed with a capacity of 9 l/sec for some 30 minutes, two times per day.
3. Transmissivity is 3.2 e-4 sqm/sec.
4. Effective storage coeffecient of aquifer is 10 percent.
5. The distribution between influx and storage volume is 50/50.
6. Effective porosity is 20 percent.

The storage volume of a 1.6 meter diameter well is 2.0 cum per linear meter below static water level. 4 meters of depht below water level thus provide for 8 cum storage. The drawdown under the given conditions after 30 minutes is 3.4 meters, leaving 0.6 meters for entrance head losses and for influx during last minutes of pumping. The influx particle velocity will on the average amount to approximately 2 mm/sec., indicating that headlosses are likely to be less than above 0.6 meters.

If the yield of a well is insufficient and the well cannot be further deepened, the influx to a well can most appropriately be improved by installing gallery pipes in the aquifer. To be effective, the galleries must be installed about 1 meter below lowest dry-season static water level, which means that such galleries normally cannot be installed during the rainy season, and that ground water lowering must take place during the construction.

3.4 Proposed Procedures for Construction.

The porous reinforced concrete rings are produced at the project headquarter or other convinient location. After curing they are transported to the construction site by lorry or tractor and trailer together with other needed construction materials.

New Wells:

Where possible, new wells should be constructed as submerged river-bed wells, where required supplied with infiltration galleries. This type of well has several advantages to river-bank wells:

1: Overburden thickness is the least possible.
2: Aquifer is normaly present and have good yield characteristics.
3: Water salinity is normally low.

Some rivers, however, have so violent floods that river-bed wells and their pump suction lines would be prone to destruction by deep scouring. In such cases it is proposed to construct a well on the river-bank next to the river, and if required supply this with gallery pipes deeply burried in the river-bed.

Overburden may be escavated by buldozer or by labor force as convinient in each case. The choice will depend on expected thickness of overburden, ground water level, and availability and operational cost of bulldozer and labour force respectively.

The bottom ring is placed on the surface and a worker starts digging out the soil within and below the ring by which action the ring will subside as the excavation goes on. Care must be taken to assure that the rings subside vertically. When the first ring has subsided so the upper edge is at ground surface, a new ring is placed on its top and the proces continues with excavation, new ring etc.

When the aquifer is met, water will enter the well from below and through the walls of the well. It is very important for the future performance of the well that excavation is continued to sufficient depht, ie some 4 to 5 meters below lowest static water level during dry season or until sufficient water continiously enters the well.

To be able to dig sufficiently deep it will be required to use a pump to evacuate the water that enters the well. For this purpose existing pumps may be used, but it is very much preferable to utilice special sump pumps, designed for this purpose, as other pumps are likely to have a very short life time when pumping a mixture of sand and water.

If the rings subside freely when 4 to 5 rings has been sunk, Corrugated culvert pipes may be put on top of the last concrete ring and participate in the further subsidence. It must in general be recommended to use casing at all times during digging, as there is a significant risk of collapse of the walls, endangering the digging crew.

Rehabilitation.

For existing wells to be rehabilitated, the procedure is more or less equivalent to above, apart from the condition that the aquifer has already been met and final depht is likely to be more precisely known before the construction.

The first concrete ring is placed in the bottom of the existing well, which in the case of very deep wells may cause some practical problems. If the installation of concrete rings is not possible due to weight etc, corrugated culvert pipes may be used instead. In this case the pipes must be perforated and where possible wrapped with geotextile. The excavation/subsidence process is commenced from here and is continued until sufficient water continiously enters the well.

The soil outside the well is then excavated to the extent possible and a geotextile blanket is placed in the bottom and on the sides of the hole. Gravel pack consisting of 30 to 60 mm clean gravel is filled in, and its top is covered with geotextile. The purpose of the geotextile is to avoid that fine sand enters the gravel pack and subsequently clogs the interstices and hinders free passage of water, and reduction of the storage capacity of the gravel pack.

If required a superstructure of culvert pipes is built on top of the concrete rings, the original hole is filled in, and remaining slopes are stabilized with heavy grasses for protection against surface erosion and caving.

Submerged River-Bed Well

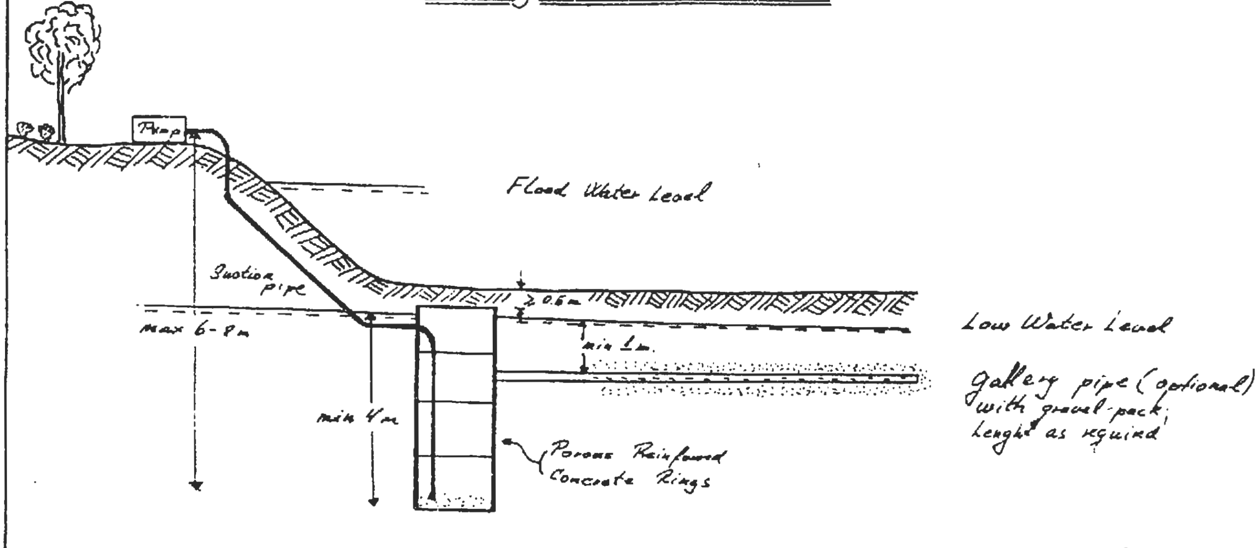


Fig 2.1

River-Bank Well.

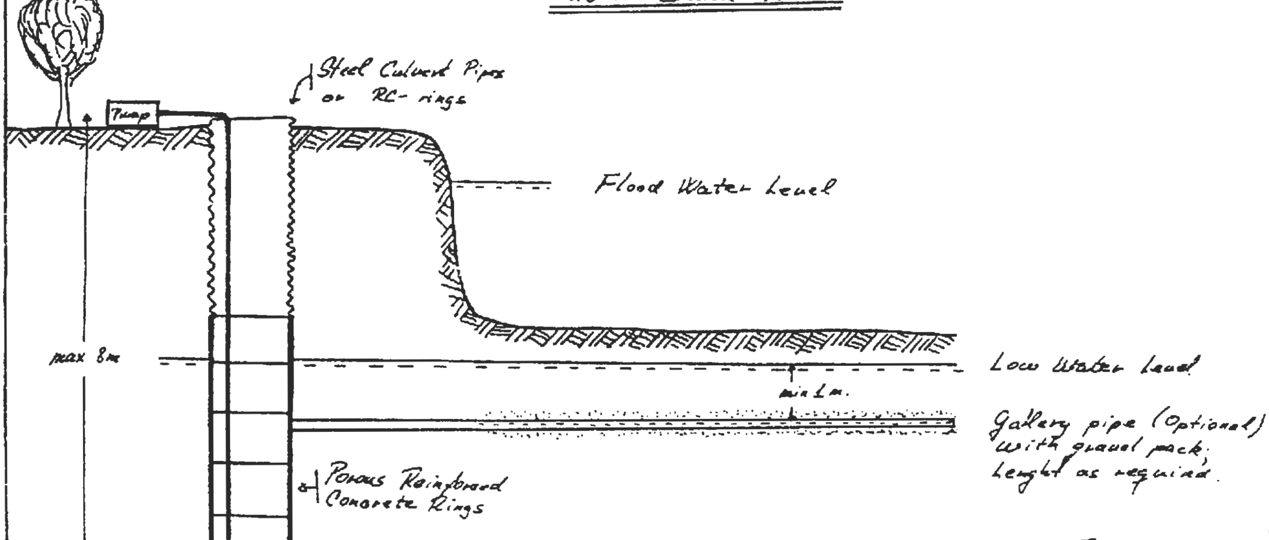


Fig 2.2

Rehabilitated Well.

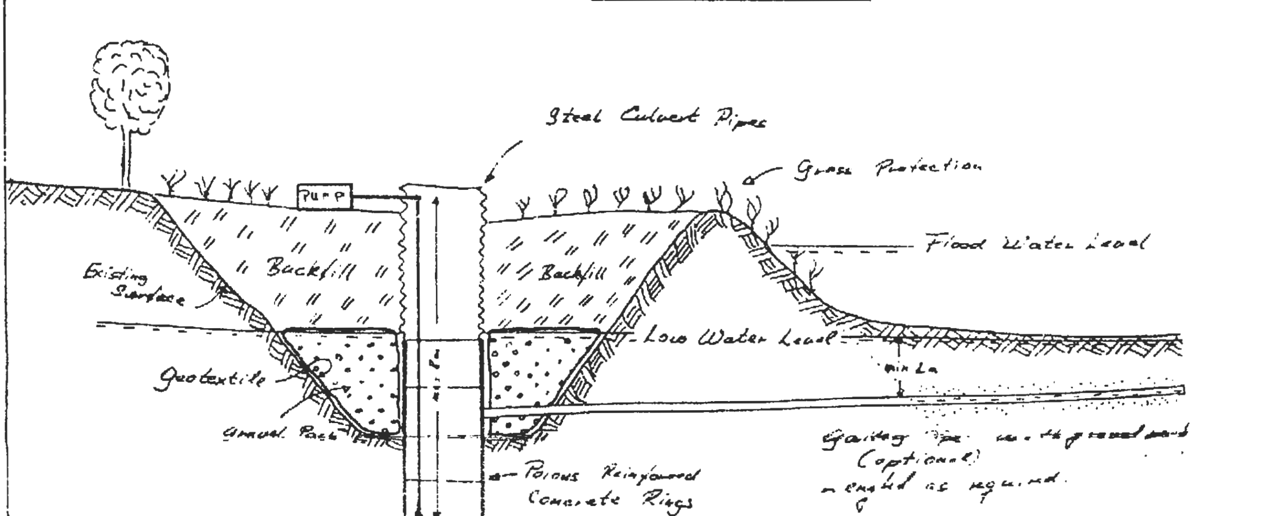


Fig 2.3

Chapter 4 : Recommendations

4. RECOMMENDATIONS.

General recommendations on designs and procedures for construction and rehabilitation of wells are given in Chapter 3. Specific recommendations on work to be performed on each individual farm are given in Appendix E.

It is recommended that the equipment for chemical water analyses is supplemented with glasware and chemicals to determine alkalinity, hardness and calcium. This will allow for calculation of carbonate (CO2--), hydroxide (OH-), bicarbonate (HCO3-), calcium (Ca++) and magnesium (Mg++). With knowledge of these parameters together with the already provided kits for cloride (Cl-) and sulphate (SO4--) it will be possible better to determine the risk connected to using water with elevated conductivities, where this might be unavoidable. The cost of the suggested kits is approximately DKK 1500 exclusive of handling and transportation. DARUDEC may arrange the purchase and transportation.

A specific hydrogeological/water balances study of the project areas cannot be justified at the present state, as the costs thus concerned would be excessive as compared to the likely benefits. Further, it is implicitly estimated that available ground water resources in general are more than sufficient for the present and near-future consumption. On the other hand the project should collect and store every bit of information on the hydrogeology of the area gained directly or indirectly in connection with its operations.

Specifically informations on rainfall, total ground water consumption, and water level in wells should be collected and filed for each individual farming area, eg on a monthly basis. With this material in hand it may after a few years be possible to give a better estimate of available ground water resources.

It has in several locations been observed, that ground water level is high and fairly constant over the year above natural 'subsurface dams' created by outcropping bedrock in the river-beds. This indicates that artificial subsurface dams may be advantageous creating increased infiltration and storage of ground water. It is, however, outside the scope and the possibilities of this study to evaluate this is any detail.

Several river sections suffer severely from bank erosion and deep scouring in the river bed. Action must be taken in several areas to reduce this phenomena, which is threatening the whole existence of several farms. The project has by now commenced emergency operations in this respect in

Horrohhaddle River.

It is recommended to call for a short term mission by a highly qualified hydrologist/river training specialist, to estimate the costs and benefits of combined river training and induced infiltration operations, and to set up guidelines for such operations. DARUDEC is able to provide such assistance by a permanent staff member of the parent company.

Appendix A: Terms of Reference.

Terms of Reference:

In telex no 322/87 of 9/04/1987 terms of reference for this mission was given as follows:

quote

+ to review all the hydrogeology data, directly linked with the foreseen wells locations,

+ to design and advice on standard open surface shallow well construction, using appropriate techniques and materials, suitable for rapid installation.

+ to carry out investigations in awdal and nw regions in order to indicate sufficient and suitable new shallow wells locations to allow the project to reach its targets (75 new one ha farms),

+ to select 75 existing one ha irrigated farms where shallow wells could be rehabilitated or up-graded.

mission's duration estimated to be 7 weeks (4 weeks in somalia and 3 weeks in europe),

unquote

By telex no 372/87 of 27/04/1987:

quote

the duration of field mission has been extended to up to six weeks including the study of existing documents in hargeisa

unquote

In letter from NWADP ref no NWADEP/ADM/2/329/87 dated 31st May, 1987 DARUDEC was asked to:

quote

investigate the performance of the borehole drilled at Kalqoray by the Water Development Agency, (WDA).

unquote

and to give:

quote

> a second opinion on the potential performance of the well, whether it will be possible to develop the well further and if so, how this can best be carried out,

unquote

This extension was accepted in letter from DARUDEC of 2nd June, 1987 provided an extension of home office time-consumption of 2 to 3 mandays. The results of the investigations are given in Appendix D.

Appendix B: Reports Studied.

Reports studied during Field Mission.

1. North West Agricultural Development Project: Feasibility Study and Technical Assistance, Technical Report No 16, Hydrogeology (final Report)
Sogreah, May 1983.

2. Pilot Watershed Management for Soil Conservation and Small Garden Development, Final Report, Volume IV, Small Irrigated Garden Development.
TAMS, October 1986.

3. Report on Geoexploration in the NW Region of Somali Democratic Republic.
Chinese Well Drilling Team (Hargeisa) April 1983.

4. Water Supply for the Refugee Camp Dam/Hargeisa. Technical Report.
Water Development Agency, December 1980.

5. Survey Report on the Possibility of the Second Water Source of Hargeisa City of the Somali Democratic Republic.
The water SUpply Survey Team of the Peoples Republic of China, 1983.

Appendix C: Work Program.

Work Program during Field Mission.

TH	May	7th	: Departure Copenhagen
FR	May	8th	: Arrival Hargeisa, Briefing with Kevin Sutton.
SA	May	9th	: Meeting Ag. General Manager, searching euipment at the airport, introductory visit to Aw Barkhaddle and Jalello.
SU	May	10th	: Picking equipment up in in airport. Reports studies Hargeisa. Visit at Kalqoray Research Farm.
MO	May	11th	: Reports studies Hargeisa.
TU	May	12th	: Reports studies Hargeisa.
WE	May	13th	: No vehicle available. Reports studies Hargeisa.
TH	May	14th	: Discussions with Mr Malik, No vehicle available. Preparations for trip to Ruqi Baki.
FR	May	15th	: No fuel available. Reports studies Hargeisa.
SA	May	16th	: Departure for Ruqi Baki,
SU	May	17th	: Ruqi Baki
MO	May	18th	: Ruqi Baki
TU	May	19th	: Ruqi Baki
WE	May	20th	: Ruqi Baki, gravity schemes on lower Dur-Dur.
TH	May	21st	: Ruqi Baki, departure for Hargeisa
FR	May	22th	: Reports studies Hargeisa.
SA	May	23th	: Reports studies Hargeisa.
SU	May	24th	: Oberhaddley
MO	May	25th	: Travel restrictions. Reports studies Hargeisa.
TU	May	26th	: Halaya and Dara Weine.
WE	May	27th	: Travel restrictions. Reports studies Hargeisa.
TH	May	28th	: Public Holyday. Reports studies Hargeisa.
FR	May	29th	: Public Holyday. Reports studies Hargeisa.
SA	May	30th	: Aw Barkhaddle.
SU	May	31st	: Malugta.
MO	June	1st	: Kalqoray and Malugta.
TU	June	2nd	: Reports.
WE	June	3rd	: Hulluq, Arabsiyo, Agamso.
TH	June	4rd	: Annayo.
FR	June	5th	: Hallayo.
SA	June	6th	: Gebeley, Elginis, Baki.
SU	June	7th	: Baki, Amud.
MO	June	8th	: Amud, Gor Gaab.
TU	June	9th	: Dara Weine.
WE	June	10th	: Hargeisa.
TH	June	11th	: Agabar, Gerdebere.
FR	June	12th	: Hargeisa.
SA	June	13th	: Hargeisa.
SU	June	14th	: Departure Hargeisa.
MO	June	15th	: Arrival Copenhagen.

Appendix D: Kalqoray Research Farm.

Kalqoray Research Farm, Performance of Borehole 1.

Background.

As part of the Phase 2 program for the horticultural section, a 20 ha irrigated research farm is planned to be implemented in an area near Kalqoray River..

For the purpose of irrigigation two boreholes were drilled late 1986/early 1987, but unfortunately none of these boreholes has yielded sufficient water for irrigation purposes.The requred yield is no less than 6 liters per second

An extension of TOR for the hydrogelogy mission has been made to include investigations and recommendations on the possible development of Borehole 1.

Available informations, Borehole 1.

The area was visited on May 10th. No samples were present at the site, but Mr. Sutton had kept samples of the granitic substratum, which appears to be fairly fractured and weathered, and thus a possible aquifer to supplement the sandy strata reportedly screened.

The documentation of the borehole consists of a drillers log, 2 testpumpings, and a work program.

The drillers log indicates that an aquifer of 'clayey sand' followed by 'very fine to fine sand with gravel intercallations' and 'medium to coarse sand'. The combined thickness of this sandy aquifer is 46 meters, and coresponds according to representatives of Hargeisa Water Supply to one of the upper aquifers exploited by the water supply wells in the area. Well no 1 is screened with 8 inch PVC screens from 76-106 m below surface.

The log of Borehole 2 is completely different from this, presenting layers of basalts and red clays.

As indicated above, the aquifer met is very similar to one of the aquifers exploited by Hargeisa Water Supply nearby. It has been reported (oral communication), that the static water level for the boreholes of the Hargeisa Water Supply is presently descending dramaticaly, reportedly due to overpumping of the aquifer system. It is thus probable that the static water level for Borehole 1 also will drop over the coming years, thereby reducing the rate of possible withdrawal. The reduction cannot be assessed on the basis of available data. The possibility exists that regulations on ground water exploitation may be enforced by the authorities to protect this vital source of potable water for the supply of Hargeisa.

The pumping tests performed, are very short, 30 minutes and 130 minutes respectively, and no recovery readings have been taken. During testpumping 1, a total of some 4300 liters have been pumped. Of this volume approximately 1800 liters (42%) originates from the storage volume of the well itself. During the second testpumping the total volume pumped is 18,000 l., of which 1950 l (10%) is storage volume. The transmissivities calculated by WDA, does thus not bear much relation to the real transmissivity of the aquifer.

The transmissivity of the sandy aquifer can from the drillers log be estimated to be no less than say 0.3 10(-3) sqm/sec, which at a well effeciency of 100 percent (no head losses) indicates a possible specific yield of 0.32 liters per second per meter drawdown. It must be stressed, that this is an estimation, but a very conservative one.

Specific capacity of the well at 30 minutes of pumping can be calculated as follows:

Testpump 1: 0.04 l/sec/m

Testpump 2: 0.06 l/sec/m

Assumed : 0.32 l/sec/m

There has been a significant increase inthe specific capacity of the well from testpumping 1 to testpumping 2 (50%), and there is a still larger gap (500%) up to the assumed possible optimal yield.

It can be assumed that this well has a very low effeciency of about 18 % and that development thus theoretically is possible.

One of the reasons for the low effeciency is most likely, that development of the borehole did not commence until nearly one month after drilling operations, as it allows the mud cake to harden and thus to be very resistive to development. At the pesent moment (early July 1987) further 6 months has eleapsed, which causes further problems with respect to development. The probability of succesful development can be estimated as 5 to 10 %, provided highly qualified equipment and personnel is mobilised.

Procedures.

First of all, the borehole shall be properly testpumped, which most appropriately can be performed by the Irrigation engineer, Mr K. Sutton. The pumping yield shall be very small, say approximately 0.5 l/s in order to get interpretable results before maximum drawdown has been reached. Full recovery shall be recorded.

The results are sent to DARUDEC headoffice for interpretation to confirm above estimate of possible yield and final determination of development procedures.

If development can be recommended on the basis of the testpumping, DARUDEC will mobilise necessarry personnel and equipment. Locally a diesel driven compressor with a minimum pressure of 8 ato and fuel for this must be provided for a period of approximately 2 month.

Costs.

1. Estimated duration of specialists stay in Somalia: 2 man-months.
2. Estimated cost of chemicals for development: 50,000 DKK
3. Estimated cost of equipment for development: 50,000 DKK
4. Estimated transportation cost for chemicals and equipment 15.000 DKK

Conclusions.

The well has presently most likely a sufficient potential for development, but the practical probability for sufficient improvement is estimated as low as 5 to 10 percent.

Lowering of the static ground water level in the area is indicating that the aqifer system is already presently over-exploited, which may later pose practical problems and may lead to regulations on ground water withdrawal in the area.

Index:

Qor-Gaab	E.2
Amud	E.4
Ruqi-Baki Area	E.8
Qabashaarey	E.12
Afarorta	E.13
Gebeley	E.14
Elginis	E.15
Hulluq	E.17
Arabsiyo	E.20
Agamso	E.22
Annayo	E.24
Malugta	E.27
Gerdebere	E.33
Agabar	E.36
Kalqoray	E.38
Horohhaddle	E.42
Dara Weine	E.46
Xumba Weine	E.50
Halaya	E.52
Aw Barkhaddle	E.56

QOR-GAAB visited June 2nd.

General: Small river in upper reaches of the Dur-Dur Catchment Area near Boroma. No major constraints observed.

1: YUSUF HABANE GAHAYR.

Structure:	4*4 m wood lined, 3 m deep well on small downthrusted area near the river.
Performance:	Pumped dry in 1 h, recovers within 5-6 h. Pumped two times per day.
Pump:	Small Marlow petrol pump.
Major problem:	Low yield/slow recovery.
Recommendation:	Most effective solution is to dig new RC-ring well in river-bed, if required perovided with infiltration galleries. Alternatively existing well could be rehabilitated by digging the well deeper using RC-rings (gravel pack ?) and steel lining.

2: ABDI QALINLEH SHIRWAC.

Structure:	4 m diam unlined well dug in 1985. Depht 8 m:0-4 m: clay, 4-5 m gravel , 5-8 m clay. Water depth: 1 m.
Performance:	Pumped dry in 20 mins, recovers over the night.
Pump:	Honda Petrol 1100 l/min,28 m.
Major problem:	Low yield/slow recovery.
Recommendation:	Well should be deepened using RC-rings to reach a second aquifer.

3: H. NUUR ABDI KAMIC.

Structure 1:	5 m diam, circular uncased well, 8 m deep, dug 1977. Water depth 1 m.
Performance:	Pumped dry in 1.5-2 h, recovers within 4-5 h. Pumped two times per day.
Pump:	Yanmar TS 50
Major problem:	Caving.
Recommendation:	Install RC-rings in bottom and possibly steel lining/grass for caving perotection.
Structure 2:	8 m deep, 8 m diam circular uncased well, mainly in clay-soil. Aquifer sand/gravel.
Performance:	Pumped dry in 3 h, recovers within 20 mins. Pumped 2 times per day.

Pump:	5 HP Honda petrol pump.
Major problem:	Caving and petrol shortages.
Recommendation:	Install RC-rings in bottom and possibly steel lining/grass for caving perotection. New diesel pump may be required to overcome petrol shortages.

4: DAHIR MUMIN WABERI.

Structure:	Newly dug well on river-bank next to river. 2.5 m diam, 5.5 m deep. Water depth presently 1.5 m
Performance:	Pumped once for 4 h with only minor drawdown.
Pump:	5HP Honda (borrowed).
Major problem:	
Recommendation:	To improve stability this well should be perovided with RC-rings/gravel pack/steel lining and if required with infiltration galleries. Farm should be considered a new farm, needing pump, pipes, and general technical assistance.

5: MOHAMED RABILEH GOOD.

Structure 1:	4 m deep, 4 m diam uncased well, 2 m water depth. Dug 1979, and suffering from severe caving,
Performance:	Pumped dry in 30 mins, recovers within 6 h. Pumped two times per day.
Major problem:	Very severe caving. Low yield/slow recovery
Structure 2:	Submerged, wood lined well in river-bed constructed in 1984. depth 4 m.
Performance:	Pumped 5 (five) times per day. Each pumping sequence lasts for 1.5 h followed by a one hour recovery period.
Conductivity	
Pump:	Same as structure 1
Major problem:	Protection of pump against floods.
Recommendation:	Abandon well no 1 and install permanent suction pipe for well no 2, reaching safe pump position inland . In a few years the wood lining of well no 2 is likely to collapse due to aging. Before this actually happens a new submerged RC-ring well in the river-bed should be constructed as to avoid break in irrigation.

AMUD visited June 7th and June 8th.

1: HUSSEIN NUUR RIALE.

Structure: 8 m deep pilot well, 1 m dia in river sediment and red clay at bottom level. Well was kept dry by 4 men with buckets while digging, which is indicative of low yield.
Performance: Never pumped.
Pump: None
Major problem: Low yield during construction.
Recommendation: Testpump well after completetion to determine potential yield of well, and decide on this basis.

2: ABDI AHMED FAHIYEH.

Structure: 6*4 m 20 m deep well, suffering from aquifer caving (red clay !!). Water depth 2 m. 1974.
Performance: Pumped dry in 20 mins, recovers within 6 h. Pumped 2 times per day
Pump: 3.5 HP Honda petrol.
Major problem: Low yield, aquifer caving.
Recommendation: The yield of the well should be improved by deepening of well before decission is taken on improvement of wall stability.

3: ABRAHAMAN HUSSEIN ARRIH.

Structure: 4 m dia well right on the riverbank. 7 m deep, 2 m water depth.
Performance: Pumped dry in 20 mins, recovers over the night
Pump: Lombardini Diesel
Major problem: Low yield.
Recommendation: Installation of gallery in river-bed.

4: BARKHAD OMER H. KHAYRE.

Structure: 5 m dia unlined well dug 1981. Sides seem fairly stable.
Performance: Pumped dry in 20 mins, recovers within 6 h. Pumped 2 times per day.
Pump: 3.5 HP Honda.
Major problem: Insufficient yield for extension
Recommendation: Deepening to increase both storage capacity and infiltration capacity. If this is not sufficient it is recommended to dig RC-ring

well in river-bed.

5: OMER OSMAN YABEH.

Structures:	The farm has 3 wells of which 2 runs dry during dry season. Reportedly these wells were never dry before 1980. The third well has excelent water both in quantity and quality all the year.
Performance:	Pumped dry in 20 mins, recovers within 20 mins.
Conductivity	300 microsiemens/cm.
Pump:	Yanmar TS70
Major problem:	Some surface caving.
Recommendation:	Abandon the 2 old wells and improve the new well by deepening/screening/gravel pack/lining.

6: EGEH HABANE RAGE.

Structure 1:	3 m diam inland well, dug 1966, 7 m deep, water depth 2 m.
Performance:	Pumped dry in 1 h, recovers within 1 h. Pumped 4 times per day.
Pump:	Honda 5 HP, 1100 l/min, 28 m.
Major problem:	Aquifer caving.
Recommendation:	Install RC-rings in bottom and deepen as required to maintain or improve yield.
Structure 2:	Well under construction.
Recommendation:	Continue construction and proceed according to conditions met. It is likely that well will need RC-rings in aquifer to obtain sufficient stability.

7: BARKHAD ADAN.

Structure 1:	4 m diam unlined well 8 m deep, dug in 1985.
Performance:	Pumped dry in 30 mins, recovers within 5-6 h. Pumped 2 times per day
Pump:	Yanmar TS70
Major problem:	Caving and low yield.
Structure 2:	6-8 m diam well.
Performance:	Pumped dry in 30 mins., recovers within 5 h.
Pump:	KOBOTA DIESEL, 251 USGPM/42 ft.
Major problem:	Low yield/slow recovery.
Recommendation:	New RC-ring well in river-bed, if required provided with infiltration galleries.

8: FARAH WABERI HUFANE.

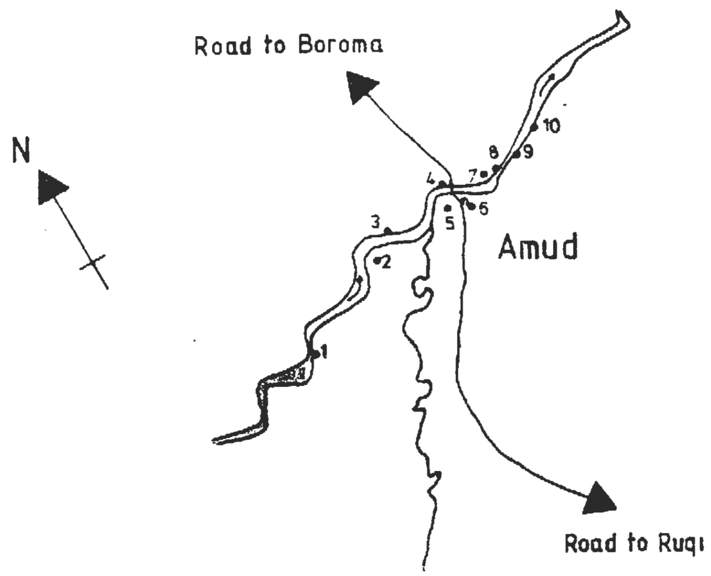
Structure 1:	6 m dia well dug in 1952, 10 m deep, 1 m water depth.
Performance:	Pumped dry in 50 mins, recovers over the night.
Pump:	Yanmar TS70
Major problem:	
Structure 2:	4 m diam well, dug 1985. (m deep, water depth 1.5 m.
Performance:	Pumped dry in 1.5 h, recovers over the night
Pump:	
Major problem:	
Recommendation:	Well 2 can be deepened by means of RC-rings to increase yield and storage capacity.

9: HUSSEIN DAHIR MOHAMED

Structure 1:	3*3 m wood lined well, 8 m deep, dug in 1983.
Performance:	Pumped dry in 0.5 h, pumped 3 times per day.
Pump:	Petter Diesel.
Major problem:	Surface-caving.
Structure 2:	6 m deep, wood lined well. 3 m water depth during rainy season.
Performance:	Pumped dry in 3 h. recovers in 15 mins during rainy season.
Pump:	Yanmar TS60
Major problem:	
Structure 3:	8 m deep well dug 1983 in gravel on top, thereafter mainly clay. Dry during dry season.
Performance:	Pumped dry in 1 h, recovers within 4-5 h (rainy season).
Pump:	Yanmar TS60
Major problem:	
Recommendation:	Replace wood lining of wells with RC-ring to improve stability. Where applicable and needed install galleries to improve yield/reduce recovery time.

10: OMAR EGEH EGAL.

Structure:	4 m deep, small diam well mainly in red clay.
Performance:	Exploited by hand, never pumped.
Pump:	None
Major problem:	Insufficient yield.
Recommendation:	New RC-ring well in river-bed, if required provided with infiltration galleries.



LEGEND

- ● Hand Dug Well
- × Borehole

North West Agricultural Development Project - Somalia	
Hydrogeological Mission Location of Wells and Boreholes Area: Amud	1:50.000 May-June 198
DARUDEC	

RUQI-BAKI AREA visited May 16th to 21st

Ruqi-Baki area is situated in a downthrusted area between high mountain ranges. The deep substratum of this area consists of Jurasic Limestone, which at least in some areas is likely to have been tectonically disturbed, presumably giving rise to water bearing fracture-zones. The limestone aquifer is likely to be recharged both locally through the younger sedimentary sequence on its top and maybe even more important from the large mountaneous areas to the south.

Despite the fact that less than 3 m of this limestone were penetrated by drilling during the former feasibility study, it was then concluded that the limestone is not important as an aquifer in the area. Recent drilling in the area has, however, produced medium to high yielding well. The hydro-chemical characteristics of these wells are not known, but from information given by non-technical authorities in the area, it appears that a certain salinity of the ground water might be expected. However no precise information could be gained during the investigations.

Phreatic aquifers are fairly widespread in the area, and consist of recent sandy/gravelly river sediments, in general with good yielding characteristics and no chemical constraints were observed.

The major problems observed are related to caving problems, both surface-caving and aquifer-caving, for both of which remedies can be procured by the assistance of the project.

On the lower reaches of Dibra Weine a considerable potential exists for developement of new farms. These areas have been given special signature on the accompanying map and covers an area of approximately 100 ha.
Following specific wells/farms were visited during the field trips:

1. SH. IBRAHIM BAKAL:

Structure:	Unlined well/river-intake, 1987.
Performance:	
Pump:	Old, make unknown.
Major problem:	Well and intake strongly prone to destruction from floods.
Recommendation:	Very expensive to improve this structure, therefore it should be considered to construct well adjacent to farm no 2.

2. AHMED ABDILAHI OBSIYE:

Structure:	Unlined inland well dug 1986.
Performance:	High production
Conductivity:	1035 yS/cm.
Pump:	Honda GX140/Daishin SCR 80.
Major problem:	Aquifer caving and erosion of well sides.
Recommendation:	Deepening/Screening/Lining.

3. HAGI MOHAMED SULDAN:

Structure:	Unlined well in river sediments, 6-8 m dia, formerly 3 m deeper.
Performance:	High production/good quality.
Pump:	Kubota Diesel 7 HP/YKC 3D.
Major problem:	Very severe aquifer caving.
Recommendation:	Deepening/Screening/Gravel Pack/(Lining).

4. AW SULEIMAN RAGE EGEH:

Structure:	Unlined pilot well presently under construction, app 1 m dia, 11/15 m deep, the lower 4-5 m cemented sand.
Performance:	Dry.
Pump:	None.
Major problem:	Dry.
Recommendation:	Deepening to max 20 m. If still dry: dig RC-well in river-bed according to general instructions.

5. SH ABDULAHI HADI TANNY.

Structure:	20*3*2 m seepage basin in cemented sand near river-bed, constructed 1982.
Performance:	Pumped dry in 2.5 h, recovers within 24 h.
Pump:	ROBIN EY20 5HP Petrol/DAISHIN SCL 80.
Major problem:	None
Recommendation:	If (later) required to improve the yield, the structure could be enlarged, best by deepening.

6. AHMED DUALEH OBSIYE.

Structure 1:	Inland open surface well, 4 m dia.
Performance:	Pumped dry in 3 h, recovers within 24 h.
Pump:	KUBOTA
Major problem:	Surface/aquifer caving.

Structure 2:	Irregular waterhole 6*5 m right below

	river-bank.
Performance:	Pumped dry in 5 h, recovers within 4 h, Pumped twice per day.
Pump:	PETTER 4.6 BHP
Major problem:	Caving and flooding risk.
Recommendation:	Deepening/Screening/Gravel Pack/Gallery/Lining of structure no 2

7. HASSAN ABDULAHI MOHAMED

Structure 1:	River bed well 6*12*1 m:
Performance:	Pumped dry in 3 h, recovers within 1 h.
Pump:	YANMAR TS 70
Major problem:	Too distant from garden

Structure 2:	2*2 m wood-lined well, 1983
Performance:	Pumped dry in 3 h, recovers within 2 h.
Pump:	YANMAR TS 50
Major problem:	Wood lining have an expected lifetime of some 3 years.
Recommendation:	Construction of new well near entrance of farms to serve new garden area. Expected depth 6-8 m (max. 10 m) of which 3-4 m have allready been escavater by buldozer.

8. OSMAN IBRAHIM BAHAR:

Structure 1:	Un-lined inland well constructed 1985.
Performance:	Can be pumped dry in 45 min., recovers within 30 min.
Pump:	YANMAR TS 60.
Major problem:	Some aquifer caving.
Recommendation:	Deepening/Screening/Gravel Pack/(Lining).

Structure 2:	Un-lined inland well constructed 1986.
Performance:	Can be punmped dry in 45 min., recovers within 20 min.
Pump:	YANMAR TS 60.
Major problem:	Some aquifer caving/Rain water erosion.
Recommendation:	Deepening/Screening/Gravel Pack/(Lining). Surface ditches required at structure no 2.

9. HASSAN DHINBIL:

Structure:	Un-lined well constructed right on/below

	river-bank, 5 m dia.
Performance:	Can be punmped dry in 3 h, but recovers within 2 h.
Pump:	HONDA GX1K/DAISHIN (520 lpm/32m).
Major problem:	Some aquifer caving / Surface erosion and risk of destruction with river floods.
Recommendation:	Deepening/Screening/(Gallery)/Gravel Pack/(Lining).

10. BARRE JAMA YOUSUF:

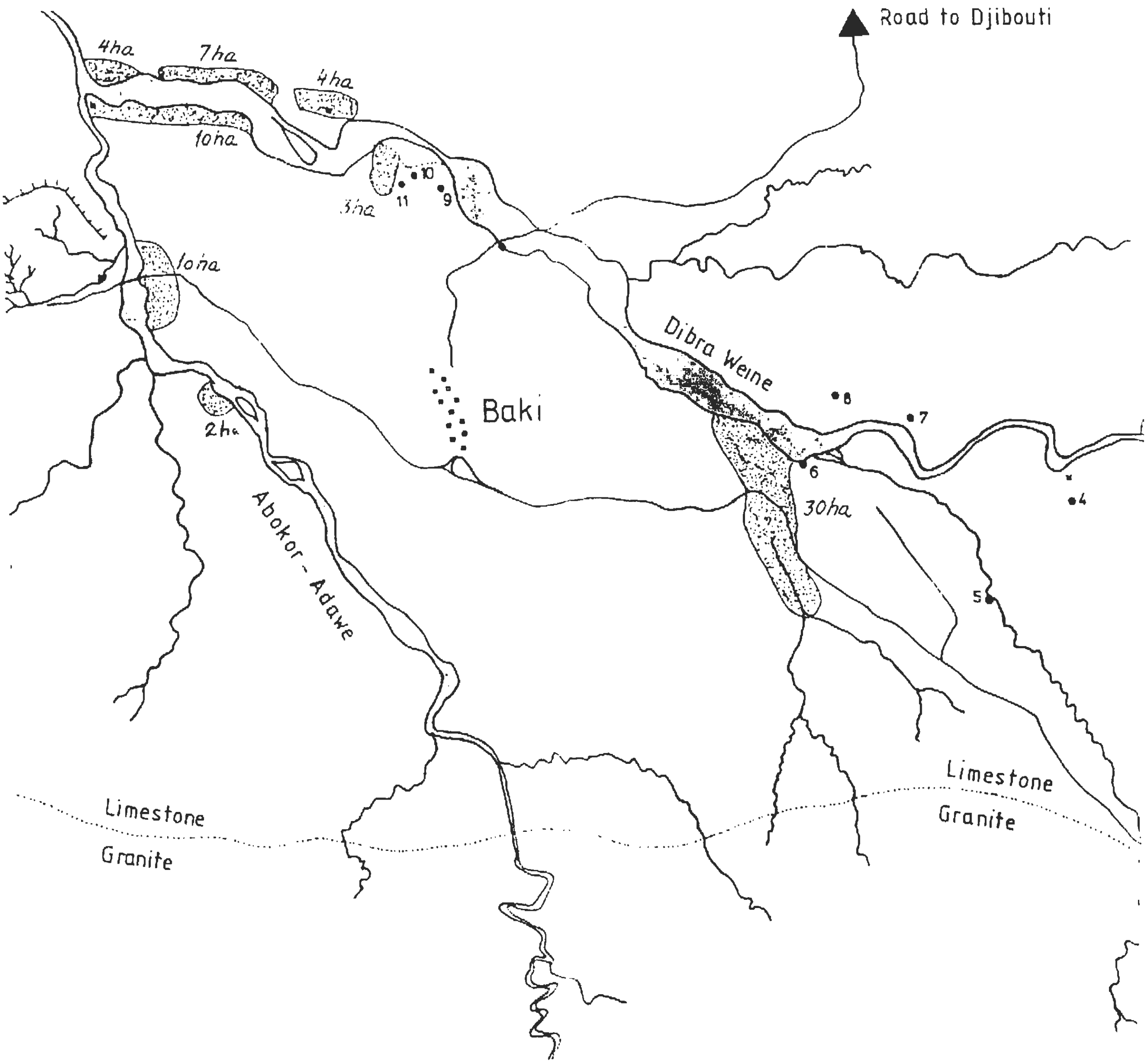
Structure:	Un-lined inland well constructed 1984.
Performance:	Can be punmped dry in 3 h, but recovers within 2 h.
Conductivity:	1000 uS/cm.
Pump:	HONDA GX1K/DAISHIN (520 lpm/32m).
Major problem:	Some aquifer caving / Surface erosion.
Recommendation:	Deepening/Screening/Gravel Pack/(Lining).

11. IBRAHIM FARAH JAMA:

Structure:	Woood-lined inland well, outer dim 6m * 6m, lining 2.5 * 2.5 m. Dug 1985.
Performance:	Can be pumped dry, but recovers within 1 h.
Pump:	KUKJE KD85 8.5 HP/PACK CHEEN 3.3 kW.
Major problem:	Some aquifer caving / Surface erosion.
Recommendation:	Deepening/Screening/Gravel Pack/(Lining)/Erosion protection.

Other exisiting wells visited during the field trip in the area near Ruqi opposite side of Dibra Weine, includes two large diam wells with a depth of nearly 20 m, which are said to be have been highly productive. These wells could be improved with respect to stability by installation of corrugated iron culvert pipes and filling the annulus with 30-60 mm gravel. To reduce the effect of reduced storage capacity of such improved wells as compared to the existing wells, the influx capacity should be improved by deepening the wells with RC-rings installed below water level. The improved wells should be supplied with either electric driven submersible sump pumps or diesel-driven shaft pumps.

Upstream of Ruqi, 3 wells on the left-hand side of the river (going downstream) were visited, all of which had problems related to stability of well slopes. All 3 wells could be improved both with respect to both yield and stability by deepening, screening, gravel pack and possibly lining of the exsisting structures. The farms on the right-hand side of the river were prone to flooding/river erosion, and are considered in-economical to protect for which reason no further action was taken.


Road to Djibouti
4ha
7ha
4ha
10ha
3ha
11
10
9
10ha
Dibra Weine
8
7
Baki
2ha
6
30ha
4
5
Abokor-Adawe
Limestone
Granite
Limestone
Granite

QABASHAAREY visited May 20th

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1. QAWRAH MUSA ELMI
2. ABDI RABEH WARSAME
3. HADI RABEH WARSAME
4. JAMA ABDI KIIRASH
5. AWALE ABDULAHI URSAD

The farms are irrigated from communal intake structure at perennial river and have a common main canal system, by which the irrigation waters are distributed. The intake structure, however, is very instable and is frequently destroyed during floods. The subsequent repair is very time consuming and it is considered ineconomical to transform the existing intake structure to a permanent one.

As a communal distribution system already exists it is recommended that a new intake structure should be constructed near the uppermost farm in the area and the water distributed from there. The intake structure should be constructed as a RC-ring well placed shortly inland of the river. The intake structure shall be supplied with one or two diesel pumps delivering their output to the existing main chanal. To obtain the required continous yield it is most likely required to construct infiltration gallery/galleries in the river-bed.

Alternatively it is most likely possible to construct individual wells on each farm with a depth of some 6 meters each.

AFARORTA visited May 20th.

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1. HUSSEIN ELMI SULDAN.
2. MUSA ELMI SULDAN
3. ALI HADDI RABEH
4. HASSAN AWALE FARAH
5. ELMI AYEH DHIDAR
6. AW IBRAHIM ABDIN KIIRASH
7. OSMAN YUSUF CRYEH
8. ARAB ABDULAHI AMUD
9. ADEN SHIRDON BADEED

The farms are (were) irrigated from communal intake structure at perennial river and have a common main canal system, by which the irrigation waters are distributed. The intake structure, however, is very instable and is frequently destroyed during floods, and was in fact destroyed effectively a few days before the field visit. It is considered in-economical to repair the previous intake structure.

As a communal distribution system already exists it is recommended that a new intake structure should be constructed near the uppermost farm in the area and the water distributed from there. The intake structure should be constructed as a RC-ring well placed shortly inland of the river. The intake structure shall be supplied with one or two diesel pumps delivering their output to the existing main chanal. To obtain the required continuous yield it is most likely required to construct infiltration gallery/galleries in the river-bed.

Alternatively it is most likely possible to construct individual wells on each farm with a depth of some 8-10 meters each, the depth likely to increase with increasing distance from the river.

One existing farm (ABDILLAHI GEELE BAAB) further downstream was visited and the requirements for assistance were investigated. Unfortunately the owner of the farm was not present, thus no exact information could be obtained. It can, however, be recommended to build a permanent pumped intake structure at the river bank, excavating the pump sump into solid rock.

GEBELEY visited June 6th.

1: H. OMER MOHAMED GEEDi.

Structure:	2 year old well, presently under reconstruction due to frequent collapsing. 14 m deep, 8 m diam, 4 m water level during rainy season 1 m during dry season. Aquifer is weathered granitic/gneissic bedrock. Extremely expensive and impressive structure.
Performance:	Never pumped, but during construction 2 men could haul the excess water by hand.
Conductivity	Reportedly sweet water.
Pump:	None
Major problem:	Low yield.
Recommendation:	The only possible way of improvement is to deepen the well to increase both storage capacity and infiltration capacity. Farmer is perepared to do so. Farmer may need other types of assistance, eg pump, pipes and technical assistance.

ELGINIS visited June 6th.

1: IBRAHIM AW ALI ELMI.

Structure:	5*4 m, 8 m deep, of which 4 m are in weathered/fractured crystalline shist.
Performance:	Reportedly the farmer can pump 24 h per day. Actually pumped 3 h/day, recovers within 2 h during rainy season. Well is dry for 2 months per. year.
Conductivity:	Reportedly the water is sweet.
Pump:	Honda Petrol, broken.
Major problem:	Dry during dry season, over-land floods destroy occasionally the well, lack of pump and pipes.
Recommendation:	Well should be deepened 2-3 m to become perennial and needs protection against overland floods (e.g. bund/diversion ditches). Pump and pipes are needed, and farmer needs general technical assistance.

2: ABDI RAGE WAIS.

Structure:	10 m deep, water depth 2 m. Bottom part of well is cut in crystalline shist.
Performance:	Pumped dry in 75 min, recovers within 4 h. Pumped 2 times per day.
Pump:	Old Italian petrol pump, presently broken down.
Major problem:	Pump.
Recommendation:	New pump.

3: MOHAMED HUDUN KAHIN

Structure:	Spring intake in river-bed, just below shallow falls.
Performance:	Sufficient water.
Conductivity	760 microsiemens/cm.
Pump:	Old Italian pump.
Major problem:	
Recommendation:	New RC-ring well in river-bed at location of spring. If required it could be provided with infiltration galleries. New pump.

Some 10 farms further downstream of farm 3 could be rehabilitated by installation of RC-ring wells at spring locations in river-bed.

The general problem in this area seems to be broken pumps, lack of pipes and general technical assistance. Farmers seem to be fairly 'aggressive' and willing/wanting to go improve their farms and structures.

HULLUQ visited June 3rd

1: AHMED DAHIR OMAR

Structure 1: 6" steel-cased borehole drilled 1984. Depht 150 ft. The well has been pumping sand since 1986.
Performance:
Conductivity Reportedly sweeter than well 2.
Pump: Submersible electric, make unknown.
Major problem: The well is pumping sand since 1986, screen (slotted casing) is probably corroded. Pump is stuck in the borehole.

Structure 2: 8" PVC-cased borehole further inland, Depht 150 ft.
Performance: Reportedly unlimited pumping is possible. Actual pumping is 8 h per day.
Conductivity 1725 microsiemens/cm.
Pump: Unknown submersible electric pump.
Major problem: Salinity (too) high

Recommendation: Withdraw pump of well no 1. If possible install new 5" PVC screen in borehole (wash down screen). Closer check up on salinity of well no 2 with respect to composition of salts.

2: HASSAN YUSUF ALI.

Structure: 12 m dia open, wood lined well, 18 m deep. Lower part in Malas (white Clay). 25 m inland. Dug 1986.
Performance: Pumped dry in 2 h, recovers within 6 h.
Conductivity Reportedly sweet.
Pump: Bernhard Petrol
Major problem: Insufficient yield.
Recommendation: It is ineconomical to improve the existing well, lifetime of wood lining will be some 3 years. Before the well collapses a new RC-ring well should be constructed in river-bed to superseede the existing well.

3: AW MOHAMED WARSAME GEELEH.

Structure: Semicircular 6 m dia wood lined well, 50 m

	inland. 20 m deep with Malas from 3 m depht.
Performance:	Pumped dry in 1 hour, recovers over the night.
Conductivity	Reportedly sweet.
Pump:	Bernhard Petrol
Major problem:	Insufficient yield.
Recommendation:	New RC-ring well in river-bed, if required provided with infiltration galleries.

4: NUUH BATUN GEELEH.

Structure:	Concrete lined 18 m deep well, water level 1.5 m, right off the bank of the river.
Performance:	Pumped dry in 40 mins, recovers within 6 h.
Conductivity	Reportedly sweet.
Pump:	Yanmar TS70
Major problem:	Insufficient yield/Long recovery time.
Recommendation:	Install gallery in river-bed.

5: OSMAN ASHUR HASSAN

Structure:	4*4 m stone/cement lined, 15 years old well, 18 m deep of which lower 12 m are in white clay, 2 m water depht.
Performance:	Pumped twice per day, each time 2 h, recovery within 6 h.
Conductivity	Reportedly sweet.
Pump:	Yanmar TS60
Major problem:	Insufficient yield.
Recommendation:	New RC-ring well in river-bed, if required provided with infiltration galleries.

6: ABDULAHI ALIN GULLED

Structure:	3*2 m wood lined well, 14 m deep.
Performance:	Owner not present, so no information available.
Conductivity	
Pump:	Yanmar TS50
Major problem:	
Recommendation:	

7: MUSA ALIN GULEED

Structure:	3*6 m well, 10 m deep, dug 1986, 1 m water depht.
Performance:	Pumped dry in 20 mins, recovers within 6 h.
Pump:	Small FORD engine.
Major problem:	Insufficient yield.
Recommendation:	Install gallery in river-bed.

8: MUSA KINAR SUGAL

Structure:	5 m dia wood lined well, dug 1980, depht 10 m, 2 m water depht. White clay in bottom of well.
Performance:	Pumped twice a day, each time 1 hour duration. Full recovery after 6 h.
Pump:	Yanmar TS60
Major problem:	
Recommendation:	Gallery can be installed in river-bed to improve yield.

9: ALI DAHLEH XERGEEYEH

Structure:	Circular wood lined well, 15 years old. 18 m depht, all in white clay. 1 m water depht.
Performance:	Pumped dry in 30 mins, recovers over the night.
Pump:	
Major problem:	The yield of the well is too small.
Recommendation:	Install gallery in river-bed to improve yield.

10: AW YUSUF ALI HAREED.

Structure:	5*5 m well, 15 years old, 10 m depht.
Performance:	Pumped a total of 2.5 h each day, recovers over the night.
Pump:	KUKJE 85
Major problem:	No problems related to water supply.
Recommendation:	None

11: YUSUF ADAN HUSSEIN.

Structure:	Well 'dug' in metamorphic rock, 3 m deep. Well is dry during dry season.
Performance:	During rainy season pumped 1.5 h per day, recovers over the night.
Pump:	HONDA 1100 l/min, 28 m head.
Major problem:	No water during dry season.
Recommendation:	Deepening of well by means of explosives and or labour-intensive methods. Low dam possible downstream to increase dry season storage/water level.

REPORT on HYDROGEOLOGY and WELLS

ARABSIYO visited June 3rd and June 8th

1: ADEN MOHAMED OLOW

Structure:	Open uncased well right on river-bank, 3*8 m, 8 m depht, water depht 4 m. Dug 1981.
Performance:	Pumped twice per day for 3 h each time. Recovery within 4 h.
Conductivity:	970 microsiemens/cm
Pump:	Aged Bernhard with 2" delivery pipes.
Major problem:	Some caving, well capacity too small for planned expansion of farm.
Recommendation:	Gallery to be installed to increase capacity. Farmer might need more powerfull pump and new larger pipes to reduce head losses to be able to irrigate new, somewhat remote area.

2: MOHAMED SH. ABDULAHI.

Structure:	8 m dia well near river-bed. 5 m depht, water depht .5 m. First constructed 1983, improved by installation of galleries 1985. According to owner the galleries were not installed in a correct manner.
Performance:	Before gallery: 50 mins pumping followed by 2 day's recovery. After gallery: 1 hour pumping followed by recovery over the night.
Conductivity	1015 microsiemens/cm
Pump:	
Major problem:	Caving and slow recovery.
Recommendation:	Caving protection on slopes by planting grass. Installation of new galleries.

3: HUSSEIN GELEE ALI.

Structure:	Well dug in weathered bedrock, 1 m deep.
Performance:	
Conductivity	
Pump:	
Major problem:	
Recommendation:	The present structure is of very limited value. If a real need exist, the possibilities for well digging should be carefully investigated, as bedrock outcrops are abundant. Existing well may be deepened or more convinient location in river-bed may be chosen.

4: ABDI AW FARAH

Structure:	Temporary river-bed well.
Performance:	Sufficient water.
Conductivity	
Pump:	
Major problem:	
Recommendation:	New RC-ring well in river-bed, if required provided with infiltration galleries.

AGAMSD visited June 3rd and June 8th

General: Water quality seems to vary very strongly and random over the area. This aspect needs better coverage than could be provided during mission before major extension of irrigation schemes.

1: MOWLID ABDULAHI

Structure:	Well on island in river. Wood lined 4 m dia, 10 m deep, 4 m water depht.
Performance:	According to owner sufficient water of good quality can be withdrawn from well.
Conductivity	1600 microsiemens/cm (1987-06-03); 2250 microsiemens/cm (1987-06-08)
Pump:	Swati Enterprise 5hp
Major problem:	The well suffers from severe caving and the island on whish the well is situated is prone to river erosion. Furthermore the owner seems to overexploit the well by selling large quantities for drinking water.
Recommendation:	Caving protection by installation of RC-rings in bottom and grass on the slopes. Gabion protection of upstream end of island. Owner should be encouraged/enforced not to overexploit the well.

2: AW MUSA YUSUF BILE.

Structure:	8 m dia uncased well, right on the river-bank. 7 m depht, 4 m water depht. Dug 1986.
Performance:	Pumped twice per day for 4 h each time. Sufficient water
Conductivity	370 microsiemens/cm.
Pump:	
Major problem:	Severe caving.
Recommendation:	Slopes to be stabilized by heavy grass. Aquifer be be stabilised by large diam culvert pipes or RC-rings.

3: MAHDI JAMA SHIREH.

Structure:	5 m deep well in clayey sand soil.
Performance:	Pumped for 2 h twice per day, recovery within 2 h.
Pump:	Bernhard.
Major problem:	Insufficient yield.

Recommendation: Deepening using RC rings, screening with RC-rings and gravel pack. Gallery should be installed if required after deepening.

4: MOHAMED OMAR BILE

Structures: 2 wells, both temporary dry season structures, flushed during rainy season. One (upstream) is 4 m deep and has not hit rock, the other one (downstream) is only 3 m deep and has hit rock at this depht, and is dry at end of dry season.

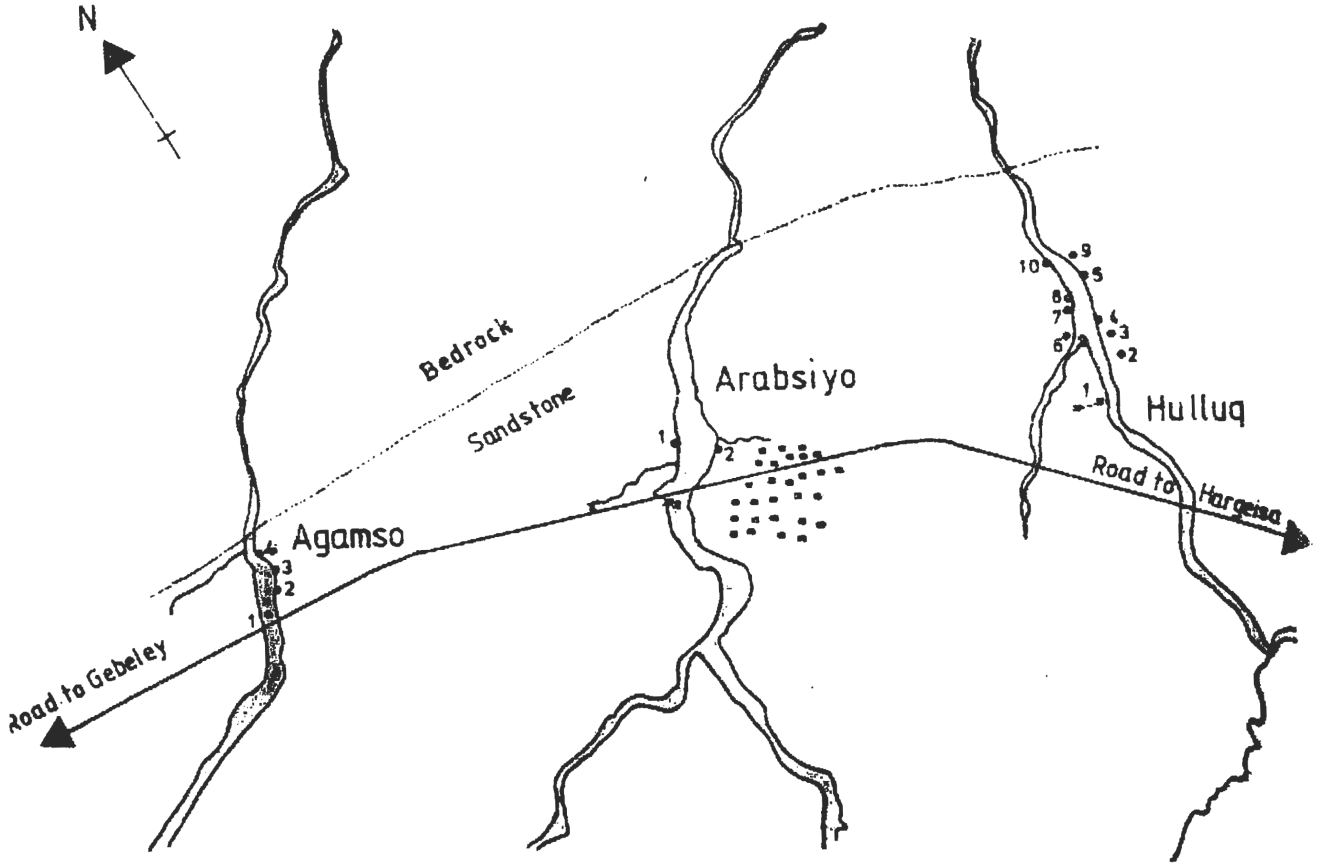
Performance: No informations as owner was not present.

Conductivity: 550 microsiemens/cm.

Pump:

Major problem: Non-permanent.

Recommendation: New RC-ring well in river-bed at location of first well, if required provided with infiltration galleries.



LEGEND

- ● Hand Dug Well
- × Borehole
- ▪ Population Center

North West Agricultural Development Project - Somalia	
Hydrogeological Mission Location of Wells and Boreholes Area: Agamso - Arabsiyo - Hulluq	Scale 1:50.000 Date May-June 198?
DARUDEC DANISH RURAL DEVELOPMENT CONSULTANTS	

ANNAYO visited on June 4th

1: JAMA MUSA DUALEH.

Structure:	10 m dia, 24 m deep pilot well dug in 1984 - now partly caved in. The well has never been proven productive, but farmer believes in water further down. Farmer estimated cost of redigging to SS 200.000.
Recommendation:	See below.

2: AHMED HUSSEIN EGAL.

Structure:	3*3 m uncased well, 16 m deep, dug in 1985. water depth 2 m. Protected on the riverside by stone macenory.
Performance:	Pumped twice per day, each time for 45 mins. Recovery within 8 h.
Pump:	Yanmar TS60
Recommendation:	See below.

3: IBRAHIM ABDULAHI ADAN.

Structure:	12 m deep irrigular well dug 1983, mainly white and red clay. Dry season water depth: 1 m.
Performance:	Pumped dry in 15-20 mins, recovers within 2 days.
Pump:	Robin EY14 3.5 HP petrol engine 530 l/min, 25 m max head.
Major problem:	Insufficient capacity.
Recommendation:	See below.

4: MOHAMED ELMI ALIN

Structure:	10 m deep semicircular 5 m dia well dug 1979, suffering from strong surface caving.
Performance:	Dry in dry season, water depth in rainy season amounts to some 4 m.
Pump:	
Major Problem:	No water in dry season.
Recommendation:	See below.

5: MAHAMOUD ELMI ALIN.

Structure: 14 m deep irregular inland well mainly in clays, lower 3 m strongly caving in heavily weathered granitic rock.
Performance: Presently dry.
Pump:
Major problem: No water.
Recommendation: Deepening with the aid of RC-rings to reach mechanicaly weathered bedrock. See below.

6: MAHAMED ABDULAHI ADAN.

Structure: Semi permanent river-bed well. constructed 1972. 3*5 m, 12 m deep. Top layers: 2 m sand, 0.5 m white clay. Aquifer: fractured/weathered gneiss. Water depth 10 m throughout the year.
Performance: Pumped dry in 2 h, recovers within 2 h.
Pump: Yanmar TS80
Major problem: Due to lack of lid, the well is filled in with sand during floods.
Recommendation: Construction of RC-lid as shown in drawing.

7: MOHAMED OSMAN ADAN.

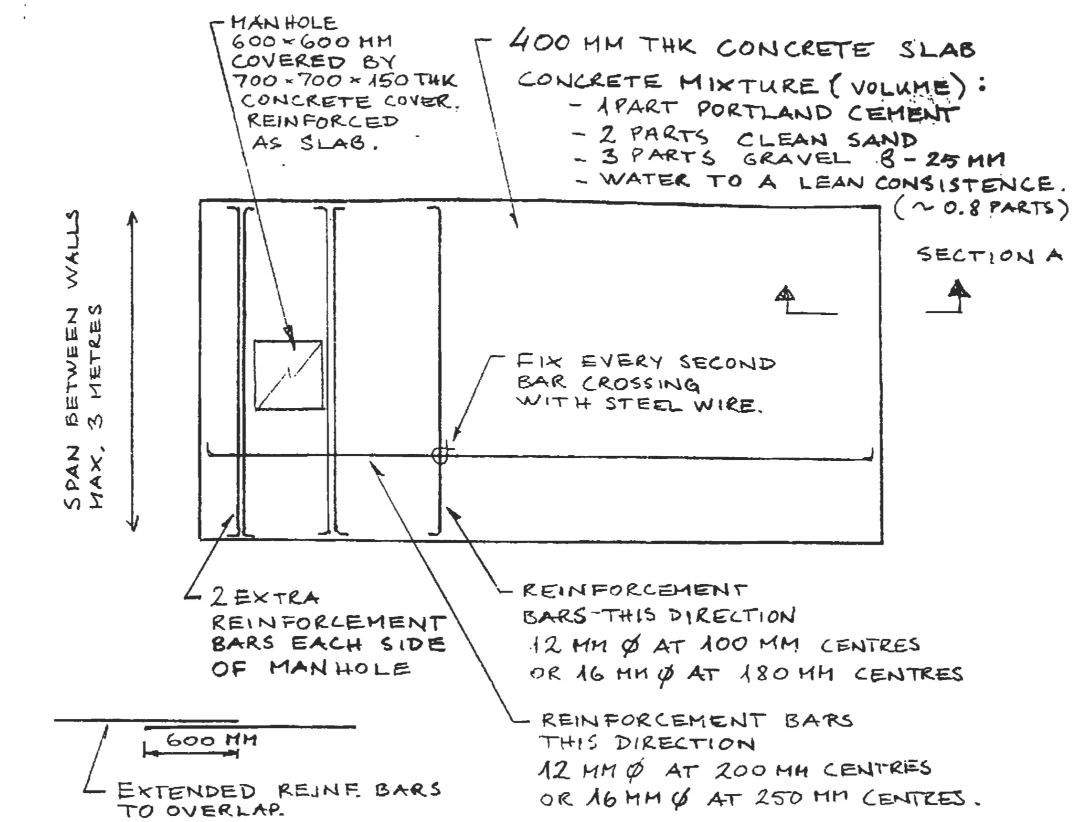
Structure: River bed wellnear the bank, 4 m deep, dug 1976. Prone to flooding. Water level drops by 1 m during dry season.
Performance: Pumped dry in 1 h, recovers within 2-3 h.
Pump: Bernhard.
Major problem:
Recommendation: Install river-bed gallery to improve yield (reduce recovery time) and possibly install RC-rings to improve stability.

8: MOHAMED ABDULAHI AHMED.

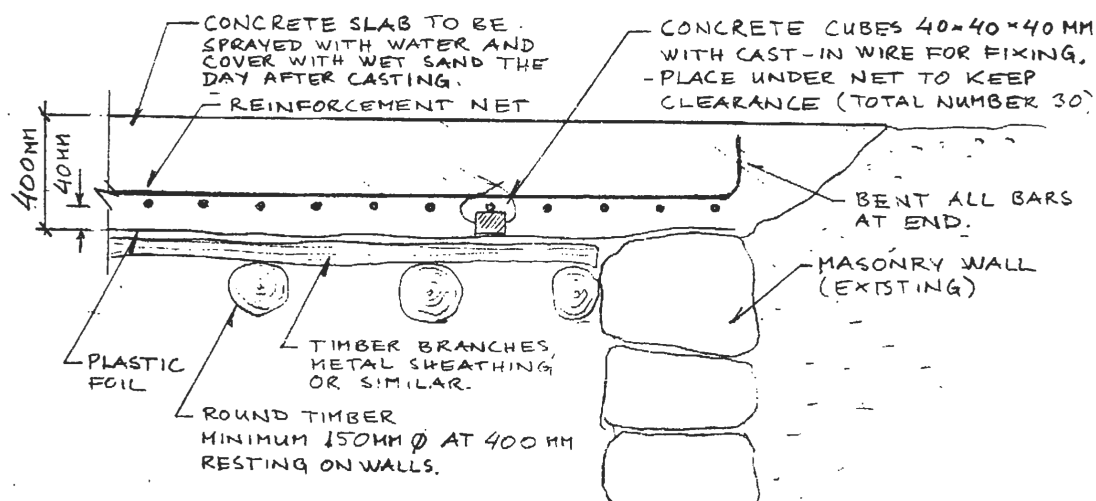
Structure: 5 m diam well, 8 m deep, 1 m water depth, Hard bed-rock at bottom.
Performance: Pumped dry in 40 mins, recovers within 3 h. Pumped twice per day.
Pump: HONDA Petrol pump.
Major problem: Long recovery time.
Recommendation: Install gallery in river-bed.

9: ELMI HANDULE JAMAK.

Structure: Stone lined river-bed bed 6 m deep well, aquifer: river sand and weathered/fractured gneiss. Constructed 1984.



PLAN 1:50



SECTION A 1:20

MATERIAL QUANTITIES:

CEMENT 3000 KG

REINF. 340 KG

(350 METRES 12 ∅ OR

CONCRETE COVER

FOR 3 × 5 M WELL OPENING

DARUDEC

Performance: Pumped dry in 1 h, recovers within 15 h.
Pump: Honda TX110 Petrol 3.5 HP.
Major problem: Slow recovery.
Recommendation: Install galleries to reduce recovery time.

10: SULEIMAN ADAN NOOR.

Structure: Irregular inland well dug 1983. 8 m deep.
Performance: Pumped dry in 2 h, recovers over the night.
Pump: Yanmar TS50
Major problem: Long recovery time and some tp caving.
Recommendation: Caving protection in top, alternatively construction of river-bed well similar to 6 and 9.

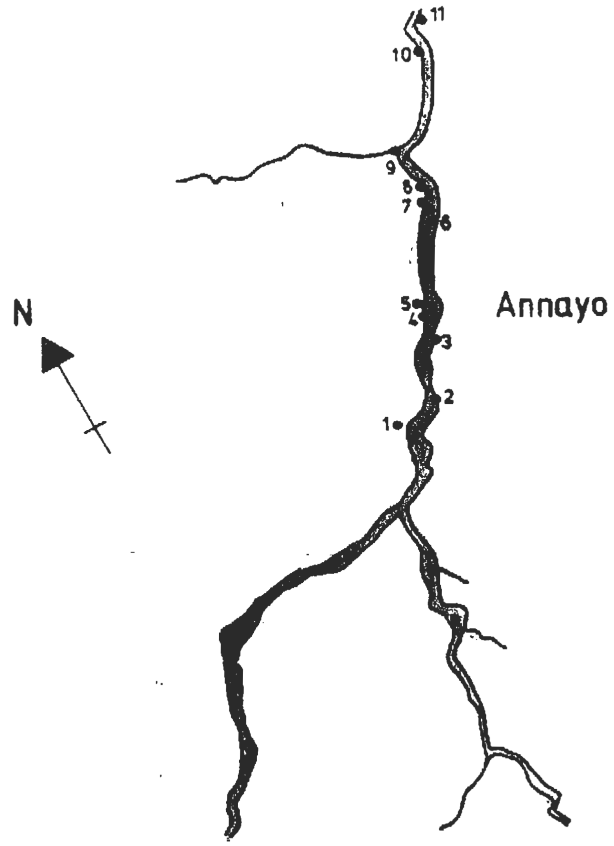
11: ALI ABDULAHI NALAYEH.

Structure: River bank well cut in hard rock, constructed 1985, 6 m deep. Presently 3 m water depth, which drops by 1 m during dry season.
Performance: Pumped dry in 1 h, recovers over the night.
Pump: Chineese 82 cu.m./h, total head 6 m.
Major problem: long recovery time.
Recommendation: Deepening and or enlarging.

In the upper reaches of the river (1-4) all wells are dug inland in clay. Some of these wells suffers severely from caving and none of the wells have reasonanble yields, mainly due to slow recovery.

In this upper area no serious efforts seems to have been made to dig river-bed wells. Farmers believe in general that water can be reached below the clay, but it was not possible to relieve the background for this belief, which may in fact be true or false.

For the upper reaches it is recommended to dig wells in the river-bed, starting from farm no 4 going gradually upstream to investigate this possibility. In the lower reaches, submerged river-bed wells are recommended.



LEGEND:

- ● Hand Dug Well
- × Borehole

North West Agricultural Development Project - Somalia

Hydrogeological Mission Location of Wells and Boreholes Area: Annayo	Scale 1:50.000 Date May-June 198

DARUDEC

MALUGTA vistited May 31st/June 1st

1: MAHAMOUD IBRAHIM AHMED

Structure:	Actually redigging 8 m. deep well in river-bed, first constructed 1986, but destroyed during first flood in 1987. Water depth 1.5 m..
Performance:	Pumped dry in 2 h, recovers within 1 h - major recovery occurs from bottom in weathered bedrock.
Pump:	Yanmar TS60.
Major problem:	Caving, and destruction during floods.
Recommendation:	New RC-ring well at this location possibly supplied with gallery pipe(s).

2: HASSAN IBRAHIM FARAH.

Structure:	10 m. deep with 3 m. water depth in river-bed.
Performance:	Pumped dry in 1 h, recovers within 4 h.
Pump:	Yanmar TS60.
Major problem:	Caving, and destruction during floods.
Recommendation:	New RC-ring well, probably with gallery pipes.

3: ABDI EGEH ALI.

Structure:	7 m. deep well in river-bed, 2 m. water depth. First constructed 1971, flooded every year.
Performance:	Pumped dry in 1 h, recovers within 30 mins.
Pump:	Yanmar TS60.
Major problem:	Caving, and destruction during floods.
Recommendation:	New RC-ring well, possibly with Gallery pipes.

4: MOHAMMED HIRSI WAIS

Structure:	River bed well; normally destroyed every year by floods.
Performance:	Pumped dry in 2.5 h, recovers within 30 mins.
Pump:	Yanmar TS60
Major problem:	Destruction by floods
Recommendation:	New RC-ring well at same location, if required with pipe gallery.

5: JIBRIL ALI FARAH

Structure 1:	Temporary river-bed well, 2.5 m. deep, 1 m. water depth.
Performance:	Pumped dry in 45 mins, recovers within 3 h.
Pump:	Yanmar TS70
Major problem:	Destruction during floods

Structure 2:	Inland well, 6 m. deep, mainly in red clay, dry during dry season.
Performance:	Pumped dry in 2 h, recovers within 3 h during rainy season.
Pump:	Yanmar TS70
Major problem:	No production during last part of dry season.

Recommendation:	Abandon inland well after construction and testrunning of permanent river-bed well with RC-ring system including gallery pipes.

6: OSMANN MOHAMMED KARIYE

Structure:	Well in river-bed, now destroyed. Original depth 5 m..
Performance:	Pumped dry in 1 h, recovers within 1.5 h.
Pump:	Indian Petter Pump, 6.25 BHP
Major problem:	Frequent destruction during floods.
Recommendation:	New Permanent RC-ring well in river-bed, possibly supplied with gallery pipes.

7: HAYBE MOHAMED SHIRWAC

Structure:	Destroyed river-bed well.
Performance:	Pumped dry in 1 h, recovers within 1.5 h.
Pump:	Yanmar TS60
Major problem:	Frequently destroyed during floods.
Recommendation:	New Permanent RC-ring well in river-bed possibly supplied with galiery pipes.

008: DAMSITE

9: ALI WARSAME QADUN

Structure: Destroyed river-bed well. Originally 4 m. deep, 1 m. water depth.
Performance: Pumped dry in 2 h, recovers within 6 h.
Pump: Yanmar TS60
Major problem: Flood destruction.
Recommendation: New Permanent RC-ring well in river-bed, possibly supplied with gallery pipes.

10: ABDULAHI FARAH JIREH.

Structure: Temporary river-bed well.
Performance: Pumped dry in 4 h, recovers within 6 h.
Major problem: River flooding.
Recommendation: New Permanent RC-ring well in river-bed probably supplied with gallery pipes.

11: HASSAN SAMATAR JAMA

Structure: 2 irrigular wells at the river-bank, protected against river erosin by self-made gabions
Performance: Pumped dry in 2+1 h, recovers within 5 h.
Pump: Elder 3.67 kW diesel pump common to both wells.
Major problem: Surface caving and long suction lines.
Recommendation: Protection against surface caving by planting grasses on the banks and by leveling of the debris from well digging/redigging. Shortening of suction lines.

12: IBRAHIM OLHAYEH DIRIXIH:

Structure: Inland large diam. well, 4 m. deep, 1 m. water level at end of dry season. Rock is struck at bottom of well.
Performance: Pumped dry in 1 h, recovers within 4 h.
Pump: Yanmar TS60
Major problem: Long recovery time.
Recommendation: New Permanent RC-ring well in river-bed possibly supplied with gallery pipes.

13: HASSAN ESSA YASSIN:

Structure:	Inland small diam. well, strongly caving.
Performance:	No pump exists, therefore no infos available.
Recommendation:	New Permanent RC-ring well in river-bed possibly supplied with gallery pipes.

14: HUSSEIN NOOR QADUN:

Structure:	Inland medium diam. well, strongly caving.
Performance:	Pumped dry in 40 mins, recovers within 20 mins.
Pump:	Bernhard petrol pump.
Major problem:	Caving and short pumping times (low yield).
Recommendation:	New Permanent RC-ring well in river-bed possibly supplied with gallery pipes.

15: DAHIR HUSSEIN MOHAMED.

Structure:	River bed well, semipermanent, 4 m. deep, 2 m. water depth.
Performance:	Pumped dry in 2 h, recovers within 2 h.
Pump:	Yanmar TS60
Major problem:	Caving/flooding risk
Recommendation:	New Permanent RC-ring well in river-bed, if required supplied with gallery pipes.

16: ALI MOHAMED BAHANAN

Structure:	River bed well, 4 m. deep, water depth 2 m..
Performance:	Pumped dry in 2 h, recovers within 0.5 h.
Pump:	Villiers petrol/kerosene engine/ TEXMO pump
Major problem:	Non-permanancy.
Recommendation:	New permanent RC-ring well in river-bed, if required supplied with gallery pipes.

17: MOHAMED ABDI GELEH.

Structure 1:	Irregular inland well.
Performance:	Rainy season: 2 h pumping followed by recvovery over the night. Dry during dry season.
Conductivity	470 microsiemens/cm
Pump:	Yanmar TS70
Major problem:	Dry during dry season.

Structure 2:	Temporary dry-season river-bed well, 6*6 m., 6 m. deep, water depth 1 m..
Performance:	Pumped dry in 1 h, recovers within 6 h.
Pump:	Yanmar TS70

Major problem:	Temporary well.
Recommendation:	New Permanent RC-ring well in river-bed probably supplied with gallery pipes.

18: MOHAMED HUSSEIN.

Structure 1:	Inland well 4 m. deep, 1 m. water depth.
Performance:	Pumped dry in 1 h, recovers within 6 h.
Pump:	Yanmar TS70
Major problem:	Long recovery time.
Structure 2:	Temporary river-bed well, 3 m. deep.
Performance:	Pumped dry in 2 h, recovers within 2 h.
Pump:	Yanmar TS70.
Major problem:	Non-permanent
Recommendation:	New Permanent RC-ring well in river-bed loacated at structure 2, if required supplied with gallery pipes.

19: SOULEIMAN ADAN.

Structure 1:	Inland well, 3 m. deep.
Performance:	Rainy season: Pumped dry in 1.5 h, recovers within 6 h.
Pump:	Yanmar TS60
Major problem:	No production during dry season.
Structure 2:	Temporary, dry-season river-bed well, 3 m. deep, 0.5 m. water depth.
Performance:	Pumped dry in 40 mins, recovers within 5 h.
Pump:	Yanmar TS60.
Major problem:	Non-permanent.
Recommendation:	New Permanent RC-ring well in river-bed, probably some 5 m. deep, and supplied with gallery pipes.

20: HAJI SOLEIMAN ADAN.

Structures:	Owner not present, but reportedly same system as no 19 with one inland well, which is unproductive during dry season and one temporary river-bed well which is detoriated

	during 1st floood each year.
Performance:	see 19) above
Pump:	Yanmar
Major problem:	see 19) above
Recommendation:	New Permanent RC-ring well in river-bed, if required supplied with gallery pipes.

21: HAJI IBRAHIM HUSSEIN FARAH.

Structure:	Two interconnected irregular circular water holes, constructed 1973.
Performance:	Pumped dry in 3+1 h, recovers overnight. Farmer consideres the yield to be sufficient.
Pump:	Yanmar TS60
Major problem:	Surface caving.
Recommendation:	Caving protection by grasses.

22: MOHAMED OMAR HASHI

Structure:	10 m dia irregular waterhole. No infos available as owner was not present.
Recommendation:	If required to improve capacity of well, galleries in river-bed could be installed.

23: SH. MUSA GALELI.

Structure:	River bed sump.
Performance:	Pumped dry in 1 h, recovers within 2 h.
Pump:	KUKJE 120.
Major problem:	
Recommendation:	Construction of new permanent RC-ring well in river-bed, if required supplied with gallery pipes.

24: MUSA HAJI GABAAX

Structure:	7 m. deep well, previously suffering from severe caving, which problem has been cured by the owner by construction of lining in local matererials.
Performance:	Pumped dry in 2 h, recovers within 2 h.
Pump:	Bernhard 239 B petrol pump
Major problem:	None. If later required the capacity of well could be improved by installing gallery pipe in river-bed.

GERDEBERE visit June 11th.

1: AHMED YUSUF BAH.

Structure:	Temporary river-bed well, frequently flooded. 2.5 m deep, 6-7 m diam, .5 m water depth. Previous inland well with 'hard' water has been abandoned.
Performance:	Pumped dry in 2 h, recovers within 2.5 h. Pumped 2 times per day.
Conductivity	5700 microsiemens/cm.!!!!!
Pump:	Yanmar TS 70
Major problem:	Very high salinity.
Recommendation:	Investigate composition of salts to decide on future efforts.

2: MOHAMED YUSUF BUH.

Structure:	Circular well in sand near river. 6 m deep, water depth 2 m. Recovery occurs manily from bottom, consisting of weathered basalt.
Performance:	Pumped dry in 1.5 h, recovers within 1.5-2 h. Pumped 4 times per day.
Conductivity	1400 microsiemens/cm.
Pump:	Bernhard
Major problem:	
Recommendation:	New RC-ring well in river-bed, if required provided with infiltration galleries. Monitor salinity.

3: ABDI HIRSI.

Structure:	3*8 m very shallow well. Recovery seems to arrive more or less directly from river-bed.
Performance:	Owner not present - no informations.
Conductivity	2800 microsiemens/cm.
Pump:	
Major problem:	Salinity.
Recommendation:	Investigate composition of salts to decide on future efforts. If feasible a new RC-ring well may be constructed in river-bed.

4: FARAH HIRSI WABARI.

Structure:	10 m diam, 1 m deep well in river-bed. Water

	depth reportedly constant around the year.
Performance:	
Conductivity	1240 microsiemens/cm.
Pump:	
Major problem:	
Recommendation:	New RC-ring well in river-bed ,if required provided with infiltration galleries. Monitor salinity.

5: MOHAMED WARSAME.

Structure:	Temporary river-bed wells.
Performance:	
Conductivity	770 microsiemens/cm.
Pump:	
Major problem:	
Recommendation:	New RC-ring well in river-bed at same location, if required provided with infiltration galleries.

6: MOHANED YUSUF ABDULAHI.

Structure:	3*3 m, 5 m deep inland well.
Performance:	Pumped dry in 2 h, recovers within 30 mins.
Conductivity	3700 microsiemens/cm.
Pump:	Bernhard
Major problem:	Salinity
Recommendation:	New RC-ring well in river-bed, if required provided with infiltration galleries.

7: BAVARKO COOPERATIVE.

Structure:	16 m deep, 6*6 m inland well. Water depth is 10 m.
Performance:	'Unlimited' yield.
Conductivity:	700 microsiemens/cm
Remark:	Informations collected to complete the description of the area.

8: ABDI HASSAN ASABLE.

Structure:	Temporary river-bed well which, has superseeded 7 (seven) inland wells, which all had saline water.
Performance:	
Conductivity	800 microsiemens/cm.
Pump:	
Major problem:	Non-permanent
Recommendation:	New RC-ring well in river-bed, if required

AGABAR visit June 11th.

1: AHMED YUSUF DIRDIR:

Structure:	5*3 m wood lined well, 10 m inland from river-bank, 6 m deep, water depth 1.5 m. Some but not severe surface caving. Red hard clay in bottom, but no basalt met.
Performance:	Pumped two times each day for a total of 2 h.
Conductivity	730 microsiemens/cm.
Pump:	Yanmar TS 50
Major problem:	
Recommendation:	Replace wood lining with RC-rings + gravel pack, gallery etc.

2: AYDID ABDULAHI SAMATAR.

Stru	3 m diam 7 m deep well, dug 1979. Red clay in bottom, completely dry in dry season.
Performance:	Dry in dry season.
Conductivity	1050 microsiemens/cm
Pump:	
Major problem:	Dry season.
Recommendation:	New RC-ring well in river-bed, if required provided with infiltration galleries.

3: ABDI ELMI KIBBAR.

Structure:	5 m wood lined inland well, dug 1975. 6 m deep, water level during dry season less than 1 m.
Performance:	Pumped dry in 15-20 mins, recovers within 30 mins. Pumped 4-5 times per day.
Conductivity	2200 microsiemens/cm.
Pump:	Yanmar TS 50
Major problem:	High salinity.
Recommendation:	New RC-ring well in river-bed, if required provided with infiltration galleries.

4: NUUH OMER HANDULEH, (Dur-Dur).

Structure:	5 m diam well in sand, 6 m deep. Suffering from surface caving.
Performance:	Pumped dry in 15 mins, pumped 4 times per day.
Conductivity	1300 microsiemens/cm.

Pump:	Yanmar TS 70.
Major problem:	Surface caving.
Recommendation:	Stabilize slopes with grass, monitor water quality.

5: MAHAMOUD OSMAN SULTAN.(Dur-Dur):

Structure:	Water hole in bed of perrinial river.
Performance:	Never dry
Conductivity	
Pump:	Bernhard
Major problem:	
Recommendation:	New RC-ring well in river-bed, if required provided with infiltration galleries. Suction lift to present pump location is too high, therefore new platform for pump. Farmer states that he needs new pump, pipes etc.

6: NUUR MOHAMED IBRAHIM.

Structure:	Inland well dug 1982, 6 m deep, strongly caving.
Performance:	Pumped dry in 40 mins., recovers within 1 h.
Conductivity	2200 microsiemens/cm.
Pump:	Bernhard
Major problem:	High salinity.
Recommendation:	As the farmer has no access to river-bed he cannot be helped to overcome salinity problem. It is likely, taht deepening the well - if possible - will increase salinity level.

7: H. OSMAN ABLI KAHIN.

Structure:	7 m deep,6 m diam inland well similar to no 6. Dug 1975.
Performance:	Pumped dry in 15 mins, recovers in less than 1 h.
Conductivity	2830 microsiemens/cm.
Pump:	Yanmar TS 70
Major problem:	High salinity.
Recommendation:	As the farmer has no access to river-bed he cannot be helped to overcome salinity problem. It is likely that deepening the well - if possible - will increase salinity level.

KALQORAY visited June 1st

1: OSMAN ASKARI

Structure 1:	10" borehole 180 ft deep, water level 170 ft.
Performance:	Pumped dry in 10 minutes
Pump:	Italian, bigger than others in area.
Major problem:	Short pumping time due to either low yield (low effeciency) and/or too exessive pumping capacity.
Structure 2:	New (1986) 10" borehole, 140 ft depth, water level 110 ft from surface.
Performance:	Unknown as not yet exploited.
Pump:	None
Recommendation:	Assist farmer to testpump wells to determine need/benefit from development of well(s) and to determine suitable size of generator set and pump(s).

2: QAMAR EGAL NOOR

Structure:	10" borehole, 140 ft deep, drilled 1983, water level 105 ft from surface.
Performance:	8 h pumping - 10 minutes recovery.
Pump:	Fairly big 6" Italian electric submersible pump driven by Bulgarian diesel generator 35 HP.
Major problem:	
Recommendation:	Determine whether pump for second borehole (1986) can be selected as to allow for simultaneous running with 1st borehole.

3: LAYLA ABOKOR

Structure:	10" borehole, 70 m deep. Drilled 1986. Owner not present so no excact informations could be provided.
Performance:	Not yet exploited, but testpumped for 17 h, yield unknown.
Recommendation:	Assist farmer to testpump well in order to determine need/benefit from developement of well and to determine suitable pumpsize and

generatorsize.

4: MICHER KAADI.

Structure:	Borehole 170 ft deep, water level 150 ft from surface.
Performance:	Pumped dry in 20 mins, recovers within 5 mins.
Pump:	Italian 6" electric submersible pump
Major problem:	Short pumping time, most likely due to need of development.
Recommendation:	Assist farmer to testpump well to determine need/benefit from development of well and to determine suitable size of generator set and pump.

5: IDRIG EGAL NUUX

Structure:	10" borehole 160 ft, water level reportedly 130 ft from surface
Performance:	Reportedly pumping is possible 24 h per day. Actual puming 8 h/day followed by recovery within 10 minutes.
Pump:	Fairly big 6" Italian electric submersible pump without nameplate driven by huge russian buildt generator set.
Major problem:	Generator is too large and consumes too much fuel. Furthermore borehole is located near a river-bank prone to erosion.
Recommendation:	Assist farmer to testpump well in order to determine need/benefit from developement of well and to determine suitable pumpsize and generatorsize.

6: ADAN JAMA ODAWA.

Structure:	8 m diam semicircular well, 8 m deep, water level 1 m. Dug in clayey soil.
Performance:	Pumped dry in 2 h, recovers within 3 h.
Conductivity:	860 microsiemens/cm.
Pump:	Yanmar TS60
Major problem:	General caving and slow recovery.
Recommendation:	Deepen well with RC-rings, fill in existing well with gravel, install lining.

7: IBRAHIM HEEF.

Structure:	Temporary dry-season well in river-bed. 6 m deep, water depth 1 m. Presently destroyed by flood.

Performance:	Pumped dry in 1 h, recovers over the night.
Pump:	Bernhard w 139 a pretrol engine
Major problem:	Flooding and slow recovery. Further, neighbouring well has shown conductivity of 8500 (eight thousand five hundred) microsiemens/cm which fact requires fairly tight monitoring of water quality also in proposed well.
Recommendation:	New RC-ring well in river-bed probably provided with galleries. Close monitoring of water quality.

8: MAHMUD ABDULAHI

Structure:	10*20 m inland water hole, 6 m deep, water depth 4 m.
Performance:	Pumped dry in 2 h, recovers within 3 h.
Pumps:	Yanmar TS70 and KUKJE KD120 8HP
Major problem:	Caving in general
Recommendation:	Caving protection by means of grass-carpet.

9: MOHAMED HASSAN MOHAMED

Structure:	4*5 m, 8 m deep well in heavily weathered basalt producing stable well walls. Water depth 1 m. Suplied with infiltration gallery: 40 m long well screen.
Performance:	Before gallery: 30 mins pumping After gallery : 4-5 h pumping.
Pump:	Yanmar TS70
Major problem:	None, related to water supply.
Recommendation:	No rehabilitation needed for water supply.

10: AHMED ABDI RAGE.

Structure 1:	8 m dia. semicircular water hole 50 m inland of river. 8 m deep, no water during dry season.
Performance:	Dry season: No water
Conductivity	2350 microsiemens/cm.
Pump:	Yanmar TS60.
Major problem:	Salinity giving visible damages on citrus.

Structure 2:	Temporary river-bed well, presently destroyed, 6 m deep of which 4 m are dug in weathered basalt.
Performance:	Reportedly sufficient water.
Conductivity:	Reportedly Sweet.
Pump:	Yanmar TS60.
Major problem:	Flooding.

Recommendation: Construction of permanent RC-ring well in river-bed, probably to be supplied with pipe galleries. Monitoring of salinity.

HOROHHADDLE visited May 24th.

The general problems of the area are moderate to high salinity of water in in-land wells used during rainy season and the non-permanence of the river-bed wells.The salinity is believed to originate from decomposition of the basalts, which constitutes a significant part of the substratum in the area.

Both problems are, however, easily solved by means of RC-ring wells in riverbeds w/wo infiltration galleries. Several existing wells/farms are prone to flooding and/or river bank erosion.

1. MOHAMED MAHAMOUD YOUSUF

Structure 1:	Inland well in sand/weathered basalt, 6*8m.
Performance:	Pumped dry in 4 h, recovers within 5 h, during dry season the well is nearly dry.
Conductivity	Slightly saline : 1290 microsiemens/cm.
Pump:	Yanmar TS60/YKS3D
Major problem:	Salinity and low water level/yield during dry season.

Structure 2:	Temporary uncased riverbed well, 5 m deep of which 2 m is sand and 3 m is weathered basalt.
Performance:	Pumped dry in 3 h, recovers within 2 h.
Conductivity:	reportedly sweet water.
Major problem:	Well is flooded and destroyed at first flood each year.

Structure 3:	Temporary uncased riverbed well, 5 m deep.
Performance:	Has never been pumped dry. Very sweet water.
Pump:	Same as 1/2.
Major problem:	Same as 2.

Recommendation:	Construction of RC-ring well in riverbed at the location of well no 3. If required provide with gallery in riverbed.

2. AHMED ADEN AHMED.

Structure:	12*8 m well near the river.
Performance:	2 h pumping time during dry season.
Conductivity	1650 microsiemens/cm.
Pump:	
Major problem:	
Recommendation:	Construction of RC-ring well in riverbed, if required provide with gallery.

3. HASSAN QALIB ISMAIL

Structure:	In-land unlined well, 6 m deep, constructed 1986.
Performance:	Pumped dry in 30 mins, recovers within 3 h.
Conductivity	3000 microsiemens/cm. Water quality is poor.
Pump:	Yanmar TS 60C/YDS 30
Major problem:	High Salinity, which apparently causes misgrowth of citrus.
Recommendation:	Abandon well and construct RC-ring well in river bed at location of former temporary well. Provide with gallery as required.

4. H. HUSSEIN HASSAN:

Structure:	Large-dia waterhole at riverbank prone to flooding.
Performance:	High Yield.
Conductivity:	630 microsiemens/cm.
Pump:	
Major problem:	Flood-protection.
Recommendation:	New permanent submerged RC-rings well in river-bed.

5. ABDULAHI MUSA DUALEH.

Structure:	In-land well 12*8*3 m near river bank.
Performance:	Dry season pumping time: 2 h.
Conductivity	Slightly saline, 1650 microsiemens/cm
Pump:	
Major problem:	
Recommendation:	New permanent submerged RC-ring well in river-bed.

6. MAHAMAD HAJI ISMAIL

Structure:	Large diameter well near the river-bank.
Performance:	Sufficient yield
Conductivity	460 microsiemens/cm

Pump:
Major problem:
Recommendation: New permanent submerged RC-ring well in river-bed, at location of existing well.

7. SALAD ALI IBRAHIM:

Structure: Large diameter well near the river-bank.
Performance: Sufficient yield.
Conductivity: 380 microsiemens/cm.
Pump:
Major problem:
Recommendation: New permanent submerged RC-ring well in river-bed, at location of existing well.

8. MAHAMOUD AW FARAH:

Structure: Large diameter well near the river-bank.
Performance: Sufficient water.
Conductivity: 330 microsiemens/cm.
Pump:
Major problem:
Recommendation: New permanent submerged RC-ring well in river-bed, at location of existing well.

9. AHMED ADAN:

Structure: Large diameter well near the river bank.
Performance: Sufficient yield.
Conductivity 565 microsiemens/cm.
Pump:
Major problem:
Recommendation: Deepening/Screening/Gravel Pack/Gallery/Lining.

10. AHMED OSMAN ALI:

Structure: Large diameter well near the river bank.
Performance: Sufficient yield.
Conductivity: 510 microsiemens/cm
Pump:
Major problem:
Recommendation: Deepening/Screening/Gravel Pack/Gallery/Lining.

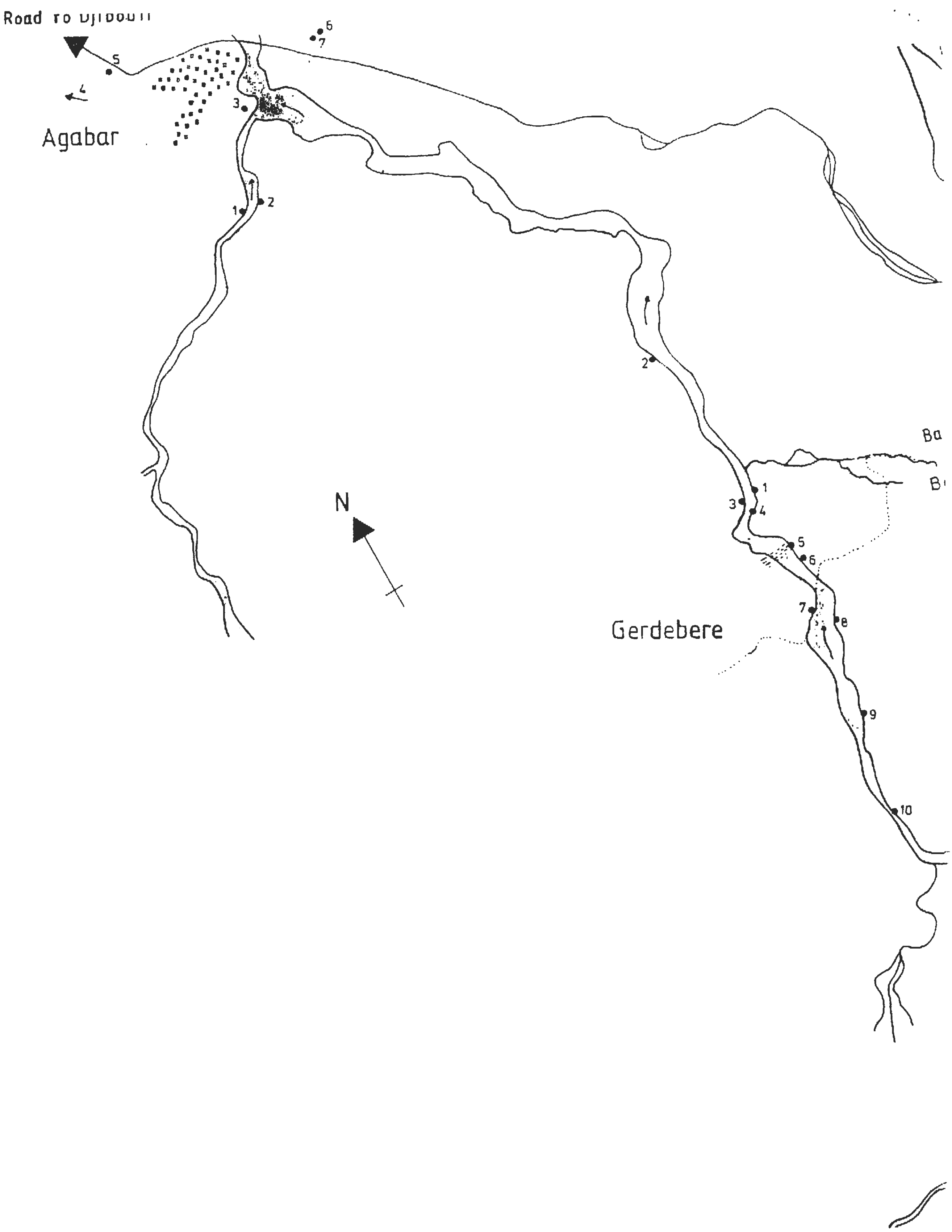
11. ISMAIL AW YUSUF

Structure: Large diameter well near the river bank.
Performance: Sufficient yield.

Conductivity 1165 microsiemens/cm.
Pump:
Major problem:
Recommendation: Deepening/Screening/Gravel Pack/Gallery/Lining.

12 ASHA ABDULAHI UDUGLEH.

Structure: Large wood-lined inland well, newly constructed.
Performance: Pumped 7 h/day and never goes dry.
Conductivity: 885 microsiemens/cm.
Pump:
Major problem: Restricted life time of wood lining.
Recommendation: It will be very expensive to improve this well with respect to increased lifetime.



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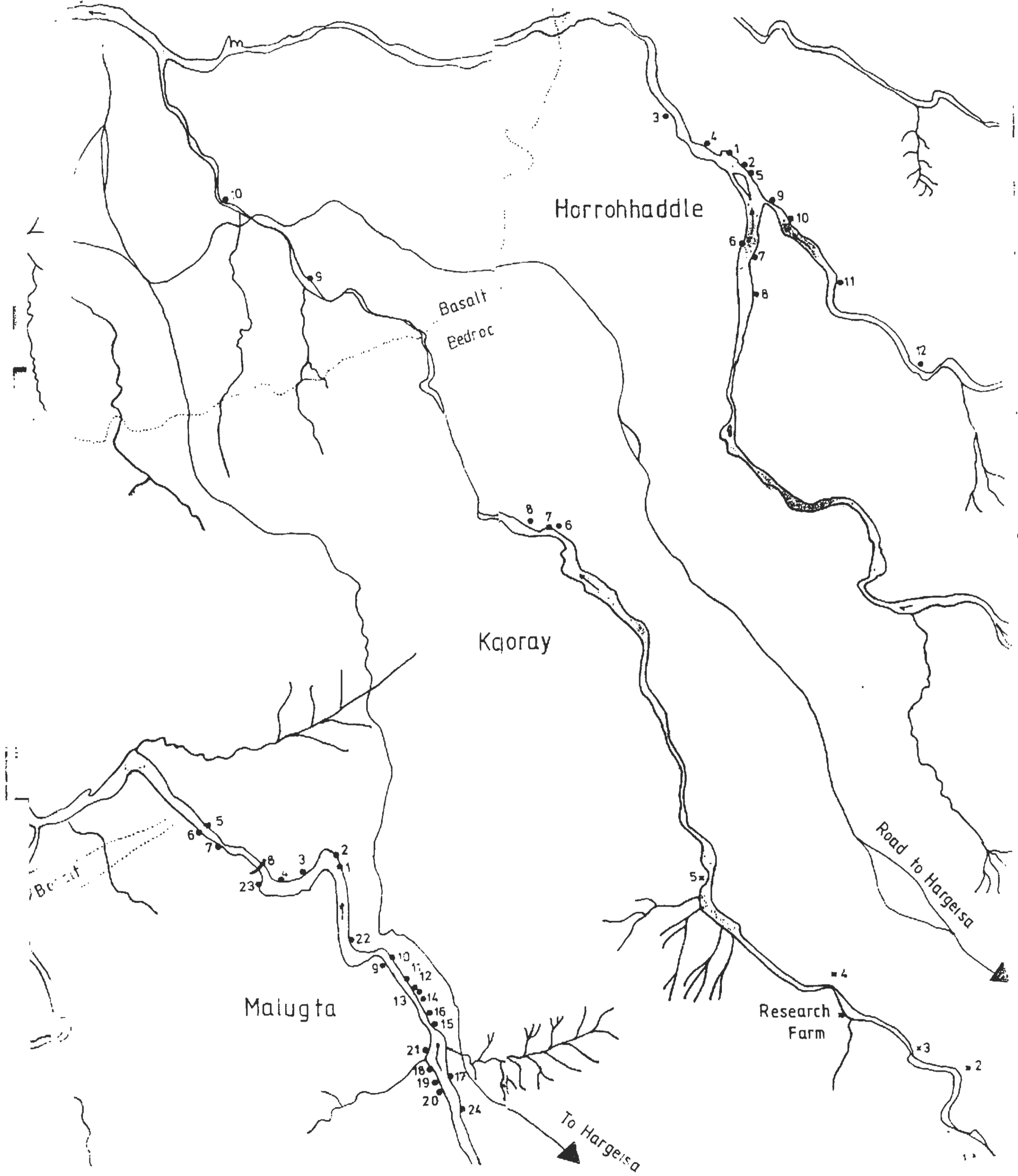


LEGEND

- Hand Dug Well
- Borehole
- Population Center

North West Agricultural Development Project - Somalia

Hydrogeological Mission Location of Wells and Boreholes Area: Hargeisa Valley	1:50 000 May-June 1987

DAPUDEC

Pumped 3-4 times per day.
Conductivity: 370 microsiemens/cm
Pump: YANMAR TS60
Major problem: Difficult to maintain.
Recommendation: New RC-rings well in river-bed possibly provided with infiltration galleries.

5: MOHAMED ABDULAHI ANBUL.

Structure: 2*4 m wood lined well, dug 1986. Water depth 1 m.
Performance: Pumped dry in 45 mins, recovers within 4 h. Pumped two times per day.
Conductivity: 410 microsiemens/cm.
Pump: YANMAR TS60
Major problem: Insufficient yield.
Recommendation: Install RC-rings in existing structure, provide with galleries as required.

6: ABDI YUSUF SUGULEH.

Structure: 5*8 m wood lined well, 6 m deep. Water depth 1.3 m. Dug 1982.
Performance: Pumped dry in 1 h, recovers within 4 h. Pumped 2 times per day.
Conductivity: 290 microsiemens/cm.
Pump: YANMAR TS 70
Major problem: Surface caving. Low yield.
Recommendation: Construction of pipe gallery in river-bed is likely to improve yield. Recommended surface caving protection: grass.

7: ABDULAHI GULEID OMER.

Structure: 8 m diam irregular well, 6 m deep. Bottom in mica shist. Dug 1974. 11 m long stone gallery constructed 1985 which improved yield. Recovery occurs on top of mica shist.
Performance: Before stoe-gallery: pumped less than 15 mins, recovery over 6 h. After stoe gallery: pumped dry in 1.5 h, recovers within 4 h. Now pumped 2 times per day.
Conductivity: 310 microsiemens/cm.
Pump: YANMAR TS70 run by 9 HP Lister engine 9/1/35.
Major problem:
Recommendation: improve yield by construction of PIPE gallery in river-bed. Surface caving: grass.

8: HASSAN OMER ODOWA.

Structure: 4*2 m wood line well. 5 m deep. Micashist at bottom. Water depth 0.5 m.
Performance: Pumped dry in 15 mins, recovers within 3 h. Pumpe 3 times per day/.
Conductivity: 360 microsiemens/cm.
Pump: YANMAR TS 70.
Major problem: Short pumping time/slow recovery.
Recommendation: Install pipe gallery in river-bed. If pumping time does not become longer then the use of a smaller pumpe is preferable.

9: AIDEED QUASALIE ALI.

Structure: River bank well near river, dug 1980. Mica shists in bottom of well. Present water depth 0.5 m.
Performance: Pumped dry in 0.5 h, recovers within 24 h.
Conductivity: 1050 microsiemens/cm.
Pump: ITT Pump & Compressor Service Model 2A1.
Major problem: Low yield/slow recovery.
Recommendation: New RC-ring well in river-bed, if required install infiltration galleries.

10: ALI H. HASSAN MAGAN.

Structure: 2 concreted wells, apparently at the location of old traditional well. Owner not present, thus no detailed informations available.
Recommendation: Search informations with owner in Hargeisa.

11: H. ABDI NOOR EGAL.

Structure 1: 2*4 m wood lined well inland in sand, gneiss in bottom, dug 1959.
Performance:
Conductivity: 650 microsiemens/cm.
Pump: YANMAR TS60
Major problem:

Structure 2: 6 m deep well in sand, severely caving, dug 1985. Actually the well is completely collapsed. Water depth reported to be 1 m.
Performance: Reportedly highly productive.
Conductivity:
Pump: YANMAR TS60
Major problem: Caving.

Recommendation:	Construct new RC-ring well at the location of structure no 2.

12: NOOR JAMA ADEN.

Structure:	2*7 m wood lined well, dug 1984. 4 m deep, 1 m water depth.
Performance:	Pumped dry in 1 h, recovers within 4 h. Pumped 2-3 times per day.
Conductivity:	350 microsiemens/cm
Pump:	YANMAR TS60
Major problem:	None except that wood lining is beginning to collapse.
Recommendation:	Replace wood lining with permeable stone/mortar lining.

13: H. MUSE ABDI ROBLEH.

Structure:	Wood lined river-bed well, dug 1979. 6-8 m diam, 4 m deep.
Performance:	Pumped dry in 2 h, recovers within 1 h. Pumped 3 times per day.
Conductivity:	350 microsiemens/cm.
Pump:	
Major problem:	Minor caving.
Recommendation:	Construct new RC-ring well in river-bed on the location of existing well, possibly provided with infiltration galleries.

14: MUSA SOLEIMAN DAHIER.

Structure:	Well in 'solid' rock, 4 m deep, protected from river flodds by gabions.
Performance:	Sufficient water.
Conductivity:	1100 microsiemens/cm.
Pump:	
Major problem:	No major problems, except that water is slightly saline. tion and monitoring of water quality. If this detoriates, river-bed gallery should be considered.

XUMBA WEINE visit June 9th

1: OSMAN JAMA HIRSI.

Structure 1: 5*10 m wood line, in-land well, 6 m deep, mainly in white clay. dug 1977.
Performance: Pumped dry in 30 mins, recovers within 6 h, pumped 2 times per day.
Conductivity 940 microsiemens/cm.
Pump: Yanmar TS60
Major problem: Caving.

Structure 2: 5*10 m wood lined in-land well, 7 m deep, 1 m water depht. Mainly in sandy, black clay.
Performance: Pumped dry in 30-60 mins, recovers within 6 h. Pumped 2 times per day.
Conductivity
Pump: Bernhard
Major problem: Caving.

Recommendation: Deepening/Screening/Gravel Pack/Lining of well no 2.

2: ALI AW ADAN OMAR

Structure: Irregular 7 m diam inland well near the junction of of Xumba weine and Jalello. Wood lining near collaps. Well depht 6 m, water depht 2 m.
Performance: Pumped dry in 5-6 h, recovers within 2-3 h.
Conductivity 1500 microsiemens/cm, decreasing tendency, but higher during dry season.
Pump: 3.5 HP Chinese petrol pump, make unknown.
Major problem: Collapsing wood lining, salinity.
Recommendation: The well should be deepened to improve both storage capacity and infiltration capacity, Water quality to be monitored.

3: ABDULAHI ISMAIL JAMA.
Structure 1: 5 m diam well in sandy clay/clay. 6 m depht, 2 m water depht in clay. Recharge occurs on top of clay.
Performance: Pumped dry in 4-5 h, recovers within 1 h.
Conductivity 420 microsiemens/cm.
Pump: Yanmar TS60
Major problem:

Structure 2: 5*5 m wood lined well, in-land, severy

	caving.
Performance:	
Conductivity	2000 microsiemens/cm.
Pump:	3.5 HP Chinese pump, make unknown.
Major problem:	High salinity.
Recommendation:	Abandon well no 2 - rehabilitate well 1 with deepening/screening/gravel pack/gallery/lining.

HALAYA visited May 26th/June 5th

The hydrogeological situation in this area can be characterised by the following sequence af sediments:

1. Sandy gravel (major aquifer)
2. White Clay (Malas)
3. Red Clay, occasionally pockets of sandy material.
4. Nubian sandstone.

Only the sandy gravel has good characteristics af an aquifer, the two clay types beeing generaly impermeable and the Nubian Sandstone reportedly have poor permeability and reportedly this aquifer is more or less saline.

The major problem observed in this area is the generally small thickness of the aquifer on top of the white clay (Malas), which means that static water level during the dry season locally descends to a level near to or even below bottom of aquifer. There is no evident solution to this problem as only few places exists where subsurface/surface dams can be constructed at a reasonable cost as compared to the benefits. It can not in general be recommended to penetrate the white clay. Marginal wells can be supplied with infiltatration galleries, but neither the risk of failure nor the expectable benefits can be determined in advance.

Following wells/farms have been visited during the mission:

1. AHMED AW HASSAN AWALEH

Structure:	Unlined 7 meter deep well, inland near river bank. Constructed 1982, collapsed 1986.
Performance:	Pumped dry in 1.5 hours, recovers within 30 mins. Sweet water.
Pump:	
Major problem:	Caving
Recommendation:	Construct new RC-ring well either on this location or in river bed.

2. EBLAH RAGE JAMA:

Structure:	Colapsed well on the river bank. Dug and collapsed 1982.
Performance:	Presumably the well had low yield.
Pump:	None

Major problem: Colapsing and low yield.
Recommendation: Construct new RC-ring well preferably in the river bed.

3. AHMED H HASSAN:

Structures: Two macon wells right on river bank protected by gabions.
Performance: Pumped for 2-3 hours dayly without drying out, recovers within 1-2 hours.
Conductivity: 420 uS/cm.
Pump:
Major problem: none.
Recommendation: Supply the wells with RC-lids to prevent filling of wells with sand during floods.

4. ALI MOHAMED ROBLEH

Structure 1: Partly collapsed open surface well constructed in 1962.
Performance: Has never been pumped thus factual yield is not known.
Pump: None
Major problem: Caving

Structure 2: Well constructed 1975, collapsed 1986.
Performance: Unknown
Pump: None
Major problem:

Recommendation: Testpumping required to determine yield/quality.

5. MOHAMED JAMA:

Structure: 3*3 m well constructed 1984, collapsed 1986.
Performance: Never pumped
Pump: None
Major problem: Severe Caving.
Recommendation: ???????????

6. MOHAMED JAMA OSMAN.

Structure: Very old well which collapsed finally in 1979.
Performance: Unknown, never pumped.
Pump: None.

Major problem:
Recommendation: ??????????????

7. ABDI OSMAN ALI:

Structure: 12 m deep well with white clay from 2.5 m.
Performance: Dry
Pump: None
Major problem: Dry
Recommendation: Abandon

8. MOHAMOUD JAMA:

Structure: Hand dug well constructed 1962, continiously collapsing.
Performance: Reportedly high yield, but not known by quantity.
Pump: None
Major problem: Caving.
Recommendation: ??????????????

9. HASSAN ALI KAHIN:

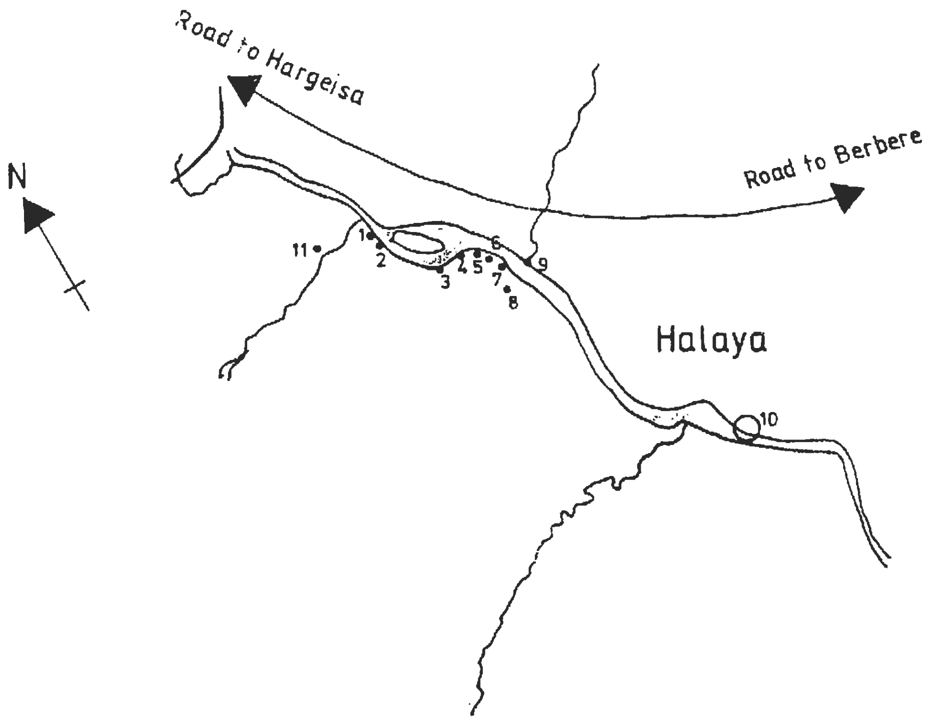
Structure: 14 m deep pilot well in gully, strongly prone to destruction by over-land floods.
Performance: Dry.
Pump: None.
Major problem: Dry.
Recommendation: Abandon and construct new RC-ring well in river bed.

10. IBRAHIM H. MUSA:

Structures: Several huge water holes in river bed, prone to flooding.
Performance: Recovery is very slow.
Pump: ?????
Major problem: Caving, slow recovery, flooding risk.
Recommendation: New RC-ring well with galleries in riverbed.

11. H. MOHAMED SH OMER

Structure: Inland fairly deep, small diameter well, presently dry, clay soil
Performance: Owner not present, thus no informations available.
Pump: None
Major problem: Caving, no water.
Recommendation: Probably not feasible to improve/redig.



LEGEND:

- ● Hand Dug Well
- × Borehole

North West Agricultural Development Project - Somalia

Hydrogeological Mission Location of Wells and Boreholes Area: Halaya	Scale 1:50.000 Date May-June 1987

DARUDEC
DANISH RURAL DEVELOPMENT CONSULTANTS

AW BARKHADDLE visited May 30th.

1: KAAHA MUSSA GEEDI:

Structure:	3 m deep well under construction, only 0.5 m water depht, which furthermore was in white clay
Performance:	Pumped dry in 1 h, did not recover within 5 h.
Conductivity	390 microsiemens/cm
Pump:	Brisggs & Stratton 3HP Petrol/Marlow.
Major problem:	Low yield.
Recommendation:	Well could be deepened by 2-3 m to provide for increased storage volume and provided with infiltration galleries in river-bed to increase speed of recovery. The latter should be escavated to the bottom level of the well. Alternatively new RC-ring well should be dug in river-bed.

2: ASHA JAMA FARAH:

Structure:	4 m deep well dug in river-bed right next to bank.
Performance:	Well is nearly dry during dry season.
Pump:	
Major problem:	Low yield during dry season.
Recommendation:	Deepening/Screening/Gravel Pack/Gallery.

3: HASSAN NOOR HUSSEIN

Structure:	5*5m well, 4 m deep, protected against river floods by wall and gabions.
Performance:	Dry from february.
Major problem:	No production in dry season.
Recommendation:	The possibility of extending production period by installation of pipe gallery below dry season water level in river-bed should be investigated. If this is possivble the existing well should be deepened using RC-rings and galery pipes. Alternatively a new RC-ring well could be constructed in rivedbed.

4: AHMED DERIA ALI

Structure:	10*10 m well on bank next to river, protected by gabions. Farmers digs temporary well in river-bed during last part of dry season.
Performance:	Rainy Season 5 h pumping with 12 h recovery, dry from february, at which time farmer digs temporary river-bed well.
Pump:	Yanmar TS60
Major problem:	No production in dry season.
Recommendation:	Provide existing well with pipe gallery in river-bed. Alternatively construction of new permanent RC-ring well in river-bed at the location of temporary well. Choice of solution depends on availability of materials and on costs.

5: SAFIA ALI HASSAN:

Structure 1:	Pilot RC-ring well under construction. The farmer has several traditional in-land wells.
Performance:	So far unknown.
Pump:	
Major problem:	
Recommendation:	If required well could be supplied with gallery, alternatively escavate below allready installed rings into substratum (sandstone/metasandstone).

6: AHMED HASSAN FAYAH:

Structure 1:	6 m deep well with Malas exposed in bottom. 1975.
Performance:	In long dry seasons, this well goes dry, else 5 h pumping with recovery over night.
Pump:	Yanmar TS70.
Major problem:	No production in dry season.
Structure 2:	5 m dia hand dug wood lined well. 1975.
Performance:	Pumped for 7 h at which time the total head of pump is exceeded. Full recovery within 1 h.
Pump:	No nameplate, max capacity 62 cum/h, max head 6 (six!) m.
Major problem:	Low-lift pump and short life expectancy of wood lining.
Recommendation:	Structure 1 might be abandonned and the pump transferred to structure 2. Wood lining in

no 2 should later be replaced by RC-rings/gravel pack and if required galleries. River bank needs further erosion protection.

7: HASSAN FARAH JAMA:

Structures: Two newly dug water holes in river-bed, strongly prone to flooding and severely suffering from caving.
Performance: Unknown
Major problem: Caving and flood protection.
Recommendation: New RC-ring well(s) in river-bed at location of existing structures.

8: MOHAMED ADEN HAKIA

Structures 4 wells near river-bed.
Performance: According to owner there is sufficient water in newest well.
Conductivity: 1st well (1980): 2180 microsiemens/cm, increasing.
2nd well (1983): 565 microsiemens/cm
3rd well (1985): 1870 microsiemens/cm
4rd well (1985): 830 microsiemens/cm

Major problem: Highly variable salinity of water both with respect to space and to time. The wells are spaced fairly close and there is a tendency to increasing salinity with time from well no 1, which may later apply allso to other wells. Salinity likely to originate from weathering products of underlying gneiss.
Recommendation: Close monitoring of water quality from each individual well. Rehabilitation of soils (gypsum) might be considered.

9: MOHAMOUD EGAL AWED:

Structures: Two rectangular wells/reservoirs mainly in white clay with recaharge arriving in sand on top of white clay.
Performance: Unknown, owner not present
Conductivity: 590 microsiemens/cm and 291 microsiemens/cm respectively.
Recommendation: Performance might be improved by installation of galleries in river-bed, depht of installation should correspond to deepest level of malas in river-bed or deeper. Galleries are likely to improve yield, especially during dry season.