PRACTICA FOUNDATION

Geulweg 16 | 3356 LB Papendrecht | the Netherlands
Tel +31 78 6150125 | www.practica.org

Flood wells in Ethiopia

Pilot report

Berry van den Pol & Robert Vuik

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Picture on front page: Farmer Mr. Abera Zemenay on his field in Woreta, Fogera.

Content

1. Introduction

This report discusses the activities and conclusions on six pilot wells that were drilled in the frame of the project 'Shallow tube wells in floodplain areas', a joint effort of MetaMeta, UNESCO-IHE, Spate Irrigation Network and PRACTICA Foundation funded by Partners voor Water. The report builds further on the field and desk research documented in the pre-pilot report by PRACTICA in July 2013.

Flood wells are an innovative concept that could provide smallholder farmers in floodplains with private access to irrigation water. This could increase the productivity of floodplains drastically, as its current use is only marginal while its potential for cash crop production is enormous. Contrary to conventional hand-dug wells, flood wells do not collapse in the rainy season and allow farmers to irrigate right after the floods recede. The concept could become of great value to increase food security and combat poverty in floodplains throughout Africa.

First the approach of the pilot will be explained, listing the different phases and activities carried out. In chapter 3 the concept and design of a flood well will be elaborated. Chapter 4 discusses the results of the site selection, execution and evaluation of the pilot wells. The experiences have provided new insights in the cost of flood wells previously assessed in the pre-pilot report. This enhanced understanding will be presented in chapter 5, followed by the conclusions and lessons for the country studies still to be executed, in chapter 6.

2. Approach

The flood wells project started with an identification study by Mr. Tesfa-Alem (Spate Irrigation Network) which pointed out the potential for flood wells of ten areas in Tigray, Oromya and SNNPR (April 2013). Further desk and field studies by PRACTICA documented in the pre-pilot report (July 2013) narrowed down this list to two areas for the implementation of six pilot wells. A map of Ethiopia's floodplains and shallow aquifers that became available shortly after served as a starting point for further desk interpretation to select the areas with the highest potential. The pilot execution phase consisted of the following steps:

1. Desk Interpretation of maps
2. Field analysis and proposed working areas
3. Engagement of drillers and farmers
4. Drilling pilot wells and installation of micro pump-sets
5. Evaluation

2.1 Desk interpretation of maps

The map of Ethiopian floodplains developed by Mr. Yohannes Keti indicated three extremely large flooded areas that were not considered in the first stage of the project; i.e. Gambella, Southern Omo and lake Tana. Both Gambella and Soutern Omo are very remote areas without major input and output markets for cash crop production. Lake Tana however showed an important potential both from a hydrogeological and marketing point of view. Further desk studies informed the decision to include the Fogera woreda in eastern Tana in the field analysis.

2.2 Field analysis and proposed working areas

Informed by the desk interpretation another field analysis was carried out in Koka, Silti and Fogera in December 2013. The study focused on assessing the scope for upscaling, taking into account the local farming systems, potential for improvement, the number of beneficiaries and the availability of alternative options for water access. The resulting socio-economic insights were used to make the final selection of pilot areas: i.e. Silti, Fogera and Becho.

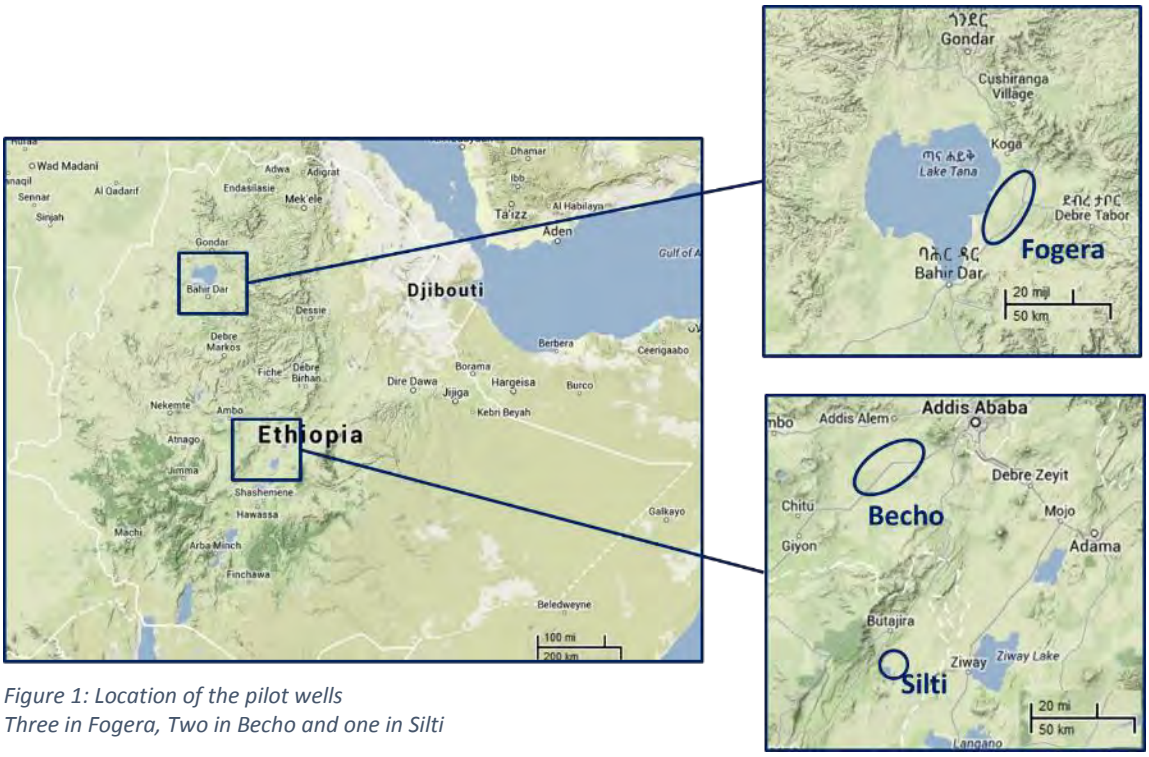


Figure 1: Location of the pilot wells
Three in Fogera, Two in Becho and one in Silti

Figure 2: Construction of drilling pipes

2.3 Engagement of drillers and farmers

A drilling team under supervision of Mr. Mengistu Worku has been formed and instructed to drill the 6 pilot wells[1], prepare drilling logs, execute pump tests and instruct farmers. A manual sludge kit with the capacity to drill 32 m has been produced locally and tested before drilling the pilot wells. The drilling equipment will stay with Mr. Worku, so that he can continue his drilling business after the end of the project. In each area farmers have been selected in collaboration with officials from the woreda and/or kebele. The final selection of farmers has been based on intake interviews to get insight into their farming systems and the potential benefits that a tube well and micro pump-set could bring.

2.4 Drilling pilot wells and installation of micro pump-sets

Six tube wells of depths ranging from 15-32 m depth have been drilled and drilling logs have been prepared for each well (see Appendix A). Four wells have been equipped with PVC and gravel pack and examined by means of a pump test. The pump test included measurements of the yield and recovery of the well and the salinity of the water (EC-value). Two wells have not been equipped and tested since no aquifers had been found within the range that could be drilled. From the four tested wells, two have proven successful and micro pump-sets have been installed for its use by the involved farmers. The drilling teams have instructed the farmers on the operation and basic maintenance of the pump.

Figure 3: Drilling by the simple sludge technique

2.5 Evaluation

The results of the drilling and pump testing activities provide an indication of the pilot areas' suitability for flood wells and micro pump-sets. Based on the encountered hydrogeological conditions, recommendations are provided on appropriate water access and withdrawal technologies.

The results of the pilot study serve as an input for country studies and disseminations in Zambia, Ghana and Mozambique and lead to an action plan for further up-scaling the approach within the pilot area(s) in Ethiopia. The country studies will take place late 2014.

[1] Initially iDE Ethiopia had been approached for this, but they had no capacity to carry out the drilling activities within the project time span. However iDE will be involved in the upscaling phase of the project.

3. Design flood wells

Currently, the pilot floodplains are characterised by seasonal cultivation. In the rainy season farmers either use their field to cultivate rice or they do not use it at all. In the dry season most farmers in Fogera, Silti and Becho either opt to grow low-value rain-fed crops, to cultivate very small fields irrigated by buckets of water, or not to use the field[2].

The introduction of flood wells allows farmers to use water from tube wells and floods conjunctively so that they can irrigate their fields during the whole year. In the rainy season floods inundate the field. This makes it possible to grow rice and moreover it recharges the shallow aquifer. The tube well is protected by stones at the base and an elevated PVC tube that can be capped if the flood rises too high (see figure 4). The 2-stroke micro pump-set can be installed and removed very easily, and with a weight of 10 kg farmers can take it home daily. In the dry season the capping is removed and farmers can use the pump to irrigate the adjacent fields. Though the technology would allow for drip irrigation, the use of furrows is recommended in order not to increase the costs for smallholder farmers. Moreover, water infiltration in the furrows directly recharges the shallow aquifer from which the water was extracted. The flow of 3 L/s is sufficient to irrigate 0.5 ha, which exceeds the field size commonly irrigated by smallholder farmers.

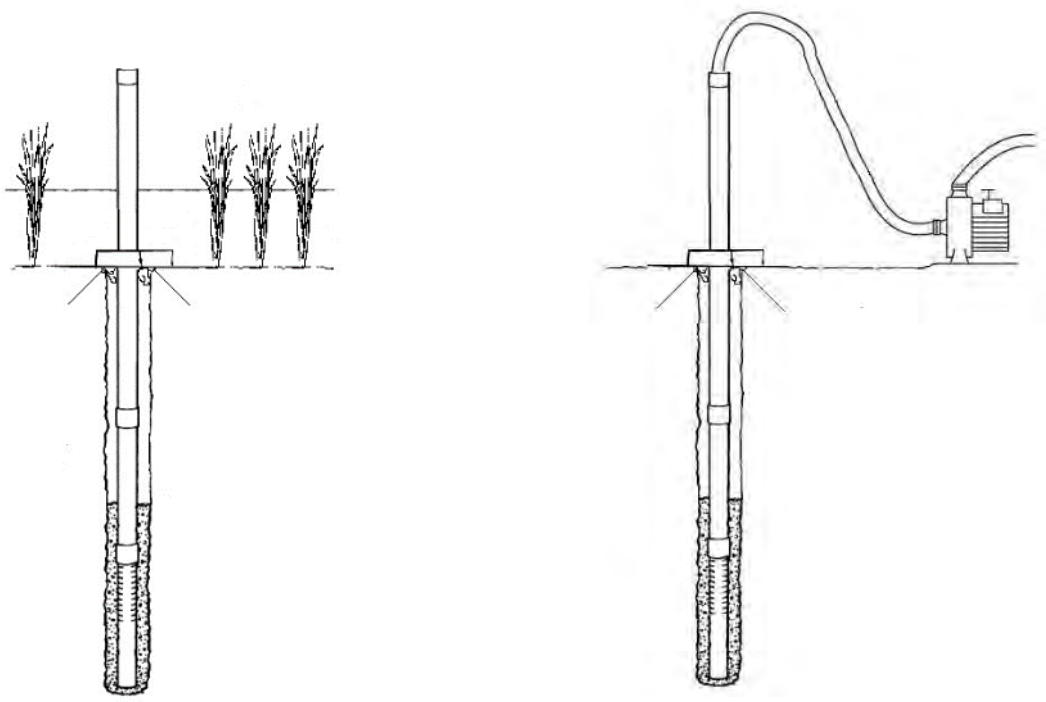


Figure 4: A flood well during the rainy season (left) and during the dry season (right)

[2] In Koka most farmers use large engine pumps to transport the water from hand-dug wells outside the floodplain.

4. Results

This chapter describes the results of the additional desk and field research carried out in the pilot execution phase, and the outcomes of the drilling activities and pump testing.

4.1 Proposed working areas

Fogera

Desk research indicated a large potential for exploring shallow tube wells in the Fogera floodplain near lake Tana. The fieldwork resulted in promising collaboration with the regional, district and local authorities. PRACTICA proposed to drill 3 pilot wells in Fogera because of:

a) the area size and the significant number of active farmers (> 10,000 households)
b) a suitable hydrogeology (shallow water tables with alluvial soils)
c) the potential to improve current farming systems (current dry-season cultivation is limited due to water scarcity)
d) the presence of institutional support (authorities willing to provide micro credit for wells and pumps)
e) market possibilities (location in between 2 major towns: Gonder and Bahir Dar).

Silti

The field analysis resulted in the selection of the largest floodplain in the area: Balo Kariso. In this floodplain small parcels are cultivated by about 600 households belonging to 3 associations that work through small farmer groups of 10 households. The fields are irrigated with watering cans filled at nearby hand-dug wells. PRACTICA proposed to drill 2 pilot wells in this area, which could help the farmers to increase their irrigated areal drastically.

Becho

A considerable part of the large Becho plain is flooded during the rainy season. Experiences from iDE in the west of the plain have demonstrated a large demand for tube wells[3]. Even in the non-flooded part farmers proved to be willing to invest in a tube well since the soil type (black cotton clay) is too unstable for hand-dug wells. Since iDE has not worked in Sebeta district in the east of the plain, a large potential for flood wells has been identified and 2 pilot wells have been proposed.

Koka

Field observations during the second mission pointed out that the major part of the Koka floodplains are already under intensive cultivation. Most farmers have hand-dug wells just outside the floodplain and large engine pumps (with 4" outlet hoses) which they use to pump the water hundreds of meters into the flooded area. In this way most of the flooded area can be covered with water from outside. With a maximum potential of only 50 households whose fields could not be reached in this way, it was ultimately decided not to drill any pilot wells in Koka.

[3] iDe has drilled over 400 wells and equipped those with a treadle pump in the last decade.

4.2 Pilot wells

The following table summarises the results of the six pilot wells.

Table 1: Overview of the pilot wells

Nr	Floodplain	Village	Farmer	Depth (m)	SWT (m)	Performance	Explanation
1	Silti	Balokeriso (Sherife)	Atgabot Group	24	1.5	Negative	Only clay
2	Fogera	Woreta	Abera Zemenay	15	4.2	Negative	Only clay; hard rock at 15 m
3	Fogera	Woreta	Kuhar Michael FTC	24	1	Negative	Only clay
4	Fogera	Shina	Tseganew Mesfine	32	3.5	Good: 3 L/s	Two aquifers and screens at 7 - 9 m (sand) and 27 - 31 m (sand)
5	Becho	Sebeta	Sori Erecha	28	4	Good: 3 L/s	Two aquifers and screens at 16-17m (sandy clay) and 26-27.5m (sand). The pump was installed at 1 m depth to overcome the suction limit.
6	Becho	Sebeta	Abera	21	5	Unknown	A small layer of sandy clay was encountered, which might act as a moderate aquifer. However, the static water level (5m in the early rainy season) is beyond the reach of the micro pump-set.

Fogera

The drilling in Fogera has generated mixed results (see table 1). Two wells were negative since no aquifer was found. The pure clay soils encountered in this area are not suitable for tube wells due to its impermeable character. Large diameter hand-dug wells may provide enough water in such soils because those wells are characterised by a larger inner surface through with water seeps into the well. Tube wells however have only a small diameter so that recharge from seepage takes too long. One well was positive as its dynamic water level stabilised quickly while pumping a yield of 3 L/s. Two sandy aquifers had been found and both have been equipped with a filter screen. In this case the recharge of the well takes places through the aquifers, which is much faster than through seepage.

Silti

In Silti the result of the test well was negative, since only clay was found. Though the Balo Kariso floodplain was bigger than the other flooded areas in Silti, it was still much smaller than the areas identified in Fogera and Becho. As a response it was decided to stop test drilling in Balo Kariso, since another trial would have a major change to encounter the same – unsuitable – soil profile.

Becho

The test drilling in eastern Becho has been relatively successful. The first well taps from two aquifers which has resulted in a yield of at least 3 L/s. The second well only drilled into a small layer of sandy clay. This does not point at a very good aquifer, but it might provide some water. However, the static water table was too deep for a micro pump-set, so its yield could not be tested. Other pumps could be installed e.g. rope pumps or direct action pumps but these are not suitable for floodplains as they cannot be removed on a daily basis. Submersible pumps are an alternative, but prove to be too costly for marginalize farmers and will require a larger borehole.

5. Drilling costs reconsidered

The experience of constructing six pilot wells has rendered the cost estimations in the pre-pilot report highly unlikely. At the time cost estimations for well drilling were based on iDE data, however it has become clear that those data do not represent market prices. The price of a 14m tube well would be at least 5000 ETB (about 200 EUR), as indicated by M. Tadesse from the Oromia Water Bureau. However, the real costs depend a lot on two highly variable factors: the total drilling depth and location of the well.

Regarding the total depth it was assumed that 14m would be sufficient for a shallow well, however in most pilot areas no aquifer was found within this depth. In Becho it turned out necessary to drill up to 28 m. If the depth is twice as large, the material cost doubles as well since it is the PVC tube that demands the major part of this. The labour cost even increases more than twice, since drilling gets heavier when the depth increases. Hence, nearby the pilot wells in Becho the price would even exceed 10,000 ETB (400 EUR). In the successful area in Fogera however, 9m depth is probably sufficient and the price may be slightly lower than 5000 ETB.

Transport is another major component of the costs faced by well drillers. If an area is too far to be reached by local and/or public transport, a vehicle must be hired which costs at least 750 ETB (30 EUR) per day. Moreover, when drilling far from home the drillers must be accommodated in one way or another, which increases the costs as well.

Hence, for a drilling enterprise to become economically viable it is necessary to be based within their market area. If not, costs increase too much and a well becomes unaffordable for smallholder farmers. Furthermore initial financial support may be necessary, as it takes some time for an enterprise to start making profit. Costs will go down over time because the experience of the team, the knowledge on local hydrogeology and the possibility to buy materials in bulk quantities will increase.

6. Conclusion

Flood wells can become a valuable innovation to increase the productivity of smallholder farms in floodplains. However the pilot has shown that the concept is not applicable everywhere. Ethiopia is geographically challenging when it comes to manual drilling technologies. Moreover most vast floodplains consist of lacustrine rather than riverine sediments. Especially, but not exclusively, the lacustrine floodplains are characterised by deep clay profiles without any sand or gravel layers within 30 m depth. This lack of an aquifer results in negative boreholes, irrespective of the chosen drilling technology.

Despite the mixed results, there seems to be a good scope for upscaling flood wells in the Becho and Fogera plains. Farmers are willing to invest in private water points and pumping technologies as they realise they can increase their income drastically by shifting to cash crops. In Fogera, the area where the positive well was located (around Shina village) is locally known for its sandy aquifers. This could be a good starting point for a local drilling team. In Becho even farmers outside the floodplain have showed their interest. In collaboration with local experts more promising areas in the two vast plains could be identified, test drilled and evaluated.

The fact that four pilot wells have been considered as negative clearly has to do with its use: irrigation by engine pump-sets. In case of moderately performing wells or water tables deeper than 5m, other pumping technologies are required. Rope pumps or low-cost solar pumps could access water levels beyond suction depth and are characterised by smaller flows. In floodplains however these technologies might be less appropriate due to a more complicated to (un)installation.

The Silti and Koka floodplains do not show a good scope for flood wells. However, both cases have generated a number of lessons for the country studies still to come. The initial selection of potential areas to introduce flood wells should be based on a study gathering maps, drilling logs and other documentation on water tables, soil types and land use. This could have indicated that the Silti floodplains are too small to create any serious scope and that the Koka floodplains are characterised by lacustrine sediments and relatively deep water tables when moving away from the lake.

Based on these insight fewer field visits are necessary to areas that are characterised by: riverine sediments, large floodplains, water tables < 5m depth, nearby input and output markets, and farming systems based on crop production. A field visit could then confirm if conventional options to access water are insufficient and/or more expensive than flood wells, and if the authorities are willing to support the development.

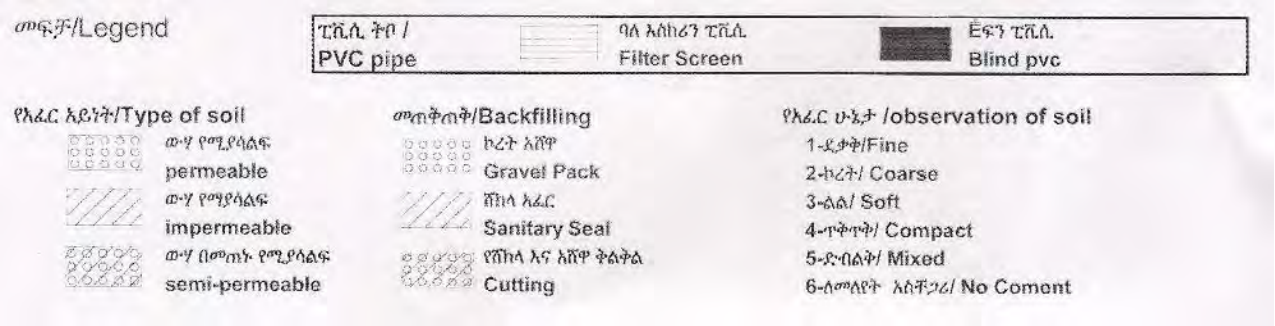
In Ethiopia the flood wells approach could be up-scaled in Fogera and Becho by:

- Training local drilling enterprises
- Establishing a supply chain for low cost pumps
- Finding partners to microfinance smallholder farmers
- Linking farmers to the main input and output markets

The development of a toolkit that comprises suitable water harvesting technologies including flood wells would provide scope to roll-out agricultural programs tailor-made to the given area. PRACTICA is willing to contribute to further research on this topic in collaboration with the project partners, in order to stimulate the productivity of floodplains in a range of different contexts.

Appendix A: Drilling logs and pump tests

Copies of the drilling logs and pump test sheets are found below. The following legend applies to the drilling log forms:



Well number 1: Silti

Drilling log

መረጃ መያዣ ቅፅ/Drilling Log

የባለቤቱ ሥም : Name of Farmer: Atgabot Group (180)

ቀን/Date : 16/02/2014

ከተማ /Town : Balokeriso sheiife

ጂፒኤስ /GPS N. 7° 58' 35" N S. 38° 23' 9" E

የቆፋሪው ሥም : Name of Driller: Mohammod

የውሃ ወለል : Water level: 1.5m

ሥዕላዊ መግለጫ Drawing: ፒቪሲ ቧቦ PVC pipe	መጠቅጠቅ Backfilling	የአፈሩ አይነት Type of soil	ጥልቀት (በሜትር) Depth (meter)	የአፈር አይነት መግለጫ Description of the soil	የአፈር ሁኔታ Observation of soil	ማስታወሻ Remark
		Sand	0	permeable	Sand Coarse	
			1			
		Clay	2	Impermeable	Clay Compact	
			3			
			4		Soft	
			5			
			6			
			7			
			8			
			9			
			10		Semi-Compact	
			11			
			12			
			13			
			14			
			15			
			16			
			17			
			18			
			19		Soft	
			20			
			21			
			22			
			23			

Pump test

Pump test

Farmer: Ategabot Group

Date: 16/02/2004

Location: Balokeriso (sherife)

Step 1:

Measure before pumping

Volume bucket	40	L
Length casing above surface	0.5	m
Static water level to top casing	2.5	m
Time when pump started	00:00:00	h

Step 2-5:

Drawdown. Measure during pumping

Time to fill bucket		Flow rate (optional)		Time when water level stabilised		Water level	
00:19:17	s	2.08	L/s		h	5.1	m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m

Step 6:

Time when pump stopped	00:24:17	h

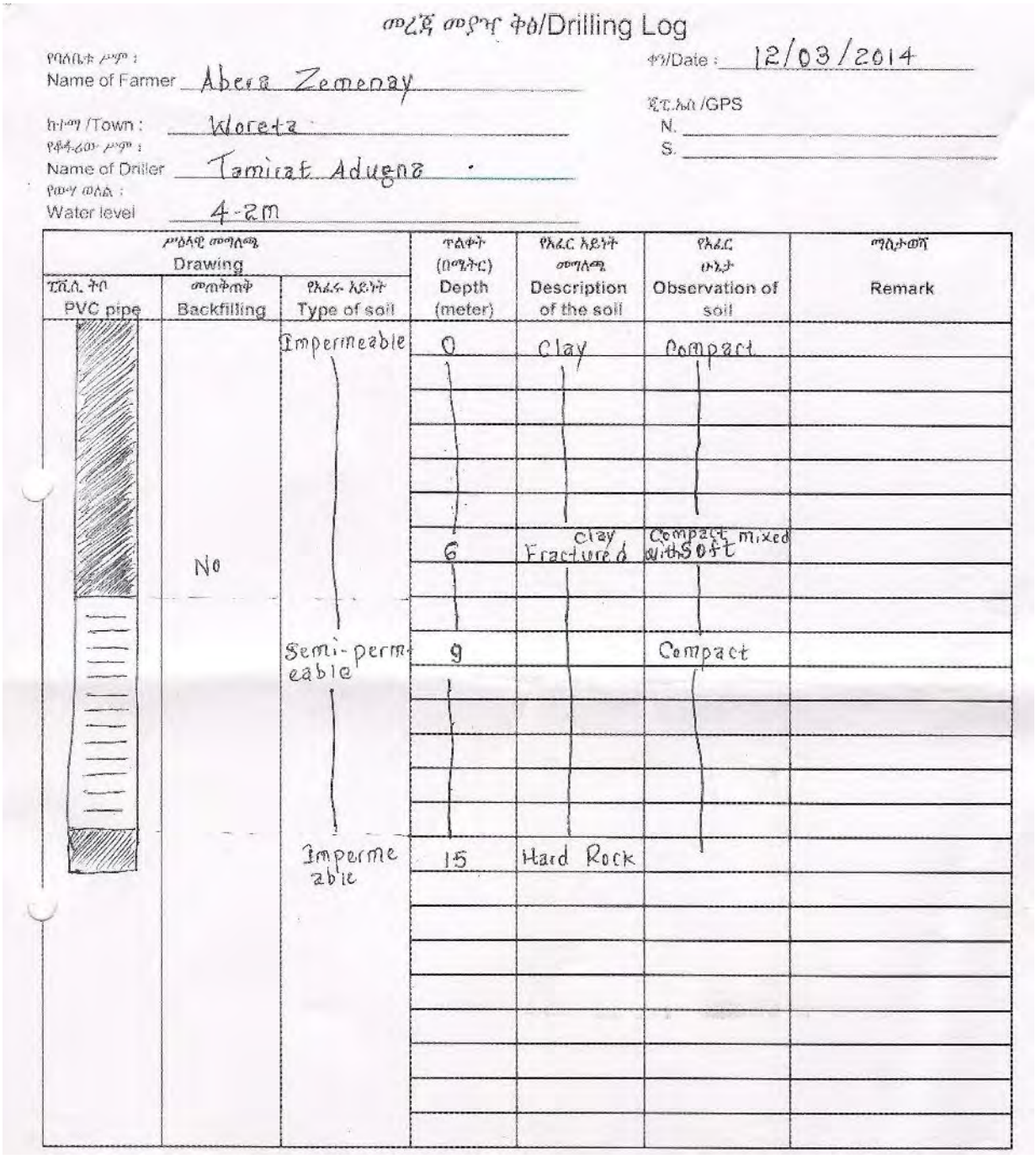
Step 7:

Recovery: Measure after pumping

Time after pumping	Water level	
0 minutes	5.7	m
1 minute	5.1	m
2 minutes	4.6	m
3 minutes	4.1	m
4 minutes	3.8	m
5 minutes	3.6	m
6 minutes	3.1	m
7 minutes	2.4	m
8 minutes	2.0	m
9 minutes	1.5	m
10 minutes		m
20 minutes		m
30 minutes		m
40 minutes		m
50 minutes		m
60 minutes		m

Well number 2: Fogera

Drilling log



መረጃ መያዣ ቅፅ/Drilling Log

የባለቤቱ ሥም :
Name of Farmer Abera Zemenay

ቀን/Date : 12/03/2014

ከተማ /Town : Woreta

የቆፋሪው ሥም :
Name of Driller Tamirat Aduna

ጂፒኤስ /GPS
N.
S.

የውሃ ወለል :
Water level 4-8m

ሥዕላዊ መግለጫ Drawing: ፒቪሲ ቱቦ PVC pipe	መጠቅጠቅ Backfilling	የአፈሩ አይነት Type of soil	ጥልቀት (በሜትር) Depth (meter)	የአፈር አይነት መግለጫ Description of the soil	የአፈር ሁኔታ Observation of soil	ማስታወሻ Remark
		Impermeable	0	Clay	Compact	
	No		6	Clay Fractured	Compact mixed with Soft	
		Semi-permeable	9		Compact	
		Impermeable	15	Hard Rock		

Pump test

Pump test

Farmer: Abera Zemenay

Date: 13/03/2014

Location:

Step 1:

Measure before pumping

Volume bucket	40	L
Length casing above surface	1m	m
Static water level to top casing	5.2	m
Time when pump started	00:00:00	h

Step 2-5:

Drawdown. Measure during pumping

Time to fill bucket		Flow rate (optional)		Time when water level stabilised		Water level	
00:15:03	s	2.68	L/s		h	5.2	m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m

Step 6:

Time when pump stopped	00:31:25	h

Step 7:

Recovery: Measure after pumping

Time after pumping	Water level	
0 minutes	5.4	m
1 minute	5.2	m
2 minutes	5.1	m
3 minutes	5.0	m
4 minutes	4.8	m
5 minutes	4.6	m
6 minutes	4.5	m
7 minutes	4.3	m
8 minutes	4.2	m
9 minutes		m
10 minutes		m
20 minutes		m
30 minutes		m
40 minutes		m
50 minutes		m
60 minutes		m

Well number 3: Fogera

Drilling log

መረጃ መያዣ ቅፅ/Drilling Log

የባለቤቱ ሥም ፡
Name of Farmer Kuhar Michael Farmers training Center
ቀን/Date : 14/03/2014

ከተማ /Town : Woreta
የቁፋሪው ሥም ፡
Name of Driller Tamirat Adugna
ጂፒኤስ /GPS
N.
S.
የውሃ ወለል ፡
Water level 1m

ሥዕላዊ መግለጫ Drawing			ጥልቀት (በሜትር) Depth (meter)	የአፈር አይነት መግለጫ Description of the soil	የአፈር ሁኔታ Observation of soil	ማስታወሻ Remark
ፒቪሲ ቅቦ PVC pipe	መጠቅጠቅ Backfilling	የአፈሩ አይነት Type of soil				
		impermeable	0	Clay	Compact	
			7		Soft	
			12		Compact	
			14		Soft	
			23			
			24			

Pump test

Since no aquifer was found, the installation and pump test have not been done.

Well number 4: Fogera

Drilling log

የጉድጓድ መረጃ መያዣ ቅፅ/Drilling Log

የባለቤቱ ሥም :
Name of Farmer Tseganew Mesfine

ቀን/Date : 08/04/2014

ከተማ /Town : Fogera (Gonder)

ጂፒኤስ /GPS
N.
S.

የቆፋሪው ሥም :
Name of Driller Tamirat Adugna

የውሃ መለስ :
Water level 3.4m

ሥዕላዊ መግለጫ Drawing			ጥልቀት (በሜትር) Depth (meter)	የአፈር አይነት መግለጫ Description of the soil	የአፈር ሁኔታ Observation of soil	ማስታወሻ Remark
ፒቪሲ ትቦ PVC pipe	መጠቅጠቅ Backfilling	የአፈሩ አይነት Type of soil				
		Impermeable	0	Clay	Compact	
			1			
			2			
			3			
			4		Soft	
			5			
		permeable	6	Sand	Course	
			7			
			8			
		Impermeable	9	Clay	Soft	
			10			
			11			
			12			
			13			
			14			
			15			
		permeable	27	Sand	Medium	
			28			
			29			
			30			
			31			
		31.5 Impermeable	32	Clay	Soft	

Lithology Legend

Pump test

Pump test

Farmer: Tseganeu Mesfine

Date: 08/04/2014

Location : Shina

Step 1:

Measure before pumping

Volume bucket:	40	L
Length casing above surface	0.7	m
Static water level to top casing	4.1	m
Time when pump started	00:00:00	h

Step 2-5

Drawdown. Measure during pumping

Time to fill bucket		Flow rate		Time when water level stabilised		Water level	
00:12:46	s	3.21	L/s	2 min	h	4	m
00:17:00	s	2.41	L/s	1 min	h	3.8	m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m

Step 6:

Time when pump stopped	30:00:00 (1/2) h

Step 7:

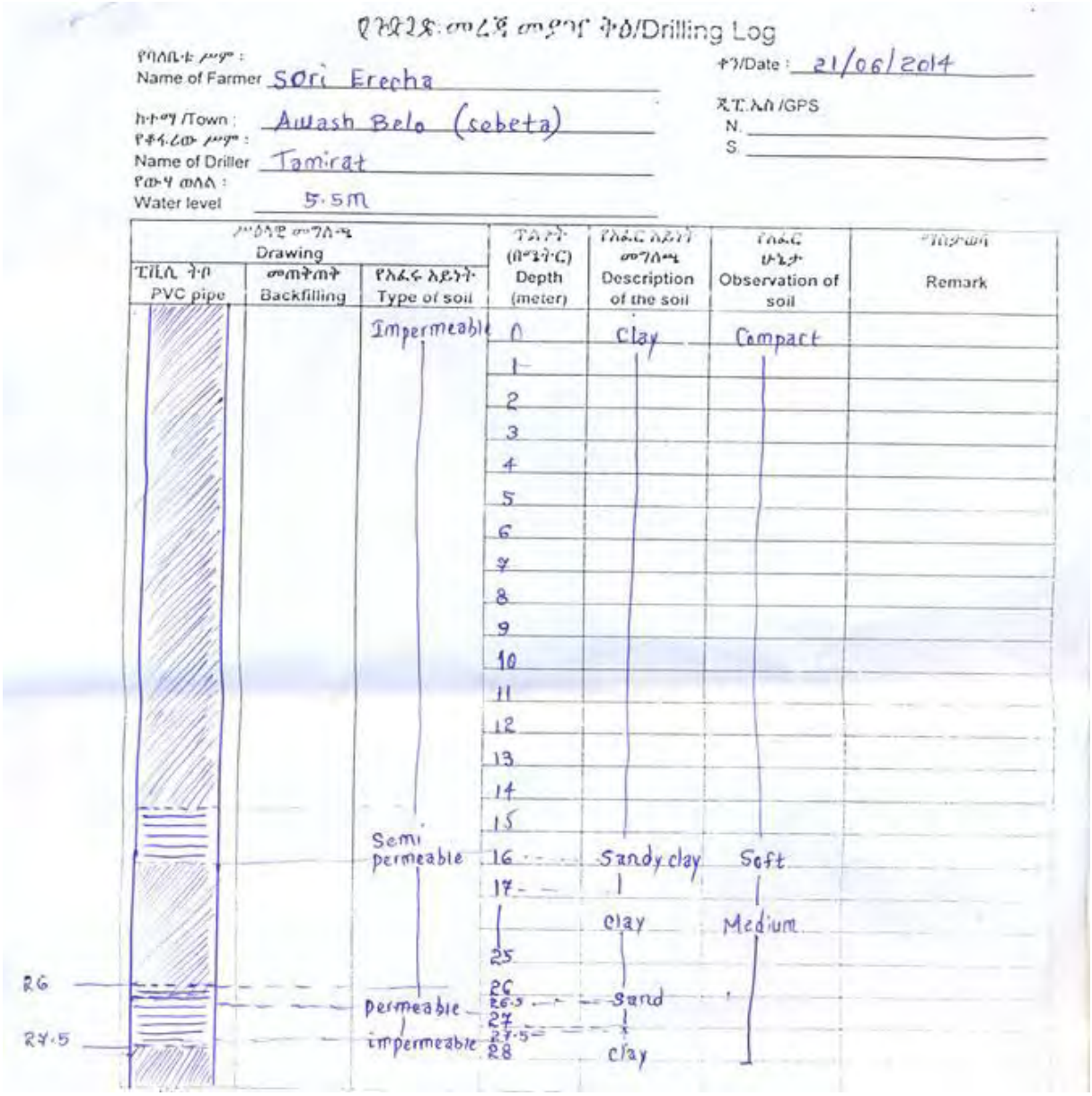
Recovery: Measure after pumping

Time after pumping	Water level	
0 minutes	3.4	m
1 minute	3.8	m
2 minutes	4	m
3 minutes	"	m
4 minutes	"	m
5 minutes	"	m
6 minutes		m
7 minutes		m
8 minutes		m
9 minutes		m
10 minutes		m
20 minutes		m
30 minutes		m
40 minutes		m
50 minutes		m
60 minutes		m

Ec = 0.34

Well number 5: Becho

Drilling log



የንጹህ መጠጥ ውሃ መያዣ ጉድጓድ/Drilling Log

የባለቤቱ ሥም : Name of Farmer Sori Erecha

ቀን/Date : 21/06/2014

ከተማ /Town : Awash Belo (sebeta)

የቆፋሪው ሥም : Name of Driller Tamirat

የውሃ መለስ : Water level 5.5m

ጂ.ፒ.ኤስ /GPS N. S.

ሥዕላዊ መግለጫ Drawing: ፒቪሲ ቱቦ PVC pipe	ሥዕላዊ መግለጫ Drawing: መጠቅጠቅ Backfilling	የአፈሩ አይነት Type of soil	ጥልቀት (በሜትር) Depth (meter)	የአፈር አይነት መግለጫ Description of the soil	የአፈር ሁኔታ Observation of soil	ማስታወሻ Remark
		Impermeable	0	Clay	Compact	
			1			
			2			
			3			
			4			
			5			
			6			
			7			
			8			
			9			
			10			
			11			
			12			
			13			
			14			
			15			
		Semi permeable	16	Sandy clay	Soft	
			17			
				clay	Medium	
			25			
26		permeable	26	Sand		
			26.5			
27.5		impermeable	27			
			27.5			
			28	clay		

Pump test

The result of the first pump test was negative, since the water table was too deep. It was then decided to ream the well to increase the diameter and to install the pump at 1 m depth to overcome the limits of a suction pump. The pump test executed after this adjustment showed a positive result.

Pump test

Date: 21/06/2014

Farmer: Sori Erecha

Location

Step 1:

Measure before pumping

Volume bucket:	10	L
Length casing above surface	-	m
Static water level to top casing	-	m
Time when pump started	00:00:00	h

Step 2-5

Drawdown. Measure during pumping

Time to fill bucket		Flow rate		Time when water level stabilised		Water level	
00:13:52	s	2.96	L/s	1.5 min	h	5.5	m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m

Step 6:

Time when pump stopped	1/2 hour	h

Step 7:

Recovery: Measure after pumping

Time after pumping	Water level	
0 minutes	4.4	m
1 minute	5.4	m
2 minutes 1.5m	5.5	m
3 minutes		m
4 minutes		m
5 minutes		m
6 minutes		m
7 minutes		m
8 minutes		m
9 minutes		m
10 minutes		m
20 minutes		m
30 minutes		m
40 minutes		m
50 minutes		m
60 minutes		m

$E_c = 0.42$

Pump test

Farmer: Sori Erecha

Date:-

Location :- Awash Belo (West shewa)

Step 1:

Measure before pumping

Volume bucket:	20	L
Length casing above surface	1.8	m
Static water level to top casing	6m	m
Time when pump started	00:00:00	h

Step 2-5

Drawdown. Measure during pumping

Time to fill bucket		Flow rate		Time when water level stabilised		Water level	
00:07:11	s	2.98	L/s	3 min	h	4.9	m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m
	s		L/s		h		m

Step 6:

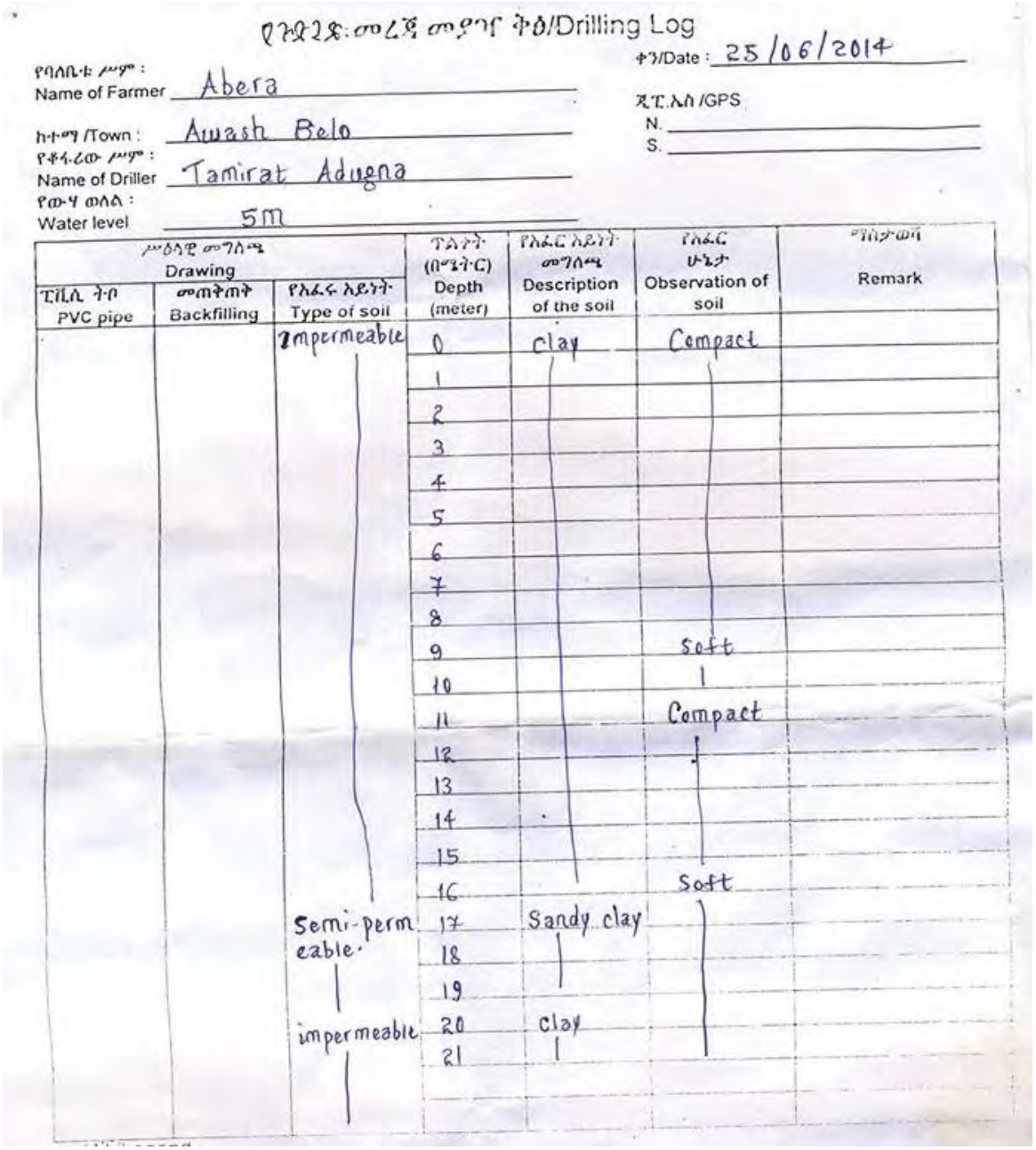
Time when pump stopped	1/2 hour	h

Step 7:

Recovery: Measure after pumping

Time after pumping	Water level	
0 minutes	4m	m
1 minute	4.3m	m
2 minutes	4.7m	m
3 minutes	4.9m	m
4 minutes		m
5 minutes		m
6 minutes		m
7 minutes		m
8 minutes		m
9 minutes		m
10 minutes		m
20 minutes		m
30 minutes		m
40 minutes		m
50 minutes		m
60 minutes		m

Well number 6: Becho



የጉድጓድ መረጃ መያዣ ቅፅ/Drilling Log

የባለቤቱ ሥም : Name of Farmer: Abera

ቀን/Date : 25/06/2014

ከተማ /Town : Awash Belo

ጂፒኤስ /GPS N. S.

የቆፋሪው ሥም : Name of Driller: Tamirat Adugna

የውሃ ወለል : Water level: 5m

ሥዕላዊ መግለጫ Drawing			ጥልቀት (በሜትር) Depth (meter)	የአፈር አይነት መግለጫ Description of the soil	የአፈር ሁኔታ Observation of soil	ማስታወሻ Remark
ፒቪሲ ቱቦ PVC pipe	መጠቅጠቅ Backfilling	የአፈሩ አይነት Type of soil				
		Impermeable	0	Clay	Compact	
			1			
			2			
			3			
			4			
			5			
			6			
			7			
			8			
			9		Soft	
			10			
			11		Compact	
			12			
			13			
			14			
			15			
			16		Soft	
		Semi-permeable	17	Sandy clay		
			18			
			19			
		impermeable	20	Clay		
			21			

Pump test

No pump test was carried out because no good aquifer had been encountered and the static water level of 5 m in the early rainy season is too deep for effective use by a micro pump-set (considering the additional cone of depression that takes place while pumping and the fact that the SWT will be even deeper during the dry season).