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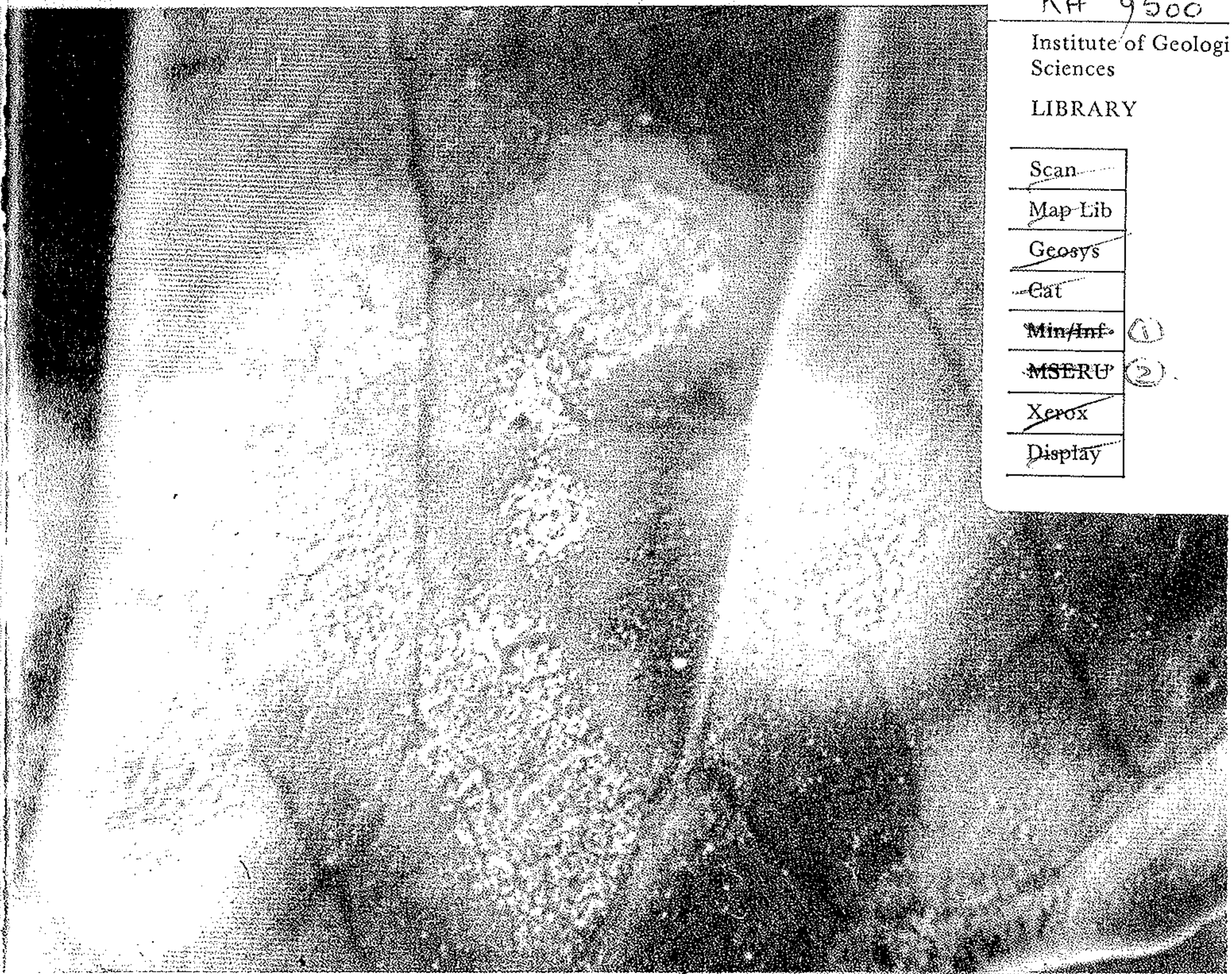

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THE "BUCKET PUMP" — A PROGRESS REPORT

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MAN'S MOST SUCCESSFIL WATER PUMP, the rope and bucket, has been in common use for over 3000 years. Even today it is the most reliable way of lifting water from wells in the rural areas of the world.

As J. Bronowski once said, 'the steady use of the same tool for so long shows the strength of the invention' — the rope and bucket must be one on man's strongest inventions.

For more than a year, Blair Research Laboratory staff have been re-examining this ancient technology and how it can be used to fit into modern day water implementation programmes. The first report of this work appeared in *Science News* last year (Vol. 17. Nos.9/10) and since that time futher progress has been made with the development of the "Bucket Pump"

In the first phase of the study, tubular "bucket pumps" were drawn by hand on a chain from tubes which descended into wide diameter wells. It became very clear however that the bacteriological quality of the water could be improved further by introducing another vital and long used tool — the windlass. The addition of the windlass, in itself an ancient concept, to the well tried bucket and chain added the final and most important component that was necessary to improve the bacteriological quality of the extracted water.

The study showed that much of the contamination that passes into the water of traditional wells actually passes down from the surface on the bucket and chain used for extracting the water. Both the rope and the bucket are commonly placed in the swampy area surrounding most traditional wells — an area which is in itself a focal point for contamination. Clearly a rope or chain wrapped around a windlass makes no contact with the ground — and this feature alone reduces the potential for recontamination of the well. However even when windlasses are used in traditional practice, the bucket itself is normally placed on the ground. Observations made on the use of tubular bucket pumps show that they rarely if ever touch the ground, possibly because it is more convenient to leave them in the head of the tube descending into the well. They are touched by hand, but this source of contamination appears, from the analysis of water samples to be negligible.

In the middle of 1983 an efficient hand operated drilling rig was designed and mass produced by an engineering company in Zimbabwe. This remarkable instrument enabled Blair Research staff to drill tubewells into water bearing aquifers in the ground and fit PVC well casings inside them. This simple and effective technique proved an excellent match fo the "bucket pump" and now large numbers are being fitted to hand drilled tubewells in different parts of the country on extended trials.

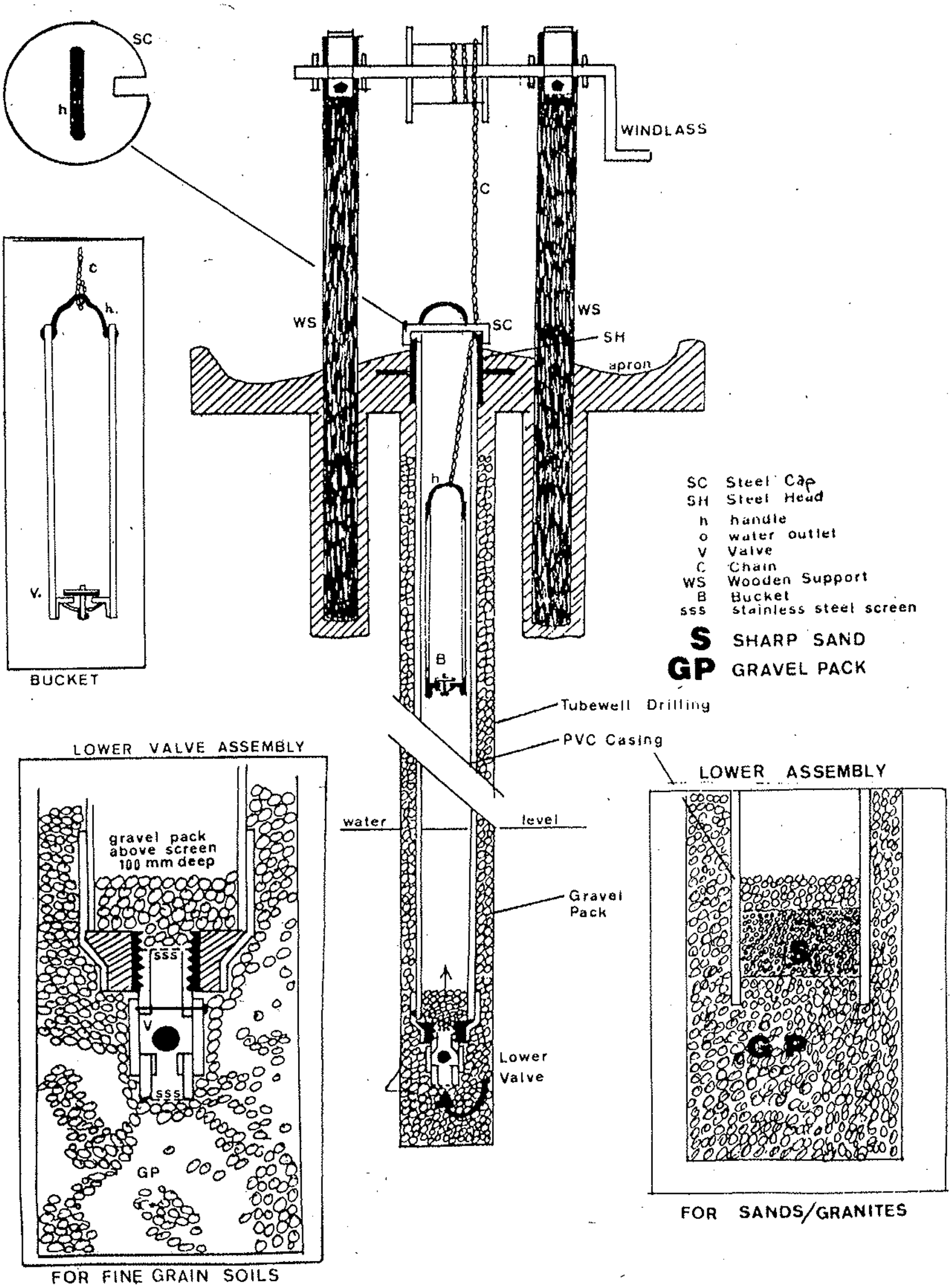
The diagram shows a cross section of a typical "bucket pump" installation. After a suitable location has been found, often with a divining stick, the hand operated rig is brought in and a tubewell is drilled by the villagers themselves under the supervision of the rig operator. It is possible to drill down 12 metres or more in a day or two and drilling continues until the bedrock is met. The next stage of the operation involves fitting a PVC casing into the tubewell — the size normally being 125mm diameter. The actual drilling itself is 170mm in diameter, the annular space between the drilling and the casing being filled with a gravel pack, normally 6mm granite chips. All earlier tubewells were fitted with a foot valve on the casing and this technique is still preferred unless soil has a high content of sand or the excavation penetrates decomposing rock. The foot valve prevents excess turbulence in the gravel pack when the bucket itself enters the water, but experience has shown that if decomposed rock or sand formations are penetrated and a bed of gravel is laid at the foot of the casing, — then a total clarification of the water can be expected. All water entering the casing does so from the bottom.

The next stage involves fitting the windlass supported on stout wooden poles above the tubewell and fitting a steel cap at the top of the casing. The components are mounted in a firm concrete foundation and left to set. A wide "apron" is then built around the tubewell — often 3 metres in diameter and this is fitted with a water run-off, up to 10 metres long which drains into a soak-away or vegetable garden. Finally the bucket itself is added, the valve in its base being tested to see that it is water tight. Water raising can then begin. At first the water is turbid, but clarification takes place rapidly and after a week or two the water becomes very clear, cool and very acceptable for domestic use.

Early buckets were made of PVC, but this material proved too weak for the job and has now been replaced with light gauge steel. Local tinsmiths are attempting to make a suitable bucket and these are currently on trial. However at the present time the best bucket is specially made for the job and is mass produced. The windlass too has been specially designed and can be purchased as a package from a local manufacturer. The strength of the device however, is that it can also be made by the local craftsman — an important feature of rural technology, if village level operation and maintenance is to become a reality.

The addition of the windlass on the bucket pump makes extracted water almost indistinguishable from the water delivered from handpumps in terms of bacteriological quality. The table shows counts made for *E. coli* per 10 ml of water taken from traditional wells, handpumps and bucket pumps. Although there are a few exceptions, most samples of bucket pump water are very similar to those recorded from handpumps, especially when compared to the high counts recorded for traditional wells. Periods of heavy rain had an influence on all water points, the *E. coli* counts be-

BUCKET PUMP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WS Wooden Support
B Bucket
sss stainless steel screen
S SHARP SAND
GP GRAVEL PACK
B
Tubewell Drilling
PVC Casing
LOWER VALVE ASSEMBLY
gravel pack
above screen
100 mm deep
sss
V
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GP
FOR FINE GRAIN SOILS
water
level
Gravel
Pack
Lower
Valve
LOWER ASSEMBLY
S
G.P
FOR SANDS/GRANITES

Data for *E. coli* per 100ml of water from traditional wells, bucket pumps and handpump supplies
Data collected from Epworth Experimental area

Date	Traditional Wells W 64	W 63	W 62	W 61	W 59	W 58	W 57	Bucket pumps (tubewells) B 21	B 20	B 19	B 18	B 17	B 16	B 13	B 11	B 10	B 9	Handpumps (tubewells) W 36	W 35	W 34	W 30	PP 8	W 3	W 31	PP 2	Weather/Comments
9.1.84	1800	1600	1800	350	550	140	65			2	25	0	0	35	0	2	0			0	2	2	8	0	5	
16.1.84	1800	350	550	350	250	250	50			550	9	0	0	0	2	225	8		17	7	45	7	275	0	8	Heavy Rain
25.1.84	225	25	1800	1600	550	25	20			7	0	2	0	0	0	5	0		0	0	0	20	5	0	0	
30.1.84	35	95	1800	900	170	425	1600			2	110	0	0	4	0	70	25		2	7	0	0	5	0	80	Heavy Rain
13.2.84	40	170	1800	95	225	110	35				2	0	5	0	2	50	11	0	0	11	0	8	8	0		
20.2.84	350	900	1600	250	20	17	250		5	2	0	2	2	0	2	0	0	0	0	0	0	0	5	17		
28.2.84	1600	225	250	45	95	1800	50		0	2	5	0	2	0	0	0	0	2	5	0	0	0	13	0		
5.3.84	80	550	350	80	80	550	130		5	2	7	0	8	14	5	0	0	0	2	2	0	0	0	2		
12.3.84	350	350	1600	550	550	350	350		0	11	14	17	0	0	5	7	0	0	2	0	0	14	5	0		
20.3.84	1600	250	1600	550	425	40	250		5	5	17	7	0	0	11	35	11	0	0	0	0	50	5	0		
26.3.84	120	170	225	550	250	17	1600	0	2	2	0	0	2	0	8	11	0	0	0	0	2	0	2	0		
2.4.84	1800	1800	95	900	250	1600	550	350	2	350	5	2	2	5	-2	1600	0	0	11	9	5	5	250	2		Very Heavy Rain
9.4.84	1800	1800	140	40	14	35	225	14	0	2	7	0	5	2	0	4	0	0	5	2	0	2	2			
24.4.84	80	50	11	7	6	2	50	0	0	0	17	2	4	4	4	0	0	0	2	0	0	0	5			
7.5.84	50	35	5	1800	40	8	170	0	0	6	4	2	5	8	11	0	5	0	2	0	0	0	0			
14.5.84	900	80	350	110	50	13	57	2	0	0	5		0	0	35		2	2	5	0	13	0	2			
11.6.84	140	14	1800	550	31	7	110	0			0	0	2	8	9	0	0	0	2	0	0	0	0			

Traditional Wells	Bucket pumps (tubewells)	Handpumps (tubewells)
MEAN E.COLI PER SAMPLE 507,93	MEAND E.COLI PER SAMPLE 25,63	MEAN E.COLI PER SAMPLE 8,73

ing raised in all cases. A high count recorded for bucket pumps in April has been associated with infiltration from a large hollow which was filled with rainwater near the water point. This feature emphasises the importance of correct siting of water points. Clearly they should be sited away from latrines and cattle kraals, but should also be sited away from depressions in the ground which can become sources of gross contamination as when heavy rains fall the contaminants are washed back into the ground water. In Epworth many of these depressions are associated with brick making and are often filled with garbage when they are left. These features may be more responsible for contamination than latrines. The importance of wide aprons and long water runoffs cannot be overemphasised.

In surveys made at Epworth, where the current study is being undertaken, the water points have become very popular and a major source of domestic water for many thousands of people. Each unit can serve up to 150 people, and possibly more, who collect approximately 3000 litres of water per day. The technique appears to be popular because it is reliable and because it is familiar. Large numbers of traditional windlasses, operating a chain and bucket, already exist in Epworth. The bucket pump described here is little more than an upgraded copy of what already occurs in traditional practice. This feature makes the system understandable and easy to manage. Very often a minor breakdown has been repaired on the spot — without a need to bring in special tools, spare parts or expertise from outside. The cost of a single unit, if purchased commercially is between $200 and $250. The steel components consisting of a bucket, chain, windlass, steel casing head and windlass mounts costs about $100. The 125mm class 6 PVC casing costs approximately $8/metre. Cement is required for the skirt and run-off. Thus in the current exercise water is being supplied at a capital cost of less than $5.00 per individual and very often $2.00 — $3.00 per head.

However there are some disadvantages — the relatively slow rate of delivery being one. With the 5 litre bucket (the smallest), delivery of water varies between 5 and 15 litres per minute depending upon depth of the well. Obviously larger buckets deliver more water, but are heavier to lift — a 10 litre bucket is still easy to lift for adults, although children find this more difficult. Another point of concern is the possibility of stones or foreign objects being thrown down the tubewell, especially by children. Remarkably enough, although these bucket pumps have been on trial for over a year there is no recorded case of objects being thrown in the well to date. It is possible that a sense of ownership by the local community may be responsible for this. At every stage, local leaders and the community itself are consulted and the tube is drilled by the villagers, who also collect building materials. On completion of the facility, it is officially opened by the health worker, who emphasises the importance of care and maintenance. The sense of involvement right from the start seems crucial.

There is no reason of course why the system could not be applied to wider diameter wells and indeed this was the original intention. If in fact the critical feature is the hygiene of the bucket and chain, then similar buckets, with simple valves in their bases could be used on upgraded traditional wells. Here particular attention would have to be paid to lining the well, possibly laying a bed of gravel at the bottom, raising the head of well with a collar and providing a wide skirt and run off.

A more recent innovation, now on trial enables the user to place the bucket within a "cup" which opens the valve in the bucket and simultaneously empties the water into the collecting can beneath. This improves the hygiene of the bucket, since the amount of handling is reduced further. It is possible that this same device could be fitted onto wider diameter wells with a water discharge pipe leading from the cup to the awaiting bucket outside a well.

With the first phase of experiments complete, the second phase begins — that of extending the techniques on a bigger scale in more remote parts of the country. Already many units have been installed far away from areas where skilled manpower is close at hand. Even if the technique should succeed, and the bucket pump becomes more common, it is inevitable that they will eventually be replaced by handpumps or piped water supplies which deliver more water and offer even greater protection of the water supply. However hand pumped and piped water supplies require a well organised repair and maintenance service. Whilst these measures are being put into practice on a wider scale it is possible that water lifting arrangements like the bucket pump described here, may find a useful place in many rural water supply programmes.

Acknowledgements

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Agritex extension explaining pump.
(Photo. Ministry of Imformation.)