JESS SECOND CONSULTANCY REPORT ON WATER QUALITY AND PUBLIC HEALTH ENGINEERING

JESS Report No. 11

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ACRONYMS AND ABBREVIATIONS

AID	U.S. Agency for International Development
ARD	Associates in Rural Development, Inc.
cu m/s	cubic meter per second
EC	electrical conductivity
GSDR	Government of the Somali Democratic Republic
ha	hectare
JESS	Jubba Environmental and Socioeconomic Studies
JuDAS	Jubba Development Analytical Studies
MJVD	Ministry of Jubba Valley Development, GSDR
MOH	Ministry of Health, GSDR
NUS	National University of Somalia
UNICEF	United Nations Children's Fund
USAID	U.S. Agency for International Development
WDA	Water Development Agency (Ministry of Mineral and Water Resources, GSDR)

PREFACE

The Jubba Environmental and Socioeconomic Studies (JESS) (project number 649-0134) are jointly funded by the Government of the Somali Democratic Republic (GSDR) and U.S. Agency for International Development (AID). JESS is part of a larger project funded by AID and the GSDR, the Jubba Development Analytical Studies (JuDAS) Project.

Technical assistance and JESS project management are being provided to the Ministry of Jubba Valley Development (MJVD) by Associates in Rural Development, Inc. (ARD), of Burlington, Vermont, under AID contract number AFR-0134-C-00-5047-00. This report describes activities that occurred in the early part of Phase II of JESS, during a December 1986 consultancy for ARD by Dr. William R. Jobin of Blue Nile Associates.

I. EXECUTIVE SUMMARY

The water quality monitoring process for the Jubba River, arranged in June 1986 with the National University of Somalia (NUS), operated satisfactorily and accumulated monthly data from June through December 1986, as well as extra weekly data during the normally rainy month of November. Although the rains in November and December were light, the river water remained highly turbid throughout the six-month period, with Secchi disk readings always less than 20 cm, and usually less than 10 cm. However, in the drainage systems of the Fanoole Rice Project and Mogambo Irrigation Scheme, the water was considerably clearer, with Secchi disk readings between 15 cm and 100 cm. Chlorides in the river were in moderate concentrations, around 100 mg/l in the rainy months of June and December, but dropping steadily during the dry season to 10 mg/l in early October. Chlorides in the drainage systems were slightly higher. During the dry season, the electrical conductivity of the drainage water was significantly higher than that of the river water, indicating leaching of accumulated salts from the irrigated fields. The conductivity in the Fanoole main drain exceeded 700 micromhos/cm in August, nearing the limit for irrigation of some crops. For comparison, the conductivity in the river near Jilib was only 300 micromhos/cm during that month.

The intrusion of ocean water in the river estuary barely reached Goob Weyn during high tides in early December when the river discharge had dropped to 90 cubic meters per second, compared to an annual average of 200 cubic meters per second.

The most striking features of aquatic habitats for mosquitoes and snails in the Irrigated Zone during December was the reduction in extent of surface waters, compared to June when many habitats were found outside of the irrigation schemes. Because of the light rains of the 1986 Deyr season (October-November), the dhesheek* near Fanoole, the seepage areas along Fanoole Canal, and the many surface water collections between Kamsuma Bridge and Goob Weyn were all dry. As the river and main canals were still highly turbid, the only potential habitats for mosquitoes and snails during December were the drainage systems.

In comparison with the luxuriant vegetation and humid environment along the Shebelli River, the Jubba River Valley was relatively hostile to aquatic organisms in December. Thus it is likely that snail and mosquito populations in the Jubba Valley,

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*Note: A dhesheek is a body of standing water not far from the river, which dries out seasonally and usually fills when the river floods. Crops are often planted along the shore as the water evaporates.

and thus bilharzia and malaria, exist at much lower levels than in the Shebelli Valley.

Community water supplies along the Jubba River included deep wells in Jamaame, Jilib, Garba Haarey and Bu'aale, and direct use of river water in all other towns, even in the larger communities of Luuq, Baardheere and Kismayo. River water was used in these towns because subsurface waters contained high concentrations of salt. Adequate supplies for towns along the river were available all year as they could always get water from the river, although it was of poor quality. However, smaller towns away from the river, such as Garba Haarey, had to occasionally resort to hand-dug wells in dry streambeds when their pumps were not functioning, with a reduction in the amount of water available. Almost all community systems were constructed and operated by the Water Development Agency (WDA) of the Ministry of Mineral and Water Resources.

II. INTRODUCTION

This report is based on a December 1986 JESS consulting visit concerning water quality and public health engineering aspects of the proposed Baardheere Dam on the Jubba River in southwestern Somalia. The scope of work is contained in the Appendix.

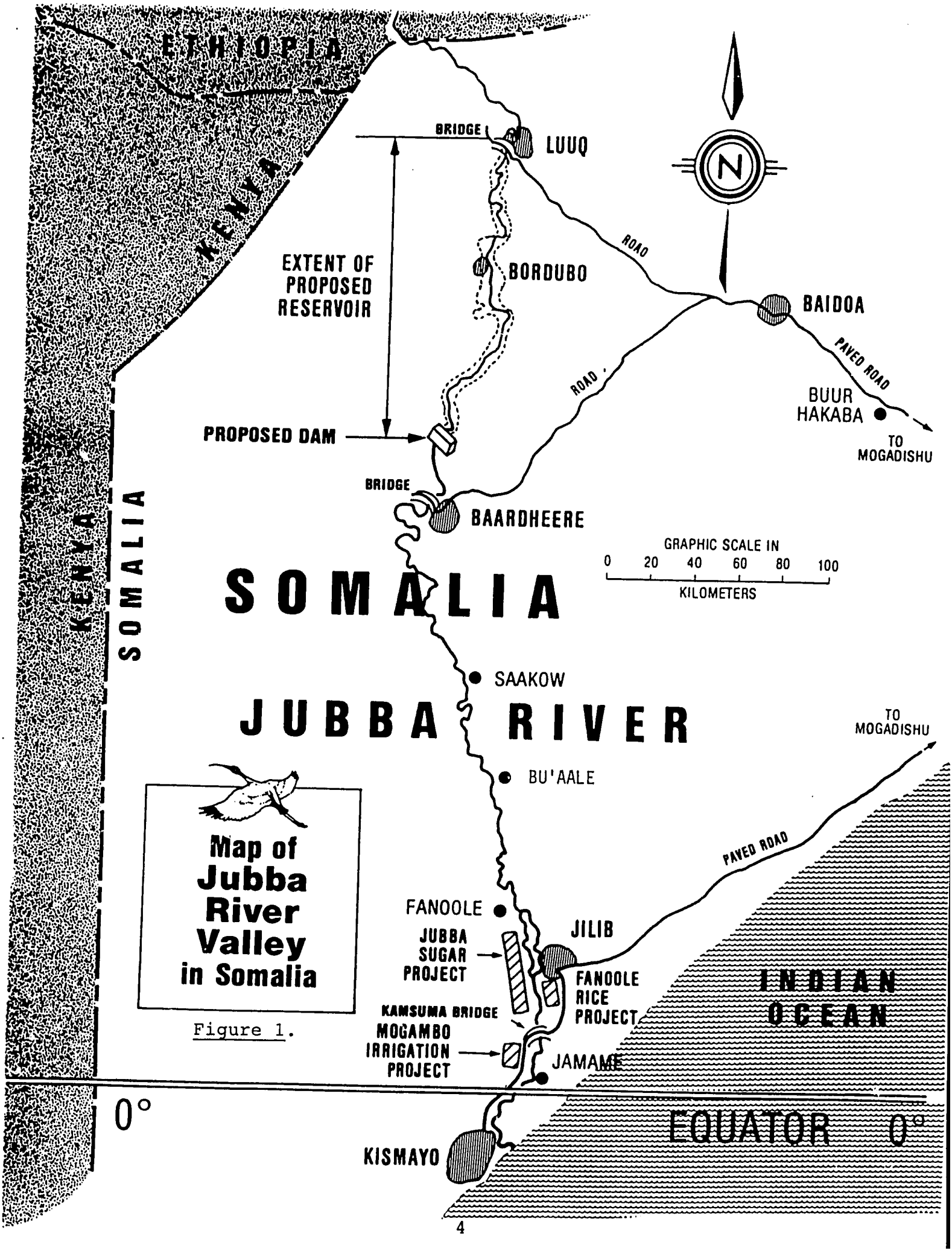
The main objective of this and other interim JESS reports is, to the extent possible, to meet the need for timely information for dam planning as MJVD, the World Bank and other organizations begin to consider specific plans for construction and operation of the dam and associated Jubba Valley activities.

JESS is divided into three phases:

- Phase I (now completed)--project start-up, design of environmental and socioeconomic studies and secondary data collection;
- Phase II (continuing until approximately April 1988)--primary, baseline data collection in the Jubba Valley; and
- Phase III (final six months of the project)--analysis of all data, and delivery to MJVD and AID of socioeconomic and environmental assessments, development guidelines and plan for long-term socioeconomic and environmental monitoring.

The December visit was the third in a series of several Blue Nile Associates plans to make for ARD during the three phases of JESS. From 1 to 21 December 1986, the author of this report visited Somalia to assist in basic data collection on water quality and public health. The consultancy was part of Phase II of JESS, during which emphasis was on collection of primary data to estimate the impact of dam construction and related development, on developing a long-term monitoring system, and on designing guidelines for future development activities.

During the December consultancy for ARD, two field trips were made to the Jubba Valley concerning water supply, disease transmission and monitoring of water quality in the Jubba River. The first field trip was for water quality and vector surveys in the irrigated zone of the valley's coastal portion, including a short diversion to Janaale in the Shebelli River Valley to compare aquatic habitats there with those of the Jubba Valley. The second trip was in the Reservoir Zone near Baardheere and focused principally on water quality sampling (Figure 1). The cooperative system established with NUS for sampling water



Map of Jubba River Valley in Somalia

Figure 1.

quality in the Jubba River was reviewed, and a summary made of the data collected before December.

This report summarizes the field activities, the general data collected, and the preliminary conclusions reached during this three-week consultancy. However, extensive analysis of the data remains to be completed, including computer simulation of water quality in the river, and simulation of vector habitats and disease transmission in existing rain-fed agricultural, irrigation and drainage systems. This extensive analysis and reporting will be completed during 1987 to meet the necessary planning deadlines for the Master Plan being developed by MJVD.

Another visit is scheduled for April 1987 to evaluate water quality, habitat conditions and community water supplies during the end of the dry season, which will be extremely dry this year due to the light rains in October and November 1986.

Negotiations were completed with the Ministry of Health regarding future surveys during June 1988 on mosquitoes, snails and flies of public health importance, and proposals were finalized for health surveys to be conducted during November and December 1987 on the major water-associated diseases (bilharzia and malaria) in the Jubba River Valley.

III. AQUATIC HABITATS IN AGRICULTURAL SYSTEMS

During the Deyr rainy season of 1986, there was very little rainfall in southern Somalia during October and November, and only light showers in December, when this survey took place. Thus, the overall condition in the Jubba River Valley was much drier than normal, and aquatic habitats for mosquitoes and snails were rare, reduced almost entirely to the irrigation schemes which were obtaining water from the Jubba River. The river level at Kamsuma Bridge on 4 December 1986 was 2.15 meters, about three meters lower than it had been in June 1986 at the end of the Gu rainy season. The flow in the river was thus about 90 cu m/s, compared to the annual mean of 200 cu m/s. This dry condition should be kept in mind when reading the rest of this section. It is especially important to note that the rainwater ponds and swamps which were the habitats for the bilharzia snails and most of the malaria mosquitoes during the previous habitat survey in June 1986, were nonexistent during this December survey. Undoubtedly, this significantly reduced transmission of the diseases during this season.

A second major consideration to bear in mind while reading this section is the relative scarcity of favorable mosquito and snail habitats in the Jubba Valley even in wet years, when compared to the Shebelli River Valley where most of the previously published studies on bilharzia were conducted. During December, a short comparative inspection along the Shebelli River was made near Janaale and it was observed that the amount of surface water was at least an order of magnitude greater in number and area of habitats than that in the Jubba Valley. The isolated aquatic habitats along the Shebelli River contained considerable water in December and appeared to be permanent, compared to the habitats in the Jubba Valley, most of which dry out normally in February and March and which were already dry this year in December, only one month after the rainy season. This fundamental difference in habitats may explain the scarcity of bilharzia snails in the Jubba Valley, and may indicate that the present prevalence and intensity of *Schistosoma haematobium* infections in the Jubba Valley may be lower than that of the Shebelli Valley. Previous impressions of high prevalence and intensity in the Jubba Valley may be due to the small size of the samples taken, or because only a few villages were surveyed.

This portion of the report on habitats is organized by agricultural systems. Background on configuration and operation of the systems can be found in the previous trip report for June 1986 (JESS CONSULTANCY REPORT ON WATER QUALITY AND PUBLIC HEALTH ENGINEERING, JESS Report No. 7, William R. Jobin, ARD, November 1986). Significant expansion occurred in the Mogambo and Fanoole irrigation projects since June, but the other projects and the dhesheek near Fanoole had not been expanded.

Dhesheek near Fanoole

Because of the low rainfall and low river level, this dhesheek did not fill during the Deyr season and was almost completely dry on 8 December (Table 1). The only water remaining was about one hectare (ha) of a weedy mudhole in the center. The rest of the land (about 30-40 ha) was covered with nearly ripe maize. One of the farmers explained that the dhesheek did not flood every year, and that it had pretty well dried out by September in 1986. However, the soil moisture remaining from the last Gu season and from recent light showers was apparently sufficient to yield a modest crop. The last surface water in the small mudhole will surely disappear before the end of December. As most of the habitat was dry since September, snails and other aquatic organisms that inhabit the site will be dry until April when the rains will probably come again. This dry period of eight months will cause high death rates among estivating bilharzia snails, which normally have to endure only two or three months of drying. Temporary elimination of the snail populations becomes likely if this happens very often.

Table 1. Deyr Season Results from Second Survey of Potential Habitats of Aquatic Vectors of Disease in Irrigated Zone of Jubba River Valley, December 1986
(parentheses indicate estimated values)

Location	Habitat	Velocity in cm/s	Depth in cm	Secchi Disk in cm	Temp °C
FANOOLE	main canal	50	150	30	30
	dhesheek		- - - - dry - - - -		
	standing water		- - - dry - - - -		
	drain	0	150	40-100	26
MOGAMBO	main canal	25	140	20	30
	reservoirs	waves	120	20	30
	drains	0	100	30-40	28-30
JUBBA	main canal	0	10-100	20	28
SUGAR	drains		under construction		
SOMALFRUIT	standing water		- - - - dry - - - -		
DHESHEEK	near Fanoole		- - - - dry - - - -		
JUBBA RIVER	near Jilib	(30)	(50-100)	20	30
	at Gob Weyn	tidal	(150)	20	29
RAIN POND	at Gob Weyn		- - - - dry - - - -		

For comparison, the results of the first survey (June 1986) are given in Table 2.

Table 2. Vector Habitats in Irrigated Zone, June 1986
(parentheses indicate estimated values)

Location	Habitat	Velocity in cm/s	Depth in cm	Secchi Disk in cm	Temp °C
FANOOLE	main canal	31	100	6	26.2
	standing water	0	30	>30	30.5
	drain	0	100-200	20-50	28.0
MOGAMBO	main canal	25	140	10	29.5
	night storage	0	150	10	26.6
JUBBA	main canal	0	50	20	29.0
SOMALFRUIT	standing water	0	20	20	--
DHESHEEK	near Fanoole	0	50	7	29.2
JUBBA RIVER	at Jilib	(100)	200-300	1	27.0
	at Gob Weyn	80	200	1	27.0
RAIN POND	near Gob Weyn	0	100	(20)	(30)

Fanoole Rice Irrigation Project

Considerable improvements were made recently in the Fanoole Irrigation Scheme, including widening and re-grading of the main canal banks and filling of ditches and depressions along the canal which formerly contained rain and seepage water. There had also been considerable land preparations and field ditching in the rice-growing zones. The rice mill was put into operation, and a new main drainage station was under construction next to the original drainage pump near the village of Mobarek. There also seemed to be considerably more planting and cultivating activity compared to last June.

The Fanoole Main Canal near Kilometer 15 was choked with emergent vegetation, including *Typhia* sp. (cattails) and an unidentified vine with broad, waxy leaves. There was also considerable floating *Pistia* sp. (water lettuce), leaving only 25 to 50 percent of the canal section free-flowing. The water was brown and turbid, with a high-velocity zone in the center of the channel but large stagnant zones along each of the weedy margins. Depth was about 1.5 m, nearly 0.5 m deeper than last June, and Secchi disk readings were 30 cm (Table 1). There were no snails of any kind, despite the clearer water. Electrical

conductivity (EC) of the water was 489 micromhos/cm, and the temperature at 1600 hours was 30°C. The canal attracted many frogs, birds, warthogs, monkeys and cattle, and also a massive infestation of sow bugs on the east bank.

Across the road from the canal at about Kilometer 20, near a village of 100 huts called Hila Sheed, a cattle watering hole had a maximum depth of 0.5 m and a total area less than one hectare. About 10 percent of the fringes were covered with cattails, the water was green, the Secchi disk reading was one centimeter, the conductivity was 1200 micromhos/cm, and the temperature at 1700 hours was 31°C. The water was not used by the villagers, who went to the canal instead. There were no snails.

Almost all the ditches, ponds and swampy areas along the canal were dry, including those reported in Table 4 of the June 1986 trip report (JESS Report No. 7). As the main canal passed through Jilib the water became deeper and flow was slower, due to control structures. At crossings and other places, human contact with the water was extensive. At 1700 hours, about 100 people were gathered on the canal at the road crossing in Jilib--mostly boys fishing, but also many adults were bathing or drawing water.

Fanoole main canal, south of Jilib, was also deep and slow flowing with highly turbid and brown water, until diversion into the rice fields. The dry canal downstream of the diversions occasionally contained pockets of rainwater or seepage water, but they did not contain snails. These small pockets were clear, with emergent grasses, probably filling only for short durations after rains.

The main drainage station on Fanoole Drain near the village of Mobarek was being enlarged. The pumping bay contained very little water, about 50 cm deep, colored light green from algae, and had an estimated Secchi disk reading of 80 cm (Table 1). The new pumps will be much larger and will probably be ready by April 1987. Thereafter, the larger discharge will increase the amount of leached salts returning to the Jubba River from the rice fields.

Drainage flow was diverted to a temporary ditch south of the pumping station which led directly to the river. Flow through the temporary ditch was very rapid at the point of diversion to the outfall drain, approaching 1 m/s. However, further upstream, in the large drain along the access road coming from the main canal crossing, the flow velocity was less than 1 cm/s, the Secchi disk reading was about 1 m, and the color of the water was light green due to algae. Light emergent vegetation along the sides and the other conditions indicated that this entire drainage system could be suitable for snails and mosquitoes. Their absence at this time may have been due to the fluctuation in level caused by intermittent operation of the drainage

diversion. Nearby fields were being leveled and prepared for rice planting.

It is very likely that the main canal and the drainage system will become ideal habitats for bilharzia snails during the dry months of January, February and March when the water clarifies. Transmission could occur near towns and villages, especially along the canal passing through Jilib.

Mogambo Irrigation Scheme

The Mogambo Irrigation Scheme had a new general manager, Mr. John Holthouse. Since June, they had completed the third and fourth night-storage reservoirs, put gravel on the main perimeter road, prepared large portions of new fields, and completed the main drainage system. A set of earth-moving machinery was leveling new rice fields at the time of the December survey, and many precast concrete inlet structures were being placed in the new fields. The first village near the main canal had a wind-driven pump for drinking water, but the village was still in the same low area with poor drainage. The flood diversion channel was dry and had not been used since last June. Cattle were grazing along the canal bottom.

The general manager stressed that they have retreated from the original plans for two rice crops per year and are now testing one rice crop per year in a rotation including sesame and two fallow periods. He had some knowledge of entomology and suggested that their precast inlet structures have stilling basins which may hold water long enough for mosquito breeding. When they are installed, they should be monitored for mosquito larvae. They will be inspected for larvae during the April 1987 vector habitat survey, and also during the habitat survey expected in June 1988.

The two older night-storage reservoirs (N11 and N12) were nearly full at noon on an extremely windy day. East winds of five to eight m/s were causing severe erosion on the western shores. Water coming in from the main canal had a conductivity of 470 micromhos/cm, the Secchi disk reading was 20 cm, and the temperature was 30^{o}C at 1200 hours (Table 1). The water color was reddish brown and the canals were free of vegetation. The night-storage reservoirs had no vegetation but many shells of large ampullarid snails (*Pila* sp. and *Lanistes* sp.) were seen along the eroding shore which was largely gravel in composition. The presence of the ampullarid snails indicated that general conditions were suitable for the bilharzia snails also. However, bilharzia snails are too short-lived to endure long periods of high turbidity when no algae are present for newly hatched snails to feed on. The ampullarids, however, live about two years and may have an amphibious stage during which they can obtain food.

The reservoir on the west side of the delivery canal contained crocodiles and many ducks, herons, egrets and other aquatic birds.

Two new night-storage reservoirs further downstream along the delivery canal were located immediately west of the village of Buulo Burwako and were put into operation in October. These reservoirs were also filling at noontime when the survey was made. Guards claimed they were 10 meters deep, and it is likely that some places may be deeper than the design depth of two meters because the reservoir areas were excavated to obtain earth for filling surrounding dikes and roadways. The reservoirs contained no vegetation, were also eroding like the other two reservoirs, contained water of the same quality, and were similar in appearance to the other reservoirs. They contained large crocodiles and many birds.

The main drainage station was at the southwest corner of the project. A small amount of drainage water was flowing by gravity to the plain west of the project, and the large pumps were not needed because of low water levels outside the system. Several drains leading to the pumping bay contained moderate floating and emergent vegetation, with 25 percent coverage by a vine with broad waxy leaves. The water was green, with a Secchi disk reading of 30 to 40 cm and conductivity of 900-1,000 micromhos/cm. The temperature was 28-30^{o}C at 1400 hours. The drains were about 10 meters wide and one meter deep with velocities near zero. There were crocodiles and large *Pila* sp. snails, but no bilharzia snails were found.

An important general observation for the Mogambo drains, and maybe for the night-storage reservoirs, was that they will probably become good habitats for bilharzia snails as they mature, especially in the dry months of January, February and March when the water becomes more clear.

A shallow pond near the village of Mana-Mufo on the east side of the road about 10 km north of Araare Bridge contained moderate-sized *Pila* sp. snails and large *Cleopatra* sp. snails. The pond bottom was anaerobic, the water was clear, and the vegetation, including lilies and sawgrass, covered 90 percent of the surface. No bilharzia snails were found. This was probably seepage water from irrigation canals or from the river, as there had been no recent rains.

Jubba Sugar Project

It was not possible to get any direct information from the management personnel at Mareerey. The consultant was advised to put his requests in writing to the Executive Director in Mogadishu. He asked Mr. Gelle of the Water Quality Laboratory if

he could supply the promised summary on daily measurements of sodium, calcium and magnesium in the Jubba River, but Mr. Gelle was busy and unable to help at the time.

The Little Jubba River, used as the main canal upstream of Mareerey, was highly turbid, red in color, with a conductivity of 350 micromhos/cm and a temperature of 28^{o}C at 1200 hours. The Secchi disk reading was 20 cm, the velocity was about one cm/s and the canal was about one meter deep (Table 1). This portion of canal was subject to large variations in depth and flow, having risen two days previously from nearly zero depth. Near Hargeisa-Loi Leida Village, at noontime, about 50 people were in the canal, their only source of water. A rain pool near the village had dried some months ago.

The main spine canal and distributary canals had been recently filled, but no irrigation was being conducted. Probably they planned to begin irrigation soon, if the river did not drop too far. Conditions of the canal appeared very similar to those encountered in the June survey, but snail searches were not conducted because high turbidity usually indicates the absence of bilharzia snails.

IV. WATER QUALITY MONITORING

NUS personnel had begun monitoring water quality in the Jubba Valley during June 1986 and continued on a monthly schedule until November, when samples were taken weekly. During December, the monthly schedule was resumed and the consultant observed the sampling procedures, reviewed the laboratory procedures and collected the accumulated data for processing. From this review process, the observations and recommendations given below were developed to improve the monitoring program during the final six months.

In general, the monitoring process was satisfactory. The proposed schedule of samples was followed except in September when no vehicle was available. The specified parameters were monitored except for trace metals and color. Arrangements were made to correct these omissions. Procedures were followed correctly, and the final data can be used with confidence. The data accumulated thus far indicated the general salt content of the river and would make possible some tentative predictions, even before completion of the final sampling. However, the flood and rains during this Deyr season were low, and problems with predictive analyses could arise if the Gu season rains also fail. In that event, it might be necessary to extend the monitoring for another year, or at least portions of it during the rainy seasons.

The consultant, assisted by Mr. Abdel Qafar of NUS, went on the December sampling runs from Baardheere to Kismaayo and personally observed all sampling procedures, which had been improved slightly over the original recommendations. At each sampling, larger four-liter bottles were used for the main sample, and supplemental samples in two 0.5-liter bottles were taken for separate acidification with sulfuric acid and with nitric acid. These improvements made it possible to conduct more retesting, and gave better data on the phosphates, nitrates and sulfates.

As mentioned above, after the triple sampling in June 1986, monthly samples were taken in July, August and October, with weekly sampling in November. In December, the monthly sampling schedule was resumed. This should continue until April, when daily conductivity and Secchi disk readings should be started on-site at Baardheere Bridge. Weekly samples should also be taken there in April for normal laboratory analyses.

As it is very likely that monitoring of conductivity at the pumps in Mareerey by the staff of the Jubba Sugar Project will continue and that the data will be made available to JESS personnel, sampling in the lower Jubba Valley can be discontinued

on 1 April, in order to facilitate the increased sampling frequency at Baardheere.

If the floods come in April, then the daily monitoring can be terminated on the last day of April, followed by weekly samples in May at all stations. If the floods are late, however, the daily sampling should continue into May until at least two--and preferably three or four--flood peaks have been recorded at Baardheere Bridge. If funds are available, a short extension of the monitoring program could be considered in April in the event that more data are desired on any particular parameter.

Analysis for trace concentrations of arsenic, boron and selenium was not carried out due to a need to recalibrate the Atomic Absorption Unit at NUS. The technician from the Milan office of Perkins-Elmer had not come as promised in August, and again failed to come in November. The samples are being held for this portion of the analysis, but a resolution of the problem should be made soon. Two other AA units are available nearby, but also require calibration.

Although the platinum salt compound was delivered to NUS in September, the color analysis had not been initiated because the proper Nessler tubes could not be found. This is an important parameter for modeling productivity and clarity in the proposed reservoir and should be initiated immediately. All other parameters were measured as agreed.

Although the rains in November and December were extremely light, the river water remained highly turbid throughout the six-month period, with Secchi disk readings always less than 20 cm, and usually less than 10 cm (Tables 1 and 3). However, in the drainage systems of the Fanoole Rice Project and Mogambo Irrigation Scheme, the water was considerably clearer, with Secchi disk readings between 15 and 100 cm.

Chlorides in the river were in moderate concentration, around 100 mg/l in the rainy months of June and December, but dropping steadily during the dry season to 10 mg/l in early October (Table 3). Chlorides in the drainage systems were slightly higher. During the dry season, the electrical conductivity of the drainage water was significantly higher than that of the river water, indicating leaching of accumulated salts from the irrigated fields. The conductivity in the Fanoole main drain exceeded 700 micromhos/cm in August, nearing the limit for irrigation of some crops. For comparison, the conductivity in the river near Jilib was only 300 micromhos/cm during that month (Table 3).

Table 3. Water Quality in the Jubba River, June-November 1986

Sampling Location & Month	Temp in °C	Secchi Disk in cm	EC Micro-mhos/cm	Chlorides in mg/l	Nitrates in mg/l
BAARDHEERE BRIDGE:					
June	25.3	1	218	12	4.0
July	-	-	452	18	-
August	29.8	5	251	11	3.6
October	29.8	6	239	7	3.4
November	30-34	1-20	231-356	16-30	-
JILIB FERRY:					
June	26.3	1	538	102	2.4
July	25.5	1	194	10	3.4
August	-	-	305	18	1.4
October	31.5	5	208	9	4.8
November	30-34	10	246-260	14-24	-
December	30.0	20	400	100	
ARAARE BRIDGE:					
June	27.5	1	452	102	5.6
July	26.0	1	194	10	2.7
August	-	-	305	18	1.8
October	-	-	208	9	6.2
November	30-34	5-10	246-292	14-24	-
December	30.0	10	510	162	
GOB WEYN:					
June	28.5	1	278	86	4.6
July	27.5	1	199	10	2.8
August	-	-	266	14	1.0
October	27.6	5	186	9	6.0
November	30-34	5-7	269-304	16-27	-
December	29.0	20	385	88	-
FANOOLE DRAIN:					
June	27.6	71	486	76	2.0
July	30.0	45	251	12	1.3
August	-	-	714	89	1.2
October	30.0	50	298	14	1.8
November	29-34	15	321-479	20-44	-
December	26.0	40	395	112	-

The intrusion of ocean water in the river estuary barely reached Gob Weyn at high tide during early December, when the river discharge was 90 cu m/s, compared to an annual average discharge of 200 cu m/s.

Supplemental water quality data were available from two other sources. The laboratory at the Jubba Sugar Project should soon supply a summary 12 months of daily sampling on calcium, sodium and magnesium in their intake water, and an ARD consultant collected comprehensive data on salts in the Shebelli River during September 1986. These should be ready for analysis before April 1987 when the JESS monitoring is completed. When assembled, these additional sets of data should thus make it possible to conduct a detailed evaluation of the potential health and agricultural impact of water quality changes in the Jubba River due to the proposed Baardheere Dam. The total annual load of salts carried by the river can be estimated and, thus, mixed or stratified conditions in the proposed reservoir can be approximated, primarily to estimate the acceptability of the dam discharge for agricultural uses downstream. It will also be possible to estimate salt increases in drainage water, and thus the salt concentrations in the river during dry periods, again to determine acceptability for agricultural uses.

V. COMMUNITY WATER SUPPLIES

The major towns and some villages of the Jubba River Valley were visited to determine the existing community water supply systems and the institutional arrangements for their construction, operation and maintenance. This survey will be repeated at the end of the dry season in March to determine whether the supplies last through the dry season.

The purpose of this assessment of community water supplies is to develop recommendations for methods of providing water supplies to new and resettled communities that will be developed as a result of Baardheere Dam construction.

Nationwide, the larger water supplies are drilled, constructed, operated and maintained by the WDA of the Ministry of Mineral and Water Resources. The pump operators are employed by the WDA and collected funds are returned directly to the WDA for recurrent expenses. Their annual expenditures in 1984 were 66 million Somali shillings for development of new community water supplies and 50 million shillings for recurrent expenses. They collected 11 million shillings in tariffs from water consumers. Prices obtained at individual wells varied considerably from official figures. For 1986, the official price for WDA water was 18 shillings per cubic meter, with daily charges per head of livestock.

The independent Kismaayo Water Agency, which owned a surface water treatment system, was an exception to the national organization. This agency reported recurrent expenditures of 20 million shillings in 1984 and tariff collections from consumers of seven million shillings. The deficit was covered by the Ministry of Finance.

The Ministry of Local Government and Rural Development also owned and operated some wells, as did the Ministries of Agriculture and of Livestock, Forestry and Rangelands.

The surveys completed during December included the towns of Kismaayo, Jamaame, Jilib, Bu'aale, Saakow, Baardheere, Garba Haarey and Luuq, as well as the villages of Gob Weyn, Buulo Burwako, Hargeisa-Loi Leida and Anoole.

Kismaayo Water Agency had a water intake and filtration system located in the village of Yontoy, with a 25-km pipeline to Kismaayo. The system was old and no longer provided efficient filtration due to lack of chemicals and spare parts. Water from the tap was soft but contained considerable turbidity, some of which settled out almost immediately. The staff at the agency office said that several plans for rebuilding the filters have been discussed but nothing has materialized. Capacity data were

not available but, based on tariff income, the capacity was estimated at 700,000 cubic meters. This would be 2,000 cubic meters per day, enough to supply 100 liters per day to a community of 20,000 people. There were a few private wells in the town, but everyone was served by the pipe system.

The village of Gob Weyn obtained all of its water directly from the river. It was hauled by donkey carts carrying 200-liter drums.

The town of Jamaame had a well constructed in 1979 near the Somaltex compound at the southern entrance to the town. The well is about 60 meters deep and has a diesel pump. An elevated storage tank of 20 cubic meters provided adequate pressure for supplying a piped distribution system. The tank was also used to supply donkey carts that came to the well site. The pump ran from 6 a.m. to 6 p.m., alternating an hour of pumping with hourly rests.

Buulo Burwako village in the Mogambo Irrigation Project had a dug well with a broken hand pump. The well was constructed by the local government about five years ago, but the pump had been broken for about a year. Water was drawn with a bucket. Although the users described the water as being sweet, clear and reliable year round, the conductivity was 4200, chlorides were 1000 mg/l, and the sodium concentration was 400 mg/l.

The town of Jilib had two drilled wells, each 72 meters deep. One is capped and awaiting a pump and engine. The other, located near the road crossing on the Fanoole Canal, was operating. This unit had a 20-horsepower Austrian diesel engine driving a Capratti pump at 1,500 rpm, running one hour off and one hour on, from 6 a.m. to 6 p.m. Elevated storage included a rectangular concrete tank of 18 cubic meters, which supplied the piped distribution system, and a 10-cubic-meter, cylindrical, metal tank for supplying donkey carts. The price charged to the donkey carts was 10 shillings for 200 liters, which they resold for 60 shillings. The estimated total consumption for Jilib from this well was 56 cubic meters per day, assuming the tanks were filled twice a day. In addition, however, there were 13 dug wells each 15 meters deep, five of which were operated by the Ministry of Local Government with hand pumps. The other wells include four in mosques and four private wells. Well water in Jilib was clear and did not have a salty taste.

The town of Bu'aale was the regional center for the WDA and had a good dug well with a pump. Sweet water was available year round through a piped distribution system and through public standpipes.

The town of Saakow had a WDA well which was reliable and sweet, but last year the pump broke and had not been repaired.

People were getting their water from the river with donkey carts. Water-associated diseases were a major concern in Saakow.

The village of Anoole, about 30 km south of Baardheere, relied completely on the river for water, distributed by donkey carts.

The town of Baardheere had a drilled well and a dug well, but the water had a conductivity over 10,000 and was unsuitable for human or animal use. Thus, all drinking water was obtained by donkey carts, which got water from the river near the bridge and at a point one kilometer upstream. Some private pump systems were also used.

The town of Garba Haarey had a WDA well, 120 meters deep with a six-inch casing, diesel-powered pump and elevated storage. It had a yield of 38 cubic meters per hour, and the water had a conductivity of 3,000 and a salty taste. Homes were supplied by pipes and by donkey carts. The well was reliable year round, but seven shallow wells in dry streambeds were used when the pump failed or when fuel was not available.

The town of Burdubo, center for refugee activities, had two drilled wells which yielded nine cubic meters per hour of salty water with a conductivity of 4,000. This system included elevated storage, but it should be realized that the town and surrounding refugee camps will be permanently flooded under 10 meters of water when the reservoir behind Baardheere Dam fills. Nearby refugee camps had various filtration systems for river water, but they also will be flooded out.

The town of Luuq used river water directly, supplied by donkey carts. However, in the surrounding refugee centers, there were at least four drilled wells which yielded up to 40 cubic meters per hour of satisfactory water with a conductivity of 700. These refugee centers are on high ground and will not be flooded by the proposed reservoir.

VI. STATUS OF PLANNING

The current status of planning by MJVD and its consultants was reviewed with personnel at the Ministry. As of mid-December 1986, planning on Baardheere Dam and the expected related developments had progressed to the point where significant decisions could be made in 1987. In order to guide the preparation of interim reports for JESS, the following summary of planning events was prepared.

- The final design of the dam has been agreed upon.
- The Pilot Study on Dhesheek Agriculture has been completed by the AHT consultants. It was expected that the first copies will be delivered to MJVD before the end of the year.
- A Master Plan will be initiated in January 1987 by AHT.
- A study on opening the Homboy Irrigation Scheme was being conducted by the Hunting Group with MMP. Mr. Finney was their agricultural economist.
- The World Bank appraisal mission for Baardheere Dam will probably be delayed until November 1987.

VII. NEXT HABITAT SURVEY IN APRIL 1987

The next scheduled consultancy by the author is for the month of April 1987, to determine vector habitat conditions during the end of the dry season, and to ensure the monitoring of water quality in the river during the first floods of the Gu season. Data will also be collected on the clarification rate of the flood waters, and on infiltration rates of subsurface water into the riverbed during the final weeks of the dry season. The intrusion of ocean water up the river mouth will also be measured during this dry period.

VIII. PROPOSED HEALTH SURVEYS IN NOVEMBER 1987

Three additional surveys on human and animal health are proposed for November and December of 1987 to indicate health conditions prior to construction of the dam, and to provide data for planning agricultural developments and for operating the dam. Arrangements were negotiated with the National Antimalaria Service of the Ministry of Health and other agencies, and include provisions for a household survey of infant health, for a schoolboy survey of malaria and bilharzia, and for a survey of intestinal parasites of schoolboys and livestock in the Kismaayo district.

The surveys will last four to five weeks and will require the services of the consultant and a parasitologist associate, plus some supplies and equipment. Final details on interagency agreements should be completed by the end of the April 1987 consultancy mentioned in Section VII, but the JESS chief of party in Mogadishu must play an important role in preparing personnel and vehicles for the surveys, prior to the arrival of the consultants in November.

IX. PROPOSED VECTOR SURVEYS IN JUNE 1988

Vector surveys are proposed for June 1988 on mosquitoes, snails and flies of importance in human and animal health, to establish pre-construction conditions and to provide data for planning agricultural developments and for operating the dam.

The surveys will measure the distribution of anopheline and other mosquitoes, measure the night-biting rate of the anophelines, ascertain the presence or absence of blackflies, evaluate the National Tsetse Fly Control Program, and determine the distribution of aquatic snails which spread bilharzia and cattle parasites.

The vector surveys will last one month, requiring a month's time of the consultant and a parasitologist associate, and two weeks' time of an entomologist associate. It may be advantageous for the entomologist associate to begin his work about 20 May 1988, when conditions are more favorable for the blackflies. Again, it will be important for the JESS chief of party in Mogadishu to assure that personnel and vehicles are ready for the consultants.

APPENDIX

Scope of Work, Phase II, William Jobin: Water Quality III

1. The contractor will conduct a four-week consultancy in Somalia beginning on or about 30 November 1986 for Associates in Rural Development, Inc. (ARD).

2. The general focus of this consultancy will primarily be on the public health aspects of water quality in the Jubba Valley and secondarily to continue water quality sampling and inspections of vector habitats for bilharzia and malaria.

3. Prior to departure for Somalia, the consultant will hold a telephone briefing with ARD project manager Richard Donovan or project technical manager Gus Tillman.

4. Upon arrival in Somalia, the consultant will hold briefing meetings with USAID project manager Sally Patton and JESS chief of party E. Drannon Buskirk, Jr., to discuss the consultant's scope of work. At these meetings a means for progress reporting during this consultancy will be defined.

5. The consultant will achieve the following objectives:

a) After clarifying with the JESS field team the plan for vector studies, the consultant and the JESS chief of party will develop an agreement (including cost, personnel and schedule) with the Ministry of Health on the implementation of a survey of malaria mosquitoes and bilharzia snails for JESS.

b) Evaluate the ongoing water quality sampling and analysis program, and make recommendations for changes, if necessary.

c) Inspect the major towns in the Jubba Valley from a potable water supply and public health perspective, in the area from Luuq to Kismaayo.

d) Investigate agricultural areas in the Jubba Valley, including irrigated, drawdown and dhesheek zones, from a health perspective and specifically focusing on vector habitats and transmission.

e) Review the current status of planning for the Baardheere Dam and other associated developments from a public health perspective.

f) In the presence of both the JESS chief of party and ARD's home office technical manager (Gus Tillman), discuss with USAID the draft proposal for epidemiological survey work in the Jubba Valley.

6. A draft typewritten or word-processed report for this consultancy should be delivered to the JESS chief of party one full day before departure from Somalia. This report should be written in a format that meets guidelines which the consultant should obtain from the JESS chief of party. This report will be the basis for a final briefing with the USAID project manager, JESS chief of party and project personnel from MJVD. Revisions to the final report should be completed within two weeks after the consultant's return to the United States and delivered to the ARD home office in Burlington, Vermont.

7. The consultant may be required to present a training seminar near the end of the consultancy in Somalia on a topic related to this consultancy.

8. At the discretion of the ARD project manager, a final briefing may be required at the ARD home office in Burlington, Vermont.