OVERSEAS DEVELOPMENT ADMINISTRATION
MINISTRY OF AGRICULTURE, GOVERNMENT OF SOMALIA

HYDROMETRY PROJECT - SOMALIA

First Progress Report
Phase 3
March - August 1988

Sir M. MacDonld & Partners Limited
Consulting Engineers
Demeter House, Station Road, Cambridge CB1 2RS

in association with

Institute of Hydrology
Wallingford, Oxon OX10 8BB
United Kingdom

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CONTENTS

1. INTRODUCTION

This Progress Report describes work on the project during the first six months from March to August 1988. The report comprises a brief summary of progress during the period together with a series of appendices covering fieldwork and other aspects in greater detail. This is the second report produced during Phase 3 of the project and follows the Inception Report produced at the beginning of April 1988. There will be two further progress reports at approximately six month intervals followed by the Final Report at the conclusion of Phase 3. It is intended that the latter will be accompanied by the publication of a revised Data Book so that the most up-to-date estimates of historic river flows will be available to assist in the future development of water use in Somalia.

The project aims to assist the Government of Somalia in the day-to-day management of the Jubba and Shebelli rivers, and to improve the reliability of the hydrometric database for both current and historic data. This work is the responsibility of the Hydrology Section of the Department of Irrigation and Land Use in the Ministry of Agriculture (MOA). Rainfall and other meteorological data is dealt with by the Food Early Warning System (FEWS) Project which comes under a different department in MOA; groundwater studies are the responsibility of the Ministry of Mineral and Water Resources.

The scheduled two year duration of Phase 3 follows work by the Consultants over a period of about two and a half years between 1983 and 1986. Phase 1 in 1983 and 1984 established the computerized database covering all available data from 1963 to 1984 for the eight primary gauging stations, together with some published but unchecked data from 1951 to 1962. Extensive fieldwork was also undertaken, including the renovation of staff gauge stations and a number of discharge measurements.

Phase 2 in 1985 and 1986 extended both the facilities of the computer system and the scope of the database. Much additional data was entered (including the new station at Mogambo on the Jubba and five stations connected with the Jowhar Offstream Reservoir), and the process of checking the historic data on the computer was begun. Fieldwork concentrated on establishing a network of automatic water level recorders. Throughout Phases 1 and 2 the training of local staff in field and office work was a major component of the project; this is being continued during Phase 3.

2. STAFFING

2.1 Expatriate Staff

Five expatriate staff members (three from Sir M. MacDonald and Partners and two from the Institute of Hydrology) are scheduled to work on the project in Somalia; four of them have made inputs during this period. One staff member, the Programmer/hydrologist, has worked on the project in the UK during this period, and there has also been intermittent Head Office backup when required.

2.2 Staff Arrivals

			Left UK	Arrived Somalia
Mr. P.F. Ede	MMP	Field Hydrologist	12th Mar	16th Mar
Dr. K.J. Sene	IH	Programmer/hydrologist	27th June	29th June
Dr. J.R. Meigh	IH	Senior Hydrologist	27th June	29th June

In addition, Mr. P.H.W. Bray, Project Coordinator (MMP), visited Somalia in April and July and worked briefly on the project. The final expatriate staff member is Mr. T.E. Evans, Consultant Hydrologist (MMP), who has two short inputs later in the project.

2.3 Staff Departures

			Left Somalia	Arrived UK
Dr. J.R. Meigh	IH	Senior Hydrologist	14th July	15th July
Dr. K.J. Sene	IH	Programmer/hydrologist	3rd August	4th August

2.4 Local Staff

Zakia Abdissalam Alim		Head of Section
Ali Yusuf Wayrax		Office/field work
Ibrahim Abdullahi Sheikh Ahmed		Office/field work
Luul Jeyte Weheliye		Office work
Mariam Sharif Ahmed	(from August)	Office work
Saiid Sheikh Abdulle		Field Technician
Maxamuud Maxamed Saiid		Driver/field work

The driver has been employed by the Project; the remaining staff are employed by the Ministry of Agriculture to work in the Hydrology Section. The work of the Section comes under the overall direction of Mohamoud Mohamed Ali, Director of Irrigation and Land Use.

2.5 Supervision

The British Development Division in East Africa (BDDEA) has maintained a close interest in the progress of the project. Mr. H. Britton, Administration Officer, visited Somalia in April and discussed the Inception Report with the resident hydrologist. In July Mr. R. Cadwallader, Engineering Advisor, undertook the first six-monthly monitoring visit. This included meetings with the Director of Irrigation and Land Use as well as with the four expatriate staff members who were all in Mogadishu at the time. Mr. Cadwallader also accompanied the expatriate hydrologists on a field trip to Afgoi.

The British Embassy in Mogadishu has provided support and communication with BDDEA in Nairobi. Visits to the project have been made by the British Ambassador (Mr. J.R. Varcoe), the First Secretary, Aid (Mr. R.C. Huxley) and the Aid attache (Miss E. Brierton).

3 WORK UNDERTAKEN

3.1 General

The start-up of this phase of the project was hampered by delays in the shipment and clearance of various items of equipment. To some extent this problem had been foreseen, but it had been decided that the advantages to be gained by an early resumption of the project would outweigh the disadvantages caused by the absence of some equipment. This attitude was justified when some important fieldwork was carried out in the first month following the arrival of the Field Hydrologist, and prior to the onset of the Gu flood season.

During his visit to Somalia the Programmer/hydrologist assisted on all field work, but his primary responsibilities related to the HYDATA package on the computer and to the Shebelli Model which was produced during Phase 2 and which will be further developed during Phase 3.

HYDATA is the Institute of Hydrology's standard package for the storage, presentation and analysis of hydrological data. It incorporates the programs written during the earlier phases of the project for the database set up on the previous project computer. The package was installed on the new computer at the beginning of July, together with the data files copied from the old computer in 1986. Operational use of HYDATA has identified certain desirable modifications which will be dealt with during the Programmer/hydrologist's UK input and brought to Mogadishu on his next visit.

The major work on the Shebelli model will be to incorporate the operation of the Jowhar Offstream Storage Reservoir. Before this can be done it has been necessary to critically examine the available data on water levels, discharges and reservoir storage. This data was entered into the computer during Phase 2 and rating curves were developed, but no quality assessment was carried out. The work of the Programmer/ hydrologist on the Jowhar data is presented in Appendix A.

3.2 Fieldwork

3.2.1 Introduction

It was appreciated at the start of Phase 3 that there was a backlog of fieldwork (such as the replacement of some missing staff gauges) which would need to be dealt with first before a programme of field visits for regular monitoring and measurement was begun. This initial work was achieved at the nearer Shebelli stations (Afgoi and Audegle) during a series of day trips in March and April when extensive renovation of staff gauges was carried out. However, work at the more distant stations was limited by problems concerning the availability of field allowances for counterpart staff. These problems were overcome in due course, but some of the planned work at Bulo Burti had to be delayed. None of the Jubba stations could be visited before the Gu season, but fortunately it was found later that no urgent work was required at the two prime sites (Lugh and Bardheere); however, extensive work will be needed at the new station of Kamsuma.

Towards the end of May a regular programme of field visits was formulated such that all stations would be visited approximately once per month. Unfortunately, only one of these trips had been undertaken when the prevailing situation in Somalia resulted in the Director of Irrigation and Land Use advising against travelling outside Mogadishu. Fieldwork resumed in early July after a break of about one month.

The regular programme of field visits is planned to achieve the following main points:

(a) Early identification of any problems with staff gauges, observer etc;
(b) Regular collection of data from the observers and where appropriate from the automatic recorders;
(c) Discharge measurements in order to identify any change in the established stage/discharge rating;
(d) Water quality monitoring;
(e) Training in fieldwork for Hydrology Section staff.

Availability of reliable transport is critical to the success of the Section's work because most of the gauging stations are very remote from Mogadishu and the journeys include sections of very rough road. The Land Rover provided under Phase 2 was not available to the project: it was in use in the Department until early June when it was transferred to other Government business. To cover the period until the new vehicle arrived from UK a Land Rover was hired locally. In late April this was replaced by a Land Rover on loan from another project funded by ODA. The new Land Rover was cleared from the port in June and has performed extremely well to date.

3.2.2 Data Collection

The Phase 3 Inception Report indicated that the data returns since the end of Phase 2 had generally been good, though the most recent period was very patchy. It is clear that the latter problem was largely due to the unreliable local postal system; with the re-introduction of visits to the stations by the Hydrology Section there has been a substantial improvement. The only station where a significant amount of data is still outstanding is Bardheere: this station was visited in July but unfortunately neither the observer nor the District Coordinator could be found. Data for January to April 1988 is missing but has apparently been sent to Mogadishu; more recent data has been delivered by the coordinator himself. It is hoped that copies of the missing data can be collected on the next visit at the beginning of September.

It was noted in the Inception Report that returns were particularly poor for Bulo Burti and Mahaddey Weyn. In the case of Bulo Burti this was primarily due to the absence of two staff gauges; although it has not yet been possible to replace these, the observer has been issued with a bridge dipper and has used this when the water level is not within the range covered by the staff gauge. The record for Bulo Burti should therefore be more complete from May 1988. For Mahaddey Weyn the data had been kept at the MOA office in Jowhar; the 1987 data was eventually received in Mogadishu in April 1988. Following a visit to Jowhar arrangements have now been made for more frequent forwarding of this data.

An observer has been found for the new station of Kurten Waarey in the lower Shebelli so that data is available from late July. An observer has yet to be appointed at Kamsuma on the lower Jubba (also a new station), but arrangements are in hand via the local MOA office in Jamamme.

Four new bridge dipper instruments have been purchased so that it will be possible for all observers to continue to take readings of water level if the level is outside the range covered by the staff gauges or if one or more gauge plates should be lost in future floods. At Kamsuma the dip measurement will be the only data for most levels because the lower part of the staff gauge was washed away in 1987 and cannot be replaced until the next dry season.

For some stations water level data has also been received via the MOA radio network. Values for Lugh Ganana and Beled Weyn have been received daily, together with occasional values for Bulo Burti and Mahaddey Weyn. Daily values had also been arriving from Bardheere, but unfortunately the radio there ceased to operate in June.

Four automatic water level recorders were installed during Phase 2 (a fifth was planned, but it was not possible to undertake the necessary construction work before the Gu flood of 1986). It was found that those at Lugh, Bardheere and Beled Weyn were in good condition and could be restarted, but the installation at Kamsuma had been severely damaged during the 1987 flood and the recorder cannot be used. The operational performance of these recorders over the next 4 to 6 months will be assessed before consideration is given to extending the network.

3.2.3 Discharge Measurements

The regular measurement of river discharge at each station is important in order to check the validity of the existing rating curve, and if necessary to derive a new equation. Over the period for which water level data is available in Somalia (primarily 1963 to date) there have been several periods when frequent discharge measurements were made (eg 1963/64 and 1980/81), but also long periods with few, if any, measurements. With the exception of Lugh (where regular measurements were made up to 1977) there were only four measurements at all stations in the period 1973-1979. The available measurements were listed in the Phase 1 Final Report and the derivation of rating curves described in detail in an appendix to the Phase 2 report. It was noted there that further analysis of the data should be undertaken to see if the fit of the ratings could be improved; this was done for Bardheere during Phase 2 and will be considered for the other stations later in Phase 3.

With the exception of one measurement at Bardheere, no river discharge measurements had been made by the Hydrology Section since the end of 1984. Measurements were restarted in July and a list of those performed prior to the writing of this Progress Report is given in Table 1. The existing current meters and associated equipment were largely found to be in good order and the Section staff quickly learnt the field techniques required, together with the calculation of the results in the office. The Shebelli has remained relatively low for most of this year, but rose in August so that a reasonable range of flows has been measured. More substantial floods have been measured on the Jubba, the largest being 370 cumecs at Kamsuma on 30th July. This is the largest flow actually measured in Somalia since 1981.

At all sites discharge measurements have been made from bridges with the current meter suspended from the gauging derrick on the bridge deck. At low flows (and hence low velocities) the 10 kg sinker weight was used, but for higher velocities it was necessary to use the 25 kg weight. Measurements at Afgoi, Lugh Ganana and Kamsuma were relatively straightforward because the derrick can be wheeled along the bridge from one position to the next without raising the meter. At Mahaddey Weyn and Beled Weyn, however, the bridge superstructure (pillars or girders) meant that after almost every reading the weight and meter had to be raised to the bridge deck and lifted round to the next position.

Table 1.

Discharge Measurements Carried Out During the Period

Date	Station	Gauge height[a] (m)	Velocity (m/s)	Area (m^2)	Discharges Measured (m^3/s)	Discharges Equation (m^3/s)	% error
5/7/88	Afgoi	2.06[b]	0.54	35.3	19.1	21.2	-10
8/7/88	Afgoi	2.005[b]	0.55	33.7	18.4	20.0	-8
12/7/88	Mahaddey	2.01	0.44	50.3	22.2	23.1	-4
21/7/88	Lugh	2.625	0.76	256.5	193.9	212.9	-9
28/7/88	Kamsuma[c]	4.60	0.87	352.4	307.2	-	
30/7/88	Kamsuma[c]	5.11	0.92	401.2	370.4	-	
14/8/88	Afgoi	3.58	0.66	83.3	55.4	56.4	-2
18/8/88	Afgoi	4.845	0.62	128.8	79.7	88.8	-10
27/8/88	Mahaddey	5.085	0.87	155.8	136.2	152.2	-11
28/8/88	Beled Weyn	2.815	1.38	119.1	164.8	161.1	+2
31/8/88	Afgoi	5.01	0.61	129.7	79.6	93.1	-15

Notes: (a) Mean gauge height during measurement period.

(b) Equivalent Gauge Height at Afgoi calculated from bridge dip measurement using revised datum difference of 7.42 m.

(c) The results for Kamsuma cannot be compared to the existing rating curve because the current gauge zero has not yet been related to that used for measurements in the period 1972 to 1976.

3.2.4 Water Quality Measurement

Data on water quality in the two rivers is very scarce. Certain projects (eg Jubba Sugar Project) have records of electrical conductivity (and in due course it is hoped to incorporate this data in the MOA database), but there is very little reliable information on sediment load. In view of the possible construction of Bardheere Dam such data is particularly important on the Jubba.

Two electrical conductivity meters have been purchased by the project and one of these has been used for spot measurements at various sites. If adequate training and incentives can be provided for the observers it would probably be appropriate to locate these at suitable sites (one on each river) so that daily readings can be made.

Two depth-integrating sediment samplers (one for suspension from a bridge and one for wading) have also been provided. When suitable arrangements have been made for the analysis of samples it is intended that sediment sampling will be undertaken together with current metering.

3.2.5 Field Trip Reports

Reports have been written on all fieldwork undertaken - initially on a trip by trip basis and more recently for one month's field trips together. These have provided an ongoing record of work carried out and have also enabled the section to keep the Director of Irrigation and Land Use fully informed of progress. These reports, which expand on the points outlined above, are reproduced in Appendix B.

3.3 Office Work

3.3.1 General

Prior to the arrival and setting-up of the new computer a considerable amount of work was done on the manual processing of incoming data. Card index boxes had been supplied earlier and these were being used to keep the weekly data cards tidy and accessible, but the monthly data sheets were simply folded and placed loosely in file covers. Many of the historic data sheets were therefore in poor condition: where possible these were repaired. The more recent ones were generally satisfactory, but in some cases individual sheets were found in various files, drawers etc. A new filing system was therefore introduced. All available sheets up to 1987 have been filed by station and a special drawer set aside for sheets from the current year.

3.3.2 Manual Processing and Analysis

Data for 1986 to date was processed manually and annual hydrographs drawn for all stations. As with all work, this was treated as a training exercise and various hydrological principles were covered. Individual erroneous readings were identified and corrected where possible. Comparison of hydrographs for the Shebelli stations was used to demonstrate the travel time of water down the length of the river. This process also showed apparent errors in the data for Bulo Burti - after considerable checking it was found that there has been a 1m error since 1985 due to a misunderstanding by the observer about the staff gauge range. This was followed up on the subsequent field trip so that future data should be correct.

Following the installation of the computer at the beginning of the programmer/hydrologist's input, the emphasis of office work has shifted to the computer (subject to the availability of electricity). However, it is considered most important that the manual processing of data is not forgotten because it is easier to ensure understanding of data processing and hydrological principles through manual training exercises rather than the use of the computer where the pressing of a few keys in an easily learnt sequence carries out a great deal of useful work without the need for full comprehension. It is therefore intended that manual processing will be continued in parallel with the use of the computer.

3.3.3 Computer Work

Training in the use of the computer (in particular the HYDATA package) has been an ongoing process as different aspects of the work have occurred. All the section staff have quickly picked up the main points. A substantial amount of the backlog of data has now been dealt with. When all stations are up-to-date it will be possible to carry out further checking of the historic data to eliminate the inevitable errors which occurred when the data was entered earlier in the project.

The new computer is an IBM PS/2 Model 50, one of the latest range of IBM personal computers. This was chosen for maximum compatibility with existing software and for the ease of potential future upgrading. It is also probable that servicing of the computer can be undertaken in Mogadishu.

Two parts of the computer equipment were faulty on arrival - the Uninterruptible Power Supply (UPS) and the external disk drive. The former has slightly hampered work because some work has to be repeated when a power failure occurs; the UPS is supposed to provide a period of battery backup so that work can be saved to disk, and a certain amount of work continued during mains power failure. The absence of the external disk drive has not affected the work of the counterpart staff, but it has caused considerable inconvenience to both the resident hydrologist and the programmer/hydrologist. It is hoped that both items will shortly be in working order.

The reliability of the mains electricity supply in Mogadishu deteriorated substantially in mid-June and this considerably hampered work on the computer in July and August. Occasional power cuts would not be a major problem because a reasonable amount of manual processing of data needs to be carried out. Also, as noted earlier, certain aspects of the training component of the project are more effectively performed without the computer. However, planned computer work was severely affected by a number of power cuts of 2-4 days' duration. After his return from a business visit to the USA, the Director of Irrigation and Land Use was able to make arrangements for a special line to be available from the existing Ministry generator to the computer in the Section; this was installed by the Project on August 22nd. Thereafter, work has been possible even when the mains supply is interrupted. Work is in hand to install an improved mains supply line so that the new air conditioner can be used; the generator supply, however, is not sufficient for operation of the air conditioner.

In addition to the routine processing of data, tables and graphs have been prepared using a Lotus spreadsheet for the 10 daily bulletin produced by the FEWS Project. This is widely circulated amongst interested parties in Mogadishu. A recent example is reproduced in Appendix C.

3.4 Liaison With Other Organisations

As noted above, a close link has been established with the FEWS project. Data received via the MOA radio network set up under that project has been made available to the Hydrology Section and in return summary tables and analysis are produced every ten days.

As required by the Terms of Reference for Phase 3, an informal link has been made with the National Water Centre (NWC) with a view to close collaboration. NWC has offered to make its computer system available as a backup to that in the Hydrology section, but to date it has not been possible for MOA and NWC to reach agreement on this interchange of data. Such an agreement would be extremely beneficial to the Hydrology Section in the event of breakdown of the project computer. It is hoped that it may also be possible to cooperate with NWC on the measurement of water quality, particularly for the analysis of samples.

It had been agreed that the radio transceivers due to be provided under the Hydrometry project would be fully compatible with those provided by FEWS and that they would be incorporated into a single network. Unfortunately, events in Somalia have made extension of the radio network impracticable for the time being.

4 FUTURE PROSPECTS

The outlook for the progress of the project over the next six months looks reasonably favourable. The Field Hydrologist will be resident through this period except for 3-4 weeks leave from mid-September. The Programmer/hydrologist will be spending some time in the UK working on the Shebelli model and some modifications to the HYDATA package. His next visit to Somalia is tentatively planned for February and March 1989, but this may be subject to change in order to fit in with the programme of the Field Hydrologist. The Project Coordinator is expected to make one brief visit during this period and it is hoped that the Consultant Hydrologist will make the first of his two visits to Somalia.

The priorities for the next six months will be to continue the programme of regular field visits to all stations and to bring the database on the computer up to date. The extensive job of checking the historic data may then begin in earnest.

APPENDIX A

ANALYSIS OF DATA FROM JOWHAR OFFSTREAM RESERVOIR

This appendix covers work carried out by Dr. K.J. Sene of the Institute of Hydrology. It relates primarily to work undertaken during his visit to Somalia between June 29th and August 3rd 1988.

JOWHAR OFF STREAM RESERVOIR

Preliminary review of data 1980-1985

Somalia Hydrometry Project

August 1988

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This report reviews the stage and gauging data received by the Ministry of Agriculture, Mogadishu (MOA) for the Jowhar Off Stream Reservoir (JOSR) for the period 1980-1985. The aims of this study were :

a) to identify gaps and inaccuracies in the data

b) to attempt to estimate reservoir losses

c) to study the operating rules for the reservoir

This information was required to assist in further development of a computer model of the river Shebelli (ref. 1). Further information on the design and detailed layout of the JOSR is given in refs. 2 and 4.

1. Availability of data

1.1 Stage data

The supply canal to the JOSR was commissioned in November 1979 and the outlet canal in June 1980. Filling commenced in the Gu flood in 1980. Stage (level) data is recorded at the following stations (Figure 1) :

Station	HYDATA Station No.
Jowhar reservoir (gauge H)	101
Shebelli downstream of supply canal (gauge C)	102
Supply canal (gauge F)	103
Outlet canal (gauge I)	104
Shebelli downstream of outlet canal (gauge J)	105

Stage data (4 readings/day for Stations 102 and 104, 2 readings/day for the other stations) have been entered onto the MOA's HYDATA database for the following periods :

(101) May 16 1980 - Dec 31 1985
(102) Jan 1 1980 - Dec 31 1985
(103) Jan 1 1981 - Dec 31 1985
(104) May 1 1980 - Dec 31 1985
(105) May 1 1980 - Dec 31 1985

Data for the period 1986-1987 has been obtained by the MOA Hydrology Section but has not yet been entered onto the database.

For the years 1980-1985, the entries in the database are reasonably complete, except that no stage readings above 2.0m have been entered for Station 104 ; according to the original record sheets at the MOA, the water level was above the staff gauge for these periods. There are a few minor errors (typographical, missing entries, incorrect observations) in the data for Stations 101, 102 and 105 (these were left uncorrected in the database). There may also be errors in the data for Stations 103 and 104, but these are difficult to identify since canal levels can, of course, change abruptly when the supply gates are opened or closed. Much of the data for Station 103 has been entered as missing when, infact, the canal was empty according to the original record sheets and/or comments entered into the database.

The readings for Station 104 are difficult to interpret in the absence of any information on the canal gate openings. The outlet canal connects directly to the Shebelli, without an outfall structure. The level in the canal may therefore be determined by the level in the Shebelli, by the gate openings, or by a combination of these two factors (i.e. a backwater effect). The original record sheets do not specify whether the canal is flowing for the periods when it contains water.

1.2 Gaugings

The following discharge measurements have been performed (Tables 1 to 4) :

Station	Dates	No. of measurements	Range of measurements (cumecs)	Typical flow range (cumecs)
102	21 Nov 1979 - 3 Dec 1980	30	5.5-96.3	0-175 *
103	10 Nov 1979 - Apr 1981	21	3.6-35.2	0-50 +, 0-40 $
104	16 Jun 1980 - 22 Jun 1980	5	5.5-8.7	0-25 +, 0-25 $
105	7 Jun 1980 - 4 Nov 1980	8	12.5-26.9	0-175 *

* Based on Mahaddey Weyn data 1980-1985
\+ Design capacity (ref. 2)
$ Based on stage data 1980-1985

The values on the MOA database were checked against the original record sheets (kept at the MOA) and appear to have been entered correctly. The stage-discharge relationships stored on the database are shown in Figures 2-5. The gaugings for Stations 102 and 103 cover a reasonable range, and fall close to the rating curve. The gaugings for Stations 104 and 105 cover too small a range and, for Station 104 especially, show a lot of scatter. The gaugings at these Stations should be repeated at soon as possible. Also, for Station 104, it would be helpful for the observer to record the gate settings and the flow state (flowing/not flowing) on the stage data cards.

Some thought should be given as to when, and by how much, Station 104 is influenced by backwater effects from the river Shebelli, and whether the flow can be uniquely determined from the stage. An alternative method of measuring flow, such as recording the gate openings and the water levels either side of the gates, might be more suitable for the outlet canal (and, according to ref. 2, is used operationally).

The MOA database also contains flow or storage data for each of the Jowhar stations for 1980-1985; a quick check confirmed that these values were obtained by converting the stage data using the ratings shown in Figures 2-5.

1.3 Reservoir level/storage relationship

The level/storage relationship for Station 101 is shown in Figure 6. This curve appears to be based on Figure 8.5 of ref. 2 (Figure 7), assuming a zero level of 95.50m a.m.s.l. This level is the same as that which appears on the 'gauge record' sheets for JOSR (used by the MOA at Jowhar since 1982), but differs from the value of 99.500m a.m.s.l. given in Figure 8.7 of ref. 2.

Some doubts have been expressed about the accuracy of the storage curve for the JOSR (ref. 3). Although it was not possible to check the form of the curve, the peak storage values recorded in the database seem reasonable. For example, for the period 1980-1985, the peak reservoir level recorded on the database was 4.17m (Dec 1982), or 99.67m a.m.s.l., corresponding to a storage of 204.35 MCM according to Figure 8.5, ref. 2. According to ref. 2, p.14, the design maximum capacity of the reservoir is 205.0 MCM so, assuming that the reservoir was completely full on this occasion, the level/storage relationships appear to give the correct maximum storage.

2. Water balances

The following water balances were evaluated using the data stored on the HYDATA database at the Ministry of Agriculture in Mogadishu :

2.1 Continuity at junctions

One test of the accuracy of the Jowhar data is to check that continuity is satisfied at each of the junctions in the reservoir system. Figure 1 suggests the following water balances :

$$\text{FLOW } 12 = \text{FLOW } 102 + \text{FLOW } 103 \qquad (1)$$
$$\text{FLOW } 102 + \text{FLOW } 104 - QJ = \text{FLOW } 105 \qquad (2)$$

where the FLOW values are total flows in a period and QJ represents losses and abstractions in the reach between Stations 102 and 105. Equation (1) assumes that there are no significant abstractions or overbank flows between Mahaddey Weyn and the Sabuun barrage (a distance of about 13 km.).

The water balances given in equations (1) and (2) were evaluated on a monthly basis for the period 1980-1985. The results of the calculations are shown in Figures 8 and 9 and the calculation sheets are given in Table 5. During this period there were several shorter periods of missing data for one or more of the stations. The monthly values shown in Figures 8 and 9 correspond only to months in which no more than 5 daily values were missing at any of the stations (pro rata values were calculated for periods with 1-5 missing daily values).

Figure 8 suggests that, for river flows of up to about 350 MCM/month, there is a total error of less than about 10% in the water balance between the three stations. A flow of 350 MCM/month corresponds to a steady flow of about 130 cumecs, which is considerably higher than the annual mean flow, which is in the range 50-100 cumecs at Mahaddey Weyn. The error is larger for higher flows - possibly due to errors in the rating curves or due to overbank losses in the Mahaddey Weyn - Sabuun reach.

The water balance shown in Figure 9 shows that, as expected, the sum of FLOWS 102 and 104 exceeds FLOW 105. The average excess is about 30 MCM/month, which is equivalent to a steady flow of about 11 cumecs, implying that QJ is about 11 cumecs. However, given the uncertainty in the gaugings for Stations 104 and 105, this estimate is unlikely to be correct. Some comments on the likely magnitude of QJ are given in Section 3.1.

2.2 Volumetric balance

Figure 1 suggests the following daily volumetric balance :

$$DV = \text{Flow } 103 - \text{Flow } 104 - QE - QI + QS + QR \qquad (3)$$

where QE and QI are the daily losses from the reservoir and canals due to evaporation and infiltration, QS are the daily drainage flows from the SNAI sugar estate, QR is the daily rainfall, and DV is the daily change in storage.

Equation (3) provides a means of estimating the total net losses -(QS+QR-QE-QI) from the reservoir, and was evaluated for each of the years 1981 to 1985. Because of the uncertainty in the stage and gauging data for Station 104, the calculations were performed only for periods in which the reservoir was being filled. It was assumed that, during these periods, the gates to the outlet canal were closed (It is not clear from either ref. 2 or ref. 4 whether the reservoir would ever be operated with both the supply and outlet canals flowing). In future work, this assumption could be checked by either :

a) locating records of the gate openings for the outlet canal or,

b) converting the stage data for Station 105 to levels a.m.s.l. and then, by cross checking levels at Station 104, deducing the periods in which the canal gates were shut.

Figure 10 shows a comparison (for 1985) of the daily changes in storage calculated from the storage data (101) with the changes expected from the data for the supply canal (103). The trend shown in Figure 10 is qualitatively correct, with changes in the inflow causing corresponding changes in storage. The storage changes (DV) show a lot of scatter. This scatter is probably due mostly to minor errors in the readings of the reservoir level. For example, for JOSR, a 1cm error in level gives an apparent change in storage of 1 MCM (assuming a typical surface area of 100 km^2).

Because of the scatter in the daily values of DV, it is not meaningful to attempt to evaluate losses on a daily basis. Instead, a monthly volumetric balance was performed for each of the years 1981-1985. The average monthly losses calculated over this period from equation (3) were :

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
*	*	*	*	11.8	20.8	17.7	19.2	21.9	20.5	*	*	(MCM)

* insufficient data

These values are compared with theoretical estimates in Section 3.1.

Some additional calculations were performed using daily flow data for Station 104 obtained from ref. 6. Only 5 full months of data are given for this Station, and neither the source or the likely accuracy of the data is stated. The values obtained for the losses using this data were :

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
13.6	8.0	16.8	*	*	*	*	*	*	*	*	*	(MCM)

* insufficient data

These estimates provide some feel for the likely dry season losses, but are of doubtful accuracy given the uncertainties in the flow data for Station 104.

3. Jowhar reservoir operations

3.1 Estimated losses and inflows

Evaporation losses

The pre-design report for JOSR (ref. 4) quoted several estimates of open water evaporation losses in the Jowhar region. These consisted of :

a) Observed values (evaporation pans) from the Afgoi Research Station, SNAI sugar estate and the Rice and Tobacco Research Farm (nr. Jowhar)

b) Estimated values obtained using the Penman formula (using meteorological data taken from ref. 5).

The Penman estimates were used in the pre-design studies and were also used in this study. The values were :

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
6.6	7.4	7.6	6.5	6.0	5.4	5.3	6.0	6.7	6.1	6.2	6.1	(mm/day)

Total = 2310 mm/year

Rainfall

The total annual rainfall in the Jowhar region is about 530 mm (ref. 7). Typical average monthly values for Jowhar are :

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
7	3	21	93	100	30	29	20	12	111	87	20	(mm/month)

Total = 533 mm/year

Infiltration losses

Ref. 4 gives estimates of infiltration losses for JOSR obtained from the results of thirteen infiltration tests which were performed before the reservoir was constructed. The initial losses, on first filling the reservoir, were expected to be of the order 5mm/day. After several years of operation, these losses were expected to drop to around 2mm/day due to rises in the water table below the reservoir and deposition of silts and clays on the bottom of the reservoir.

SNAI sugar estate operations (refs. 2 and 4)

The SNAI sugar estate is situated in a region bounded by the Shebelli, the JOSR and the supply canal to the JOSR. The estate is irrigated by water abstracted from the Shebelli. The original design for JOSR specified that surplus water from SNAI should be collected by a drainage system and, depending on its salinity, either pumped into the JOSR or fed to a disposal area outside the reservoir. A gravity overflow drain was also intended to feed into the JOSR. However, although the pump station was built, the pumps have not yet been installed. At present, therefore, there are virtually no drainage flows from SNAI to JOSR.

It is possible that, in the near future, a rehabilitation program may be started at SNAI, during which the drainage pumps may become operational. For future reference, estimates of the likely magnitude of the drainage flows are given below :

Ref. 2, Table 1.2 (Table 6), gives the following estimated irrigation requirements for all projects in the Jowhar reach :

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.4	22.7	27.7	17.4	18.1	21.1	20.2	22.4	25.9	18.4	20.1	25.1 (MCM)

Total = 267 MCM/year

It is not known how much of this flow is used by the SNAI sugar estate. It is assumed here that all of this flow is used by SNAI. Ref. 4 (p.29) assumes that 30% of this irrigation water seeps into the water table, and so requires pumping into the JOSR. The resulting estimates of the drainage are then :

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
8.2	6.8	8.3	5.2	5.4	6.3	6.1	6.7	7.8	5.5	6.0	7.5 (MCM)

Total = 80 MCM/year

These estimates omit any contribution to the drainage from rainfall on the sugar estate. It should be noted that the drainage flows are unlikely to exceed the combined capacity of the drainage pumps (3.6 cumecs) and the overflow drain (2.5 cumecs). An upper bound on the drainage is therefore 6.1 cumecs, or about 16 MCM/month.

Total net losses

At present, there are no drainage flows from SNAI into JOSR, so the total net losses are equal to the sum of the evaporation and infiltration losses, minus the inflows due to rainfall. To calculate these quantities, an estimate is required of the annual variation in the surface area of the reservoir. On a monthly basis, the following average values were obtained for the period 1982-1985 :

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Storage (MCM)	114	81	47	19	24	50	56	52	77	106	135	134
Area (km^2)	88	78	66	38	44	67	70	68	77	85	96	96

The areas were obtained from Figure 8.5 of ref. 2.

Using these values, the following tentative estimates of the total net monthly losses from the JOSR can be calculated (all values in MCM). The calculations are summarised in Table 7 (2mm/day infiltration assumed) and Table 8 (5mm/day infiltration assumed).

Month	Evaporation	Infiltration (2mm/day)	(5mm/day)	Rainfall	Total losses (2mm/day)	(5mm/day)
Jan	18.0	5.5	13.6	0.6	22.8	31.0
Feb	16.2	4.4	10.9	0.2	20.3	26.9
Mar	15.5	4.1	10.2	1.4	18.3	24.4
Apr	7.4	2.3	5.7	3.5	6.2	9.6
May	8.2	2.7	6.8	4.4	6.5	10.6
Jun	10.9	4.0	10.1	2.0	12.9	18.9
Jul	11.5	4.3	10.9	2.0	13.8	20.3
Aug	12.6	4.2	10.5	1.4	15.5	21.8
Sep	15.5	4.6	11.6	0.9	19.2	26.1
Oct	16.1	5.3	13.2	9.4	11.9	19.8
Nov	17.9	5.8	14.4	8.4	15.3	23.9
Dec	18.2	6.0	14.9	1.9	22.2	31.1
Totals	167	53	132	36	185	264

Note that the contribution from rainfall omits any inflow from local runoff. This inflow is likely to be small; its maximum possible annual value (omitting losses) is of the order of the maximum reservoir area (about 110 million square metres) multiplied by the annual rainfall (0.533m) minus the value 36 MCM ~~given above i.e. about 23 MCM.~~

Figures 11(a) and 11(b) show the annual variation in the theoretical total net losses together with the losses estimated in Section 2.2. It can be seen that both methods of calculation lead to losses of a similar order of magnitude, with a similar annual variation. The best agreement is obtained between the theoretical net losses, assuming an infiltration of 5mm/day, and the measured losses calculated for periods in which the reservoir was being filled.

3.2 Operating strategy

The Operation and Maintenance Manual for JOSR (ref. 2) suggests the following operating strategy :

- The supply canal should be operated on a seasonal basis, abstracting Der and (if possible) Gu flows in excess of the minimum flows required for irrigation of all regions downstream of the Sabuun offtake. The supply canal should be closed during the dry season.
- The stored flows should be released when the river flow at the exit from the outlet canal falls below the minimum required for irrigation in the downstream reaches.

The minimum flow requirements are given in Table 1.2 of ref. 2 (Figure 6). In practise, this strategy means - crudely - that water should be abstracted mainly in the months July-November, and possibly in the months May-June, and released in the months December-April.

The records for JOSR for 1980-1985 (Figures 12 and 13) show that this strategy was followed fairly closely during this period, although, again, it is not clear during which periods the outlet canal gates were open (much of the missing data on Figure 13 for Station 104 corresponds to periods in which the water was above the top of the staff gauge). The reservoir releases show the expected seasonal pattern with, in most years, filling occurring in both the Gu and Der flood seasons. It seems that, in most years, once the reservoir has been filled the supply canal is closed until the next flood season begins.

A forecasting model for the river Shebelli could allow for operations at JOSR in one of the following ways :

a) Assume that the reservoir is operated strictly according to Table 1.2. of ref. 2., or

b) Use past records (Figures 12 and 13) to deduce the abstractions and releases achieved in practice and assume that the reservoir will be operated in the same way in the future, or

c) Allow the forecaster to enter the anticipated abstractions and releases independently of the model.

Each of these methods will be evaluated in the revised Shebelli computer model.

4. References

1. River Shebelli Model. Institute of Hydrology. March 1986.

2. Jowhar Offstream Storage Project. Operation and Maintenance Manual. MMP April 1981.

3. Meeting with Mohamoud M. Ali, P.Ede, J.Meigh, K.Sene. Ministry of Agriculture, 3 July 1988.

4. Jowhar Offstream Storage Project. Pre-Design Phase report. MMP October 1973.

5. Contributo alla Climatalogia della Somalia, Firenge 1965, Ministereo della Outre Mare, Fantolli.

6. Shebelli Water Strategy Study. Hydrologic Data Report. Lahmeyer International, March 1986.

7. Shebelli Water Strategy Study. Appendix B - Water Resources Studies (Draft). Lahmeyer International. (Date not given)

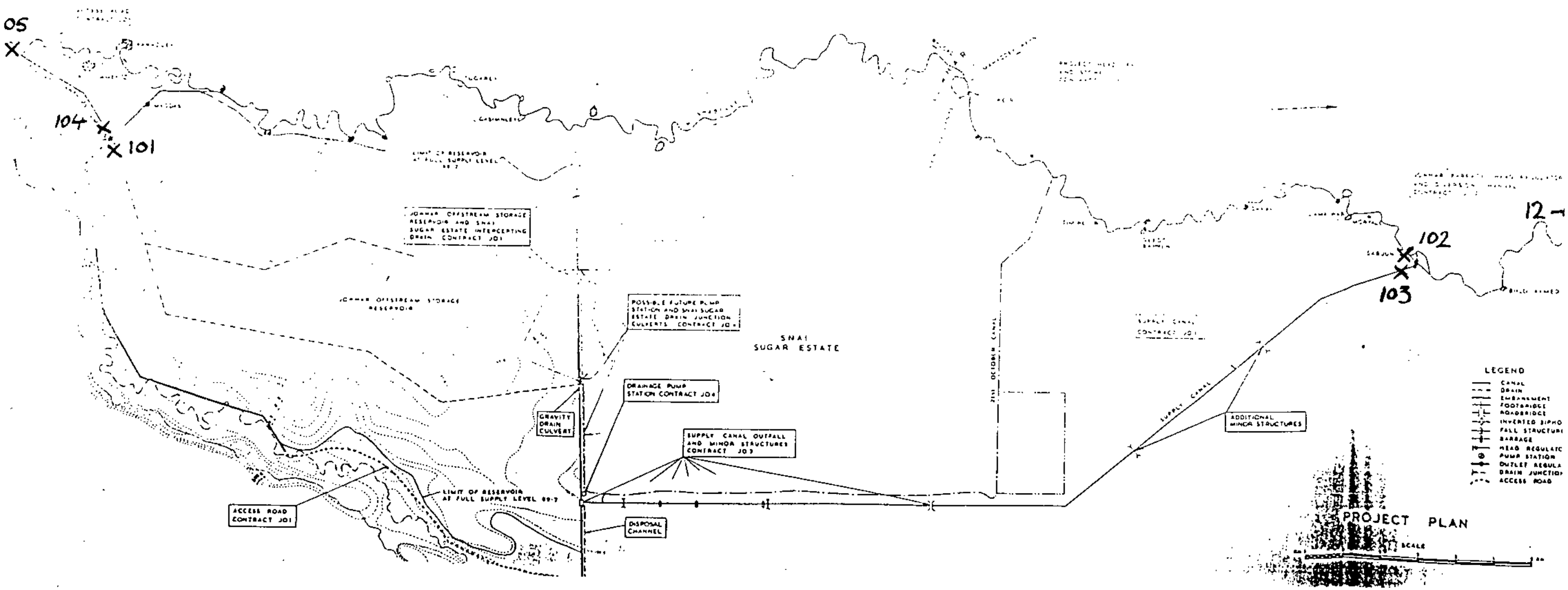


FIGURE 1 Sketch showing the layout of the reservoir and the location of the gauging stations (from ref. 2)

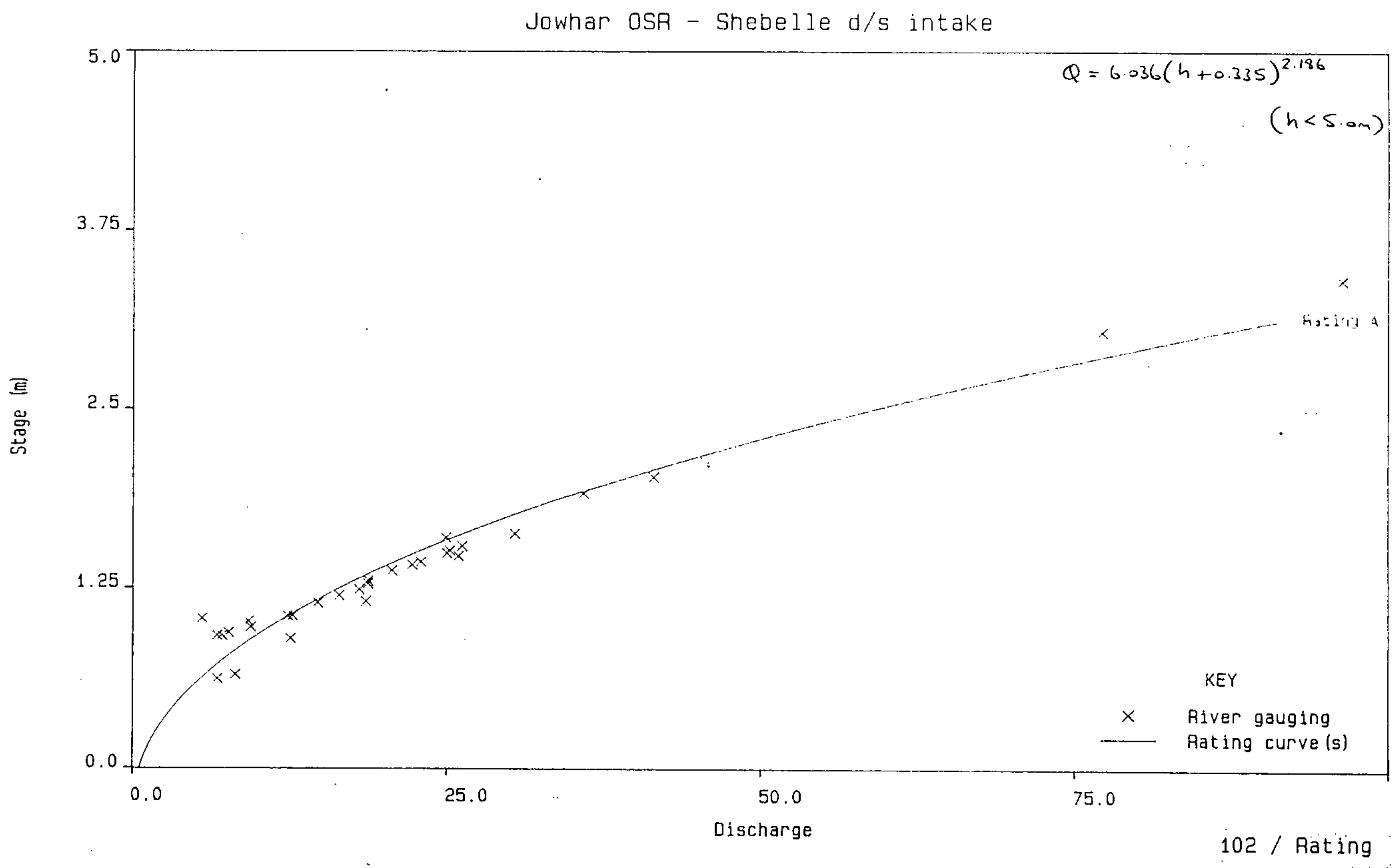


FIGURE 2 Gaugings and rating for Station 102 (as stored on the MOA HYDATA database)

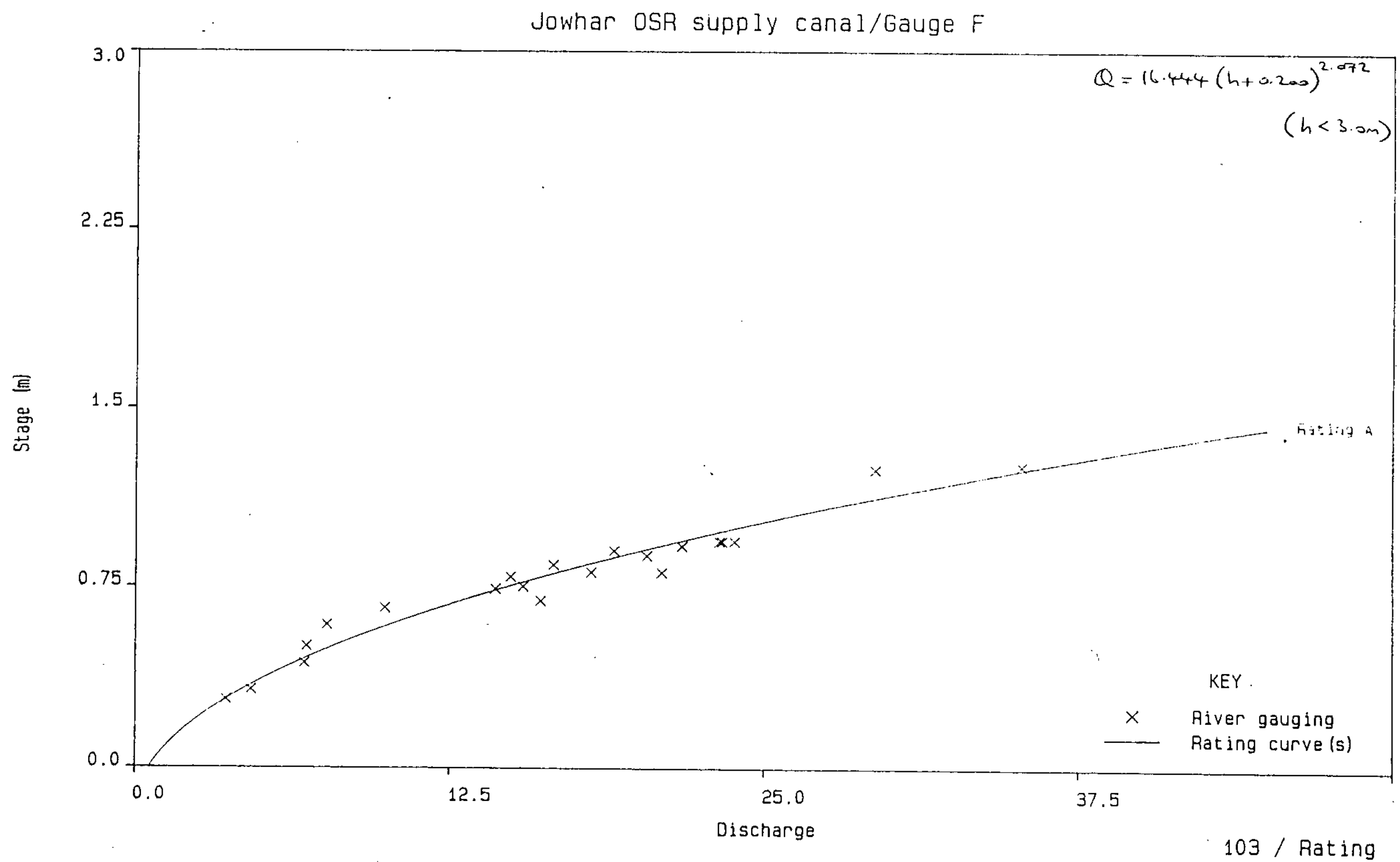


FIGURE 3 Gaugings and rating for Station 103 (as stored on the MOA HYDATA database)

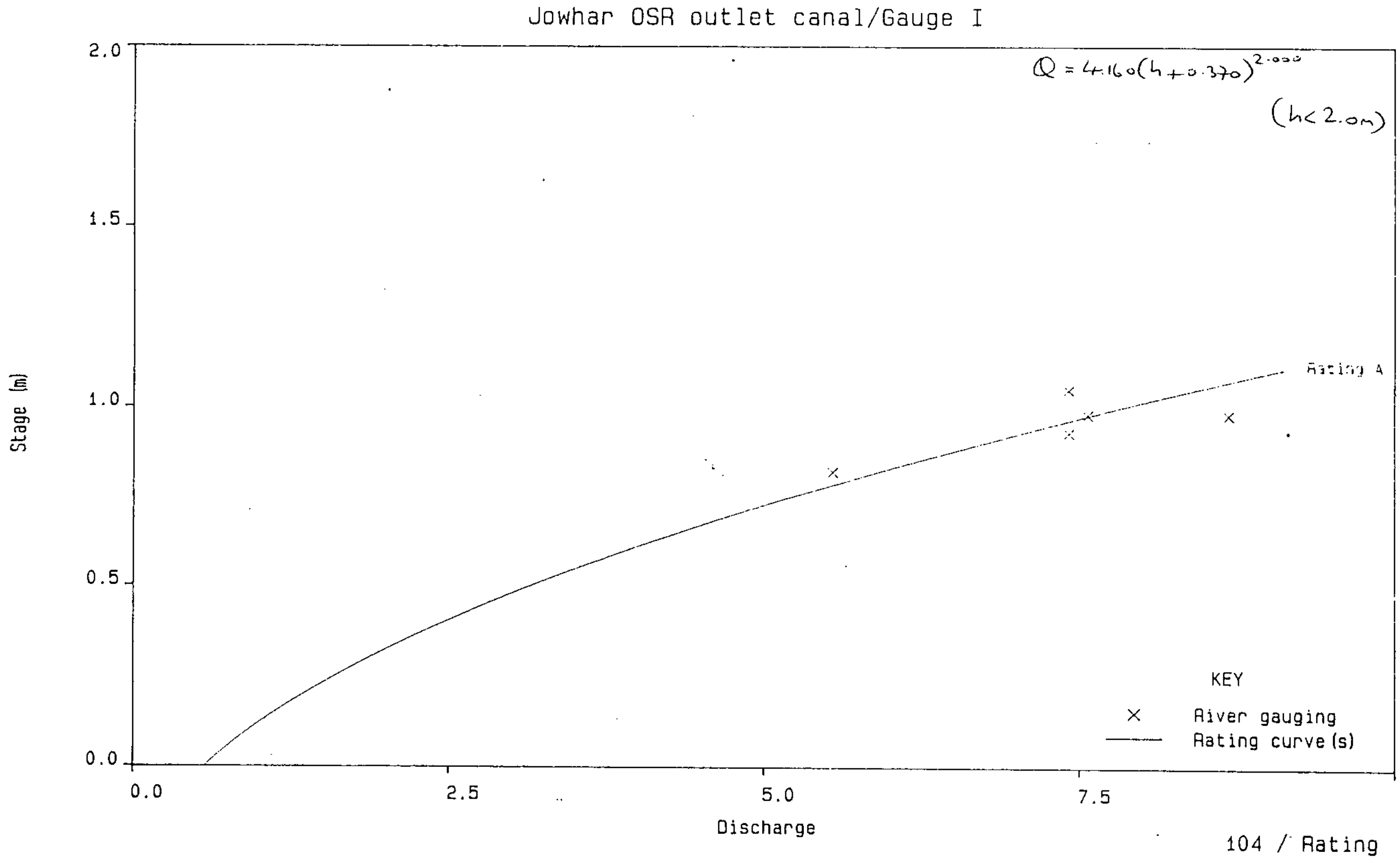


FIGURE 4 Gaugings and rating for Station 104 (as stored on the MOA HYDATA database)

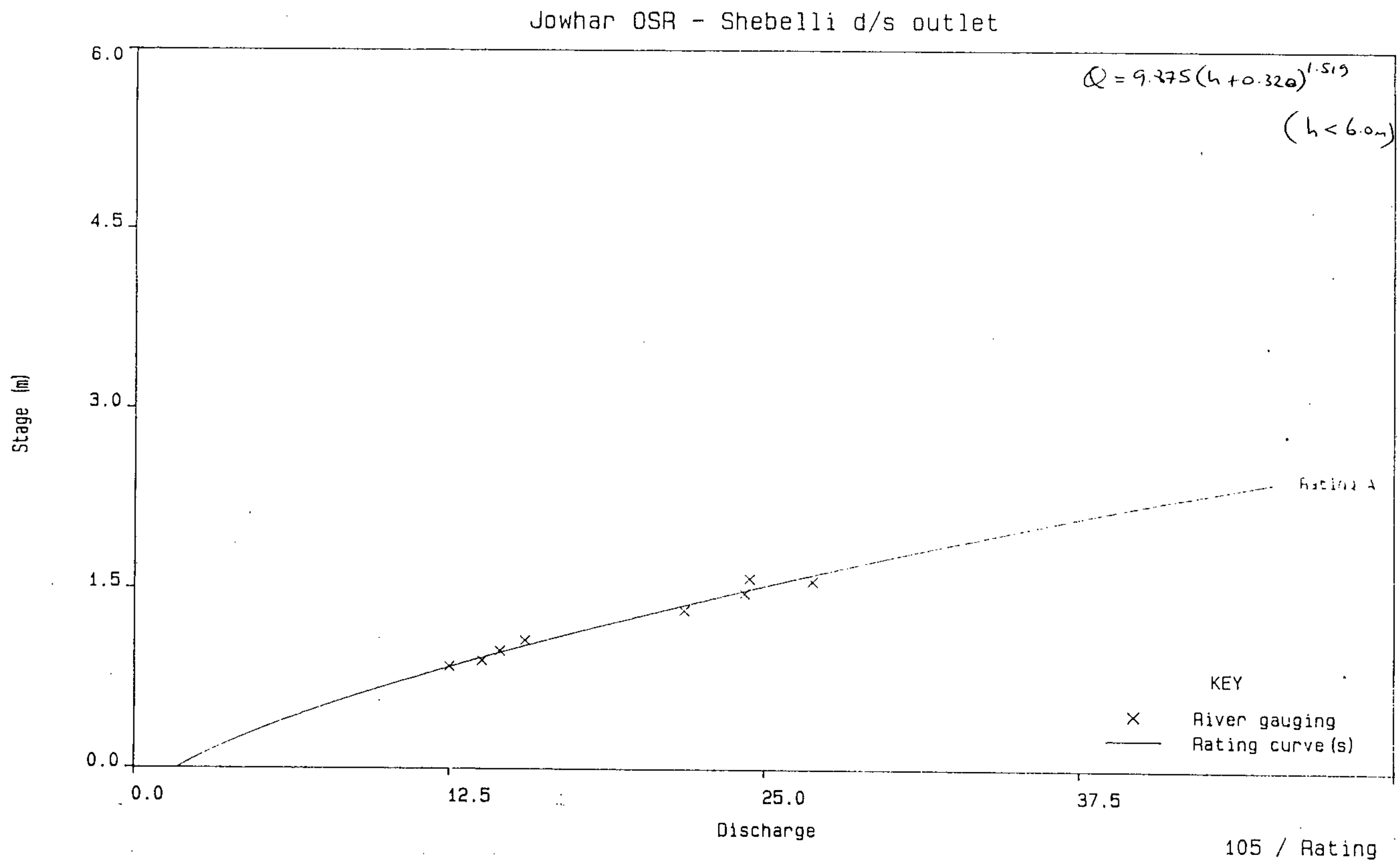


FIGURE 5 Gaugings and rating for Station 105 (as stored on the MOA HYDATA database)

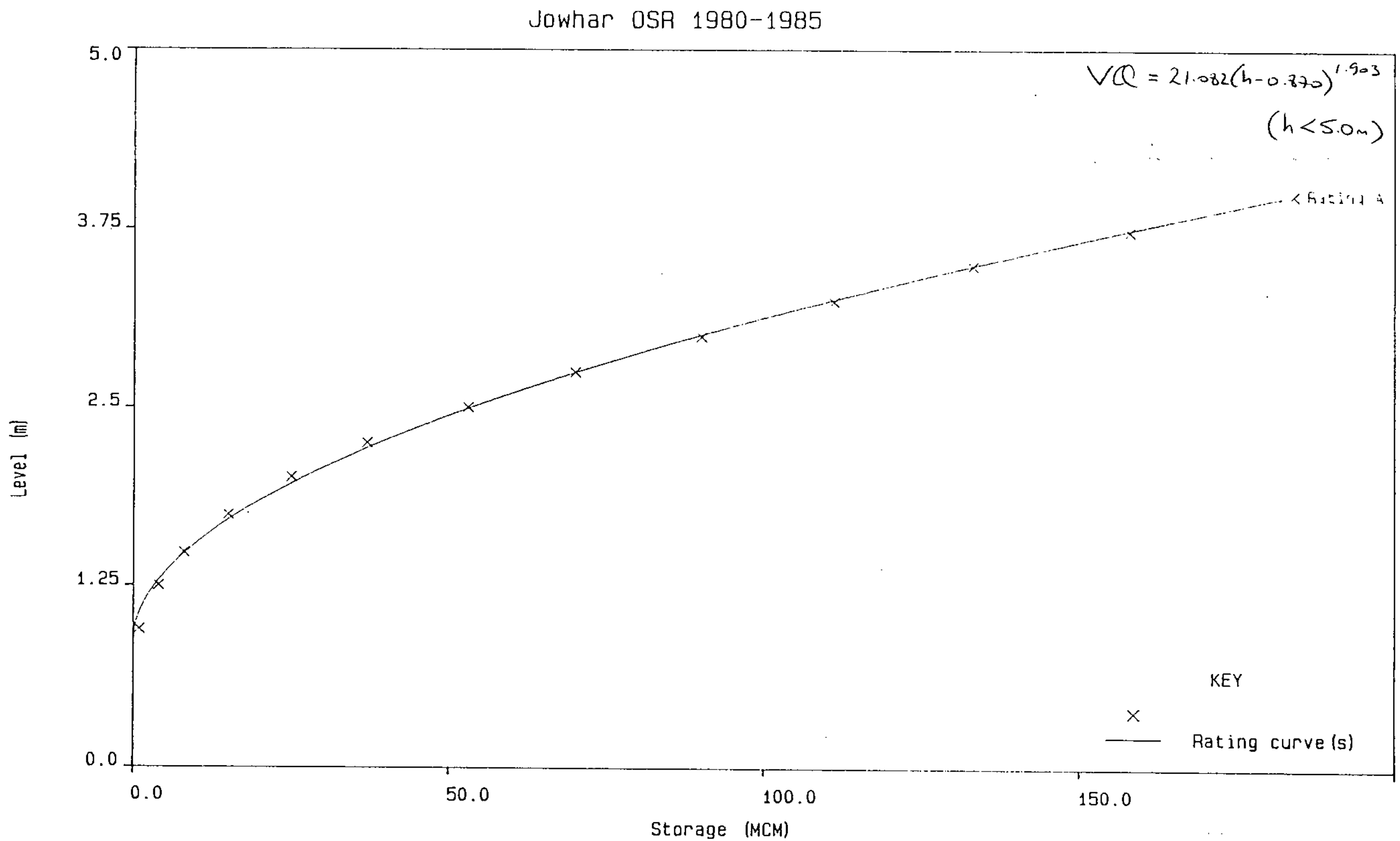


FIGURE 6 Level/storage relationship for the reservoir (as stored on the MOA HYDATA database)

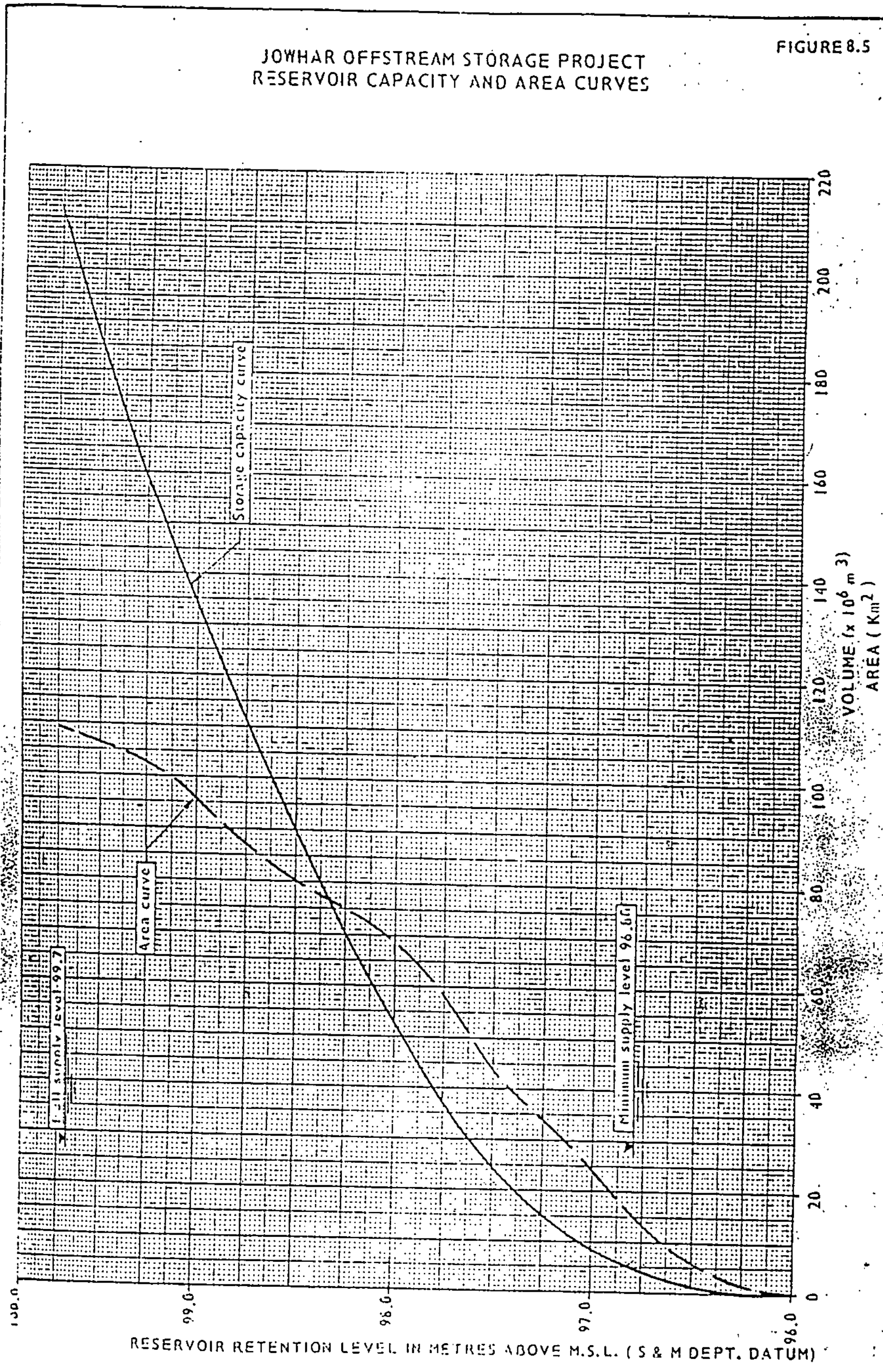


FIGURE 7 Level/storage relationship for the reservoir (from Ref. 2)

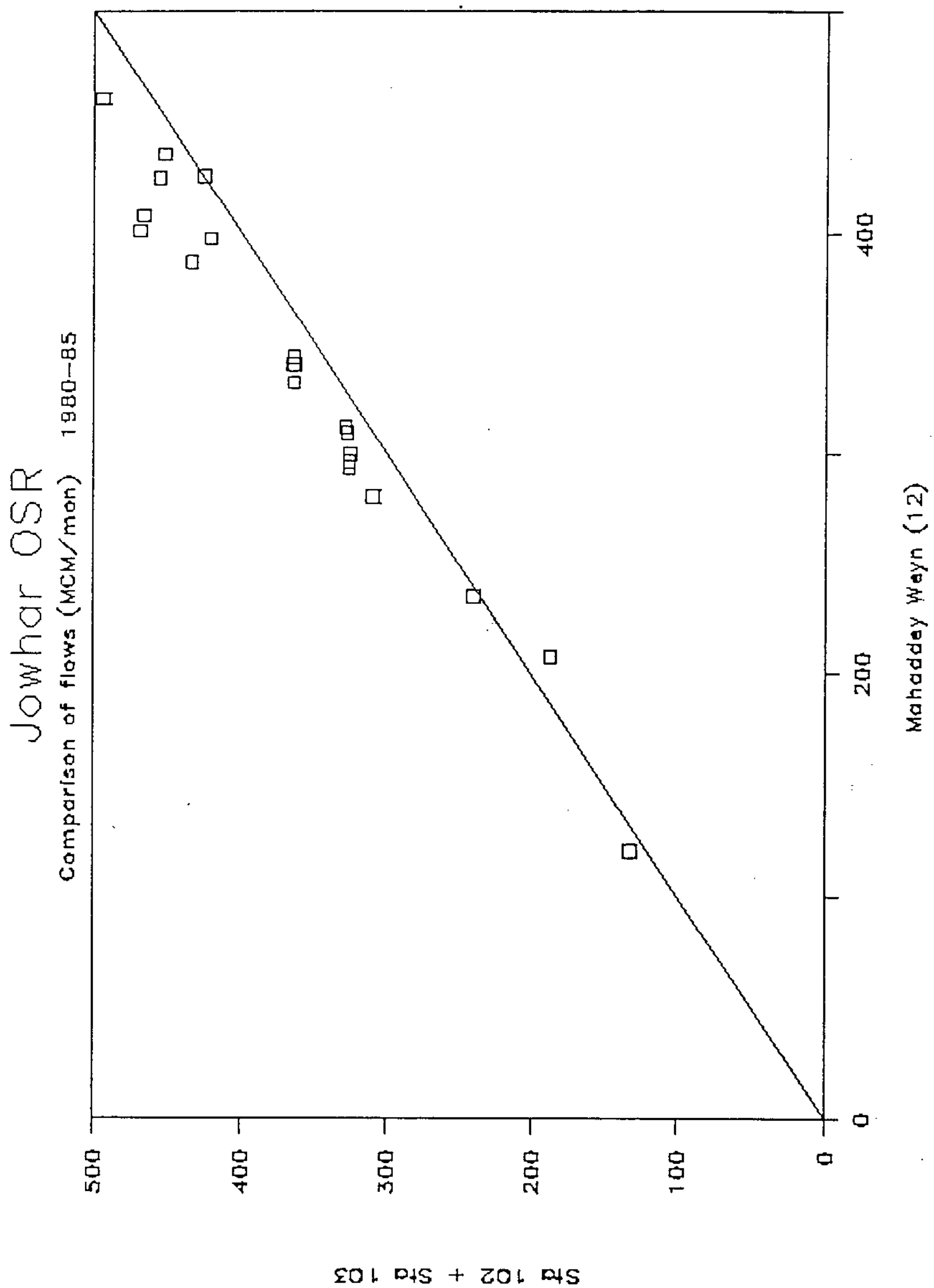


FIGURE 8 Evaluation of Equation (1) on a monthly basis for the period 1980-1985

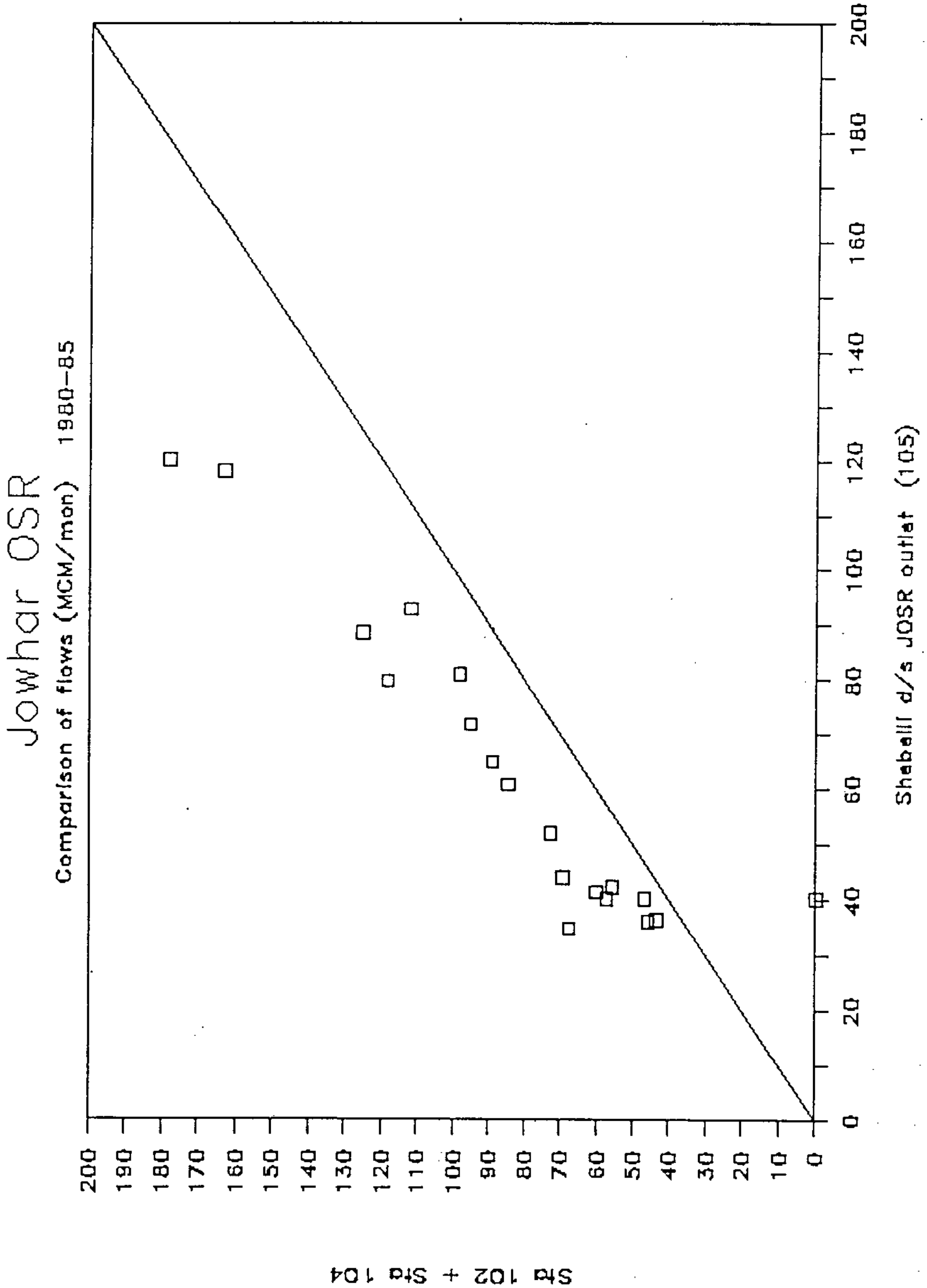


FIGURE 9 Evaluation of equation (2) on a monthly basis for the period 1980-1985

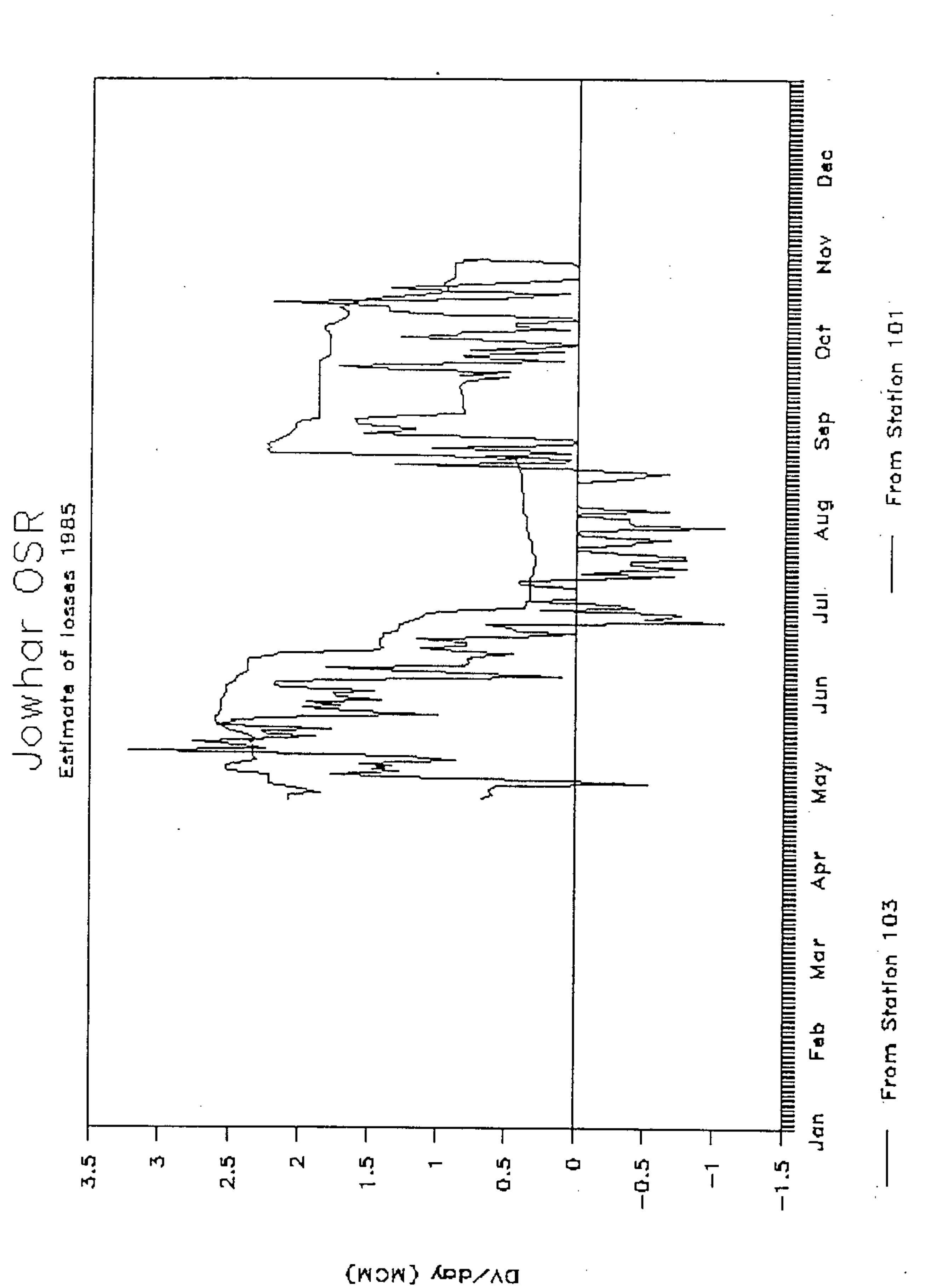


FIGURE 10 Example of calculations of daily changes in storage calculated from readings for Stations 101 and 103

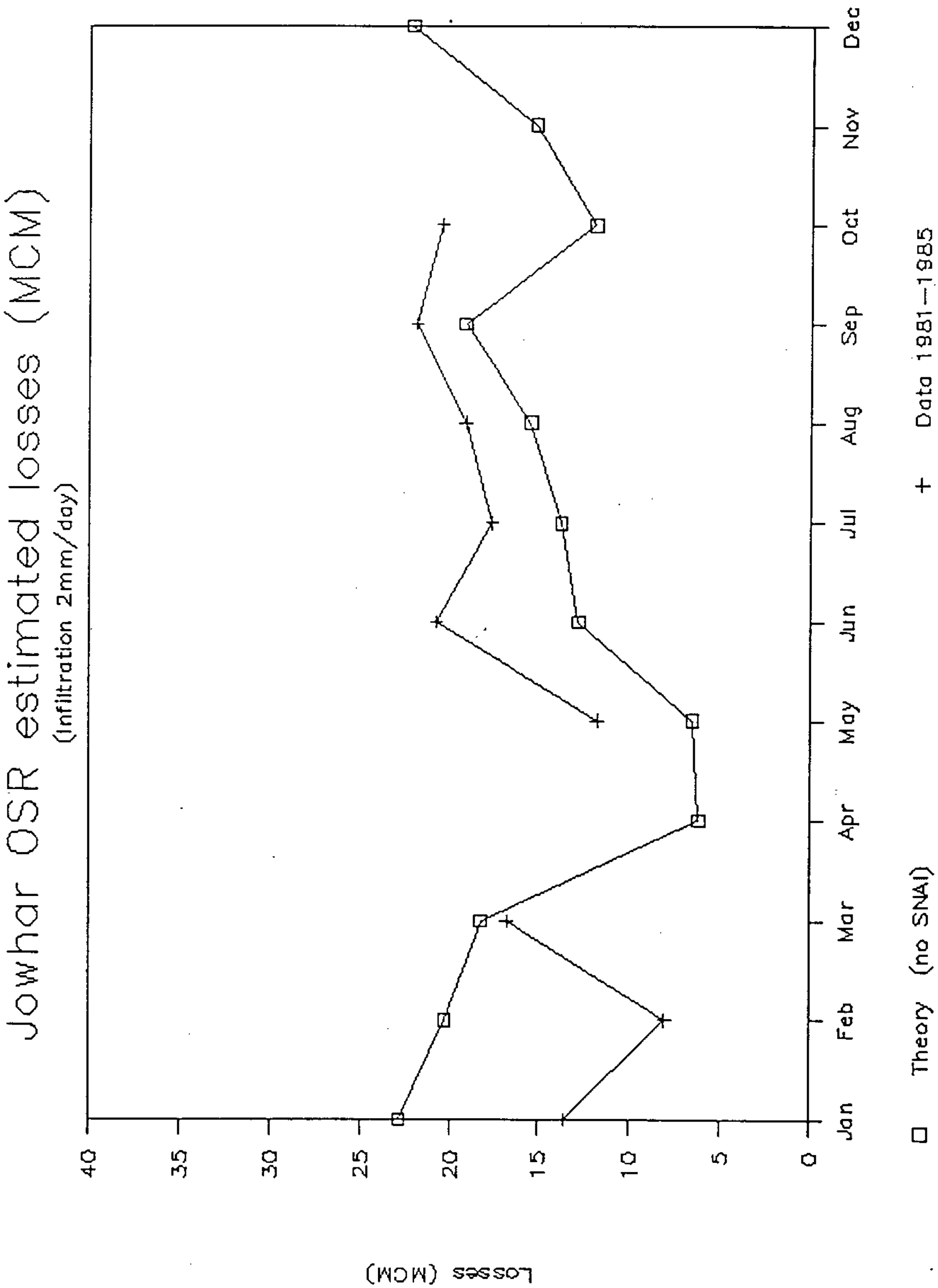


FIGURE 11(a) Comparison of measured and theoretical monthly reservoir losses (infiltration 2mm/day)

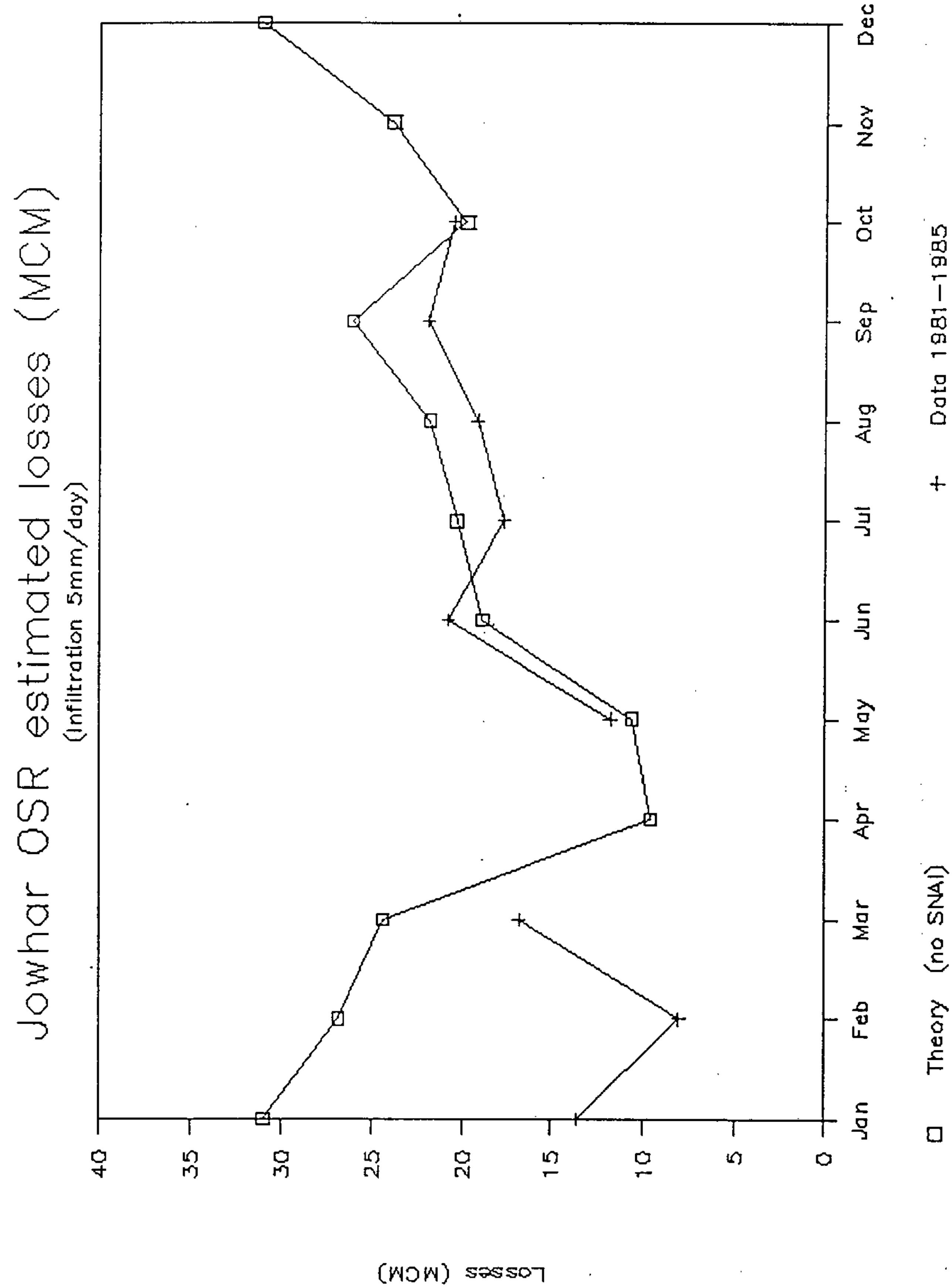


FIGURE 11(b) Comparison of measured and theoretical monthly reservoir losses (infiltration 5mm/day)

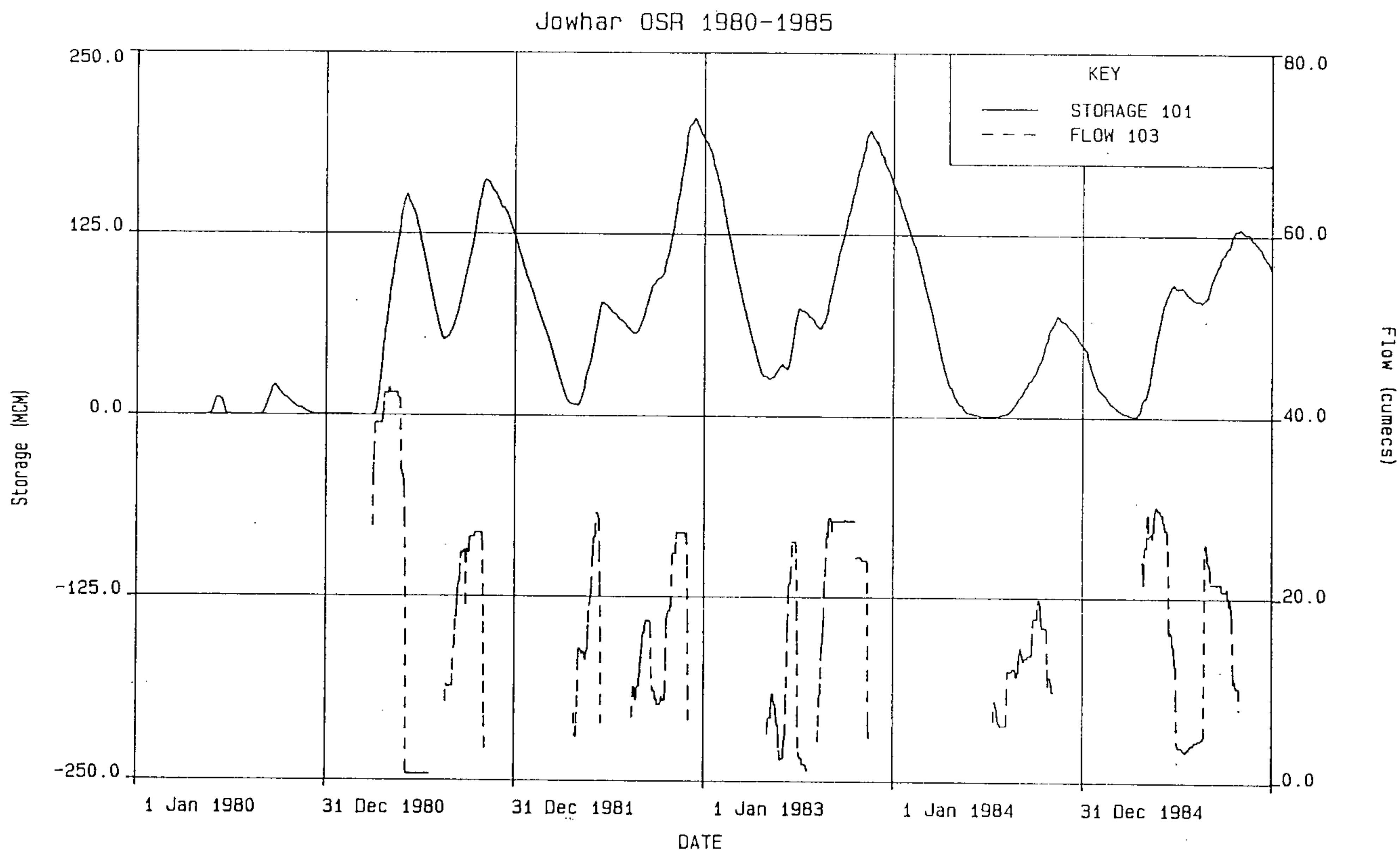


FIGURE 12 Reservoir operations 1980-1985. Storage and flow in the supply canal

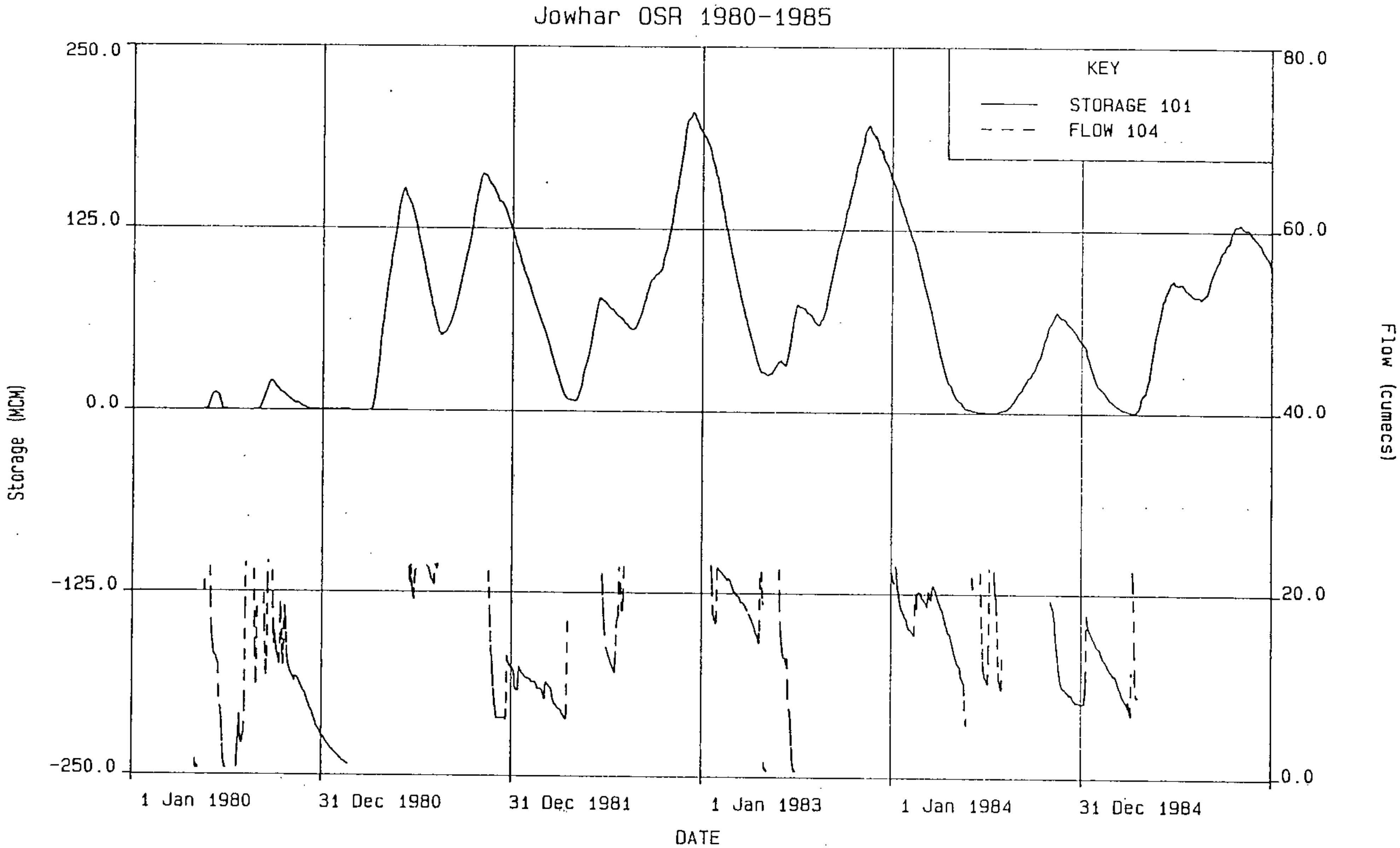


FIGURE 13 Reservoir operations 1980-1985. Storage and flow in the outlet canal

Discharge measurements for station 102 : Jowhar OSR - Shebelle d/s intake

Order Number	Date	Rating	Stage (m)	Velocity (m/s)	Area (sq m)	Discharge (cumecs)	--- Comparison --- Diff./Rat.	Plot
1	21 Nov 1979	A	1.595	0.528	47.16	24.900	0.02/A	-
2	22 Nov 1979	A	1.535	0.533	49.16	26.200	-0.09/A	<-
3	25 Nov 1979	A	1.505	0.498	50.60	25.200	-0.08/A	<-
4	26 Nov 1979	A	1.465	0.522	49.62	25.900	-0.15/A	<<-
5	28 Nov 1979	A	1.425	0.484	47.31	22.900	-0.08/A	<-
6	29 Nov 1979	A	1.485	0.507	49.31	25.000	-0.10/A	<-
7	1 Dec 1979	A	1.405	0.490	45.31	22.200	-0.07/A	<-
8	2 Dec 1979	A	1.365	0.488	42.21	20.600	-0.05/A	<-
9	5 Dec 1979	A	1.295	0.470	39.79	18.700	-0.05/A	<-
10	6 Dec 1979	A	1.275	0.421	44.42	18.700	-0.07/A	<-
11	9 Dec 1979	A	1.195	0.374	43.85	16.400	-0.05/A	<-
12	11 Dec 1979	A	1.145	0.341	43.11	14.700	-0.02/A	<-
13	16 Dec 1979	A	1.055	0.317	38.80	12.300	0.01/A	-
14	18 Dec 1979	A	1.055	0.349	36.39	12.700	-0.02/A	-
15	22 Dec 1979	A	1.035	0.175	31.43	5.500	0.41/A	->>>>
16	23 Dec 1979	A	1.015	0.283	32.51	9.200	0.14/A	->>
17	1 Jan 1980	A	0.935	0.271	28.04	7.600	0.16/A	->>
18	5 Jan 1980	A	0.915	0.273	24.54	6.700	0.20/A	->>
19	7 Jan 1980	A	0.915	0.259	27.41	7.100	0.17/A	->>
20	16 Jan 1980	A	0.975	0.317	29.65	9.400	0.09/A	->
21	26 May 1980	A	3.415	0.716	134.50	96.300	0.20/A	->>
22	28 May 1980	A	3.045	0.658	117.33	77.200	0.17/A	->>
23	3 Jun 1980	A	2.025	0.714	58.03	41.430	-0.05/A	<-
24	4 Jun 1980	A	1.905	0.623	57.54	35.850	-0.02/A	-
25	10 Jun 1980	A	1.235	0.579	31.09	18.000	-0.08/A	<-
26	15 Jul 1980	A	0.895	0.470	26.68	12.540	-0.17/A	<<-
27	20 Jul 1980	A	1.155	0.506	36.62	18.530	-0.18/A	<<-
28	22 Jul 1980	A	1.625	0.552	55.09	30.410	-0.14/A	<<-
29	30 Nov 1980	A	0.615	0.275	24.44	6.720	-0.10/A	<-
30	3 Dec 1980	A	0.645	0.293	27.78	8.140	-0.17/A	<<-

Total number of gaugings = 30

TABLE 1 Gaugings for Station 102

Discharge measurements for station 103 : Jowhar OSR supply canal/Gauge F

Order Number	Date	Rating	Stage (m)	Velocity (m/s)	Area (sq m)	Discharge (cumecs)	--- Comparison --- Diff./Rat.	Plot
1	10 Nov 1979	A	0.690	0.601	26.79	16.100	-0.10/A	<-
2	11 Nov 1979	A	0.810	0.686	26.38	18.100	-0.04/A	<-
3	18 Nov 1979	A	0.750	0.579	26.60	15.400	-0.02/A	-
4	22 Nov 1979	A	0.660	0.469	21.11	9.900	0.08/A	->
5	24 Nov 1979	A	0.320	0.275	16.73	4.600	-0.02/A	<-
6	26 Nov 1979	A	0.280	0.225	16.00	3.600	-0.00/A	-
7	27 May 1980	A	1.260	0.867	40.60	35.200	0.02/A	-
8	23 Aug 1980	A	0.500	0.407	16.71	6.800	0.05/A	->
9	25 Aug 1980	A	0.590	0.442	17.22	7.610	0.10/A	->
10	30 Aug 1980	A	0.430	0.395	16.99	6.710	-0.02/A	-
11	31 Aug 1980	A	0.740	0.577	24.78	14.300	0.01/A	-
12	1 Sep 1980	A	0.810	0.771	27.11	20.900	-0.11/A	<-
13	3 Sep 1980	A	0.880	0.705	28.79	20.300	-0.03/A	<-
14	4 Sep 1980	A	0.940	0.744	31.18	23.200	-0.04/A	<-
15	7 Sep 1980	A	0.940	0.758	31.40	23.800	-0.06/A	<-
16	8 Sep 1980	A	0.940	0.754	30.90	23.300	-0.04/A	<-
17	10 Sep 1980	A	0.920	0.726	29.89	21.700	-0.02/A	<-
18	14 Sep 1980	A	0.900	0.691	27.50	19.000	0.03/A	->
19	15 Sep 1980	A	0.840	0.634	26.18	16.600	0.04/A	->
20	17 Sep 1980	A	0.790	0.603	24.71	14.900	0.04/A	->
21	4 Apr 1981	A	1.245	0.831	35.38	29.400	0.12/A	->>

Total number of gaugings = 21

TABLE 2 Gaugings for Station 103

Discharge measurements for station 104 : Jowhar OSR outlet canal/Gauge [

Order Number	Date	Rating	Stage (m)	Velocity (m/s)	Area (sq m)	Discharge (cumecs)	--- Comparison --- Diff./Rat.	Plot
1	16 Jun 1980	A	1.050	0.421	17.60	7.410	0.09/A	->
2	17 Jun 1980	A	0.980	0.462	16.36	7.560	0.00/A	-
3	18 Jun 1980	A	0.930	0.440	16.84	7.410	-0.03/A	<-
4	18 Jun 1980	A	0.980	0.470	18.47	8.680	-0.09/A	<-
5	22 Jun 1980	A	0.820	0.391	14.17	5.540	0.04/A	->

Total number of gaugings = 5

TABLE 3 Gaugings for Station 104

Discharge measurements for station 105 : Jowhar OSR - Shebelli d/s outlet

Order Number	Date	Rating	Stage (m)	Velocity (m/s)	Area (sq m)	Discharge (cumecs)	--- Comparison --- Diff./Rat.	Plot
1	7 Jun 1980	A	1.580	0.613	39.80	24.400	0.09/A	->
2	8 Jun 1980	A	1.460	0.569	42.53	24.200	-0.02/A	<-
3	9 Jun 1980	A	1.320	0.561	38.86	21.800	-0.04/A	<-
4	11 Jun 1980	A	1.070	0.530	29.25	15.500	0.04/A	->
5	12 Jun 1980	A	0.980	0.549	26.41	14.500	0.01/A	-
6	14 Jun 1980	A	0.850	0.477	26.21	12.500	0.00/A	-
7	24 Jun 1980	A	0.900	0.528	26.14	13.800	-0.03/A	<-
8	4 Nov 1980	A	1.560	0.590	45.59	26.900	-0.05/A	<-

Total number of gaugings = 8

TABLE 4 Gaugings for Station 105

JOWHAR OFF STREAM RESERVOIR - Water balances 1980 - 1985

(All volumes in million cubic metres)

Year	Month	Sta 12	Sta 102	Sta 103	Sta 104	Sta 105	Sta 14	Water balances (S102+103)	(S102+103-S12)	(S102+104)
1980	Jan		22.292				9.941			
	Feb		12.78				4.103			
	Mar		8.822				0			
	Apr		17.644				4.46			
	May		230.72				170.27			
	Jun		44.007		23.359	34.855	62.604			67.366
	Jul	51.868	41.532				36.711			
	Aug		191.69				154.18			
	Sep		193.22			165.13	162.6			
	Oct	141.02	139.97		38.236	119.99	120.36			178.206
	Nov	51.267	41.449		26.211		52.817			67.66
	Dec	15.393	10.104		16.728					26.832
1981	Jan	4.589	4.133		8.232		0			12.365
	Feb	0.148					0			
	Mar						42.674			
	Apr	425.24	323.14	101.67		258.99	205.33	424.81	-0.43	
	May	435.19	343.19	108.38		295.35	235.72	451.57	16.38	
	Jun	207.95	176.36	10.035		163.65	158.63	186.395	-21.555	
	Jul	85.279	62.092			92.472	97.163			
	Aug	266.46	253.27			220.3	182.92			
	Sep	397.39	367.33	52.799			229.46	420.129	22.739	
	Oct	424.24	384.28	70.717		291.89	232.9	454.997	30.757	
	Nov	182.31	174.02			156.69	154.59			
	Dec	63.294	50.952		21.606	52.038	69.215			72.558
1982	Jan	37.109	31.173		28.906	41.405	51.091			60.079
	Feb	20.362	21.733		24.228	36.003	31.688			45.961
	Mar		23.073		23.733	40.28	39.347			46.806
	Apr	145.59	144.01			126.74	106.21			
	May	331.48	322.19	41.914		281.57	243	364.104	32.624	
	Jun	277.1	265.92			232.52	203.92			
	Jul	126.77	124.17		38.997	117.83	113.37			163.167
	Aug	270.69	277.03			240.5	204.32			
	Sep	339.73	327.05	37.181		278.92	236.13	364.231	24.501	
	Oct	339.89	329.03	34.538		261.65	213.66	363.568	23.678	
	Nov		400.65	67.381		306.05	242.32	468.031		
	Dec		273.57			240.72	205.06			
1983	Jan	128.3	127.23			139.84	137.61			
	Feb		59.141		52.9	92.924	78.386			112.041
	Mar	58.335	46.418		51.942	81.025	61.849			98.36
	Apr	77.443	73.84		44.46	79.781	70.065			118.3
	May	299.33	307.24	17.243		269.1	225.86	324.483	25.153	
	Jun	386.59	389.21	44.112	23.452		242.09	433.322	46.732	412.662
	Jul	209.62	212.53			207.04	190.61			
	Aug	379.36	397.4				236.83			
	Sep	400.68	395.35	73.41			244.33	468.76	68.08	
	Oct	407.45	393.95	71.875		321.23	253.97	465.825	58.375	
	Nov	352.68	367.66			302.88	241.34			
	Dec	165.96	170.92			168.18	151.23			
1984	Jan	69.033	72.421		52.969	88.681	77.641			125.39
	Feb	54.823	44.147		44.961	64.89	55.507			89.108
	Mar	43.708	31.677		52.943	60.744	59.837			84.62
	Apr	35.687	26.196		43.102	44.087	41.946			69.298
	May	105.28	100.24			94.848	68.792			
	Jun	169.25	177.95			173.82	148.52			
	Jul	147.88	147.78			143.41	124.04			
	Aug	295.92	296.06	29.221		271.05	208.08	325.281	29.361	
	Sep	292.98	287.92	37.454		248.05	199.64	325.374	32.394	
	Oct	280.06	266.08	43.316		243.02	197.11	309.396	29.336	
	Nov		59.333		35.937	71.881	75.336			95.27
	Dec		32.543		23.093	42.215	28.146			55.636
1985	Jan		20.807		36.337	40.323	24.214			57.144
	Feb		12.794		30.881	36.421	7.452			43.675
	Mar		10.405		25.783	40.323				0
	Apr		186.51			149.6				
	May	460.1	418.75	75.528		241.85	210.82	494.278	34.178	
	Jun	311.23	272.7	55.168		212.8	189.24	327.868	16.638	
	Jul	120.54	122.33	9.964		152.19	110.16	132.294	11.754	
	Aug	343.41	336.83	27.022		304.33	222.81	363.852	20.442	
	Sep	308.83	270.39	56.265		272.8	213.39	326.655	17.825	
	Oct	235.64	197.96	42.17		212.56	174.54	240.13	4.49	
	Nov	84.103	73.363			101.81	79.616			
	Dec	49.522	29.823			45.993	33.068			

TABLE 5 Calculation sheets - evaluation of equations (1) and (2)

Existing Situation: Irrigation Requirements and Operational Study Results (Mm^3)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Irrigation requirements in the Jowhar reach	27.37	22.66	27.71	17.41	18.05	21.11	20.21	22.37	25.91	18.35	20.09	25.11	266.92
Downstream requirements	30.41	18.56	20.64	13.47	37.31	59.70	57.91	20.87	31.07	64.86	72.80	62.66	490.21
Downstream requirements including channel losses	31.3	18.9	20.9	13.7	38.8	63.0	60.8	21.4	32.1	68.6	77.8	66.2	513.5
Available d/s flow													
50% reliability*	37	21	39	70	109	91	84	128	164	189	1 55	113	210
75% reliability*	31	19	21	31	53	63	60	75	136	179	1 39	66	952
90% reliability*	31	19	21	11	38	60	33	16	33	87	89	66	678

Note: * Not a homogeneous sequence

Source Sir M. MacDonald & Partners Ltd., 1978

TABLE 6 Table 1.2 from ref. 2

JOWHAR OSR - Theoretical estimates of losses (infiltration 2mm/day)

	Evaporation (mm/day)	Evaporation (mm/month)	Rainfall (mm/month)	Infiltration (mm/day)	Infiltration (mm/month)	Mean area (km2)	Evaporation (MCM)	Rainfall (MCM)	Infiltration (MCM)	SNAI total (MCM)	SNAI drainage (MCM)	Total losses (MCM)	Losses excluding SNAI (MCM)	Total losses (MCM) from data 1981-1985
Jan	6.6	204.6	7	2	62	88	18.0048	0.616	5.456	27.37	8.211	14.6338	22.8448	13.6
Feb	7.4	207.2	3	2	56	78	16.1616	0.234	4.368	22.66	6.798	13.4976	20.2956	8
Mar	7.6	235.6	21	2	62	66	15.5496	1.386	4.092	27.71	8.313	9.9426	18.2556	16.8
Apr	6.5	195	93	2	60	38	7.41	3.534	2.28	17.41	5.223	0.933	6.156	
May	6	186	100	2	62	44	8.184	4.4	2.728	18.05	5.415	1.097	6.512	11.8
Jun	5.4	162	30	2	60	67	10.854	2.01	4.02	21.11	6.333	6.531	12.864	20.8
Jul	5.3	164.3	29	2	62	70	11.501	2.03	4.34	20.21	6.063	7.748	13.811	17.7
Aug	6	186	20	2	62	68	12.648	1.36	4.216	22.37	6.711	8.793	15.504	19.2
Sep	6.7	201	12	2	60	77	15.477	0.924	4.62	25.91	7.773	11.4	19.173	21.9
Oct	6.1	189.1	111	2	62	85	16.0735	9.435	5.27	18.35	5.505	6.4035	11.9085	20.5
Nov	6.2	186	87	2	60	96	17.856	8.352	5.76	20.09	6.027	9.237	15.264	
Dec	6.1	189.1	20	2	62	96	18.1536	1.92	5.952	25.11	7.533	14.6526	22.1856	
Totals		2305.9	533		730		167.8731	36.201	53.102		79.905	104.8691	184.7741	

Days	Mean monthly storage 1981-1985 (MCM) 1981	1982	1983	1984	1985	Mean (1982-1985)	Area (km2)
31	0	104.18	175.2	143.51	34.236	114.2815	88
28		71.997	128.11	110.89	13.062	81.01475	78
31		39.717	78.446	68.394	3.608	47.54125	66
30	29.153	10.567	37.505	25.183	3.933	19.297	38
31	111.64	24.122	29.202	5.403	38.41	24.28425	44
30	141.06	69.713	45.412	0.626	84.17	49.98025	67
31	96.803	67.861	70.325	0.405	86.477	56.267	70
31	56.794	58.767	65.687	6.163	80.868	52.87125	68
30	78.445	80.39	107.03	21.878	101.21	77.627	77
31	130	104.77	152.94	45.109	122.72	106.38475	85
30	156.06	160.17	189.22	65.748	125.19	135.082	96
31	136.23	198.52	173.53	56.255	111.6	134.97625	96

TABLE 7 Calculation sheets - evaluation of equation (3) (infiltration 2mm/day)

JOWHAR OSR - Theoretical estimates of losses (infiltration 5mm/day)

	Evaporation (mm/day)	Evaporation (mm/month)	Rainfall (mm/month)	Infiltration (mm/day)	Infiltration (mm/month)	Mean area (km2)	Evaporation (MCM)	Rainfall (MCM)	Infiltration (MCM)	SNAI total (MCM)	SNAI drainage (MCM)	Total losses (MCM)	Losses excluding SNAI (MCM)	Total losses (MCM) from data 1981-1985
Jan	6.6	204.6	7	5	155	88	18.0048	0.616	13.64	27.37	8.211	22.8178	31.0288	13.6
Feb	7.4	207.2	3	5	140	78	16.1616	0.234	10.92	22.66	6.798	20.0496	26.8476	8
Mar	7.6	235.6	21	5	155	66	15.5496	1.386	10.23	27.71	8.313	16.0806	24.3936	16.8
Apr	6.5	195	93	5	150	38	7.41	3.534	5.7	17.41	5.223	4.353	9.576	
May	6	186	100	5	155	44	8.184	4.4	6.82	18.05	5.415	5.189	10.604	11.8
Jun	5.4	162	30	5	150	67	10.854	2.01	10.05	21.11	6.333	12.561	18.894	20.8
Jul	5.3	164.3	29	5	155	70	11.501	2.03	10.85	20.21	6.063	14.258	20.321	17.7
Aug	6	186	20	5	155	68	12.648	1.36	10.54	22.37	6.711	15.117	21.828	19.2
Sep	6.7	201	12	5	150	77	15.477	0.924	11.55	25.91	7.773	18.33	26.103	21.9
Oct	6.1	189.1	111	5	155	85	16.0735	9.435	13.175	18.35	5.505	14.3085	19.8135	20.5
Nov	6.2	186	87	5	150	96	17.856	8.352	14.4	20.09	6.027	17.877	23.904	
Dec	6.1	189.1	20	5	155	96	18.1536	1.92	14.88	25.11	7.533	23.5806	31.1136	
Totals		2305.9	533		1825		167.8731	36.201	132.755		79.905	184.5221	264.4271	

Days	Mean monthly storage 1981-1985 (MCM)						
	1981	1982	1983	1984	1985	Mean (1982-1985)	Area (km2)
31	0	104.18	175.2	143.51	34.236	114.2815	88
28		71.997	128.11	110.89	13.062	81.01475	78
31		39.717	78.446	68.394	3.608	47.54125	66
30	29.153	10.567	37.505	25.183	3.933	19.297	38
31	111.64	24.122	29.202	5.403	38.41	24.28425	44
30	141.06	69.713	45.412	0.626	84.17	49.98025	67
31	96.803	67.861	70.325	0.405	86.477	56.267	70
31	56.794	58.767	65.687	6.163	80.868	52.87125	68
30	78.445	80.39	107.03	21.878	101.21	77.627	77
31	130	104.77	152.94	45.109	122.72	106.38475	85
30	156.06	160.17	189.22	65.748	125.19	135.082	96
31	136.23	198.52	173.53	56.255	111.6	134.97625	96

TABLE 8 Calculation sheets - evaluation of equation (3) (infiltration 5mm/day)

APPENDIX B

FIELD TRIP REPORTS

This appendix contains copies of the field trip reports produced during this period, brought together in a single document. The discharge measurement calculation sheets are included at the end of the appendix rather than after each particular report.

APPENDIX B

CONTENTS

B1. Field Trip to Afgoi and Audegle 28 March 1988

Participants:

Peter Ede
Zakia
Ali
Luul
Saiid
Maxamuud

Afgoi

Arrived 0840 at MOA office, but the observer had apparently gone to Merca. Saw his book readings up to and including 0600 today - Staff Gauge 0.84, Bridge Dip 6.66.

Staff gauge attached to u/s pillar on old bridge was surrounded by debris to about 1.4 m - well above water level. Clearly he makes Dip and subtracts from 7.50 m which was the original GH of the MB. This was corrected to 7.47 m in 1980 and measured by Rod Hawnt in 1983/84 as 7.46 m. Considering the state of the old bridge these differences are small. Hawnt noted the observer's `fixing' of SG/MB readings to ensure that the sum was always 7.50 m, and accordingly took away the bridge dipper. In view of the difficulty in reading the SG (acute angle of sight from available point on old bridge, plus debris) this is not recommended. Indeed, on a still day the dip is probably a more accurate measure of water level. However, we must try to explain to the observer that he should only record the data he actually observes (any calculation of SG from MB or vice versa will be done in the Hydrology office in Mogadishu). Furthermore, if it is possible to make both measurements we must explain that they will not necessarily add up to 7.50 m (or any other particular value) and the sum may vary from day to day. The latter point will be particularly difficult to get across.

Three gauge plates (2 to 5 m) were missing, but two were recovered from the debris round the pillar and were taken to Mogadishu for repainting. Undergrowth was cleared from the 1-2 m plate and the top of the 0-1 m plate (on the other side of the pillar). The latter was slightly loose and should be re-fixed if water levels permit. The water level after removal of debris was about 0.79 m, matching our check bridge dip of 6.66 m. The plates were repainted from 0.8 to 2.0 m.

To fix the missing/loose gauge plates, ties of the form described by Keith Stallard in Stage 2 Mission Report Appendix I.3 will be required, together with the ladders. Further clearing of debris should also be undertaken - using waders if necessary.

A water level chart recorder was installed on the d/s side of the old bridge by the Italian salinity study team in about 1983. The bottom of the metal stilling well is silted up and it is understood that the recorder has been inoperative for a considerable period. Hawnt established a new MB on the recorder housing in 1984, but this does not appear to have been used.

In view of the silt round that pillar it is not a particularly suitable location. Consideration was given to establishing an MB on the new bridge, but because this is about 2 m higher, problems from wind would be more extensive. For the time being, readings should continue from the old bridge.

The old bridge is not in good condition and in a few years time is likely to be unsafe. In due course it will therefore be necessary to establish new staff gauges.

Audegle

Arrived 11.30. Bridge Dip 5.89 m. We later found the observer and his reading at noon was 5.86 m - a minor difference considering the wind.

The staff gauges are near the old bridge about 200 m u/s. Some silt was removed from the 1-3 m stand and the reading was checked as 1.45 m. The 3-5 m stand is secure, but the plates had come off and are safely stored in the nearby village. They will need repainting before fixing.

At various times the SG range has covered 0-6 m. However, the reinstallation of 0-1 m and 5-6 m stands is not an urgent priority. In fact, because of the collapsed old bridge and surrounding debris this is not a good site and the previous recommendations for re-siting the gauges near the new bridge are endorsed. However, higher priority rehabilitation work at other sites means that this may not be possible until the 1989 low flow period.

At Afgoi on our return the level had dropped to about 0.71 m. Returned to Mogadishu at 1530.

Peter Ede
29th March 1988

SOMALIA HYDROMETRY PROJECT

B2 Field Trips to Afgoi (April 4th 1988) and Mahaddey Weyn, Bulo Burti and Beled Weyn (April 5th - 6th)

Participants:

Peter Ede
Zakia (Afgoi only)
Ali
Saiid
Ibrahim (Afgoi only)
Maxamuud

Afgoi 4th April 1988

Saw observer and explained most of the points noted in previous field report. He had just started writing 0.00 for SG reading because the water was too low for a dipper reading. In these circumstances he was instructed to write "no water" in the comments column on the card and to do a bridge dip from the new bridge. This should also be noted on the card, but because the new bridge is much higher there should be no risk of confusion. Whenever possible, the original MB will be used (i.e. beside the SG).

The MB on the new bridge is on the downstream side just to the Baidoa side of the middle of the span. It is on the middle rung of the railings, just to the left of an upright (18th from Baidoa side). The initial painted arrow is to be supplemented by a hacksaw cut on the next visit. Dip at 1100 was 9.05 m, compared to the SG of about 0.45 m found after clearance of debris.

It became apparent that the observer's bridge dipper had been faulty for several months and measurements have been made by eye. Thus recent data is subject to additional uncertainty. We gave the observer our dipper (the only one available to the office team) and examined the faulty dipper in Mogadishu. The fault was diagnosed, but repair will be extremely difficult.

In Mogadishu it had proved impossible to obtain SG ties of the sort used previously by Keith Stallard. However, two possible designs were provided by an Italian workshop, DELBON Tel. 21853, in Mogadishu. One proved successful in initially fixing the 2-3 m plate; the other was too small but otherwise would probably have been O.K. Further ties will be made as soon as possible to complete the job. Only time will tell whether they are sufficiently robust to withstand flood water and tree trunks etc. The 0-1 m plate was straightened and should be hammered in slightly before fixing to the pillar.

Recent data was collected from the observer.

Mahaddey Weyn 5th April 1988

Arrived 1050; observer apparently in Jowhar. It was very difficult to read the SG because the plates were dirty and surrounded by debris which could not be cleared from the bank. Guessed water level approx. 0.5 m. Using an improvised water level dipper (weight tied to broken dipper cable) bridge dip approximately 6.90 m, corresponding to 0.62 m on the SG. Silt was dug out from the base of the 2-4 and 4-6 m SG stands.

Bulo Burti 5th April 1988

Arrived 1330; unable to find observer. Water level below the 1-3 m SG. No sign of lower gauge. Dug out some silt from 1-3 m stand, but further work needed, preferably with a new spade. 5-7 m stand uprooted by floods and is lying near the 3-5 m stand. The stand is in good condition, but the concrete round it must be broken before it can be shifted. The condition of the SG plates is not very good and they should probably be replaced.

With great difficulty we obtained permission to make a bridge dip. Approx. 9.56 m, corresponding to a GH of 0.58 m.

Beled Weyn 5th April 1988

Arrived 1645 and confirmed accommodation with Italian Medical Team (arranged via their Mogadishu office). Then proceeded to bridge. Water level close to gauge zero, but difficult to tell because channel needs digging out. Started to paint SG on bridge abutment (1.5 m upwards).

Check levelling of MB established by Chris Green on 15 October 1985 (top rung of d/s railing by 5th vertical from right bank) gave MB equivalent to GH of 7.58 m. This is the same as that reported by Rod Hawnt in 1983 for a different MB which we could not trace but which was also said to be on the top rung of the railings. Bridge dip was about 7.54 m, equivalent to SG = 0.04 m.

The battery of the automatic recorder was changed, but the recorder showed no sign of working. Yet again, the pulley wire had come off the wheel, but at least it had not broken, and the float and counterweight appeared to be attached.

We tried to remove the recorder to take it back to Mogadishu, but decided to check method of fixing of spare unit in Mogadishu before using excessive force! The base of the pipe was badly silted. This was cleared sufficiently to allow water to enter, but the float would probably be impeded at low levels. The nuts fixing the partial closing of the bottom of the pipe were rusted on the threaded bolts and could not easily be removed.

Beled Weyn 6th April 1988

Completed painting almost to 5 m level. Top section already in satisfactory condition. Dug out channel to lower SG. Still difficult to read, but observer's estimate of 0.02 m seemed reasonable. Bridge dip 7.52 m (EGH = 0.06 m), using observer's dipper. He had apparently not been using this for a long time. Ali instructed him to measure this as well as the SG. We collected data sheets for January - March and cards from 1st March onwards. Earlier cards had apparently been posted to Mogadishu, but they have not reached the Hydrology section. Ali tried to sort out the discrepancy between date and day of the week - next time cards are printed the day of the week should be given in Somali as well as English. The observer complained that he was not receiving any allowance from the project. We said it was possible that there might be some allowance later, but we could not pay for repairs to his bicycle.

Bulo Burti 6th April 1988

MOA office locked, but found observer in the town. Arranged for retrieval of upper gauge stand (500/= advance, balance of 2,000/= on next visit). Materials needed for re-installation are available locally. The observer has no bridge dipper so cannot take any readings at present. Until new dippers are obtained it would be best to transfer the dipper currently at Beled Weyn.

Mahaddey Weyn 6th April 1988

The observer was again unavailable. Apparently he had gone to Mogadishu. The data is locked inside his house and his family have no key. They said he was posting cards each week - but none have reached the Hydrology section for over a year. (1987 cards received from Jowhar in the office on 6.4.88).

Travelling: Petrol consumption approx 120 litres (lower than expected). About 6-7 hours driving to Beled Weyn. Road very bad from Balcad to Jowhar and immediately north of Mahaddey Weyn. Otherwise good, but deteriorating towards Beled Weyn.

Peter Ede
7th April 1988

B3 Field Trips to Afgoi and Audegle (11, 14 and 17 April 1988)

Participants:

Peter Ede
Zakia (11/4 only)
Ali
Ibrahim
Saiid (17/4 only)
Maxamuud

Afgoi 11th April 1988

This visit was largely unproductive because the additional ties for fixing the SG plates proved to be the wrong size. However, some useful preparatory work was done and the bottom plate was painted down to the current water level of 0.45 m.

Check levelling of the new bridge MB relative to the old bridge MB gave its EGH as 10.09. This appears to conflict with the bridge dip recorded last week (9.05 + 0.45 = 9.50 m) so the level should be re-checked on the next visit. (A later check of the level instrument showed that some adjustment was required, but this seems unlikely to account for a difference of nearly 60 cm).

The water level dipper given to the observer last week had broken and it was taken back to Mogadishu. The wire inside was found to be loose.

Afgoi 14th April 1988

River up significantly in last 3 days - SG = 0.89 m. We returned the bridge dipper to the observer - working again, but if the temporary repair does not last a soldering iron should be obtained. The bridge dip was 6.54 m and that from the new bridge 8.64 m. Dip (old bridge) + SG gives 7.43 m compared to the recorded datum difference of 7.47 m. The dip from the new bridge indicates an EGH of a little over 9.5 m. We were refused permission to carry out check levelling.

The higher water level made access more difficult, but with considerable acrobatic assistance from the observer the 3-5 m plates were fixed to the bridge pillar. The 0-1 m and the 2-3 m plates were fixed more securely than previously. Metre figures were painted onto the pillar.

Audegle 14th April 1988

The river had stopped flowing, but there was a small pool in the river bed near the lower SG stand. The stand was partially dug out and the level of the pool was found to be 1.16 m. This shows reasonable agreement with the zero flow point of the rating equation of 1.14 m. The 3-4 m plate was fixed to the upper stand by drilling and bolting, but because of the time taken it was decided to leave the remaining work (fixing the 4-5 m plate and painting all plates) until the next visit.

Audegle 17th April 1988

The flow had reached Audegle overnight and the SG reading was 1.55 m. The bridge dip was 5.71 m. We fitted a new battery to the observer's dipper.

The 4-5 m SG plate was bolted to the gauge stand and all plates were repainted from the current water level up to 5 m. Metre figures were painted on - either on the plate or the stand. If another visit can be made before the river rises substantially it may be possible to fix a lightweight 5-6 m SG to the top of the 3-5 m stand. The 1-3 m stand seems secure, but it is slightly off the vertical. There may be a small error in the gauge zero of the 3-5 m plates compared to the 1-3 m plates, but this should not be significant.

Following rainfall the condition of the road between Afgoi and Audegle had deteriorated substantially and travelling was both slower and less comfortable.

At Afgoi on our return (at 1300) the water level was 0.97 m, slightly higher than three days earlier.

Peter Ede
20th April 1988

SOMALIA HYDROMETRY PROJECT

B4 Field Trips to Middle and Lower Shebelli (22-23 April 1988)

Participants:

Peter Ede
Peter Bray (MMP)
Ali (MMP driver)

Jowhar 22nd April 1988

Water level at bridge d/s of Jowhar offtake (sugar estate) was ?.96 m. There are no metre marks. The SGs continue to approximately 1.6 m above the current water level. This is unlikely to be sufficient for sizable floods.

At Sabuun (offtake for Jowhar OSR) there are a number of SGs. In the canal d/s of the gates there is a 0-3 m SG on a slightly skew and loose wooden post. The bottom was slightly silted. There was virtually no flow through the offtake structure. The level of the small pool of water was probably slightly below the gauge zero. The SG post has two side markers - "50" at 1.69 m and an illegible figure at 1.18 m.

Upstream of the offtake there are 3-5 m SGs on the left bank, but these are silted to about 3.3 m. On the right bank brackets on the barrage indicate the location of previous SGs. This is probably the best site if the gauges are to be reinstalled. In the river d/s of the barrage there are 1-6 m plates attached to the retaining wall. The 0-1 m plate is missing.

Current water level estimated as 0.95 m. There are remains of some old gauges on the left bank a short distance d/s.

Apart from a few pools of water the Jowhar reservoir was empty. The SG level by the outlet was 1.43 m.

23rd April 1988

The water level at **Afgoi** at 0840 was 1.83 m, up by nearly a metre in six days. Took road to Audegle on north side of river - slightly longer but a much better road than that on the south side. Level at **Audegle** at 1010 was 2.55 m - exactly 1 m higher than last week. The TBM established on the new bridge during a previous MMP survey was checked and found to be about 28.5 cm below the new MB. When the survey details are received from UK the level of the MB may be determined.

At **Kurten Waarey** the water level at 3pm was 1.01 m . The river had apparently started flowing overnight. The 1-6 m gauges installed by Keith Stallard two years ago were in very good condition except that there are no metre marks. These should be added before we endeavour to train the barrage operator to read the level. We met Mr Hassan Hussein of the MOA at Kurten Waarey. He was keen to help with future readings.

We had intended to level the SGs to the u/s SG, but the latter was in poor condition and of unusual design. It was not clear exactly which points on the gauge the numbers referred to. If it is considered desirable to keep records of u/s levels then new gauges should be installed.

Report From Kamsuma, River Jubba

Mr Bray visited Mogambo in mid-April and reported on the automatic recorder at Kamsuma bridge. On April 15th it was found that the stilling pipe and staff gauges were in place down to SG approx 4.3 m, but that there was no trace of the lower sections. It is assumed that the float and counterweight have been lost. The missing pipe sections correspond to those installed in April 1986. The water level was estimated to be about 3 m below the base of the remaining pipe.

By April 19th the river had risen substantially following heavy rainfall at Bardheere and elsewhere in the Jubba valley and the level was 4.68 m on the SG.

The prospects for reinstalling the lower part of the pipe will have to be assessed when the river is lower. In the meantime it may be possible to set the recorder to cover the high river levels.

Peter Ede
24th April 1988

B5 Field Trips to Audegle (26th April) and Lower Jubba (17th-22nd May)

Participants:

Peter Ede
Ali (Audegle only)
Ibrahim (Audegle only)
Maxamuud

Audegle 26th April 1988

River up slightly in last 3 days - 1.89 m (+6 cm) at Afgoi and 2.64 m (+9 cm) at Audegle. The 3-5 m gauge stand was extended with a piece of angle aluminum and a plastic gauge plate fixed to it to cover the range 5-6 m. It proved difficult to fix it precisely and there is a gap of a few mm at the 5 m level. However, this is only a temporary measure to cover this year's floods and any resultant error will be insignificant compared to those caused by the debris surrounding the old bridge. This causes a significant dam effect so that the staff gauges are in a reservoir at a slightly higher level than would previously have been the case for the same discharge. The fall in water level at the bridge was estimated to be about 20 cm.

Lower Jubba Trip 17th to 22nd May 1988

Kamsuma

At Kamsuma (at 1600 on 17/5) a bridge dip measurement was made from the 32 m mark on the d/s side of the bridge. This was the point used by Rod Hawnt in 1984/5, but there is no sign of a specific MB point. It is assumed that he used the painted mark indicating the 32 m point. The approximate dip reading was 6.98 m. The water level was well below the bottom of the remaining section of pipe and it was confirmed that the lost section was that installed in April 1986; SGs installed then have also disappeared and the bottom 20-30 cm of the upper staff gauge (i.e. from 4.00 m) has broken off.

The automatic recorder was tested with a working battery and was found to be working correctly; however, there was no point in setting it up because the water level was below the pipe. As expected, the float and counterweight were missing.

Check levelling was carried out on 19/5/88 and the MB (32 m) was found to have an EGH of 9.96 m relative to the staff gauge (top = 8 m) attached to the pipe. The bridge dip was 7.19 m - corresponding to SG = 2.77 m. Rod Hawnt gave the MB a level of 18.00 m, but this was a nominal value and it is not yet possible to relate the new SG/MB levels to the data available for 1972-76. On 22/5 the MB reading was 6.95 m. The appointment of an observer and provision of a bridge dipper is an urgent requirement.

Mogambo

The Mogambo Irrigation Project (supervised by MMP staff) records the SG level at Mogambo Pump Station each weekday morning. It had been arranged in 1986 that the readings would be extended to the MOA standard of 3 readings per day (except for Fridays when one reading would be taken), and this was done for a period. However, constraints on the project (particularly transport) mean that it is not at present practicable to increase the number of readings. It is believed that it would be preferable to ask the MIP pump station attendant to make the readings after providing appropriate training. This will be considered on the next visit.

SG readings during the visit were as follows:

18/5 at 1500	9.18 m	20/5 at 0900	9.11 m
19/5 at 0830	9.18 m	22/5 at 0745	9.41 m
19/5 at 1230	9.14 m		

Mareere

In 1986 Keith Stallard arranged for the data recorded at the Jubba Sugar project to be entered on MOA sheets and sent to Mogadishu. This worked for a period but no data has been received recently. Mr Jim Kelly (General Manager) and Mr Keith Ward (Agricultural Manager) kindly offered to assist us in restoring the link so that MOA can take advantage of the virtually complete record of river levels at Mareere since 1977. Mr Ward said he would send up-to-date sheets of mean daily water levels and thereafter monthly sheets from the standard MOA book which I provided. For the time being this data will be sent via the MMP office at Mogambo.

Jamamme

The station at Jamamme was abandoned in 1985 owing to various problems encountered in maintaining an accurate record (see Stage 2 Mission Report, Appendix IV.I pp 12-16). However, in order to correlate the historic data there with data at Mogambo and Kamsuma it will be necessary to carry out a number of bridge dip measurements there and plot them against the Mogambo data. The MB used by Rod Hawnt was identified (painted mark on u/s bridge deck) and two readings taken:

20/5 at 0945	8.01 m
21/5 at 1215	7.87 m

Shebelli River

Afgoi and Audegle stations were visited on the journey and the following readings observed (SG unless noted):

	17/4 am	22/5 pm
Afgoi	3.82	Dip = 4.94 m (EGH = 2.53)
Audegle	5.13	3.75 m

When the river level fell the gauge at Afgoi remained obscured by debris caught on the pillar so the SG could not be read.

Peter Ede
27th May 1988

SOMALIA HYDROMETRY PROJECT

B6 Field Trip to Upper Shebelli 30th - 31st May 1988

Participants:

Peter Ede
Ali
Ibrahim
Saiid
Maxamuud

Mahaddey Weyn

Once again we were told that the observer was in Jowhar, though he had not been at the MOA office there when we called on May 30th. We left a new data book and a supply of weekly cards with his wife. The readings were as follows:

	SG	Dip
30th May at 11.00	2.48	5.06
31st May at 14.30	2.61	4.88

Note: different dippers were used for these readings.

Bulo Burti

At 1330 on 30th May the SG was 1.94 m. The observer understood this to be 0.94 m; we explained that the bottom of the lowest staff gauge represents 1.00 m and that we hope to install a 0-1 m SG next year. The bridge dip was 8.24 m. Discussions were held with the observer and the District Coordinator; there appeared to have been some dispute between them with the result that the observer was not always taking the readings. On this day the coordinator had read the SG in the morning (also making a 1 m error); the data book showed three readings for the day, including the evening one due four hours later. The coordinator admitted copying his one reading to the other two times but claimed that this was the first time he had done so; the frequency of days when all three readings are identical casts some doubt on this.

The bridge dipper repaired in Mogadishu (previously from Afgoi) was handed over and it was agreed that one dip measurement would be made each day to supplement the SG readings; this will be increased to three times if the water level is outside the SG range. Because of the difficulty encountered in repairing the dipper it is expected that the dip results will be relatively inaccurate; the SG readings should be used wherever possible. Saiid remained in Bulo Burti to make arrangements for the next day's work.

On 31st May it had been planned that the 5-7 m SG would be re-fixed, but cement was no longer available locally so the work could not be carried out. The SG level was 1.81 m at noon. On a future visit cement must be taken from Mogadishu.

Beled Weyn

On 30th May at 1630 the SG level was 0.85 m. The automatic recorder was restarted with the level set at a nominal 1.80 m. When the water level rises it will be necessary to compare the recorder data to that from the observer and make an appropriate adjustment to the recorder data. Yet again the pulley wire had come off the wheel; if/when this happens again it may be necessary to open the pipe to see if the counterweight is being blocked as the float rises.

On 31st May data was collected from the observer. For more than a month only one reading had been recorded per day; the observer said that he had been too busy because of the absence of the coordinator. We asked him to try to increase the number of readings as soon as possible. We retrieved the bridge dipper which will be required at Kamsuma; in any case the observer had not been using it, though another dipper should be provided for the low flow season when the water level may drop below the SG.

Logistics

Total distance 750 km. Accommodation was again generously provided by the Italian Medical Team at Beled Weyn. Petrol consumption around 150 litres - new Land Rover ("110" range) much less economical than previous MMP vehicle.

Peter Ede
1st June 1988

B7 Fieldwork Undertaken during July 1988

The following trips were made:

5th July	Afgoi and Audegle
8th July	Afgoi
12th July	Jowhar and Mahaddey Weyn
19th-21st July	Bardheere and Lugh Ganana
27th-30th July	Kurten Waarey, Kamsuma, Mogambo, Jamamme and Fanoole

Participants:

	5	8	12	19-21	27-30
Peter Ede	y	y	y	y	y
Kevin Sene	y	y	y	y	y
Jeremy Meigh	y	y	y		
Robin Cadwallader		y			
Ali	y		y	y	y
Ibrahim	y		y	y	
Maxamuud	y		y	y	y

Afgoi 5th July 1988

This trip was arranged to test the existing current meter equipment and some of the new field equipment. It provided valuable experience because most of the team had little or no experience of current metering and none had used this particular equipment. The discharge measurement was the first by the Hydrology Section for over two years and is intended to be the first of a series at all MOA gauging stations during the remainder of Phase 3 of the project.

The measurement was made from the d/s face of the new bridge using the Braystoke suspension derrick. Velocities were measured only at 0.6 of the depth from the water surface because the depths were hardly sufficient for measurements at 0.8 of the depth which are required for the standard two point method.

On returning to the office the discharge was calculated by hand using the appropriate MOA measurement/computation sheets. The results were later checked against the output from a Lotus spreadsheet program specially written to carry out the calculations. These calculations are attached to this report.

Results:	Bridge Dip measurement	= 5.36m
	Equivalent Gauge Height	= 2.11m (staff gauge obscured)
	Discharge	= 19.1 cumecs

The measured discharge was about 14% below that implied by the existing rating equation. It should be noted that the bridge suspension method is not particularly accurate for shallow river conditions because the measurement of depth is accurate to no more than the nearest 10cm.

It had been planned to test the sediment sampler but it was found that a special fixing bracket was required.

Audegle 5th July 1988

Data recently received from Audegle casts doubt on the SG readings because recorded values for 17th and 22nd May differ substantially from those observed by Peter Ede during the lower Jubba field trip. Unfortunately it was not possible to make inquiries about this because the observer was absent.

At about 1215 the readings were as follows:

Staff gauge	3.26 m
Bridge dip	4.11 m

The new electrical conductivity meter was used for the first time and a reading of 860 micro-siemens obtained (after temperature correction).

Afgoi 8th July 1988

An additional trip was made to Afgoi for the benefit of Mr Cadwallader, the Engineering Advisor from BDDEA in Nairobi. The water level was only slightly different from that three days earlier and similar results were obtained. The discharge measurement/calculation sheet is attached.

Results:	Bridge dip	= 5.41 m (start)
		= 5.42 m (finish)
	EGH	= 2.055 m
	Discharge	= 18.4 cumecs

This result is about 13% below the rating equation. A possible reason for part of the under-estimation of this and the previous measurement is the conversion to EGH - although the gauge was obscured by debris it appeared that the water level was at or below the 2m mark. The conversion is based on survey work carried out in 1984, since when individual plates have been replaced, possibly slightly out of position. A further survey should be undertaken to clarify this matter.

Jowhar and Mahaddey Weyn 12th July 1988

At Jowhar we met Mr Hajir (MOA engineer for Jowhar OSR), the District Coordinator and also the Mahaddey Weyn observer whom we had previously failed to find. A substantial amount of data was collected and discussions were held about staff gauge plates which need to be replaced during the next low flow season - basically as noted in the field trip report for 22nd April.

At Mahaddey Weyn a discharge measurement was undertaken. The site is very good because the approach is straight and there is no interference from bridge piers (though on this occasion a tree trunk and associated debris under the bridge caused very low velocities over part of the section). However, measurements are more difficult than at most bridges because the road is very narrow and the pillars supporting the arch above the bridge deck necessitate raising the current meter and weight to the bridge deck between successive readings. On this occasion work was also hampered by a very strong wind.

Results: Staff gauge = 2.01 m
Discharge = 22.2 cumecs (4% below rating)

Calculations are attached.

Upper Jubba Trip 19th-21st July 1988

Bardheere

Arrived Bardheere at 4pm after 8 hour journey. Data observations were as follows:

SG 1.79 m
Dip 6.24 m (EGH = 1.75 according to previous survey)

The automatic recorder was found to be in good order when a new battery was fitted; however, there appeared to be no movement in the water level in the pipe despite the usual minor fluctuations in the river surface level. The recorder box was therefore removed in order to look into the stilling well. A bridge dip measurement inside the pipe indicated that the water level was similar to that outside so it was assumed that the absence of minor fluctuations was due to very effective damping rather than because the pipe was completely silted up.

On the morning of July 20th the SG reading was 1.76 m. The recorder indicated a gradual fall during the night and it is believed that it is working correctly. It may be a little slow to follow changes in water level, but that would be better than an insufficiently damped system where the float moves with every wave.

Electrical conductivity on 20th July was 190 micro-siemens - substantially lower than that found on the Shebelli.

Lugh Ganana

Lugh was reached at 5pm on July 20th after a circuitous route from Bardheere. The road towards Audinle near Baidoa was followed for 120 km before turning left and crossing the Jubba to Garbahaare; thereafter, the wrong route was taken and we found ourselves at Bula Hawa near the Kenyan and Ethiopian borders from where it was another 100 km to Lugh. The road to Garbahaare was good but thereafter all roads are poor and extremely dusty. Even if the right route were to be found between Garbahaare and Lugh it is probably better to travel via Audinle.

The recorder was found to be in good order, except that the rear small pulley wheel had mysteriously disappeared. It must be assumed that this was lost in the river on a previous visit but not reported: the nut and bolt which are meant to position the wheel were firmly fixed so the wheel could not have fallen off. The recorder was started at 5.45pm. The staff gauge reading was approximately 2.53 m (difficult to read because plate is very worn and needs repainting in the dry season) but it was too windy to take a bridge dip measurement.

By the morning of July 21st the river had risen to 2.60 m; the automatic recorder had successfully followed this change. The degree of damping seemed to be exactly right - the work done by Keith Stallard in 1986 has certainly paid off.

A discharge measurement was carried out from the bridge. The results of this (which are attached) may not be particularly accurate for two main reasons. Firstly, the 10 kg weight was not really sufficient for the velocities experienced over much of the section; secondly, verticals were set at 8 m intervals which is probably too great for this site because of the substantial variations in velocity across the section (there was one point of zero velocity and others with low values, partly but not entirely attributable to the bridge piers). Velocities were measured using the two point method (0.2 and 0.8 of depth) except for shallow areas where two measurements were made at a single point (0.6 x depth).

Results:	SG	= 2.61 m (start)
		= 2.64 m (finish)
	Discharge	= 193.9 cumecs

This is about 9% below the rating, which may be considered a good result in the light of the inadequacies outlined above. The measurement again proved to be a good training exercise because the problems encountered were substantially different from those on the more sedate river Shebelli. The EC reading was 150 - lower than that at Bardheere.

Afgoi

Check readings were taken on the journey:

	SG	Dip
19th July at 0820	2.05	5.37
21st July at 1745	*	5.37

* SG obscured, but level clearly below the EGH of 2.10 m.

Arrived Mogadishu at 6pm after 8 hour journey.

Logistics:

Accommodation in Bardheere at the local hotel and in Lugh by courtesy of Mr. Rao of UNHCR (contact provided by the Lugh District Coordinator).

Total distance = 1350 km ; diesel consumption approx 205 litres.

Lower Jubba Trip 27th-30th July

Kurten Waarey (River Shebelli) July 27th

At 1015 the level on the staff gauge was 2.15 m. Mr Hassan Hussein of the MOA was unfortunately not available but we met another MOA employee (Ahmed) who was enthusiastic about the recording of river levels. He assisted in explaining the requirements to the barrage operator who will make the readings. He also appeared keen (see reports of K. Stallard's visit in April 1986). However, there must be major doubts about whether the data will be accurate because both of them were having considerable difficulty in correctly interpreting the staff gauge; this problem also appeared to extend to the Hydrology Section in the person of Ali. Extensive training (starting with our own team) is needed. It was agreed that we would return on our way back to Mogadishu for further explanations, but the need to undertake an additional discharge measurement at Kamsuma precluded this. A further visit will be made during a day trip from Mogadishu early in August.

Lower Jubba

In the light of radio data received from Lugh it was expected that a significant flood would reach the lower Jubba during our visit; this duly materialized by the morning of July 28th when the level at Kamsuma had risen by over 1.1 m since the previous evening. Because of this flood a number of check readings were made at Kamsuma, Mogambo and Jamamme in order to track the progress of the flood and hopefully to assist in due course in constructing reliable relationships between the three sites. The full list is given below.

	Kamsuma		Mogambo	Jamamme
Date/time	SG	Dip	SG	Dip
27 @ 1740		6.78		
28 @ 0800	4.31	5.65		
1100	4.44	5.50*		
1115			10.60	
1145				7.05*
1320	4.56			
1530	4.64*			
1700*	4.72			
1805				6.50
1830			10.99	
29 @ 1015			11.46	
1100				5.65*
1645				5.45
1740			11.55	
2015			11.57	
30 @ 0625			11.60	
0650				5.25
0800	5.12	4.85		
0945	5.10	4.86		

* indicates approximate reading

Kamsuma Recorder

As previously reported, the lower half of the stilling well has been lost; however, it was decided that the recorder should be restarted in an attempt to measure the flood levels. A new float and counterweight were installed with the length of cable set such that the float should remain within the pipe when the water drops below the bottom of the pipe because the counterweight will be blocked by the pulley wheel. The recorder was started at 5pm on July 28th when it became clear that the total lack of damping at the base of the pipe was leading to massive fluctuations in the water level in the pipe. On July 30th the recorder showed a value some 2 m different from that on the staff gauge; it was concluded that the rate of change in the level was too great for the shaft encoder to work correctly. The recorder was therefore disconnected and the battery removed.

Fanoole Project

The Fanoole Project offices near Jilib were visited on July 28th. Unfortunately, Mr Abdukadir Abdullahi (whom Zakia had spoken to in Mogadishu) was absent. We were taken to a staff gauge nearby and observed the level to be 4.09 m at 0940. The deputy observer (Faduma Haaji Ahmed) was apparently unable to read the staff gauge, but she did say that the level at 0730 had been 3.56 m. Back in the office she explained that the reading was obtained by adding a constant (depending on which staff gauge was read) to the observed reading; the only plausible way to match this to our observation required that the level had risen by 0.92 m in just over two hours. This is unlikely and it was decided that a further visit would be needed to try and sort out the observations.

The office contains a substantial amount of river level data, both for Jilib and for other locations on the Jubba. The staff seemed to be very helpful and it was agreed that we would return on a future visit when we would have sufficient time to examine the data and see which of these observations might be incorporated into the MOA database. In the meantime the readings will be entered into a standard MOA data book, together with the calculation of the reading from the actual observation and the addition of the constant.

Discharge Measurements at Kamsuma

The river discharge was measured on 28th July and again before our departure for Mogadishu on 30th July. The 25 kg weight was used for the first time - essential in view of the high velocities. Even with this we encountered considerable problems with drag on the cable when weeds became caught. Another difficulty occurred in determining the river depth - in parts of the section it was not easy to be sure when the weight had reached the bed.

The results of the two measurements indicate an unusual velocity distribution with distinct reverse flow over part of the section and variable stratification of flow - in some places the higher velocity was found near the bed rather than near the surface. It would be best to carry out a more extensive measurement to define the velocity profile more accurately, but with the river level changing rapidly this would have introduced additional errors.

These measurements will help substantially in identifying the rating equation for Kamsuma. It is particularly valuable to have achieved measurements at flood levels because these are often missed. That on 30th July was the highest flow measured at any gauging station in Somalia since 1981.

Results:

	28th	30th
Staff gauge (start)	4.56	5.12
Staff gauge (end)	4.64	5.10
Discharge (cumecs)	307.2	370.4
EC (micro-siemens)		200

Full calculations are attached.

Afgoi

As usual, check readings were made en route:

	SG	Dip
27th July at 0730	2.69 m	4.71 m
30th July at 1650	2.32 m	5.08 m

These readings once again cast doubt on the established relationship between SG and Dip readings.

Peter Ede
12th August 1988

B8 Fieldwork Undertaken during August 1988

The following trips were made:

4th August	Afgoi
9th August	Kurten Waarey, Audegle, Afgoi
14th August	Afgoi
18th August	Afgoi
27th-29th August	Mahaddey Weyn, Bulo Burti, Beled Weyn
31st August	Afgoi

Participants:

	4	9	14	18	27-29	31
Peter Ede	y	y	y	y	y	y
Zakia			y	y		y
Ali	y	y		y	y	y
Ibrahim	y	y	y	y	y	y
Luul	y					
Mariam						y
Maxamuud	y	y	y	y	y	y

Afgoi 4th August 1988

A brief trip was made to carry out a check survey. It had also been hoped to see the observer in order to determine exactly which readings he has been taking and which he may have been inferring (using an incorrect relationship between SG and MB readings), but he was absent. Although the time was only 10am he had already entered the river level for 12 noon - not surprisingly entering the same value as observed in the morning. In recent weeks he has only entered the staff gauge reading, even though at times the gauge has been substantially obscured. The values recorded for July 21st (2.10) and 30th (2.43 at noon, dropping to 2.40 at 1800) suggest that he has been using the bridge dipper on those occasions and "converting" to SG level. On the 21st the SG was obscured, but the level was clearly below 2.1 m and on the 30th our dip reading at 1650 was 5.08 which the observer would convert to SG = 2.42.

The water level observations were as follows:

SG = 2.65m
Dip = 4.78m

Dip from MB established on new bridge was approx. 6.90m

The Bench Mark reported by Gemmell in 1980 and by Hawnt in 1984 was identified as a bolt-head embedded in the top of the left bank downstream abutment of the old bridge. (Hawnt described it as a white painted cross but it is presumed that he used the same point.) This BM has a level of 84.91 m amsl.

Levelling between this BM and the MB on the old bridge produced a reduced level for the MB of 84.87 m. This compares to the previously established value of 84.89 m and implies that the MB has an EGH of 7.45 m rather than Hawnt's 7.47, Gemmell's 7.49 or the original 7.50 which is still used by the observer.

Levelling was then carried out between the MB and the top of the staff gauge (6.00 m). The latter was found to have RL = 83.43 m - the same as found by Hawnt. This, however, does not allow for any slippage/overlap of any of the lower plates. If possible a full survey to the lower plates should be done during the dry season. In the meantime it is considered best to adjust the datum difference in accordance with the results of a number of concurrent measurements of SG and MB made recently by the Project. Eight such pairs of readings are available for which the average datum difference is 7.42m (range 7.40 to 7.43).

Lower Shebelli 9th August 1988

Visited GTZ office at Shalambood and collected some survey data for Kurten Waarey and Audegle. At **Kurten Waarey** the MOA office was again deserted but we did find the acting coordinator, Abdullahi Mussa Shirdon, who accompanied us to the barrage. At 1100 the SG reading was 2.48 m, but the observer was apparently in Kurten Waarey. We found him there and returned. At 1200, SG = 2.46 m. The observer apparently read this correctly, but his values for earlier days conflict with observations by GTZ so the data will need to be checked carefully.

At **Audegle** the levels at 1430 were 3.75 (SG) and 3.52 (Dip). The datum difference measured by GTZ is 7.135 m. These readings therefore imply a drop in water level between the two sites of 13-14 cm. GTZ have accurately surveyed the drop at the old bridge from the SG to a point 64 m d/s of the bridge. On four occasions with the SG in the range 3.71 to 3.86 the difference in level was 13 or 14 cm, while the difference was only 7 or 8 cm with the SG around 4.50 - 4.60 m. The level at the new bridge would be a further 1 or 2 cm lower. Visual observation on earlier visits suggests that the drop may be greater when the river level is lower than the current level. This would be expected as the obstruction is greater because of the debris round the bridge pillars.

At **Afgoi** the readings were as follows:

	0805	1525
SG	2.86	2.84
Dip	4.57	4.59

Afgoi 14th August 1988

With the river level significantly higher than on the previous occasions in July, a discharge measurement was undertaken. The results were as follows (full calculations attached):

SG	3.58 m
Dip	3.82 m
Discharge	55.4 cumecs
Mean velocity	0.66 m/s

This discharge is within 2% of the value given by the rating equation.

Afterwards two vertical velocity profiles were measured in order to investigate whether the standard two point method provides a reasonable approximation to the mean velocity over a vertical. Two verticals were selected - one near the middle of the channel where the velocity was greatest and one towards the right bank where the flow was much slower and clearly did not conform to the standard pattern with maximum velocity near the surface. The profiles are shown in the attached figure. In both cases the average velocity is closely approximated by the mean of the velocities at 0.2 and 0.8 of the depth. At the 18m point (where the profile is standard) the mean velocity is also closely approximated by the velocity at 0.6 x depth (single point method), but this is not so for the non-standard profile at the 28m point.

Some data was collected from the observer and it was confirmed that some readings in July marked as staff gauge were in fact implied values calculated from bridge dip readings. We repeated the earlier request that he should record which reading he actually makes and leave us to do any conversion.

Afgoi 18th August 1988

The river level was well over a metre higher than on the previous visit. The results of the discharge measurement were as follows:

SG (start)	4.85 m
SG (finish)	4.84 m
Discharge	79.7 cumecs
Mean Velocity	0.62 m/s

This result is some 10% below the rating equation, which is well within the spread of previous measurements at Afgoi. However, the drop in velocity compared to the previous measurement is surprising. The highest point velocity was 0.98 m/s compared to 1.09 m/s on 14th August.

Upper Shebelli 27th-29th August 1988

Mahaddey Weyn 27th August 1988

The river was very near to its "bank full" level. A discharge measurement was undertaken with a large number of verticals. The detailed results show that the section is regular and that over most of the width the velocity is almost constant. The only exception is a point towards the right bank where very low velocities were found close to the bed. This corresponds to the point where a tree trunk was observed on July 12th when the level was much lower; this partly explains the discrepancy between the measured and rated discharges. The results were as follows:

SG (start)	5.08 m
SG (finish)	5.09 m
Discharge	136.2 cumecs
Mean velocity	0.87 m/s
EC	480 micro-siemens

On 29th August at 1015 the SG level had risen slightly to 5.16 m. Some data was collected from Jowhar; however, most recent data had apparently already been sent to Mogadishu.

Bulo Burti

Readings made were as follows:

	SG	Dip
27th August at 1620	4.45	5.66
28th August at 0810	4.49	5.61
29th August at 0800	4.54	5.58

The observer's dipper had broken and was replaced by the one currently in use by the Hydrology Section. This may explain some erratic dip readings since the dipper was provided in May. Data was collected.

Beled Weyn 28th August 1988

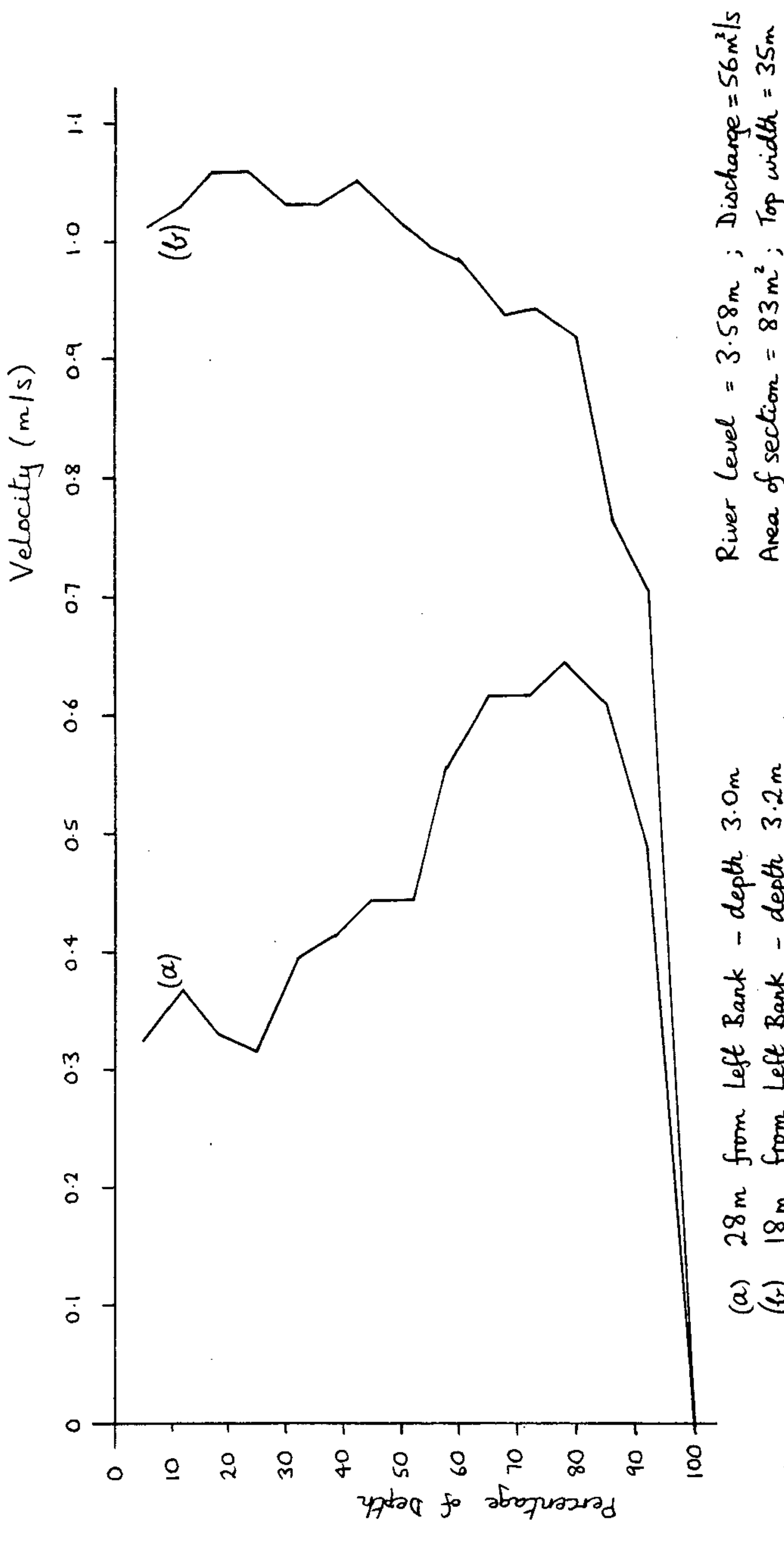
The observer and the coordinator were both absent - apparently they had gone to Mogadishu a few days earlier. Somebody else was reading the staff gauge each morning and transmitting the value over the radio. These values may be a little less accurate than those of the regular observer - the value for the 28th was 2.85 m compared to our observation of 2.81 m at 1100 (the river still appeared to be rising slightly). Recent data was received in Mogadishu from the observer on 28/8/88.

A discharge measurement was carried out. Traffic on the narrow bridge and the girders of the superstructure make this an awkward bridge for measurements. Water velocities were substantially higher than those experienced at other sites. The measured discharge was some 2% above that indicated by the rating equation. Results were as follows:

SG (start)	2.81 m
SG (finish)	2.82 m
Discharge	164.8 cumecs
Mean velocity	1.38 m/s

The automatic water level recorder was checked but no useful data could be retrieved because the battery was flat. It had been in place for nearly three months, but previously batteries have lasted for much longer than that (it is suspected that old batteries have a shorter life, despite having been successfully recharged). Furthermore, data is supposed to be retained by the permanent lithium cell so that it can be retrieved when a new battery is connected, but this did not prove to be the case. In addition the cable had once again come off the pulley wheel. The Beled Weyn recorder seems destined to cause problems! A newly recharged battery was connected and the recorder re-initiallised with the level 2.82 m.

Vertical Velocity Profiles at Afgoi on 14/8/88



Afgoi 31st August 1988

A discharge measurement was carried out with the river close to its highest level this year. One source of minor potential error was removed with the use of a new counter unit which had just been received from England - on the old one the automatic stop facility was faulty which could have led to small errors in counting the number of meter revolutions and hence determining the velocity. Results were as follows:

SG (start)	5.02 m
SG (finish)	5.00 m
Discharge	79.6 cumecs
Mean velocity	0.61 m/s

Despite the higher water level (up more than 15 cm since the previous measurement) the area, velocity and discharge were all virtually unchanged. The measured discharge was therefore further removed from the rating equation - about 15% below. Free spinning of the impellor seemed to be slightly impeded; later examination showed that a small adjustment was required. This would partly explain the low measured discharge. It is possible that this could also apply to previous measurements.

Peter Ede
5th September 1988

DISCHARGE MEASUREMENTS UNDERTAKEN DURING THE PERIOD

The following pages contain the calculation sheets for the discharge measurements carried out in July and August. A total of eleven measurements were made as follows:

Date	River	Station
5th July	Shebelli	Afgoi
8th July	Shebelli	Afgoi
12th July	Shebelli	Mahaddey Weyn
21st July	Jubba	Lugh Ganana
28th July	Jubba	Kamsuma
30th July	Jubba	Kamsuma
14th August	Shebelli	Afgoi
18th August	Shebelli	Afgoi
27th August	Shebelli	Mahaddey Weyn
28th August	Shebelli	Beled Weyn
31st August	Shebelli	Afgoi

DISCHARGE MEASUREMENT BY CURRENT METER

			Start	Finish
Station:	Shebelli at Afgoi			
Date:	5th July 1988			
Method:	Suspension from bridge (d/s face) with 10kg weight	Time	0920	1025
Origin:	Left Bank	Dip	5.36	5.36
Observers:	Ali/Ibrahim/Peter Ede/Kevin Sene/Jeremy Meigh			
Meter:	Braystoke BFM 001 No. 75-306 Impellor No. 475-1379			

Calculations made by method of mean velocity over section between two verticals.
Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	0.0	0.00	-	50	0	0.000	0.000					
				50				0.026	0.30	2.00	0.60	0.015
2	2.0	0.60	.6d	50	10	0.061	0.052					
			.6d	50	6	0.042		0.270	0.80	2.00	1.60	0.433
3	4.0	1.00	.6d	50	95	0.519	0.489					
			.6d	50	84	0.460		0.574	1.00	2.00	2.00	1.149
4	6.0	1.00	.6d	50	121	0.659	0.659					
			.6d	50	121	0.659		0.692	1.25	2.00	2.50	1.729
5	8.0	1.50	.6d	50	133	0.724	0.724					
			.6d	50	133	0.724		0.657	1.55	2.00	3.10	2.036
6	10.0	1.60	.6d	50	110	0.600	0.589					
			.6d	50	106	0.578		0.693	1.75	2.00	3.50	2.426
7	12.0	1.90	.6d	50	147	0.800	0.797					
			.6d	50	146	0.794		0.779	1.80	2.00	3.60	2.806
8	14.0	1.70	.6d	50	141	0.767	0.762					
			.6d	50	139	0.757		0.673	1.75	2.00	3.50	2.355
9	16.0	1.80	.6d	50	102	0.557	0.584					
			.6d	50	112	0.611		0.337	1.63	2.00	3.25	1.095
10	18.0	1.45	.6d	50	16	0.093	0.090					
			.6d	50	15	0.087		0.268	1.53	2.00	3.05	0.817
11	20.0	1.60	.6d	50	85	0.465	0.446					
			.6d	50	78	0.427		0.537	1.53	2.00	3.05	1.636
12	22.0	1.45	.6d	50	109	0.595	0.627					
			.6d	50	121	0.659		0.593	1.48	2.00	2.95	1.750
13	24.0	1.50	.6d	50	101	0.551	0.559					
			.6d	50	104	0.568		0.361	1.10	2.00	2.20	0.794
14	26.0	0.70	.6d	50	34	0.190	0.163					
			.6d	50	24	0.136		0.081	0.35	1.10	0.39	0.031
15	27.1	0.00	-	50	0	0.000	0.000					

Total Area (sq.m) = 35.29   Total discharge (cumecs) = 19.07   Mean Velocity (m/s) = 0.54

DISCHARGE MEASUREMENT BY CURRENT METER

	Start	Finish
Time	1030	1120
Dip	5.41	5.42

Station: Shebelli at Afgoi
Date: 8th July 1988
Method: Suspension from bridge (d/s face) with 10kg weight
Origin: Left Bank
Observers: Peter Ede/Kevin Sene/Jeremy Meigh
Meter: Braystoke BFM 001 No. 75-306 Impellor No. 475-1379

Calculations made by method of mean velocity over section between two verticals.
Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	0.0	0.00	-	50	0	0.000	0.000					
				50				0.018	0.25	2.00	0.50	0.009
2	2.0	0.50	.6d	50	5	0.037	0.037					
			.6d	50	5	0.037		0.279	0.65	2.00	1.30	0.363
3	4.0	0.80	.6d	50	98	0.535	0.522					
			.6d	50	93	0.508		0.551	1.00	2.00	2.00	1.103
4	6.0	1.20	.6d	50	107	0.584	0.581					
			.6d	50	106	0.578		0.645	1.30	1.80	2.34	1.508
5	7.8	1.40	.6d	50	129	0.703	0.708					
			.6d	50	131	0.713		0.653	1.55	1.80	2.79	1.821
6	9.6	1.70	.6d	50	112	0.611	0.597					
			.6d	50	107	0.584		0.693	1.75	1.80	3.15	2.183
7	11.4	1.80	.6d	50	155	0.843	0.789					
			.6d	50	135	0.735		0.771	1.70	1.80	3.06	2.360
8	13.2	1.60	.6d	50	140	0.762	0.754					
			.6d	50	137	0.746		0.754	1.70	1.80	3.06	2.307
9	15.0	1.80	.6d	50	137	0.746	0.754					
			.6d	50	140	0.762		0.530	1.70	1.80	3.06	1.621
10	16.8	1.60	.6d	50	54	0.298	0.306					
			.6d	50	57	0.314		0.244	1.50	1.80	2.70	0.658
11	18.6	1.40	.6d	50	36	0.201	0.182					
			.6d	50	29	0.163		0.367	1.45	1.80	2.61	0.957
12	20.4	1.50	.6d	50	99	0.541	0.551					
			.6d	50	103	0.562		0.578	1.40	1.80	2.52	1.458
13	22.2	1.30	.6d	50	107	0.584	0.605					
			.6d	50	115	0.627		0.580	1.33	1.80	2.39	1.383
14	24.0	1.35	.6d	50	101	0.551	0.554					
			.6d	50	102	0.557		0.400	1.15	1.30	1.50	0.598
15	25.3	0.95	.6d	50	42	0.233	0.246					
			.6d	50	47	0.260		0.123	0.48	1.60	0.76	0.094
16	26.9	0.00	-	50	0	0.000	0.000					

Total Area (sq.m) = 33.73   Total discharge (cumecs) = 18.42   Mean Velocity (m/s) = 0.55

DISCHARGE MEASUREMENT BY CURRENT METER

Station: Shebelli at Mahaddey Weyn
Date: 12th July 1988
Method: Suspension from bridge (d/s face) with 10kg weight
Origin: Left Bank
Observers: Ali/Ibrahim/Peter Ede/Kevin Sene
Meter: Braystoke BFM 001 No. 75-306 Impellor No. 8011-504

	Start	Finish
Time	1225	1350
Stage	2.01	2.01

Calculations made by method of mean velocity over section between two verticals.
Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	0.00	0.00	-	50	0	0.000	0.000					
				50				0.161	0.70	2.10	1.47	0.237
2	2.10	1.40	.6d	50	60	0.328	0.323					
			.6d	50	58	0.317		0.341	1.65	2.90	4.78	1.633
3	5.00	1.90	.6d	50	67	0.365	0.360					
			.6d	50	65	0.355		0.460	1.85	2.30	4.26	1.958
4	7.30	1.80	.6d	50	103	0.557	0.560					
			.6d	50	104	0.563		0.597	1.90	2.40	4.56	2.724
5	9.70	2.00	.6d	50	120	0.648	0.635					
			.6d	50	115	0.621		0.617	2.00	2.30	4.60	2.840
6	12.00	2.00	.6d	50	111	0.600	0.600					
			.6d	50	111	0.600		0.591	2.00	2.40	4.80	2.836
7	14.40	2.00	.6d	50	106	0.573	0.581					
			.6d	50	109	0.589		0.584	1.95	2.40	4.68	2.733
8	16.80	1.90	.6d	50	106	0.573	0.587					
			.6d	50	111	0.600		0.579	1.85	2.30	4.26	2.463
9	19.10	1.80	.6d	50	106	0.573	0.571					
			.6d	50	105	0.568		0.503	1.85	2.35	4.35	2.186
10	21.45	1.90	.6d	50	78	0.424	0.435					
			.6d	50	82	0.445		0.244	1.70	1.80	3.06	0.747
11	23.25	1.50	.6d	50	9	0.058	0.053					
			.6d	50	7	0.048		0.047	1.50	0.50	0.75	0.035
12	23.75	1.50	.6d	50	6	0.043	0.041					
			.6d	50	5	0.038		0.053	1.68	0.65	1.09	0.058
13	24.40	1.85	.6d	50	10	0.063	0.066					
			.6d	50	11	0.068		0.172	1.83	1.80	3.29	0.564
14	26.20	1.80	.6d	50	51	0.280	0.277					
			.6d	50	50	0.275		0.305	1.35	2.30	3.11	0.948
15	28.50	0.90	.6d	50	61	0.333	0.333					
			.6d	50	61	0.333		0.167	0.45	2.70	1.21	0.203
16	31.20	0.00	-	50	0	0.000	0.000					

Total Area (sq.m) : 50.26 Total discharge (cumecs) = 22.16 Mean Velocity (m/s) = 0.44

DISCHARGE MEASUREMENT BY CURRENT METER

			Start	Finish
Station:	Jubba at Lugh Ganana			
Date:	21st July 1988			
Method:	Suspension from bridge (d/s face) with 10kg weight	Time	0750	0910
Origin:	Left Bank	Stage	2.61	2.64
Observers:	Ali/Ibrahim/Peter Ede/Kevin Sene			
Meter:	Braystoke BFM 001 No. 75-306 Impellor No. 8011-504			

Calculations made by method of mean velocity over section between two verticals.
Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	14.4	0.0	-	50	0	0.000	0.000					
				50				0.125	0.30	3.60	1.08	0.135
2	18.0	0.6	.6d	50	49	0.269	0.251					
			.6d	50	42	0.232		0.609	1.85	6.00	11.10	6.764
3	24.0	3.1	.8d	50	163	0.877	0.968					
			.2d	50	197	1.059		1.031	3.00	8.00	24.00	24.739
4	32.0	2.9	.8d	50	172	0.925	1.093					
			.2d	50	235	1.261		1.083	2.85	8.00	22.80	24.688
5	40.0	2.8	.8d	50	169	0.909	1.072					
			.2d	50	230	1.235		1.080	3.25	8.00	26.00	28.083
6	48.0	3.7	.8d	50	151	0.813	1.088					
			.2d	50	254	1.363		0.820	3.30	8.00	26.40	21.651
7	56.0	2.9	.8d	50	151	0.813	0.552					
			.2d	50	53	0.291		0.791	3.00	8.00	24.00	18.978
8	64.0	3.1	.8d	50	156	0.840	1.029					
			.2d	50	227	1.219		0.851	2.80	8.00	22.40	19.057
9	72.0	2.5	.8d	50	149	0.803	0.672					
			.2d	50	100	0.541		0.753	2.75	8.00	22.00	16.575
10	80.0	3.0	.8d	50	131	0.707	0.835					
			.2d	50	179	0.963		0.503	2.50	8.00	20.00	10.055
11	88.0	2.0	.8d	50	37	0.205	0.171					
			.2d	50	24	0.136		0.424	1.80	8.00	14.40	6.106
12	96.0	1.6	.8d	50	118	0.637	0.677					
			.2d	50	133	0.717		0.339	1.40	8.00	11.20	3.794
13	104.0	1.2	.6d	50	0	0.000	0.000					
			.6d	50	0	0.000		0.281	1.20	8.00	9.60	2.701
14	112.0	1.2	.6d	50	103	0.557	0.563					
			.6d	50	105	0.568		0.524	0.95	8.00	7.60	3.983
15	120.0	0.7	.6d	50	85	0.461	0.485					
			.6d	50	94	0.509		0.543	0.80	8.00	6.40	3.473
16	128.0	0.9	.6d	50	112	0.605	0.600					
			.6d	50	110	0.595		0.460	0.80	8.00	6.40	2.944
17	136.0	0.7	.6d	50	59	0.323	0.320					
			.6d	50	58	0.317		0.160	0.35	3.30	1.16	0.185
18	139.3	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 256.54 Total discharge (cumecs) = 193.91 Mean Velocity (m/s) = 0.76

DISCHARGE MEASUREMENT BY CURRENT METER

			Start	Finish
Station:	Jubba at Kamsuma			
Date:	28th July 1988	Time	1320	1530
Method:	Suspension from bridge (d/s face) with 25kg weight	Stage	4.56	4.64
Origin:	Right Bank			
Observers:	Ali/Maxamuud/Peter Ede/Kevin Sene			
Meter:	Braystoke BFM 001 No. 75-306 Impellor No. 8011-504			

Calculations made by method of mean velocity over section between two verticals. Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	8.0	0.0	-	50	0	0.000	0.000					
				50				0.151	1.55	4.00	6.20	0.934
2	12.0	3.1	.8d	50	43	0.237	0.301					
			.2d	50	67	0.365		0.751	4.10	4.00	16.40	12.312
3	16.0	5.1	.8d	50	217	1.165	1.200					
			.2d	50	230	1.235		1.317	5.15	4.00	20.60	27.140
4	20.0	5.2	.8d	50	244	1.309	1.435					
			.2d	50	291	1.560		0.927	5.35	4.00	21.40	19.833
5	24.0	5.5	.8d	50	136	0.733	0.419					
			.2d	50	18	0.104		0.123	5.25	4.00	21.00	2.573
6	28.0	5.0	.8d	50	-14	-0.083	-0.174					
			.2d	50	-48	-0.264		0.356	5.55	4.00	22.20	7.901
7	32.0	6.1	.8d	50	229	1.229	0.885					
			.2d	50	100	0.541		1.112	6.30	4.00	25.20	28.026
8	36.0	6.5	.8d	50	211	1.133	1.339					
			.2d	50	288	1.544		1.304	6.25	4.00	25.00	32.604
9	40.0	6.0	.8d	50	220	1.181	1.269					
			.2d	50	253	1.358		1.188	5.75	4.00	23.00	27.327
10	44.0	5.5	.8d	50	184	0.989	1.107					
			.2d	50	228	1.224		0.972	4.80	4.00	19.20	18.665
11	48.0	4.1	.8d	50	136	0.733	0.837					
			.2d	50	175	0.941		0.951	4.45	4.00	17.80	16.924
12	52.0	4.8	.8d	50	174	0.936	1.064					
			.2d	50	222	1.192		1.060	4.85	4.00	19.40	20.567
13	56.0	4.9	.8d	50	179	0.963	1.056					
			.2d	50	214	1.149		0.992	5.15	4.00	20.60	20.438
14	60.0	5.4	.8d	50	137	0.739	0.928					
			.2d	50	208	1.117		0.953	4.80	4.00	19.20	18.306
15	64.0	4.2	.8d	50	172	0.925	0.979					
			.2d	50	192	1.032		0.904	4.25	4.00	17.00	15.370
16	68.0	4.3	.8d	50	135	0.728	0.829					
			.2d	50	173	0.931		0.773	4.30	4.00	17.20	13.303
17	72.0	4.3	.8d	50	107	0.579	0.717					
			.2d	50	159	0.856		0.737	3.65	4.00	14.60	10.766
18	76.0	3.0	.8d	50	111	0.600	0.757					
			.2d	50	170	0.915						

(cont.)

(cont.)

Jubba at Kamsuma 28th July 1988

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
18	76.0	3.0	.8d	50	111	0.600	0.757					
			.2d	50	170	0.915		0.729	2.85	4.00	11.40	8.315
19	80.0	2.7	.8d	50	114	0.616	0.701					
			.2d	50	146	0.787		0.513	2.45	4.00	9.80	5.031
20	84.0	2.2	.8d	50	58	0.317	0.325					
			.2d	50	61	0.333		0.163	1.10	4.70	5.17	0.841
21	88.7	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 352.37 Total discharge (cumecs) = 307.18 Mean Velocity (m/s) = 0.87

DISCHARGE MEASUREMENT BY CURRENT METER

	Start	Finish
Time	0800	0945
Stage	5.12	5.10

Station: Jubba at Kamsuma
Date: 30th July 1988
Method: Suspension from bridge (d/s face) with 25kg weight
Origin: Right Bank
Observers: Ali/Maxamuud/Peter Ede/Kevin Sene
Meter: Braystoke BFM 001 No. 75-306 Impellor No. 8011-504

Two measurements at each vertical.

Calculations made by method of mean velocity over section between two verticals.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	7.9	0.0	-	50	0	0.000	0.000					
				50								
								0.381	1.95	4.10	7.99	3.049
2	12.0	3.9	.8d	50	83	0.451	0.763					
			.2d	50	200	1.075						
								1.007	5.20	4.00	20.80	20.941
3	16.0	6.5	.8d	50	206	1.107	1.251					
			.2d	50	260	1.395						
								1.354	6.20	4.00	24.80	33.567
4	20.0	5.9	.8d	50	245	1.315	1.456					
			.2d	50	298	1.598						
								0.985	6.00	4.00	24.00	23.651
5	24.0	6.1	.8d	50	163	0.877	0.515					
			.2d	50	27	0.152						
								0.116	6.15	4.00	24.60	2.854
6	28.0	6.2	.8d	50	-19	-0.109	-0.283					
			.2d	50	-84	-0.456						
								0.460	6.40	4.00	25.60	11.777
7	32.0	6.6	.8d	50	261	1.400	1.203					
			.2d	50	187	1.005						
								1.272	6.65	4.00	26.60	33.839
8	36.0	6.7	.8d	50	217	1.165	1.342					
			.2d	50	283	1.518						
								1.264	6.85	4.00	27.40	34.638
9	40.0	7.0	.8d	50	182	0.979	1.187					
			.2d	50	260	1.395						
								1.192	6.75	4.00	27.00	32.188
10	44.0	6.5	.8d	50	188	1.011	1.197					
			.2d	50	258	1.384						
								1.084	5.70	4.00	22.80	24.718
11	48.0	4.9	.8d	50	174	0.936	0.971					
			.2d	50	187	1.005						
								1.061	4.95	4.00	19.80	21.017
12	52.0	5.0	.8d	50	189	1.016	1.152					
			.2d	50	240	1.288						
								1.103	5.35	4.00	21.40	23.600
13	56.0	5.7	.8d	50	173	0.931	1.053					
			.2d	50	219	1.176						
								1.051	5.45	4.00	21.80	22.907
14	60.0	5.2	.8d	50	174	0.936	1.048					
			.2d	50	216	1.160						
								1.028	4.95	4.00	19.80	20.357
15	64.0	4.7	.8d	50	174	0.936	1.008					
			.2d	50	201	1.080						
								0.928	4.55	4.00	18.20	16.892
16	68.0	4.4	.8d	50	149	0.803	0.848					
			.2d	50	166	0.893						
								0.821	4.75	4.00	19.00	15.607
17	72.0	5.1	.8d	50	126	0.680	0.795					
			.2d	50	169	0.909						
								0.760	4.30	4.00	17.20	13.074
18	76.0	3.5	.8d	50	119	0.643	0.725					
			.2d	50	150	0.808						

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Jubba at Kamsuma 30th July 1988

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
18	76.0	3.5	.8d	50	119	0.643	0.725					
			.2d	50	150	0.808		0.665	3.30	4.00	13.20	8.783
19	80.0	3.1	.8d	50	100	0.541	0.605					
			.2d	50	124	0.669		0.512	2.80	4.00	11.20	5.735
20	84.0	2.5	.8d	50	82	0.445	0.419					
			.2d	50	72	0.392		0.236	2.25	2.00	4.50	1.062
21	86.0	2.0	.8d	50	5	0.038	0.053					
			.2d	50	11	0.068		0.027	1.00	3.50	3.50	0.093
22	89.5	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 401.20 **Total discharge (cumecs) = 370.35** **Mean Velocity (m/s) = 0.92**

DISCHARGE MEASUREMENT BY CURRENT METER

Station:	Shebelli at Afgoi		Start	Finish
Date:	14th August 1988			
Method:	Suspension from bridge (d/s face) with 10kg weight.	Time	0920	1030
Origin:	Left Bank	Stage	3.58	3.58
Observers:	Ibrahim/Maxamuud/Zakia/Peter Ede			
Meter:	Braystoke BFM 001 No. 75-306 Impellor No. 8011-504			

Calculations made by method of mean velocity over section between two verticals. Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	0.0	0.0	-	50	0	0.000	0.000					
				50				0.248	0.35	2.00	0.70	0.174
2	2.0	0.7	.6d	50	92	0.499	0.496					
			.6d	50	91	0.493		0.601	0.95	2.00	1.90	1.143
3	4.0	1.2	.8d	50	133	0.717	0.707					
			.2d	50	129	0.696		0.761	1.35	2.00	2.70	2.056
4	6.0	1.5	.8d	50	144	0.776	0.816					
			.2d	50	159	0.856		0.849	1.75	2.00	3.50	2.973
5	8.0	2.0	.8d	50	158	0.851	0.883					
			.2d	50	170	0.915		0.885	2.30	2.00	4.60	4.073
6	10.0	2.6	.8d	50	144	0.776	0.888					
			.2d	50	186	1.000		0.883	2.70	2.00	5.40	4.767
7	12.0	2.8	.8d	50	151	0.813	0.877					
			.2d	50	175	0.941		0.783	2.90	2.00	5.80	4.540
8	14.0	3.0	.8d	50	135	0.728	0.688					
			.2d	50	120	0.648		0.804	3.20	2.00	6.40	5.146
9	16.0	3.4	.8d	50	151	0.813	0.920					
			.2d	50	191	1.027		0.944	3.30	2.00	6.60	6.231
10	18.0	3.2	.8d	50	157	0.845	0.968					
			.2d	50	203	1.091		0.941	3.25	2.00	6.50	6.119
11	20.0	3.3	.8d	50	152	0.819	0.915					
			.2d	50	188	1.011		0.715	3.30	2.00	6.60	4.717
12	22.0	3.3	.8d	50	94	0.509	0.515					
			.2d	50	96	0.520		0.379	3.10	2.00	6.20	2.348
13	24.0	2.9	.8d	50	56	0.307	0.243					
			.2d	50	32	0.179		0.257	2.75	2.00	5.50	1.416
14	26.0	2.6	.8d	50	72	0.392	0.272					
			.2d	50	27	0.152		0.383	2.80	2.00	5.60	2.143
15	28.0	3.0	.8d	50	120	0.648	0.493					
			.2d	50	62	0.339		0.547	3.00	2.00	6.00	3.280
16	30.0	3.0	.8d	50	111	0.600	0.600					
			.2d	50	111	0.600		0.497	2.80	2.00	5.60	2.785
17	32.0	2.6	.8d	50	71	0.387	0.395					
			.2d	50	74	0.403		0.409	1.65	2.00	3.30	1.351
18	34.0	0.7	.6d	50	79	0.429	0.424					
			.6d	50	77	0.419		0.212	0.35	1.20	0.42	0.089
19	35.2	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 83.32 Total discharge (cumecs) = 55.35 Mean Velocity (m/s) = 0.66

DISCHARGE MEASUREMENT BY CURRENT METER

Station:	Shebelli at Afgoi		Start	Finish
Date:	18th August 1988			
Method:	Suspension from bridge (d/s face) with 25kg weight	Time	0855	1015
Origin:	Left Bank	Stage	4.85	4.84
Observers:	Ibrahim/Ali/Maxamuud/Zakia/Peter Ede			
Meter:	Braystoke BFM 001 No. 75-306 Impellor No. 8011-504			

Calculations made by method of mean velocity over section between two verticals. Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	0.0	0.0	-	50	0	0.000	0.000					
				50				0.080	0.70	2.00	1.40	0.112
2	2.0	1.4	.6d	50	29	0.163	0.160					
			.6d	50	28	0.157		0.249	1.75	2.00	3.50	0.873
3	4.0	2.1	.8d	50	87	0.472	0.339					
			.2d	50	37	0.205		0.447	2.35	2.00	4.70	2.100
4	6.0	2.6	.8d	50	107	0.579	0.555					
			.2d	50	98	0.531		0.617	2.75	2.00	5.50	3.396
5	8.0	2.9	.8d	50	125	0.675	0.680					
			.2d	50	127	0.685		0.712	3.15	2.00	6.30	4.486
6	10.0	3.4	.8d	50	131	0.707	0.744					
			.2d	50	145	0.781		0.783	3.60	2.00	7.20	5.636
7	12.0	3.8	.8d	50	147	0.792	0.821					
			.2d	50	158	0.851		0.773	3.85	2.00	7.70	5.955
8	14.0	3.9	.8d	50	110	0.595	0.725					
			.2d	50	159	0.856		0.692	4.05	2.00	8.10	5.606
9	16.0	4.2	.8d	50	127	0.685	0.659					
			.2d	50	117	0.632		0.760	4.30	2.00	8.60	6.537
10	18.0	4.4	.8d	50	137	0.739	0.861					
			.2d	50	183	0.984		0.857	4.30	2.00	8.60	7.374
11	20.0	4.2	.8d	50	142	0.765	0.853					
			.2d	50	175	0.941		0.844	4.30	2.00	8.60	7.259
12	22.0	4.4	.8d	50	130	0.701	0.835					
			.2d	50	180	0.968		0.751	4.55	2.00	9.10	6.832
13	24.0	4.7	.8d	50	105	0.568	0.667					
			.2d	50	142	0.765		0.583	4.45	2.00	8.90	5.186
14	26.0	4.2	.8d	50	84	0.456	0.499					
			.2d	50	100	0.541		0.457	4.30	2.00	8.60	3.934
15	28.0	4.4	.8d	50	99	0.536	0.416					
			.2d	50	54	0.296		0.489	4.35	2.00	8.70	4.258
16	30.0	4.3	.8d	50	118	0.637	0.563					
			.2d	50	90	0.488		0.557	4.25	2.00	8.50	4.738
17	32.0	4.2	.8d	50	101	0.547	0.552					
			.2d	50	103	0.557		0.463	3.80	2.00	7.60	3.517
18	34.0	3.4	.8d	50	76	0.413	0.373					
			.2d	50	61	0.333						

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Shebelli at Afgoi 18th August 1988

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
18	34.0	3.4	.8d	50	76	0.413	0.373					
			.2d	50	61	0.333		0.317	2.60	2.00	5.20	1.650
19	36.0	1.8	.8d	50	51	0.280	0.261					
			.2d	50	44	0.243		0.131	0.90	2.20	1.98	0.259
20	38.2	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 128.78 **Total discharge (cumecs) = 79.71** **Mean Velocity (m/s) = 0.62**

DISCHARGE MEASUREMENT BY CURRENT METER

			Start	Finish
Station:	Jubba at Kamsuma			
Date:	30th July 1988			
Method:	Suspension from bridge (d/s face) with 25kg weight	Time	0800	0945
Origin:	Right Bank	Stage	5.12	5.10
Observers:	Ali/Maxamuud/Peter Ede/Kevin Sene.			
Meter:	Braystoke BFM 001 No. 75-306 Impellor No. 8011-504			

Calculations made by method of mean velocity over section between two verticals. Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	7.9	0.0	-	50	0	0.000	0.000					
				50				0.381	1.95	4.10	7.99	3.049
2	12.0	3.9	.8d	50	83	0.451	0.763					
			.2d	50	200	1.075		1.007	5.20	4.00	20.80	20.941
3	16.0	6.5	.8d	50	206	1.107	1.251					
			.2d	50	260	1.395		1.354	6.20	4.00	24.80	33.567
4	20.0	5.9	.8d	50	245	1.315	1.456					
			.2d	50	298	1.598		0.985	6.00	4.00	24.00	23.651
5	24.0	6.1	.8d	50	163	0.877	0.515					
			.2d	50	27	0.152		0.116	6.15	4.00	24.60	2.854
6	28.0	6.2	.8d	50	-19	-0.109	-0.283					
			.2d	50	-84	-0.456		0.460	6.40	4.00	25.60	11.777
7	32.0	6.6	.8d	50	261	1.400	1.203					
			.2d	50	187	1.005		1.272	6.65	4.00	26.60	33.839
8	36.0	6.7	.8d	50	217	1.165	1.342					
			.2d	50	283	1.518		1.264	6.85	4.00	27.40	34.638
9	40.0	7.0	.8d	50	182	0.979	1.187					
			.2d	50	260	1.395		1.192	6.75	4.00	27.00	32.188
10	44.0	6.5	.8d	50	188	1.011	1.197					
			.2d	50	258	1.384		1.084	5.70	4.00	22.80	24.718
11	48.0	4.9	.8d	50	174	0.936	0.971					
			.2d	50	187	1.005		1.061	4.95	4.00	19.80	21.017
12	52.0	5.0	.8d	50	189	1.016	1.152					
			.2d	50	240	1.288		1.103	5.35	4.00	21.40	23.600
13	56.0	5.7	.8d	50	173	0.931	1.053					
			.2d	50	219	1.176		1.051	5.45	4.00	21.80	22.907
14	60.0	5.2	.8d	50	174	0.936	1.048					
			.2d	50	216	1.160		1.028	4.95	4.00	19.80	20.357
15	64.0	4.7	.8d	50	174	0.936	1.008					
			.2d	50	201	1.080		0.928	4.55	4.00	18.20	16.892
16	68.0	4.4	.8d	50	149	0.803	0.848					
			.2d	50	166	0.893		0.821	4.75	4.00	19.00	15.607
17	72.0	5.1	.8d	50	126	0.680	0.795					
			.2d	50	169	0.909		0.760	4.30	4.00	17.20	13.074
18	76.0	3.5	.8d	50	119	0.643	0.725					
			.2d	50	150	0.808						

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Jubba at Kamsuma 30th July 1988

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
18	76.0	3.5	.8d	50	119	0.643	0.725					
			.2d	50	150	0.808		0.665	3.30	4.00	13.20	8.783
19	80.0	3.1	.8d	50	100	0.541	0.605					
			.2d	50	124	0.669		0.512	2.80	4.00	11.20	5.735
20	84.0	2.5	.8d	50	82	0.445	0.419					
			.2d	50	72	0.392		0.236	2.25	2.00	4.50	1.062
21	86.0	2.0	.8d	50	5	0.038	0.053					
			.2d	50	11	0.068		0.027	1.00	3.50	3.50	0.093
22	89.5	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 401.20 Total discharge (cumecs) = 370.35 Mean Velocity (m/s) = 0.92

DISCHARGE MEASUREMENT BY CURRENT METER

Station: Shebelli at Afgoi
Date: 14th August 1988
Method: Suspension from bridge (d/s face) with 10kg weight
Origin: Left Bank
Observers: Ibrahim/Maxamuud/Zakia/Peter Ede
Meter: Braystoke BFM 001 No. 75-306 Impellor No. 8011-504

	Start	Finish
Time	0920	1030
Stage	3.58	3.58

Calculations made by method of mean velocity over section between two verticals. Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	0.0	0.0	-	50	0	0.000	0.000					
				50				0.248	0.35	2.00	0.70	0.174
2	2.0	0.7	.6d	50	92	0.499	0.496					
			.6d	50	91	0.493		0.601	0.95	2.00	1.90	1.143
3	4.0	1.2	.8d	50	133	0.717	0.707					
			.2d	50	129	0.696		0.761	1.35	2.00	2.70	2.056
4	6.0	1.5	.8d	50	144	0.776	0.816					
			.2d	50	159	0.856		0.849	1.75	2.00	3.50	2.973
5	8.0	2.0	.8d	50	158	0.851	0.883					
			.2d	50	170	0.915		0.885	2.30	2.00	4.60	4.073
6	10.0	2.6	.8d	50	144	0.776	0.888					
			.2d	50	186	1.000		0.883	2.70	2.00	5.40	4.767
7	12.0	2.8	.8d	50	151	0.813	0.877					
			.2d	50	175	0.941		0.783	2.90	2.00	5.80	4.540
8	14.0	3.0	.8d	50	135	0.728	0.688					
			.2d	50	120	0.648		0.804	3.20	2.00	6.40	5.146
9	16.0	3.4	.8d	50	151	0.813	0.920					
			.2d	50	191	1.027		0.944	3.30	2.00	6.60	6.231
10	18.0	3.2	.8d	50	157	0.845	0.968					
			.2d	50	203	1.091		0.941	3.25	2.00	6.50	6.119
11	20.0	3.3	.8d	50	152	0.819	0.915					
			.2d	50	188	1.011		0.715	3.30	2.00	6.60	4.717
12	22.0	3.3	.8d	50	94	0.509	0.515					
			.2d	50	96	0.520		0.379	3.10	2.00	6.20	2.348
13	24.0	2.9	.8d	50	56	0.307	0.243					
			.2d	50	32	0.179		0.257	2.75	2.00	5.50	1.416
14	26.0	2.6	.8d	50	72	0.392	0.272					
			.2d	50	27	0.152		0.383	2.80	2.00	5.60	2.143
15	28.0	3.0	.8d	50	120	0.648	0.493					
			.2d	50	62	0.339		0.547	3.00	2.00	6.00	3.280
16	30.0	3.0	.8d	50	111	0.600	0.600					
			.2d	50	111	0.600		0.497	2.80	2.00	5.60	2.785
17	32.0	2.6	.8d	50	71	0.387	0.395					
			.2d	50	74	0.403		0.409	1.65	2.00	3.30	1.351
18	34.0	0.7	.6d	50	79	0.429	0.424					
			.6d	50	77	0.419		0.212	0.35	1.20	0.42	0.089
19	35.2	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 83.32 **Total discharge (cumecs) = 55.35** **Mean Velocity (m/s) = 0.66**

DISCHARGE MEASUREMENT BY CURRENT METER

Station:	Shebelli at Afgoi			Start	Finish
Date:	18th August 1988				
Method:	Suspension from bridge (d/s face) with 25kg weight		Time	0855	1015
Origin:	Left Bank		Stage	4.85	4.84
Observers:	Ibrahim/Ali/Maxamuud/Zakia/Peter Ede				
Meter:	Braystoke BFM 001 No. 75-306 Impellor No. 8011-504				

Calculations made by method of mean velocity over section between two verticals. Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Velocity Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	0.0	0.0	-	50	0	0.000	0.000					
				50				0.080	0.70	2.00	1.40	0.112
2	2.0	1.4	.6d	50	29	0.163	0.160					
			.6d	50	28	0.157		0.249	1.75	2.00	3.50	0.873
3	4.0	2.1	.8d	50	87	0.472	0.339					
			.2d	50	37	0.205		0.447	2.35	2.00	4.70	2.100
4	6.0	2.6	.8d	50	107	0.579	0.555					
			.2d	50	98	0.531		0.617	2.75	2.00	5.50	3.396
5	8.0	2.9	.8d	50	125	0.675	0.680					
			.2d	50	127	0.685		0.712	3.15	2.00	6.30	4.486
6	10.0	3.4	.8d	50	131	0.707	0.744					
			.2d	50	145	0.781		0.783	3.60	2.00	7.20	5.636
7	12.0	3.8	.8d	50	147	0.792	0.821					
			.2d	50	158	0.851		0.773	3.85	2.00	7.70	5.955
8	14.0	3.9	.8d	50	110	0.595	0.725					
			.2d	50	159	0.856		0.692	4.05	2.00	8.10	5.606
9	16.0	4.2	.8d	50	127	0.685	0.659					
			.2d	50	117	0.632		0.760	4.30	2.00	8.60	6.537
10	18.0	4.4	.8d	50	137	0.739	0.861					
			.2d	50	183	0.984		0.857	4.30	2.00	8.60	7.374
11	20.0	4.2	.8d	50	142	0.765	0.853					
			.2d	50	175	0.941		0.844	4.30	2.00	8.60	7.259
12	22.0	4.4	.8d	50	130	0.701	0.835					
			.2d	50	180	0.968		0.751	4.55	2.00	9.10	6.832
13	24.0	4.7	.8d	50	105	0.568	0.667					
			.2d	50	142	0.765		0.583	4.45	2.00	8.90	5.186
14	26.0	4.2	.8d	50	84	0.456	0.499					
			.2d	50	100	0.541		0.457	4.30	2.00	8.60	3.934
15	28.0	4.4	.8d	50	99	0.536	0.416					
			.2d	50	54	0.296		0.489	4.35	2.00	8.70	4.258
16	30.0	4.3	.8d	50	118	0.637	0.563					
			.2d	50	90	0.488		0.557	4.25	2.00	8.50	4.738
17	32.0	4.2	.8d	50	101	0.547	0.552					
			.2d	50	103	0.557		0.463	3.80	2.00	7.60	3.517
18	34.0	3.4	.8d	50	76	0.413	0.373					
			.2d	50	61	0.333						

(cont.)

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Shebelli at Afgoi 18th August 1988

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
18	34.0	3.4	.8d	50	76	0.413	0.373					
			.2d	50	61	0.333		0.317	2.60	2.00	5.20	1.650
19	36.0	1.8	.8d	50	51	0.280	0.261					
			.2d	50	44	0.243		0.131	0.90	2.20	1.98	0.259
20	38.2	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 128.78 Total discharge (cumecs) = 79.71 Mean Velocity (m/s) = 0.62

DISCHARGE MEASUREMENT BY CURRENT METER

			Start	Finish
Station:	Shebelli at Mahaddey Weyn			
Date:	27th August 1988			
Method:	Suspension from bridge (d/s face) with 25kg weight	Time	1050	1340
Origin:	Left Bank	Stage	5.08	5.09
Observers:	Ali/Ibrahim/Maxamuud/Peter Ede			
Meter:	Braystoke BFM 001 No. 75-306 Impellor No. 8011-504			

Calculations made by method of mean velocity over section between two verticals. Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	0.0	0.0	-	50	0	0.000	0.000					
				50				0.095	1.95	2.90	5.65	0.535
2	2.9	3.9	.8d	50	30	0.168	0.189					
			.2d	50	38	0.211		0.359	4.05	1.20	4.86	1.743
3	4.1	4.2	.8d	50	89	0.483	0.528					
			.2d	50	106	0.573		0.633	4.45	1.40	6.23	3.946
4	5.5	4.7	.8d	50	140	0.755	0.739					
			.2d	50	134	0.723		0.804	4.85	1.30	6.31	5.070
5	6.8	5.0	.8d	50	161	0.867	0.869					
			.2d	50	162	0.872		0.895	5.00	1.20	6.00	5.369
6	8.0	5.0	.8d	50	172	0.925	0.920					
			.2d	50	170	0.915		0.924	4.95	1.10	5.44	5.032
7	9.1	4.9	.8d	50	169	0.909	0.928					
			.2d	50	176	0.947		0.981	5.05	1.20	6.06	5.948
8	10.3	5.2	.8d	50	186	1.000	1.035					
			.2d	50	199	1.069		1.027	5.05	1.20	6.06	6.222
9	11.5	4.9	.8d	50	187	1.005	1.019					
			.2d	50	192	1.032		1.063	4.95	1.20	5.94	6.313
10	12.7	5.0	.8d	50	200	1.075	1.107					
			.2d	50	212	1.139		1.108	4.95	1.10	5.45	6.034
11	13.8	4.9	.8d	50	194	1.043	1.109					
			.2d	50	219	1.176		1.109	4.90	1.00	4.90	5.436
12	14.8	4.9	.8d	50	193	1.037	1.109					
			.2d	50	220	1.181		1.144	4.90	1.40	6.86	7.849
13	16.2	4.9	.8d	50	210	1.128	1.179					
			.2d	50	229	1.229		1.169	4.90	1.00	4.90	5.730
14	17.2	4.9	.8d	50	200	1.075	1.160					
			.2d	50	232	1.245		1.165	4.90	1.30	6.37	7.424
15	18.5	4.9	.8d	50	207	1.112	1.171					
			.2d	50	229	1.229		1.193	4.90	1.20	5.88	7.018
16	19.7	4.9	.8d	50	227	1.219	1.216					
			.2d	50	226	1.213		1.169	4.95	1.20	5.94	6.947
17	20.9	5.0	.8d	50	195	1.048	1.123					
			.2d	50	223	1.197		1.131	5.05	1.10	5.56	6.282
18	22.0	5.1	.8d	50	202	1.085	1.139					
			.2d	50	222	1.192						

(cont.)

(cont.)

Shebelli at Mahaddey Weyn 27th August 1988

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Velocity Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
18	22.0	5.1	.8d	50	202	1.085	1.139					
			.2d	50	222	1.192		1.112	5.20	1.20	6.24	6.940
19	23.2	5.3	.8d	50	195	1.048	1.085					
			.2d	50	209	1.123		0.944	5.20	1.20	6.24	5.891
20	24.4	5.1	.8d	50	91	0.493	0.803					
			.2d	50	207	1.112		0.784	4.95	1.20	5.94	4.658
21	25.6	4.8	.8d	50	81	0.440	0.765					
			.2d	50	203	1.091		0.836	4.80	1.30	6.24	5.217
22	26.9	4.8	.8d	50	141	0.760	0.907					
			.2d	50	196	1.053		0.844	4.90	1.10	5.39	4.550
23	28.0	5.0	.8d	50	101	0.547	0.781					
			.2d	50	189	1.016		0.760	4.80	1.10	5.28	4.013
24	29.1	4.6	.8d	50	95	0.515	0.739					
			.2d	50	179	0.963		0.752	4.35	1.30	5.65	4.253
25	30.4	4.1	.8d	50	123	0.664	0.765					
			.2d	50	161	0.867		0.719	3.90	1.10	4.29	3.083
26	31.5	3.7	.8d	50	105	0.568	0.672					
			.2d	50	144	0.776		0.623	3.45	1.20	4.14	2.578
27	32.7	3.2	.8d	50	96	0.520	0.573					
			.2d	50	116	0.627		0.401	2.80	1.20	3.36	1.349
28	33.9	2.4	.8d	50	40	0.221	0.229					
			.2d	50	43	0.237		0.201	2.20	1.30	2.86	0.576
29	35.2	2.0	.8d	50	24	0.136	0.173					
			.2d	50	38	0.211		0.087	1.00	1.80	1.80	0.156
30	37.0	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 155.84   Total discharge (cumecs) = 136.16   Mean Velocity (m/s) = 0.87

DISCHARGE MEASUREMENT BY CURRENT METER

Station: Shebelli at Beled Weyn
Date: 28th August 1988
Method: Suspension from bridge (d/s face) with 25kg weight
Origin: Left Bank
Observers: Ali/Ibrahim/Maxamuud/Peter Ede
Meter: Braystoke BFM 001 No. 75-306 Impellor No. 8011-504

	Start	Finish
Time	1120	1330
Stage	2.81	2.82

Calculations made by method of mean velocity over section between two verticals. Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	4.0	0.0	-	50	0	0.000	0.000					
				50				0.433	0.40	1.50	0.60	0.260
2	5.5	0.8	.6d	50	159	0.856	0.867					
			.6d	50	163	0.877		1.019	1.30	2.70	3.51	3.576
3	8.2	1.8	.8d	50	212	1.139	1.171					
			.2d	50	224	1.203		1.141	1.90	1.70	3.23	3.687
4	9.9	2.0	.8d	50	200	1.075	1.112					
			.2d	50	214	1.149		1.275	2.15	2.70	5.80	7.400
5	12.6	2.3	.8d	50	278	1.491	1.438					
			.2d	50	258	1.384		1.471	2.50	1.70	4.25	6.251
6	14.3	2.7	.8d	50	273	1.464	1.504					
			.2d	50	288	1.544		1.511	2.85	1.50	4.28	6.459
7	15.8	3.0	.8d	50	274	1.470	1.518					
			.2d	50	292	1.566		1.503	3.15	1.80	5.67	8.521
8	17.6	3.3	.8d	50	256	1.374	1.488					
			.2d	50	299	1.603		1.494	3.50	1.40	4.90	7.318
9	19.0	3.7	.8d	50	262	1.406	1.499					
			.2d	50	297	1.592		1.495	3.80	2.30	8.74	13.065
10	21.3	3.9	.8d	50	257	1.379	1.491					
			.2d	50	299	1.603		1.520	4.00	1.60	6.40	9.729
11	22.9	4.1	.8d	50	272	1.459	1.550					
			.2d	50	306	1.640		1.532	4.15	1.30	5.40	8.266
12	24.2	4.2	.8d	50	267	1.432	1.515					
			.2d	50	298	1.598		1.538	4.30	2.70	11.61	17.851
13	26.9	4.4	.8d	50	276	1.480	1.560					
			.2d	50	306	1.640		1.608	4.35	1.30	5.66	9.094
14	28.2	4.3	.8d	50	310	1.662	1.656					
			.2d	50	308	1.651		1.639	4.15	2.20	9.13	14.963
15	30.4	4.0	.8d	50	307	1.646	1.622					
			.2d	50	298	1.598		1.488	3.95	1.80	7.11	10.581
16	32.2	3.9	.8d	50	209	1.123	1.355					
			.2d	50	296	1.587		1.486	3.65	1.60	5.84	8.675
17	33.8	3.4	.8d	50	306	1.640	1.616					
			.2d	50	297	1.592		1.426	3.40	2.20	7.48	10.663
18	36.0	3.4	.8d	50	222	1.192	1.235					
			.2d	50	238	1.277						

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Shebelli at Beled Weyn 28th August 1988

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
18	36.0	3.4	.8d	50	222	1.192	1.235					
			.2d	50	238	1.277		1.233	3.30	1.20	3.96	4.885
19	37.2	3.2	.8d	50	212	1.139	1.232					
			.2d	50	247	1.325		1.201	3.10	2.10	6.51	7.822
20	39.3	3.0	.8d	50	202	1.085	1.171					
			.2d	50	234	1.256		0.984	2.85	1.50	4.28	4.207
21	40.8	2.7	.8d	50	143	0.771	0.797					
			.2d	50	153	0.824		0.519	2.65	0.70	1.86	0.962
22	41.5	2.6	.8d	50	67	0.365	0.240					
			.2d	50	20	0.115		0.239	2.60	0.60	1.56	0.372
23	42.1	2.6	.8d	50	61	0.333	0.237					
			.2d	50	25	0.141		0.119	1.30	1.00	1.30	0.154
24	43.1	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 119.06 Total discharge (cumecs) = 164.76 Mean Velocity (m/s) = 1.38

DISCHARGE MEASUREMENT BY CURRENT METER

				Start	Finish
Station:	Shebelli at Afgoi				
Date:	31st August 1988				
Method:	Suspension from bridge (d/s face) with 25kg weight		Time	0910	1040
Origin:	Left Bank		Stage	5.02	5.00
Observers:	Ibrahim/Ali/Maxamuud/Zakia/Mariam/Peter Ede				
Meter:	Braystoke BFM 001 No. 75-306 Impellor No. 8011-504				

Calculations made by method of mean velocity over section between two verticals. Two measurements at each vertical.

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
1	0.0	0.0	-	50	0	0.000	0.000					
				50				0.113	0.55	2.00	1.10	0.125
2	2.0	1.1	.6d	50	33	0.184	0.227					
			.6d	50	49	0.269		0.284	1.60	2.00	3.20	0.909
3	4.0	2.1	.8d	50	85	0.461	0.341					
			.2d	50	40	0.221		0.460	2.45	2.00	4.90	2.254
4	6.0	2.8	.8d	50	115	0.621	0.579					
			.2d	50	99	0.536		0.629	2.95	2.00	5.90	3.714
5	8.0	3.1	.8d	50	133	0.717	0.680					
			.2d	50	119	0.643		0.707	3.35	2.00	6.70	4.735
6	10.0	3.6	.8d	50	141	0.760	0.733					
			.2d	50	131	0.707		0.723	3.80	2.00	7.60	5.493
7	12.0	4.0	.8d	50	109	0.589	0.712					
			.2d	50	155	0.835		0.715	3.95	2.00	7.90	5.647
8	14.0	3.9	.8d	50	101	0.547	0.717					
			.2d	50	165	0.888		0.695	4.05	2.00	8.10	5.627
9	16.0	4.2	.8d	50	113	0.611	0.672					
			.2d	50	136	0.733		0.741	4.35	2.00	8.70	6.450
10	18.0	4.5	.8d	50	129	0.696	0.811					
			.2d	50	172	0.925		0.839	4.50	2.00	9.00	7.549
11	20.0	4.5	.8d	50	132	0.712	0.867					
			.2d	50	190	1.021		0.821	4.50	2.00	9.00	7.393
12	22.0	4.5	.8d	50	107	0.579	0.776					
			.2d	50	181	0.973		0.735	4.40	2.00	8.80	6.466
13	24.0	4.3	.8d	50	104	0.563	0.693					
			.2d	50	153	0.824		0.583	4.35	2.00	8.70	5.070
14	26.0	4.4	.8d	50	86	0.467	0.472					
			.2d	50	88	0.477		0.457	4.45	2.00	8.90	4.071
15	28.0	4.5	.8d	50	108	0.584	0.443					
			.2d	50	55	0.301		0.503	4.40	2.00	8.80	4.424
16	30.0	4.3	.8d	50	119	0.643	0.563					
			.2d	50	89	0.483		0.579	4.05	2.00	8.10	4.688
17	32.0	3.8	.8d	50	103	0.557	0.595					
			.2d	50	117	0.632		0.488	3.40	2.00	6.80	3.319
18	34.0	3.0	.8d	50	75	0.408	0.381					
			.2d	50	65	0.355						

(cont.)

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Shebelli at Afgoi 31st August 1988

Vertical number	Distance (m)	Depth (m)	Depth of observation	Time (s)	Revs	Velocity Point	Velocity Mean (m/s)	Section	Mean depth (m)	Width (m)	Area (sq.m)	Discharge (cumecs)
18	34.0	3.0	.8d	50	75	0.408	0.381					
			.2d	50	65	0.355		0.283	2.55	2.00	5.10	1.442
19	36.0	2.1	.8d	50	31	0.173	0.184					
			.2d	50	35	0.195		0.092	1.05	2.30	2.41	0.222
20	38.3	0.0	-	50	0	0.000	0.000					

Total Area (sq.m) = 129.72 Total discharge (cumecs) = 79.60 Mean Velocity (m/s) = 0.61

APPENDIX C

EXAMPLE 10 DAY BULLETIN PRODUCED BY THE FEWS PROJECT
(with assistance from the Hydrology Section)

Technical Assistance ODA, Land & Water
04. SEP. 88

SOMALI DEMOCRATIC REPUBLIC
WASAARADDA BEERAHA
MINISTRY OF AGRICULTURE
FOOD EARLY WARNING DEPARTMENT

TEN DAY EARLY WARNING
INFORMATION BULLETIN
for
THIRD DECADE (21-31) AUGUST 1988

RAINFALL SITUATION

Very little rainfall has occurred during the decade, over southern and central areas of the country, with few scattered showers nowhere producing more than 1.6 mm.
In the Awdal Region, Borama reported 54.1 mm over seven rainy days.

RIVER FLOWS

The flow in both rivers has remained above normal. The Juba flow ranged from 295 Cumecs on the 22nd to 375 Cumecs on the 27th. The Shebelle rose steadily to over 160 Cumecs at the end of August, its highest so far this year. The Shebelle is very full throughout its length and some flooding has been reported near Bulo Burti.

AGRICULTURAL SITUATION

Crops: Harvesting of the 1988 Gu crops is nearly completed except in some areas of Middle and Lower Juba and in the Northwest Region. Although the aggregate cereal output is estimated at some 434.550 tons (96% of 1987 Gu production), it should be stressed that important regional production variations have been assessed due to below normal rainfall in Hiraan, northern part of Gedo and to a lesser extent in the Central Regions and Bakool.
Birds damage (Quelea quelea) (*): Major problems are reported in the rice fields in Lower Juba. At Mogambo bird population is estimated at 3 million and spraying operations are underway.
Bird populations are estimated at 3 million at Awgosh (Baidoa) (no damage reported), and in the Lower Shebelle at respectively 3.5 million, 4 million and 2.5 million at Arbowoheerow, Kaysuney (Awdheejle) and Buule Farm (no damage reported).
In the Middle Shebelle (Baroweyn) where birds population estimation is actually carried out, prevention operations will start as soon as the rice crops reach the milky stage.

Range: The range situation remains favourable and water availability is adequate.

PRICES SITUATION

Following full supply of markets, maize prices decreased sharply, especially at Balad, Mogadishu and Jowhar. Sorghum prices remained rather stable except at Balad and Lugh.
At Jowhar cowpeas averaged 89.4 SoShs/kg, some 10% less than last decade. Sharp price increases were reported for both sesame seed and sesame oil. At the end of August, sesame oil peaked at 640 SoShs (Jowhar) and 600 SoShs (Mogadishu) per litre.
Note: Monthly Mogadishu Averages (SoShs/kg or /ltr), (% change compared to July): white maize 57.1, (-26.2); red sorghum 56.1, (+3.1); imported rice 259.5, (+51.4); wheat flour 273.4 (+68.7); sesame seed 217.3, (+14.5); cowpeas 96.7, (+21.9); imported oil 345.2, (+27.1); sesame oil 502.9, (+23.1); sugar 282.4, (+22.5)

(*) Source: Plant Protection Department.

DEPARTMENT OF IRRIGATION AND LAND USE

HYDROMETRY PROJECT

RIVER FLOW REPORT 31-Aug-88

RIVER JUBBA AT LUGH GANANA

10 Day period	10 day mean discharges (cumecs)				Cumulative Water Volume (MCM)			
	Normal	1987	1988	1988 as % normal	Normal	1987	1988	1988 as % normal
JAN I	35	33	31	89	30	30	27	89
II	28	25	30	107	54	52	53	97
III	21	20	29	138	74	71	80	108
FEB I	15	15	29	193	87	84	105	121
II	11	11	23	209	97	93	125	129
III	10	10	17	170	104	100	137	132
MAR I	8	9	15	188	111	106	150	136
II	11	13	20	182	120	119	168	139
III	17	44	15	88	137	161	182	133
APR I	34	53	10	29	166	207	190	115
II	128	169	94	73	277	353	272	98
III	142	187	146	103	399	515	398	100
MAY I	186	135	175	94	560	631	549	98
II	259	260	144	56	784	856	673	86
III	274	1111	158	58	1044	1912	824	79
JUN I	241	878	92	38	1252	2670	903	72
II	196	494	87	44	1422	3097	978	69
III	154	283	138	90	1555	3342	1097	71
JUL I	209	232	113	54	1735	3542	1195	69
II	243	251	183	75	1945	3759	1353	70
III	219	178	349	159	2153	3928	1685	78
AUG I	204	167	323	158	2330	4073	1964	84
II	231	118	420	182	2529	4174	2327	92
III	266	139	323	122	2782	4307	2606	94
SEP I	286	223			3029	4499		
II	290	145			3280	4625		
III	253	146			3498	4751		
OCT I	310	211			3766	4933		
II	442	426			4148	5301		
III	359	359			4489	5642		
NOV I	283	417			4734	6003		
II	225	314			4928	6274		
III	162	164			5068	6416		
DEC I	93	115			5148	6515		
II	63	92			5203	6594		
III	47	66			5248	6656		

Notes: (1) Normal is the median from the period 1968-1987

(2) All flow values are provisional

(3) Any use of this data should acknowledge the source to be the Hydrology Section, Department of Irrigation and Land Use, Ministry of Agriculture.

DEPARTMENT OF IRRIGATION AND LAND USE

HYDROMETRY PROJECT

RIVER FLOW REPORT 31-Aug-88

RIVER SHEBELLI AT BELED WEYN

10 Day period	10 day mean discharges (cumecs) Normal	1987	1988	1988 as % normal	Cumulative Water Volume (MCM) Normal	1987	1988	1988 as % normal
JAN I	11	9	6	55	9	8	5	55
II	9	7	5	55	17	14	10	55
III	10	6	5	52	26	20	14	54
FEB I	9	5	5	59	34	24	19	55
II	8	5	4	53	40	28	22	55
III	7	5	3	45	45	32	24	54
MAR I	11	4	2	16	55	35	26	48
II	9	5	2	22	62	40	28	44
III	11	25	3	29	72	63	30	42
APR I	26	35	5	20	94	94	35	37
II	54	92	18	33	141	173	50	36
III	76	97	109	144	207	257	145	70
MAY I	74	64	118	160	271	312	246	91
II	111	114	46	42	366	411	286	78
III	109	212	29	27	470	612	314	67
JUN I	71	377	21	29	532	938	332	62
II	43	492	11	25	569	1363	341	60
III	33	208	20	60	598	1543	359	60
JUL I	40	68	20	50	632	1601	376	59
II	50	57	31	63	675	1651	403	60
III	58	51	49	85	731	1699	445	61
AUG I	79	48	73	92	799	1741	508	64
II	106	32	117	111	891	1768	610	68
III	123	31	150	122	1008	1798	739	73
SEP I	143	36			1131	1829		
II	142	71			1254	1890		
III	137	73			1372	1953		
OCT I	111	89			1468	2030		
II	105	68			1558	2089		
III	89	68			1643	2153		
NOV I	80	82			1712	2224		
II	44	35			1750	2255		
III	32	17			1777	2269		
DEC I	22	12			1797	2280		
II	17	10			1811	2288		
III	13	8			1823	2296		

Notes: (1) Normal is the median from the period 1963-1987

(2) All flow values are provisional

(3) Any use of this data should acknowledge the source to be the Hydrology Section, Department of Irrigation and Land Use, Ministry of Agriculture.

FEWS PROJECT

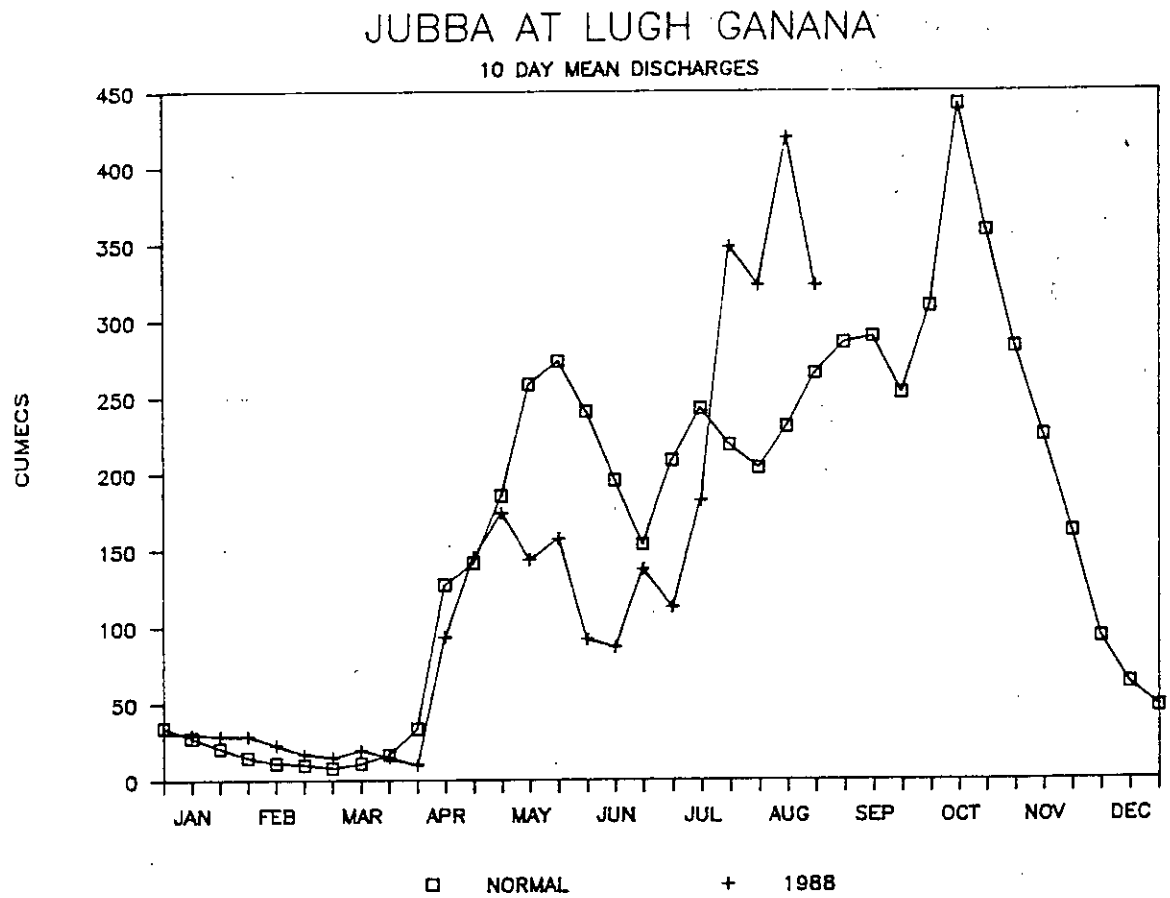
DECADAL RAINFALL REPORT

for

Third Decade August 1988

STATION	21	22	23	24	25	26	27	28	29	30	31	Ten day Total	Cumulative totals 1988	1987	Normal	1988 0 Normal 0
Jilib	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	593.6	469.6	395.1	150.2
Kismayo	.	.	.	.	.	.	.	.	.	.	.	.	.	.	864.7	.
Boale	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	374.2	343.4	.	.
Genale	.	.	.	.	.	.	.	.	.	.	.	.	.	369.7	342.8	.
Dinsor	.	.	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	.	.	337.3	249.9	.
Bardera	.	.	.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.	.	.	219.7	.
Jowhar	0.0	0.0	0.2	0.0	0.0	0.0	0.3	0.0	0.3	0.0	0.0	0.8	350.1	422.5	277.6	126.1
Balad	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5	381.7	432.1	256.8	148.6
Afgoi	.	.	.	.	.	.	.	.	.	.	.	.	.	450.9	318.0	.
Lafoole	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	595.7	542.8	329.1	181.0
Mogadishu	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	1.6	464.1	444.2	313.2	148.2
Lugh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	108.9	204.2	194.3	56.0
Baidoa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	536.0	249.4	358.1	149.7
Bulo Berti	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	341.8	.	495.4	69.0
Hoddur	.	.	.	.	.	.	.	.	.	.	.	.	.	288.0	205.6	.
Belet Weyne	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	87.5	434.8	180.3	48.5
Dusamareb	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	174.0	.	240.6	72.3
Galcaio	.	.	.	.	.	.	.	.	.	.	.	.	.	105.3	116.3	.
Garoe	.	.	.	.	.	.	.	.	.	.	.	.	.	.	49.8	.
Borama	.	4.0	10.6	14.0	5.5	4.9	6.0	9.1	0.0	0.0	0.0	.	.	.	405.6	.
Hargeisa	.	.	.	.	.	.	.	.	.	.	.	.	.	382.3	336.3	.
Burao	.	.	.	.	.	.	.	.	.	.	.	.	.	.	139.1	.
Erigavo	.	.	.	.	.	.	.	.	.	.	.	.	.	236.7	295.6	.
Qardo	.	.	.	.	.	.	.	.	.	.	.	.	.	.	69.9	.

NOTES: Rainfall in Millimetres   Dots (.) indicate missing values


JUBBA AT LUGH GANANA
10 DAY MEAN DISCHARGES
CUMECS
0
50
100
150
200
250
300
350
400
450
JAN
FEB
MAR
APR
MAY
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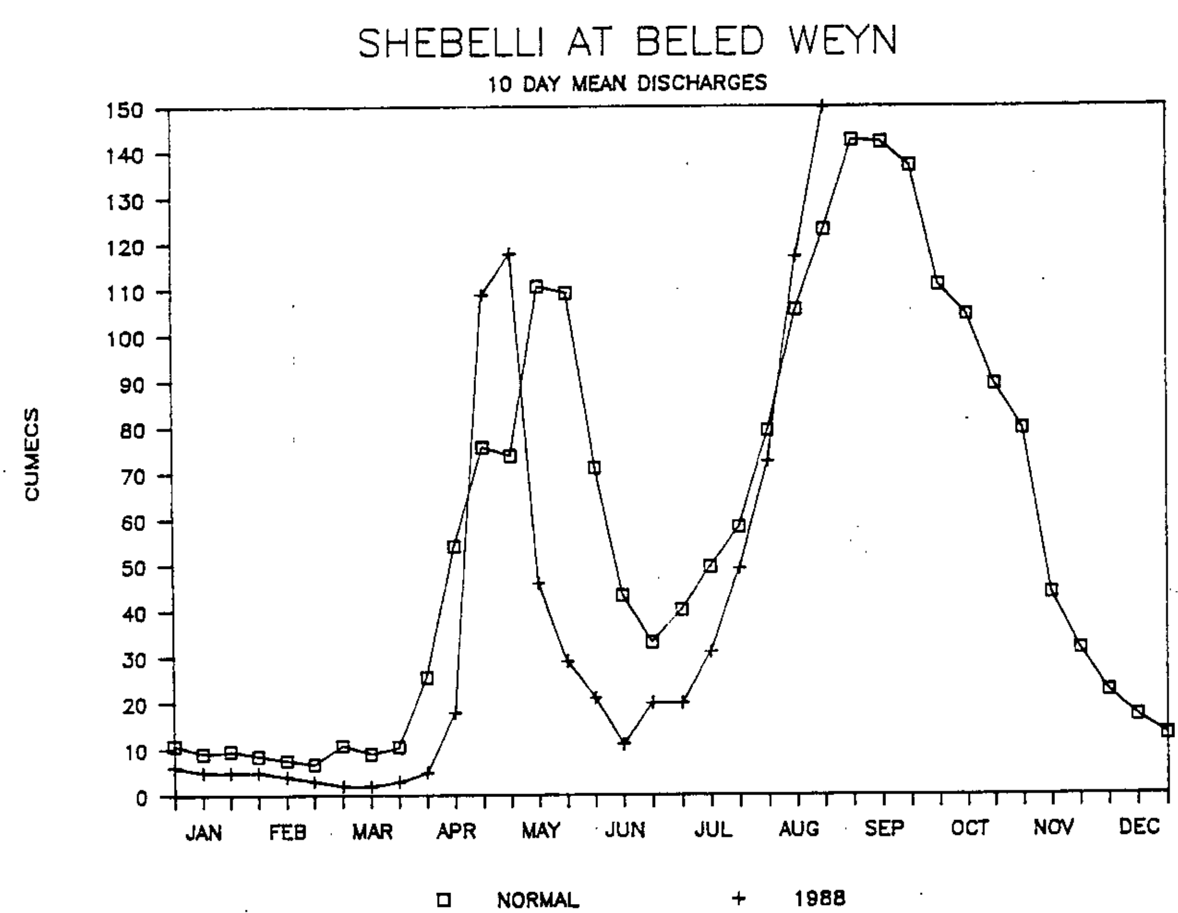
NORMAL
1988


SHEBELLI AT BELED WEYN
10 DAY MEAN DISCHARGES
CUMECS
0
10
20
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90
100
110
120
130
140
150
JAN
FEB
MAR
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MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
NORMAL
1988

FEWS PROJECT

RETAIL PRICES
for
Third Decade August 1988

STATION	Maize		Sorghum		Wheat Flour		Rice		Sesame Seed		Cowpeas		Imported Oil		Sesame Oil		Sugar	
	SoSh/kg	%	SoSh/kg	%	SoSh/kg	%	SoSh/kg	%	SoSh/kg	%	SoSh/kg	%	SoSh/ltr	%	SoSh/ltr	%	SoSh/kg	%
Kismayo	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Jilib	65.1	7.1	N.A.	N.A.	300.0	15.4	209.9	4.9	142.4	0.0	102.4	0.0	500.0	0.0	516.4	3.3	300.0	0.0
Boale	39.7	8.5	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	89.6	0.0	360.0	0.0	450.0	-11.8	275.5	2.0
Genale	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Dinsor	N.A.	N.A.	31.5	N.A.	240.0	N.A.	280.0	N.A.	N.A.	N.A.	157.3	N.A.	414.3	N.A.	464.3	N.A.	280.0	N.A.
Bardera	64.0	N.A.	38.4	N.A.	280.0	N.A.	300.0	N.A.	119.0	N.A.	146.4	N.A.	500.0	N.A.	N.A.	N.A.	260.0	N.A.
Balad	54.0	-25.8	47.3	-24.9	252.7	-8.3	260.0	0.0	231.4	36.8	89.6	-12.5	364.5	10.8	486.4	12.3	267.3	-1.4
Mogadishu	47.8	-22.1	53.7	-8.5	265.0	-2.2	276.4	10.1	238.7	17.6	92.4	-9.8	340.9	-1.5	582.7	24.5	292.7	7.0
Jowhar	64.4	-17.4	62.6	-1.7	278.2	-0.6	280.0	0.0	181.6	20.2	89.4	-10.8	360.0	-3.0	575.5	33.5	277.3	2.7
Lugh	87.1	7.4	67.0	23.4	170.0	-5.6	280.0	0.0	N.A.	N.A.	128.0	18.4	360.0	-8.0	N.A.	N.A.	270.0	1.7
Baidoa	77.4	2.8	44.4	5.2	232.7	-6.2	260.0	1.6	N.A.	N.A.	126.6	6.9	383.6	9.6	504.5	0.9	267.3	1.2
Bulo Berti	69.0	-11.5	54.7	9.4	N.A.	N.A.	243.6	1.5	N.A.	N.A.	136.4	-2.6	300.0	0.0	500.0	23.5	301.8	0.6
Hoddur	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Belet weyn	77.1	-18.5	82.7	-8.1	240.0	0.0	280.0	0.0	133.5	0.0	96.0	0.0	400.0	0.0	550.0	6.2	280.0	0.0
Dusa mareb	63.6	4.1	69.1	11.1	192.7	5.8	242.7	0.7	N.A.	N.A.	116.2	4.6	400.0	N.A.	N.A.	N.A.	257.3	6.2
Galcaio	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Garowe	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Borama	121.2	N.A.	135.0	N.A.	160.0	N.A.	180.0	N.A.	N.A.	N.A.	N.A.	N.A.	300.0	N.A.	N.A.	N.A.	217.5	N.A.
Hargeisa	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Burao	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Erigavo	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Qardho	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Note: % = % change from last decade.
Prices for white maize, red sorghum
(except Borama, Hargeisa, Burao and Erigavo: white sorghum)
Prices for imported rice

Produced in collaboration with the Marketing Unit, Planning Department.