

# LESOTHO HIGHLANDS DEVELOPMENT AUTHORITY

## FLOW RELEASES DOWNSTREAM OF THE LESOTHO HIGHLANDS WATER PROJECT (LHWP) STRUCTURES

*(April 2002 to December 2002)*



*TOWER ON MALIBAMATŠO RIVER @ KAO*

FEBRUARY 2003

OPERATIONS AND MAINTENANCE GROUP

Operations Planning  
Branch - HYDROLOGY  
SECTION

## **EXECUTIVE SUMMARY**

This Report: “Flow Releases Downstream of the Lesotho Highlands Water Project (LHWP) structures – February 2003” as now published provides an update of the amounts of water that have been released downstream of the four operational structures of the LHWP (i.e. Katse Dam, ‘Muela Dam, Matsoku Diversion Weir and Tunnel and Mohale Dam) from April 2002 to December 2002.

The report indicates that 134.65 MCM ( $5.667\text{m}^3/\text{sec}$ ) has been released from the Katse Dam. The IFR Policy became effective on the 13<sup>th</sup> December 2002 and indicates an average release from Katse Dam of  $1.3\text{ m}^3/\text{sec}$ . It can be seen from Table 1 in the text that the average release up to the end of December 2002 has been well in excess of IFR Policy Requirements. 3.979 MCM ( $0.17\text{m}^3/\text{sec}$ ) has been released from ‘Muela Dam.

It is estimated that the total flow downstream of the Matsoku weir and tunnel is 38.413 MCM ( $1.62\text{ m}^3/\text{sec}$ ). For Mohale Dam, the flow released downstream from impounding date of the 1<sup>st</sup> November 2002 up to December 2002 has been 3.43 MCM ( $0.65\text{ m}^3/\text{sec}$ )

On the overall, the above flow releases from the LHWP four operational structures have been consistently higher than the recommended target releases.

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## **FOREWORD**

The “Flow Releases Downstream of LHWP Reservoirs, Revision 2 – April 2002” Report was published in April 2002. The Treaty specifies the minimum amounts of water that must be released downstream of the LHWP Reservoirs as discharge in cubic metres per second ( $m^3/s$ ) and as volume in Million Cubic Metres (MCM). Revision 2 Report was therefore published to check if the Treaty requirements were met. It was thus deduced that all the Treaty requirements were met and exceeded.

The Project Authorities made a decision then that reports subsequent to Revision 2 Report must be issued every six (6) months to assess whether LHDA complies with the Treaty and that the In - stream Flow Requirements (IFR) are being observed.

The data records for December 2002 were already ready for inclusion in this report during its compilation. Hence this report covers the period April 2002 to December 2002.

## **INTRODUCTION**

The Report “Flow Releases Downstream of the Lesotho Highlands Water Project (LHWP) structures” is being published to provide a record of the flow volume, in Million Cubic Metres (MCM), released downstream of the existing and operating LHWP structures for the nine (9) months period. The operational structures that are being reported on are the Katse Dam, the 'Muela Dam, the Matsoku Diversion Weir and Tunnel and Mohale Dam.

Katse Reservoir started impoundment in October 1995 when the two Diversion Tunnels that were used to pass water downstream were closed. Construction was still in progress at that stage and impoundment was thus restricted to rise at a pace lagging behind construction.

The discharge facilities at Katse Dam are composed of a ten (10) bay spillway with a crest level of 2053 metres above sea level (masl) designed for a Probable Maximum Flood (PMF) of 6252 m<sup>3</sup>/s at a surcharge level of 7.2 m above its crest. There are two (2) Low - Level Outlets (LLOs) at an elevation of 1938 masl, each with a capacity of 422 m<sup>3</sup>/s at Full Supply Level (FSL). Each LLO has one emergency gate and one radial gate installed in series. A third discharge facility consists of a compensation pipe capable of discharging between 300 to 800 litres per second through a sleeve valve and the fourth discharge facility consists of a Mini – Hydro pipe capable of discharging the maximum up to 0.5 m<sup>3</sup>/s.

The 'Muela Dam is provided with a compensation pipe with a capacity of 0.4 m<sup>3</sup>/s and one bottom outlet (sleeve) valve capable of discharging 7.6 m<sup>3</sup>/s. The spillway is designed for a PMF of 584 m<sup>3</sup>/s.

Matsoku Diversion Weir and Tunnel was inaugurated and commissioned on the 26<sup>th</sup> October 2001. That is, Matsoku became operational from its inauguration date. The weir is equipped with a tunnel facility to transfer water from Matsoku River to Katse Reservoir. The facility has been designed such that all the flows up to 0.65m<sup>3</sup>/s (650 litres per second) pass through a discharge valve downstream. Water in excess of 0.65 m<sup>3</sup>/s is diverted via the tunnel to Katse Reservoir up to a maximum of 47 m<sup>3</sup>/s. All amounts of flow in excess of 47 m<sup>3</sup>/s will then spill downstream over the weir. This weir has, therefore been transferring water since its inauguration and commissioning date, 26<sup>th</sup> October 2001.



Impoundment of Mohale Dam began on the 1<sup>st</sup> November 2002 with the lowering of the stoplogs to close the second diversion tunnel. The first diversion tunnel had been plugged in 2002. Initially water was released through valves built into the stoplogs until the reservoir rose to sufficient level (1985.0 masl) to allow safe releases through the Low Level Outlet (LLO) system and then once the reservoir reached 2005.0 masl through the compensation pipe work and the LLO. Any release through the stoplogs has to be piped through the concrete plug being constructed to permanently close the tunnel behind the stoplogs; the pipe will be blocked once the plug has cooled and has been grouted.

The LLO leads to a 1400mm sleeve valve which can safely discharge between 5 and 36 cumecs at 1985.0 masl, and between about 10 and 65 cumecs at full supply level.

The compensation pipe work leads from a series of intake valves at 10m vertical intervals in the compensation intake structure to a bifurcation, one branch terminating in a 200mm sleeve valve and the other in a 500mm sleeve valve, allowing safe releases in the range 0.1 to nearly 5 cumecs at the 2005.0 masl reservoir minimum operating level. (There is also a connection built in for a future mini-hydro set currently closed by a blank flange.)

A 200mm bypass allows water from the LLO system to be discharged into the compensation pipe work. The dam is protected by a 50m wide free discharge ogee spillway at 2075 masl.

This report provides information on the quantity of water that has been discharged downstream of LHWP structures from April to December 2002. Firstly, the chronology of events and the summaries of flow releases as well as the figures and the tables for each of the four operational structures are presented. Finally, conclusions and recommendations are also presented.

## **1.0 CHRONOLOGY OF EVENTS AND SUMMARIES OF FLOW RELEASES FROM THE FOUR OPERATIONAL STRUCTURES.**

### **1.1 Chronology of Events of the Katse Dam:**

#### **1.1.1 Compensation Outlet**

The sleeve valve of the compensation pipe at the Katse Reservoir had been designed to safely discharge water within the range of 0.3 to 0.8 m<sup>3</sup>/s for reservoir levels ranging from Minimum Operating Level (MOL) to Full Supply Level (FSL). This valve is, however, capable of discharging 1.897 m<sup>3</sup>/s under FSL conditions but it is recommended that this should only be done for short periods. The valve was set at 70% to release the discharge of approximately 1.4 m<sup>3</sup>/s, which is, therefore outside the safe range of the valve. After the production of the Revision 2 Report in April 2002, the valve was set at 35% to release the discharge of 0.75 m<sup>3</sup>/s ± 10% deviation. The adjustment was done on the 25<sup>th</sup> April 2002. The deviation of ± 10% had been included to cater for the variations in reservoir levels, as the discharge through the sleeve valve of the compensation pipe is a function of the reservoir level. The total volume of water released through the sleeve valve of the compensation pipe from April 2002 to December 2002 is 18.780 MCM.

### **1.1.2 Low level Outlet for Water Quality Testing (Test 1)**

The Low – Level Outlets (LLOs) were opened on the 4<sup>th</sup> September 2002 in order to conduct Water Quality tests on water released from the bottom of the reservoir. The test was conducted in two steps of LLO gate opening, the step up opening and then the step down opening. One LLO gate was initially opened at 100% releasing the discharge of 410.32 m<sup>3</sup>/s for 33 minutes to fill up the tail water pond. The volume released was 0.812 MCM. Thereafter that LLO was closed and the second one opened at 5% releasing 13.46 m<sup>3</sup>/s for two (2) hours, from 09:15 hours to 11:15 hours. The volume released was approximately 0.1 MCM. The LLO opening was then stepped up to 10% releasing 27.72 m<sup>3</sup>/s for only one hour, from 11:15 hours to 12:15 hours. The volume released was also 0.1 MCM. The LLO gate was finally stepped up to 15% opening for the completion of the step up test. It was opened for an hour, from 12:15 hours to 13:15 hours with a release rate of 42.19 m<sup>3</sup>/s, which converts to a volume of 0.15 MCM.

The gate was then closed down in a step down manner from 15% to 10% to 5% for 30 minutes each. The volume released in a step down closing was 0.05 MCM for 10% opening and 0.02 MCM for 5% opening.

The total volume released for the whole test was 1.236 MCM. The water level in the reservoir continued to rise indicating that the reservoir inflow was in excess of the releases.

### **1.1.3 Routine discharges through the Low level Outlet**

The operational procedure at Katse Dam is to open the Low Level Outlets to prevent discharge over the dam crest spillway to protect the right bank immediately downstream of the dam wall.

The LLOs were thereafter opened during the evenings to minimize impeding access for downstream communities and to lower the reservoir level to prevent water from spilling over the spillway. One gate was opened at 50% on the 4<sup>th</sup> September, from midnight to 06:30 hours of the morning of the 5<sup>th</sup> September 2002. It was arranged that the openings must be done at night to make it easy for people to cross the river downstream during the day as it takes a lot of time for the river flow to reduce to near normal after the LLOs are opened and then closed. The releases were therefore done from 18:00 hours to midnight from the 5<sup>th</sup> to the 16<sup>th</sup> September 2002 and the percentage openings were varied between 50% and 70%. The total volume released in this function amounted to 72 MCM.

On the 7<sup>th</sup> September water began to spill over the spillway. Thus water was discharging over the spillway during the day and at night and through the LLOs. The Katse Dam spilled until the 15<sup>th</sup> September 2002, discharging a total volume of 11.306 MCM. This indicates that the months of August and September 2002 were very wet.

#### 1.1.4 Low level Outlet for Water Quality Testing (Test 2)

The second Water Quality test was scheduled for the 17<sup>th</sup> December 2002. It was, however, conducted on the 18<sup>th</sup> December. One LLO gate was opened at 57% for 42 minutes, from 06:18 hours to 07:00 hours at the beginning of the test to fill up the tail water pond. The flow rate at this percentage opening was 165.80 m<sup>3</sup>/s, which converts to a volume of 0.42MCM.

The second LLO was, thereafter, opened at 20% releasing 56.20 m<sup>3</sup>/s for three (3) hours, from 07:00 hours to 10:00 hours. The volume released was 0.61MCM. The gate opening was then stepped up to 25% releasing 71.20 m<sup>3</sup>/s for another three (3) hours, from 10:00 hours to 13:00 hours. The volume released was 0.77 MCM. The last step up percentage for this test was at 30% gates opening. It also lasted for three (3) hours from 13:00 hours to 16:00 hours releasing 85.40 m<sup>3</sup>/s, which converts to a volume of 0.92 MCM.

The gates were then stepped down to 25% opening, which lasted three (3) hours, from 16:00 hours to 19:00 hours, releasing the flow rate of 71.20 m<sup>3</sup>/s. Its corresponding volume was 0.77 MCM. It was already late then, so the gate was completely closed at 19:00 hours, after the first step down test.

The total volume released for the second LLO test was 3.49 MCM. The days were similarly very wet and the reservoir level was continuously rising, as was the case during the first test. That is, the month of December 2002 saw a lot of rainfall. The total volume of water released downstream of the Katse Dam for the first and second tests therefore amounts to 4.73 MCM.

### **1.1.5 Further Routine discharges through the Low Level Outlet**

The LLOs were thereafter opened during the evenings as in September to reduce the water level to prevent spillage. They were opened at 38% on the 23<sup>rd</sup> December 2002 at 20:40 hours. The percentage opening was increased to 75% at 21:40 hours on the same day. The reservoir level was still increasing and a spill of 0.75 m<sup>3</sup>/s was experienced. This situation therefore led to a percentage opening of 100% on the 24<sup>th</sup> December 2002 at 21:00 hours and closed at 06:00 hours of the 25<sup>th</sup> December 2002. The gate was again opened at 100% on the 29<sup>th</sup> December at 01:30 hours and the spill of 0.75 m<sup>3</sup>/s was also experienced. The gate was closed at 02:00 hours of the same day 29<sup>th</sup> December 2002. The total volume of water released through the LLOs from the 23<sup>rd</sup> to the 29<sup>th</sup> December 2002 amounts to 25.97 MCM. The volume spilled was only 4,025.00 cubic metres (m<sup>3</sup>) in December 2002. This takes the volume released through the LLOs to a total of 102.679 MCM and the volume, which flowed over the spillway to 11.310 MCM for the period April to December 2002.

## **1.2 Summary of Flow Volumes Releases from the Katse Dam**

### **1.2.1 Spillage**

Katse Dam has spilled three times since April 2002. The period of spill and its amount are as shown below.

PERIOD	DISCHARGE
-07 <sup>th</sup> Sept. 2002 to 15 <sup>th</sup> Sept. 2002	11,306,345.00 m <sup>3</sup>
-23 <sup>rd</sup> Dec. 2002 to 23 <sup>rd</sup> Dec. 2002	2,700.00 m <sup>3</sup>
-29 <sup>th</sup> Dec. 2002 to 29 <sup>th</sup> Dec. 2002	1,350.00 m <sup>3</sup>

The low – level outlets were regularly used to draw down the Reservoir level prior to the spill event in an effort to prevent its occurrence. However, the spills eventually took place because the level could not be drawn down due to high and prolonged rainfall that fell for extended number of days and hours, especially during the months of August and September 2002. It can be seen that the second and the third spill discharges were small and lasted for very short periods. The total volume discharged over the spillway for the period, April to December 2002, was therefore 11,310,369 m<sup>3</sup> (11.310 MCM), which converts to a corresponding average spill discharge of 0.48 m<sup>3</sup>/s.

### **1.2.2 Discharges through the Low Level Outlet**

The volume released through the LLOs amounts to 102.679 MCM for this period, and equates to an average discharge of 4.322 m<sup>3</sup>/s. This amount includes the LLO discharges for water quality testing as had been indicated earlier. The periods of LLO discharges and their amounts for water quality testing are as shown in the table below.

PERIOD	DISCHARGE
-04 <sup>th</sup> Sept. 2002 to 04 <sup>th</sup> Sept. 2002	1.236MCM
-04 <sup>th</sup> Sept. 2002 to 16 <sup>th</sup> Sept. 2002	71.989MCM
-18 <sup>th</sup> Dec. 2002 to 18 <sup>th</sup> Dec. 2002	3.490MCM
-23 <sup>rd</sup> Dec. 2002 to 28 <sup>th</sup> Dec. 2002	25.964MCM

### **1.2.3 Compensation and Mini Hydro Discharges**

The actual total volume of water released through the compensation and mini-hydro outlets is 20.660 MCM, which converts to 0.87 m<sup>3</sup>/s for the same period.

#### 1.2.4 In - stream Flow Requirements (IFR)

The IFR Policy became effective on the 13<sup>th</sup> December 2002 and indicates an average release from Katse Dam of 1.3 m<sup>3</sup>/s. It can be seen from Table 1 below that the average release up to the end of December 2002 has been well in excess of IFR Policy requirements. Summary of Discharges from Katse Dam are shown in Table 1 below.

**Table 1: Flow Releases from Katse Dam**

<b>Discharge Facility</b>	<b>Volume (MCM)</b>	<b>Average Flow Rate (m<sup>3</sup>/s)</b>
Spillway	11.310	0.48
Low Level Outlet (including tests)	102.697	4.322
Compensation Outlet	18.780	0.79
Mini – Hydro Outlet	1.881	0.079
IFR Bulk	0.000	0.00
<b>Total</b>	<b>134.650</b>	<b>5.667</b>

#### 1.2.5 Hydrometric Monitoring

The Hydrometric stations downstream of the Katse Dam were also monitored and their discharges calculated. The Paray Hydrometric station registered a volume of 238.121 MCM, which converts to an average flow of 10.02 m<sup>3</sup>/s for the period April to December 2002. And the volume recorded at the Weir at Paray amounts to 239.785 MCM and it is equivalent to the average flow of 10.09 m<sup>3</sup>/s.



## 1.2.6 Monthly Releases from Katse Dam

Table 2 below gives the volumes of water released downstream of the Katse Dam since April 2002 to December 2002 for each month. It also gives the overall total at the end of the period.

**Table 2: Monthly Flow Releases from the Katse Dam**

Months Since April 2002	Low – level Outlet (Radial Gates) Volume in Cubic Metres	Compensation Volume in Cubic Metres	Mini – Hydro Volume in Cubic Metres	Spillway Volume in Cubic Metres	Monthly total in Million Cubic Metres (MCM)	Paray Hydrometric Station Flows in cubic metres (m <sup>3</sup> )	Paray Weir Station Flows in cubic metres (m <sup>3</sup> )
Apr-02	-	3,056,369	207,360	-	3.26	6,834,154	6,500,390
May-02	-	1,998,276	214,272	-	2.21	5,857,056	5,738,515
Jun-02	-	1,929,087	207,360	-	2.14	10,338,278	10,261,469
Jul-02	-	1,983,001	207,360	-	2.19	5,855,414	5,328,806
Aug-02	-	1,978,448	207,360	-	2.19	34,510,838	36,443,520
Sep-02	73,225,013	1,948,862	207,360	11,306,345	86.69	111,298,493	115,587,907
Oct-02	-	2,006,649	214,272	-	2.22	10,297,498	8,231,501
Nov-02	-	1,871,796	200,448	-	2.07	13,587,696	11,783,491
Dec-02	29,453,976	2,007,416	214,762	4,025	31.68	39,541,738	39,909,629
	102,678,989	18,779,904	1,880,554	11,310,369	134.650	238,121,165	239,785,229
<b>Volume in MCM</b>	<b>102.679</b>	<b>18.780</b>	<b>1.881</b>	<b>11.310</b>	<b>134.650</b>	<b>238.121</b>	<b>239.785</b>
	<b>Comp + Mini =</b>	<b>20.660</b>					
<b>Total water released downstream of Katse</b>					<b>134.65 MCM</b>		

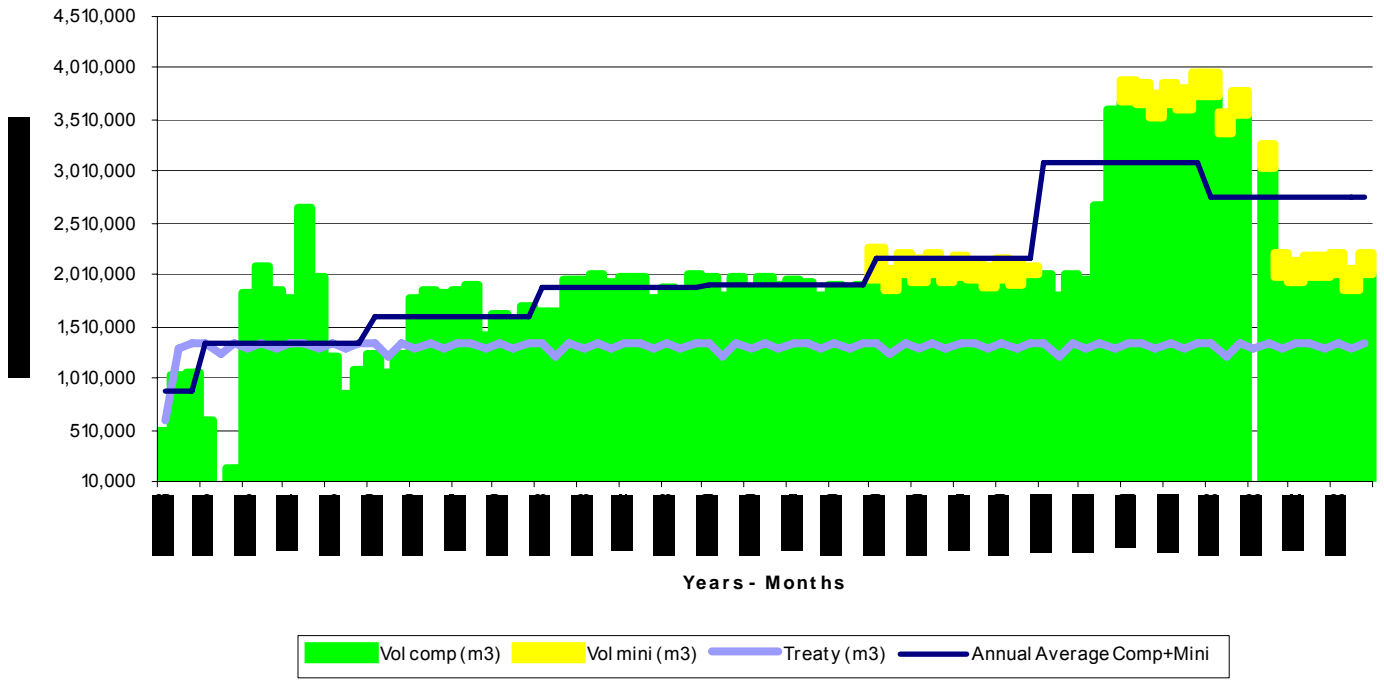
Figure 1 compares the Treaty required guaranteed minimum flow with the flow from the Katse compensation pipe. It is seen that the outflow from the compensation pipe has consistently been more than the Treaty guaranteed minimum flow.

Figure 2 shows the different outlet flows at Katse and how they compare with the Treaty required guaranteed minimum flow and the annual average of the total outflows.

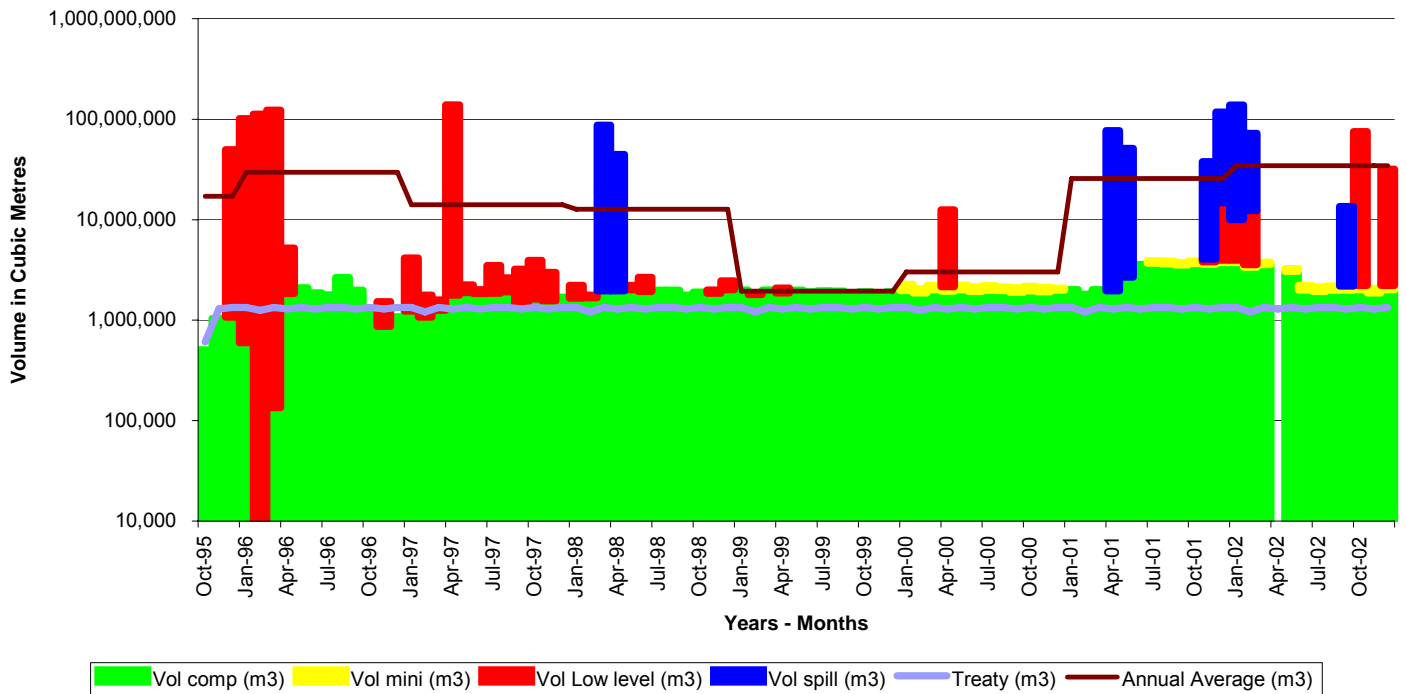
Figure 3 gives the Hydrometric station and the Weir flows of Malibamatšo River at Paray as compared with all the releases from the Dam. These indicate that the flows at the above recording stations had always been higher than the releases from the Katse Dam.

(N.B. Figures 1, 2, and 3 have vertical logarithmic scale, which tends to compress the vertical scale especially as it moves upward).

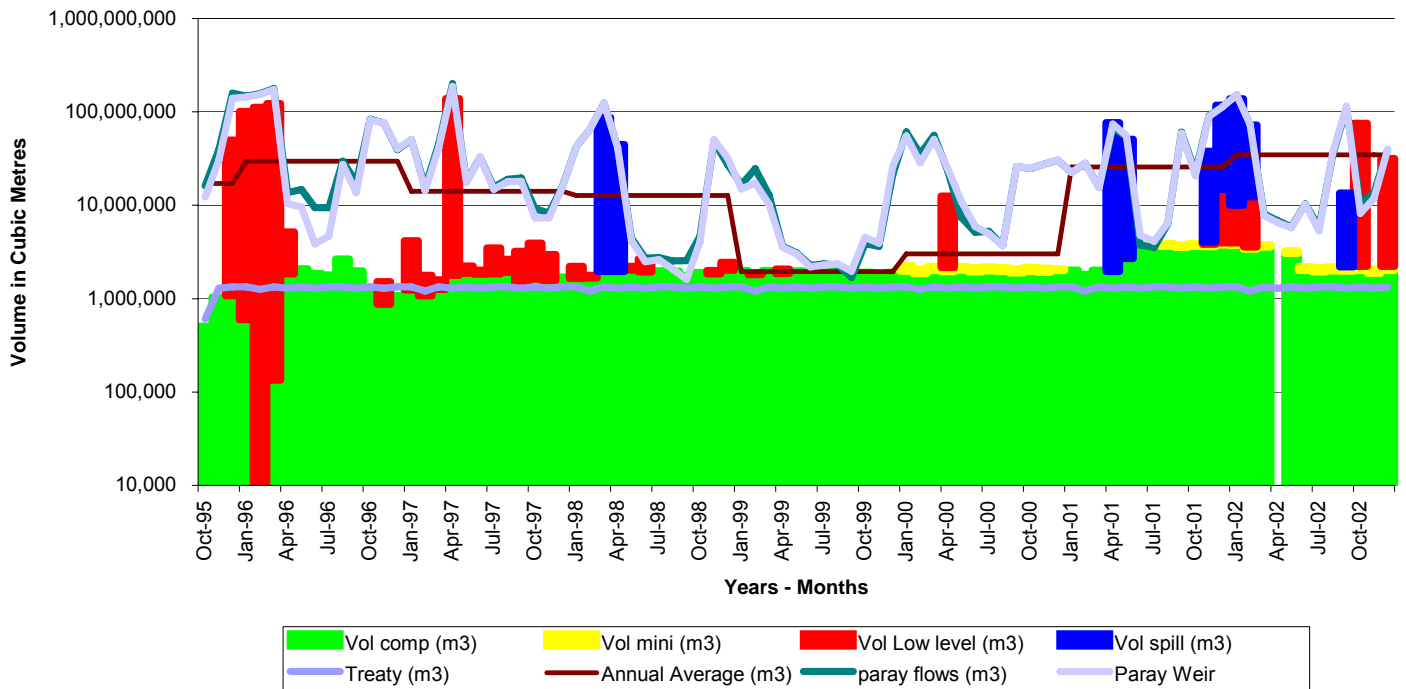
**FIGURE 1 - Historic Monthly Flow Releases - Katse Reservoir  
Actual vs Treaty guaranteed Minimum Flows**



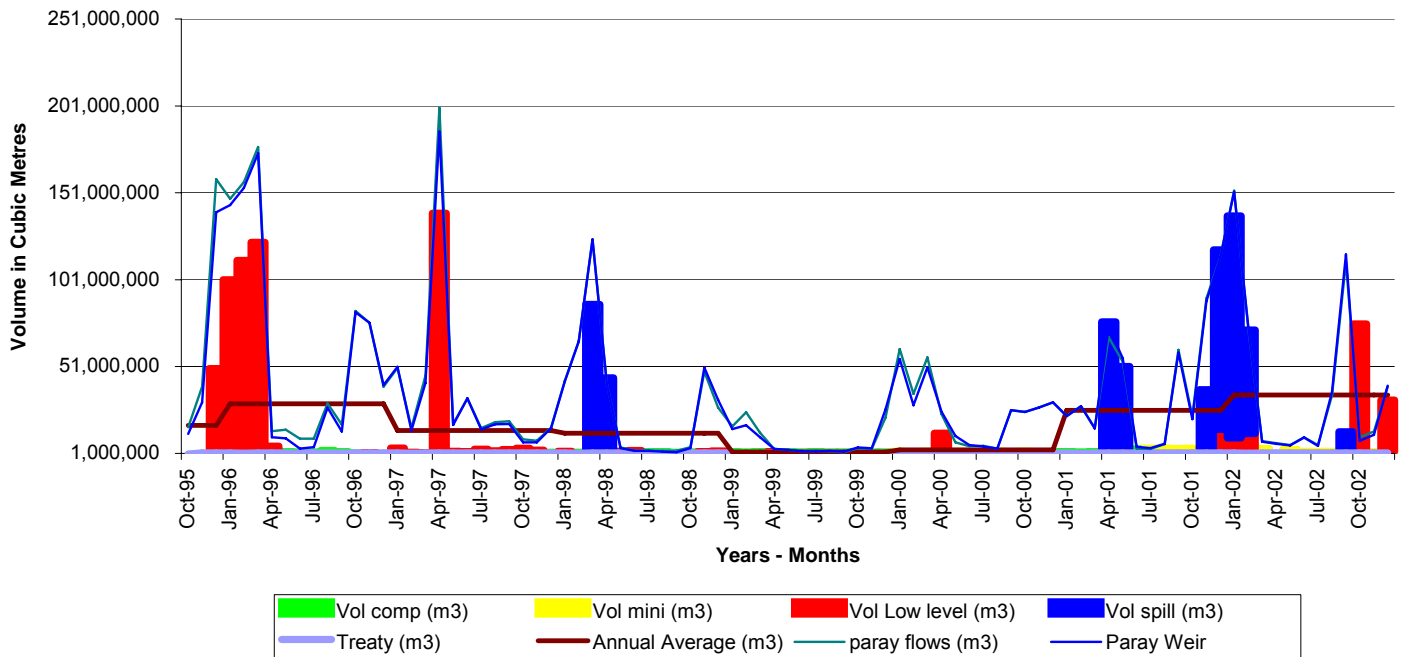
**FIGURE 2 - Historic Monthly Flow Releases - Katse Reservoir**  
 All flow Releases vs Treaty guaranteed Minimum Flows.



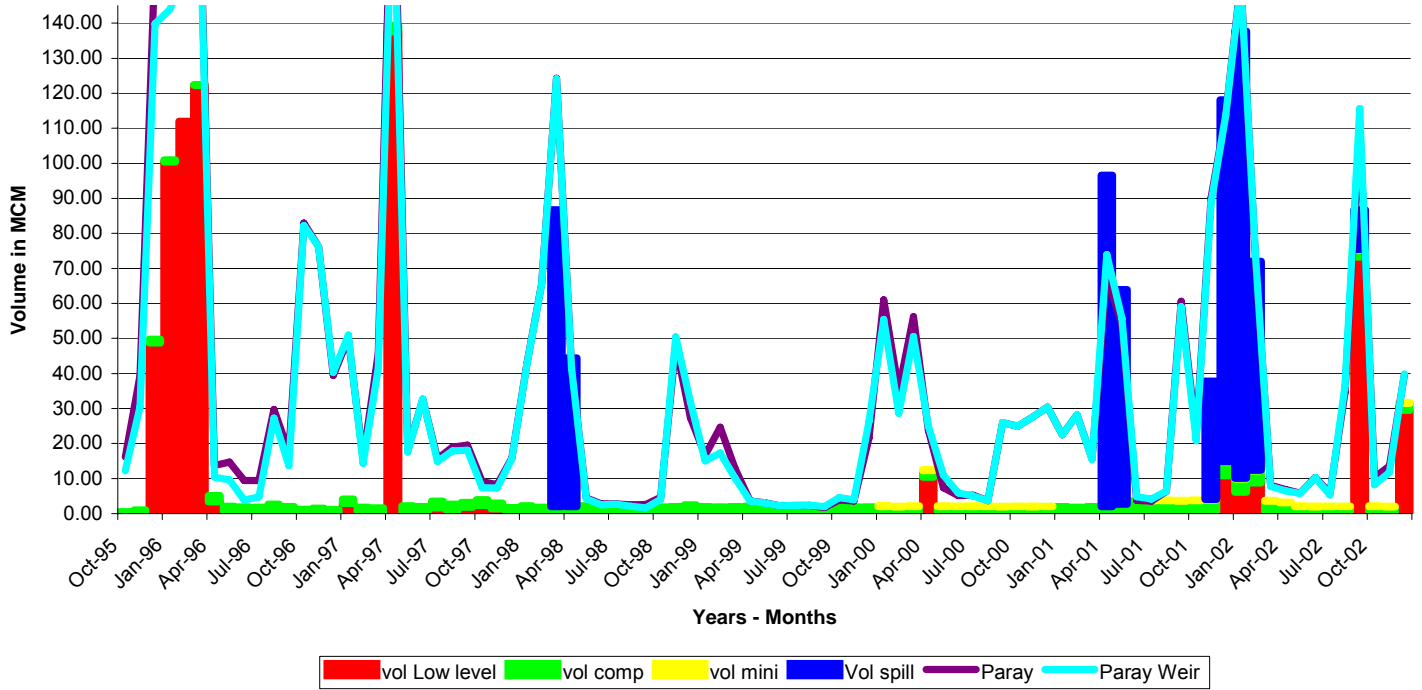
**FIGURE 3 - Historic Monthly Flow Releases - Katse Reservoir  
Comparison with Paray Hydrometric Station and Weir data**



**FIGURE 4 - Historic Monthly Flow Releases - Katse Reservoir**  
**Indicating the comparison of Releases with Paray Hydrometric Station and Weir data in**  
**Cubic Metres (the axis cuts at 1,000,000.00)**



**FIGURE 5 - Historic Monthly Flow Releases - Katse Reservoir**  
 Indicating the comparison of the Releases with the Paray Hydrometric Station and Weir data in MCM



### 1.3 Chronology of Events of the ‘Muela Dam

The volume of water released downstream of the ‘Muela Reservoir into the Hololo River from April to December 2002 amounts to 3.979 MCM and converts to an average flow of 0.17 m<sup>3</sup>/s. This amount, which is equivalent to an estimated Nqoe catchment MAR, was released through the compensation pipe. (The LLO was not used at ‘Muela during the period under consideration. There was no spill flow either).

### 1.4 Flow Releases from ‘Muela Dam

Table 3 below gives the monthly volumes of water released downstream of ‘Muela Dam from April 2002 to December 2002.

**TABLE 3: Monthly Flow Releases from ‘Muela Dam**

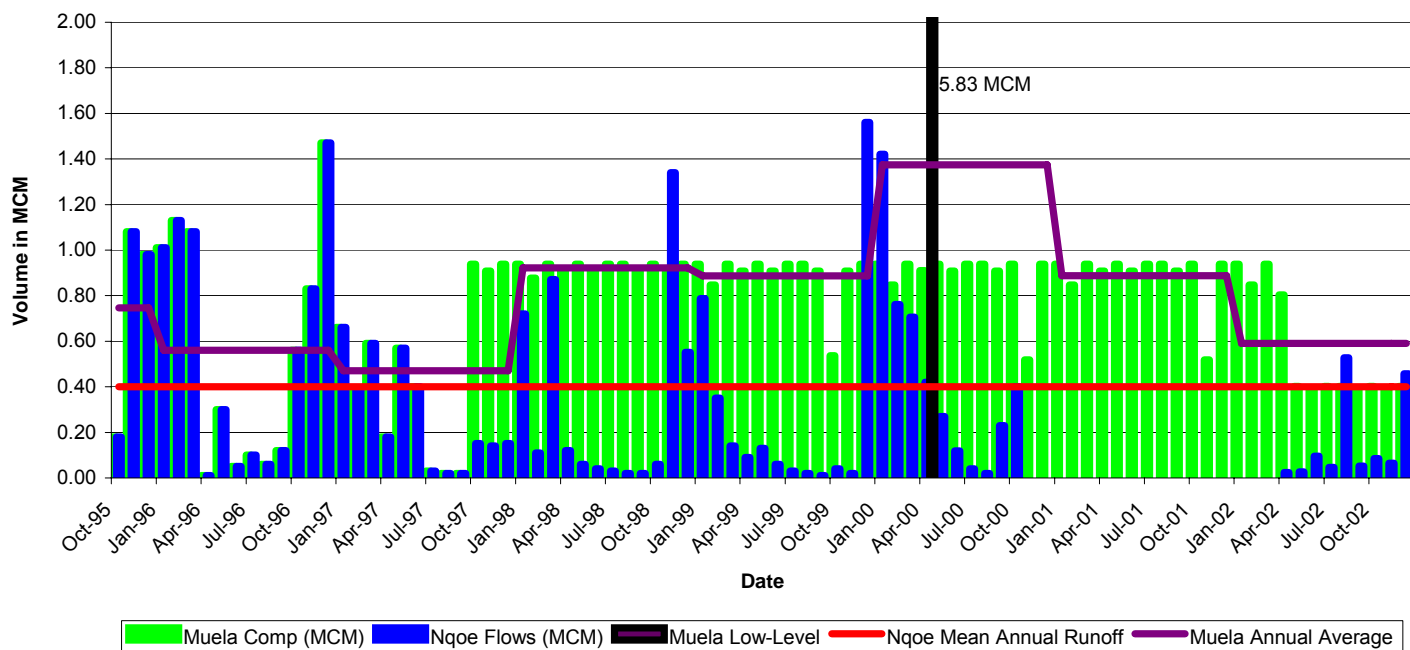
Months Since April 2002	Low – level Outlet (Radial Gates) Volume in Cubic Metres	Compensation Volume in Cubic Metres	Spillway Volume in Cubic Metres	Monthly total in Million Cubic Metres (MCM)	Nqoe Hydrometric Station Flows in Cubic Metres (m <sup>3</sup> )
Apr-02	-	803,520.00	-	0.80	23,846.40
May-02	-	401,760.00	-	0.40	25,833.60
Jun-02	-	388,800.00	-	0.39	94,953.60
Jul-02	-	401,760.00	-	0.40	46,396.80
Aug-02	-	401,760.00	-	0.40	526,780.80
Sep-02	-	388,800.00	-	0.39	51,667.20
Oct-02	-	401,760.00	-	0.40	84,931.20
Nov-02	-	388,800.00	-	0.39	64,281.60
Dec-02	-	401,760.00	-	0.40	457,228.80
	-	3,978,720.00	-	3.979	1,375,920.00
<b>Volume in MCM</b>	-	<b>3.979</b>	-	<b>3.979</b>	<b>1.376</b>
<b>Total water released downstream of ‘Muela Dam</b>				<b>3.979</b>	



**Figure 6: 'Muela Dam Releases from the Compensation Pipe and Mean Annual Runoff (MAR) of Nqoe River**

Figure 6 shows the flows from the 'Muela Dam outlets as compared with those from the Nqoe River. The annual averages of these two flows are also shown on this figure. It is observed that the 'Muela Dam outflows are consistently higher than the average Nqoe flows. It is however seen that the flows shown on the figure converge to the mean annual flow for Nqoe River during the last nine (9) months.

**FIGURE 6- Muela Dam Releases from compensation pipe and Nqoe Mean Annual Runoff (MAR)**  
 ( Compensation vs Nqoe MAR)



## 1.5 Chronology of Events of Matsoku Diversion Weir

No records have been collected from the Matsoku weir due to the difficulties experienced. A snag list was prepared for the necessary corrective measures to be taken for well functioning of the weir. The flows of Matsoku river hydrometric station downstream of the weir at Ha Seshote are therefore used and transferred to the Matsoku weir by using the weighting factor of the catchment areas at the hydrometric station at Ha Seshote and at the Matsoku weir. It seems that the total flow downstream of the Matsoku Weir and Tunnel for the period April 2002 to December 2002 is 38.413 MCM, which converts to 1.62 m<sup>3</sup>/s. This amount is consistently higher than the average flow of 0.65 m<sup>3</sup>/s, which is the flow that the weir has to release downstream whilst transferring excess water into Katse Reservoir. This is in accordance with the designed operational procedures of the Matsoku Diversion Weir.

The Matsoku River Hydrometric station at Ha Seshote was used to evaluate the performance of the Matsoku Weir. This station recorded the volume amounting to 42.526 MCM (1.79 m<sup>3</sup>/s) for the same period.

## 1.6 Flow Releases from Matsoku Diversion Weir:

The Table 4 below shows the Matsoku Weir and Tunnel estimated flows against the Matsoku River @ Seshote Hydrometric Station for the period April 2002 to December 2002.

**Table 4: Estimated Monthly Flow Releases from Matsoku Weir.**

Months Since April 2002	Matsoku Weir Compensation Volume in Cubic Metres	Spillway Volume in Cubic Metres	Monthly total in Million Cubic Metres (MCM)	Matsoku Hydrometric Station Flows
<b>Apr-02</b>	1,153,910	-	1,153,910	1,341,878
<b>May-02</b>	1,957,509	-	1,957,509	2,276,381
<b>Jun-02</b>	2,710,139	-	2,710,139	3,151,613
<b>Jul-02</b>	1,988,639	-	1,988,639	2,312,582
<b>Aug-02</b>	13,160,265	-	13,160,265	15,304,032
<b>Sep-02</b>	5,127,696	-	5,127,696	5,962,982
<b>Oct-02</b>	2,475,657	-	2,475,657	2,878,934
<b>Nov-02</b>	2,763,184	-	2,763,184	3,213,302
<b>Dec-02</b>	7,075,728	-	7,075,728	6,084,570
	38,412,730	-	38,412,730	42,526,275
<b>Volume in MCM</b>	<b>38.413</b>	<b>-</b>	<b>38.413</b>	<b>42.526</b>
<b>Total water released downstream of Matsoku Weir</b>				<b>38.413</b>

## 1.7 Chronology of Events of Mohale Dam

In accordance with the construction contract requirements, releases to the riverbed downstream were maintained throughout the initial stages of impounding at or above 0.3 cumecs as construction allowed.

At this stage, the measuring weir just downstream is not available. All the quoted releases are therefore from uncalibrated valve openings or field estimates/observations for now.

Impoundment of Mohale Dam commenced on 1<sup>st</sup> November 2002 when the stoplogs were lowered in diversion tunnel No. 2. Downstream discharge of 300 litres/s then commenced via valves in the stoplogs.

Following the reservoir level rising through 1985.0 masl on 8-Dec-02, after press releases, radio announcements, and visits to downstream residents, the LLO was opened up to 10% opening on 16-Dec-02 with the expectation of releasing 6.0 cumecs for some days. In the event, the valve-opening indicator seemed to be misaligned and release was limited to about 3.5 cumecs. Temporary power supply problems hampered operation of the valve – the permanent supply will not be fully complete until April – and prudence dictated that the valve be closed on 20-Dec-02 through Christmas, and the maximum release possible using the bypass between LLO and the compensation pipe work was left running.

From impounding on 1-November-02 until the end of the month 0.80 MCM was released. Up to 16-Dec-02 a further 0.44 MCM was released thus an average of 0.30 cumecs. Thereafter to year's end a further 2.32 MCM, an average of 0.44 cumecs, was released. At year's end, stored volume was 85.03 MCM while a total of 3.43 MCM an average of 0.65 cumecs had been released. Instructions to operators are that average releases from 16-Dec-02 are to be 2.45 cumecs at the dam. The arrangements are being done to make up (i.e. good) for the existing temporary deficit that has been caused by also considering the need to construct the measuring weir just downstream of the dam. This activity had to await the commencement of impounding.

The average flow at Marakabei weir for the period November and December 2002 was 1.71 cumecs.

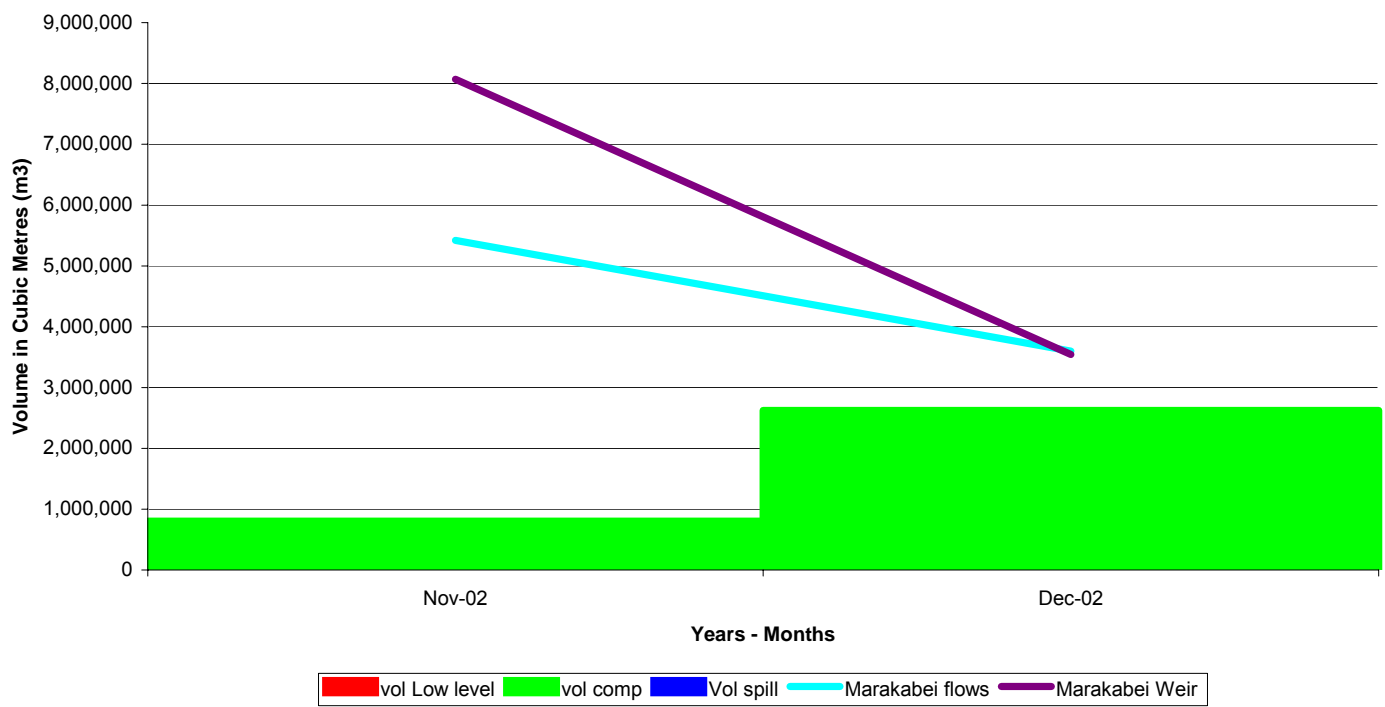
### 1.8 Flow Releases from Mohale Dam

The Table 5 below shows the Mohale Dam flows against the flow records on Senqunyane River @ Hydrometric Station and the weir for the period November to December 2002.

**Table 5: Flow Monthly Releases from Mohale Dam**

Months Since November 2002	Mohale Dam Compensation Volume in Cubic Metres (m <sup>3</sup> )	Spillway Volume in Cubic Metres	Monthly total in Million Cubic Metres (MCM)	Low – level Outlet Volume in Cubic Metres (m <sup>3</sup> )	Marakabei Hydrometric station flows in Cubic Metres (m <sup>3</sup> )	Marakabei Weir Station Flows in Cubic Metres (m <sup>3</sup> )
Nov-02	803.520	0.00	0.804	0.00	5,422,982	8,067,341
Dec-02	2,623,104	0.00	2,623	0.00	3,599,770	3,544,474
	3,426,624	0.00	3..427	0.00	9,022,752	11,611,814.40
<b>Volume in MCM</b>	<b>3.427</b>	<b>0.00</b>	<b>3.427</b>	<b>0.00</b>	<b>9,023</b>	<b>11,612</b>
<b>Total water released downstream of Mohale Dam</b>				<b>3.427</b>		

**FIGURE 7: Mohale Dam Releases since impoundment up to 31st December 2002**



## 2.0 CONCLUSIONS

There have been various discharges downstream of the Katse and 'Muela Dams. The flow through the compensation pipe at Katse has consistently been above the required Treaty guaranteed minimum flow of 500 litres per second.

The flow release of  $0.75 \text{ m}^3/\text{s} \pm 10\%$  variation from the Dam had been implemented since the 25<sup>th</sup> April 2002 and the Hydrometric station downstream of the Katse Dam, about 1Km from the dam wall, to monitor all the releases has been rehabilitated. It is therefore awaiting the development of the rating equations for the calculations of the flow rates from the Dam.

The flow downstream of the 'Muela Dam has also been consistently higher than the annual average inflow from the Nqoe River. The compensation valve at Muela is now set to release the mean annual runoff of Nqoe River.

There is no recorded information on the flows released downstream of the Matsoku Weir. The Hydrometric Station flows of Matsoku River at Ha Seshote have been used to estimate the flows that have been released downstream of Matsoku weir whilst transferring excess water into the Katse reservoir. . It is thus deduced that its performance has consistently satisfied the design flows of  $0.65 \text{ m}^3/\text{s}$  for the Diversion Weir and Tunnel on Matsoku River.

Mohale impoundment started on the 1<sup>st</sup> November 2002 with an average of release of 0.30 cumecs (i.e. 300ℓ/sec) up to the 18<sup>th</sup> December 2002. From the 19<sup>th</sup> December an average 1.30 cumecs was released till the end of December 2002.



### **3.0 RECOMMENDATIONS**

It is being recommended that the process of addressing the snag list of the Matsoku Diversion Weir and Tunnel must be speeded up (by Engineering and Consultants/Contractors) for the records to be obtained and Matsoku Weir to function as per its design with appropriate quantities of water being measured and known.

The Project Authorities have made a decision that this report must be issued every six (6) months. While this decision is being observed, it is therefore recommended that the production of the report should also be done on the basis of the Hydrological year to enable the analysis to be done with the records from other Hydrometric stations for hydrological publications.