

# LESOTHO HIGHLANDS DEVELOPMENT AUTHORITY

## ANNUAL FLOW RELEASES INSTREAM FLOW REQUIREMENT (IFR) IMPLEMENTATION AND MONITORING

*(October 2003 to September 2004)*



TOWER ON MALIBAMATSO RIVER @ KAO

REPORT N0.5

JANUARY 2006

**STRATEGIC AND CORPORATE SERVICES DIVISION  
MONITORING AND EVALUATION BRANCH**

Aquatic Systems Section  
HYDROLOGY

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## EXECUTIVE SUMMARY

This Report: “Annual Flow Releases for IFR Policy Implementation and Monitoring – January 2006” provides information on the operations and monitoring of the Lesotho Highlands Water Project (LHWP) structures regarding flow releases for Instream Flow Requirements downstream of the Katse Dam, the Mohale Dam, the ‘Muela Dam and the Matsoku Diversion Weir and Tunnel for the period October 2003 to September 2004.

The actual total amount of **47.67** MCM was released from the Katse Dam. The target Dam release, as specified in the IFR Policy, amounts to **34.55** MCM for low flows, **1.5** MCM for freshets and **31.50** MCM for within – year floods and thus the total flow releases of **47.67** MCM were **19.88** MCM (**29.4%**) lower than the total target release of **67.55** MCM for the entire period, October 2003 to September 2004. The target releases were based on the calculated quantities required to supplement the Khohlontšo inflows to achieve the prescribed flow requirements at IFR site 2.

The volume recorded at the Katse Bridge Hydrometric Station on IFR river reach 2 downstream of katse Dam amounted to **63.65** MCM whilst the target IFR volume for IFR site 2 stands at **91.41** MCM. This gives a **30.4%** deficit at the Hydrometric Station and does not include the unrecorded and hence unknown contribution from the Khohlontšo tributary.

There was no spillage experienced from the Katse Dam for the period reported on.

The total amount of **37.56** MCM was released from the Mohale Dam through the operation of a 500 mm diameter Sleeve Valve and a 200 mm diameter Sleeve Valve. The target Dam release as specified in the IFR Policy amounted to **19.56** MCM for low flows and **7.80** MCM for within – year flood releases and thus the targeted total Dam release stands at **27.36** MCM for

the period October 2003 to September 2004. The releases from the Dam exceeded this requirement by **10.20 MCM (27.3%)**. However, a deficit was continuously accumulating in IFR site 7 flows due to less than expected contributions from the intervening catchment.

The volume recorded at IFR site 7 amounted to **49.31 MCM** whilst the target IFR flow volume stands at **70.12 MCM**. This therefore indicates that the total deficit experienced at IFR site 7 for the period October 2003 to September 2004 stands at **20.81 MCM (29.7%)**.

There was no spillage experienced from the Mohale Dam. The Dam is still on its impoundment phase.

'Muela Dam released **4.74 MCM** which is the long term Mean Annual Runoff of the Nqoe River as had been derived from the upstream Hydrometric Station – Nqoe River at 'Muela. No spill occurred at 'Muela Dam.

Downstream releases are estimated as **14.79 MCM** from the Matsoku Diversion Weir and Tunnel. The estimations are based on the downstream Hydrometric Station (Matsoku River at Ha – Seshote) records and on the fact that the design operation of the Weir demands that flows below and up to **0.6 m<sup>3</sup>/s** be released downstream prior to any transfers into the Katse Dam. The volume of **16.00 MCM** is the estimated transfer into the Katse Dam. No spill was experienced.

The tables and figures indicating all the downstream releases and river flows are included in this report for clarity, good understanding and timely reference.

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## FOREWORD

This Report is the fifth publication of the “Flow Releases Downstream of the LHWP Structures” report. It is, however, renamed the “Annual Flow Releases for IFR Policy Implementation and monitoring” due to the need to publish the Annual IFR report that details out all the efforts taken towards implementing the requirements of the IFR Policy and Procedures and thus monitoring the compliance of the releases to the predetermined flow regimes on an annual basis. It is important to note that the information that was provided in the Flow Releases Downstream of LHWP structures report is the same information that is required for the Annual Flow Releases for IFR Policy Implementation and Monitoring report; hence these two reports are now being combined.

This report captures activities and tasks done from October 2003 to September 2004 for all the Dam Structures namely the Katse Dam, the Mohale Dam, the ‘Muela Dam and the Matsoku Diversion Weir and Tunnel.

It is also important to note that some of the information regarding downstream flow releases and their compliance to the Instream Flow Requirement (IFR) Policy and Procedures is now being published monthly since the beginning of October 2003. These monthly reports are then consolidated at the end of the Hydrological year for the production of the Annual Flow Releases for IFR Policy Implementation and Monitoring Report to review the overall performance of the system.

The IFR Policy was approved on the 13<sup>th</sup> December 2002 and the associated IFR Procedures were approved later in July 2003. The full implementation of the IFR Policy and Procedures regarding flow releases from Mohale Dam, proper recording of flows and monthly



reporting on the performance of the IFR sites and the IFR Policy was effected from the 1<sup>st</sup> August 2003 ; before then the Washington DC agreement was in force for impounding and filling Mohale Dam. The proper implementation of the IFR Procedures was not effected for the Katse Dam until the approval of the IFR Procedures themselves since monthly release schedules for low flow and flood releases in different hydrological years had not been issued (as the Procedures had not been approved), however, the IFR Policy (after its approval in December 2002) was applied to the extent that annual IFR release targets under the IFR Policy were met whilst the minimum rate of flow required by the LHWP Treaty also continued to be observed.

## **INTRODUCTION**

The IFR Policy was approved on the 13<sup>th</sup> December 2002, and the associated IFR Procedures were approved later in July 2003. The Policy stipulates the amounts of water that must be released from Dam structures to sustain the environment, aquatic lives and social activities downstream. The compliance of the releases to the required IFR Policy amounts is then monitored and this report provides the recorded flow volumes, in Million Cubic Metres (MCM), and the required IFR flows released downstream of the existing and operating LHWP structures for the period October 2003 to September 2004 for the Katse Dam, the Mohale Dam, the 'Muela Dam and the Matsoku Diversion Weir and Tunnel.

A surveying exercise was carried out from the 19<sup>th</sup> to the 20<sup>th</sup> July 2004 at IFR site 2 reach, see figures 1 and 2. This exercise was meant to identify and survey the Cross – Sections that the IFR Consultants used during the IFR studies (LHDA Contract 648 and LHDA Contract 678). These Cross – Sections should serve as the baseline information for the monitoring of the IFR site in respect of the Discharge carrying capacity of the Malibamatšo River system at IFR site 2 after the construction and operation of the Katse Dam. Possible changes from erosion and deposition of sediments within and along the IFR reach will be reflected in the Hydraulic characteristics including depth and width of flow.

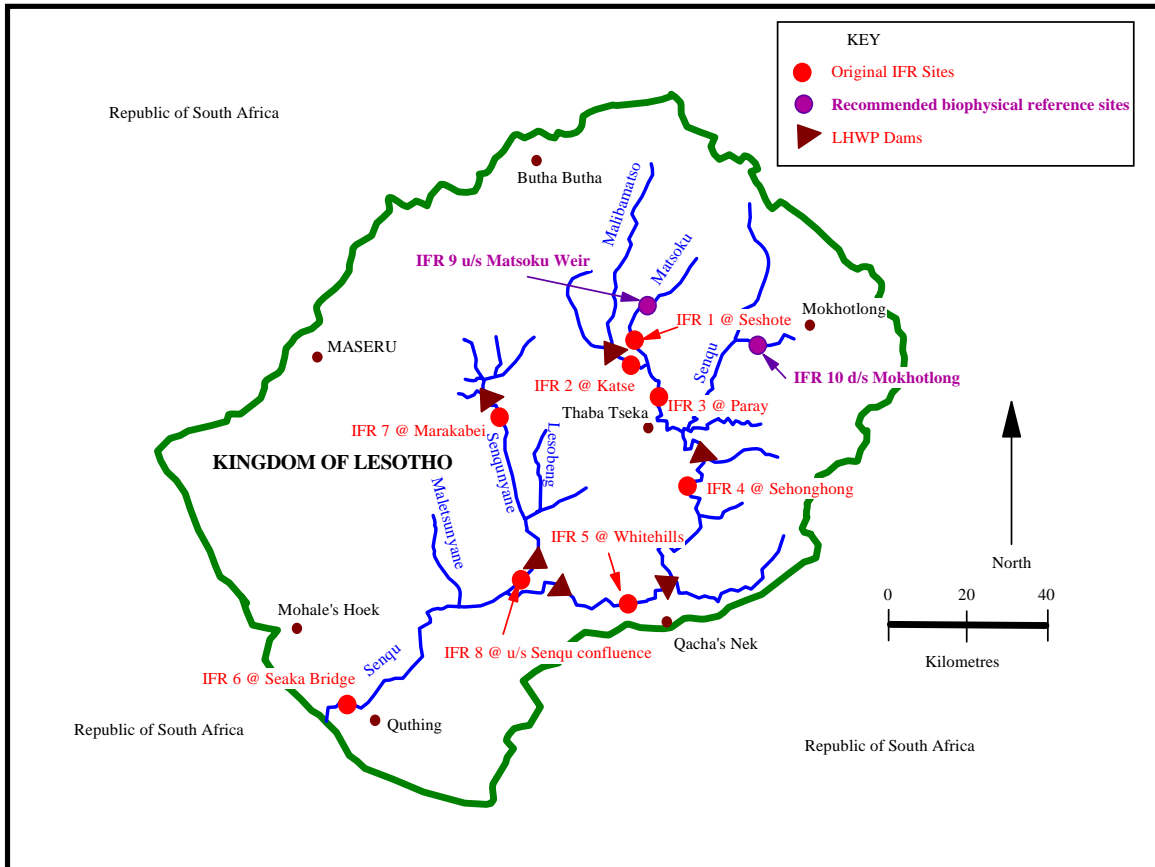
All the IFR sites are clearly marked on Figure 1, which shows the major affected river systems within the Highlands of Lesotho. Figure 2 shows the Katse Dam, the Downstream Hydrometric Station (Katse Bridge), the Khohlontšo Stream and the IFR site 2 reach. The Hydrometric Station is situated 1.06 Km downstream of the Katse Dam wall and there is no flow measuring station at IFR site 2. The main flow contributing stream to the Malibamatšo River, the Khohlontšo Stream is situated 2 Km downstream of the Katse Dam wall and 1 Km downstream of the Flow Measuring station, the Katse Bridge Hydrometric Station hence there are no flow records available for this stream and for IFR site 2. The IFR site 2 reach is located 3.06 Km downstream of the Katse Dam wall. Figure 3 gives the locations along the Senqunyane River where IFR site 7 is situated 28 Km downstream of the Mohale Dam wall.

Two (2) out of the scheduled five (5) within – year floods for the current Hydrological year 2003/2004 were released from the Katse Dam. The flood magnitude of 31 m<sup>3</sup>/s was released from the 30<sup>th</sup> April to the 2<sup>nd</sup> May 2004. The average flood magnitude of 25.39 m<sup>3</sup>/s was released for two (2) days from the 18<sup>th</sup> to the 20<sup>th</sup> August 2004 from the Katse Dam and only one (1) of the scheduled two (2) within – year floods was released from the Mohale Dam. The flood magnitude of 15 m<sup>3</sup>/s was released from the 25<sup>th</sup> to the 27<sup>th</sup> August 2004 from the Mohale Dam. A scheduled freshet was not released from Katse Dam in November 2003, nor was a scheduled flood released in November 2003 and January 2004 although the April/may flood release was larger to compensate, and the scheduled February flood release from Mohale was not made.

This report provides the results obtained in all these activities.

**Figure 1: Hydrological Map showing Location of the original IFR sites and reference sites**

- IFR Site 1\* Matsoku near Seshote
- IFR Site 2\* Malibamatšo 3 km downstream from Katse road bridge
- IFR Site 3\* Malibamatšo at Paray
- IFR Site 4 Senqu at Sehong-hong
- IFR Site 5 Senqu at Whitehills



- IFR Site 6 Senqu at Seaka
- IFR Site 7\* Senqunyane at Marakabei
- IFR Site 8\* Senqunyane upstream of the Senqu confluence.

Figure 2: The Katse Dam and the IFR site 2 reach

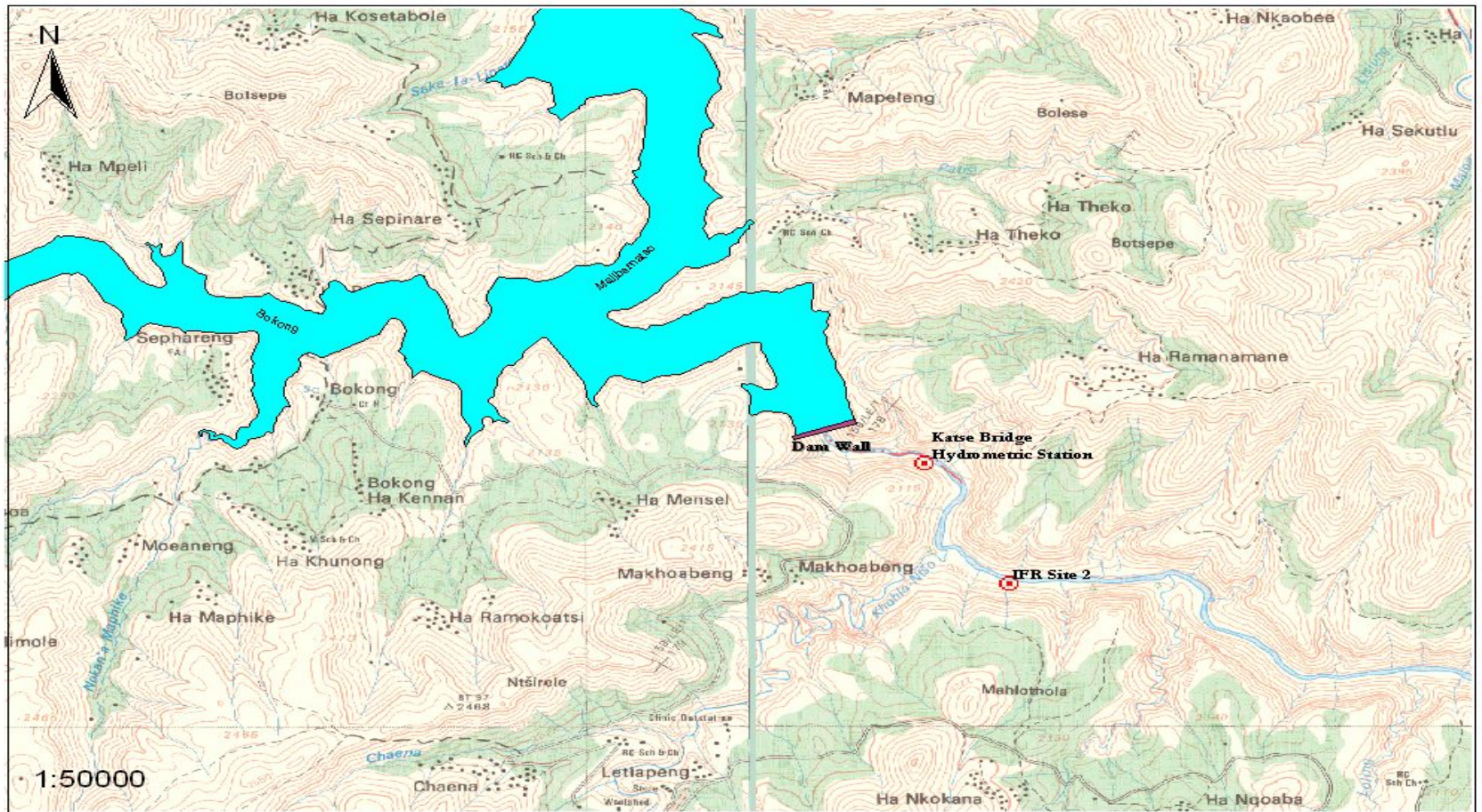
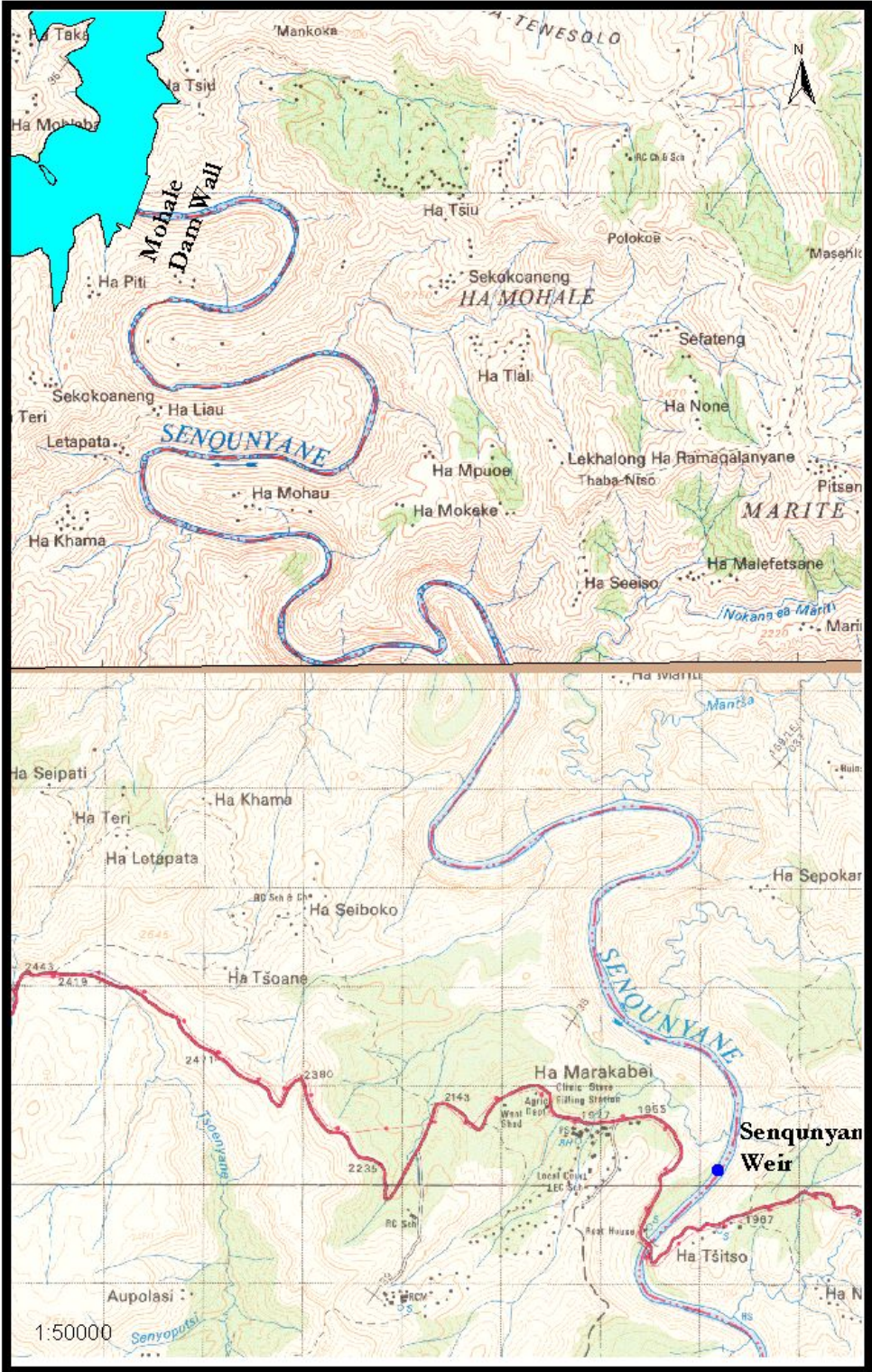


Figure 3: The Mohale Dam and the IFR site 7 reach



## 1. KATSE DAM

The target 2003/2004 Hydrological Year Class for the Katse Dam was slightly above an Average Hydrological Year<sup>1</sup> with the target of **67.55** MCM to be released from the dam and **91.41** MCM having flowed pass the IFR site 2 downstream of the Katse Bridge Hydrometric station. Table 1 on the next page provides the volumes of water releases as stipulated in the IFR Policy and Procedures and the actual released amounts downstream of the Katse Dam and at the Katse Bridge hydrometric station just upstream of IFR site 2, since October 2003 to September 2004. It also provides the overall total at the end of the period.

There was a flood release of 387 m<sup>3</sup>/s for half an hour on the 9<sup>th</sup> October 2003 as an authorized action to enable the Cape Town Productions Company to take photographs from the Katse Dam for its advertisements. The total volume released for that activity was approximately 0.7 MCM.

The flood magnitude of 2.68 MCM was released in April 2004 and the other part amounting to 5.36 MCM proceeded into May 2004. Thus a total of 8.04 MCM was released as a scheduled within – year flood for the month of April 2004.

Another flood with the magnitude of 4.43 MCM was released as a scheduled within – year flood for August 2004. No spill was experienced for the entire Hydrological Year.

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<sup>1</sup> In contrast to the widespread drought conditions in southern Africa.

**Table 1:**

**Monthly Flow Releases and the Target IFR flows from the Katse Dam**

Month	Inflow MCM/ Hydrological Year classification	Target Dam Releases* MCM				Actual Dam Releases** MCM			IFR Site 2 Target Volume MCM	Katse Bridge Hydrometric Station **Actual Volume MCM	IFR Site 3 Actual Volume MCM
		Floods	Freshets	Low Flow	Total	Floods	Freshets	Total			
Oct-03	7.44 /Plus 1	0.00	0.00	2.95	2.95	0.70	0.00	3.63	5.05	5.06	4.73
Nov-03	15.08 /Plus 1	9.00	1.50	3.11	13.60	0.00	0.00	3.01	16.80	4.57	5.84
Dec-03	20.72 /Plus 1	0.00	0.00	3.21	3.21	0.00	0.00	3.22	7.00	4.47	4.79
Jan-04	60.56 /Minus 1	4.50	0.00	3.20	7.70	0.00	0.00	2.74	10.56	4.39	8.71
Feb-04	82.88 /Minus 1	9.00	0.00	3.08	12.08	0.00	0.00	3.43	16.67	5.17	19.62
Mar-04	105.14 /Minus 1	0.00	0.00	2.95	2.95	0.00	0.00	2.95	5.78	5.00	16.64
Apr-04	54.29 /Average	4.50	0.00	3.24	7.74	2.68	0.00	5.94	9.90	4.93	12.79
May-04	7.11 /Average	0.00	0.00	3.21	3.21	5.36	0.00	8.60	3.98	10.18	10.58
Jun-04	5.24 /Average	0.00	0.00	2.85	2.85	0.00	0.00	2.84	3.44	4.76	8.35
Jul-04	0.78 /Average	0.00	0.00	2.41	2.41	0.00	0.00	2.42	2.69	3.84	5.12
Aug-04	1.17 /Average	4.50	0.00	2.14	6.64	4.43	0.00	6.58	6.75	7.65	7.37
Sep-04	1.03 /Average	0.00	0.00	2.20	2.20	0.00	0.00	2.31	2.79	3.63	7.97
<b>Total for Year</b>	<b>361.44</b>	<b>31.50</b>	<b>1.50</b>	<b>34.55</b>	<b>67.55</b>	<b>13.17</b>	<b>0.00</b>	<b>47.67</b>	<b>91.41</b>	<b>63.65</b>	<b>112.51</b>

\*\* There is no gauging station at IFR site 2, the designated point for demonstrating compliance with IFR Policy.



## **1.1. Summary of Flow Volumes Released from the Katse Dam**

### **1.1.1. Spillage**

Katse Dam did not spill since October 2003 to September 2004.

### **1.1.2. Discharges through the Low Level Outlet**

The volume released through the Low Level Outlet (LLO) amounts to **13.17** MCM for this period. This amount is attributed to the LLO discharges for within – year flood releases and filming advertisements as had been indicated earlier.

### **1.1.3. Dam Releases**

The actual total volume of water released from the Katse Dam Outlets is **47.67** MCM, which is 19.88 MCM (**29.4%**) lower than the targeted IFR release requirement of **67.55** MCM.

### **1.1.4. Recorded Flows at the Katse Bridge Hydrometric Station**

The total volume of water recorded at the Katse Bridge Hydrometric Station is **63.65** MCM. The LHDA decided to use the records of this flow recording station to give indications of the response of IFR site 2 reach to the Dam releases and the catchment contributions due to the absence of the recording station at IFR site 2 reach (see figure 2). The amount of recorded water at the Hydrometric Station is **27.76** MCM (**30.4%**) less than the stipulated IFR target flow at the IFR site 2 for the

considered period, October 2003 to September 2004 but does not include any contribution from the Khohlontšo tributary.

The above figures indicate that there is a deficit being experienced both in Dam releases and at the actual IFR site reach.

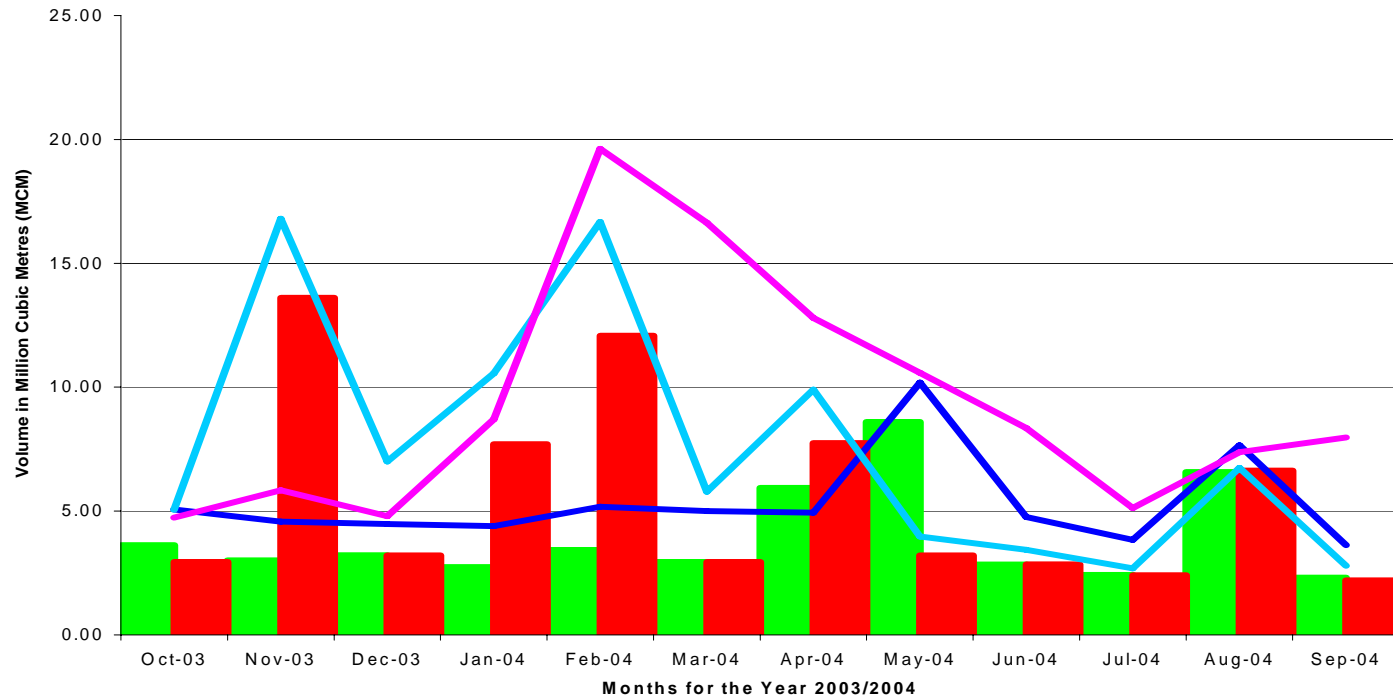
It must, however be noted that the Katse Bridge Hydrometric Station was rehabilitated to directly capture the releases from the Katse Dam, but it has been realized that this station is also capturing some of the incremental catchment flows. That is why the flows recorded at the Katse Bridge Hydrometric Station are higher than the releases from the Katse Dam and lower than the IFR site 2 reach target flows. This becomes more evident during high flows when Khohlontšo tributary contributes considerably higher flows to the IFR Site 2 reach. The Khohlontšo Tributary stream is located downstream of the Katse Bridge Hydrometric Station and its flow is therefore not measured. It is, hence not possible to accurately determine how much of the mentioned deficit of 30.4% would have been met by these unmeasured contributions to the flow at IFR site 2.

**Figure 4:**

**The Monthly Flow Releases and the target IFR releases from the Katse Dam.**

Figure 4 on the next page graphically presents the recorded Monthly Flow Releases from the Katse Dam, the recorded flows at the Hydrometric station on Malibamatšo River at Paray Weir IFR site 3 reach, the Hydrometric Station at Katse Bridge just downstream of the Katse Dam (labeled IFR Site 2 Reach) and upstream of IFR site 2 reach, and the target IFR releases at both the Katse Dam site and IFR site 2.

**FIGURE 4: Actual Versus IFR target Flow Releases From Katse Reservoir for the Hydrological Year 2003/2004**



- Actual Dam Site Releases MCM
- Target Dam Site Releases for IFR Requirements MCM
- Actual Recorded at IFR Site 2 Reach MCM
- IFR Site 2 Reach Target Flows MCM
- Actual Recorded at IFR Site 3 Reach (Malibamatso at Paray Weir) MCM

## 2. MOHALE DAM

The target 2003/2004 Hydrological Year Class for the Mohale Dam varied from Average to a Minus 1 Hydrological Year Class with **27.36** MCM to have been released from the dam site in order to achieve a target of **70.12** MCM flowing past IFR site 7. Table 2 below gives the volumes of water as stipulated in the IFR Policy and Procedures and the actual released amounts downstream of the Mohale Dam and actual recorded flows at IFR site 7. It also provides the overall total at the end of the period October 2003 to September 2004.

**Table 2:**

### **Monthly Flow Releases and the target IFR Flows from Mohale Dam**

Month	Inflows to Mohale/ Hydrological Year classification	Target Dam Releases MCM			Actual Dam Releases MCM		IFR Site 7 Target Volume MCM	IFR Site 7 Actual Volume MCM
		Floods	Low Flows	Total	Floods	Total		
Oct-03	/Average	0.00	2.00	2.00	0.00	1.86	6.88	2.64
Nov-03	/Average	0.00	3.11	3.11	0.00	2.84	11.09	3.79
Dec-03	/Average	0.00	1.47	1.47	0.00	1.65	4.98	2.28
Jan-04	/Minus 1	0.00	1.61	1.61	0.00	0.91	5.73	2.42
Feb-04	/Minus 1	3.90	2.54	6.44	0.00	2.67	12.67	4.88
Mar-04	/Minus 1	0.00	2.54	2.54	0.00	3.52	7.62	7.58
Apr-04	/Average	0.00	2.33	2.33	0.00	6.58	8.17	7.85
May-04	/Average	0.00	1.61	1.61	0.00	2.55	3.72	2.10
Jun-04	/Average	0.00	0.78	0.78	0.00	7.29	1.73	5.57
Jul-04	/Average	0.00	0.39	0.39	0.00	1.22	0.91	1.08
Aug-04	/Average	3.90	0.66	4.56	3.89	4.88	5.45	5.82
Sep-04	/Average	0.00	0.52	0.52	0.00	1.59	1.17	3.30
<b>Total</b>		<b>7.80</b>	<b>19.56</b>	<b>27.36</b>	<b>3.89</b>	<b>37.56</b>	<b>70.12</b>	<b>49.31</b>

The volume of water released downstream of the Mohale Dam into the Senqunyane River system from October 2003 to September 2004

amounts to **37.56** MCM. This amount is **10.20** MCM higher than the target IFR release of **27.36** MCM.

There was a scheduled flood release of 15 m<sup>3</sup>/s (**3.89** MCM) for the month of August 2003, and this was the only flood released as a scheduled flood for Mohale Dam during 2003/2004 Hydrological year. A scheduled flood in February 2004 was not released.

## **2.1. Summary of Flow Volumes Released from the Mohale Dam**

### **2.1.1. Spillage**

Mohale Dam has not yet experienced any spill since its impoundment to September 2004.

### **2.1.2. Discharges through the Low Level Outlet**

The volume released through the LLOs amounts to **3.89** MCM for this period. This amount is attributed to the LLO discharges for within year flood releases as had been indicated earlier.

### **2.1.3. Dam Releases**

The actual total volume of water released from the Mohale Dam Outlets is **37.56** MCM, which is **10.20** MCM (**27.2%**) higher than the targeted IFR release requirement.

### **2.1.4. Flows Recorded at IFR Site 7 Reach**

The total volume of water recorded at the IFR Site 7 Reach is **49.31** MCM. This amount of water release is **20.81** MCM (**29.7%**) less than

the stipulated IFR target flow at this site for the considered period, October 2003 to September 2004.

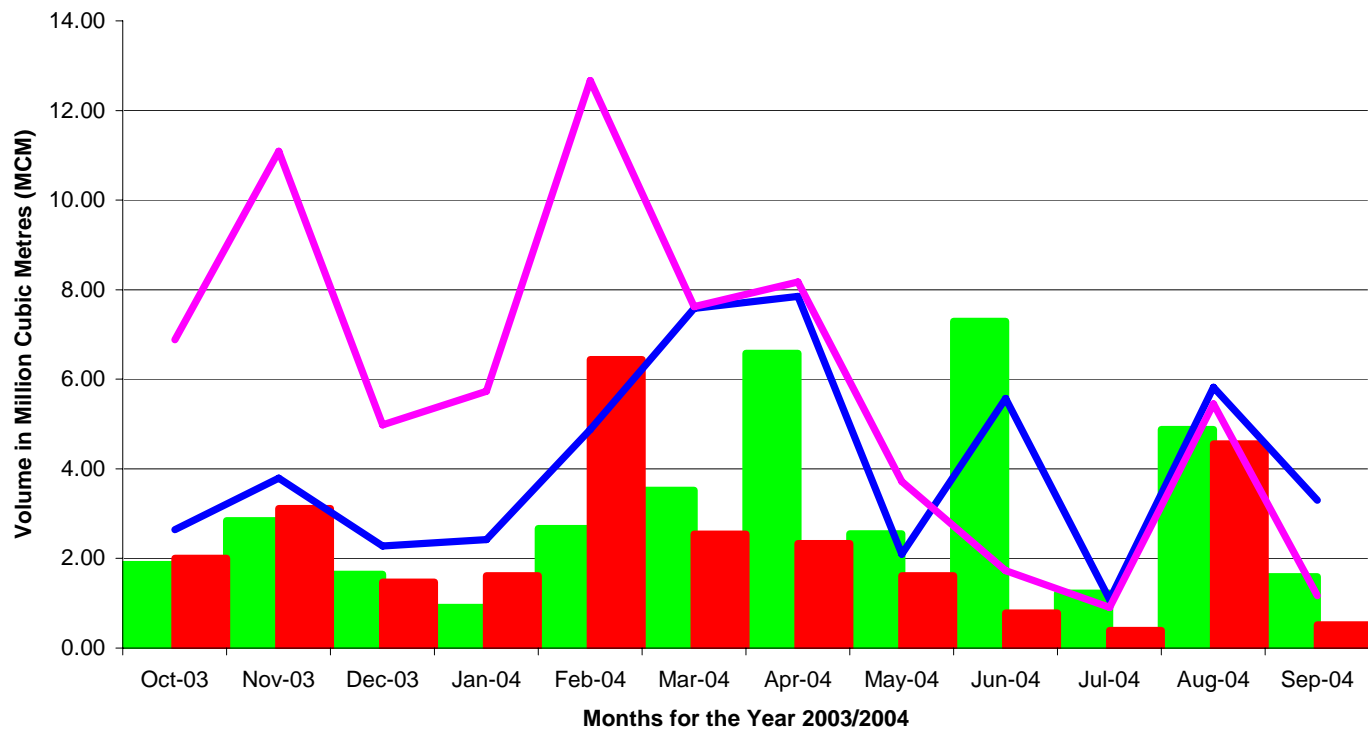
The above – recorded figures indicate that even with the over delivery of **27.2%** in dam releases there was still a deficit of **20.81 MCM (29.7%)** experienced at the IFR site 7 reach for the period October 2003 to September 2004. This was because inflows from the incremental catchment area were far less than had been assumed.

**Figure 5:**

**The Monthly Flow Releases and the target IFR releases from the Mohale Dam.**

Figure 5 presents the recorded Monthly Flow Releases from the Mohale Dam. It also shows the recorded flows from the Hydrometric station on Senqunyane River at Marakabei Weir, IFR site 7 reach and the target IFR releases at the Mohale Dam site and the IFR site 7 reach.

**FIGURE 5: Actual Versus IFR target Flow Releases From Mohale Reservoir for the Hydrological Year 2003/2004**



█ Actual Dam Site Releases MCM  
█ Target Dam Site Releases and IFR Policy Requirements MCM  
— Actual Recorded at IFR Site 7 Reach MCM  
— IFR Site 7 Reach Target Flows MCM

### 3. 'MUELA DAM

Table 3 below gives the monthly volumes of water released downstream of the 'Muela Dam from October 2003 to September 2004. It also provides the overall total at the end of the period.

**Table 3:**  
**Monthly Flow Releases from the 'Muela Dam**

Months Since October 2003 to September 2004	Actual Dam Site Releases	Target Dam Site Releases for IFR Requirements	Actual Recorded at Nqoe River Upstream of the 'Muela Dam	Actual Recorded at Hololo River downstream of the 'Muela Dam
	MCM	MCM	MCM	MCM
Oct-03	0.40	0.40	0.00	4.44
Nov-03	0.39	0.39	0.15	3.64
Dec-03	0.40	0.40	0.08	0.90
Jan-04	0.40	0.40	0.49	2.95
Feb-04	0.38	0.38	0.43	3.99
Mar-04	0.40	0.40	0.45	2.35
Apr-04	0.39	0.39	0.11	0.62
May-04	0.40	0.40	0.01	0.04
Jun-04	0.39	0.39	0.00	0.52
Jul-04	0.40	0.40	0.00	0.99
Aug-04	0.40	0.40	0.00	1.09
Sep-04	0.39	0.39	0.01	0.77
<b>Total for Year 2003/2004</b>	<b>4.74</b>	<b>4.74</b>	<b>1.73</b>	<b>22.30</b>

The volume of water released downstream of the 'Muela Dam into the Hololo River system from October 2003 to September 2004 amounts to **4.74** MCM. This amount is equivalent to the long-term Nqoe catchment Mean Annual Runoff (MAR). There is



no IFR requirements and stipulations for 'Muela Dam since the Nqoe River Flows are not considered to be part of the Treaty Flows, hence the Mean Annual Runoff is being released continuously from 'Muela Dam. The Low Level Outlet valve was not used at 'Muela during the period under consideration and there was also no spill flow experienced either.

### **3.1. Summary of Flow Volumes Released from the 'Muela Dam**

#### **3.1.1. Spillage**

'Muela Dam did not spill since October 2003 to September 2004.

#### **3.1.2. Discharges through the Low Level Outlet**

There was no volume released through the LLO.

#### **3.1.3. Dam Releases**

The actual total volume of water released from the 'Muela Dam Outlets is **4.74** MCM, which is of cause the target long term Mean Annual Runoff of the Nqoe River System ( $0.15 \text{ m}^3/\text{s}$ ).

#### **3.1.4. Flows Recorded at Hololo River Downstream of the 'Muela Dam**

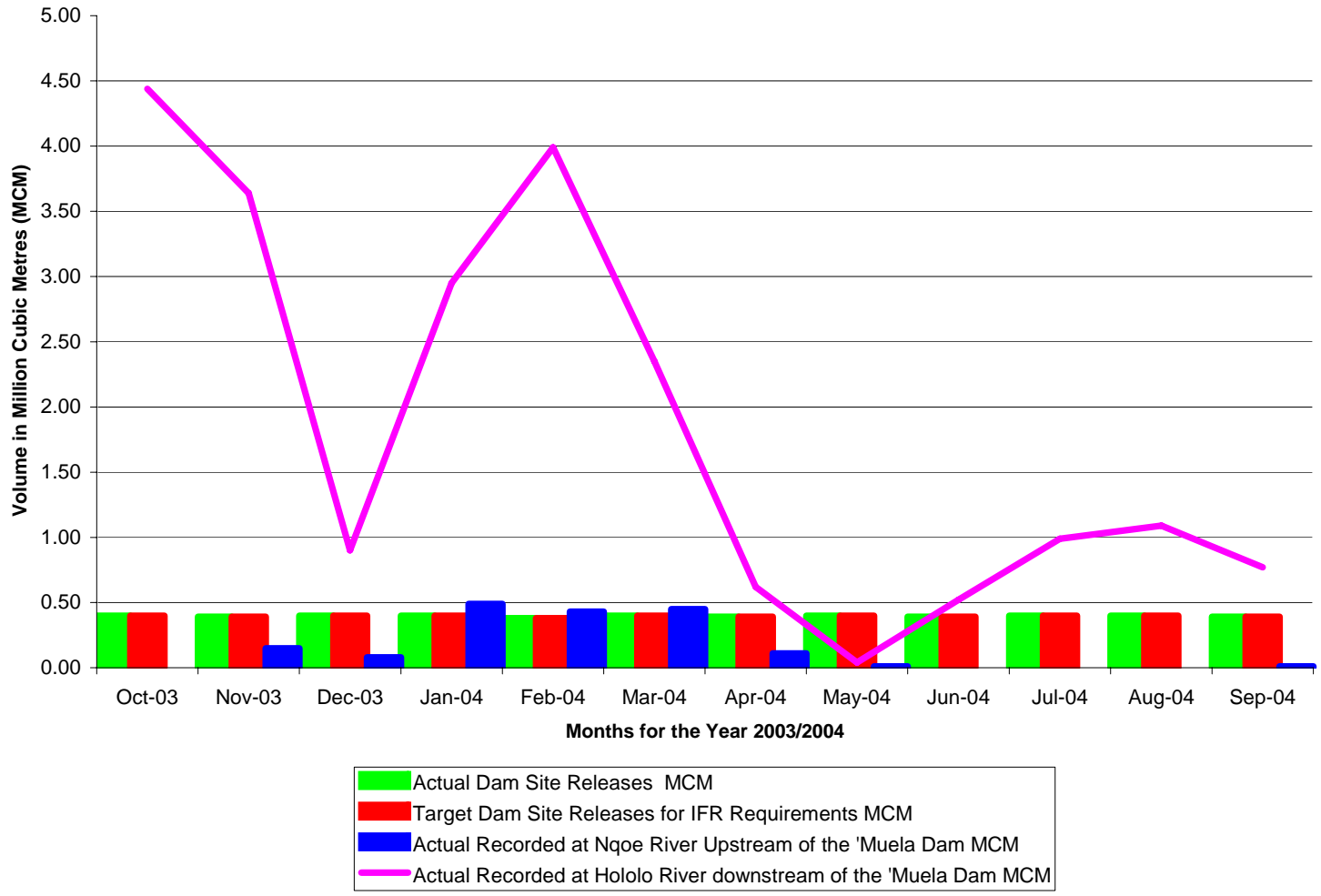
The total volume of water recorded at the Hololo River System is **22.30** MCM. This amount of water recorded at Hololo River System far exceeds the target flow released from the 'Muela Dam as it includes inflow from the larger Hololo river catchment.

**Figure 6:**

**The Monthly Flow Releases and the target IFR releases from the 'Muela Dam.**

Figure 6 on the next page shows the flows from the 'Muela Dam outlets as compared with those from the Nqoe River Hydrometric Station. The Hololo River flows are also shown on this figure. It is observed that the Nqoe Inflows are far less than the 'Muela Dam Outflows. The Nqoe flows decreased in magnitude to zero (0) MCM for the month of October 2003, June, July and August 2004. Thus the October 2003 to September 2004 period was a severely dry year for the Nqoe catchment area.

**FIGURE 6: Actual versus target Flow Releases from the 'Muela Dam since October 2003 to September 2004**



#### 4. MATSOKU DIVERSION WEIR AND TUNNEL

Table 4 below shows the Matsoku Diversion Weir and Tunnel estimated flows against the Matsoku River at Ha – Seshote Hydrometric Station for the period October 2003 to September 2004.

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

Months Since October 2003 to September 2004	Actual Matsoku Weir Releases	Target Matsoku Weir Releases for IFR Requirements	Estimated Transfers to Katse Dam	Actual Recorded at Matsoku River downstream of the Diversion Weir and Tunnel	Estimated Matsoku Weir Inflows
	MCM	MCM	MCM	MCM	MCM
Oct-03	0.48	1.61	0.00	0.53	0.48
Nov-03	1.29	1.56	1.26	2.83	2.55
Dec-03	1.41	1.61	0.38	1.69	1.54
Jan-04	1.37	1.61	3.17	5.04	4.53
Feb-04	1.50	1.50	4.19	6.32	5.69
Mar-04	1.61	1.61	2.97	5.09	4.58
Apr-04	1.56	1.56	2.43	4.42	3.98
May-04	1.36	1.61	0.15	1.67	1.51
Jun-04	0.79	1.56	0.00	0.88	0.79
Jul-04	1.09	1.61	0.00	1.21	1.09
Aug-04	0.94	1.61	0.14	1.20	1.08
Sep-04	1.39	1.56	1.31	3.00	2.70
<b>Total for Year 2003/2004</b>	<b>14.79</b>	<b>19.01</b>	<b>16.00</b>	<b>33.88</b>	<b>30.52</b>

The Matsoku Diversion Weir and Tunnel is actually a none storage facility and therefore there are no IFR requirements implied for this Weir, however, the targeted flow volume, if the flow rate of **0.6 m<sup>3</sup>/s** was constantly released downstream, amounts to **19.01 MCM** for the period October 2003 to September 2004.

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 **33.88 MCM** for the same period.

## **4.1. Summary of Flow Volumes Released from the Matsoku Diversion Weir and Tunnel**

### **4.1.1. Spillage**

Matsoku Diversion Weir and Tunnel did not spill since October 2003 to September 2004.

### **4.1.2. Discharges through the Tunnel Outlet to Katse Dam**

The estimated total volume of **16.00** MCM was transferred into Katse reservoir for the period since October 2003 to September 2004.

### **4.1.3. Estimated Matsoku Weir Releases**

The estimated total volume of water released from the Matsoku Diversion Weir and Tunnel Outlets is **14.79** MCM.

### **4.1.4. Flows Recorded at Matsoku River Downstream of the Diversion Weir and Tunnel**

The total volume of water recorded at the Matsoku River System is **33.88** MCM and the estimated Matsoku Diversion Weir and Tunnel Inflows as computed amounts to **30.52** MCM.

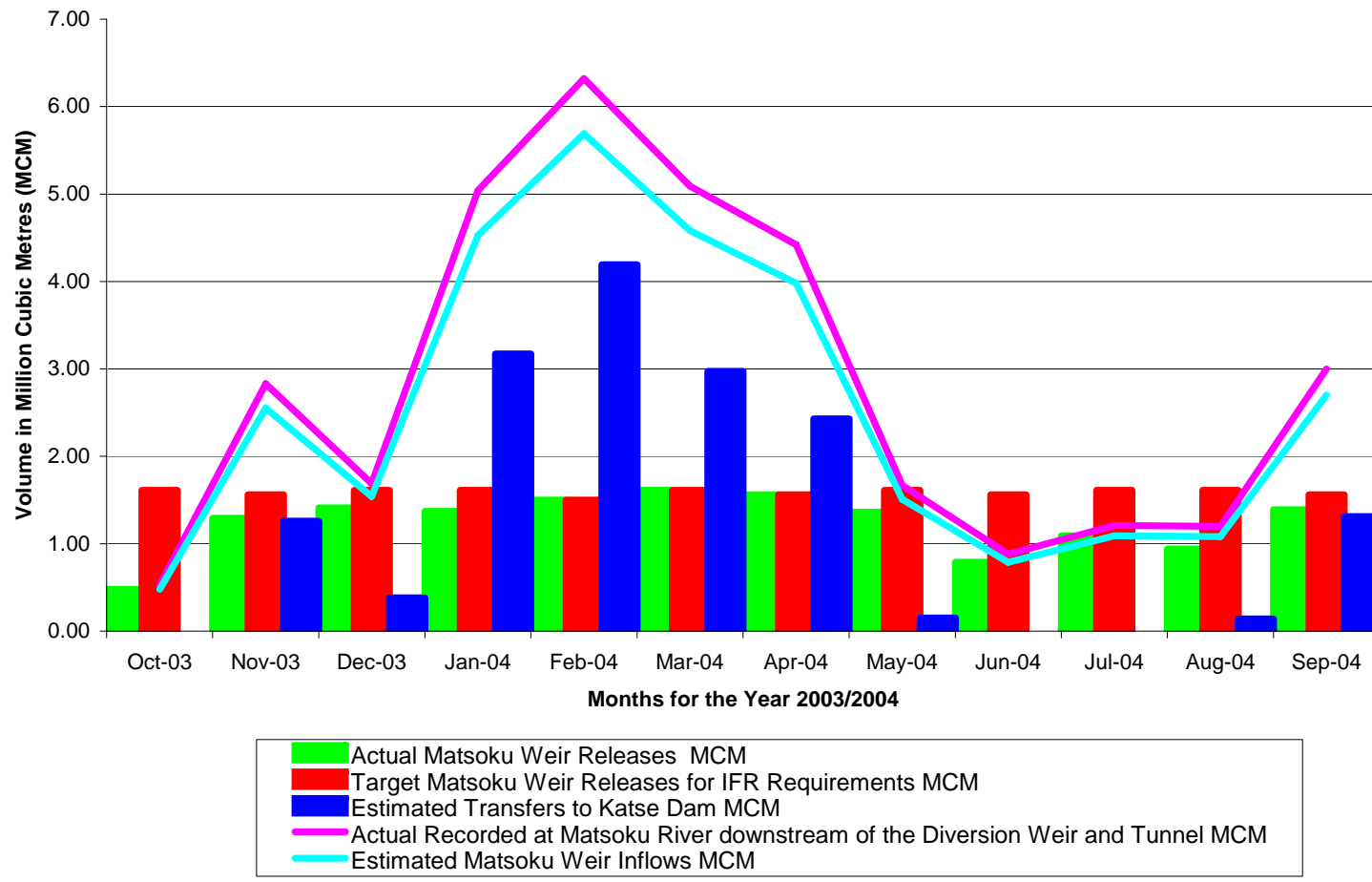
#### **Figure 7:**

**The Monthly Estimated Flow Releases and the target releases requirement from the Matsoku Diversion Weir and Tunnel.**

Figure 7 on the next page shows the estimated downstream flows from the Matsoku Diversion Weir and Tunnel as compared with the Targeted releases and the Transfers into the Katse Dam. The estimated Matsoku

Weir Inflow and the Matsoku Hydrometric Station at Ha – Seshote flows are also shown on this figure.

**FIGURE 7: Matsoku Diversion Weir and Tunnel Flow Estimates and Matsoku at Ha - Seshote actual Flows**



## 5. CONCLUSIONS

The actual total volume of **47.67** MCM was released from the Katse Dam from October 2003 to September 2004. The target flow release, as specified in the IFR Policy, amounts to **67.55** MCM for the entire period, October 2003 to September 2004. The Dam has under delivered by **29.4%**.

More importantly, the volume recorded at the downstream hydrometric station amounts to **63.65** MCM whilst the target IFR volume at IFR site 2 stands at **91.41** MCM. This gives a **30.4%** deficit. The deficit at IFR site 2 would be somewhat less as the contribution from the Khohlontšo tributary is not measured.

A total volume of **37.56** MCM was released from the Mohale Dam through the alternate operation of a 500 mm diameter Sleeve Valve and a 200 mm diameter Sleeve Valve. The target flow release as specified in the IFR Policy amounts **27.36** MCM from October 2003 to September 2004. The Dam has over delivered by **27.3%**.

However, the volume recorded at IFR site 7 amounts to **49.31** MCM and the target IFR volume stands at **70.12** MCM. This indicates that there is a deficit of **29.7%** experienced at IFR site 7 reach for the period October 2003 to September 2004.

Generally releases from both the Katse Dam and the Mohale Dam have been insufficient to meet the stipulated flow quantities at the downstream IFR compliance sites. In the case of Mohale, this is because the contributions from the intervening catchments were over estimated. Since flows at IFR site 2 cannot be measured, it is not possible to say with accuracy what the deficit is at that site. On the other hand the required within – year floods were not satisfactorily released from either dam.



The flow downstream of the 'Muela Dam has been far higher than the annual average Inflow from the Nqoe River for the period October 2003 to September 2004. The Compensation valve at 'Muela Dam is constantly set to release the long – term mean annual runoff of Nqoe River system, which is estimated to be **0.15** m<sup>3</sup>/s. There is no IFR implied for 'Muela Dam. The total volume released from the 'Muela Dam from October 2003 to September 2004 is **4.74** MCM.

The Hydrometric Station flows of Matsoku River at Ha Seshote have been used to estimate the Inflows into the Matsoku Weir and the Outflows that have been released downstream of Matsoku Weir whilst transferring excess water into the Katse reservoir. The volume of water transferred via the Diversion Tunnel into the Katse reservoir equates to **16.00** MCM whilst the volume of water released downstream equates to **14.79** MCM.

There were no flood marks identified at the IFR site 2 for the April flood release of **31** m<sup>3</sup>/s from the Katse Dam and nothing could be established of that flood (at the IFR site 2). However, the discharge of **37.06** m<sup>3</sup>/s had gone past the Katse Bridge Hydrometric Station during the time of release.

## **6. RECOMMENDATIONS**

It is recommended that Hydrometric Stations be constructed at IFR Sites so that the targeted flows at IFR Sites could be compared with the actual recorded flows at those sites. That is downstream of Matsoku Weir (IFR Site 1) and at IFR Site 2 downstream of the Katse Bridge Hydrometric Station and Khohlontšo tributary.

It is also recommended that the surveyed Cross – Sections, namely A2, B2 and C2 be used as the base – line data since the Specialist Report –

Volume 1: Hydraulics, November 1999 only gives the results obtained from the surveyed Cross - Sections and not the data from the surveyors.

It is also recommended that Surveys for sediment monitoring be carried out periodically at gauging station cross sections.

The IFR Policy required the issue of corrigenda to correct detailed provisions and the IFR Procedures will also require a revision to be issued to correct inaccuracies, to reflect changes, and to clarify provisions. That should be done in a timely manner.