



# **Modernization Strategy for Irrigation Management**

**in**

**ALMATTI LIFT SYSTEMS -KJBNL**

**KARNATAKA - INDIA**

**MASSLIS  
a MASSCOTE approach  
to  
Lift Irrigation Systems**

**[Draft version 25/06/08].**



## CURRENCY EQUIVALENTS

Currency Unit = Indian Rupee (Rs)  
US\$1.0 = Rs 45.34

## MEASURES AND EQUIVALENTS

1 meter	=	3.28 feet
1 ha	=	2.47 acres
1 km	=	0.620 miles
1 cubic meter (m <sup>3</sup> )	=	35.310 cubic feet
1 million acre foot (MAF)	=	1.234 Billion cubic meter (Bm <sup>3</sup> )
1 cubic feet per second (cusec)	=	28.5 litre per second (l/s) = 0.0285 cubic meter per second (m <sup>3</sup> /s)
TMC	=	Thousand Million Cubic Feet = 28.3 Million Cubic Meters
MCM	=	Million Cubic Meter

## ABBREVIATIONS AND ACRONYMS

NRLW	Water Service of the Land and Water Development Division of FAO
CA	Command Area
CCA	Culturable Command Area
CR	Cross regulator
DO	Direct outlet
FAO	Food and Agriculture Organization
FO	Farmer Organization
GCA	Gross Command Area
ITRC	Irrigation Training and Research Centre (California Polytechnic University)
KBJNL	Krishna Bhagya Jala Nigam Limited
LMA	Local Management Agency
MAF	Million Acre Feet
MASSCOTE	Mapping Systems and Services for Canal Operation Techniques
MASSLIS	Mapping System and Services for Lift Irrigation System
M&E	Monitoring and Evaluation
NCA	Net Command Area (irrigable)
O&M	Operations and Maintenance
OFWM	On-Farm Water Management
RAP	Rapid Appraisal Procedure
WUA	Water Users Association

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## Executive summary

A Masscote training workshop was organised for 50 engineers and managers from the Krishna Bhagya Jala Nigam Limited (KBJNL) focussing on ALMATTI Lift Irrigation Systems from 13<sup>th</sup> to 21<sup>st</sup> May 2008.

The Rapid Appraisal of Performance was carried out by 4 groups coached by FAO staff and other resources persons from Karnataka on ALBC – ARBC - Mulwad West and Mulwad East. It appears that productivity of land (620 \$/ha) and water (0.037 \$/m<sup>3</sup>) are significantly low compare to similar systems in the region, which might be related to the juvenile stage of the systems and the fact that irrigation is still under development. The internal indicators of Almatti systems are also quite low similarly, despite being recently built systems. Water level is not controlled at all and the system loses progressively control generating acute problems of sensitivity and deficit at tail-end. Discharge is not accurately measured at the station nor along the canal.

Capacity of the infrastructure for transport is not limited. Measurement capacity and water level control are deficient preventing from effective management. Volume pumped from running hours of the pumps is largely underestimated at ALBC. Perturbations are mainly related to the on and off functioning on the stations, to run-off and inaccuracy of management. Water accounting shows that irrigation at field level contribute to 40% of the supply while 24 % is provided by groundwater pumping and 36% by rainfall. In terms of outputs, evapotranspiration from irrigated crops amounts to only 17% of the total water inputs to the GCA, while some 65 % of the same are returning to the river and the Almatti reservoir. This shows clearly that water management improvement has a high potential within the command area, not so much to save water but to save energy: *Water is recycled not energy.*

The analysis of the lift stations shows that the cost of energy spent for irrigation, even at a bargain tariff of (0.8 Rs per KWh) is very high as compare to O&M. More detailed analysis of ALBC station shows that design of outlet is not optimum as some static head losses occur, similarly the running point seems to highly deviate form the optimum point for which pump are constructed generating significant reduction of efficiency. Overall efficiency of the ALBC is about 60% ( 56 to 63 % depending on the methodology used) this could be improved.

Operating costs are very high at moment some 6000 Rs per ha. Means to reduce that figure should be sought for by expanding irrigated areas and improving efficiency of water and energy management.

As usual service to users is by designed constrained; cropping is theoretically limited and imposed to users according to water availability. In practice there is high chance to see same evolution as those stated elsewhere and managers should anticipate a new type of service and allocation mechanisms more flexible, more reliable and more equitable. Various scenario for services provision have been investigated by participants, with various general conditions and tolerance associated to.

Water management strategy should be based on the concept of keeping as much as possible surface water (irrigation and precipitation) in the command area to minimize the energy inputs for groundwater pumping , backwater pumping and lifting at inlet.

## Introduction and Background

The Masscote application presented here has been initialized through a training workshop in Karnataka for engineers and managers from the Krishna Bhagya Jala Nigam Limited (KBJNL) focussing on ALMATTI irrigation systems from 13<sup>th</sup> to 21<sup>st</sup> May 2008. The contributions of the working group sessions at this workshop (RAP–MASSCOTE) have been largely included in this report. The MASSCOTE exercise has been further proceed by a team of KJBNL, comprising officers from KJBNL HQ as well as officers from the Almati project itself together with the supporting FAO team composed of Daniel Renault (NRLW-HQ) and PS Rao (FAO Delhi) as well as the Masscote resource staff from KNNL Mrs Shukumar, Murley, Kulkarny and Mohanar .

This document presents the status of the Masscote application development immediately after the workshop. It has several purposes:

- suggest some specific strategies to managers of the Alamatti system on how they should conceptualise the modernization of irrigation management;
- produce food for thought for decision-makers in Karnataka before engaging in investment plans, particularly on how to ensure that diagnosis and solutions are investigated properly in modernization projects;
- introduce the MASSCOTE and RAP exercises to a large audience through real-case application within the KJBNL one of the 3 Nigams of Karnataka
- develop a specific module of Masscote [MASSLIS] which is dedicated to lift irrigation system.

# 1. THE MASSCOTE/MASSLIS APPROACH

The generic methodology used in the study is called Mapping System and Services for Canal Operation Techniques (MASSCOTE). It has been developed by the Land and Water Division (NRLW) of FAO on the basis of its experience in modernizing irrigation management in Asia. MASSCOTE integrates/complements tools such as the rapid appraisal procedure (RAP) and Benchmarking to enable a complete sequence of diagnosis of external and internal performance indicators and the design of practical solutions for improved management and operation of the system.

MASSCOTE is a methodology aiming at the evaluation of current processes and performance of irrigation systems and the development of a project for modernization of Canal Operation.

Operation is a complex task involving key activities of irrigation management which implies numerous aspects which have to be combined in a consistent manner. These aspects are:

- service to users
- cost of producing the services
- performance M& E
- Constraints and opportunities on Water resources
- Constraints and opportunities of the physical systems

MASSCOTE aims to organize project development into a stepwise revolving frame including:

- mapping the system characteristics, the water context and all factors affecting management;
- delimiting manageable subunits;
- defining the strategy for service and operation for each unit;
- aggregating and consolidating the canal operation strategy at the main system level.

MASSCOTE is an iterative process based on ten successive steps, but more than one round is required in order to determine a consistent plan. Some steps need to be rediscussed and refined several times before achieving a satisfactory level of consistency.

A specific module of MASSCOTE for Lift Irrigation System is developed as part of the exercise in ALMATTI, it is called MASSLIS for Mapping System and Services for Lift Irrigation System.

## ***Presentation of the Masscote methodology***

The first steps of MASSCOTE (Table 1) are conducted for the entire command area with the goal of identifying homogeneous managerial units for which specific options for canal operation are further sought by running the various steps of MASSCOTE for each unit taken separately. Then, aggregation and consolidation is carried out at the main system level. Thus, the methodology uses a back-and-forth or up-and-down approach for the different nested levels of management.

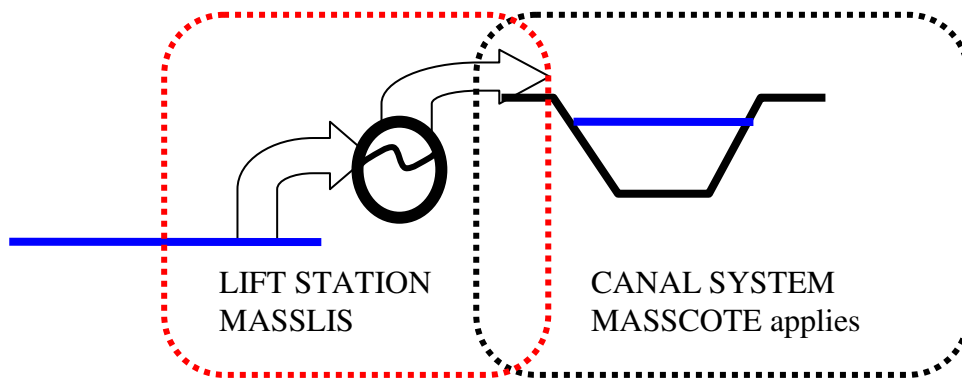
**Table 1. 10 STEPS of MASSCOTE**

Mapping ....	Phase A – baseline information
1. The performance (RAP)	Initial rapid system diagnosis and performance assessment through the RAP. The primary objective of the RAP is to allow qualified personnel to determine systematically and quickly key indicators of the system in order to identify and prioritize modernization improvements. The second objective is to start mobilizing the energy of the actors (managers and users) for modernization. The third objective is to generate a baseline assessment, against which progress can be measured.
2. The capacity & sensitivity of the system	The assessment of the physical capacity of irrigation structures to perform their function of conveyance, control, measurement, etc. The assessment of the sensitivity of irrigation structures (offtakes and cross-regulators), identification of singular points. Mapping the sensitivity of the system.
3. The perturbations	Perturbations analysis: causes, magnitudes, frequency and options for coping.
4. The networks & water balances	This step consists of assessing the hierarchical structure and the main features of the irrigation and drainage networks, on the basis of which water balances at system and subsystem levels can be determined. Surface water and groundwater mapping of the opportunities and constraints.
5. The cost of O&M	Mapping the costs associated with current operational techniques and resulting services, disaggregating the different cost elements; cost analysis of options for various levels of services with current techniques and with improved techniques.
Mapping ....	Phase B – Vision of SOM & modernization of canal operation
6. The service to users	Mapping and economic analysis of the potential range of services to be provided to users.
7. The management units	The irrigation system and the service area should be divided into subunits (subsystems and/or unit areas for service) that are uniform and/or separate from one another with well-defined boundaries.
8. The demand for operation	Assessing the resources, opportunities and demand for improved canal operation. A spatial analysis of the entire service area, with preliminary identification of subsystem units (management, service, O&M, etc.).
9. The options for canal operation improvements / units	Identifying improvement options (service and economic feasibility) for each management unit for: (i) water management, (ii) water control, and (iii) canal operation.
10. The integration of SOM options	Integration of the preferred options at the system level, and functional cohesiveness check. Consolidation and design of an overall information management system for supporting operation.
11. A vision & a plan for modernization and M&E	Consolidating a vision for the Irrigation scheme. Finalizing a modernization strategy and progressive capacity development. Selecting/choosing/deciding/phasing the options for improvements. A plan for M&E of the project inputs and outcomes.

## MASSLIS: Masscote approach for Lift Irrigation System

A Lift Irrigation System is a Canal System (or subsystem) fed by a lifting device. Thus the main feature that differentiates a lift system from a canal gravity fed system is only the lifting station at head. MASSCOTE analysis should apply for the transport and distribution components as for a classical open channel system. Readers are advised to refer to the FAO IDP 63 which describes in details the MASSCOTE methodology.

**MASSLIS = Special MASSCOTE for LIFT STATION + MASSCOTE for Canal**



*Figure 1 A Sketch of MASSCOTE & MASSLIS*

The lift station at headworks is obviously adding important points that need to be addressed properly in the diagnosis and planning for modernization.

In this study a MASSCOTE analysis for the canal and a MASSLIS approach for the Lift Irrigation System, are carried out thus each step of the process is divided in two sub-steps one classical for Masscote one addressing the specificities of the lift system for Masslis.

## 2. The Almatti Lift Irrigation Systems ALIS

The Almatti lift irrigation systems (ALIS) are located at upstream part of the Upper Krishna project and fed by the Almatti reservoir (figure 2). They are composed of three main systems (figure 2):

- ARBC
- ALBC
- MULWAD (East and West)



Figure 2. Karnataka map and location of the ALIS project

### ARBC

The Almatti Right Bank Canal is one of the Lift Irrigation Scheme proposed on the fore shore reservoir of the Almatti by partial gravity flow and lift flow canal. The Construction of Almatti Right Bank Canal head work is completed in all respects under stage-I. The A.R.B.C. off takes from Back No.53 of Almatti Dam and commences from the Irrigation sluice of the reservoir, the length of the main canal is 67.00 K.Ms before it tailed off to river Malaprabha. The sill level of the Delivery head discharge at the off-take is 14.911 Cumecs.

The main canal is fed by gravity when water level in Almatti reservoir is high and by pumping when it is low.

Three pumps of 5 Cumecs capacity (2 +1) are installed, capacity of each is 1050 KW, total power requirement of 2400 K.W. The irrigable command area under A.R.B.C. is 9900

Hectares, benefitting lands of Hungund and Bagalkot Taluk. The total No. of villages benefitted under Hungund and Bagalkot Taluk are 23 and 18 villages respectively.

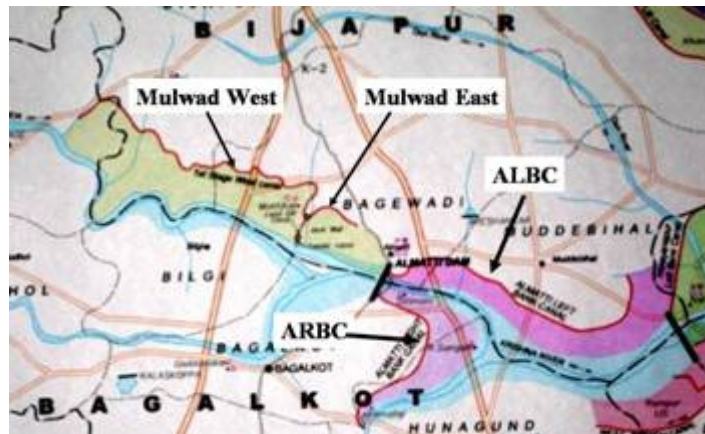


Figure 3. Map of the 3 Almatti lift irrigation systems

There are 24 Distributaries under A.R.B.C. Total expenditure incurred so far is 90.05 Crores. The potential created up to the end of January-2008 is 8949.04 Hectares. The balance potential is programmed to be achieved in the next financial year. Sincere efforts are being made in co-ordination with the CADA Executive Engineer, in identifying the area that could be irrigated by extending the CADA works/Lateral works.

The second Lift of AR.B.C. is proposed at K.M. 4.92 of Almatti Right Bank Canal. This is named as Timmapur Lift Irrigation Scheme proposed to irrigate 20100 ha of Lands in Bagalkot and Hungund Taluka. The water is to be lifted to two delivery chambers located at R.L. 540 & 560 Meters. The Total discharge required for the Timmapur Lift Irrigation Scheme is 9.581 Cumecs. The Total T.M.C. of Water Allocated for Almatti Right Bank Canal and Timmapur Lift Irrigation Scheme is 5 T.M.C.

### ALBC

The ALBC LIS envisages to provide irrigation to 20,235 ha by utilizing 5.65 TMC of water. Total length of the canal is 85kms with 43 distributaries.

Two pumps of 3.56 Cumecs capacity plus one of 2.16 cumecs are installed, capacity are respectively 1250 and 745 KW, total power requirement of 4200 K.W. Length of the raising main is 135 m. The irrigable command area under A.L.B.C. is 16200 Hectares, under stage 1 and 4035 hectares under stage 2.

### MULWAD (East and West)

The Mulwad LIS envisages to irrigate 30,850 ha using 8.45 TMC. The total length of the canal including lead off canal East and West is 101km. with 49 distributaries. Two stages of pumping and a canal link in between. Lift elevation is between 504 and 560 m

East = 5000 ha

West = 25850 ha

### 3. MASSLIS in ALMATTI Lift Irrigation Systems

#### Step 1. RAPID DIAGNOSIS

A RAP (Rapid Appraisal Procedure) was carried out as part of the first step of the exercise during the workshop. The following sections is the RAP executive summary.

#### Step 1.1 RAP Methodology for Canal System

The RAP is a quick and focused examination of irrigation systems and projects that can give a reasonably accurate and pragmatic description of the status of irrigation performance and provide a basis for making specific recommendations related to hardware and management practices. The first step in evaluating irrigation performance, whether at the farm level or an entire irrigation project, is to perform a rapid appraisal (RAP) of the system as it is being operated.

The RAP can be described as follows:

The Rapid Appraisal Process (RAP) for irrigation projects is a 1-2 week process of collection and analysis of data both in the office and in the field. The process examines external inputs such as water supplies, and outputs such as water destinations (ET, surface runoff, etc.). It provides a systematic examination of the hardware and processes used to convey and distribute water internally to all levels within the project (from the source to the fields). External indicators and internal indicators are developed to provide (i) a baseline of information for comparison against future performance after modernization, (ii) benchmarking for comparison against other irrigation projects, and (iii) a basis for making specific recommendations for modernization and improvement of water delivery service.

Use of a systematic RAP for irrigation projects was introduced in a joint FAO/IPTRID/World Bank publication entitled *Water Reports 19 (FAO) – Modern Water Control and Management Practices in Irrigation – Impact on Performance* (Burt and Styles 1999). That publication provides an explanation of the RAP approach and gives the results from RAPs the authors conducted at 16 international irrigation projects. Refer to Water Report 19 for further background to the RAP approach, available directly from FAO (<http://www.fao.org/icatalog/inter-e.htm>).

RAP is now fully integrated as the STEP 1 or the foundation of the new approach developed by FAO for modernization strategy and plans which is called MASSCOTE.

A key component of the successful application of the RAP and MASSCOTE approaches is the knowledge and experience of qualified technical experts that can make proper design and modernization decisions. It is critical that MASSCOTE-RAPs are conducted by irrigation professionals with an extensive understanding of the issues related to modern water control. This technical capacity building will be addressed initially through training workshops that are going to be held by the FAO. In addition to making proper recommendations for modernization, evaluators using the RAP approach must have the ability to synthesize the

technical details of a project with the concepts of water delivery service into a functional design that is easy-to-use and efficient.

Key performance indicators from the RAP help to organize perceptions and facts, thereby facilitating the further development of a modernization plan through the different steps of MASSCOTE. From the RAP we have already some good indications on:

- Further investigations that should be carried out for the development of the modernization plan.
- Specific actions that can be taken to improve project performance
- Specific weakness in project operation, management, resources, and hardware
- The potential for water conservation within a project

Broad goals of modernization are to achieve improved irrigation efficiency, better crop yields, less canal damage from uncontrolled water levels, more efficient labor, improved social harmony, and an improved environment by reducing a project's diversions or increasing the quality of its return flows. In general, these goals can only be achieved by paying attention to internal details, or the internal indicators. The RAP addresses these specific internal details to evaluate how to improve water control throughout the project, and how to improve the water delivery service to the users.

### **Looking at different management levels**

When one analyzes a project by "levels" (office, main canal, second level canal, third level canal, distributaries, field), a huge project can be understood in simple terms. The operators of the main canal only have one objective – everything they do should be done to provide good water delivery service to their customers, the distributary/minor canals (and perhaps a few direct outlets from the main canal). This "service concept" must be understood and accepted by everyone, from the chief engineer to the lowest gate operator. Once it is accepted, then the system management becomes very simple. Personnel on each level are only responsible for that level's performance.

An important step of MASSCOTE is precisely to start from this diagnosis and re-organize the management of the system into units which are functional, responsible and responsive and consistent with the main features diagnosed in the gross command areas. On large system the partitioning into management units is fundamental to allow an effective service oriented management from one level to the other down to the end-users.

Main canal operators do not need to understand the details of that day's flow rate requirements for all the individual fields. Of course, in order to subscribe to the service concept, operators generally need to know that their ultimate customer is the farmer. But the details of day-to-day flow rates do not need to be known at all levels. Rather, the main canal operators have one task to accomplish – to deliver flow rates at specific turnouts (offtakes) with a high degree of service.

### **Performance indicators**

The external indicators compare input and output of an irrigation system to describe overall performance. These indicators are expressions of various forms of efficiency, for example water use efficiency, crop yield, and budget. But they do not provide any detail on what

internal processes lead to these outputs and what should be done to improve the performance. They, however, could be used for comparing the performance of different irrigation projects, nationally or internationally. Once these external indicators are computed, they are used as a benchmark for monitoring the impacts of modernization on improvements in overall performance.

The internal indicators quantitatively assess the internal processes (inputs - resources used and the outputs - services to downstream users) of an irrigation project. Internal indicators are related to operational procedures, management and institutional set-up, hardware of the system, water delivery service etc. These indicators are necessary in order to have comprehensive understanding of the processes that influence water delivery service and overall performance of a system. Thus they provide insight into what could or must be done to improve water delivery service and overall performance (the external indicators).

**Participants were divided into 4 groups:**

- **Group A: ALMATTI LEFT BANK CANAL**
- **Group B: ALMATTI RIGHT BANK CANAL**
- **Group C: MULWAD LIFT IRRIGATION SCHEME West**
- **Group D: MULWAD LIFT IRRIGATION SCHEME East**

They spent 1.5 day on the field and gave ratings to all internal indicators. During a plenary session rating were reviewed and finalized.

**In the following sections indicators of performance are given as average for the 3 systems unless specified otherwise**

**External performance indicators: Very low productivity for land and water**

The productivity of land is estimated at 620\$ per ha actually irrigated by canal water. It is low compare to systems recently studied by FAO in ASIA and elsewhere as seen in figure 4. Almatti systems ranks 23th out of 28.

Performance in terms of productivity of irrigation water is also among the lowest at 0.037 \$/m<sup>3</sup> of water.

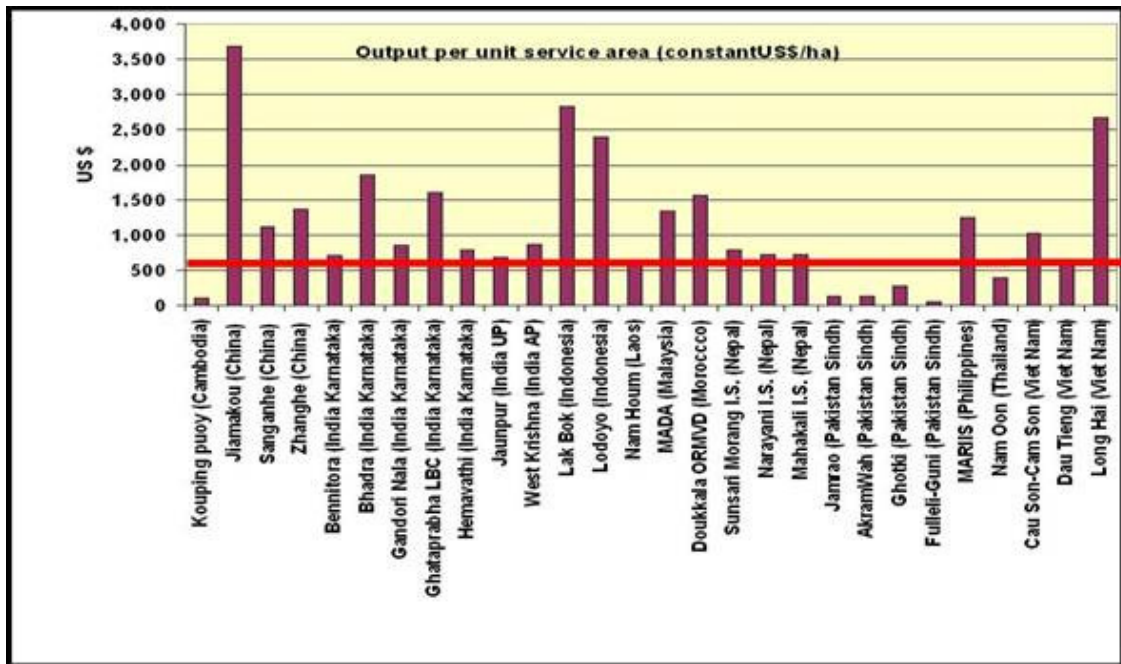


Figure 4. Output per unit area in ALIS compare to other systems

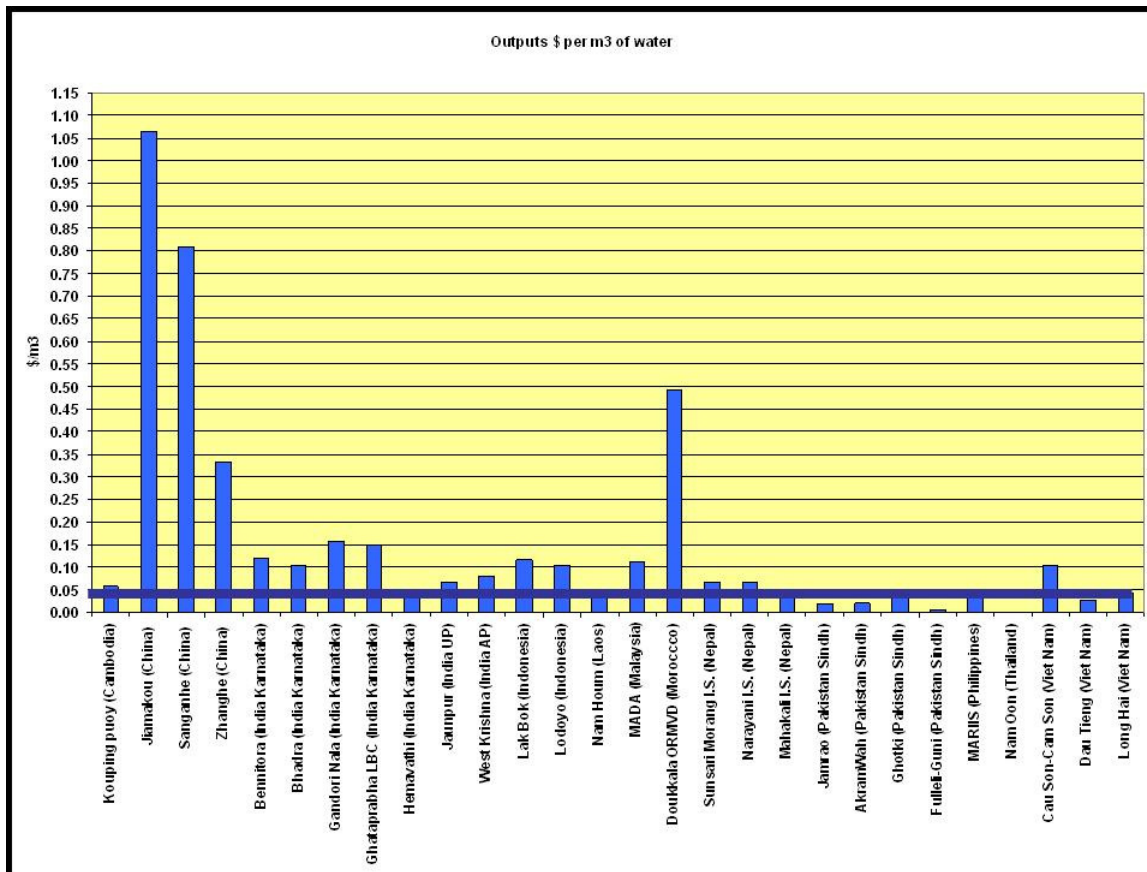


Figure 5. Output per unit of water in ALIS compare to other systems

## Internal performance indicators

The values of the primary internal indicators reflect an evaluation of the key factors related to water control and service throughout the command area. The internal indicators and their sub-indicators at each level of the system are assigned values from 0 to 4 (0 indicating least desirable and 4 indicating most desirable).

**Table 1** summarizes the internal performance indicators for the Main Canal of ALIS. It shows medium to low values suggesting some problems of poor levels of performance.

**Table 1. ALIS Internal Performance Indicators for the Main canal of ALIS**  
(Maximum possible value = 4.0, minimum possible value = 0.0)

Internal Performance Indicator	Value (0-4)
Cross regulator hardware	<b>0.9</b>
Headgates (distributaries/minors) from the Main Canal	<b>2.2</b>
Communications	<b>3.0</b>
General Conditions	<b>1.5</b>
Operations	<b>2.4</b>
<b>Actual Water Delivery Service by the Main Canals to the Secondary Canals (overall index)</b>	<b><u>1.3</u></b>

### No water level control

Cross regulators are not used for water level control but to evacuate flow in excess in combination with a near by escape. Basically the water level is not controlled along the main canal.

Problems linked to the absence of control are particularly obvious upstream and downstream of the main canals:

- upstream sections of ARBC and ALBC have been designed for much larger CA than currently developed. In these sections full discharge for existing irrigated area is by far too low to reach FSD.
- downstream sections of the main canals which experience discharges dramatically reduced by excess withdrawals upstream.

Although generally speaking the sensitivity of the offtakes is low and water deliveries to the secondary level remains to a certain extent under control, there is still obviously an amplification of the perturbations as we go downward. The result is that the tail-enders are facing insufficient supply of water.

### Secondary and Tertiary Canals

The performance of the secondary canals in the ALIS is summarized by the key internal indicators in Table 2. In general, the performance indicators for the second level canals are quite similar than those for the main canal.

The secondary canals **are not equipped** with **water level control structures** whereas discharge changes a lot from one season to the other and probably during each season as well. During low flows in the canals the issue of water level is critical and operators are taking some temporary measures to raise the water level (blocks placed at bottom bed of the canal).

This lack of water control structures increases the chaos downward.

**Table 2. Internal Performance Indicators for the secondary canals in ALIS**  
(Maximum possible value = 4.0, minimum possible value = 0.0)

Internal Performance Indicator	Value (0-4)
Cross regulator hardware	<b>0.3</b>
Turnouts (watercourses) from the Distributaries/Minors	<b>2.2</b>
Communications	<b>3.0</b>
General Conditions	<b>1.6</b>
Operations	<b>1.9</b>

**Table 3. Internal Performance Indicators for the Minors/laterals/Field channels in ALIS**  
(Maximum possible value = 4.0, minimum possible value = 0.0)

Internal Performance Indicator	Value (0-4)
Cross regulator hardware	<b>0.4</b>
Turnouts (watercourses) from the Minors/Laterals	<b>0.0</b>
Communications	<b>2</b>
General Conditions	<b>1.3</b>
Operations	<b>1.3</b>

### Final deliveries in ALIS

The internal indicators that characterize the actual water delivery service at the farm level are summarized in **Table 4**. The water delivery service being provided to the farmers is relatively low. This is a measure of the flexibility, reliability, equity, and measurement of the water supply to individual fields.

**Table 4. ALIS Final Delivery Point Internal Performance Indicators (0-4)**  
(Maximum possible value = 4.0, minimum possible value = 0.0)

<b>Actual Water Delivery Service to Individual Ownership Units (e.g., field or farm)</b>	<b>1.2</b>
Measurement of volumes	<b>0</b>

Flexibility	2
Reliability	2
Apparent equity.	1

The ratings for the internal indicators describing employees and farmer organizations show significant room for improvement. Employees, especially field operations staff, had little or no incentive to provide excellent service to farmers and were not empowered to make decisions on their own. The farmer organization indicator is low due to the fact that they had little ability to influence the real-time management of the system or to rely on outside help for enforcing rules and policies. Farmer organizations have been organized and trained as a part of previous reform efforts but have only minimal input into the day-to-day operation of the system.

### **Management and Water user societies**

Water User Associations in ALIS are embryonic; none of them are working effectively therefore most indicators about WUA are zero.

### **The key findings of the field visit are summarized below:**

1. Low productive system: semidry crops – intensity low
2. Irrigation development low
3. Irrigation services are poor
4. No WUA
5. Maintenance is deficient
6. Control of discharge is weak
7. No control of water level
8. Siltation a serious problem.
9. High inequity along MC.
10. Access road difficult (Jungle)
11. Absence of indications on most structures

### **But:**

It has also been found that these systems are not too complex for management, they are not very large and composed of a long main canal serving numerous short distributaries, with tail enders of the distributaries served by the water of the reservoir through individual pumping. All main and secondary canals are concrete lined. Irrigation with surface water is recent in the CAs and need to be strengthened. No bad habits have yet been developed.



*Plate 1. Temporary Cross-wall built for raising water level upstream ALBC at current low discharge [deteriorated and inefficient].*



*Plate 2. Cross-regulator use to channel out excess water through near by escape ALBC*



*Plate 3. Rudimentary Cross-regulator built by farmers to raise water head in ALBC*



*Plate 4. Slab and rocks placed at bed bottom to raise water head in Mulwad East Canal*



*Plate 5. Secondary canal in ALBC, jungle limiting access.*



*Plate 6. Secondary canal equipped with a flume in ALBC, no gauge installed and presence of rocks .*



*Plate 7. Secondary canal at tail end of ALBC, section largely reduced by depot.*



*Plate 8. On going desiltation works.*

## Step 1.2 RAP for the Lift Stations

As part of the study in Almatti a preliminary assessment of the lift stations has been carried out using a Rapid Appraisal Procedure. The information gathered and analysis made about the lift stations in ALIS are presented in the various steps of MASSLIS in the following sections.

The main features of the lift stations are summarized in table 5.

**Table 5. Main features of the lift stations**

	inlet	Outlet	raising main length m	Head min. at inlet m	Head at MC entrance m	Average head lift m
ARBC	gravity and pumped from Almatti Reservoir	Vertical up non submerged	10	504.75	520.6	10
ALBC	head variable pumped from Almatti Reservoir	Vertical up non submerged	135	504.75	530.15	17.4
Mulwad 1 <sup>st</sup>	head variable pumped from Almatti Reservoir	Vertical siphoned	666	504.75	528.8	
Mulwad 2 <sup>nd</sup>	head constant Canal	horizontal	1200	526.54	560.41	

### Inlet

Pumps are turbine type powered by vertical motors. They are installed below minimum water level with more than 2 meters of submergence at inlet.

The ARBC system is mixed: at high level of water in the reservoir, water feeds the canal by gravity at low level pumping is required.

### Outlet

Arrangements for outlets in the delivery chamber are diverse as shown in plate 9 below. Analysis of head losses and efficiency shows that the design for ALBC and ARBC are not optimum (vertical lift up) as part of the energy input into the stream is lost in the chamber. Arrangements made for Mulwad (horizontal or vertical siphoned) are better.



*Plate 9. Diverse arrangements for outlet in delivery chamber: Vertical lift-up left in ALBC and right in ARBC – Horizontal in Mulwad and vertical siphoned in Mulwad.*

## **Records and monitoring at pump station**

Running hours for each pump are manually recorded. These records are used by managers to determine the volume pumped at the lift station. It is shown further in section on capacity that the estimation of volume pumped from pumping hours is not at all accurate and by far underestimated, for instance by 37% for ALBC.

## **Step 2. SYSTEM CAPACITY AND SENSITIVITY.**

**Objective:** *Assessing the physical capacity of irrigation structures to perform their function of transport, control, measurement, etc.*

*Assessing the sensitivity of Irrigation Structures (offtakes and regulators), identification of singular points. Mapping the sensitivity.*

### **Step 2.1. The capacity along the canal**

The assessment by participants of the capacity elements within the Almati Lift systems has yielded to the following:

- Storage in main reservoir is sufficient but NO online storage
- Conveyance system is OK.
- Some reduced capacity due to siltation.
- Some sections are affected by seepage.
- Diversion capacity is OK
- Distribution capacity is OK
- Control of water level is deficient
- Measurements— mostly no devices installed and no gauges for the few devices installed.
- Safety: not enough escapes
- Transmission through mobile phone is OK
- Service roads along main canal are in good condition. However along secondary and tertiary canals roads are often deteriorated and some no longer functional with jungle.

### **Irrigation capacity**

At this early stage of the development of the infrastructure irrigation capacity is not yet known with accuracy. Some canals have been developed but not yet till the tertiary levels.

We have considered that the development is quite uniform throughout the CA of ALIS and we have used proportional figures to the ultimate areas for each project. The following figures:

**Table 6. Areas developed, equipped and irrigated in ALIS**

	Potential after Phase 1 project (ha)	Equiped for irrigation as of today (ha)	Total ha irrigated in 2006/2007 (ha)
ALBC	16200	8065	5404
ARBC	9900	4929	3302
Mulwad East	5000	2489	1668
Mulwad West	25850	12870	8624
Total	56950	28355	19000

The capacity of the ALIS systems are still much beyond potential and designed. An estimated 19000 ha irrigated in 2006/2007 which places irrigation intensity at 66 % of the equipped area.

## **The sensitivity along the canal**

- By design sensitivity of offtake is low ( $<1$ ) when canals are run at FSD
- Actually some offtakes are facing harsh problems of sensitivity and supply limitations due to low water level in canals.

## **Step 2.2 The lift station capacity**

The capacity of a lifting structure is defined in terms of discharge (Q) at the outlet of the station or the entrance of the main canal. This capacity depends on the internal characteristics of the station (power & efficiency) and the water level conditions of the supply and of the restitution. These two levels determine head at the lift station.

For a lift station the discharge lifted [Q] into the system at a given elevation will then depends on:

- the water levels (head conditions) at lift station
- the power and energy input
- the head losses within the station (inlet and outlet pipes ; pumps)
- the energy efficiency of the pumps.

## **Setting point vs Best Efficient Point (BEP)**

Pumps are designed for a Best Efficient Point (BEP) for which efficiency is maximum. However for the 3 lift stations offtaking from the reservoir, inlet water level varies significantly during the season and thus the running conditions of the pumps deviate from the BEP.

## **Detailed analysis of ALBC station**

Only ALBC station has been evaluated as part of the RAP. The static head at inlet of ALBC varies as follows:

- H1 minimum=508 m
- H1 average = 513.8 m
- H1 maximum = 519.6 m

With a restitution level at 531.2 m, the lift head then varies between 11.6 m and 23.2 m. Head losses generated in the raising main pipe should be added to this to determine the dynamic head (0.5 m for high discharge and 0.3 for low discharge).

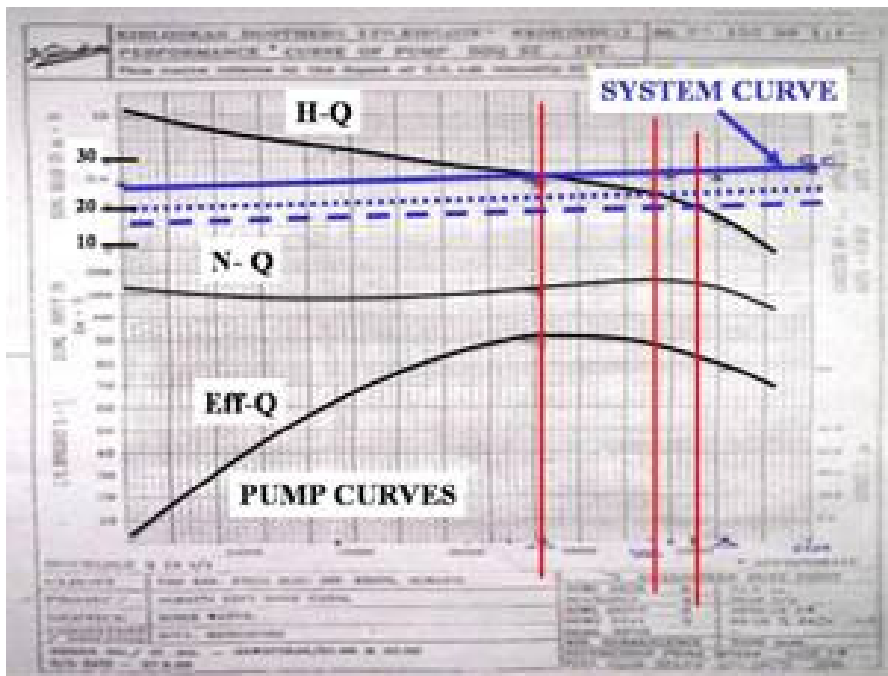
The following table of the running conditions for ALBC was obtained from the efficiency curves given by the pump manufacturers as shown in figure 6. :

**Table 7. Variation of head discharge and efficiency for the main pump in ALBC**

	Dynamic head	Discharge m <sup>3</sup> /s	Efficiency
Min	11.9	5.507	0.701
Max	24	4.174	0.892
Average	17.95	5.000	0.804

The BEP of the pump given by the manufacturer is for a bowl head of 25.9 and reaches 89.50 %. It can be seen from table above that the average running conditions of the pumps are deviating significantly from BEP and that has two effects:

- Average discharge capacity is significantly increased from 3650 to 5000 l/s, difference is big + 37% (it varies between 14 % and 51%).
- Average running efficiency of the pump is much below optimum: 80.4 % instead of 89.5 %.



*Figure 6. Discharge-Head=Power-Efficiency diagrams of the main pump used in ALBC as given by the manufacturer*

### Capacity of estimating volume input at head of systems

Managers tend to record number of hours run by each pumps. Whenever (not often) they want to estimate the volume of water input they simply multiply this amount by the nominal discharge of the pump.

The analysis above leads to the following conclusions as far as the capacity of assessing the volume is concerned:

- Using pumping hours is absolutely insufficient to give accurate discharge and volume.
- One should associate water levels and accurate assessment of head losses in the pipe.
- In any circumstances the BEST option should be to have a separate measurement point upstream of the main canal and/or a measuring device on the raising main pipe.

### **STEP 3: THE PERTURBATIONS**

Perturbations analysis: causes, magnitudes, frequency and options for coping with.

The perturbations in ALIS have been identified by the workshop participants as follows:

- Unauthorised offtakes and lifting of water from canal
- Unauthorised operation of gates by the farmers.
- Rains- water enters the main canal
- Lack of drainage
- Operation of pumps is one of the main causes of perturbations.
- Temporary constructed obstructions (walls) to raise water level at offtake
- Inaccuracy in management
- Seepage from banks

Perturbations are significant in case of main pump operation and illegal withdrawals from pump sets.

#### **The options to cope with have been identified as follows:**

1. Share the surplus / deficit equally among the users.
2. Surplus to be diverted to Minor Irrigation tanks and on-line storages/canal used for storing surplus water.
3. Cross regulators to be operated frequently to maintain the depth of water in the canals within the tolerance.
4. Storing surplus of water (rainfall) in the main canal by allowing water level rising above FSD and encroaching the freeboard when safety conditions allows.
5. Storing surplus of water in the main canal by running systematically the canal below FSD (where sensitivity of offtakes is not too high), and use the level up to FSD to store surplus of water.

## Step 4 MAPPING WATER & ENERGY BALANCE

**Objective:** *The objective here is to map the nature and structure of all the streams and flows that affected and are influenced by the command area. It includes assessing the hierarchical structure and the main features of the Irrigation and drainage networks, natural surface streams and groundwater, and the mapping of the opportunities and constraints including drainage and recycling facilities.*

*An additional specific objective for the lift systems is to map down the balance of energy at the lift stations.*

### STEP 4.1. WATER ACCOUNTING:

Water balance is computed for the 3 subsystems considered as one system. The following areas have been used for the quantification of the precipitation with a Rainfall in 2006/2007 amounting to 351 mm.

**Table 8. Areas used for water balance in ALIS**

	Irrigation developed (CA)	Gross Command Area (GCA)
ALBC	?????	???????
ARBC	???????	???????
MULWAD	???????	???????
TOTAL	28355 ha	85 476 ha

Precipitation in the GCA amounts to a total of 300 MCM and to 100 MCM on irrigated fields.

### High inaccuracy on irrigation estimated volume

Irrigation inputs are calculated from the running hours of the pump stations and as such come with a high inaccuracy. The estimation of the volume pumped into canals is 179 MCM. However as shown in Step 2 actual diversion for ALBC is 37 % more than that of using the discharge capacity at BEP. Thus one can expect that the value above is significantly underestimated and that the actual value might be much **higher than 200 MCM**. Only a detailed survey of the two other pump stations as that of made for ALBC would lead to more reliable estimation of the irrigation inflows.

### Water Balance: inputs at GCA

**Table 9. Inflows partition to the Gross Command Area ALIS**

Sl. No.	Mode of input	Quantity in MCUM	Percentage
1	Irrigation diversion	179	33%
2	Groundwater pumping	69	12 %
3	Gross precipitation in GCA	300	55 %
<b>Total:</b>		<b>548</b>	<b>100%</b>

## Water Balance: inputs at field levels

**Table 10. Inflows partition at field levels**

Sl. No.	Mode of input	Quantity in MCUM	Percentage
1	Irrigation supply at field (conveyance efficiency at 63%)	113	40%
2	Groundwater pumping	69	24 %
3	Gross precipitation in irrigated fields	100	36%
<b>Total:</b>		<b>213</b>	<b>100%</b>

## Water Balance: outputs

**Table 9 Outflows partition in ALIS**

SL. No	Mode of output	Quantity in MCUM	Percentage
1	ET of vegetation and trees out side the CCA , within the GCA	86	18%
2	ET of irrigated crops during the two seasons	83	17%
3	Aggregated portion accountable for seepage, lateral flows, percolation and run-off which is stored in the downstream reservoirs	310	65%
<b>Total:</b>		<b>479</b>	<b>100%</b>

SL. No	Mode of output	Quantity in MCUM	Performance
1	Irrigation supply at field level	113	
2	Irrigation requirement (ET <sub>crop</sub> - Effective precipitation)	36.7	32 % efficient

## Step 4.2 MAPPING the ENERGY Balance

The purpose here is to map the energy balance for the lift system, i.e. the energy spent to at the lift station vs the energy input into the flow at head of the canal systems.

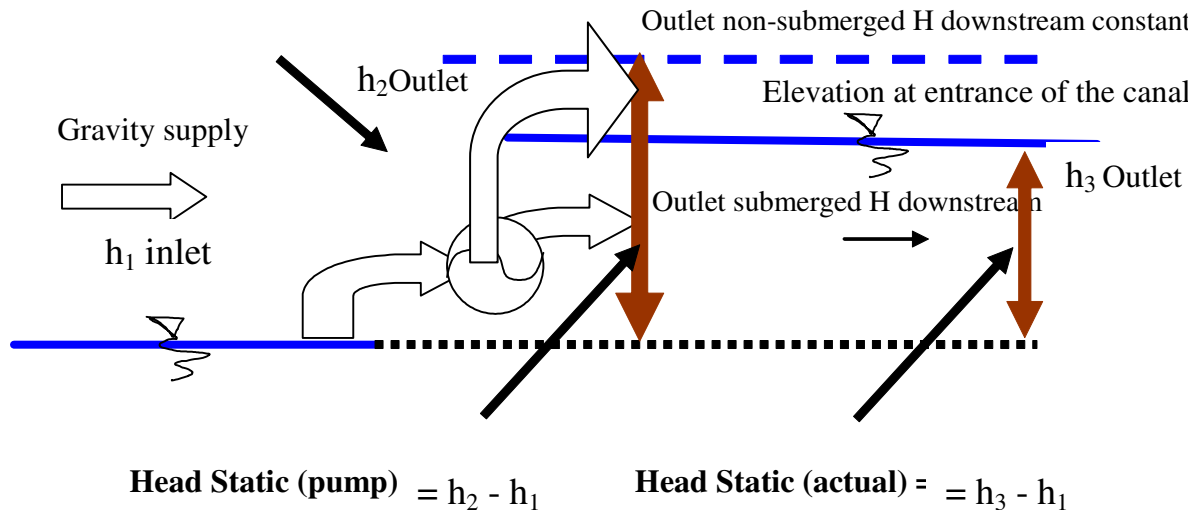


Figure 9. Sketch showing the important variables for a lift station.

### Energy produced by the lift station

The energy input in terms of quantum of water elevated is given by the following equation:

$$Energy(KWh) = \frac{Volume(m^3) \times Headstatic(actual)(m)}{367} \quad (1)$$

Head static (actual) is the difference of water elevation between canal inlet ( $h_1$ ) and outlet ( $h_3$ ).

### Energy spent at lift station

The energy spent at a lift station depends on the total head, the volume pumped ( $V$ ) and the efficiency of the system [ $\eta$ ].

$$Energy(KWh) = \frac{Volume(m^3) \times Headtotal(m)}{367} \times \left[ \frac{1}{Efficiency} \right] \quad (2)$$

Head total is the head static of the pump [ $h_2 - h_1$ ] plus head losses in the inlet and outlet pipes.

The energy balance analysis can be run through 2 methods:

- Head losses and efficiency
- Energy balance

## Application of energy balance to ALBC

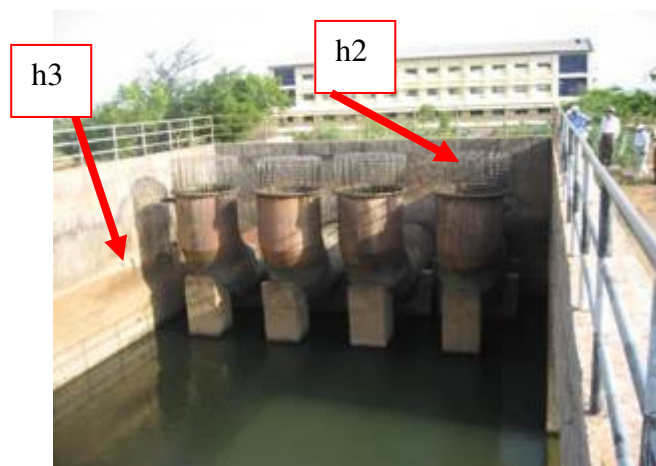
The energy balance has been made for ALBC with 2 methods: the head analysis and the energy spending analysis.

### 1. Energy performance from head analysis

The energy performance is a combination of efficiencies of the pump and motor as well as function of head losses by friction in the pipes or by losses of static head. Table 10 exhibits the relevant figures of head and efficiency for ALBC.

**Table 10. Head data at the lift station**

h1 minimum	h1 average	h1 maximum	h3 restituted at present	h2 outlet	Delta H at outlet h2-h3	Average static head h3-h1 avg	Head losses along the raising pipe	Head total
508	513.8	519.6	528.5	531.2	2.7	14.7	0.4	17.8



*Plate 10 Outlet configuration of ALBC*

**Table 11. Efficiency from head analysis under current conditions**

Efficiency Head static/head total	Efficiency pump for average conditions	Efficiency motor	Overall Efficiency
82.6 %	80 %	96 %	63.4 %

Given the losses of elevation at the outlet and head losses in the pipe, the efficiency for head (head produced/head spent) is estimated to reach 82.6%. The pump efficiency for the average running head is 80 % and the motor efficiency is 96%. Thus the estimated **ALBC overall efficiency** is at **63.4 %**.

## 2. Energy performance from average running conditions

Period of reference: 10 July 2007 to 31 March 2008

Pump1 = 5364 hours at 5 m<sup>3</sup>/s (reference to average water level) and Pump2 = 501.45 h at 2.95 m<sup>3</sup>/s  
Volume total lifted = 101.9 MCM

Energy input into the stream =  $101.9 \text{ MCM} \times 14.7(\text{m}) / 377 = 3.97 \text{ MKWh}$

Energy spent at the lift = Capacity of pump (KW) x Running hours = 7.078 MKWh

**The Overall Efficiency for ALBC = 56 %**

The difference between the two above estimations (56 and 63%) might result from several reasons: underestimation of the head losses in the raising pipe, inaccuracy of records,...

### Analysis

The overall efficiency estimated for ALBC is low for two reasons: one is related to the outlet conditions for which a significant loss of head occurs at present (2.7 m). This head losses will be reduced in future when the new irrigation system will be developed as static head (and FSD) will increase. However outlet arrangements similar to those made for the two Mulwad stations would have suppress that cause of inefficiency.

The second reason is the running conditions deviating too much from BEP, average pump efficiency drops from 0.9 to 0.8 due to lower total head.

Without this head losses and an average running condition at BEP electricity consumption would have been reduced by 1.76 MKWh per year with an overall efficiency of 84%. That would reduce energy bill by 25% of the total. At subsidized price of 0.8 IRs per KWh it represents a saving of 1.4 Millions IRs per year. For a normal price of IRs 3 per KWh that would be some IRs 5.3 Millions for ALBC only.

## Step 5 MAPPING THE COST of OPERATION

**Objective:** the objective is to gather as much as possible elements of costs entering into the operation of the system in order to identify where possible gains should be sought for with the current service and operational set up, and what would the cost of implementing improved service. This step thus focus on mapping the cost for current operation techniques and services, disaggregating the elements entering into the cost, costing options for various level of services with current techniques and with improved techniques.

### Too high cost for Operation and Maintenance of ALS

54.3 Millions Rs is the total O&M budget for Mulwad East and West as shown in figure below. The lift stations amounts to 62% of the total 41 % for Energy and 21 % for OM. The total lift is about 60 meters.

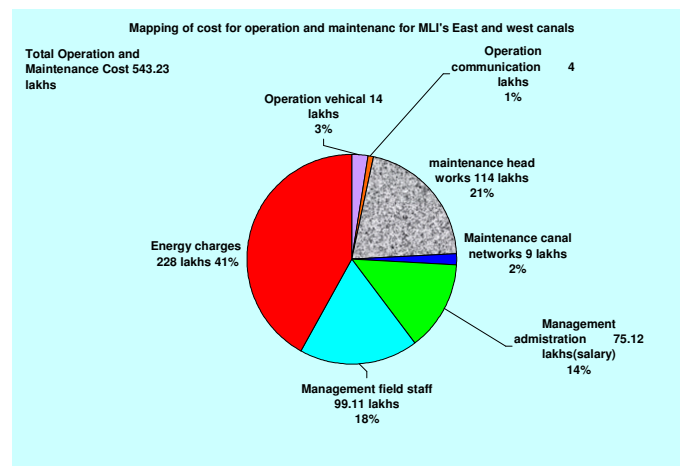


Figure 10. Breakdown of the budget for Mulwad LIS

29.3 Millions Rs is the total O&M budget for ARBC, with a lower share for the headworks (25%) as the system has a low lift or is gravity fed. Budget breakdown is shown in figure 11.

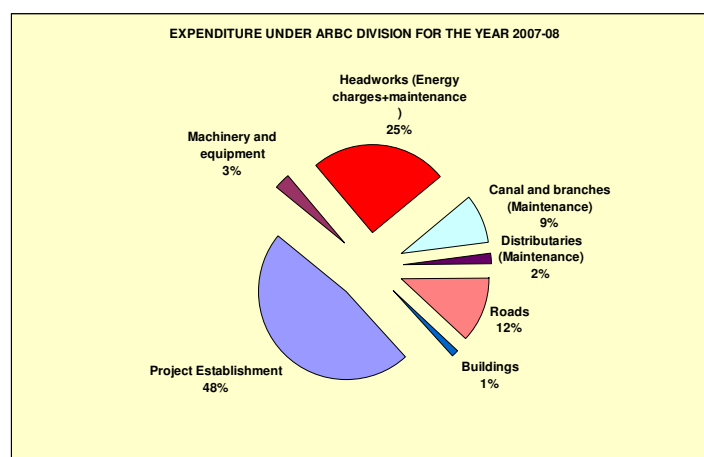


Figure 11. Breakdown of the budget for ARBC LIS

ALBC budget is 30.7 Millions Rs. Energy cost and pump station maintenance represent a share of 40%.

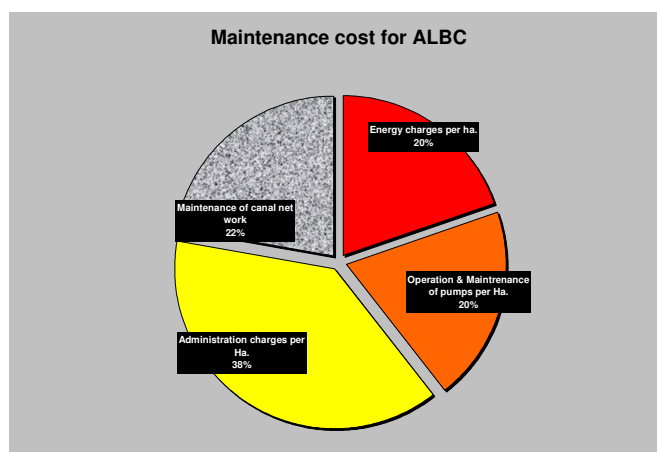


Figure 12. Breakdown of the budget for ALBC LIS

### **ALIS unit cost per area too high**

The total budget for the 3 projects is 114MRs which puts the unit cost at 6000 Rs per ha irrigated and 4000 Rs per ha equipped.

### **Step 6 SERVICE to USERS**

**Objective:** *Mapping existing and possible options for services to Users with consideration to Farmers and Crops as well as to Other Users of water.*

The concept of service to users is at the heart of modern management. To defining the right service for the right users, all aspects and options of the water services, a single one go is not sufficient. Usually several back and forth are required to converge towards a “service” that is desirable, possible to implement and at an agreed upon cost with the users, consistent with the management constraints and set up.

What is presented in this section is thus not the definitive response for services but the state of the thinking at a given point of time for the Almatti lift systems. As said earlier surface irrigation is at early stage of development in the CA and the users’ needs are still uncertain or embryonic.

### **The various uses/users**

The first stage was to clarify the uses and users, it maps out as follows:

1. Farmers
2. Water Societies [not yet formed]
3. Domestic water supply to villages
4. Environment and Ecosystems, fisheries
5. Afforestation and water amusement parks - Vegetation & trees

The main use of water at the initial stage of the scheme development of the system is obviously irrigation supply to farmers, however other uses such afforestation or fisheries are not neglectible and may come more significant in the future.

## Service along the infrastructure

The service along the canal system is proposed with the following characteristics:

- Pre set : Flexibility in main canal discharges (+20% of discharge)
- Flexibility in 2nd level canals (+20% of discharge)
- Reliability: highly reliable during rabi, varied reliability during kharif
- Equity: equity during rabi and less equity in kharif due to system constraints (delayed)

## Service to farmers

### Service to farmers

**Table 13. service characteristics**

Service component	Target	Tolerance
• Discharge	q lit/sec	+/-15% (Kharif) +/-10% (rabi)
• Timeliness	At the hour	+/- 3 day (kharif) +/- 1 days(rabi)
• Duration	6 hr	+/-30 min (K&R)
• Flow characterises	Stable flow	+/-15% (Kharif) +/-10% (rabi)
• Compensation when at fault	Direct compensation of water	Max. 3 days periods

## Afforestation

Plantation of trees have already started along canals of ALIS, also parks and garden at Almatti dam have been created. In the command area, trees are seldom because of the long dry spell during Rabi, however it is expected that the introduction of irrigation will change progressively that. Trees will now develop throughout the year taking advantage of the precipitations in Kharif and irrigation during Rabi. It is expected a significant increase of trees in the command area along roads, bunds between fields etc..

This development of perennial vegetation is a service which is de facto brought by the surface irrigation. Studies in North India show that despite covering some 10% of the CA, the impact of trees on water consumption is minimum (2%) whereas the value for local communities is very high. Thus this is a de facto service that should received support from management.

## Vision

The vision brought forward by participants is as follows:

***“An agriculture system supported by scientific and water conserving irrigation approaches with service oriented management, operation costs recovered in 20 years horizon”***

## SCENARIO

Starting with the service analysis and based on the above vision, a scenario for each lift system has been developed by each group. Here we are presenting a consolidated scenario regrouping the main ideas discussed by participants.

	Elements of the scenario	Features of the scenario
1	Agriculture system: vision of the agriculture in the CA	<b><i>“An agriculture system supported by scientific and water conserving irrigation approaches with service oriented management, operation costs recovered in 20 years horizon”</i></b>
2	Types and rules/flexibility for cropping irrigated cropping pattern	<p>Two different options were considered by the groups:</p> <ul style="list-style-type: none"> <li>• The Imposed Cropping Pattern (ICP) is the classical approach: Semidry crops. Flexibility for cropping pattern not desirable. Violation of cropping pattern should be punishable.</li> <li>• The Imposed Water Allocation (IWA): Flexibility for crops is allowed to users volume allocated is imposed. Farmers can grow any crop with available canal water. This option fully considers the current contradiction of having a ban on high water consuming crops like sugar cane paddy etc., while government allows sugar factories in the locality, the flexibility can be given to some extent on higher prices to grow the sugarcane.</li> </ul> <p>Agreement were reached on:</p> <ul style="list-style-type: none"> <li>• Water logged area which are suitable to grow paddy and can be allowed.</li> <li>• Crops which consumes less water have to be encouraged</li> <li>• Diversified crops and cash-crops where ground water potential is available</li> <li>• Advance techniques like Drip and sprinkler irrigation</li> </ul>
3	Types of water users (farmers – others)	<ul style="list-style-type: none"> <li>• Farmers</li> <li>• Industries</li> <li>• Fisheries</li> <li>• Domestic</li> <li>• Entertainment (water parks)</li> <li>• Afforestation</li> </ul>
4	Allocation of water to farmers : rules, management under severe deficit, (wet/dry year)	<p>Allocation of water follows the different paths according to the two options considered in section 2.</p> <p>With ICP condition, less water consuming crops will be allowed.  Rabi 85% Kharif 30% Two seasonal 10%</p> <p>For IWA allocation should be basd on volumetric basis to WUAs</p> <ul style="list-style-type: none"> <li>• Allocation varies for kharif because of contribution of rain fall</li> <li>• Allocation for rabi is fixed</li> <li>• Deficit to be shared equally</li> </ul>

5	<b>Systems: Major decisions for expansion and changes for Operation and Maintenance</b>	<ul style="list-style-type: none"> <li>• Establishment of full fledged qualified professional with modern methods of management and operation systems (adopting wi-fi and other systems).</li> <li>• Adopting online system for control, management and operation of the canals.</li> <li>• All outlets are to be provided with measuring devices</li> <li>• Canal lining with geo-membrane technique to avoid minimize the seepages, water logging etc.</li> <li>• Improved O&amp;M with SCADA</li> <li>• Measurement of discharges at all level canals</li> <li>• Automation and effective operation of the system with construction of duckbill weirs at the off takes/diversions.</li> <li>• Formation of WUA/professional agencies for Operation &amp; Maintenance.</li> </ul>
6	<b>Water Service: flexibility, Reliability, equity, cost.</b>	<ul style="list-style-type: none"> <li>• <b>Flexibility:</b> The frequency and duration of supply are to be flexible as per the necessities.</li> <li>• <b>Reliability:</b> The present delivery conforms to the 85% of prior expectations of users. It should be with tolerance of one day during Rabi and 3 days during Kharif.</li> <li>• <b>Equity:</b> The present delivery conforms to the 75% of prior expectations of users. It should be with tolerance of (+) or (-) 5%.</li> <li>• <b>Cost:</b> The service cost works out to Rs.2000/ha(approx)</li> </ul>
7	<b>Techniques at field level</b>	<ul style="list-style-type: none"> <li>• Fields of every individual farmer should be levelled for effective use of water</li> <li>• Bunding and contouring work should be taken up for soil conservation.</li> <li>• Drainage system for water logged area is to be adopted.</li> <li>• Surplus flows to be stored in buffer storages (Tanks in CA) and reused</li> <li>• Adopting advanced agriculture system like drip irrigation and sprinklers</li> </ul>
8	<b>Alternative resource of water (Groundwater, river)</b>	<ul style="list-style-type: none"> <li>• The lift irrigation scheme canals are running in contour along the valley of the river so the sole abundant source of water is the water in reservoirs and backwater along rivers.</li> <li>• Lifting water from river</li> <li>• Borewells</li> <li>• Ground water, river, rejuvenation of waste water.</li> <li>• Conjunctive use of ground water and canal water</li> </ul>
9	<b>Budget and finance (water fees : tariff, recovery , financial balance)</b>	<ul style="list-style-type: none"> <li>• Water tax to be collected by revenue department. or equivalent powers should be vested to irrigation department or through WUAs</li> <li>• The APMC authorities should conduct the auction of the agricultural products of the farmers after obtaining the clearance certificate from the irrigation officers.</li> <li>• The water fees shall be fixed to the cost equivalent to the 1% of the capital cost + maintenance cost per year.( for 2007-08 ALBC it works out to Rs3000/-per ha per year)</li> </ul>
10	<b>Role of the main agency and of other bodies</b>	<ol style="list-style-type: none"> <li><b>1. Role of main agency KBJNL</b> <ul style="list-style-type: none"> <li>• MOM of canal network up to secondary outlet level</li> <li>• To notify the cropping area and types of crops to be grown</li> <li>• To provide services to water user with assured releases of water as per schedules</li> <li>• Raising of demand and collection of water rates.</li> <li>• Co-ordination with the allied departments.</li> </ul> </li> <li><b>2. Role of other bodies WUAs</b> <ul style="list-style-type: none"> <li>• MOM of canal network below outlet level</li> <li>• Seasonal preparation of farm land</li> <li>• Plan for growing the crops within the stipulated water period</li> <li>• Plan for effective use of water</li> <li>• Should be in contact with the service provider and department of agriculture</li> <li>• Implementation of guide line issued by the service provider</li> <li>• Proper payment of water charges.</li> </ul> </li> </ol>

		<ul style="list-style-type: none"> <li>• Safeguarding of the canal network and structures</li> <li>• Federation of WUAs: Role-policy decisions and dispute redressal</li> </ul> <p><b>3. Agriculture Department</b></p> <ul style="list-style-type: none"> <li>• Land development and drainage</li> <li>• Provision of necessary instructions in optimum use of water, fertilisers etc., to achieve high yield.</li> </ul>
<b>11</b>	<b>Organization of the main agency</b>	<i><u>This aspect is discussed in STEP 7</u></i>
<b>12</b>	<b>Groups of water users : Importance, role, budgets</b>	<ul style="list-style-type: none"> <li>• One water user society should be formed for every 500 ha or part thereof.</li> <li>• Regularization of crop pattern</li> <li>• Water management from the tertiary canal onwards.</li> <li>• Levy and collection of water rates from the member of the society.</li> <li>• Equitable distribution of water among the farmers of the society.</li> </ul>
<b>13</b>	<b>Irrigation Water Productivity</b>	<ul style="list-style-type: none"> <li>• Increased to three to four times by increasing yield 2 times and more efficient water management.</li> <li>• Rs. 150.00 crore/year.( after development of the entire system)</li> </ul>
<b>14</b>	<b>RISKS associated to the scenario</b>	<ul style="list-style-type: none"> <li>• Farmers are adopting illegal methods of withdrawing water from canal and back waters and putting the cross walls to raise the water level and destroying the canal and canal structures.</li> <li>• The maintenance of the system is involved with high risk as there are no judicial / cohesive powers with the department.</li> <li>• Inability to provide water for heavy duty crops</li> <li>• The initial investment cost shall be very high and may continue for a certain period till the system stabilises itself in comparison with the productivity.</li> <li>• Tariff of electrical charges may increase to match real cost.</li> <li>• WUAs may become defunct in due course.</li> <li>• Deterioration of system if WUAs fail to maintain</li> <li>• Small WUAs may not have professional skill to manage</li> </ul>
<b>15</b>	<b>OPPORTUNITIES associated</b>	<ul style="list-style-type: none"> <li>• Development of socio economic status of the society.</li> <li>• Complete recovery of water tariffs</li> <li>• Equitable water supply among users</li> <li>• Increase in employment , Socio economic development of the region, self sufficiency in food productions, ground water recharging.</li> <li>• High productivity</li> <li>• Conjunctive use of ground and canal water</li> <li>• Scope for additional utilisation of 36.50 TMC to cover 1,80,750 ha</li> </ul>

## Step 7 PARTITIONING IN MANAGEMENT UNITS

*The irrigation system management should be partitioned into few level of management and the command area should be divided and subunits (subsystems and/or subcommand areas) that are held homogeneous and/or separate from one another by a singular point or a particular borderline.*

### Management levels

Several options were discussed for management set up at the workshop:

1) Option A: Main agency serving few Local Management Agencies serving WUAs: Main agency of KNJNL operating the main system Lift station and main canals, serving professional Local Management Agencies operating the secondary canals serving themselves small WUAs. In this option the interface between main agency and LMA is at main canal offtakes.

2) Option B: Main Agency serving directly WUAs.  
In this option the Main agency controls water management down to the secondary outlets. WUAs control water below outlets.

These two options are possible because the Command Area of each separated system is not big: 3 levels of organization are not compulsory required and the option with two levels only might be simpler to implement.

In any case further investigation needs to be done as part of the follow up Masscote exercise to examine the advantages and disadvantages of these two options. Improved performance and cost-effectiveness should be the ground on which decision should be made regarding these two options.

The organization hierarchy and staff type for option A is given below:

<b>Organization</b>	<b>KBJNL is Main Agency</b>
LMA's	6 Nos (10000 Ha/LMA)
WUAs	500 Ha each
SE	1
EE	2 ( 30,000 Ha/EE)
AEEs	6 ( 10,000 Ha/AEE)
AEs	24
JE's	15
F.D.A	9
S.D.A	18
Computer operator	4
Pump operators	8
Electrical engineer	3
Tele-phone operator	3
Work inspectors-----	10
Saudi/patkari-----	20
Peon/watchmen-----	9
Drivers-----	9

## **Step 8 MAPPING THE DEMAND FOR OPERATION**

*Objective: Assessing Means, opportunity & demand for Canal Operation*

*A spatial analysis of the entire command areas, with preliminary identification of Sub-Command Areas (Management, service,..)*

In general terms the demand for operation is the results of the level of service to be provided, the importance of perturbations and the sensitivity of the structures along the system. In the Almatti LIS, the approach of the demand for operation has been made with the following steps:

- Water management Strategy
- Service strategy
- Operation strategy

### **Water management strategy**

Water resource is sufficient to feed the officially approved (by the interstate tribunal) and currently installed CAs. What is critical for the strategy is the energy expenditure as seen in STEP 5. Therefore the issue of water is the issue of energy management. As such increasing water storage capacity and retain as much as possible water from precipitation and recycled streams in the command area should be the main “strategy”. This aims to minimize the required water lifted and reduce the energy bills.

This strategy is valid for both seasons but of course during Kharif, fluctuations of internal water flows are much higher than during Rabi and thus operation of the lift stations more delicate.

### **Kharif:**

The water management strategy during Kharif aims at maximizing the internal storage (canals, tanks, groundwater, soils, bandaras, etc). Anticipation of the precipitations should be done to avoid water losses at spills.

- Main canal: Continuous flow, tolerance: +/-10%, flow varied during rain fall
- Distributary: Within the Distry Rotation to 3rd level canal, tolerance: +/-10%
- Pumps to be made use of storing water in buffer storages (online and within CA) during rains for optimum utilization of pumps. If there is shortage in utilization in kharif pumping from canal to be allowed with suitable tariff.

### **Rabi:**

- Main canal: Continuous flow, tolerance: +/-10%
- Distributary: Within the Distry Rotation to 3rd level canal, tolerance: +/-10%
- No pumping from canal by private pumps
- Ensure better service to areas without ground water potential.
- Recycling facilities to be made use of by the users.

### **Service strategy (also previously discussed in the scenario)**

1) Allocation of water to farmers:

- Allocation on volumetric basis to WUAs

- Allocation varies for kharif because of contribution of rain fall
- Allocation for rabi is fixed
- Deficit to be shared equally

2) Schedule of watering: Rotation among distributaries for both Kharif and Rabi. Rotation should be at week level so that the laps between 2 irrigations is reduced to 14 days. Current practice is 10 days rotation leading to a too long laps of 20 days.

3) Deliveries: tolerance of 1 day for Rabi and 3 days for Kharif

4) Specific rules for services to downstream users:

- Water to be fed from tail end to upwards at the beginning of seasons
- Within the distributary rational delivery starts from tail end
- It is the responsibility of tail enders not to waste water

### **Operation strategy**

In Kharif there are two issues related to precipitations:

- Necessity to prompt cut-off the lift supply whenever rain occurs within the CA
- Restart of the rotation irrigation after a period of following due to wide spread rain in the area. Anticipation of delivery needs to be done to avoid a peak of the demand at the same time when soil moisture replenished by rain has depleted uniformly throughout the area.

Rotation no flexibility	: kharif: flexibility in main canal (discharge varies due to rains)
Duration	: weekly
Rabi	: flexibility in main canal
Kharif storages/canal	: Flow controlled by CRs and surplus Stored in buffer
Information system	: Manual SCADA, digitisation of data
Operation rules at various levels	Karif- TOL 10 cm Rabi- TOL 10 cm

Main canal : Khariff: 120 days

CR operated to maintain Water level at FSD.

New structures to be added

CRs (mixed) and escapes, duck bill weirs in Dy

### **Step 9 OPERATION IMPROVEMENTS: CANAL & LIS**

The following points are proposed:

- Measuring devices at canal and distributary heads / baffle modules
- Additional CRs, mixed CRs and escapes in main canal
- Canal de-silting and removal of vegetation
- Duckbill weirs ( Dys)
- Manual SCADA
- Remote monitoring of key locations (lift points and delivery chambers) at Central office

- CRs to be automated (motorised)
- Weather forecasting data to be used for canal operation
- Rain gauge station to be installed
- Name boards in the canal system

#### **Special improvements for lift station**

- Measures (capacitors) to be taken for improvement of power factor
- Communication facility between 1st and 2nd lifts and canal network
- Safety measures to be taken (pumps and motors etc.,)
- Discharge measurements at both lifts
- Illumination and security for Jack wells

#### **Improving the lift station ALBC**

The design of the outlet of the lift station is not optimum: with a submerged structure some 2.7 meters losses could have been avoided with reference to today running conditions.

**Table . Improved Efficiency (head analysis) with a redesigned outlet.**

Efficiency Head static/head total	Efficiency pump for average conditions	Efficiency motor	Overall Efficiency
97.4 %	75 %	96 %	70.1 %

A redesigned outlet would lead to a significant reduction of the head lift. Despite a reduction of pump efficiency from 80 % to 75% the overall efficiency is largely increased from 63 to 70 %. The new design is giving significant gains which are estimated at 10 % of the energy bill.

Another point to be checked by expert is the choice and design of the pumps: it seems that for the average running conditions we are deviating much of the BEP which reduces significantly the efficiency (from BEP 89 % down to 75%).

### **Step 10 AGGREGATING AND CONSOLIDATING MANAGEMENT**

Immediate follow up of the MASSCOTE workshop as defined by the ALIS project managers are as follows:

- *Actual assessment of CCA*
- *Water balance to be further investigated*
- *Buffer storage/ online storage sites to be identified*
- *Opportunities for savings in power consumption to be explored*
- *Actual cropping pattern to be assessed by satellite data*
- *Recycling facilities (barrages/bandharas) to be identified*
- *Groundwater mapping to be done*
- *Drainage maps to be prepared*
- *Withdrawal from river to be assessed*

23<sup>rd</sup> June 2008.