DIAGEO

Uganda Breweries Ltd.

UN Cleaner Production Assesment
Water and Waste Water

Job No. 18884-001-003

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UNEP

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1 Summary

United Nations Environmental Programme have asked Danbrew to conduct an assesment of Uganda Breweries Ltd. in order to identify the potential of saving water and to verify the Cleaner Production methods are appropriate remedies to achieve this potential.

The assessment is part of the ABREW project with the aim of identifying the total potential of water consumption and waste water reductions in the African Brewing Sector. The outcome of the project will be a well documented strategy for implementation and thereby potential funding.

The purpose of Cleaner Production is to continuously reduce consumption and discharge during production. One of the main ideas is that high consumption production facilities can reduce usage by 20 to 50% with out investing in new equipment. Instead of new equipment an effort for training and reengineering the processes is suggested as a remedy.

The report covering assessment of Uganda Breweries Ltd. has three parts; Pre-assessment, In-plant assessment and Feasibility Studies.

The Pre-assessment is based on data send to Danbrew by Uganda Breweries. The data has been computed and the result has been verified by the brewery on the first day of the in-plant assesment. The Pre-assessment shows that Uganda Breweries Ltd. is a medium water consuming brewery with a water / beer ratio of 9.0. Low consuming breweries have a ratio of 5. Packaging accounts for most of the excess consumption, but also Brewhouse and Domestic, Office, Canteen & Garden have the potential for reducing water consumption and discharge.

The 2 day "In-plant" assesment revealed an efficient, well driven brewery with effective processes and few areas of poor water housekeeping except for Packaging. The packaging department has aging equipment and subsequent excessive consumption of water and the pasteurizer and the vacuum pump alone could save more than 400.000 hl of water a year. Water saving in the packaging department is dependent on serious investments in new equipment as well as extended maintenance. The equipment is hard pressed to meet sales requirements which in turn allows little time for maintenance; a vicious circle.

The Brewhouse did not show any significant problems and most of the apparent excess water consumption appeared to be a measuring problem that could be solved by having a meter installed the right place. But some of the leaks in the Brewhouse could have been dealt with faster if the spare parts could be more readily obtained.

In low consuming breweries the Warehouse, Domestic, Office, Canteen & Garden only account for 0,05 of the beer / water ratio. In Uganda Breweries Ltd. t is 0.62. A way to reduce the water consumption would be to reuse more of the treated waste water for gardens and toilets etc.

The in-plant assesment of the management systems showed that their attention is paid to water saving due to standards set by the Diageo Group. The brewery is in the process of being ISO 14001 certified and has already appointed a person for the Bre-

Summery

whouse function to be a specialist within Cleaner production. The responsibility for water consumption is placed solely on the Utility Manager. Uganda Breweries Ltd. monitors the Key Performance Indicators (KPI) on billboards around the brewery, but the water consumption is not part of this reporting.

The feasibility study for investments in new equipment covers a new pasteurizer and a new vacuum pump since those are the obvious suggestions that require major investments.

An investment in a new pasteurizer with equivalent capacity will be 1.5 billion UGX and the payback time will be one year. The fast payback is due to the major beer losses in the pasteurizer. Water/energy saving is not an argument to the brewery by it self even though the water saving potential is 330.000 hl/year.

A new vacuum pump can not be financed by the saving in water. Alternatively it is suggested to recalculate the cooling water using existing cooling facilities. The water sawing potential is 80.000 hl/year.

An extension of the yeast recovery process may be done with out any major investment and with a potential of recovering extra 1% of lost beer. This is equivalent to water saving of 70.000 hl/year.

The conclusion of the assesment of Uganda Breweries is that there is potential water saving of more than 3 million hl/year or 30% and there is equivalent potential of waste reduction.

The UN assumption of 32 hl water per hl beer at African Breweries can not be confirmed. The comprehensive metering at the brewery that Danbrew have confirmed shows a water ratio of 9.0.

Since Uganda Breweries is medium water consuming the Cleaner Production assumptions for high and low consuming breweries does not apply directly. For Uganda Breweries Ltd. the approach would be to take action in all three areas of Cleaner Production; Training, Engineering and Equipment. It this sense UBL falls in the category of low water consuming breweries.

The recommendation is to focus on the packaging area and have new equipment in place since major saving can be achieved along with reduced wastage and supports the correct attitude towards water reductions. The present very high utilisation and the increasing sales demand support the urgency of new equipment in Packaging.

2 Introduction

This assessment of the water consumption and the waste water discharge at Uganda Breweries is part of a UNEP project covering the Water consumption in African breweries. The project is named Abrew and is funded through UN. Danbrew was commissioned to conduct the assessment.

2.1 Objectives

The objective of the Abrew project is to

- identify the potential for water savings in the African brewery sector and suggest solutions.
- develop a UN project for external funding for implementing water conservation measures in the brewing sector and subsequently in the entire beverage sector in Africa.

The objective of the assessments is to test the preliminary assumptions of the Abrew project such as

- African breweries has a water usage of 32 hl water per 1 hl beer.
- Cleaner Production methods are assumed to generate savings of 20 to 50%.

These two assumption together with the assumption of that African breweries can contribute with 171 million m^3 of water saving.

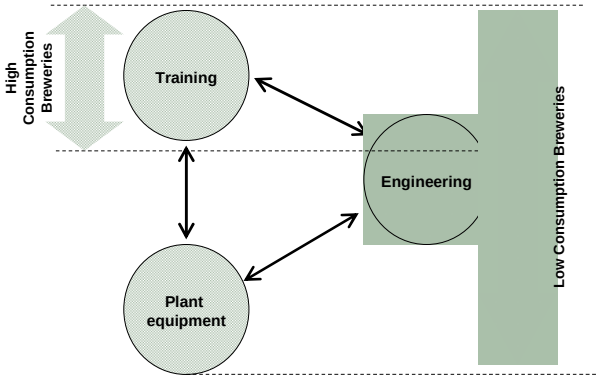
The objective of the assessment is also to test the Cleaner Production (CP) approach for the African Brewery sector. This is done by using an Audit tool develop by Danbrew for CP assessments of water consumption. The results of the test will be incorporated in the audit tool.

2.2 Methodology

The methodology of the assessment is derived from the CP manual from UNEP: Environmental Management in the Brewing Industry (Technical Report N° 33).

The purpose of CP is to continuously reducing consumption and emissions from production processes, products and services. The preferred CP option is reduction of waste at source[1].

Upgrading a brewery in order to implement CP, requires action in three areas that are interrelated as illustrated below. Action in one area without taking complementary action in the other two areas may greatly reduce its effectiveness[2].

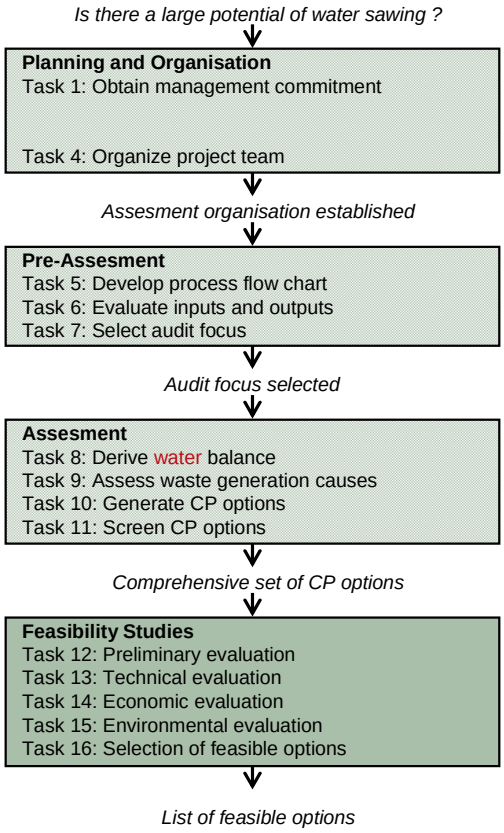


High Consumption Breweries can immediately achieve substantial reduction by addressing management issues and small changes in ancillary operations and process systems.

Low Consumption Breweries need to begin focusing on all three functional groups in detail.

The process of a CP-assessment is described in Technical Report N° 33[3]. Normally the process would be initiated by the brewery, but in this situation the process is initiated by UNEP with a reduced objective compared to normal CP. Therefore the process is reduced to the following:

[1] Technical Report N° 33, p. 39
[2] Technical Report N° 33, p. 40
[3] Technical Report N° 33, Annex 5 p. 101



Compared to the normal CP-assessment approach the implementation & continuation phase is not included. Neither are the tasks of identifying barriers and solutions (task 2) and set up of plant wide CP goals (task 3).

Only the assessment phase has been conducted on site at the brewery. All other phases have been done at the premises of Danbrew. The pre assessment has been done on the basis of a questionnaire and a water audit tool. The purpose of the questionnaire is

1. to get a basic impression of the brewery

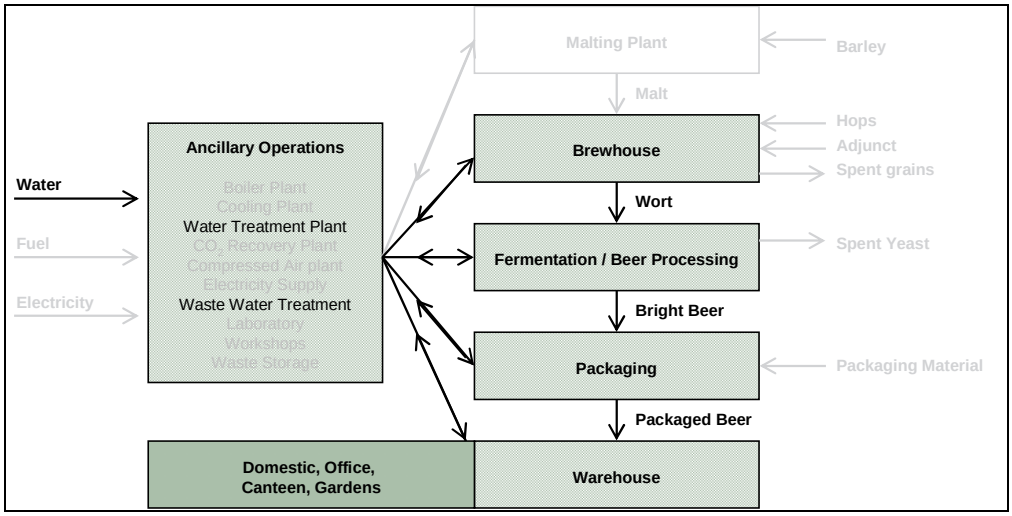
2. to provide material balance data for the water audit tool

The Assessment has been done on doing a tour on the brewery following the water flow (water flow tour) and by interviewing relevant people at the brewery. The water audit tool is more thoroughly described in the section below.

2.3 Water Audit Tool

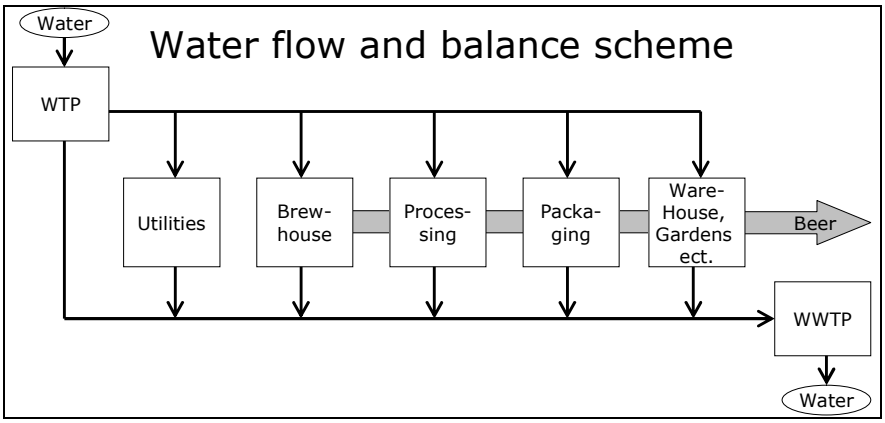
The purpose of the Water Audit Tool is to provide a guide line for the water balances in each part of the process. This requires a process overview, measurements for the relevant parameters and benchmarks. With this information potential water saving can be calculated for each part of the process in order to focus the effort to save water. But the tool also intends to support the decision process of implementing water saving initiatives by calculating the value of the water saving.

The brewing process is described generically in the Technical Report[4]. The generic process also includes other inputs than water and it includes the malting process. For the purpose of an Audit with focus on water usage the holistic process from the Technical Report needs to be simplified. This is illustrated below in the schematic layout of a brewery. The function of Domestic, Office, Canteen and Gardens have been added to the model as an entity together with the Warehouse.



A further simplification of the water flow is illustrated below and is the platform of the Water Audit Tool, which is used in the water CP-assessment of the brewery.

[4] Technical Report N° 33, p. 19



For each of the functions in the process a water balance can be made that defines

1. Input of water
2. Output of beer
3. Output of beer loss
4. Output of waste water
5. Quality of waste water (kg. COD/HL) (only total)

The actual readings can be compared to benchmarks and potential saving can be calculated as the difference between the actual and the benchmark. The focus area of the in-plant assessment should be where the largest potential saving exists.

In order to motivate a water saving effort the water savings are theoretically converted into amounts. This is done from two perspectives; The input / output perspective and the Beer loss perspective.

The input/output perspective is based on the assumption that efforts to reduce water consumption at the brewery will also result in saving of other consumptions and in lees output of waste water. A major input to the brewery is energy that is used to circulate the water around and both to cool and to heat the water. The water audit tool calculates the potential saving on energy by a simple extrapolation between the low and high consuming benchmarks. This approach is used on malt and adjunct, energy, fuel and waste water and the price of all these input and output are therefore part of the data collection. It could be argued that workforce should also be included as well as the cost of the equipment, but the aim is to keep the model as simple as possible and secondly to stay in line with the input/output definitions of the UN Technical Report No 33.

The beer loss perspective is relevant in the sense that beer loss is also loss of water and that the value of beer is high since it's the product of all the inputs to the process.

Both the perspectives are based on the assumption that a reduction in water usages will result in reductions according to benchmarks in other fields of the process. This is

a very rough assumption, but experience with Lean manufacturing shows that such rough simplifications work. Lean manufacturing is also based on an assumption of that focusing on waste and continuous improvement will reduce cost.

2.4 Evaluation of the tool used at the pre-assessment.

Originally the tool was build using Microsoft Visio with Excel objects incorporated, but during the pre-assessment it became evident that this solution was not sufficient. This was due to both IT problems with the Excel and Visio links. But also the fact that the solution could dot handle larger time series.

The development of water usage during the last two years has proved to be important and therefore the tool has now been developed using Excel with the ability to analyse the data of up to two years.

It also became clear during the assessment that the metering in most breweries is not consistent. The reason for this is that metering of water is not normally being prioritised during e.g. installation of new equipment. Therefore meters are sometimes not in the right places which make it difficult to calculate the water balance. One day during the visit at the brewery should be allocated to go though the data and the results from the pre-assessment to have them verified.

The tool is designed for monthly recording of data instead of the most common standard at breweries of weekly recording. This reduces the data in the model significantly, but makes it difficult to us as a tool for ongoing management follow up at the brewery.

3 Pre-assessment

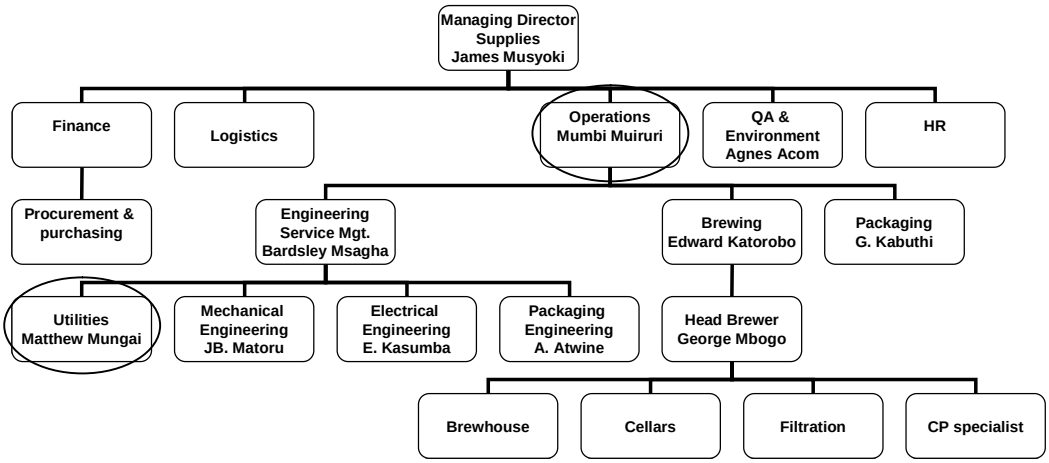
The pre-assessment of Uganda Brewery (UBL) took place in the period from November 2006, when the questionnaire was submitted until the first day of the visit at the site January 22, 2007.

The purpose of the pre-assessment is to analyse the water balance of the brewery and from that derive the focus areas that needs to be addressed during the in-plant assessment.

3.1 Organisation

Uganda Brewery (UBL) is owned by East African Breweries Ltd (EABL). UBL is situated in Kampala. EABL is part of the Diageo group which has HQ in London. EABL is divided in to two separate entities. One is covering sales and distribution in East Africa and the one is covering production at UBL as well as at the brewery in Nairobi.

The management contact person for the project was UBL's Operations Director Mumbi Muiruri. The appointed operational contact was the Utility Manager Matthew Mungai. The organisation of UBL is as shown below.



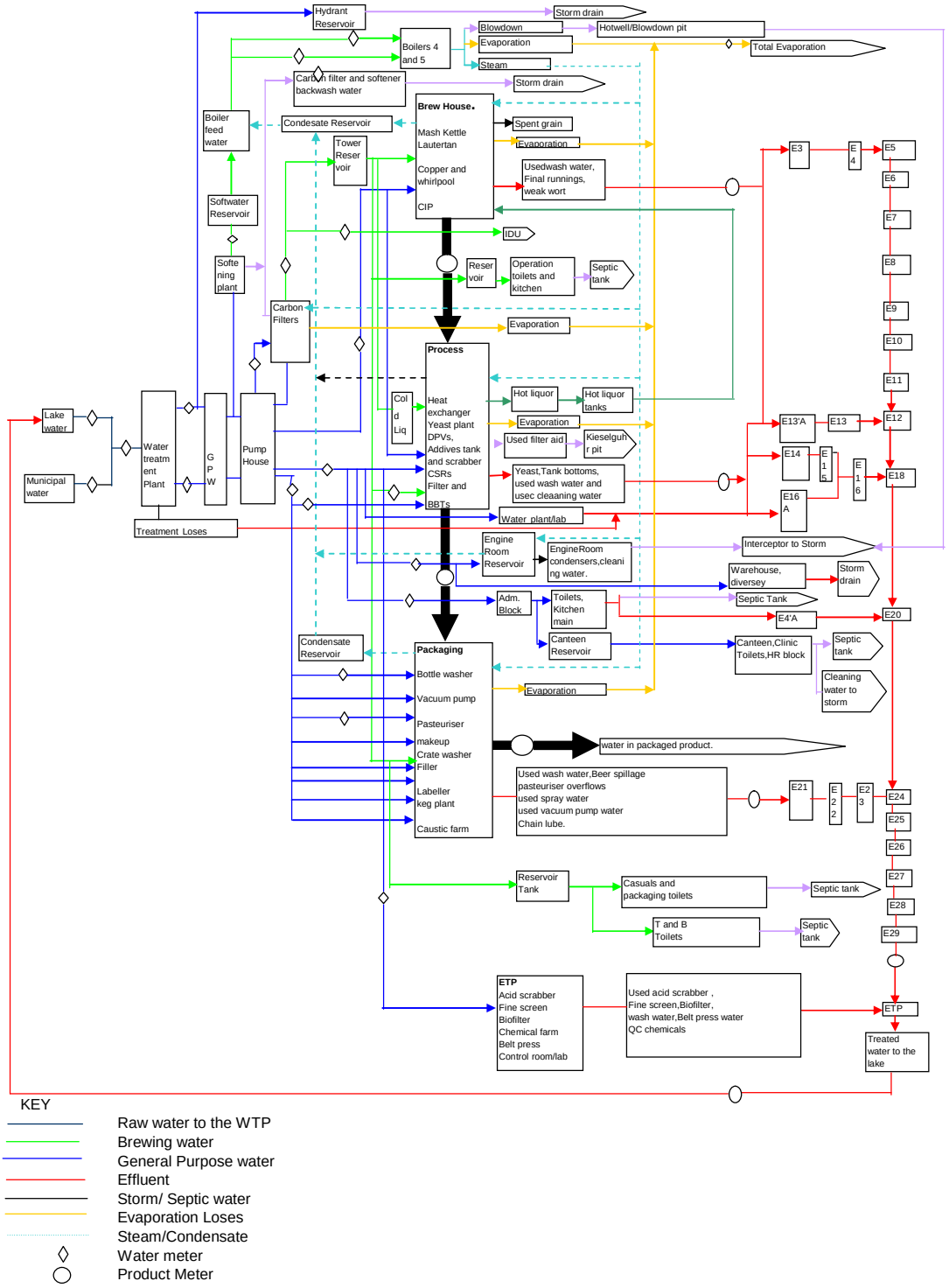
3.2 Production information

The brewery has an annual production in 2006 of 785.000 hl. of beer with a peak month production of 10,2%. December is peak month and March is lowest month. The brewery produces 3 beer types/brands; Bell Lager (40%), Pilsner Lager (20%) and Senator Lager (40%). There is no other production at the brewery.

The brewery has 7 working days with 2 shifts of 12 hours and is therefore working to the extent utilisation. In packaging there is a capacity of 40.000 bph. The target is 60% efficiency but currently the efficiency is 46-51%.

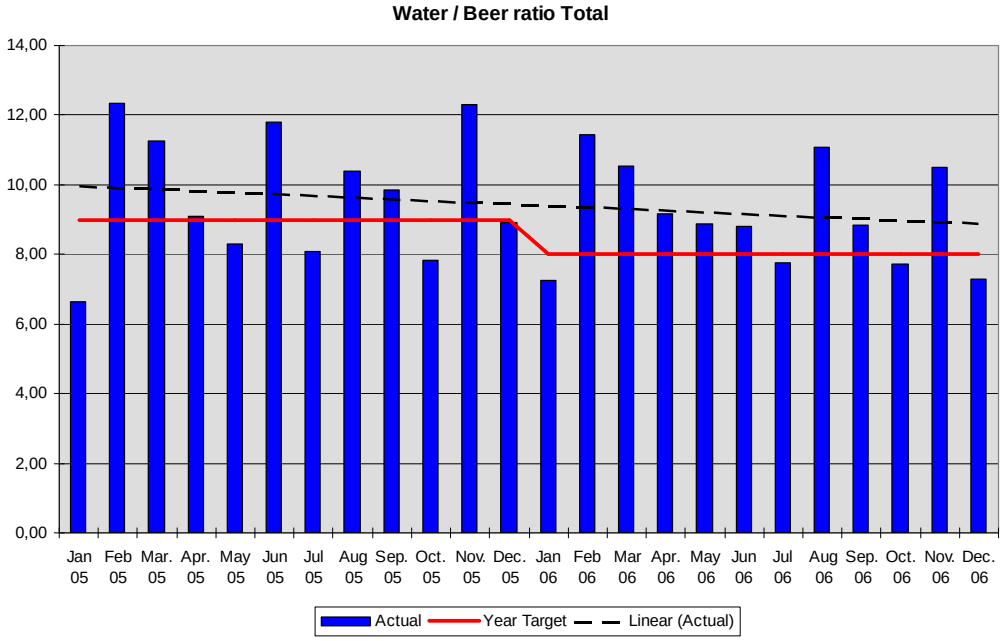
The brewery uses 500 ml returnable bottles. A minor part of the production is Kegs.

3.3 Water flow diagram provided by UBL



3.4 Overall water intake

The water intake to the brewery has been decreasing during the last two years with an average volume consumption in 2005 of 9.5 hl water per hl beer dropping to an average in 2006 of 9.0. This development is illustrated in the graph below. The red line in the graph is the target set by Operations Director.



3.5 Water balance

The 2006 water balance of UBL is illustrated below. The water balance shows that there exists potential savings in 4 out of 5 functions of the brewery.

	Per HL of Beer Sold			Total of the brewery		
	Actual	Low Consumption Brewery	Savings potential	Actual	Low Consumption Brewery	Savings potential
Beer sold	**1**	**1**	**-**	786,329	786,329	-
Water intake in HL						
Utilities	0.42	0.25	0.17	330,946	196,582	134,364
Brewhouse	2.70	1.25	1.45	2,119,640	982,911	1,136,728
Beer Processing	0.70	1.45	0.00	551,980	1,140,177	0
Packaging	4.76	2.00	2.76	3,740,495	1,572,658	2,167,837
Warehouse ect.	0.62	0.05	0.57	489,861	39,316	450,545
Total water intake	**9.20**	**5.00**	**4.95**	**7,232,922**	**3,931,645**	**3,889,474**
Waste water						
Wastewater in HL	7.45	3.5	3.95	5,854,483	2,752,152	3,102,331
COD kh	1.49	1.00	0.49	1,170,897	786,329	384,567
BOD kg	0.77	0.80	0.00	608,866	629,063	0
Beer losses in hl						
Brewhouse	0.0050	0.0100	0.00	3,931	7,863	0
Processing	0.0350	0.0250	0.01	27,522	19,658	7,864
Packaging	0.0150	0.0150	0.00	11,795	11,795	0
Warehouse	0.0000	0.0005	0.00	0	393	0
Total beer loss	**0.055**	**0.051**	**0.010**	**43,248**	**39,710**	**7,864**

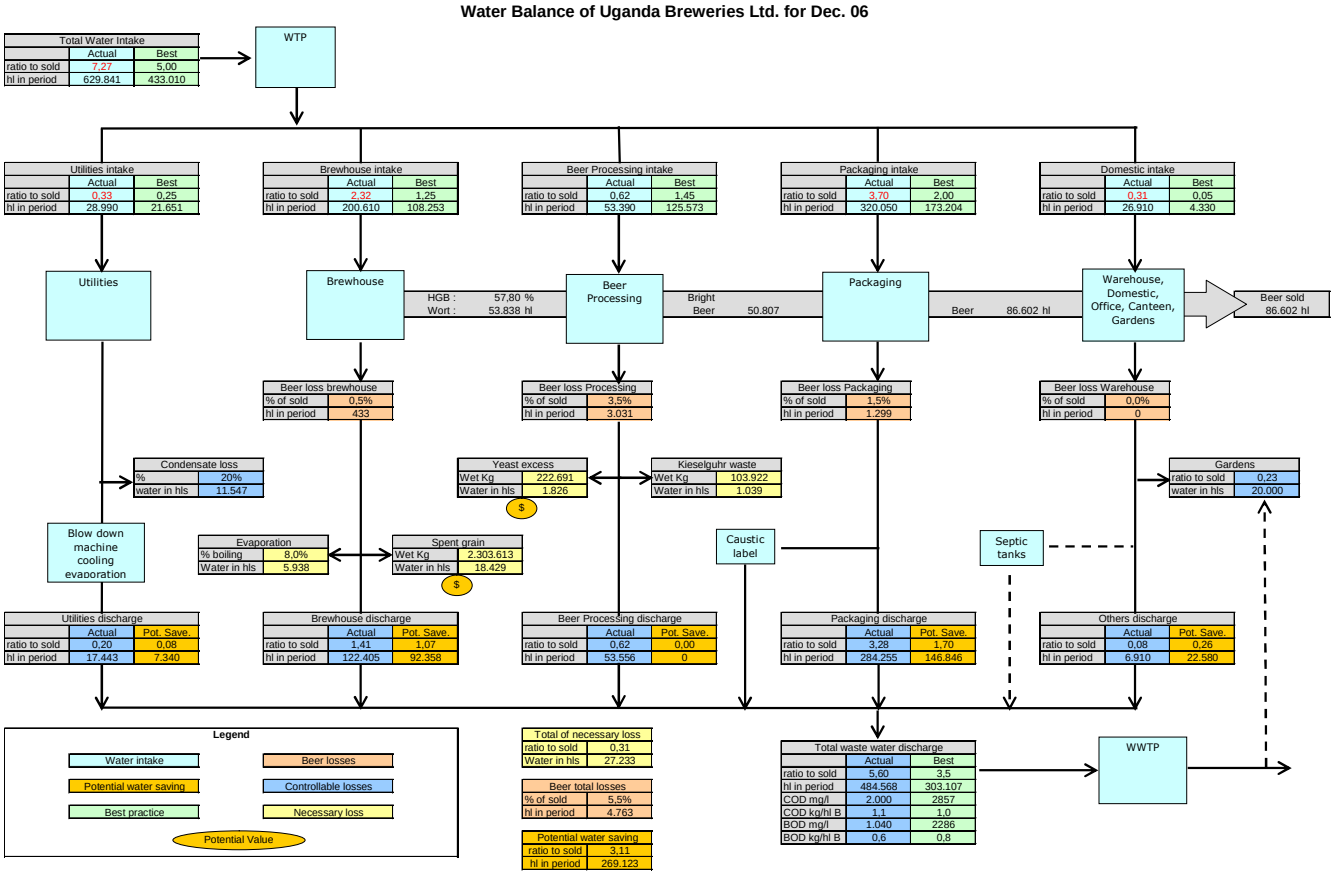
The most significant saving is within Packaging where the water intake is equivalent to a water/beer ratio of 4.7 where in a low consumption brewery it is 2.0. This is a large effect due to Packaging being the largest water consumer in the brewery. The potential saving is calculated to 2.1 million hl./year

Secondly the Brewhouse has potential of savings of 1.1 million hl if the water ratio is brought down from 2.6 to 1.3.

Thirdly there is a potential at the Warehouse, Domestic, Office, Canteen and Gardens where the ratio is 0.6 compared to low consumption ration of 0.1. The potential saving is 0.4 million hl./year.

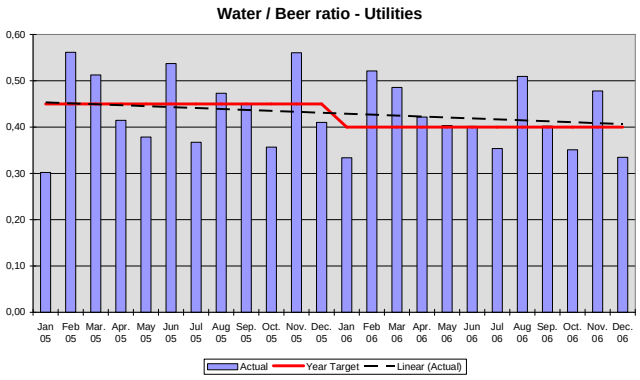
The fourth area is utilities with a potential saving 0.1 million hl. due to a present ration of 0.4 compares to low consumption ration of 0.3.

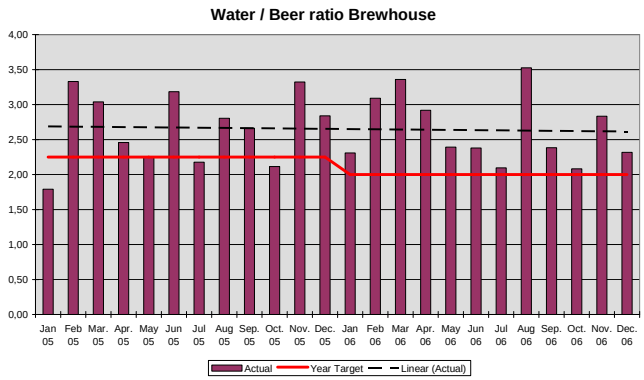
The complete flow of the water as well as the Beer is illustrated in the model below:

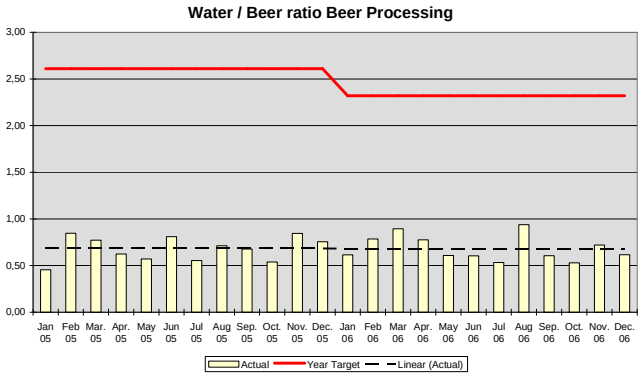


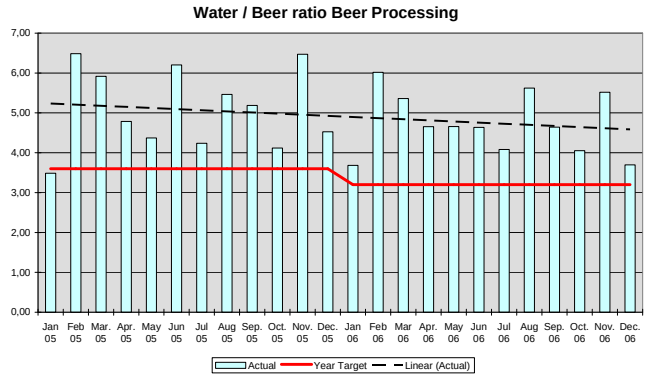
3.6 Water intake development per function

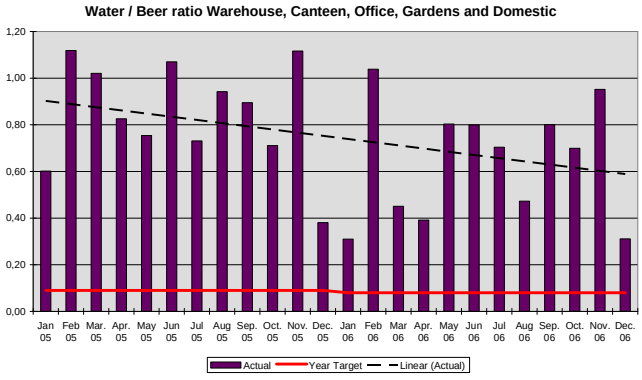
The trend analysis shows improvement during the 2 years for all function except Beer Process, that all ready has very low intake.











3.7 Water usages in a financial perspective

Saving water will normally result in savings in the cost of acquiring water. Since UBL pays a flat fee for the right to extract water from Lake Victoria there are no direct variable costs associated with the water intake, neither is there any variable cost associated with the waste water disposal discharged back in to the lake (just a flat fee).

If we, on the other hand, assume that water saving is related to the intake of other materials as well as the amount of waste products and byproducts, the financial implication can be estimated from this by extrapolating between high and low consumption benchmarks using the water consumption as the indicator. The result of such input output extrapolation would be as follows:

	Per HL of Beer Sold			Total of the brewery		
	Actual	Low Consumption Brewery	Savings potential	Actual	Low Consumption Brewery	Savings potential
Extrapulated effect on other input/outputs						
Malt / adjuct in kg	15.99	15.00	0.99	12,572,831	11,794,936	777,895
Energy in MJ	215.95	150.00	65.95	169,809,020	117,949,362	51,859,657
Electricity in kWh	13.30	10.00	3.30	10,456,274	7,863,291	2,592,983
Spent grain	15.66	15.00	0.66	12,313,533	11,794,936	518,597
Excees yeast	3.00	3.00	0.00	2,358,987	2,358,987	0

Given the following unit prices

Cost of Malt/Adjunct per kg	967.50	UGX
Cost of Energy per MJ	18.69	UGX
Cost of electricity per kWh	123.00	UGX

the financial effect of such extrapolation would be yearly savings of 2.0 Billion UGX/year or 2,595 UGX/HL of beer as shown below:

	Per HL of Beer Sold			Total of the brewery		
	Actual	Low Consumption Brewery	Savings potential	Actual	Low Consumption Brewery	Savings potential
	UGX			UGX		
Financial effect on inputs						
Cost of Water	0.00	0.00	0.00	0	0	0
Cost of Malt / adjuct	15,469.62	14,512.50	957.12	12,164,214,078	11,411,600,799	752,613,279
Cost of Energy	4,035.82	2,803.28	1,232.54	3,173,480,041	2,204,299,557	969,180,484
Cost of Electricity	1,635.60	1,230.00	405.60	1,286,121,664	967,184,771	318,936,894
Total inputs	**21,141.04**	**18,545.78**	**2,595.26**	**16,623,815,784**	**14,583,085,127**	**2,040,730,657**
Financial effects on outputs						
Cost of Waste Water	0.00	0.00	0.00	0	0	0
Value of spent grains	156.60	150.00	6.60	123,135,328	117,949,362	5,185,966
Value of excess yeast	0.00	0.00	0.00	0	0	0
Total outputs	**156.60**	**150.00**	**6.60**	**123,135,328**	**117,949,362**	**5,185,966**
Financial total	**21,297.64**	**18,695.78**	**2601.86**	**16,746,951,112**	**14,701,034,489**	**2,045,916,623**

Another perspective to the savings would be to look at the cost implication from beer losses and assuming that an effort to reduce water usage will affect the beer losses equivalent. The financial effect would then be 408 million UGX/year or 519 UHX/hl of-beer shown below:

	Per HL of Beer Sold			Total of the brewery		
	Actual	Low Consumption Brewery	Savings potential	Actual	Low Consumption Brewery	Savings potential
	UGX			UGX		
Beer loss						
Cold Wort	157	315	0	123,815,723	247,646,128	0
Bright Beer	1,817	1,298	519	1,429,091,154	1,020,767,869	408,323,285
Packaged Beer	2,100	2,100	0	1,651,267,242	1,651,291,072	0
Beer loss total	**4,075**	**3,713**	**519**	**3,204,174,119**	**2,919,705,069**	**408,323,285**

The savings in both the beer loss perspective and the input/output perspective give an indication of the financial potential of savings.

This is of cause based on the assumption that the effort for reducing water usage will affect the usage of other materials and their equivalent waste. An in-plant assessment of the potential should provide a better indication.

3.8 Audit focus for the in-plant assessment

The focus of the in-plant assessment of UBL is:

	Actual ratio Peak / non peak	Low Consumption Ratio	Potential savings
Average usage in 2006	9,2	5,0	3.9 million hl/year 2.040 million UGX
Major loss at Packaging	4,7	2,0	2,0 million hl/year 1.140 million UGX
Medium loss at Bre-whouse	2,6	1,3	1,1 million hl/year 597 million UGX

In order to target the focus areas the following people should be involved:

- QA & Environment Manager Agnes Acom
- Brewing Manager Edward Katorobo
- Packaging Manager G. Kabuthi
- Utilities Manager Matthew Mungai
- Mechanical Engineering Manager JB. Matoru
- Packaging Engineering Manager A. Atwine
- Head Brewer George Mbogo
- CP specialist

4 In-plant assessment

The in-plan assessment of Uganda Brewery (UBL) has taken place in the period from January 24 until January 25, 2007.

The purpose of in-plant assessment is to identify the causes of high water consumption and discus possible solutions with the people involves in the following functions in the process:

- Packaging
- Brewhouse
- Warehouse / Domestic

The In-plant assessment is based on a tour on the brewery following the flow of the water from the water treatment plant to waste water outlet. The focus areas will be subject for a more through investigation and interviews with key persons.

4.1 Water Tour

The brewery is well maintained with relative few water leaks, being kept clean and tidy, with Packaging as an exception.

The age of equipments varies and the newest major investment is the Waste Water Treatment Plant. The equipment at Packaging is the oldest in terms of running hours.

The utilisation capacity of the brewery seems to be close to the limit in both Beer Processing and in Packaging. This will inevitable result in less time for maintenance, which especially seems to be the situation at Packaging.

4.2 Packaging

The situation in Packaging is poor both in terms of water usage and in other areas. The water intake at Packaging is 3.7 million hl at a water / beer ration of 4.7. The water saving potential is 2.1 million hl. At the same time the beer losses in Packaging is 2.0% and this should only be around 0.5%.

During the 3 day visit there were observed much more broken bottles on the floor than necessary. The urge to keep the place need and tidy seem to be limited. This was very much demonstrated by the pile of crates on the picture below:

In-plant assessment

There are leaking pipes all over the packaging area. The Pasteurizer and Vacuum Pump are major causes of water loss.

The Pasteurizer is not in balance and one of the circulation pumps is out of order. The result is a yearly water usage of 330.000 hl as shown on the two pictures just below. A new pasteurizer would use around 1.000 hl since it only uses water for start-up/shut down and not when it is operating. However the loss can be reduced if the broken pump is replaced or repaired and the machine brought into balance in terms of water usage and correct zone temperatures.

The vacuum pump on the picture below is using large quantities of water for cooling the pump. It is estimated that the pump uses 10 hl/h or approx. 80.000 hl. year. There exist two solutions to this both involving new equipment. The vacuum pump can be replaced with a non-water using vacuum pump or the water from the water pump can be cooled down again and reused. Such solution would require a cooling tower.

Even though that problems of not keeping the packaging area need and tidy is related to management, the cause is the poor condition of the equipment. The equipment is too old and is not properly maintained. New technologies has been developed that will save water, but better maintenance and operation of the existing will also have positive effect on the water losses and the beer losses.

The very high utilisation with production 24 hour a day for 7 days a week leaves very little space for maintenance. The market forecast shows that there will be a need for even more capacity. In this sense the root cause can be determined to be insufficient capacity.

4.3 Brewhouse

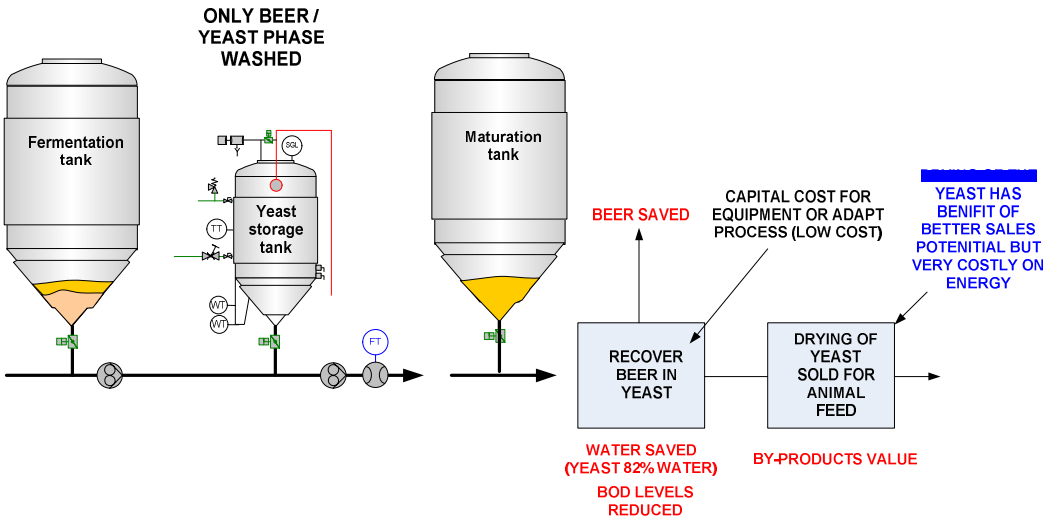
The pre assessment showed that the Brewhouse was using 2.1 mil. hl of water a year a water/ beer ration of 1.3. This gives a potential water saving of 1.1 mil. hl.

The in-plant assessment of the process did not give any indications of such high usage, and only minor water leaks were found.

An example was this steam leakage that obviously (marks on the wooden door) has been there for a very long time. The Mechanical Engineer informed that the relevant spare part to solve this problem would take approx. 2 month from ordering until delivery. Such delivery time most be considered as an cause of wasting water in the delivery period but also it is a barrier for solving the problem.

The reason for the apparently high usages of water in Brewhouse was the positions of the meters. The meters at UBL are placed in a way that it is not possible to segregate Brewhouse from Beer processing in the right way. As a result the two functions should be seen as one, with at total water consumption of 2.6 mil. hl. at a ration of 2.6 with a potential saving of 0.5 mil. hl. Such minor saving of 19% is with in range without investment in new equipment, but metering should be in place in order to target the water usage.

One way of saving could be excess yeast recovery following the principle illustrated below:



UBL is already recovering beer from the maturation tank bottoms. It was suggested that all excess yeast could be treated in the same manner as that currently used for maturation tanks. There is a potential of recover extra 1% of lost beer. This is equivalent to water saving of 70,000 hl/year.

In contrast to the more common yeast recovery method this suggestion is without any investment, but there is a risk of affecting the beer quality. Breweries using this

method have differing results. UBL actually plan to follow the suggestion and Danbrew will be interested in hear of their experience.

The yeast from UBL is presently being transported to the municipal waste water treatment plant since the UBL waste water treatment plant does not have sufficient capacity. UBL is presently installing a yeast dryer that can solve this. The yeast recovery method mentioned above may increase the yeast solid concentration allowing better operation of the drying (>18% solid needed at the stream rollers) and avoid over pre-heating of the yeast going to the Yeast Dryer.

4.4 The Warehouse, Domestics, Office, Canteen and Gardens

The water usage in Warehouse Domestics, Office, Canteen and Gardens is 0.5 mil. hl. at a ration of 0,6. This is a very considerably excess compared to low consuming breweries where the ration is 0.05.

The in-plant assessment did not give any reasons to the high usage other than there where large areas of the gardens that would need watering during dry periods and the water from the Waste Water Treatment Plant could be use for this. This solution could also apply for the toilets, even though that there was no indication of the toilets being the cause of the high usage. The brewery does have a small header tank for garden irrigation purposes.

4.5 Management and Training

In different places around on the brewery the management presented the past weeks results on billboards as shown in the example below. There was no visible focuses on water usage.

The Utility Manager is responsible for the water usages and the water/beer ration is set to be less the 7 for year 2007. This aim is set by the Operations Director. But the aim is not broken down in to each of the functional areas of the brewery and neither is the responsibility. The driver for water saving is the environmental standards of Diageo Group.

A person has recently been appointed responsible of Cleaner Production and is reporting to the Brewhouse Manager. This function is not in operations yet. The driver for establishing such function is the environmental standards of Diageo and the opportunity of getting support from Uganda Cleaner Production Centre (UCPC).

Even though the brewery is in good condition a number of minor improvements could help to save water. Eg. use of hoses for cleaning with smaller diameter and/or with pistols with is illustrated by the picture below of the 1½ inch hose pipe on the floor. The lack of such simple solution indicates a potential for more management focus on water consumption.

Compared to the large water usage of a brewery this might be a minor issue but it is important for the management to visually demonstrate their effort to save water and especially avoid clear visual failures of saving water. At UBL water saving is already a difficult message to communicate. As the Utility Manager stated:

> "How can we convince people that there is a need for saving water when they can take a look out of the windows and see Lake Victoria"

4.6 List of CP-options

Training and engineering:

- The responsibility of water usages should be given to those persons who are responsible for the process where the water is being used.
- Correct metering between Brewhouse and Beer Processing should be implemented.
- CP-training for people in Packaging. When Packaging is on the same level as other departments the CP-training programme should involve all employees.
- Yeast recovery from fermentation tanks.
- Change of spare part vendor. Eg. LCH A/S, Copenhagen Denmark who has specialised in deliveries world wide over night.
- Watering the gardens with water from Waste Water Treatment Plant (if not already done)

Major investments in equipment:

- New pasteurizer (with higher capacity)

- New vacuum pump or irrigation system

The investment in equipment is considered as a barrier of gaining substantial water savings at UBL.

5 Feasibility Study

In this chapter the feasibility for the water improving investments is calculated and evaluated in economic, technical and environmental perspective.

The investments that is subject for the calculation is:

- New Pasteurizer
- Vacuum pump

The other CP options are not subject for feasibility studies since the investments related to them is either very small or only related to the time spent for management and training.

5.1 New Pasteurizer

Losses of beer can be reduced by maintenance and balancing the old pasteurizer or by acquiring a new pasteurizer. Both solution are technical feasible.

The cost of a new Pasteurizer with the same capacity as the existing is as follows:

Pasteurizer (Basic model)	520,000	EUR
Shipping	25,000	EUR
Installation	45,000	EUR
Duty, Clearing and Forwarding	88,500	EUR
Pasteurizer total	678,500	EUR
Pasteurizer total	**1,493**	**M UGX**

A new and efficient pasteurizer will result in savings on beer loss and on water usages. The cost of beer loss is in this calculation set equivalent to the sales price since production is lower than market demand.

The estimated value of one beer is 725 UGX. The actual cost have not been available during the assessment and therefore the value is estimated from the sales price taking into account the there is 60% added tax.

In addition to this the beer loss is due to bottle breakages and the loss of the returnable bottles must also be taking into account. A new bottle costs 392 UXG and is expected to have a lifetime of 20 trips. The average age of bottles being destroyed in the pasteurizer is assumed to be 10 trips with a value of 196 UGX.

The loss of bottles in the old pasteurizer is 1% according to the recordings of UBL. With a annual production of 785.000 hl the value of the lost beer is 1,446 million UGX.

In terms of water energy usage the calculation is as follows.

UBL has calculated the cost water supply by summing the energy, the cost of manning and maintenance and the cost of waste water treatment. The cost calculation is 44.1 UGX pr. hl.

The cost of heating the water in the pasteurizer can be calculated from the temperature increase (20 K) and cost of energy (123 UGX/KWH). The cost for heating of one hl of water is 28.6 UGX.

The in-plant assessment showed an unnecessary loss of water of 40 hl/h or 330,000 hl/year equivalent 24.1 million UGX.

Value of beer lost	1,446	billion UGX
Cost of water	14	billion UGX
Cost of heating	10	billion UGX
Total saving	**1,470**	**billion UGX**

From a financial perspective a new pasteurizer will have a pay back time of one year.

In an environmental perspective the feasibility of operating with a new pasteurizer is evident, since:

- No change in contamination of process wastes.
- No cross media effects.
- No change in toxicity, degradability or tractability
- 330,000 hl of water saved per year
- 1.5 million kWh of electricity saved per year

5.2 Vacuum Pump

The loss of water due to the vacuum pump can be reduced significantly either by replacing the pump with a no-water-consuming pump or by installing a water cooling facility for the vacuum pump.

Current experience has shown problems running with no-water-consuming pump, but advances will make them more practical.

Generally with already installed pumps a circulation system with an existing tower etc. is envisaged.

The total cost of a new Vacuum Pump with the same capacity as the existing is approximately 25.000 EUR or 55 billion UGX. The cost of installing a water cooling de-

pend very much of the existing opportunities at the brewery but it should not exceed 10 billion UGX.

The water consumption of the present vacuum pump is approx. 80.000 hl/year and considering the present cost of water calculated by UBL this has a value of 35 million UGX. The savings is not able to cover the interest of the investment in any of the two cases. In a financial perspective water saving will not a drive a more effective solution, unless the brewery can use existing facilities (which is likely).

In an environmental perspective the feasibility of operating with a new pasteurizer is evident, since:

- Reduced contamination of process wastes.
- No cross media effects.
- Reduced toxicity, degradability or tractability
- 80.000 hl of water saved per year
- Minor saving in electricity