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Water Management at a Textile Industry: A Case Study in Dhaka

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ABSTRACT

There are various major textile industries in Dhaka, namely the agricultural primary sector, secondary manufacturing sector textiles and electronic products and a public services sector. The textile industrial sector is established at four sites, two of which are in Narayangong the capital city of Dhaka, and the others are in Chittagong district. The textile industry plays a major role in the country's economic growth and employment creation. It contributes about 40-45% of the country's Gross Domestic Product and employs over 40000 women, which makes it the second largest employer after the government. In every industrial sector where there is production of waste; be it solid, liquid or gaseous; the first tier of management is waste minimization and pollution prevention to reduce the quantities and strength of wastes generated. However, not all wastes from industrial activities can be minimized or recycled, which introduces treatment as the second tier of waste management. The final option in the management of waste is disposal. In order to provide comprehensive and proper wastewater management actions for garments Industrial Pty all three tiers will be addressed.

Keywords: *Water, Management, Textile Industry, Bangladesh*

INTRODUCTION

There are various major textile industries in Dhaka, namely the agricultural primary sector, a secondary manufacturing sector textile and electronic products and a public services sector. The textile industrial sector is established at four sites, two of which are in Narayangong the capital city of Dhaka, and the others are in Chittagong district. The textile industry plays a major role in the country's economic growth and employment creation. It contributes about 40-45% of the country's Gross Domestic Product and employs over 40000 women, which makes it the second largest employer after the government.

Unfortunately the textile industry is also an industrial sector that uses vast amounts of water, exerting increased pressure on available natural resources. Water as a resource experiences this pressure in Maseru, where two of the country's textile industries are situated. Water is Dhaka's primary natural resource and even though it is considered abundant, seasonal and annual variations makes it a scarce resource. For example, the capital Dhaka is already in a critical water shortage situation. The total water supplied to the city amounts to 28 Ml/day, of which more than one third (12 Ml/day) is used by the textile industries, with 1,8 Ml/day lost due to evaporation and spillages, and the rest discharged as effluent (Gibbs and Gibbs, 2002).

The effluent from the textile industries is loaded with various chemicals and dyes from the wet processes involved within the industry. Until mid 2004 there has been no form of treatment for any effluent from the Dhaka based industries. All effluents have been discharged into the Burigonga stream, finally ending up in this River. For this case study, the water management at CGM Industrial in Dhaka will be investigated. The effluent produced from this textile industry is now treated in a wastewater treatment plant, with a portion of the treated water returned to the washing and dyeing plant for reuse and the remainder discharged. On occasions, untreated water is discharged into the Burigonga stream to avoid overflow of the treatment plant, resulting in water quality problems downstream from the Industrial site.

OBJECTIVES OF THE STUDY

1. Evaluate current water management practices at CGM Industrial
2. Compile an active water balance for the company, and
3. Present suitable water management actions to negate the company's negative impacts on Dhaka's scarce water resource.

RESEARCH METHODOLOGY

Given the objectives of this study, the critical part for their achievement will be obtaining data for compilation of the water balance for the company. The results from the water balance will assist in presenting suitable water management actions for the company.

Twenty four days (1 working month) will be spent at the industry for collection of data and inspection of the overall production processes entailed within the company. It is believed that this will provide sufficient data to represent what happens within the company each month. The type of data collected will be more of a quantitative than a qualitative nature. This is based on the objectives of the dissertation, which are compiling a water balance (quantitative data) and using the results of this data in assisting the company to develop a comprehensive water management plan. During the time spend at the company, overall water and chemical usage in the washroom will also be observed and this will be outlined in the conclusions and recommendations. During the twenty four days of data collection, the number of loads processed for each of the four wet processing combinations will be noted. Each process combination consists of various wet processing operations and the amount of water used for each process differs depending on the operations entailed in each. Each process will be assessed and the amount of water consumed will be used in compilation of the water balance for each. In order to compile a comprehensive water balance, additional data with regard to water usage within the company, other than the process water, will also be obtained. This data includes water used for steam, cleaning water, checking water, water used for ablution facilities, drinking water, as well as water used for personal hygiene. All these water streams constitute the input water into the company, which should essentially be equal to the water leaving the company, as there are no big water storage facilities at the company. It is anticipated that exit water streams will most likely be confined to process wastewater, evaporation water, water absorbed by stones, as well as drinking and ablution facilities wastewater. The amount of water used at the company will be presented either from direct data collection of the amount used for each of the process combinations for the number of loads processed during the twenty four days spent at the company, or through assumptions made due to lack of readily available data. Water discharged from the company will also be assessed based on interviews with the personnel responsible for the wastewater treatment plant, as well as from assumptions made during the data collection period (should sufficient monitoring and sampling/analyses of discharge water not be available). Using data obtained as set out above, active water balances for each process combination will be compiled and conclusions and recommendations will be made based on the outcome of the overall water balance for the company.

RESULTS AND DISCUSSION

Water at garments Industrial is used for several purposes; including drinking, personal hygiene (washing dishes and hands) and for the main focus of this dissertation, wet processing used during the manufacturing of garments (jeans). In all factories Presitex, the same processes are carried out, represented in the overall water balance for garments in Figure 1; with a simplified water balance presented in Figure 1.

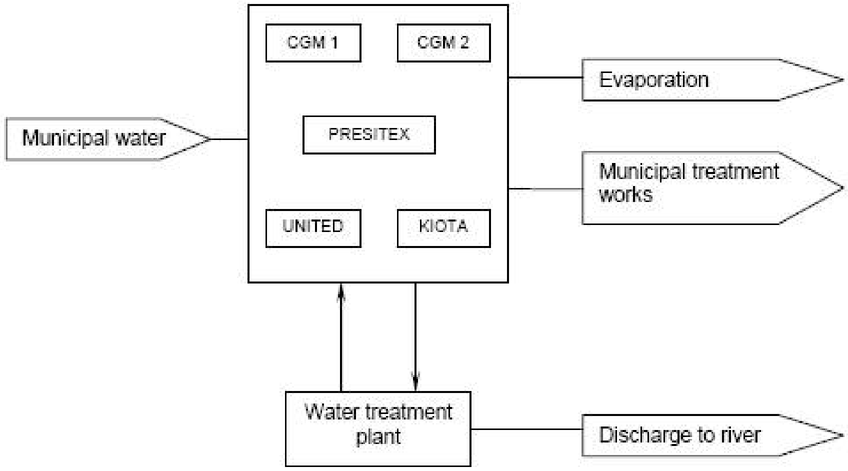
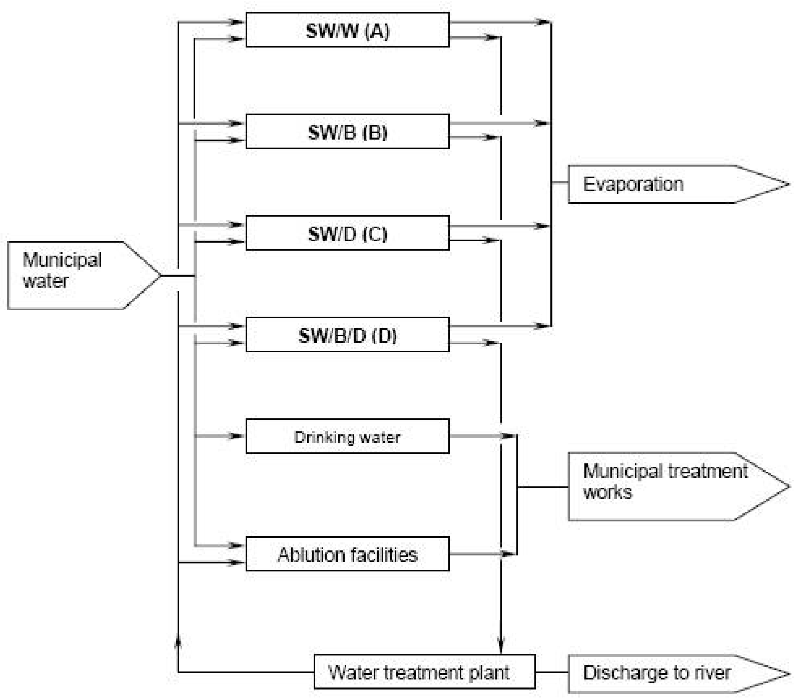


Figure 1: Overall water balances for garments industry



SW/W (A): stone washing/washing (Process A) **SW/D (C)**: stone washing/dyeing (Process C)
SW/B (B): stone washing/bleaching (Process B) **SW/B/D (D)**: stone washing/bleaching/dyeing (Process D)

Figure 2: Simplified water balance for processes entailed at garments factory

The simplified water balance for garments (Figure 2) is representative of each of all factories. Municipal water enters and is used in the wash room for the four main wet processes, namely stone washing/washing, stone washing/bleaching, stone washing/dyeing, and stone washing/ bleaching/dyeing; as well as for cleaning of floors. Municipal water is also used for drinking water and to augment ablution facilities' water requirements. The effluent generated from garments factory consists of the wastewater from the wash room processes, and drinking and ablution facilities. The effluent from the wash room processes is discharged to the water treatment plant; where it is treated, a portion recycled back to the factory and the remainder discharged to the river. Water from the drinking and ablution facilities is discharged into WASA's (municipal) sewerage system. Finally, water is also lost from the factory through evaporation, mostly from the drying processes.

Table 1: The number of loads processed at CGM 1

Date	SW/W	SW/B	SW/D	SW/B/D	Number of machines in
01/12/04	11	-	26	-	7
02/12/04	1	2	45	-	9
03/12/04	14	12	73	-	18
04/12/04	-	-	32	-	8
06/12/04	4	-	64	87	27
07/12/04	-	-	90	5	19
08/12/04	-	-	65	108	29
09/12/04	-	-	96	-	16
10/12/04	-	-	94	-	16
11/12/04	-	-	31	44	17
13/12/04	-	-	94	-	17
14/12/04	-	16	90	-	21
03/01/05	6	-	20		8
04/01/05	-	-	16	-	4
05/01/05	-	-	61	-	14
06/01/05	-	-	74	-	15
07/01/05	-	-	77	-	15
08/01/05	-	-	66	-	15
10/01/05	8	-	54	8	16
11/01/05	8	-	86	-	16
12/01/05	4	-	163	-	27
13/01/05	-	-	167	1	28
14/01/05	-	-	21	161	30
15/01/05	-	-	30	160	30
Total	**56**	**30**	**1 635**	**574**	

Depending on the style and size of the garments to be processed, a particular load can consist of a different number of garments. For smaller size garments there would be a lot more pieces of garments than a bigger size of the same style. For example, a particular load can have 150 garments that weigh 70 kg and for the next load 220 garments, which still weigh 70 kg. At garments the weight of the load to be processed is kept standard at 70 kg, although the garments may vary in number. For this dissertation a single load of 120 garments weighing 70 kg was used for all calculations.

Table 2: The number of operations that used steam at garments

Process	Steam using operations	No of loads processed	Total number of operations
Process A	2	56	112
Process B	4	30	120
Process C	3	1 635	4 905
Process D	4	574	2 296

Table 3: Flow rates for the operations in the stone washing/washing process combination

Stream	Flow rate (l/d)	Source
A1	1 167	Section 4.4.1
A2	9 333	Section 4.4.2
A3	1 167	Section 4.4.3
A4	1 167	Section 4.4.4
A5	1 167	Section 4.4.5
A6	117	Section 4.4.6
A7	7	Section 4.4.7
A8	136	Section 4.4.8
A9	6 382	Section 4.4.9
A10	78	Section 4.4.10
A11	20 565	A1 + A2 + A3 + A4 + A5 + A6 +A7 + A 8 + A9 – A10

Table 4: Flow rates for the operations in the stone washing/ bleaching process combination

Stream	Flow rate (l/d)	Source
B1	625	Section 4.5.1
B2	5 625	Section 4.5.2
B3	625	Section 4.5.3
B4	1 875	Section 4.5.4
B5	1 875	Section 4.5.5
B6	625	Section 4.5.6
B7	625	Section 4.5.7
B8	125	Section 4.5.8
B9	12	Section 4.5.9

B10	146	Section 4.5.10
B11	5 455	Section 4.5.11
B12	57	Section 4.5.12
B13	17 556	B1 + B2 + B3 + B4 + B5 + B6 + B7 + B8 + B9 + B10 + B11 B12

Table 5: Flow rates for the operations in the stone washing/dyeing process combination

Stream	Flow rate (l/d)	Source
C1	34 063	Section 4.6.1
C2	306 563	Section 4.6.2
C3	34 063	Section 4.6.3
C4	68 125	Section 4.6.4
C5	68 125	Section 4.6.5
C6	6 813	Section 4.6.6
C7	136	Section 4.6.7
C8	5 968	Section 4.6.8
C9	234 687	Section 4.6.9
C10	2 512	Section 4.6.10
C11	756 031	C1 + C2 + C3 + C4 + C5 + C6 + C7 + C8 + C9 - C10

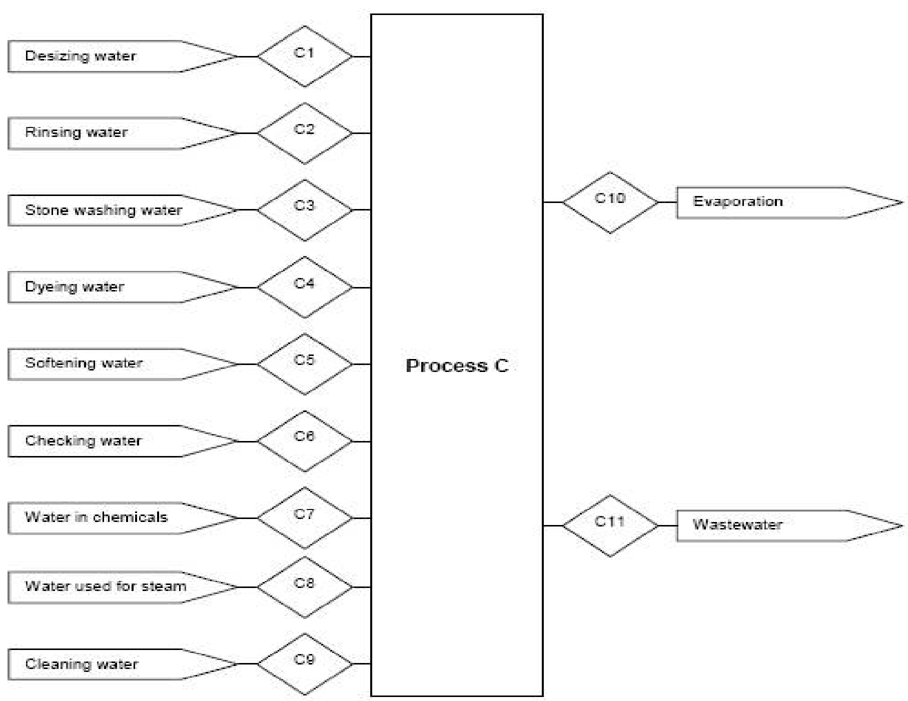


Figure 3: Water balance for the stone washing/dyeing process combination.

Table 6: Flow rates for the operations in the stone washing/bleaching/ dyeing process combination.

Stream	Flow rate (l/d)	Source
D1	11 958	Section 4.7.1
D2	107 625	Section 4.7.2
D3	11 958	Section 4.7.3
D4	35 875	Section 4.7.4
D5	35 875	Section 4.7.5
D6	11 958	Section 4.7.6
D7	23 917	Section 4.7.7
D8	3 588	Section 4.7.8
D9	120	Section 4.7.9
D10	2 793	Section 4.7.10
D11	110 034	Section 4.7.11
D12	965	Section 4.7.12
D13	354 736	D1 + D2 + D3 + D4 + D5 + D6 + D7 + D8 + D9 + D10 + D11 – D12

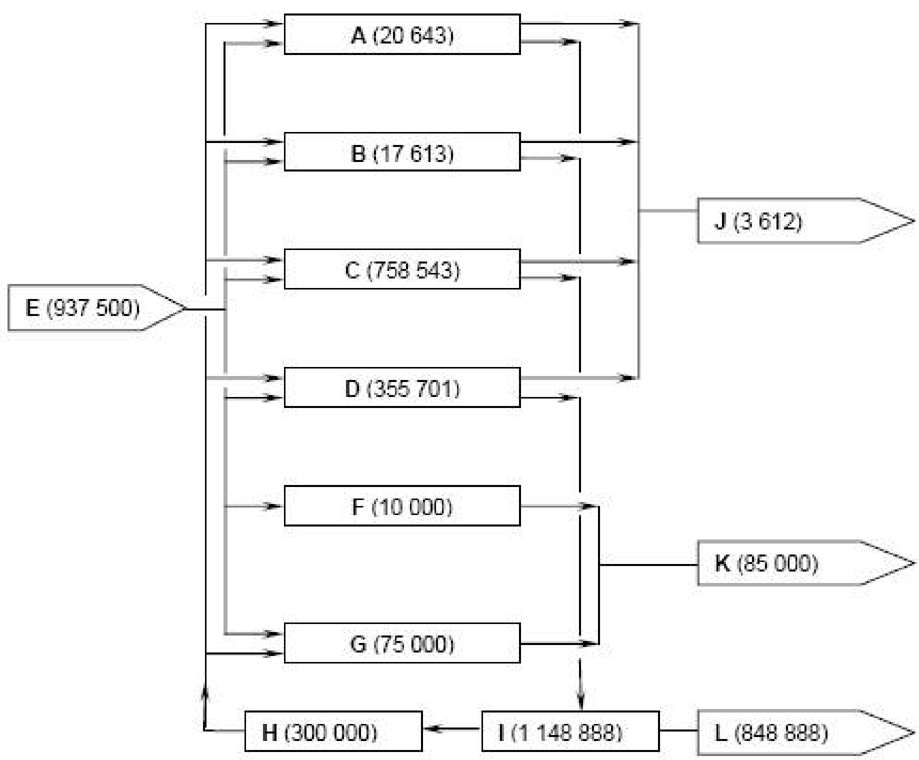


Figure 4: Simplified water balance for processes en tailed at textile

CONCLUSIONS AND RECOMMENDATIONS

In every industrial sector where there is production of waste; be it solid, liquid or gaseous; the first tier of management is waste minimization and pollution prevention to reduce the quantities and strength of wastes generated. However, not all wastes from industrial activities can be minimized or recycled, which introduces treatment as the second tier of waste management. The final option in the management of waste is disposal. In order to provide comprehensive and proper wastewater management actions for garments Industrial Pty (Ltd). all three tiers will be addressed.

Waste Minimization

In the past, focus on waste has been end-of-pipe treatment technologies, but current trends are towards waste minimization and pollution prevention, which are implemented in a variety of ways (Watts, 1997).

Reduction of wastewater volume

Most wastewater leaving a textile industry needs treatment before it can be reused in any way. However, there are waste streams that can still be reused without treatment, but this requires segregation of the streams from the different wet processing operations. It was observed during the time spent at the company that the wastewater from CGMI factories is not segregated and this poses a problem in reusing any of the streams without treatment.

Jeans wet processing wastewater is very variable in character and studies have shown that the highest total suspended solids (TSS) content is at the first operation of the wet processing; the desizing operation. This is due to the removal of the sizing agent and the chemicals used in the manufacturing of the denim fabric. High levels of TSS are also experienced in the stone washing operation due to the fragmentation of the pumice stones. These types of wastewater require treatment before they can be reused.

On the other hand, the rinsing operations produce wastewaters with lower solids content and it might be of a good practice to segregate the wastewater from the different operations entailed in CGMI's factories in order to reuse the rinsing wastewaters. This will have savings on the company's wastewater productions as well as treatment costs because specific rinsing water can be reused (in another load of the same requirements) as process water for a preceding operation; that is, rinsing water following a desizing operation can be reused as desizing water for the next load. It should, however, be taken into consideration that rinsing water also contain a significant amount of colour, which is likely to stain the white pockets of jeans if used as process water.

It is therefore recommended that the company investigate the acceptable levels of colour that allows rinsing water to be used as process water without staining. The investigation results can also be used in the determination of treatment requirements for different wastewater streams and thus contributing a lot to the company's savings. There may also be waters that can be collected and reused without the necessity for treatment, once the required quality of water for different operations is established.

Good housekeeping practices

It was also observed during the time spent at garments that chemicals are sometimes applied in excessive and unnecessary amounts in the factory. Chemicals that are often overused include detergents and enzymes. Using more chemicals than is necessary results in slippery floors that require cleaning, resulting in increased wastewater production.

In this regard it is recommended that the company engages in the purchase of automatic feed systems that can be programmed based on the weight and style of the load to be processed. Although this might be expensive, it will in the long run save the company money with regard to spillages, wrong chemical mixes (that have to be discarded) and large amounts of water used to clean up floors.

Avoiding spillages (which have to be cleaned off by running water over the floors in order to dilute the chemicals to prevent shock loads from reaching the treatment plant) and preparing the precise quantities of chemical mixes will not only conserve the water, but will reduce the strength of the wastewater. It is very important to adjust chemical loading as well as process water to the weight of the load and the style of the garments to be processed. Failure to do these results, not only in increased amounts of wastewater, but cost to the company's production because such a load will have to be reprocessed.

Cleaning of floors is solely depended on the judgment of the operators and this operation is resulting in significant water losses. It was observed during time spent at the company that there is no consistency in cleaning floors. Lack of consistency in cleaning floors seems to be a major problem that is costing the company a lot of money in water costs as well as treatment costs. It is recommended that efforts are made to only clean the floors when necessary and high pressure valves that automatically close after a certain quantity of water has run through the hose pipe should be installed.

Although a number of recommendations have been given with regard to good housekeeping practices, effective housekeeping depends on the efforts, cooperation and support of the operating personnel to implement the recommendations to the fullest extent possible in order to reduce the industry's pollution load (Jones, 1973).

Substitution of chemicals

Substitution of chemicals can result in significant reduction of pollution load and can even make water reclamation possible. Chemicals are sometimes added to counteract the negative effects of other chemicals. Instead of adding more chemicals to the bath, the offending chemicals can be substituted with a chemical with fewer harmful effects. For example, hydrogen peroxide can be used instead of calcium hypochlorite during actual bleaching operations, which would also negate the use of sodium hypothiosulphide to neutralize the reaction of calcium hypochlorite.

Metals are used as essential ingredients in some dyes and sizing agents, ultimately forming part of any wastewater produced. The metals in wastewater can inhibit biological treatment resulting in inefficiently treated wastewater. It is recommended that Material Safety Data Sheets for every chemical reaching the industry is comprehensively assessed and any hazardous chemicals be substituted with environmentally friendly products. The substitution of chemicals can often be done without any significant effect on the quality of the product.

Process modifications

Some operations within the wet processing combinations require the use of hot water. The water is heated by pumping steam generated from a boiler into the washing machines. The washing machines are in the same room as the dryers that are operated at high temperatures. The company should investigate the possibility of passing process water through the dryers before reaching the washing machines. Thus heating the process water to the desired temperatures with subsequent savings in energy and water used for steam generation.

Reduction of process chemicals

It was identified that in the garments factory, some operations had to be re-run because anticipated results had not been acquired. This might be due to the loss of strength of those chemicals. It is recommended that the company engages in quality control of the chemicals used in wet processing operations. The strength of the chemicals supplied should be tested, because some chemicals lose their strength or efficiency with time. This will improve operations efficiency and reduces the need to re-run operations due to inefficient results. The impact will be on water savings, treatment savings, as well as chemical savings.

Effluent Treatment and Disposal

The stages for effluent treatment from the five factories comprising CGMI are not efficient for proper treatment of the wastewater from the factories. The wastewater from the plant is reused in the ablution facilities at the factories' site and it has been observed that the treated water is still foamy. This has also been highlighted by nearby residents in a local newspaper. For the poor community, it is seen as a bargain to use the water for laundry because they do not need to buy soap (Lesiamo, 2005). However, this is not acceptable with regard to environmental, health and safety requirements.

The plant does not undertake any sampling or analysis of wastewater prior to discharge. It was, however, identified that some of the wastewater discharged from the industry's wastewater plant is not in compliance with wastewater discharge standards/guidelines through observations made during the time spent at the industry, as outlined in Figure 3.20. Section 45 of the Environment Act, 2001 of Lesotho prohibits the discharge of any hazardous substance into any waters or any other part of the environment except in accordance with the industrial wastewater guidelines and other relevant guidelines prescribed by the Lesotho Environment Authority. Lesotho has not yet developed any guidelines but has adopted Industrial Wastewater Guidelines for South Africa. Based on the South African Guidelines, wastewater to be discharged into water bodies or the environment should be clear of any color. It is therefore recommended that further investigations be undertaken by the company to identify practical efficient treatment methods of the wastewater; to discourage the use of the "soapy" water from the industry's treatment plant by the nearby residents; and to ensure safe disposal into the water resources without detrimental effects to the water inhabitants, as well as users downstream. It has also been highlighted that the treatment plant cannot accommodate the effluent from all the factories, resulting in discharging a portion of untreated water into the nearby stream resulting in pollution problems. The company should be aware that Lesotho is a signatory to the SADC Protocol of Shared Watercourses and it is against the principles of this protocol to engage in pollution of water bodies. The waste collected from the different stages of the treatment plant can be dewatered to significantly reduce the volume of the waste to be disposed off and thus conserving disposal sites.

REFERENCES

1. ALVAREZ D, GARRIDON N, SANS R and CARRERAS I (2003) Minimization - optimization of water use in the process of cleaning reactors and containers in a chemical industry. *Cleaner Production,* March 2003.
2. BARCLAY S and BUCKLEY C (2002a) Waste minimization guide for the textile industry. *Water Research Commission report,* Vol. 1, No. TT 139/00, April 2002, Pretoria.
3. BARCLAY S and BUCKLEY C (2002b) Waste minimization guide for the textile industry. *Water Research Commission report,* Vol. 2, No. TT140/00, April 2002, Pretoria.

4. BUCKLEY CB (1997) Managing emergencies - *Water and environmental management,* 11, April 1997.
5. CARROLL B (1997) Environmental strategies for sustainable development - A New town in Mallorca. *Water and environmental management,* 11, August 1997.
6. EDWARDS AMC (1996) Water and wastewater minimization - *Water and environmental management,* 10, August 1996.
7. GUPTA GS, PRASAD G and SINGH VN (1990) Removal of chrome dye from aqueous solutions using mixed adsorbents: coal and fly ash. *Water Research* 24 (1), 45 - 50.
8. JONES HR (1973) *Pollution control in the textile industry.* Noyes Data Corporation, New Jersey.
9. KLEIN L (1957) *Aspects of river pollution.* Academic Press Inc. Publishers, New York.
10. MOLAOLI L (2005) Treatment of textile wastewater, *personal communication,* Wastewater Technician: Thetsane Wastewater Treatment Plant. January 2005, Lesotho.
11. NAZAROFF WW and ALVAREZ-COHEN L (2001) *Environmental Engineering Science.* John Wiley and Sons Inc., New York.
12. RAMAKRISHNA KR and VIRARAGHAVAN T (1997a) Dye removal using low cost adsorbents. *Water Science and Technology,* 36, 189 – 196.
13. ROTH ER (1964) *Effluent and water treatment manual - The economics of control of process water.* Thunderbird Enterprises LTD, London.
14. WATTS JR (1997) *Hazardous wastes- Sources, Pathways, Receptors.* John Wiley and Sons Inc., New York.