Title:
An Integrated Solution to Water Shortage in the Latex Glove Manufacturing Industry: A Sri Lankan Project Feasibility Study

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Abstract:

Sri Lanka is poised to expand its economy by developing its agricultural, industrial and service sectors. The Rubber Manufacturing Industry has been an integral part of the economy and the Central Bank has reported that in 2011 the industry reached US$ 1.2 Billion. Sri Lanka is now expanding the rubber plantations to the drier Northern and Eastern Provinces. In the Eastern Province the target is to increase the current 300 acres to 10,000 acres by the end of 2015, while 25 acres have been planted in the North on an experimental scale.

In the manufacture of latex based gloves, large volumes of water are required resulting in effluents from washing, leaching, coagulation and surface treatment processes. This paper reports on a case study made on the Lalans Rubber Examination Glove Factory, a leading manufacturer in Sri Lanka. The report also highlights the need to further develop water supply and wastewater treatment facilities to accommodate the increasing industry needs at Seethawaka Export Promotion Zone (SEPZ) at Avissawela, Sri Lanka, where this factory is located. Avissawela is located 50 km from Colombo at the outer perimeter of the main rubber growing area.

SEPZ is located within the River Kelani basin. The River Kelani flows from Sri Pada Mountain (2243 Meters) in the Central highlands to the West Coast supplying 80% of the drinking and industrial water to Colombo. It also receives discharges from industries and agricultural activities along the way. Fresh water is abstracted at SEPZ as well as its treated effluent is discharged into River Kelani at a point where the tributary Seethawaka Oya meets the main River, 45 km upstream of Colombo.

This feasibility study for Lalan Rubbers is intended to implement a pilot system which will reclaim water from effluent using reverse osmosis membrane technology (RO). The initial treatment process is physicochemical to remove suspended and dissolved materials. The wastewater streams not used for water reclamation shall be treated with physicochemical / biological methods and combined with the RO reject. The latter has been ascertained is within the discharge limits imposed for discharges to the SEPZ Central Wastewater Treatment Plant. The study also recommends options for increasing fresh water abstraction at SEPZ by using river bank filtration. It was noted that the capacity of the SEPZ wastewater treatment plant may be expandable by a technology upgrade.

The results of this study would be useful to the City Cluster Development Concept as it is considered for the nearby townships which can provide the manpower and supporting services for SEPZ. The case study also suggests the approach may be replicated for glove industry elsewhere as standalone projects and its adaptability for other industries such as the textile and leather which consume large quantities of water. Introduction of water reclamation and desalination technologies will open the possibility of expanding industrialization while reducing impact on water resources needed for agricultural and human consumption.

The project was initiated under ADB CCED Phase II, to address the critical problem of shortages of water in industrial parks that has prevented latex industry expansion. Rubber cluster stakeholders conceived the integrated water management project and the related pre-feasibility study was completed in 3Q 2010. Under ADB City Cluster Economic Development Phase III, 2012, Technical Assistance in Support of the Rubber Industry Cluster implemented by Asian Development Bank, a full feasibility study was carried out from June 2012 to December 2012 by this team of Consultants.

The major focus was to develop a lasting cost-effective solution to address water shortages experienced by latex based rubber products manufacturing industries operating in industrial zones. The government of Sri Lanka has established export processing zones at various locations throughout the country. These zones are administered by the Board of Investment of Sri Lanka (BOI) which provides land, infrastructure and utilities for industries. In addition the Government provides preferential tax incentives and import export tariffs to industries located within the zone. The stakeholder factory, Lalan Rubber, is located in the SEPZ located at Avissawela, a town about 50 km, south east of from Colombo, Sri Lanka.

The SEPZ lies in close proximity to the banks of the Kelani River which is one of the major rivers in Sri Lanka. The Kelani River is a source of drinking water to the city of Colombo and flows into the sea at the northern boundary of the city. Water is extracted from the river and treated in a common Water Treatment Plant (WTP) by the National Water Supply and Drainage Board (NWSDB) which is the primary government agency responsible for water supply and sewage treatment in the country. The treated water is purchased by the BOI and distributed to industries located within the zone. The capacity of the intake and treatment plant is 9,500 m3/day per day.

Lalan Rubber is located in the SEPZ. BOI has been instrumental in establishing the Seethawaka Industrial Promotion Zone (SEPZ)/Industrial Park (IP) in February 2001. River Kelani flows along the northern and eastern boundaries of the SEPZ. 9500 m3/d water is abstracted from the river and treated at the BOI Water Treatment Plant (BOI-WTP) operated by the National Water Supply and Drainage Board (NWSDB). Treated water is supplied to factories within the SEPZ. Wastewater generated is collected with a common sewer system, conveyed to 9500 m3/d capacity BOI Wastewater Treatment Plant (BOI-WWTP), and treated before discharge downstream into River.

BOI-WTP and BOI-WWTP have reached maximum design capacity. Due to this BOI, is unable to accept new factories into the SEPZ nor provide additional water supply to factories already in the zone. 31 companies occupy a land area of 168 Ha. The total no of plots available is 71 covering an area of 185.4 Ha. It is also not permitted for individual factories to abstract water from the River to augment their needs due to the capacity constraint on treatment of waste water.

The Lalan Rubbers Pilot Project is to address a specific problem at SEPZ, which is the constraint on the supply of fresh water and discharge capacity for effluent. This is a capacity problem which is an impediment to the growth of industries such as Lalan Rubbers who have ready orders for supply of gloves, which they are unable to fulfill. The main target of the project is the supply of adequate water at competitive cost and the discharge of treated effluent of acceptable quality to SIPZ.

The possible solutions to the problem were considered by the team of consultants and are given below with comments on the feasibility

	Solution	Feasibility
1	BOI to increase fresh water supply and effluent treatment capacity. Typically this would be to double capacity to around 20,000 m3/day	This would require major construction and capital investment by the Government which would normally be in the region of Rs 2-5000 Mn. Approval and implementation of such projects would typically take 5-10 years.
2	A solution tailor made for Lalan Rubbers which will not affect the operation of BOI treatment plants.	This is feasible and can be implemented in the short term without increasing either the influent or effluent quantity of Lalan Rubbers. Cost will be around Rs 52 Mn and take 6 Months to construct.
3	A solution for BOI Fresh Water Supply by use of tube wells and river bank filtration.	This method is feasible and in use in many developed countries. Cost of treatment is reduced and good quality water obtainable. No major infrastructure need be constructed. Requires further hydro-geological investigation by the Water Resources Board.
4	A solution for the BOI Effluent Treatment Plant.	It is feasible to increase the capacity of the existing plant by modifying the treatment process using existing infrastructure. This will require an independent full feasibility study.

The normal course of action given in option one, above is for BOI to increase capacity by new construction to augment existing capacity. This would require special government approvals and cost in the region of Rs 2 to 5,000 Mn. This would require cabinet level policy decisions and approvals and is therefore classified as a long term project.

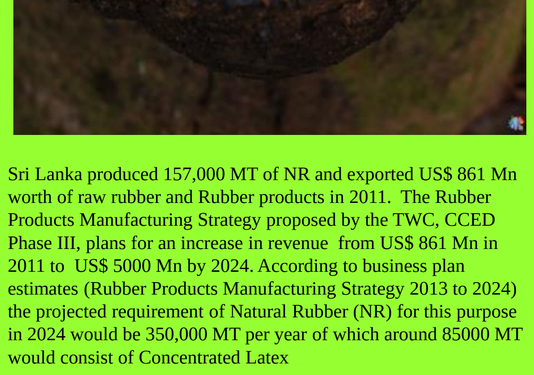
The second option is a standalone project implemented by Lalan Rubbers to increase capacity by reclaiming water used in the process by the using advanced RO technology. This option will not have any impact on the operation of BOI WWTP or WTP.

In option 3, the team of consultants propose a plan of action for the SEPZ, to augment its supply of fresh water. The team proposes extraction of water by a series of tube wells by river bank filtration to give required amount of water without further treatment.

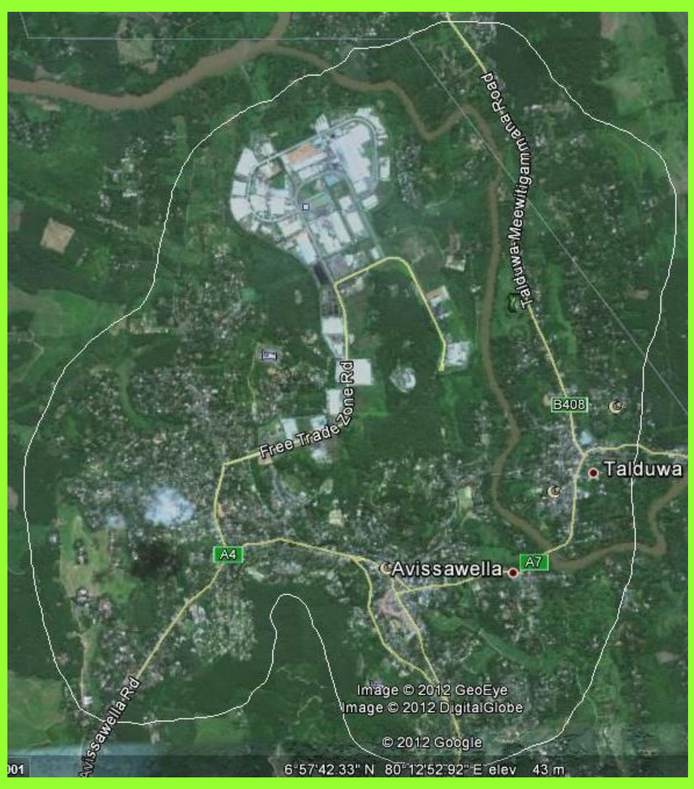
In the option four, the team proposes a plan of action for the SEPZ, to increase the present processing capacity of 9500M³ at its existing Effluent Treatment Plant (ETP) by around 100% by improving the existing infrastructure and introducing new technology, so that cost are kept to a minimum. This needs to be addressed by a separate full feasibility study and is considered a medium term plan.

Considering the four options, it is decided to initiate action on option two which will provide immediate relief to Lalan Rubbers.

The Kelani River is a 145-kilometre-long (90 mi) river in Sri Lanka. Ranking as the fourth longest river in the country, it stretches from the Sri Pada Mountain Range to Colombo. It supplies approximately 80% of the water used in Colombo. In addition, the river is used for transport, fisheries, sewage disposal, sand mining and for production of hydroelectricity. Through these factors, many people depend on the river for their daily routine in life. Depending on the operation of three reservoirs, the river flow varies from 20 m^3 (706 cu ft) to 25 m^3 (883 cu ft) in the dry seasons, and 800 m^3 (28,252 cu ft) to 1,500 m^3 (52,972 cu ft) during the monsoons. The annual sand extraction from the river is approximately 600,000 m^2 (6,458,346 sq ft) to 800,000 m^2 (8,611,128 sq ft). From a barge, people dive to the river bed, from where the sand is lifted to the barge in a bucket, and when the barge is full, it is taken to the river bank and unloaded by a separate team. The sand mining causes the river bed to sink by approximately 10 cm (4 in) per year. At present, two main concerns in connection with the river are flooding during the monsoon and saline intrusion in the dry season.



Sri Lanka produced 157,000 MT of NR and exported US$ 861 Mn worth of raw rubber and Rubber products in 2011. The Rubber Products Manufacturing Strategy proposed by the TWC, CCED Phase III, plans for an increase in revenue from US$ 861 Mn in 2011 to US$ 5000 Mn by 2024. According to business plan estimates (Rubber Products Manufacturing Strategy 2013 to 2024) the projected requirement of Natural Rubber (NR) for this purpose in 2024 would be 350,000 MT per year of which around 85000 MT would consist of Concentrated Latex



SEPZ is located in close proximity to Seethawaka, Avissawela Townships and a village called Talduwa. There are other villages in this area which is the location of an ancient kingdom of Seethawaka. Due to the location of the industries and employment opportunities a village has sprung up around the SEPZ to house the migrant labour. According to recent census statistics, the city cluster population is around 150,000. Allowing for a growth rate of 2% per annum we may project a population of 183,000 over the next 10 years. Hence the requirement for domestic water would be around 20,000 m3/day.

Present requirement for industrial water at SIPZ is 9,500 m3/day. Allowing for an increase of 100% this would be around 20,000 m3/day for industrial water and total treatment capacity required would be around 50,000 m3/day. Such a quantity would require the conventional type of treatment plant at a capital cost of around Rs 10 Bn, going by the current cost of projects being carried out by NWSDB. Therefore this would constitute a major investment by the government of Sri Lanka. This is case specific to SEPZ and Avissawela area and probably the scenario for most BOI EPZ located close to existing townships.

In the case of factories located outside BOI, EPZ in rural settings with lower population density, it would be possible to supply water from common treatment plants of capacity less than 5000 m3/day to human settlements in the close vicinity. In the case of new greenfield BOI EPZ sites close to existing townships, given the economics of scale, it would be better to design for treatment plants of capacity in excess of 50,000 to 100,000 m3/day to supply drinking water to the towns as well as industrial water for the factories.

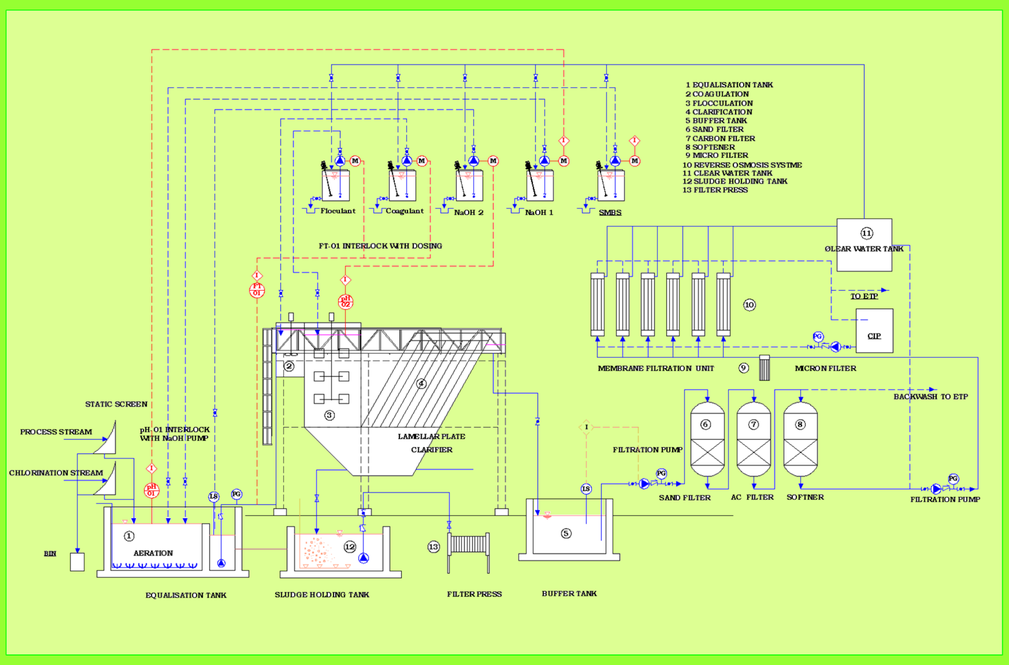
In most cities and suburbs of Sri Lanka disposal of sewage is by septic tank and soakage pits built with each housing unit. In the city of Colombo there is an old system dating to the times of the British where sewage is discharged into sewers and then pumped out to the sea. The regulation for building a septic tank is that distance of 50 feet from the closest well be maintained. Problem of wells being contaminated by sewage are not commonly reported. BOI EPZ and some Industrial Factories are usually equipped with separate sewage treatment plants. In the case of CCED it may be possible to treat sewage along with industrial waste but is not practical due to the cultural issues and would then exclude possibility of reclaiming and reuse.

This Pilot Project is to be implemented at Lalan Rubbers Pvt Ltd. A leading manufacturer of Rubber Latex Products in Sri Lanka. Lalan Rubbers at SIPZ produces examination gloves for the export market. It has a production capacity of 1.5 Mn gloves per day, consumes 1300 m3/day of fresh water and discharges 1150 m3/day of effluent. It directly employs 300 persons and indirectly provides income for 1000 to 2000 families of small holders. It consumes 10,000 kg of latex per day and 90 MT of biomass which also helps sustain the local economy.

Due to limitations in the capacity of water supply and effluent treatment at the BOI SIPZ, Lalan Rubbers is not in a position to expand its production to meet the rising demands of its customers.

This project seeks to provide a technological solution to the water problem at Lalan Rubbers by reclaiming part of the effluent discharged while maintaining the quality of effluent discharge within the standards specified by BOI SEPZ.

It is found that the project is technologically and economically feasible and can serve as a model and benchmark for other latex manufacturing factories as well as industries using large amounts of water thus reducing the use of fresh water by industry. The enhancement in fresh water usage is about 50% of the total water usage, which has a significant impact on the water sustainability of the industry.



The proposed pilot water reclamation plant at Lalan Rubbers is designed to have the following unit treatment processes – (i) coagulation for enhanced SS and organics (including rubber) removal, (ii) clarification for liquid-solids separation, (iii) filtration for more solids removal, (iv) activated carbon sorption for residual dissolved organics removal, (v) softening for Ca and Mg removal, (vi) micro-filtration [MF], and (vii) RO.

When running the RO based system, it is suggested the RO be operated with 60-65% permeate and 35-40% reject. Such operating conditions are more likely to result in relatively trouble-free membrane operations and a reject which is not so high in TDS as to cause problems to downstream treatment processes at the BOI-WWTP.

The installation cost of a water reclamation plant sized in accordance to the flows indicated above and for softening only is $0.360 Mn while that equipped with the RO unit for overall TDS removal is $0.403 Mn. The operating costs for the two systems are $0.49/m3 water treated and $0.51/m3 water treated respectively. Allowing for plant depreciation over 8 years, the cost of reclaimed water is $0.627 and $0.631/m3 product water. A plant capable of reclaiming about 800 m3/d water from 1300 m3/d wastewater shall require 1000 m2 of space. Such a water reclamation plant shall generate 800 kg of sludge solids/d requiring disposal at a landfill. The approximately 500 m3/d reject water from the shall be blended with other wastewater and pre-treated before discharge into the common sewer for conveyance to the BOI-WWTP.

This feasibility study is undertaken by the Integrated Water Management Project, Team of Consultants, under the auspices of the Asian Development Bank (ADB). Resources Development Consultants, Colombo is the Project implementer and the Project is operationalised through the Rubber Secretariat of Sri Lanka. The team of consultants is a workgroup composed of a Lead Consultant, International Effluent Treatment Consultant, Wastewater Treatment Design Engineer, Municipal Water Expert, Rubber Effluent Treatment Consultant and Economic & Financial Consultant.