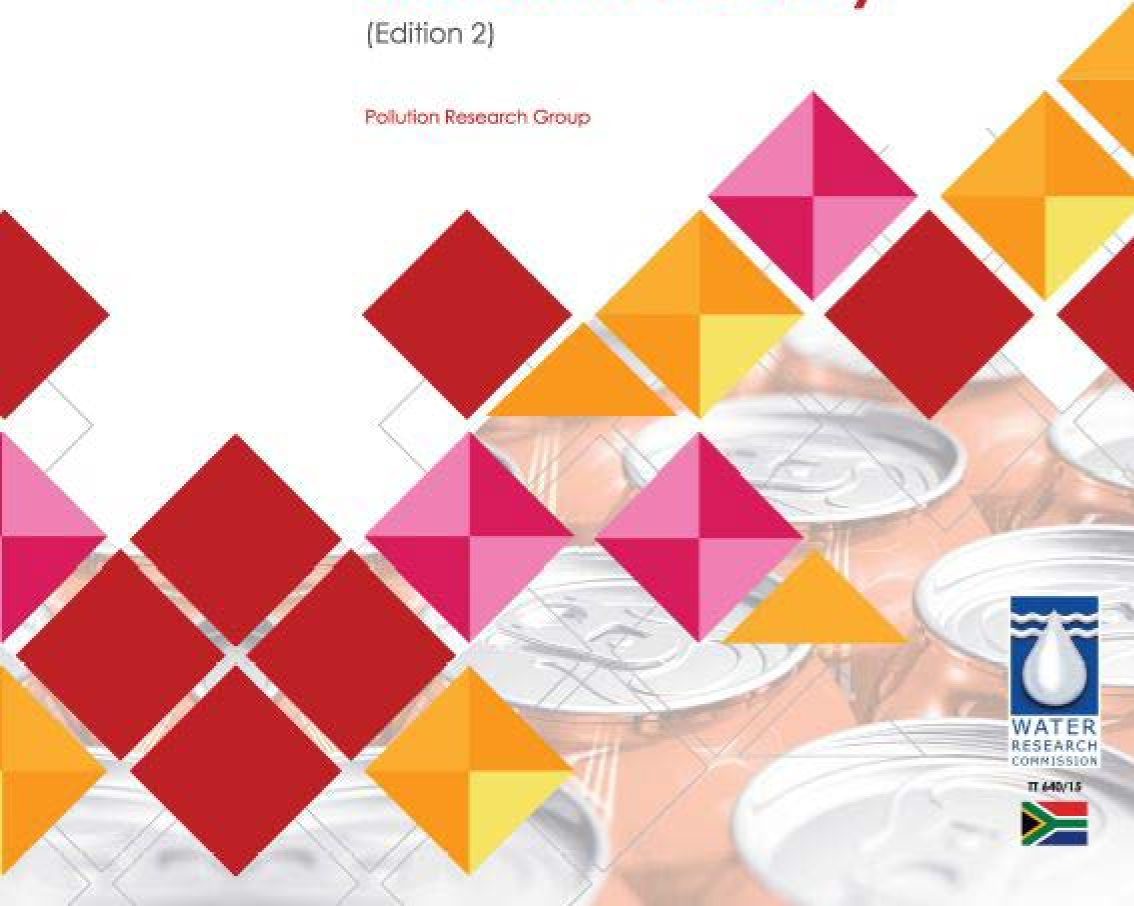
Natsurv 3:

Water and Wastewater Management in the Soft Drink Industry

(Edition 2)

Pollution Research Group



WATER RESEARCH COMMISSION

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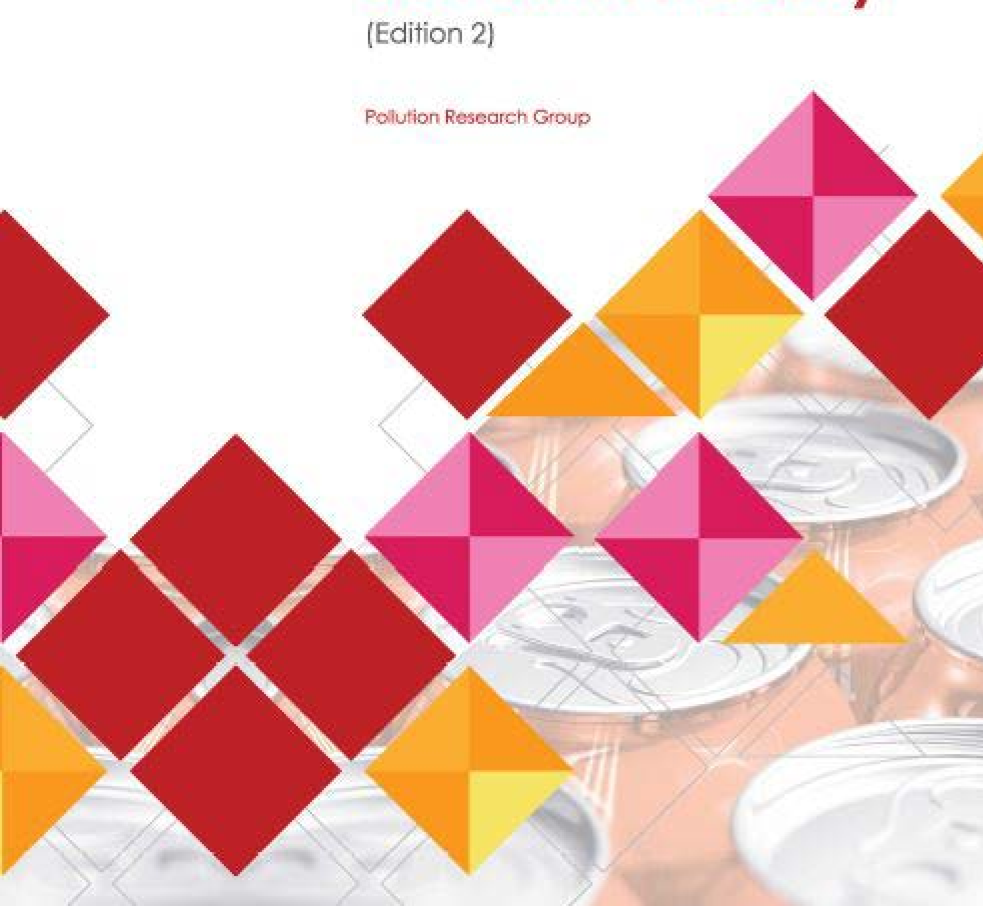

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NATSURV 3: Water and Wastewater Management in the Soft Drink Industry (Edition 2)

Report to the
Water Research Commission

by

Pollution Research Group
University of KwaZulu-Natal, Durban

WRC Report No. TT 640/15

October 2015

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Executive Summary

The aim of this project is to undertake a survey of the South African Soft Drink industry in order to obtain an overview of operations, specific water use, specific effluent volume and the extent to which best practice is being implemented. This was achieved through a review of the appropriate literature, holding workshops, interviewing companies and undertaking site visits.

A previous survey of this industrial sector was conducted in 1987 by Binnie and Partners Consulting Engineers. Since this time, the industry has undergone a number of significant changes such as new legislation, new markets, social attitudes, change in ownership (more international), etc., as well as the use of updated technology, the manufacture of new products and the variety of packaging materials available. In addition, there is growing awareness of the need to optimise water use and reduce the production of waste, and this should be reflected in the specific water consumption and effluent production. It was therefore considered an opportune time to review the water and wastewater management practises of the soft drink industry and identify the changes that have been made since the 1987 survey.

A comparison of the main results from both the previous study and the current survey is provided in Table 1.

Table 1: Comparison of water and wastewater management practises in 1987 and 2014 based on survey results

Parameter	2014 Survey results[1]			1987 Survey results[2]		
	N[3]	Range	Av. of N Companies	N[3]	Range	Av. of N Companies
Water use (KL/y)	12	1 000 to > 500 000	170 000	25	17 000 to 260 000	85 000
Production (KL/y)	16	1 000 to > 500 000	120 000	25	7 000 to 98 000	33 000
Specific Water Intake (L/L)	14	1.0 to 4.5	1.6	25	1.3 to 5.3	2.7
Effluent Discharge (KL/y)	11	1 000 to 400 000	120 000	12	14 000 to 255 000	87 000
Specific effluent volume (L/L)	13	0.1 to 3.8	0.8	12	0.4 to 2.4	1.72[4](0.96)
Specific pollution load – COD (mg/L)	9	87 to 725 000	-	12	360 to 8 450	3 800[4] (3 520)
Specific pollution load –TDS (mg/L)	4	10 to 19 000	-	12	390 to 6 450	5 340[4](2 130)
Specific pollution load –SS (mg/L)	2	55 to 3 500	-	10	10 to 950	0.45[4](0.09)
pH	9	2.8 to 12.2	-	12	4 to 11.8	

Note: [1]These results are taken over all companies surveyed and is a mix of carbonated drinks, fruit drinks and bottled water and also a large range in the size of operation
[2]These results are taken from the carbonated soft drink companies only
[3]N = number of companies contributing data
[4]The values out of brackets are companies with bottle washing facilities, and the values in brackets are companies with no bottle washing facilities

This comparison shows the following:

- On average the water used by the soft drink sector has increased approximately 2-fold, however there is a much larger range in water consumption than previously reported.
- Production volumes have increased 4-fold even though the number of soft drink companies in South Africa has reduced overall.

- The average specific water intake (SWI) has decreased from 2.7 litres water per litre product to 1.6 litres water per litre product with a lower range of values.
- As would be expected due to the increase in water use, the average effluent volume has increased (but not in proportion to the increase in water use).
- The average specific effluent volume (SEV) remains constant. No differentiation was made in the 2014 survey between bottling plants with bottle washing facilities and those without.
- The reported COD range is higher in the 2014 survey. This is most likely a result of the lower SWI which can result in a more concentrated pollution load.
- Where reported, the TDS and SS ranges were higher in 2014, but more information is needed to determine if this is a trend. It should be noted that the increase in TDS and SS is due to the inclusion of 100% fruit drink manufacturers.
- The pH range is more variable than previously reported.

It therefore appears as though while the soft drink sector is consuming more water, this water is being used more efficiently than in the past. More data on the pollution concentrations are required before any conclusions can be drawn regarding changes in the pollution load.

With regards to best practice, a comparison of specific water intake to benchmark figures shows that the South African companies are operating at a lower specific water intake. An analysis of best practice options implemented by the surveyed companies indicates that the majority are aware of the need to optimise water use through internal reuse. More focus needs to be made on the preventative management practices such as measuring, monitoring and raising staff awareness to ensure that water use is optimised and raw materials and product are not wasted.

It must be noted that during the time this project was underway (2012 to 2014) significant changes were taking place in the South African soft drink sector in terms of mergers and change in ownership. For this reason it was difficult to obtain buy-in and participation from many companies.

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- The Water Research Commission for funding the project
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- All soft drink companies who gave of their time to complete the survey and participate in the site visits and interviews
- The regulators who provided input into the development of the guide and data on pollution loads.

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List of Abbreviations

BIER	Beverage Industry Environmental Round Table
CAGR	Compound Annual Growth Rate
CIP	Clean in place
COD	Chemical oxygen demand
DEA	Department of Environment Affairs
DWA	South African Department of Water Affairs
DWA	German Association for Water, Wastewater and Waste
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAC	Electronically activated water
EC	European Commission
EWS	eThekwini Water and Sanitation
GMP	Good management practices
HACCP	Hazard Analysis and Critical Control Point
ISO	International Standards Organisation
KZN	KwaZulu-Natal
L	Litre
LCA	Life cycle assessment
MJ	Mega Joules
ML	Mega litres
NRGB	Non-returnable glass bottles
PET	Polyethylene terephthalate
QA	Quality assurance
QC	Quality control
RGB	Returnable glass bottles
RO	Reverse Osmosis
RTD	Ready to Drink
SABS	South African Bureau of Standards
SAFJA	South African Fruit Juice Association
SANBWA	South African National Bottled Water Association
SEV	Specific effluent volume
SS	Settable solids
SWI	Specific water intake

List of Abbreviations

TDS	Total dissolved solids
THM	Tri halo methane
UK	United Kingdom
UV	Ultraviolet
WRC	South African Water Research Commission
WSA	Water services authority
WSP	Water services provider

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1. Introduction

Soft drinks can be described as sweetened water-based beverages (usually balanced with the addition of an acid), which can be carbonated, flavoured and coloured, and which often contain an amount of fruit juice, fruit pulp or other natural ingredients. They come in two main forms, namely ready-to-drink (RTD), and concentrated or made-to-dilute forms which are diluted with water by the consumer. Bottled water is also included in this definition of soft drinks and can be still or carbonated, plain or flavoured.

The soft drink chain consists of two main components – the syrup manufacturer and the bottler. A generic process flow diagram for the production and distribution of a carbonated soft drink is provided in Figure 1.1.

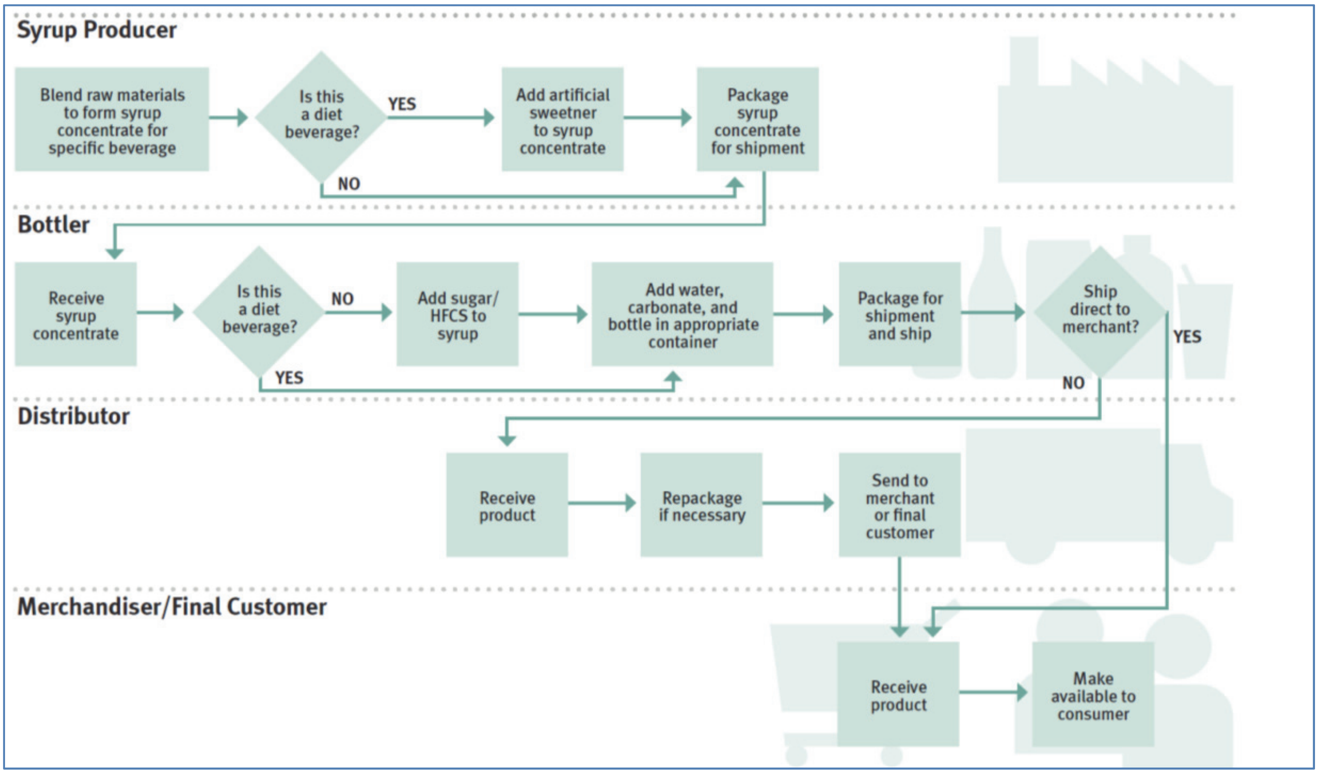


Figure 1.1: Generic process flow along the carbonated soft drink supply chain (NPLAN, 2011)

The global consumption of soft drinks has increased from 1 171 x10^6 ML in 2011 to 1 974 x10^6 ML in 2014 (and predicted to rise to 2 128 x10^6 ML in 2016) (Statista, 2013).

A report by Cramer (2013) investigates the impact of the increase in the "health conscious" consumer, on the market share of carbonated soft drinks. A comparison of the global nine-year revenue CAGR (Compound Annual Growth Rate) for various segments within the non-alcoholic beverage industry shows the clear decline in the growth of the carbonated soft drink sector, and in increase in the bottled water, ready to drink tea (RTD), and sports and energy drinks (see Table 1.1). However, the sales of carbonated drinks still remain the main revenue for soft drink manufacturers.

Table 1.1: Comparison of the Compound Annual Growth Rate in the Global Soft Drink Sector (Cramer, 2013)

Beverage segment	9-year Global Revenue CAGR	Year on Year Growth in 2012
Carbonate soft drinks	5.6 %	2.2%
Fruit Juices	6.6%	2.6%
Bottled Water	9.5%	4.1%
Ready to Drink Tea	10.1%	5.8%
Sports and Energy Drinks	11.6%	8.3%

This analysis shows that the global soft drink market has altered significantly since the publication of the 1987 NATSURV guide (Binnie & Partners, 1987) which would therefore have an impact on the profile, technology, and water and wastewater management practises within this sector.

1.1 Overview of the South African Soft Drink Industry

Since 1987 the soft drink market has expanded to include new products, in particular bottled water and energy and sports drinks. These changes are summarised in Table 1.2.

Table 1.2: Expansion of the soft drink market since 1987

Products in 1987	Products added since 1987
Carbonated soft drinks	Iced teas (also termed RTD – Ready to Drink teas)
Carbonated and still fruit juices	Carbonated and still water – plain and flavoured
Fruit and diary blended juices	Functional water (water with addition of vitamins)
Juice concentrates (liquids and powders)	Energy and sports drinks

Figure 1.2 provides a detailed overview of the various soft drink categories. As can be seen, these can be broadly divided into “still” and “carbonated” drinks, with further sub-categories.

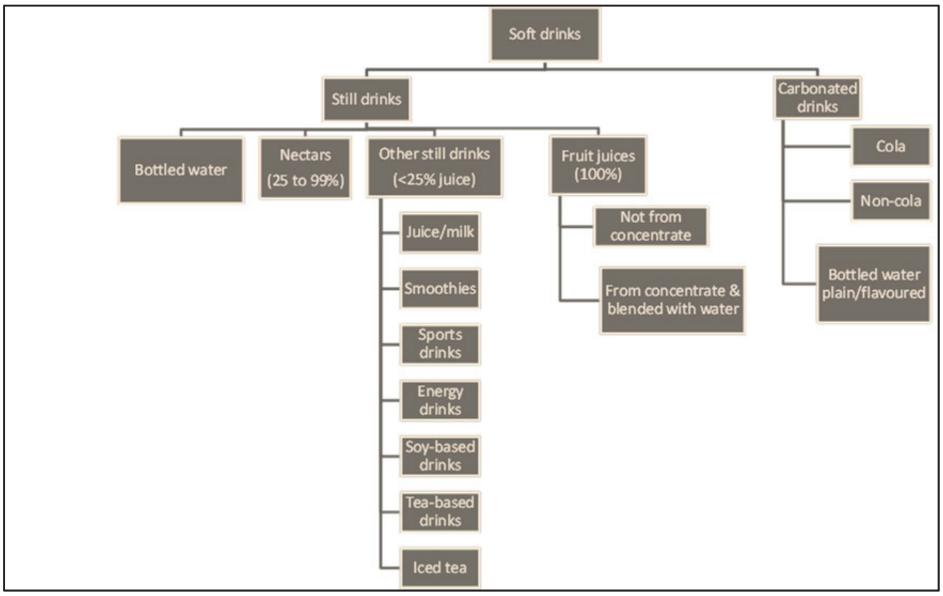


Figure 1.2: General soft drink industry categories (Metcalf, 2013)

In addition, there are a number of different packaging options (and sizes) such as bottles (polyethylene terephthalate (PET) and glass), cans, cartons, bags (plastic or composite), and catering packs.

Based on information gathered from Euromonitor (2014), the Soft Drink Industry in South Africa produced in the region of 3 700 ML of soft drink per year in 2012, more than double the volume recorded in 1987 (1 500 ML/year). The majority of this production is non-cola carbonates (42%), followed by cola carbonates (33%) and 100 percent fruit juice (9%). If the carbonated and still bottled water categories are added together, this sector accounts for nearly 9% of the total. This shows the importance of this "new" soft drink category. A chart providing an overview of the production per category is provided in Figure 1.3.

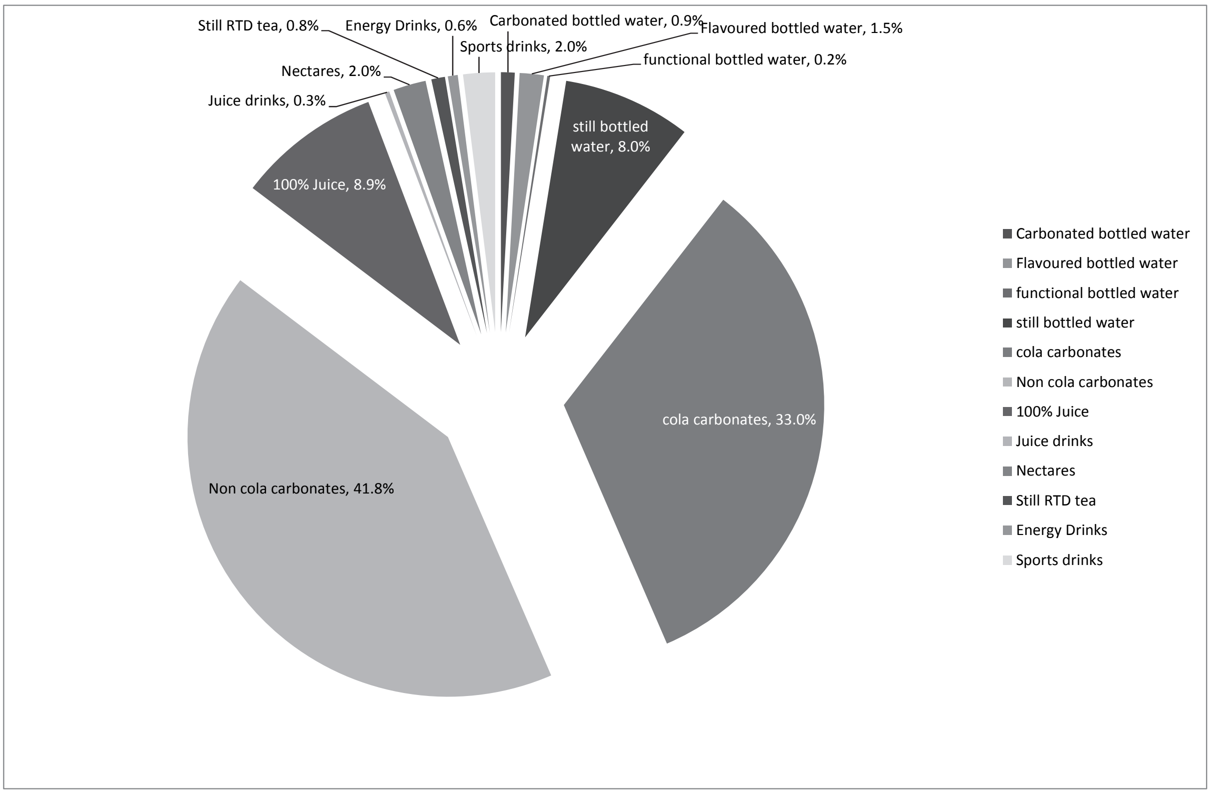


Figure 1.3: Production break-down per soft drink category (% by volume) for 2012 (Euromonitor, 2014)

These figures have remained more or less constant over the last 5 years (2007 to 2012).

The categories can be described briefly as follows:

- **Cola and non-cola carbonated soft drinks**: There are a large variety of cola (e.g. Coca-Cola, Tab, etc.) and non-cola (e.g. Fanta, Sprite, etc.) carbonated soft drinks on the market. As can be seen from Figure 1.3 this sector accounts for the majority of the market share in South Africa (nearly 75%). Carbonated flavoured water is included in this sector (and not in the bottled water sector) and accounts for a further 1.5% of the market share.
- **Non-carbonated soft drinks**: Non-carbonated soft drinks include 100% juice, nectars, juice drinks, ready to drink (RTD) teas, and sports drinks. In total this sector accounts for about 14% of the market.

- **Bottled water:** All water packed into sealed containers and sold for human consumption that does not contain sugars, flavourings (etc.) is classified as bottled water. There are three main types of water – natural water, water defined by origin and prepared water.

A sector that has not been addressed in this Guide is the production of packaged tap water by municipalities for emergency situations, as well as water sachets for sporting events.

Predictions given by Euromonitor (2014) showed a steady increase in consumption in all categories from 2007 to 2014, and a predicted continued growth (at a much slower rate) to 2017. This is shown in Table 1.3.

Table 1.3: Increase in soft drink production from 2007 to 2014 and 2014 to 2017 (Euromonitor, 2014)

	2007-2014		2014-2017	
	Increase in volume ML	**Percent increase**	**Increase in volume ML**	**Percent increase**
Carbonated bottled water	4	0.1%	1.1	0.0%
Flavoured bottled water	17.6	0.5%	5	0.1%
Functional bottled water	8.4	0.3%	2.1	0.1%
Still bottled water	89.3	2.7%	38.3	1.0%
cola carbonates	47.1	1.4%	39.7	1.0%
Non-cola carbonates	281.1	8.5%	64.3	1.6%
100% Juice	89.8	2.7%	35.5	0.9%
Juice drinks	1.7	0.1%	0.7	0.0%
Nectars	10.7	0.3%	4.8	0.1%
Still RTD tea	11.5	0.3%	4.4	0.1%
Energy Drinks	8.7	0.3%	5.6	0.1%
Sports drinks	23.4	0.7%	7.7	0.2%
TOTAL	**593.3**	**17.9%**	**209.2**	**5.4%**

What is bottled water? (SANBWA, 2011)

Natural water: Approximately 70% of all bottled water in South Africa is natural water. Natural water is bottled water derived from an underground formation which has not been modified and has not undergone treatment other than separation from unstable constituents by decantation or filtration, removal of carbon dioxide, or addition of carbon dioxide.

Water defined by origin: This includes spring and mineral water and accounts for 20% of bottled water in South Africa. This is water obtained from a specific environmental source such as a spring and which is not passed through a community water system. Treatment carried out during the bottling process may not alter the essential physico-chemical characteristics or compromise the safety of the packaged water.

Prepared water: Approximately 10% of all bottled water in South Africa is prepared water. The water used in prepared water has undergone antimicrobial treatment as well as treatment that alters the original physical or chemical properties of the water.

What are Fruit drinks? (SAFJA, 2015)

Fresh Fruit juice: 100% fruit juice with no permitted additives and sold within 2 hours of extraction.
Unsweetened Fruit juice: 100% juice with permitted additives
Fruit nectar:

50% juice (min)	40%-35% juice (min)	20% juice (min)	12,5% juice (min)
Pineapple Orange Naartjie Grapefruit Grape Apple	Apricot 35% Peach 40% Pear 40% Unspecified fruit 40%	Granadilla Guava Banana Blackcurrant Lychee Mango Papaya	Lemon Lime

Fruit Squash: 24% juice (min) in undiluted form and 6% (min) in diluted form
Fruit drinks: contains 6%juice as a minimum
Fruit flavoured drink: contains less than 6% juice

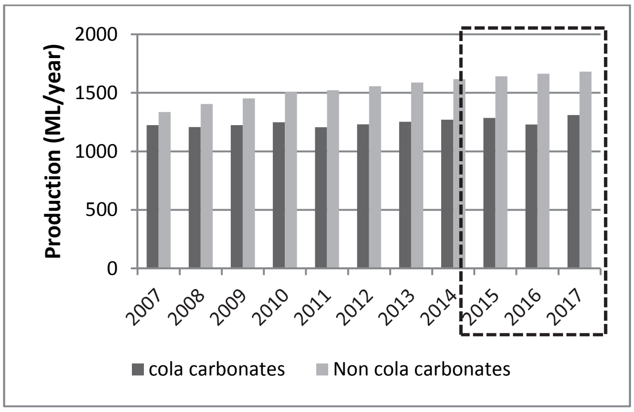
What are Sports and Energy Drinks? (BSDA, 2012)

Energy drinks provide functional benefits by boosting energy and alertness. The functionality is obtained from ingredients such as glucose, caffeine or taurine.

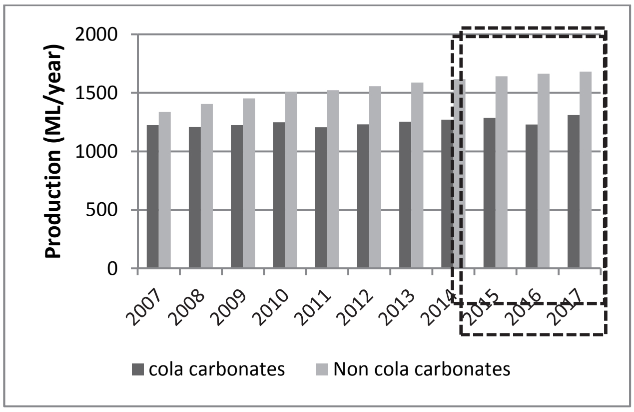
Sports drinks: There are three types of sports drinks all of which contain various levels of fluid, electrolytes and carbohydrate:

- **Hypotonic:** These drink are designed to be consumed during exercise, contain a low carbohydrate content and a higher concentration of salt and sugar than the human body;
- **Isotonic**: Contain similar concentrations of salt and sugar as in the human body and are consumed during exercise.
- **Hypertonic**: These drinks contain high levels of carbohydrate in order to provide maximum energy uptake and are consumed after exercise

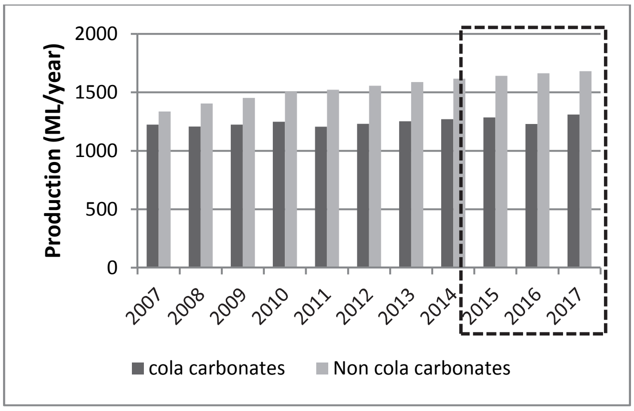
The Graphs in Figure 1.4 show the growth in the main sectors of the soft drink industry (actual and predicted) from 2007 to 2017 (Data taken from Euromonitor (2014)).



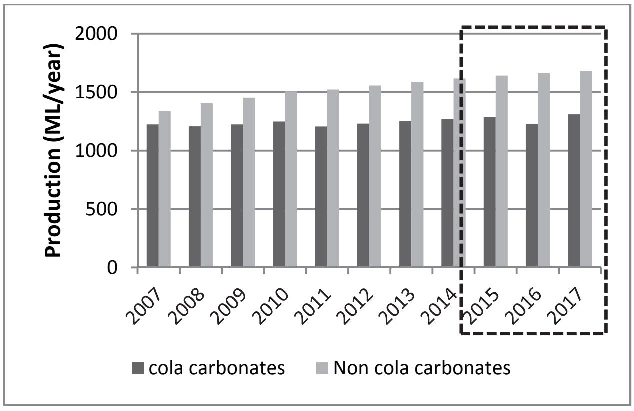
(a) Carbonates



(b) Juice and iced tea



(c) Bottled water



(d) Energy and sports drinks

Figure 1.4: Actual and predicted growth in the soft drink sector in South Africa (2007-2017)

According to information obtained from Euromonitor International (2015), the following can be noted with regards to soft drink consumption in South Africa:

- Consumption of carbonated soft drinks continues to grow as they generally cost less per unit volume than non-carbonated drinks such as juices.
- Due to the general increase in the cost of living, consumers are moving more towards the purchase of concentrates which can be diluted at home.
- Bottled water growth in South Africa, while increasing in volume year on year, is low due to the tap water being safe to drink. Per capita consumption has grown at a slower rate from 2008, when an average person would consume just over six litres of bottled water per year, whilst an average person now only consumes eight litres of water per year.
- Energy and sports drinks are still a relatively small market within South Africa, and rely on clever marketing and promotion to sell the product. Growth is predicted to be driven by an increase in demand for energy drinks.
- South African consumers are responding to the call for healthier beverages, with sales in juices increasing.
- Consumption of ready to drink (RTD) teas is still low due to limited information on the product and limited marketing.

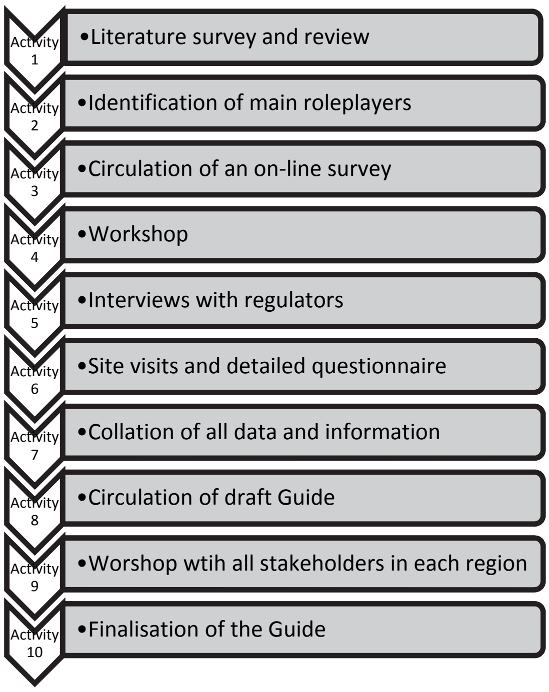
1.2 Project objectives

The aim of this project is to undertake a survey of the South African Soft Drink industry in order to obtain an overview of operations, specific water use, specific effluent volume and the extent to which best practice is being implemented. This is to be achieved through a review of the appropriate literature, holding workshops, interviewing companies and undertaking site visits.

A previous survey of this industrial sector was conducted in 1987 by Binnie & Partners Consulting Engineers (Binnie & Partners, 1987). Since this time, the industry has undergone a number of significant changes such as new legislation, new markets, social attitudes and change in ownership as well as the use of updated technology, the manufacture of new products and the variety of packaging materials available. In addition, there is growing awareness of the need to optimise water and energy use and reduce the production of waste, and this should be reflected in the specific water consumption and effluent production. It was therefore considered an opportune time to review the water and wastewater management practises of the soft drink industry and identify the changes that have been made since the 1987 survey.

1.3 Methodology Summary

The approach used in order to undertake the survey consisted of a combination of on-line electronic surveys, detailed site visits with questionnaires, interviews and workshops. Both industry and regulatory stakeholders were contacted. A summary of this process is given in this section with the detailed information provided in the Appendices to this Guide.



1.3.1 Literature survey and review

A detailed literature survey and review was undertaken in order to obtain an understanding of the soft drink industry both within South Africa and internationally as well as the best practice opportunities for this sector. The best practice review is provided in Appendix 1.

1.3.2 Identification of main role players

Soft drink companies were identified through internet searches, contact with regulators, and referrals from organisations within the industry supply chain. The location of the organisations identified at the start of the project is provided in Figure 1.5.

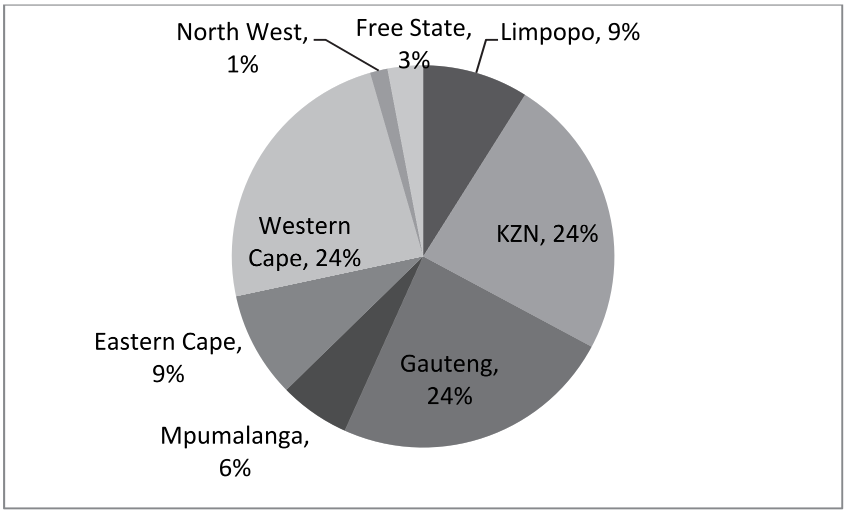


Figure 1.5: Location of the soft drink companies identified in the initial survey

As shown in Figure 1.5, the main locations are KwaZulu-Natal, Gauteng and the Western Cape, followed by the Eastern Cape and Limpopo. In total 67 different organisations were identified (at this stage it was not clear as to which of these were bottling sites). Of these 45% were classified as carbonated soft drink organisations, 34% as fruit juice companies and the remaining 21% as bottled water companies.

In comparison, the 1987 project identified 40 carbonated soft drink bottling plants which accounted for 85% of the production with the remaining 15% producing fruit juices. These plants were situated predominantly in the then Transvaal and Cape Provinces, with only a few in Natal and the Orange Free State (Binnie & Partners, 1987)

1.3.3 On-line surveys

An on-line survey was created using SurveyMonkey (SurveyMonkey, 2015) which was then circulated to all soft drink companies. This survey aimed to obtain an overview of production figures, water use and effluent generation, as well identifying the best practices implemented within the companies. Two versions of this survey were created and circulated, the first one asked for company details and figures to be inserted by the company (circulated November 2013), while the second asked for no company details and contained ranges of values that could be selected for each question (circulated October 2014). The response to both these surveys was very poor (see Table 1.4). These on-line surveys are provided in Appendix 2.

Table 1.4: Summary of responses to the on-line surveys

	Number of companies sent the link	Complete responses	Incomplete responses	TOTAL
Original survey	78	5	1	**6**
Updated survey	67	1	6	**7**

The reasons for the difference in the number of companies contacted for the different surveys is that circulation of the first survey resulted in the identification of organisations that no longer existed, or where the contact details were incorrect and no new contact could be found. This left a total of 67 (as given in Section 1.3.4). All of these companies were sent the second survey.

1.3.4 Site visits and detailed questionnaires

Site visits were undertaken at those soft drink companies who were open to participating in the project. This included a brief site walk-through and the completion of a detailed questionnaire to obtain further insight into the water and wastewater management practices. This information, together with that obtained from the on-line survey was used to compile the figures provided in this Guide. Section 4 provides an overview of the organisations participating in the site visits and detailed questionnaires. Appendix 3 provides the detailed questionnaire.

1.3.5 Interviews

Telephonic interviews and email surveys were undertaken with regulators in all the provinces in order to obtain their input into the development of the Guide, and to obtain information on the effluent tariffs and pricing of water and effluent.

1.3.6 Workshops

A workshop was held in April 2014 in Durban which was attended by soft drink companies from Durban and Western Cape, as well eThekwini Water and Sanitation unit. The aim of this workshop was to obtain buy in to the project and input into the type of information that should be included in the Guide. Further workshops were held in February 2015 in KwaZulu-Natal, Gauteng and the Western Cape to present the draft Guide and finalise the document. These workshops were attended by representatives of the soft drink industry and authorities (local, provincial and national).

2. Process Overview

2.1 Main process steps

An overview the soft drink manufacturing process is provided in this section. It provides a generic description of the main stages within the process, as well as any additional processes that may be carried out depending on the type of soft drink produced. This includes descriptions of the following:

- Storage of concentrate / raw product
- Water treatment
- Sugar dissolving
- Blending
- Carbonation / pasteurisation
- Filling and Packaging
- Bottle forming
- Bottle washing / rinsing
- Cleaning in place (CIP)

The production processes followed by a soft drink company depends on the product being manufactured and the type of packaging to be used. In general, the processes described in the 1987 Guide are still valid, but due to the technological advances made over the years there have been some changes to the process steps, an increase in automation, increased production throughput and reduced labour requirements.

The combination of these steps depends on the whether a carbonated or non-carbonated soft drink is being produced. A generic description of each of these steps is provided in the following sections. More detailed information on these processes can be found in Ally (2015), Hirsheimer (2011), NPLAN (2011), SANBWA (2011), Shachman (2004), Steen (2006) and Ashurt (2005).

2.1.1 Storage of concentrate / raw materials

Generally, concentrates are supplied via tank cars and pumped into bulk storage tanks at the manufacturing plant. The storage area or tanks need to be cooled to keep the concentrate below 0^{o}C. The concentrate may be pumped directly from the storage tanks to blending for dilution with water, or for mixing with other concentrates prior to dilution.

Granulated sugar is generally supplied in bags and is then dissolved in treated water to produce a "simple syrup" or liquid sugar solution. This simple syrup is then pumped to the blending area.

Other raw materials include additives such as stabilisers, flavourants, sweeteners (for sugar free formulations) and preservatives.

2.1.2 Water treatment

Water is used throughout the soft drink production process from sugar dissolving or concentrate dilution to blending in the final product. The degree of water treatment required depends on the quality of the water supplied to the factory. Treatment methods commonly include sand filtration to remove suspended solids, activated carbon filtration to remove colour and organic contaminants, UV treatment or ozonation to kill bacteria, micro filtration ('polishing') to remove particles and bacteria, and reverse osmosis (RO) membrane filtration to reduce dissolved solids. Water may also require softening by means of ion-exchange techniques. The main change that has been seen in water treatment technology since the 1987 Guide is the use of membrane processes.

Water that is to be used for the manufacture of bottled water requires various treatment processes depending on the end market (natural water -spring and mineral water, water defined by origin, prepared water, sparkling, etc.) and the source (borehole, river, dam, tap, etc.). Again, common processes that can be used include sand filtration; distillation; deionization; reverse osmosis, micro filtration, nano filtration; sand filtration; activated carbon filtration; and ultraviolet sterilisation.

2.1.3 Blending

Blending is the process of combining liquids and this can take place in either a continuous or batch operation. In batch processes, the liquids (e.g. concentrate and water) are mixed in one tank as a set volume, and then transferred to the next process step before another batch can be blended. Samples are taken at the end of each batch to ensure quality is met. Continuous, or in-line, blending involves the continuous mixing of the liquids en-route to the next process step via a buffer tank. The product is sampled continuously and the flow rate of the concentrate and water is adjusted to ensure the correct quality is achieved.

In the case of carbonated soft drinks, the flavourants, colouring, acids, preservatives and other additives are added to the simple syrup at this stage to form the final syrup mix for blending with treated water prior to carbonisation. An important step at this stage is the de-aeration of the water prior to blending as excess air can impact on the carbonisation process and can cause foaming.

For the production of fruit juices, other ingredients may be added in the blending stage, but are generally added as a pre-blending mix in the final preparation stage.

2.1.4 Carbonation / pasteurisation

In the manufacture of traditional carbonated soft drinks, the blended mixture is then sent to the filler area where carbon dioxide is added. In order for the carbon dioxide to be absorbed, the soft drinks are cooled using large, ammonia and glycol based refrigeration systems combined with cooling towers. The carbon dioxide is stored in a liquid state and piped into carbonation units as needed. In general, soft drinks contain between 15 to 75 psi (100 to 500 kPa) of carbon dioxide depending on the type of product (Hirsheimer, 2011). The final product is then packaged into bottles, cans or plastic polyethylene terephthalate (PET) containers.

For non-carbonated drinks such as fruit juices, pasteurisation is the next step after blending. There are two main types of pasteurisation – tunnel and flash. In tunnel pasteurisation the juice is heated in tubular or plate heat exchangers to 80 to 95^{o}C and remains at this temperature while passing through the holding cell. The juice is then cooled with water to filling temperature prior to packaging. Free air and dissolved oxygen are removed via a deaerator. In flash pasteurisation, instead of heating the container of liquid, the batch of liquid is subjected to high temperatures as it is being poured into sterile containers. This method uses higher temperatures than traditional pasteurization and requires less time.

For carbonated soft drinks that have reduced preservatives, the blended mixture is pasteurised prior to carbonation.

2.1.5 Filling and packaging

There are two main types of filling processes which are followed; namely aseptic (cold) and hot filling. In aseptic filling, the bottles, cans or cartons are first sterilised and then filled with the aseptic (sterile) soft drink. It eliminates the need for preservatives, but requires stringent procedures to ensure there is no contamination. In hot filling, the container is filled with the hot (>85°C) pasteurised product to decontaminate the inner surface and the closure. The container is then cooled rapidly, and results in a product with a shelf life of between 6 and 12 months. Typical containers used include glass and plastic bottles, and cans.

In most cases, pasteurised juice is sent to the filler room and any overflow returned to the pasteuriser. An aseptic buffer tank is sometimes required to prevent any problems on the filler line from impacting on the upstream processes, and allow for continuous adjustment of flow and pressure as required for the filling capacity. The same pasteurisation design is used for both aseptically filled juices and non-aseptic juices, while a different design is required for hot filling.

The majority of carbonated soft drinks are filled via the aseptic fill method due to the reduced process requirements. It must be ensured that the type of container being used is able to withstand the pressure required.

Once the container is filled, they are sealed depending on the type of packaging used (e.g. capping of bottles), labelled, crated, plastic wrapped and stored for distribution.

The largest difference in this stage compared to the 1987 Guide is the introduction of plastic (PET) bottles, the use of lightweight aluminium cans, the development of lighter glass bottles and the introduction of specialised cartons.

2.1.6 Bottle blowing

PET bottles can be provided by a supplier, but in the larger manufacturing sites, they are produced on site. This involves the use of *preforms* which are moulded from pellets of resin with the colour and bottle neck finish applied. There preforms can be stored for up to six months if transported and handled carefully to prevent damage. In order to blow the bottle, the preform is heated in an oven to 90, transferred to the bottle mould, stretched and blown with first low pressure, then high pressure air to create the correct shape.

2.1.7 Bottle washing / rinsing

The use of returnable glass bottles (RGB) for reuse requires that they are cleaned prior to being filled. This is a water intensive process and also requires an efficient recycling programme for the collection and return of glass bottles. With the introduction of plastic bottles for the packaging of soft drinks, many of the bottling plants no longer make use of returnable bottles and therefore have no need for a bottle washing line. Where bottle washing takes place, the main steps involved include a pre-rinse, a caustic soak and two rinses. In general, the rinse water and the caustic wash water are recycled within the process. Crate washing may also take place resulting in further water use.

In some operations, the new PET bottles and cans need to be rinsed with treated process water prior to filling.

2.1.8 Cleaning in place

Effective cleaning of all operational equipment is essential for good operational management and results. This is generally carried out by a cleaning unit which contains the required cleaning solutions and controls the cleaning sequences. In newer bottling plants a general Cleaning In Place (CIP) programme consist of (i) rinsing with water for a period of time with the wastewater discharged to drain, (ii) scouring with a caustic mix (1.5% solution) at 80°C for a set time period (often 15 minutes) with recovery of the caustic solution, (iii) rinsing with water at 75°C for a set time period (often 15 minutes) with the caustic-contaminated wastewater discharged to drain, and (iv) a cold water rinse which can be recirculated to the CIP tank for use in the first rinse. Where fruit pulp is used, an acid may need to be added to ensure proper cleaning (Steen, 2006). Older bottling plants may not include the recovery of caustic and rinse water (steps (iI) and (iv)). Newer technology involves the use of electrochemically activated water that reduces the number of CIP steps and is carried out cold.

2.2 Scale of Operation

Water consumption is the key environmental issue in the soft drink industry. Most of the water that is not contained in the product leaves the manufacturing site as wastewater, generally high in chemical oxygen demand (COD). A smaller volume is evaporated in cooling towers or used for irrigation on site.

Solid waste arises from packaging and rejects, either from internal inspection or returned goods, while noise from generators, refrigeration and vehicle movements can add to noise pollution.

Generally, the main air emissions from soft drink manufacturers originate from coal or oil fuelled boilers and to a lesser extent from dust and odours. Energy consumption is another area of concern due to stresses on the South African electricity supply and the need for energy in all stages of processing, as well as in the transport requirements (raw materials, product, off-site sold waste disposal, etc.).

Generic process flow diagrams are provided in this section for the main soft drink categories (carbonated drinks, fruit juices and bottled water), with the stages at which the environmental issues highlighted above may be expected to arise indicated on the diagrams.

2.2.1 Water pre-treatment

The main ingredients in the operation of the water treatment plant are the chemicals for the flocculation process. These disappear with the settled solids to the wastewater treatment plant where they form part of the remaining sludge. All filter systems (sand filter, carbon filter, polishing filter and reverse osmosis membrane filters) need to be recovered, mostly through backwashing with clean water. The first part of the backwash water contains most of the removed impurities and is disposed of through the waste water system. The last part of the backwash water is relatively clean and can be reused by feeding it back into the beginning of the water treatment process. The process flow is shown in Figure 2.1.

2.2.2 Carbonated drinks

The environmental impact from the bottling process depends strongly on the type of packaging used. In modern bottling plants the bottle blowing and filler machines are combined and little else than energy is used in the filling process. Returnable Glass Bottles (RGB) need to be washed before being filled. This process is water and energy intensive as it makes use of steam, water and caustic. Besides re-use of the water within the bottle washer, bottle washer waste water can in some cases also be used in the crate washer or other low-grade uses. Although technically possible caustic recovery from the bottle washer waste water is often not yet economically viable. Pre-blown bottles and cans mostly only need a quick rinse before the filling process. This water can be re-used for several cycles. Packaging waste is formed by broken glass bottles and rejects from the filling of PET bottles and cans. The process flow is shown in Figure 2.2.

2.2.3 Fruit juices

The water use, waste and emissions from the fruit juice production process are similar to that of the carbonated soft drink process. The cooling water used in the cooling step after the pasteurisation can be reused for several other functions, depending on the temperature of the water after the cooling process. The process flow is shown in Figure 2.3.

2.2.4 Bottled water

The production of non-flavoured bottled water is also similar to that of the production of carbonated beverages, but there is no blending of ingredients and therefore less wastewater from the CIP process. The process flow is shown in Figure 2.4.

2.2.5 Cleaning in place

The main environmental impact of the CIP process lies in the consumption of water and chemicals, as well as in the generation of wastewater. The type of product (e.g. juice, carbonated beverage or unflavoured water) determines the frequency and intensity of the CIP process and the pollution load of the waste water. The process flow is shown in Figure 2.5.

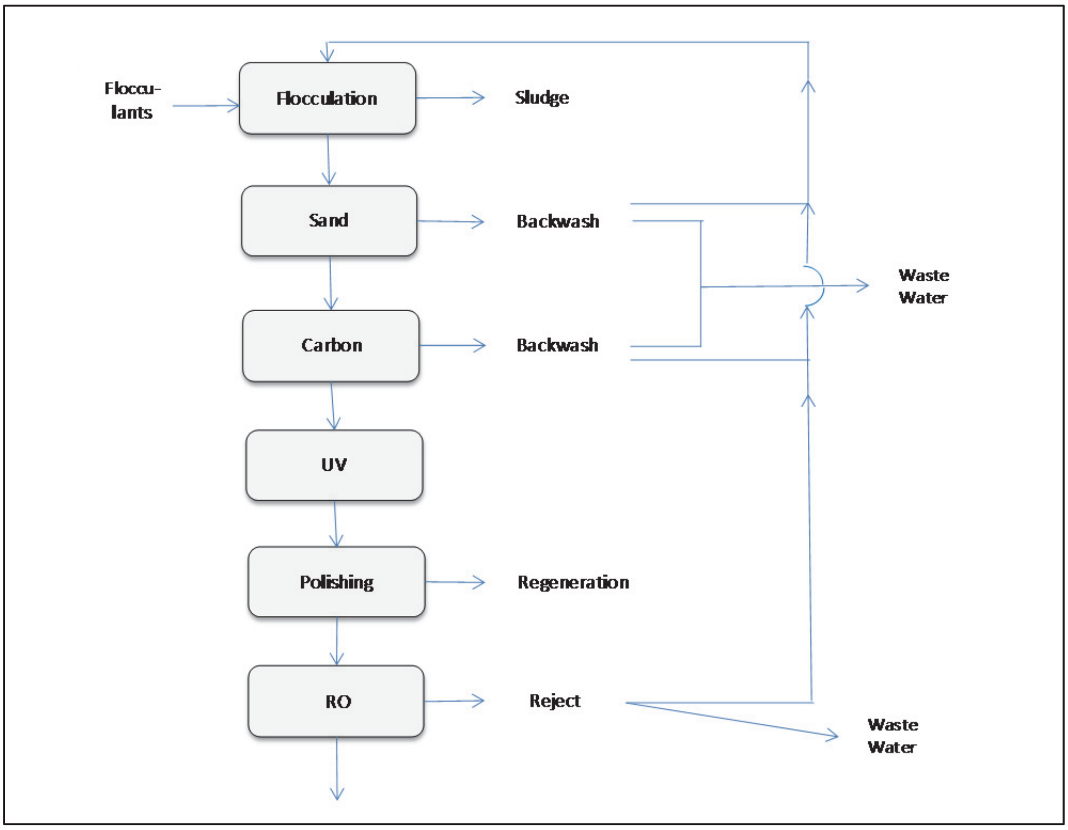


Figure 2.1: Generic process flow diagram for water treatment

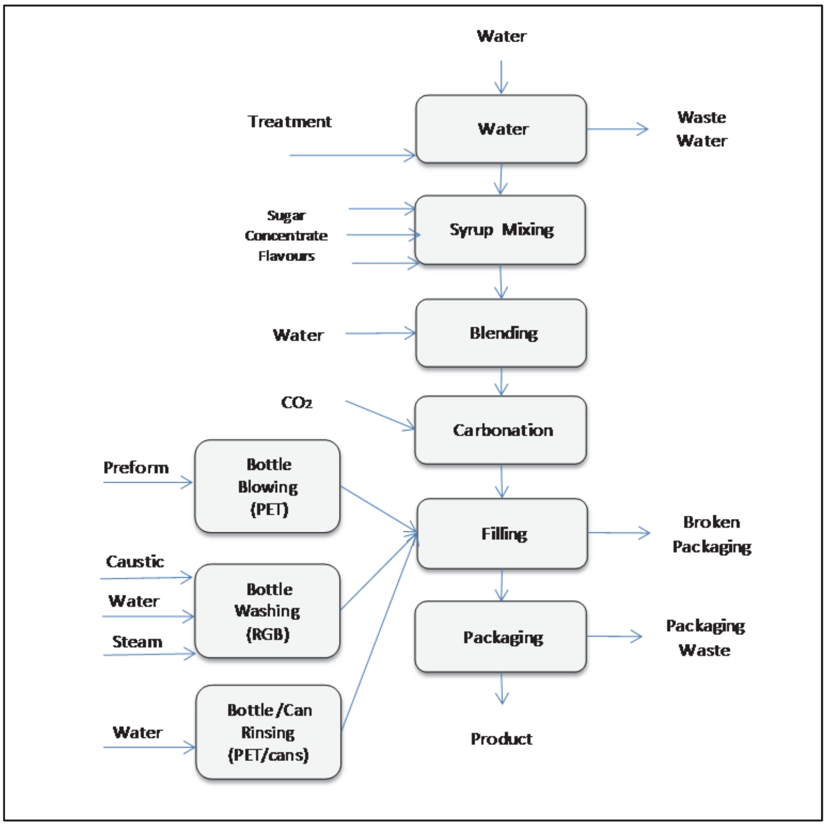


Figure 2.2: Generic process flow diagram for carbonated soft drink production

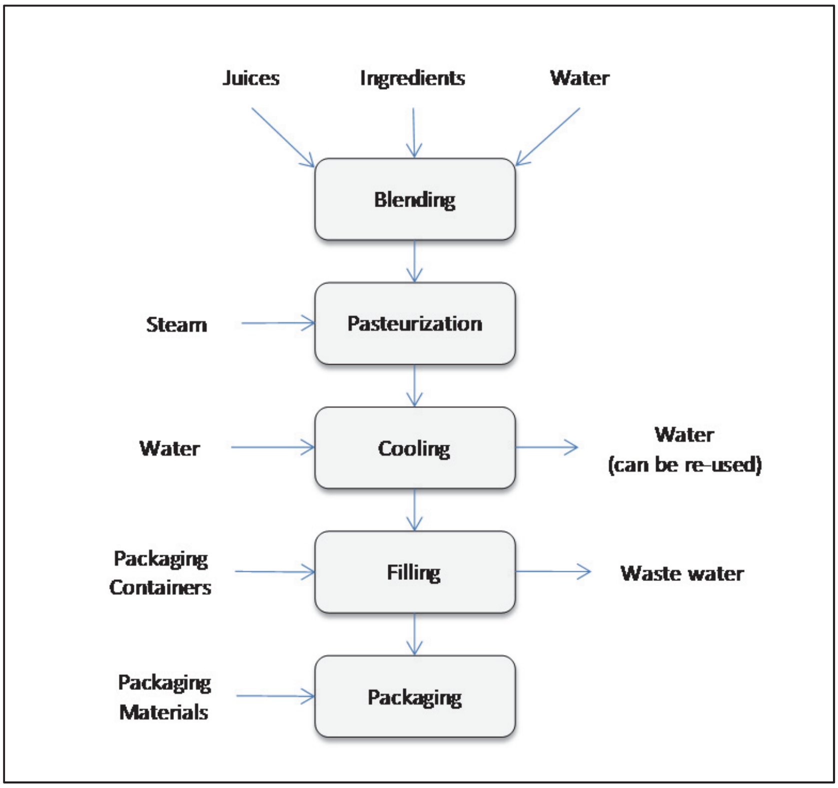


Figure 2.3: Generic process flow diagram for fruit juice production

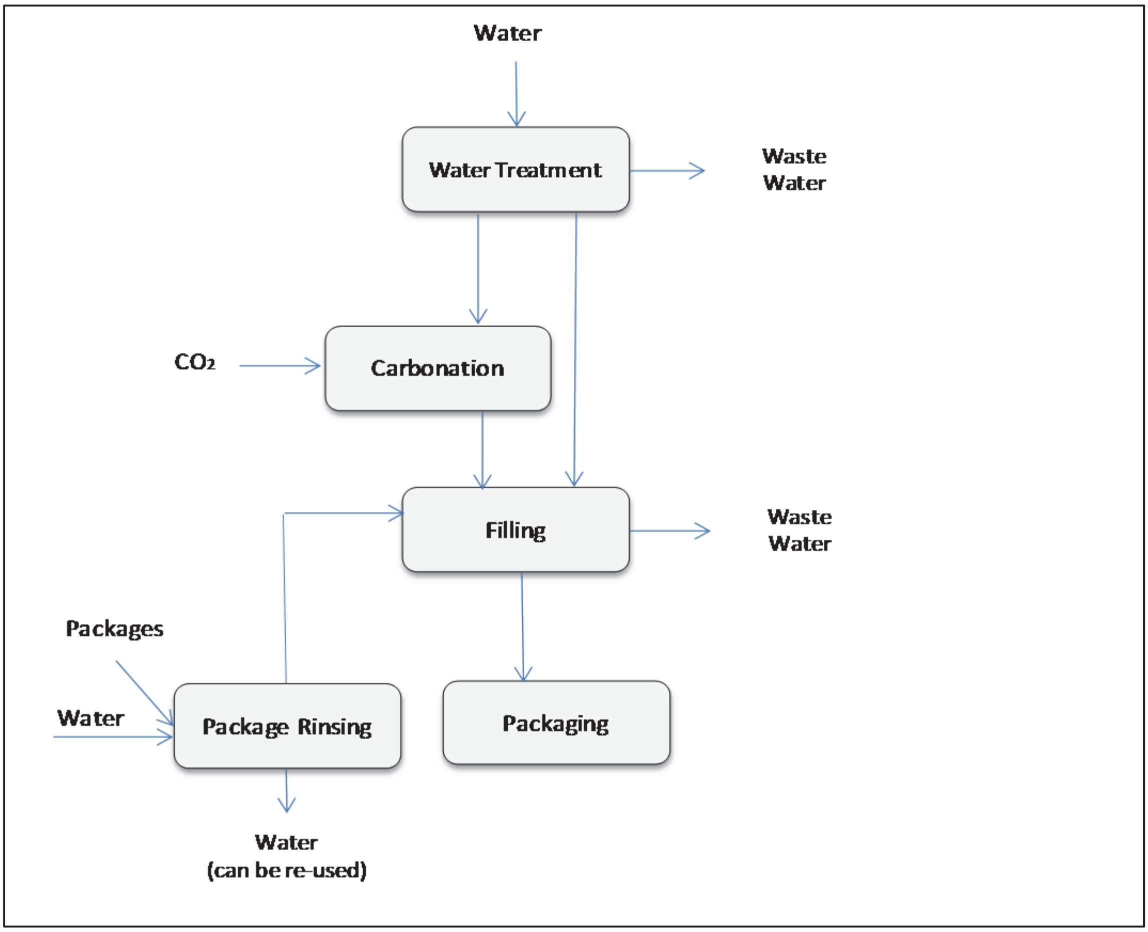


Figure 2.4: Generic process flow diagram bottled water production

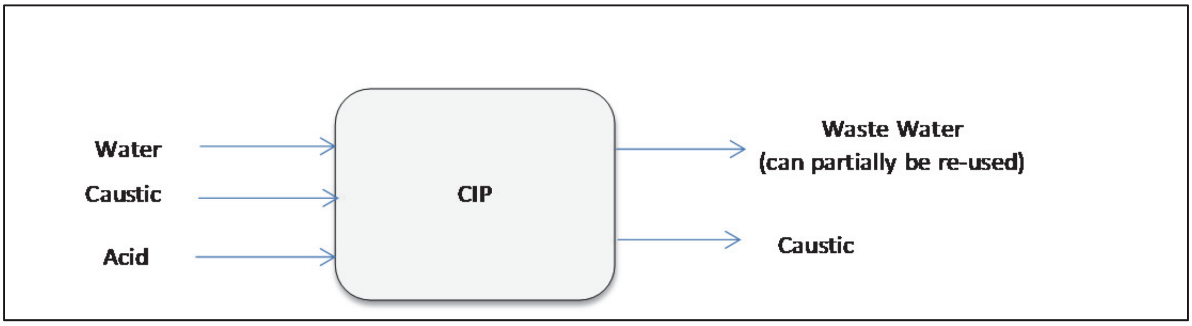


Figure 2.5: Generic process flow diagram for Clean-in-Place

3. Regulations

A summary of the legislation and guidelines relevant to the South African Soft Drink Sector is provided in Appendix 4.

South Africa has a three-tier system of government, i.e. national, provincial and local spheres of government. In general terms, national government is responsible for high level security functions, economic regulation and social development; the provincial government for regional economic planning, housing, environmental management, rural livelihoods and human development; and local government for basic service provision (which links closely with housing) and for creating an enabling environment for local business (Sutherland, 2013).

The relationship between these three spheres of government is based on a system of co-operative governance defined in the Constitution. Co-operative governance requires that each sphere respects the powers and functions of other spheres, cooperates with each other and coordinates actions and legislation (SA Government, 1996).

On a local level, governance takes place through municipalities such that all areas, including urban and rural, fall under local municipal control. There are three types of municipalities – metropolitan, district and local municipalities (as defined by the Municipal Demarcation Act). The largest metropolitan areas are governed by Metropolitan municipalities which have exclusive municipal executive and legislative authority in their respective areas, while the rest of the country is divided into district municipalities, each of which consist of several local municipalities. There are eight metropolitan municipalities, 44 district municipalities and 226 local municipalities within South Africa (Yes!Media, 2015).

3.1 National Policy for Water, Effluent and the Environment

The Bill of Rights in the Constitution of the Republic of South Africa, 1996 (Act 108 of 1996) enshrines the concept of sustainability; specifying rights regarding the environment, water, access to information and just administrative action. These rights and other requirements are further legislated through the National Water Act (NWA), 1998 (Act 36 of 1998). The latter is the primary statute providing the legal basis for water management in South Africa and has to ensure ecological integrity, economic growth and social equity when managing and using water.

The NWA introduced the concept of Integrated Water Resource Management (IWRM), comprising all aspects of the water resource, including water quality, water quantity and the aquatic ecosystem quality (quality of the aquatic biota and in-stream and riparian habitat). The IWRM approach provides for both resource directed and source directed measures. Resource directed measures aim to protect and manage the receiving environment. Examples of resource directed actions are the formulation of resource quality objectives and the development of associated strategies to ensure ongoing attainment of these objectives; catchment management strategies and the establishment of catchment management agencies (CMAs) to implement these strategies.

On the other hand, source directed measures aim to control the impacts at source through the identification and implementation of pollution prevention, water reuse and water treatment mechanisms. The integration of resource and source directed measures forms the basis of the hierarchy of decision-taking aimed at protecting the resource from waste impacts. This hierarchy is based on a precautionary approach and the order of priority for water and waste management decisions and/or actions are shown in Figure 3.1.

RESOURCE PROTECTION AND WASTE MANAGEMENT HIERARCHY

Step 1: Pollution Prevention

↓

Step 2: Minimisation of Impacts

Water reuse & reclamation Water treatment

↓

Step 3: Discharge or disposal of waste and/or waste water

Site specific risk based approach Polluter pays principle

Figure 3.1: Hierarchy of decision making to protect water resources (DWS, 2015)

The overall Resource Protection and Waste Management Hierarchy sets out the interpretation of policy and legal principles as well as functional and organisational arrangements for resource protection and waste management in South Africa. Operational policies describe the rules applicable to different categories and aspects relating to waste discharge and disposal activities. Research will probably adopt a fourth step to this hierarchy in future through the recovery of resources from waste (which is in line with the Department of Environmental Affairs (DEA) legislation.

Further information on some of the relevant policies is provided in this section.

3.1.1 Water policy

The recently formed Department of Water and Sanitation (DWS, 2014 – formerly the Department of Water Affairs (DWA) and the Department of Water Affairs and Forestry (DWAF)) is the water and sanitation sector leader in South Africa. DWS is the custodian of South Africa's water resources and of the National Water Act (Act 36 of 1998) (DWAF, 1998) and the Water Services Act (Act 108 of 1997) (DWAF, 1997). DWS is also the national regulator of the water services sector.

The National Water Act provides the legal framework for the effective and sustainable management of water resources within South Africa. The Act aims to protect, use, develop, conserve, manage and control water resources as a whole, promoting the integrated management of water resources with the participation of all stakeholders (DWAF, No date).

The Act stipulates the requirements for, among others, the development of a National Water Strategy and Catchment Management Agencies, the protection of water resources through classification, setting reserves (basic human need and ecological), determining resource quality objectives and promoting pollution prevention, and through the provision of penalties for non-compliance.

The Water Services Act Deals mainly with water services or potable (drinkable) water and sanitation services supplied by municipalities to households and other municipal water users. It contains rules about how municipalities should provide water supply and sanitation services. Within each municipal area, bylaws are developed which outline the water supply and effluent discharge regulations and tariffs for that area (see Section 3.2).

3.1.2 Wastewater policy

Under the National Water Act (Act 36 of 1998), norms and standards for the purification of wastewater or effluent prior to discharge have been set. These consist of general and special standards and set limits for aspects such as pH, temperature, chemical oxygen demand (COD), suspended solids, metals, etc. The test method that is to be used to determine these levels are also specified. Areas where the special standards apply are listed. Any industries or municipal or private wastewater treatment works discharging to river or sea must comply with these limits. In turn, the entity operating a wastewater treatment works must set limits for industries discharging to the works such that the DWS final discharge limits can be met. This is discussed in Section 3.2.

3.1.3 Environmental policy

The constitution of South Africa states that everyone has the right to an environment that is not harmful to his or her health or well-being (SA Government, 1996) and the right to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development. Regulation that addresses these rights falls under the responsibility of the Department of Environmental Affairs (DEA).

Policy that is the most relevant to the soft drink sector is the National Environmental Management Act, 1998 (Act 107 of 1998) and in particular, the National Environmental Management: Waste Act, (Act 59 of 2008) and the National Environmental Management: Air Quality Act, 2004 (Act no. 39 of 2004). Broadly speaking, these Acts outline the requirements for the storage and handling of waste onsite (hazardous and non-hazardous), licensing requirements, the establishment of waste management plans, the setting of limits for air emissions, and the setting of penalties for offenses. Both these acts emphasise the need for the implementation of cleaner production and clean technologies to reduce the generation of pollution at source. These Acts have been amended more than once to update requirements as new technologies are developed and environmental protection has become more of a priority. More detail is provided in Appendix 4.

3.2 Bylaws and Effluent Tariffs

The Water Services Act sets out the regulatory framework for institutions tasked with the supply of water services and provide for different water services institutions to be established as follows:

- The water services authority (WSA) – i.e. the responsible municipality
- The water services provider (WSP) – whose role is to physically provide the water supply and sanitation services to consumers

Generally within each municipality (the WSA) there is a department or unit that is responsible for the provision of water and the treatment of wastewater or the delivery of sanitation (the WSP).

The bylaws and tariffs for the eight metropolitan municipal areas are described in this section.

3.2.1 eThekwini Municipality

Important policy documents from the eThekwini Municipality include the Policies and Practices of the eThekwini Water and Sanitation Unit (EWS, 2013) which outline the policy related to provision of water and sanitation services, the Water Services Development Plan (EWS, 2011)and the Sewage Disposal Bylaws (EWS, 1999). The tariff schedule provides the related costs (EWS, 2014).

Any industry wishing to discharge to a wastewater treatment works must apply for a trade effluent permit. Requirements for this permit include the undertaking of a cleaner production assessment to identify measures to reduce the consumption of water and generation of wastewater at source. Trade effluent will not be accepted if it contains concentrations of substances above stated limits and separate limits are provided for sewerage works with a capacity both greater than, and less than, 25 ML/day. A third set of limits is applicable for industry discharging directly to one of the two sea outfalls (EWS, 2011).

Industrial, commercial and institutional customers are charged for the acceptance of sewage into the Municipal sewerage system by means of a volume based sewage disposal charge which replaced sewerage rates from 1 July 2010.

In addition to the above charge, industries that are permitted to discharge trade effluent and with a COD greater than 360mg/l and SS greater than 9ml/l (pollution loading exceeding that of 'normal' domestic sewage) are charged for their high strength effluent at the rate calculated as given in Equation 1 (EWS, 1999).

Equation 1:

$$\text{Volume based charge} + V\left(\frac{COD}{360} - 1\right) + Z\left(\frac{SS}{9} - 1\right)$$

Where:	
COD	: Chemical Oxygen Demand in mg/l
SS	: Settleable Solids in l/l
V	: rate for the treatment in the treatment works of standard domestic effluent having a prescribed COD value
Z	: rate for the treatment in the treatment works of standard domestic effluent having a prescribed settleable solids value

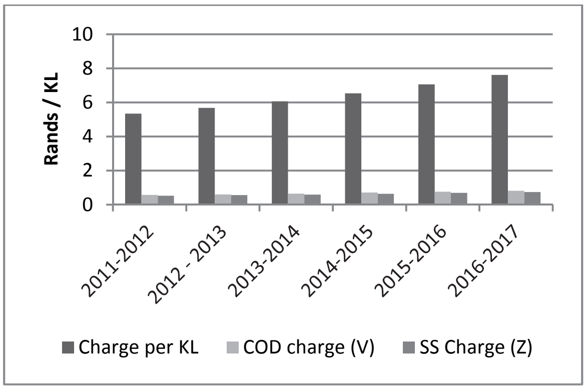
The volume of trade effluent discharged is determined by either a trade effluent meter, which is read every month and readings forwarded to the municipality, or through a water balance questionnaire which is filled in by the company. The water balance questionnaire subtracts the volume of domestic effluent, water used in product, in the process and loss due to evaporation from the incoming volume to give a percentage of trade effluent produced. Limits for effluent quality are set depending on the size of the receiving wastewater treatment works.

Data on basic unit cost for water and effluent and the values for V and Z are provided in Table 3.1.

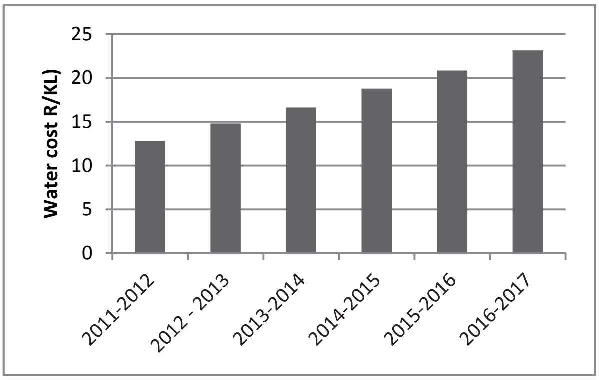
Table 3.1: Basic unit costs for water and effluent in eThekwini Municipality (EWS, 2014)

Period	Effluent			Water
	Rand / KL	COD charge (V)	SS Charge (Z)	R /KL
2011-2012	5.34	0.57	0.52	12.8
2012-2013	5.68	0.6	0.56	14.79
2013-2014	6.07	0.65	0.59	16.63
2014-2015	6.54	0.71	0.64	18.78
2015-2016	7.06	0.76	0.69	20.84
2016-2017	7.62	0.82	0.74	23.14

The trends on water and effluent costs from 20211/2012 to 2015/2016 are shown in Figure 3.2.



(a): Trends in charges for eThekwini Municipality with predicted increase



(b): Trends in water price for eThekwini Municipality with predicted increase

Figure 3.2: Trends on water and effluent costs in eThekwini Municipality (EWS, 2014)

3.2.2 City of Johannesburg

The Water Services Bylaws provide a description of the policy related to the provision of water and the discharge of industrial effluent. Limits are set for effluent quality with which industry must comply. An application for relaxation on these limits can be made, but this is dependent on a number of criteria being met including the use of best available technologies and the implementation of a waste minimisation programme (CoJ, 2008).

Trade effluent tariffs are calculated based on the formula given in Equation 2.

Equation 2:

$$\left[C + T\frac{COD}{700}\right] + \left[T\ \frac{(Metal-factor)}{factor}\right] + C(7 - pH) + (C + T)\frac{FOG-200}{200}$$

Where: (CoJ, 2014)
C = 492.42 c/KL
T = 537.00 c/KL
COD = Chemical Oxygen Demand
FOG = Fats, Oils and Grease

- All concentrations of metals (mg/l) must be greater than the factor for the formula to apply
- pH term applies if pH is less than 4
- FOG term applies if FOG is greater than 200 mg/l

Metal	Factor	Metal	Factor	Metal	Factor	Metal	Factor
As	2.5	**Hg**	1	**Se**	2.5	**Cr**	20
Cd	2.5	**Mo**	5	**Zn**	20	**Cu**	20
Pb	10						

3.2.3 City of Tshwane

The relevant policies within the City of Tshwane are the Sanitation and Water Tariff Policies which outline the approach taken by the Municipality when setting water and sanitation charges. There are three different categories for industrial effluent charge (Tshwane, 2014):

1. **Normal conveyance and treatment cost**: Applies to effluent of the same quality as domestic wastewater discharged to sewer and is calculated by multiplying the combined unit conveyance and treatment cost by the volume discharged. Industrial consumers will be charged the tariff cost with a rebate of 10%.
2. **Extraordinary Treatment Cost:** Applies when the pollution loading exceeds that of normal wastewater and the cost is calculated as given in Equation 3:

Equation 3:

$$Tc = Qc.t[0.6\ \frac{(CODc-CODd)}{CODd} + 0.25\ \frac{(Pc-Pd)}{Pd} + 0.15\ \frac{(Nc-Nd)}{Nd}]$$

Where:
T_c = extraordinary cost to the consumer
Q_c = wastewater volume (KL)
t = unit treatment cost of wastewater (R/KL)
COD_c = total COD in mg/l of wastewater including biodegradable and non-biodegradable
COD_d = total COD of domestic wastewater in mg/l
P_c = orthophosphate concentration of wastewater in mg phosphate/l
P_d = orthophosphate concentration of domestic wastewater in mg phosphate/l
N_c = ammonia concentration of wastewater in mg nitrogen/l
N_d = ammonia concentration of domestic wastewater in mg nitrogen/l
2014 tariffs:
t = R 0.94 / KL
COD_d = 710 mg/l
P_d = 10 mg/l
N_d = 25 mg/l

3. **Non-compliance with By-Law limits**: where the limits are exceeded, the tariff given in Equation 4 will apply:

Equation 4:

$$T_C = Q / D.N\ [C_{AIP} – B_{LL}/W_{PL}]t_{NC}$$

Where:	
T_c	= charge for non-compliance
Q	= monthly volume in KL
D	= working days in the month
N	= number of days exceeding by-law
C_{AIP}	= average concentration of parameter exceeding bylaw
B_{LL}	= bylaw limit
W_{PL}	= Water Affairs standard limitation on parameter exceeding bylaw
t_{NC}	= tariff (R 0.65 / KL

Table 3.2: Basic unit costs for water and effluent in Tshwane (Tshwane, 2015)

	Water Tariff R/KL			Effluent Tariff R/KL		
	2012-2013	**2013-2014**	**2014-2015**	**2012-2013**	**2013-2014**	**2014-2015**
0-1 0 000 kℓ	**11.89**	**13.08**	**14.39**			
10 001-100 000 kℓ	**11.29**	**12.42**	**13.66**			
More than 100 000 kℓ	**10.52**	**11.57**	**12.73**			
Charged at 60% of incoming water				**4.66**	**5.13**	**5.64**

3.2.4 City of Cape Town

The City of Cape Town has bylaws relating to Wastewater and Industrial Effluent (CoCT, 2014) which sets out the requirements and limits for industrial effluent discharge, and a Treated Effluent Bylaw (CoCT, 2010) which outlines the permitted use of treated effluent (e.g. for irrigation, etc.).

Limits are set for effluent discharge with respect to general pollution loads such as COD and electrical conductivity, as well as for chemical substances, heavy metals, and inorganic content (Schedule 1 of the Wastewater and Industrial Effluent). Failure to comply with these limits results in the application of a surcharge factor (CoCT, 2013).

3.3 Health and Safety

The Department of Health is responsible for regulating aspects related the health and safety of food and drink products through the Food Control section. This department is responsible for ensuring the safety of food in South Africa based on the basic needs of communities and the right of South Africans to make informed food choices without being misled. The Act that covers all these aspects with respect to the soft drink industry is the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No. 54 of 1972; Amendment Act, No. 39 of 2007). This Act regulates aspects related to the content of fruit drinks, carbonated drinks, bottled water and energy drinks. There are Acts specific to each type of soft drink, each of which have undergone a number of amendments to make changes to definitions, content and limits. These are summarised in Appendix 4.

A key requirement of all food and drink manufacturing sites is the implementation of a Hazard Analysis and Critical Control Point (HACCP) system. This is regulated under the above mentioned Act regulation number *R 908: Regulations relating to the application of the Hazard Analysis and Critical Control Point system (HACCP system) 27th June 2003*. The manufacturing site must ensure that the system is in accordance with the principles as provided for by the Joint Food and Agricultural Organization / World Health Organization ("FAO / WHO") Food Standards Programme Codex Alimentarius Commission's general requirements (food hygiene), entitled: "*Hazard Analysis and Critical Control Point (HACCP) System and Guidelines for its Application"*, published in the Supplement to Volume 113-1997 document of the Commission; as updated from time to time (DoH, 2003).

Related to the HACCP system is the regulation regarding the microbial standards for foodstuffs and related matters, GNR.692 of 16 May 1997 under the Foodstuffs, Cosmetics and Disinfectants Act, 1972. A number of revisions have taken place with the latest being R706 in September 2011. This provides the limits of the microbial content of the various soft drinks and the SABS ISO test methods that must be used (DoH, 1997).

3.4 Marketing and Labelling of Fruit Drinks

Legislation pertaining to the marketing and labelling of fruit drinks is administered by the Department of Agriculture, Forestry and Fisheries. The main act is the *Marketing Act, 1968 (Act 59 of 1968): Regulations relating to the Classification, Packing and Marketing of Fruit Juice and Drink intended for Sale in the Republic of South Africa* which was replaced by the *Agricultural Products Standards Act, 1990 (Act No 119 of 1990): Regulations relating to the classification, packing and marketing of Fruit Juice and Drink intended for Sale in the Republic of South Africa* (See Appendix 4). These acts, and the amendments to these acts, provide information on the classification of fruit juice and drinks, the required concentrations of juice, which additives are permitted and which substances are prohibited, the types of containers and packing which can be used, how the product should be marked and the methods of inspections. These regulations provide detailed information and requirements with which the soft drink manufacturer has to comply.

4. Overview of Participating Companies

Information on water and wastewater management practices in the South African soft drink industry was collated from the on-line survey results and site visits. A profile of the companies surveyed is provided in Table 4.1 and summarised in Figure 4.1.

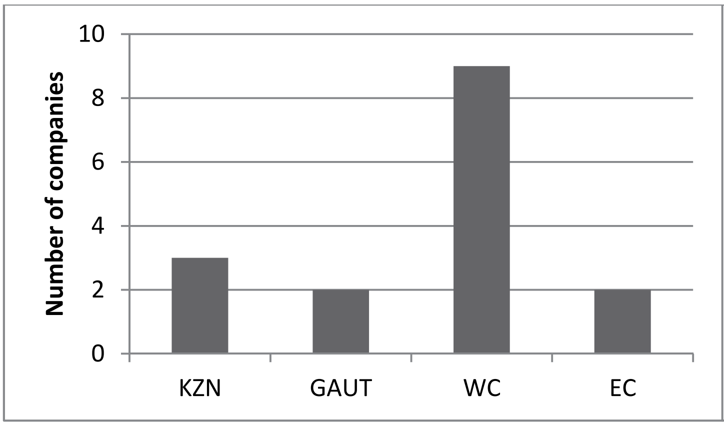
Table 4.1: Profile of companies participating in the survey

	Company reference	On-line survey		Site visit and interview	Region	Size	Production Range (KL/y)
		Original	Updated			No. employees	
Carbonated soft drinks	1	x	X		KZN	>450	120 000-140 000
	2		X		EC	200-450	240 000-260 000
	3		X		WC	200-450	> 500 000
	4			X	WC	> 1 300	320 000-340 000
	5			X	WC	Not given	40 000-60 000
	6			X	EC	Not given	180 000-200 000
	7	x		X	WC	Not given	100 000-120 000
	8			x	KZN	Not given	120 000-140 000
	16		x		GAUT	50-200	40 000-60 000
Bottled Water	9		X		WC	<50	1 000-5 000
	10			X	WC	< 50	80 000-100 000
Fruit Drinks	11			X	GAUT	50-200	10 000-20 000
	12			X	WC	<50	1 000- 5000
	13		X		WC	200-450	1 000-5 000
	14	x			WC	50-200	40 000-60 000
	15	x			KZN	Not given	20 000-40 000

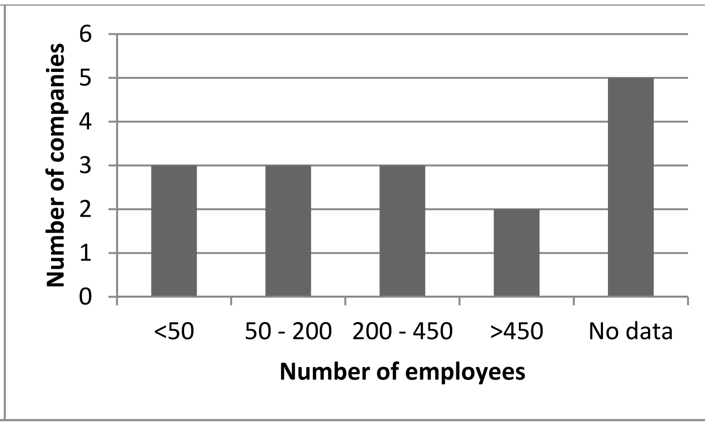
The majority of the companies that participated in the survey are situated in the Western Cape (Figure 4.1(a)), and produce carbonated soft drinks as their main product (in addition to other soft drink products such as bottled water, iced tea and sports / energy drinks). Of those companies that provided data regarding size, most are small to medium sized companies, with two large companies and 2 micro companies.

The main packaging type is PET with some returnable and non-returnable glass bottles as well as returnable PET bottles being used. Cans were only reported to be used by one company.

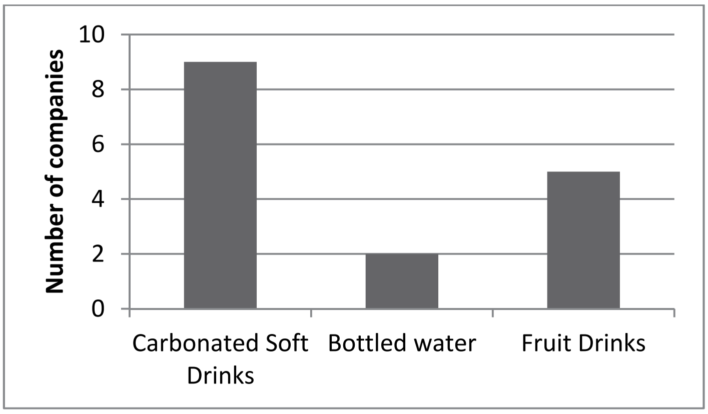
Production volumes vary from 1 800 KL/year for a small fruit juice company, to approximately 588 000 KL/year for a large carbonated soft drink company.



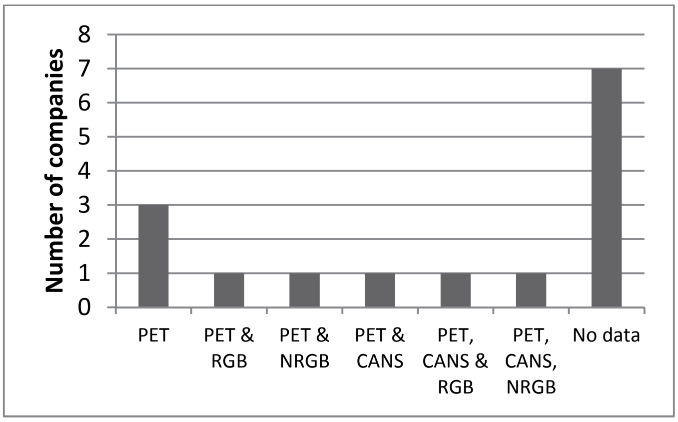
(a) Location of participating companies



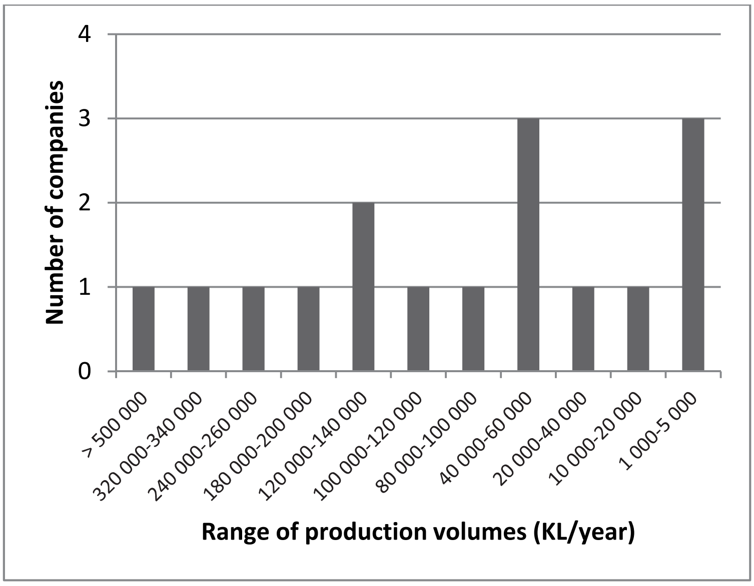
(b) Size of participating companies with respect to number of employees



(c) Categorisation of participating companies



(d) Type of packaging used



(e) Profile of company production volumes in KL per year

Figure 4.1: Profile of companies participating in the survey (a) Location; (b) size; (c) sector; (d) type of packaging; and (e) Annual production volume

5. Water Use and Water Management

5.1 Water and the Soft Drink Industry

Water is the main raw material for soft drink manufacture, making up between 87% to 92% in a typical soft drink (Shachman, 2004). Therefore the quality of the water used must meet stringent standards as it has a serious impact on the taste and appearance of the drink as well as its physical and microbiological stability on the shelves in stores. These standards ensure consistent taste and quality of the soft drink and eliminate the risk to the consumer and the manufacturer.

5.2 Water Use

In order to determine the current status of water consumption within the soft drink sector, participating companies were asked to provide the following information:

- Source of water
- Water quality problems
- Water pre-treatment carried out
- Average water use per unit production

This information was then compared to international benchmarks.

5.2.1 Source of water and pre-treatment

Within Europe the minimum requirement is that all water used in a soft drinks factory must comply with the EC Drinking Water Directive 80/778/EEC (Steen, 2006). Soft drink manufacturers therefore treat all incoming water (apart from natural mineral water where no treatment is allowed) in order to meet these requirements, along with any specific requirements set by the company. Within South Africa, the quality of the final soft drink product is legislated by the Department of Health (see Section 3.3), and therefore all water entering the manufacturing plants is treated to ensure compliance with these requirements. Most bottling companies also have their own water quality standards which are sometimes stricter than the standards from the Department of Health.

An example of the typical water quality requirements for soft drink manufacture is shown in Figure 5.1. The main aspects that are checked include organoleptic (odour and taste), physical (colour and turbidity), chemical (alkalinity, conductivity, pH and chemical content such as metals, nutrients, etc.) (Steen, 2006).

The most common method of meeting water quality standards is treatment using a multi-barrier approach where a combination of sand filtration, carbon filtration, membrane filtration and disinfection (either by ultra-violet (UV) or chlorination) is used. Daily checks on the quality of the water entering the production process are carried out to ensure that all quality requirements are met. The main aspects that are checked are shown in Figure 5.1.

Table 5.1: Typical daily checks on water used in soft drink manufacturing (Steen, 2006)

Test	Incoming water	Treated Water
UV efficiency	No	Yes
Taste, odour and appearance	No	Yes
Microbiological levels	Yes[1]	Yes[1]
Alkalinity	No	Yes
Turbidity metre[2]	Yes	Yes
Silt density	Yes	Yes
Free chlorine	No	Yes

***Notes:** [1]The tests would usually be TVC<500 per 100ml sample at 25°C with no coliforms present in the same size sample. Faecal streps should be absent in a 100 ml sample.*

[2]This should have an automatic data logger

The participating companies were surveyed as to the source of water, the type of pre-treatment carried out, and any concerns the company has regarding water quality. This information is provided in Table 5.2.

Table 5.2: Summary of water source and pre-treatment processes

	Company reference	Source of water	Water treatment	Issues with water
Carbonated Soft Drinks	1	Municipal	Sand filtration, Activated carbon, UV disinfection, Chlorine disinfection	No data
	2	Municipal	Membrane filtration, Activated carbon, RO	No data
	3	Municipal	Sand filtration, Membrane filtration, Activated carbon, UV disinfection	No data
	4	Municipal	Sand filter; Ca hypochlorite disinfection; carbon filter; polishers (nanofiltration); UV; bag filter; RO	pH variation
	5	Municipal	No data	No data
	6	Municipal	Chlorination; flocculation; sand filter; carbon filter; nanofiltration; RO	high THMs
	7	Municipal	Sand filter, carbon filter, polishing filter, UV	No data
	8	Municipal	Sand filtration; carbon filtration; UV	No data
	16	Municipal	Sand filtration, Activated carbon, UV disinfection, Chlorine disinfection	No data
Bottled Water	9	Municipal	none	No data
	10	borehole and spring	UV; 5 µm filter; 1 µm filter; 0.2 µm filter; UV; ozonation	No data
Fruit Drinks	11	Municipal	10 µm filter; 5 µm filter; carbon block; UV filter	No data
	12	Municipal	No data	No data
	13	Municipal	None	No data
	14	River	Treated to potable standard then carbon filter, UV and deaeration	No data
	15	Municipal	No data	No data

Note: THM: Tri halo methane

The majority of the companies that participated in the survey obtain water from the municipality, with only one company using borehole and spring water, and one company obtaining water from a river scheme which they then treated to potable standards prior to pre-treatment for processing. Only one company provided the criteria for the water quality and stated that it had to be pathogen and chlorine free.

Where data was provided, the most common treatment process for companies producing carbonated soft drinks is sand filtration, activated carbon, membrane filtration and UV disinfection. One of the bottled water company stated that they used no pre-treatment, while the other made use of a combination of filters and ozonation. Fruit drink companies made use of carbon filters and UV disinfection.

Only two companies mentioned problems with the quality of the incoming water, namely pH variations and high tri halo methanes (THM).

In comparison, water treatment in the 1987 Guide typically consisted of the addition of treatment chemicals such as lime, chlorine and flocculants followed by a clarifying stage and filtration by sand and carbon filters (Binnie&Partners, 1987).

5.2.2 Water metering

Water is used in nearly all areas of the production process, with the majority of water leaving the site in the product. In order to accurately account for water use within a soft drink manufacturing plant, it is essential for sub-metering to be installed on the main water using areas. The participating companies were asked to supply the number of water meters installed on-site, and the frequency at which these meters were read. This information is summarised in Table 5.3.

Table 5.3: Summary of the number and position of meters on site

	Company reference	No. of meters	Reading frequency	Position of meters												
				Main	Pre-treatment	Factory	mixing	blending	Filling	bottle washing	CIP	Admin non -process	Truck washing	utilities	Crate washing	Effluent
Carbonated Soft Drinks	1	-	-													
	2	3	-		1		1	1								
	3	-	-													
	4	7	-	1					3	1				1	1	
	5	14	varies	-												
	6	46	daily	-												
	7	2	-	1								1				
	8	-	-													
Bottled Water	9	-	-													
	10	0	NA													
Fruit Drinks	11	4	monthly	1							P	P				
	12	1	never	1												
	13	-	-													
	14	9	-	1	1	1	1	1	1		1	1				1
	15	8	-	1	1			1	1		1		1	1		1
	16	-														

Note: A dash implies that no data was supplied; P means it is planned

As can be seen from Table 5.3, the number of sub-meters installed ranged from none (use was made only of the municipal meter readings provided on a monthly basis) to 46. Not all companies provided information on where the meters were installed. It is also evident that in general the soft drink companies meter water consumption more so that the other sectors, while the two bottled water companies are not metering water consumption at any stage of the process.

The survey did request an indication of the volume of water used in each of the main process areas, but no feedback was obtained. However, a study in the UK identified the main water using areas within soft drink manufacture, excluding water in product (78%) as the pasteurisers followed by the rinsing of containers and the boiler house (WRAP, 2007). This is shown in Figure 5.1.

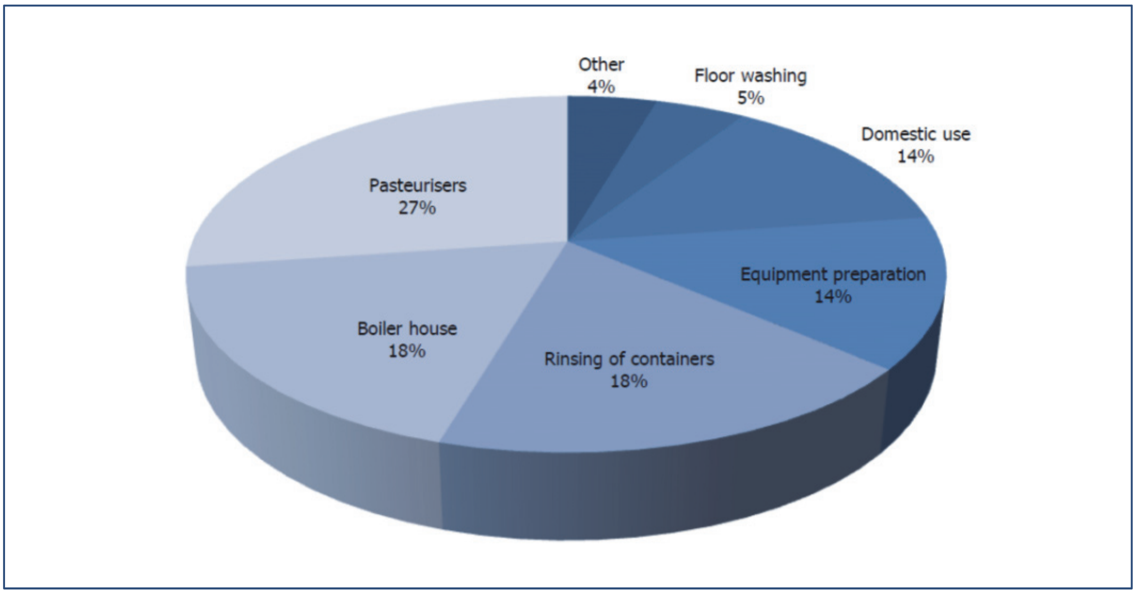


Figure 5.1: Main water using areas in soft drink manufacture (excluding water in product) (WRAP, 2007)

5.2.3 Storm water management

Companies that participated in the site visit were also asked about their storm water management. Table 5.4 summarises the results of this survey.

Of the seven companies that were asked this question, only two had formal storm water plans, while a further two had no formal policy but carried out activities to protect the storm water from contamination. The remaining three companies had no storm water plans and did not bund their chemical or waste areas. Only three of the seven companies have marked the storm water drains. A further question that should have been included in this survey is whether the truck washing areas and workshops are bunded to prevent oil from entering the storm water drains.

Table 5.4: Summary of storm water management in participating companies

Company reference	Is there a storm water plan?	Are chemical storage areas bunded?	Are waste storage areas bunded?	Are storm water drains marked?	Other Comments
4	no	yes	yes	yes	There are map of drains but no formal plan
5	yes	yes	yes	yes	
6	no	yes	yes	yes	water runs into nearby surface water body; drains cleaned annually
7	no	no	no	no	Cleaning of the storm water system happens only when necessary, and then a drain cleaning company is called.
10	no	no	no	no	
11	yes	yes	yes	no	Water from vehicle washing & waste area cleaning flowed into storm water- have since placed more drainage on site to allow the waste water to flow to sewer.
12	no	no	no	no	

5.2.4 Water consumption and specific water intake

The range of annual water consumption and specific water intake (SWI – litres of water used per litre of production) for the participating companies is provided in Table 5.5. This data was either provided by the company, or calculated using the water consumption and production data provided in the survey. Where information was supplied, those companies undertaking bottle and crate washing were highlighted as these operations may result in a higher water consumption. Fruit companies that process fruit on-site (rather than manufacture from concentrate) will also have a higher water consumption.

SWI for companies producing carbonated soft drinks varied from between 1.2 to 1.5 L/L and 2.2 to 2.8 L/L. The SWI was only provided for one bottled water company (1.2-1.5 L/L) and that for fruit drink manufacturers ranges from 1.0-1.2 to 4.0 to 4.5 L/L. As can be seen, the fruit drink company that processes fruit on-site has a higher SWI than the other companies.

The previous 1987 Guide provided a target SWI of 2.3 L/L based on the average SWI for the factories surveyed (Binnie&Partners, 1987). Where the actual SWI could be calculated rather than a range, the average SWI of seven of the carbonated soft drink companies in Table 5.4 is 1.6 L/L which is far below this benchmark figure provided in the previous guide

Table 5.5: Specific Water Intake (SWI) calculated for participating companies

	Company reference	Main products	Annual production (KL/year)	Annual water use (KL/year)	Range of SWI (L/L)	Notes
Carbonated Soft Drinks	1	Carbonated soft drinks	120 000-140 000	240 000-260 000	1.8-2.0	Bottle & crate washing
	2	Carbonated soft drink	240 000-260 000	260 000-280 000	1.2-1.5	
	3	Carbonated and non-carbonated soft drinks	> 500 000	> 500 000	-	
	4	Carbonated soft drinks	320 000-340 000	> 500 000	1.5-1.8	Bottle & crate washing
	5	Carbonated soft drinks	40 000-60 000	60 000-80 000	1.2-1.5	Crate washing
	6	Carbonated soft drinks; flavoured bottle water	180 000-200 000	450 000-500 000	2.2-2.5	
	7	Carbonated soft drink	100 000-120 000	140000-160 000	1.2-1.5	
	8	Carbonated soft drinks	120 000-140 000	200 000-220 000	1.2-1.5	
	16	Carbonated soft drinks	40 000-60 000	60 000-80 000	1.5-1.8	Bottle & crate washing
Bottled Water	9	Still and carbonated bottled water	1 000-5 000	2 000-5 000	1.2-1.5	Bottle washing
	10	Still and carbonated bottled water	80 000-100 000	-	-	Bottle washing
Fruit Drinks	11	100% Fruit Juice	10 000-20 000	10 000-20 000	1.2-1.5	
	12	100% Fruit Juice	1 000- 5000	0-2 000	1.0-1.2	
	13	100% fruit juice	1 000-5 000	-	-	Crate washing
	14	100% fruit drinks	40 000-60 000		4.0-4.5	Process fruit on-site
	15	Fruit drinks	20 000-40 000	100 000-120 000	3.5-4.0	Crate washing

5.3 International trends

In order to determine how the South African industry performs with respect to specific water intake, a literature review was undertaken to obtain some figures from international studies. This information is summarised in Table 5.6.

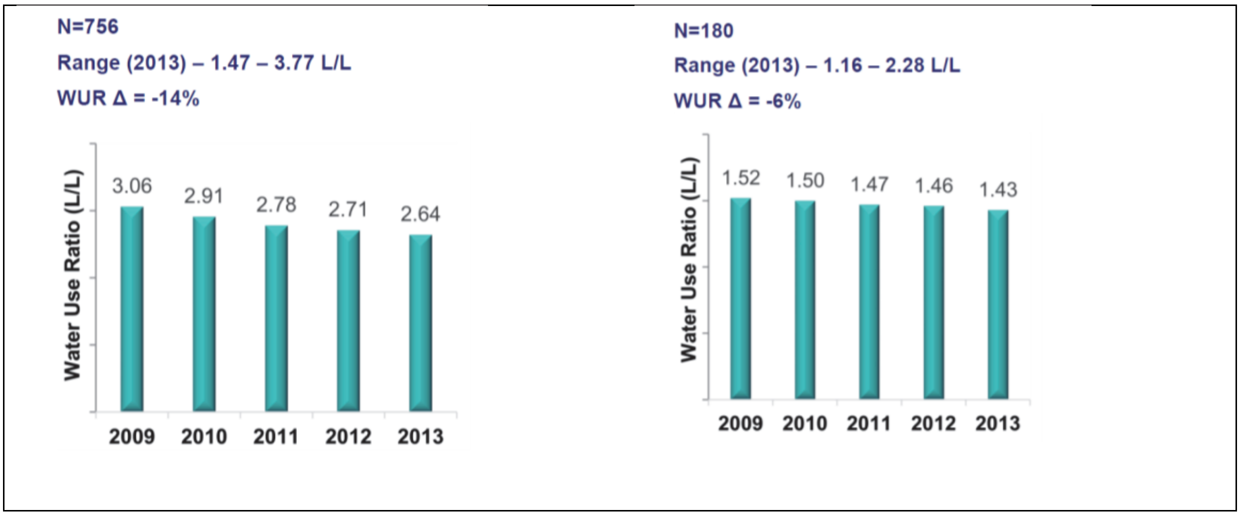
The Beverage Industry Environmental Round Table (BIER) produces an annual report which provides an overview of the soft drink sector based on surveys undertaken within member organisations. Aspects included in this survey are specific water intake and specific energy utilisation. A comparison is made of these figures to results from previous years and in this way trends can be plotted.

WRAP is a UK organisation that works with industry and government to promote resource efficiency and waste prevention within the manufacturing and commercial sectors. The benchmark figures from this source provided in Table 5.6 were obtained from various literature and survey sources and provide an indication of the specific water intake based on average water consumption and best practise water consumption compared to production (WRAP, 2007).

Table 5.6: Benchmark figures for specific water intake from international studies

Category	Specific Water Intake (L/L)			Survey basis	Reference
	Min	Max	Average		
Carbonated soft drinks	1.47	3.77	2.64	756 companies	Beverage Industry Environmental Roundtable (BIER, 2015)
	1.36		1.53	Member data and lit	WRAP (2007)
Mineral water / soft drinks	0.64	1.45		DWA-standard M 766 “Waste water of Soft drink, Fruit juice and Mineral water industry	SA Department of Water Affairs (DWA, 2010)
Bottled water	1.16	2.18	1.43	180 companies	Beverage Industry Environmental Roundtable (BIER, 2015)
			1.7	SA Benchmark	South African National Bottled Water Association (SANBWA, 2011)
Mineral water / Soft drinks / Fruit juices/nectars & Fruit juice drinks	0.99	2.22		DWA-standard M 766 “Waste water of Soft drink, Fruit juice and Mineral water industry	German Association for Water, Wastewater and Waste draft paper (DWA, 2010)
Fruit juice	0.5		3.5	Member data and lit	WRAP (2007)
Fruit juices/nectars & Fruit juice drinks	1.74	3.25		DWA-standard M 766 “Waste water of Soft drink, Fruit juice and Mineral water industry	SA Department of Water Affairs (DWA, 2010)
Fruit drinks	1.36		1.53	Member data and lit	WRAP (2007)

An example of the trend for SWI taken from the (BIER, 2015) report are provided in Figure 5.2 for the carbonated soft drink and bottled water sectors.



(a) Example of average SWI trends for the carbonated soft drink sector

(b): Example of average SWI trends for the bottled water sector

Figure 5.2: International trends of the average specific water intake (L/L) for the soft drink sector (WUR Δ = change in water use ratio) (BIER, 2015)

Note: *These BIER benchmark figures were obtained from a survey of bottling plants from all regions, and therefore the average may appear to be on the high side. It should be noted the South African bottling plants are on a par with those operating in Europe.*

Figure 5.3, Figure 5.4 and Figure 5.5 provide a comparison of the SWI calculated for the participating companies to the benchmark figures provided in Table 5.6.

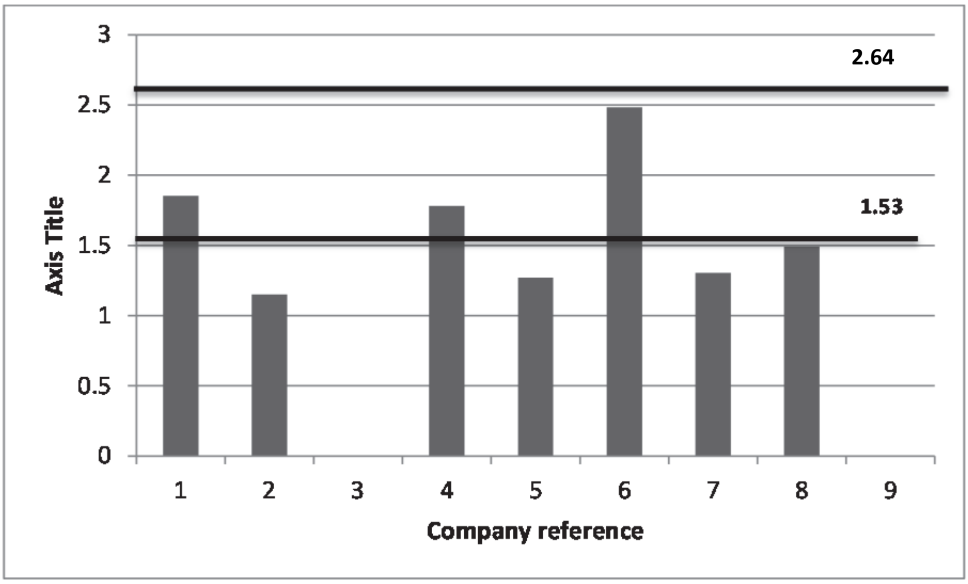


Figure 5.3: Comparison of specific water intake (L/L) for participating carbonated soft drinks companies

The average SWI from a survey of 756 carbonated soft drink bottling plants (BIER, 2015) is given as 2.64 L/L while that from a survey in the UK is 1.53 L/L (WRAP, 2007). The majority of the participating companies consume less than 2.0 L per L production, while four companies use less than 1.53 L/L production.

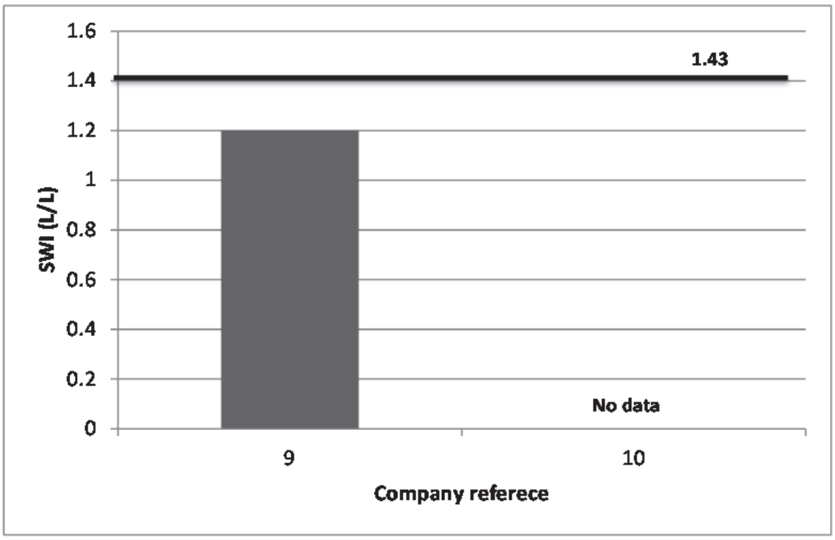


Figure 5.4: Comparison of specific water intake (L/L) for participating bottled water companies

Comparison of the SWI for bottled water production is difficult as only one company provided data which enable the calculation of the SWI. As can be seen from Figure 5.4, this company uses less than both the benchmarks provided in literature (1.43 L/L shown in Figure 5.4; 1.7 L/L not shown).

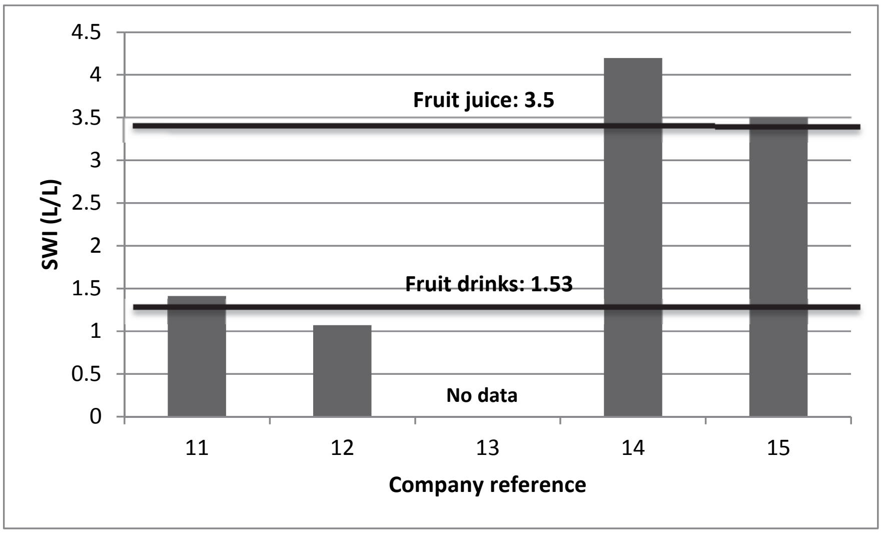


Figure 5.5: Comparison of specific water intake (L/L) for participating fruit drinks companies

With regards to the SWI for fruit juices, it depends on whether the company produces 100% fruit juice or fruit drinks. There are two benchmark lines provided in Figure 5.5 – the higher line relates to the average SWI for 100% fruit juice, while the lower line relates to fruit drinks. As can be seen, two of the four companies that provided data lie below both lines, once uses 3.5 L/L, and the fourth uses more than 4 L/L.

6 Wastewater Generation and Management

In order to determine the status of wastewater generation and management in the soft drink sector, companies were surveyed with respect the following information:

- The volume of wastewater generated and specific effluent volume (i.e. the volume of effluent produced per unit production)
- The typical effluent pollutant loads such as chemical oxygen demand (COD), total dissolved solids (TDS) and settable solids (SS)
- The type of effluent treatment carried out prior to discharge; and
- Any concerns with regards to the quality of the effluent.

6.1 Effluent generation and pollutant loads

The effluent generated from a soft drink industry contains wasted soft drink and syrup, wash water from bottle and crate washing, and caustic / detergents and machine lubricant. It is generally high in COD and TSS and will contain nitrates, phosphates, sodium and potassium.

The main sources of wastewater generation within the soft drink process include:

- Production losses
- Bottle and crate washing
- General factory washing
- Truck washing
- CIP

Within South Africa, the main concern for the majority of soft drinks companies is the high COD content as this is generally higher than the limits specified by the municipalities for discharge to sewer. An in-depth study into the source of COD in the effluent within a carbonated soft drink company (Ally, 2015) identified the main cause was due to sugar losses from the following areas:

- Ready to drink (RTD) as a result of post sanitation losses, QA & QC losses and under-fills and over-fills Losses
- Filler-bowl losses
- Simple and final syrup losses
- Dumped batches
- Sugar handling & storage

The estimated contribution to the COD in the effluent from these areas in this study amounted to approximately 150 000 kg per year.

This type of assessment is useful in identifying those areas where changes can be implemented in order to reduce losses, thereby reducing loss of profit through both the loss of water (as effluent) and sugar, as well as a reduction in the COD charge.

The results of the survey into the wastewater volumes and pollution concentrations from the participating companies is summarised in Table 6.1.

From Table 6.1 it can be seen that the SEV ranges from a low of 0.07 L/L for a fruit drink company to a high of 3.8 L/L for a 100% fruit juice company. The remaining companies recorded low SEV of between 0.12 L/L and 1.35 L/L. This range is lower than that obtained in the 1987 guide of 0.41 to 2.44 L/L (Binnie&Partners, 1987). It should be noted that Company 14 produces more effluent than water consumed as the processing of fresh fruit results in an overall effluent gain.

Few companies provided information on the effluent pollutant concentrations, with a wide range of CODs being reported. Where provided, the pH of the effluent from carbonated soft drink manufacturers tended to be alkaline, while those from the fruit drink sites were acidic. Only two TDS ranges were reported and these were less than 500 mg/L. The SS reported for the carbonated site was low (<20), while those reported from fruit drink sites were higher.

Due to the limited data on pollutant concentrations provided by the companies, data was sourced from local regulators in order to obtain a more detailed overview. This information is provided in Table 6.2.

This data shows that the effluent characteristics of soft drink companies varies greatly, even within the same company as is shown by the large range of values for all parameters measured.

Table 6.1: Summary of effluent characteristics from participating companies

Company reference	Annual water use (KL/year)	% Effluent of incoming water	Annual effluent (KL/Year)	SEV[1]	Pollutant Concentration			
					COD (mg/L)	pH	TDS (mg/L)	SS (mg/L)
Carbonated soft drinks								
1	240 000-260 000	40-50%	100 000-120 000	0.88	2 500	9 to 10	0 to 500	0 to 20
2	260 000-280 000	10-20%	40 000-60 000	0.17	-	6 to 7	-	-
3	> 500 000	-	-	-	-	-	-	-
4	> 500 000	44%	240 000-260 000	0.78	100 to 6 100	6.5 to 11	20 to 140	-
5	60 000-80 000	21%	16 000-18 000	0.27	-	-	-	-
6	450 000-500 000	60%	240 000-260 000	1.35	-	-	-	-
7	140000-160 000	42%	20 000-40 000	0.55	-	-	-	-
8	200 000-220 000	10-30%	20 000-40 000	0.15	-	-	-	-
16	60 000-80 000	30-40%	20 000-40 000	-	10 000 to 20 000	5 to 6	-	-
Bottled Water								
9	2 000-5 000	<10%	200-400	0.12	-	-	-	-
10	-	-	-	-	-	-	-	-
Fruit Drinks / Juice								
11	10 000-20 000	29%	4 000-6 000	0.41	780 to 3 500	4.1 to 6.1	-	100 to 600
12	0-2 000	6%	0-200	0.07	13 000	-	-	0 to 200
13	-	-	-	-	-	-	-	-
14	-	-	-	3.8	-	-	-	-
15	100 000-120 000	-	380 000-400 000	2.50	-	-	-	-

Note: *[1]SEV = Specific effluent volume*

Table 6.2: Soft drink company pollution concentration data from local regulators (EWS (2015) and Tshwane (2015))

Type of product	Av. water use (KL/month)	Av. effluent volume (KL/month)	COD (mg/l)		TDS (mg/l)		Suspended Solids (mg/l)		pH (mg/l)	
			Range	Av.	Range	Av.	Range	Av.	Range	Av.
Carbonated	1 600	1 700	4078 to 29 570	15450	-	-	-	-	5.6 to 11.6	7.6
Carbonated	2 800	2 000	87 to 4 580	4580	9.9 to 656	-	-	-	4.6 to 12.2	6.8
Carbonated	280	14	98 to 24 730	14022	0	350		127	2.8 to 7.4	6.17
Carbonated	21 000	10 000	2 367 to 4 521	3254	-	-	-	-	6.7 to 9.7	8.3
Carbonated	33 200	15 000	1 214 to 19 740	9245	-	-	-	-	6.2 to 11.8	8.5
Carbonated	-	3 000	125 to 15 840	4580	-	-	-	-	4.6 to 12.2	6.8
Carbonated	91 200	-	752 to 1 201	966	1731 to 3 545	2639	53 to 102	77	8.8 to 10.4	9.51
Fruit drinks	< 100	-	-	-	-	-	-	-	-	-
Fruit drinks	1 700	-	269 to 17 670	6910	610 to 18 878	6900	104 to 759	327	7.3 to 11	8.5
Fruit drinks	1 300	-	176 to 610	394	1700 to 6 849	3200	56 to 267	159	6.1 to 6.6	6
Unknown	2 800	-	5 to 1 995	86	88 to 1 609	767	28 to 822	290	3.7 to 7.1	5.84
Unknown	-	< 100	98 to 23 500	14000	-	-	-	-	2.8 to 7.4	6.2

Table 6.3: Summary of effluent management implemented by participating companies

Company reference	Effluent treatment	Effluent meter?	Reading frequency?	Monitoring by municipality	Tests carried out on-site	Frequency of own tests	Effluent Concerns
Carbonated soft drinks							
1	pH adjustment; holding tank	-	-	-	-	-	-
2	none	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	none	yes	daily	monthly	COD, conductivity, pH	daily	The COD is too high. Effluent is becoming more concentrated due to the fact that less water is being used
5	none	no	-	monthly	pH	daily	-
6	pH correction	Installing	-	annual	-	-	pH variations
7	-	no	-	-	-	-	-
8	-	-	-	-	-	-	-
16	None	-	-	-	-	-	-
Bottled water							
9	none	-	-	-	-	-	-
10	none	no	-	don't know	no	-	-
Fruit drinks / juice							
11	none	no	-	3 times in 10 years	-	-	-
12	None	no	-	no	no	-	Acidity might damage drain pipes
13	-	-	-	-	-	-	-
14	Irrigation	-	-	-	-	-	-
15	screening; skimming; settling	No data	-	-	-	-	-

6.2 Effluent Management

Table 6.3 summarise the type of effluent monitoring carried out by the companies and the type of treatment.

Based on the survey, it is evident that very little effluent treatment takes place and generally involves simple processes such as screening and pH adjustment. Only one company has an effluent meter installed, while a second is in the process of installing a meter. The remaining companies therefore make use of an estimation to determine the effluent volumes (and therefore costs). One fruit juice manufacturing company uses the final effluent for irrigation.

It also appears that the municipality does not undertake regular monitoring, or if they do, the companies are not aware of this, or of the results. Only two companies undertake in-house monitoring and assessment.

6.3 International Trends

In order to effectively treat wastewater from the soft drink industry, it is important to segregate the various wastewater streams. This will allow for optimum treatment for either reuse or disposal.

A study on the United Kingdom soft drink industry revealed that the majority of manufacturers had no treatment system installed or only pH adjustment, and those that did first segregated the wastewater streams to allow for the high COD streams to be trucked off-site for anaerobic digestion. A further option was to collect the wastewater in tanks and then use this for land spreading (WRAP, No date(a)).

The UK practise is similar to the SA findings in that the majority of sites carried out no treatment, or only pH adjustment.

7 Energy Aspects

The detailed questionnaire which was used to guide interviews with the companies contained a short section on energy use and management. However, few companies provided information on this section and did not see the relevance to the Guide. The on-line survey did not include questions related to energy use. It should be noted that there is a direct relationship between electricity use and water consumption / effluent production (at the power stations and coal mines).

7.1 Energy consumption and management

Information on energy use was requested from those companies that participated in the survey. The results are summarised in Table 7.1.

As can be seen from Table 7.1, very little information was obtained on energy use and management from the participating companies with only six companies providing limited data. Where data was provided, this was converted into MJ using the typical energy content of fuels as shown in Table 7.2.

Table 7.1: Summary of information on energy management from participating companies

Company reference	Electricity use (KWh/year)	Coal use (kg/year)	Fuel oil (L/year)	Truck fuel (L/year)	Steam generation	Meters				Compressed air leaks?
						Electricity	boiler feed water	make up water	steam	
4	-	-	-		From coal		1	1	1	
5	-	-	-	-	no	A few	-	-	-	no – strict maintenance
7	-	-	12 000	-	From fuel oil		-	-	-	-
10	-	-	-	-	From electricity	1	-	-	-	yes
11	255 348	-	-	336 000	no	3	-	-	-	no
14	-	-	-	-	-	-	-	-	-	-

Table 7.2: Calorific values for some fuel types (DME, 2009)

Fuel type	Energy content
Electricity (Kwh)	3.6 MJ/Kwh
Coal	24.3 MJ/kg
LPG	26.7 MJ/L
HFO	41.6 MJ/L
Diesel	38.1 MJ/L

Using the calorific values in Table 7.2, it was possible to calculate the Energy Use Ratio (EUR) for companies 7 and 11, while that for company 14 was obtained from the company's web site. This is summarised in Table 7.3. The difference in the EUR for company 11 excluding and including the fuel used for transport shows the significant impact this aspect of the operation has on the overall energy footprint.

Table 7.3: Specific energy ratio of participating companies

Company reference	Product type	Total Energy use (MJ)	Energy Use Ratio (MJ/L)
7	Carbonated soft drink	499 200	0.004
11	Fruit drinks	919 253 (13 720 853)[1]	0.07 (1.04)[1]
14	100% Fruit	-	0.39

Note: [1] Including diesel for transport

7.2 International trends

Information on international trends was sourced from (BIER, 2015) and is presented in Figure 7.1.

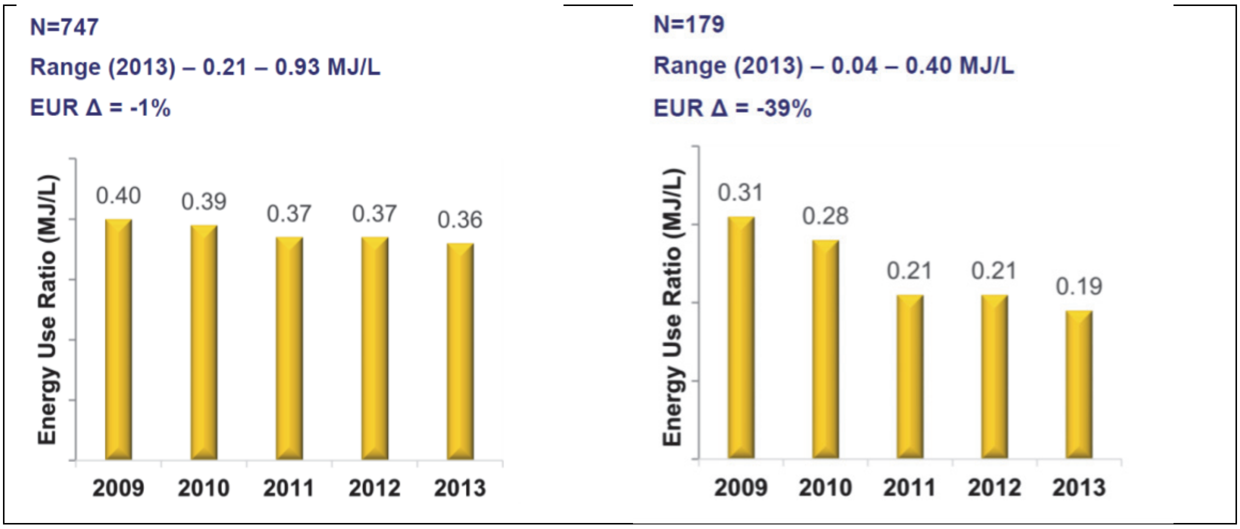


Figure 7.1: International trends in specific energy use (MJ/L) for (a) carbonated soft drinks and (b) bottled water (EUR Δ = change in energy use ratio) (BIER, 2015)

Based on these figures, a carbonated soft drink bottling site should use between 0.21 and 0.93 MJ/L, while a bottled water plant should use between 0.04 and 0.40 MJ/L. The one carbonated soft drink site that provided data is far below the benchmark figure, but it must be noted that this only took electricity consumption into account. The actual figure may therefore be significantly higher if transport costs are included. In addition, Company 7 does not undertake on-site bottle blowing which would have been included in the BIER survey. There was no data available for a fruit drink plant. The most important aspect to note from Figure 7.1 is the overall reduction in specific energy use from 2009 to 2013, with the greatest reduction taking place in the bottled water sector.

The main influences on the water and energy ratios have been identified as:

- the use of refillable containers,
- the presence of on-site bottle blowing, pasteurisation and automatic cleaning processes,
- the varying water treatment systems,
- the use of high efficiency equipment, and
- the number and type of products

Source: (BIER, 2015)

8 Water Use: Best Practice

There are a number of best practice opportunities for optimising water use within the soft drink sector. This section will highlight some of these options, with a more detailed literature review provided in Appendix 1.

Any best practise programme should follow the waste management hierarchy (Figure 8.1) with avoidance / elimination (i.e. zero waste) being the ultimate goal. Source reduction is the next most favoured step followed by reuse, recycling, segregation, treatment and disposal. This is the approach promoted by South African legislation. In addition, there is the need to recognise GMP (good manufacturing practise) which only allows water to be reused if it meets the standards of potable water. The options discussed in this section are therefore subject to legislation, regulation and GMP.

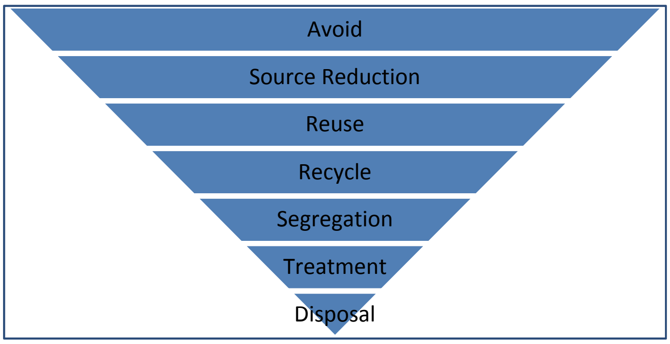


Figure 8.1: Waste management hierarchy

The aim of this section is to highlight options for source reduction and the reuse and recycling of water, with last three steps, segregation, treatment and disposal being discussed in Section 9.

8.1 Good Management Practices

General good management practises can result in significant savings in water. These include aspects such as maintenance, training and awareness.

8.1.1 Maintenance

A maintenance programme that gives priority to the repair of water leaks is key to an effective water management programme. In many cases leaks either go unnoticed or ignored as they have not been quantified. Measurement of the volume and cost of leaks generally results in rapid repair action. Staff should be engaged in order to recognise water leaks and report them to the relevant person.

8.1.2 Training and awareness

It is important to make staff aware of the cost of water, not only in terms of the monetary value, but also the environmental value due to the limited water resources within the country.

8.1.3 Washing of floors

Washing of equipment and factory floors is important in the soft drink industry, but some options can be implemented in order to save water in this area. These include the use of flow restrictors on hoses to ensure an optimum spray flow, the installation of automatic shut off triggers on hoses to prevent them being left running, making use of high pressure systems where possible to limit the volume of water used, and to make use of dry cleaning methods and squeegees before using a hose.

8.2 Water Treatment

Opportunities for the optimisation of water use begin at the start of the process at the water treatment plant. Options include:

- Sand filter backwash recovery
- Carbon filter backwash recovery
- Carbon back filter backwash based on pressure drop or chlorine concentration
- Implementing a program to monitor RO recovery rate, reject rate, transmembrane pressure, silt density index, pH across membrane modules, and maximise recovery rate
- Re-use RO reject water

8.3 Metering, Monitoring and Targeting

One of the simplest ways in which water and energy use can be optimised is through the installation of water and electricity sub meters within high consumption areas. These meters should then be read on at least a weekly basis and compared to a relevant variable such as product through put over the same time period. This would then set a target (e.g. litres water per litre product) on a weekly basis and highlight any variations from this target which could indicate a problem on the production floor. It is estimated that the implementation of a monitoring and targeting programme can save a company in the region of 5 to 10% in water, 3% in electricity and 10% in compressed air costs. More information can be found in WRAP (2014), ETSU (1998(a) and ETSU (1998(b).

Sub-metering also allows a water balance to be undertaken for the site on a daily basis which will assist in the identification of the main water using areas and the detection of water leaks.

8.4 Optimisation of Clean in Place (CIP)

CIP is used to remove product soil from pipes and equipment to prevent contamination of the final product. Optimisation of the CIP system can result in significant savings in water, energy and chemicals as well as improving the cleaning efficiency. Some best practice options include (WRAP, No date (b)):

- designing equipment with fewer parts and no points that detergent cannot reach or where fluid accumulates;
- improving production planning and scheduling in order to reduce cleaning requirements during product changeovers;
- automation of the system;
- regular visual examination of stainless steel surfaces to check the efficacy of the CIP and identifying the cause of any remaining soil;
- implementing real-time cleaning verification to reduce over cleaning;
- recovery of caustic solution and rinse water for reuse;
- Using “pigs” for syrup lines
- Select detergents and disinfectants with lower environmental impacts; and
- Use water-efficient spray devices

Case Study (UNIDO, No date)
A soft drink manufacturer in Egypt implemented Electronically Activated water for CIP which resulted in the following savings:

- 88 MWh/year (3%) in electricity,
- 60% of CIP rinse water
- 90% of chemicals used in the CIP
- A reduction in TDS by about 634 tons/year (78%)
- A reduction in the duration of cleaning time to 1/3, thus increasing the site’s productivity.

Some more innovative CIP systems that have been developed include the use of air or ozone in place of water, and using low temperature disinfectants (WRAP, No date (b)).

An example of a CIP system is provided in Figure 8.2.

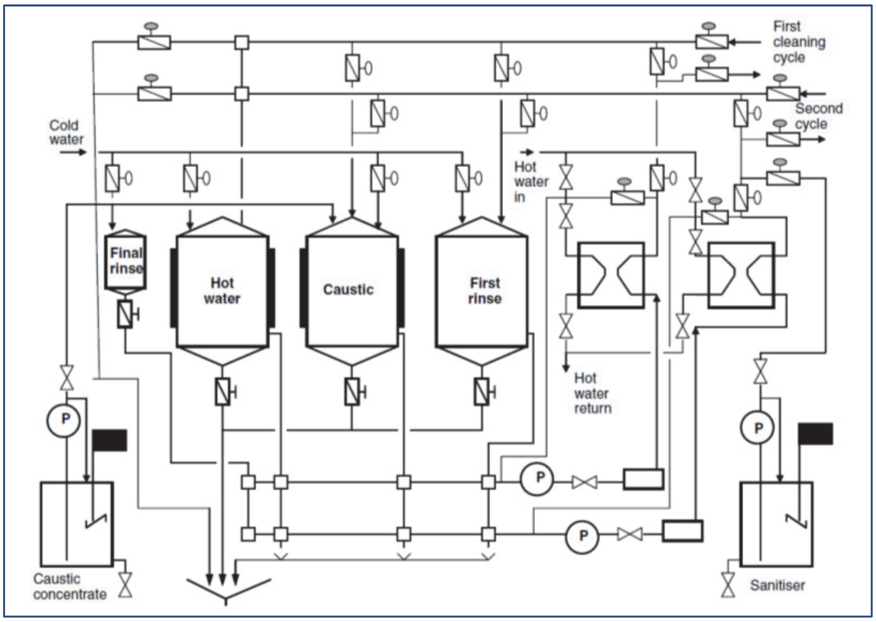


Figure 8.2: Closed loop CIP system (Steen, 2006)

8.5 Other Process Optimisation Measures

8.5.1 Bottle rinsing and washing

Rinsing and washing of bottles prior to filling is another area where optimisation of the process and reuse of water can result in water savings. Examples include:

- the use of a two-step rinse;
- implementing counter-current (or cascade) rinsing; and
- Undertaking regular checks on the rinse set points to ensure they are set at an optimal flow.

8.5.2 Conveyors

Simple options for optimising water use in this area is to undertake regular inspections of the line to ensure that the spray volume settings are correct, and that there is no clogging or ineffective spray patterns. Automatic controls should also be installed to ensure that water does not flow when the belt is not running. It has been reported that savings of up to 45% can be achieved when these types of systems are well maintained (WRAP, 2007).

8.5.3 Can warmers

Water savings can be made in the can warmers through automatic temperature control instead of using make-up to manage the bath water temperature.

8.6 Utilities

8.6.1 Cooling water

Interventions that can be made to optimise the cooling water system include:

- Use of recycled water for cooling water make-up;
- Measuring the drift losses and undertaking repairs, or installing drift eliminators;
- Ensuring that the make-up water tanks are not overflowing; and
- Maximising the cycles of concentration from three to six will reduce cooling tower make-up water by 20% and cooling tower blow-down by 50% (WRAP, 2007).

8.6.2 Pumps

Pumps are an integral part of the process, and water savings can be made in this area through pump seal water conservation and a smart water control system.

8.6.3 Steam systems

Boilers and steam generators use varying volumes of water depending on their efficiency, the size of the system and the volume of condensate return. Ways in which water can be saved in this area includes:

- Undertaking regular surveys of the steam traps and condensate return systems and repairing any leaks;
- Installing proper insulation of the steam and condensate pipes to reduce losses (and therefore the need for more water);
- Optimising blow-down volumes though automation; and
- Maximising condensate return to reduce water, energy and chemical demand.

8.7 Water Recovery and Reuse

The South African National Water Resources Strategy (Second Edition) identifies water reuse as one of a number of important strategies to balance water availability with water requirements in future and the extent of water reuse in South Africa is very likely to increase substantially over time. Annexure D of this report provides a strategy for a considered approach to the implementation of water re-use projects that are consistent with the National Water Resource Strategy and national water policy and legislation (DWA, 2011).

Within this document, examples of water reuse strategies for various industrial sectors are presented, one of which is the soft drink sector. An example of the proposed water reuse options is provided in Figure 8.3.

It must be noted, that while Figure 8.3 shows condensate being used for truck washing, condensate should always be directed back to the boiler for the most efficient use of resources.

In addition, the re-use of treated wastewater in the bottling process or even in the final bottle rinse requires several additional treatments after the conventional wastewater treatment process with at least the use of reverse osmosis (RO) treatment. It is therefore a costly procedure. Furthermore this practice has a high reputational risk as soft drink producers do not want their products associated with wastewater.

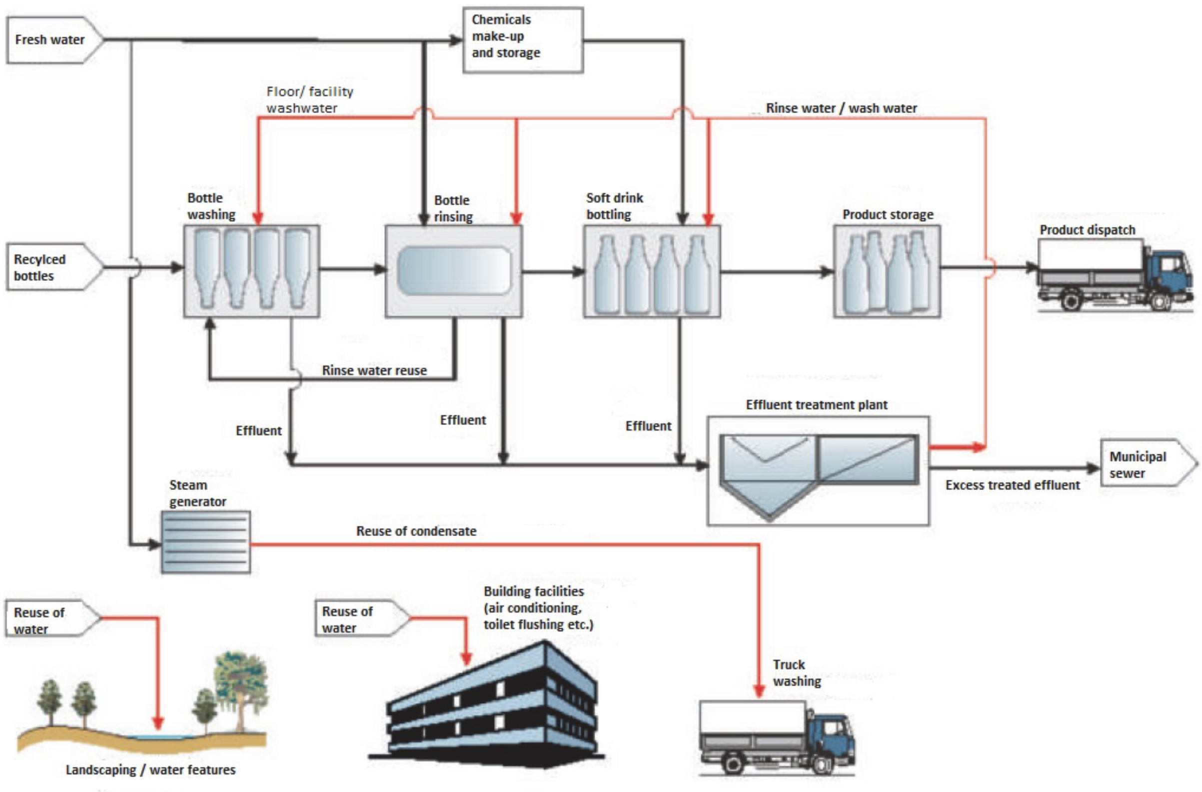


Figure 8.3: Water reuse applications for a soft drink bottling facility (DWA, 2011)

8.7.1 Condensate recovery

If condensate from the steam system is captured it should always be fed back into the boiler to save energy and to save costly (i.e. treated) water.

8.7.2 Bottle and crate washing

Where bottle and crate washing is undertaken, wastewater from the bottle washer can be used for crate washing.

8.7.3 Vehicle washing

Truck washing can be carried out with treated wastewater or with other water flows such as last rinse of the bottle washer, or bottle rinse water from the PET or canning line.

8.7.4 Rain water harvesting

This involves the collection of rain water from the roof of the factories for use in non-process related activities such as truck washing and landscaping. This option is of course limited by the seasonal rainfall volumes and therefore cannot be depended on as a consistent source of water.

8.7.5 Filter backwash water recovery

Water from backwashing sand- and carbon filters as well as RO reject water can be fed back as raw water into the water treatment plant and re-used.

8.8 Ablutions

The use of water in the ablutions for washing and flushing is often overlooked and is an area where there is frequently damage to the facilities resulting in leaks. Some options that can be implemented include:

- reducing the volume of the cisterns;
- installing waterless urinals;
- Installing dual flush toilets or low flush toilets;
- Installing water efficient shower nozzles; and
- Fixing leaks as soon as they are observed.

8.9 Landscaping

For factories with gardens, water savings can be made through the use of the following interventions:

- Use automatic irrigation systems;
- Undertake regular check of spray heads of irrigation systems;
- Water wise gardening;
- Use rinse water or treated effluent for irrigation;
- Remove alien vegetation; and
- Set operation times of irrigation systems in early morning or late afternoon to limit losses through evaporation

8.10 Water Management Investigations

Other investigations that can assist in the development of a water management programme include participating in a water stewardship programme, undertaking a water pinch analysis, a life cycle assessment (LCA) and water footprinting.

8.10.1 Water stewardship

Since water is a resource that is essential for human use and for natural systems, the way in which it is used and in what quantities is of great importance to communities, NGOs, governments and industry. Many soft drinks companies have therefore begun projects to assess the vulnerability of their water sources. This includes technical vulnerability (hydro-geological availability of water in the future), social acceptance by the community of the water use and regulatory permission to use water (BIER, 2012).

This leads companies to commit to Water Stewardship. This means that water in communities and nature can be balanced through support to achieve healthy watersheds and sustainable communities. Locally relevant initiatives could include reforestation, watershed protection, community water access, rainwater harvesting, and agricultural water use efficiency. In the case of smaller companies, many do not have the resources to package water stewardship into a programme in the way that larger companies can. However, this does not mean that smaller companies are not committed to water stewardship.

8.10.2 Water pinch analysis

Pinch analysis, in the broadest sense, is concerned with the optimal use of resources (such as energy and materials) in a multi-process system. Water pinch analysis focuses on the optimal use of water and was developed due to the widespread use of water as a multipurpose resource (ILSI, 2003). A number of methodologies exist for water pinch analysis, but regardless of the methodology used, optimisation of the *water-using system* is achieved by introducing water *reuse*, or increasing the degree of water reuse to limit the volume of freshwater required. The degree of reuse is limited by the concentration of contaminants present in the water stream and the water pinch process identifies where these limitations are and where water can be reused. A generic example of this type of analysis is provided in (ILSI, 2003).

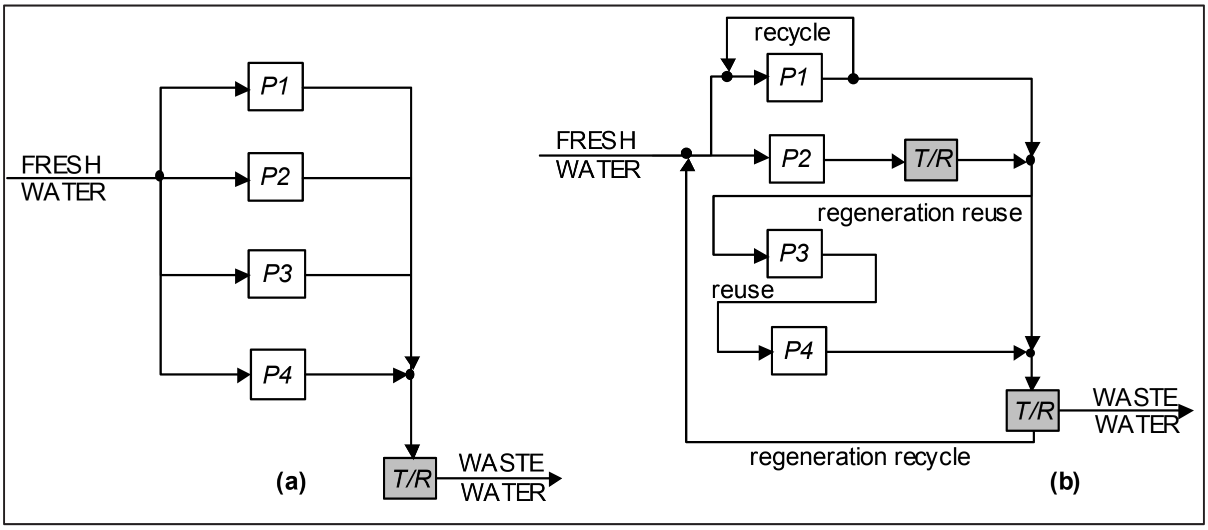


Figure 8.4: Conventional water-using strategy with once-through use of water and end-of-pipe treatment (a). Water-using strategy after the application of water pinch analysis (b) (ILSI, 2003).

8.10.3 Life cycle assessment and water footprinting

> It is interesting to note that in general the volume of water used by a bottling plant has decreased with the introduction of PET as this has reduced the need for washing of returnable glass bottles and crates, as well transport requirements (and therefore vehicle washing). However, as noted here, the manufacture of one 0.5 litre PET also consumes water, and therefore, bottling plants that buy in ready-formed PET bottles are transferring this water use elsewhere. Therefore, even though they may appear more water efficient, this is not the case if the Life Cycle is taken into account.

Looking at water use beyond the production process itself gives an idea of the total effect that soft drink production has on water resources. This methodology is termed Water Footprinting and has many analogies with Life Cycle Assessment (LCA) (Ercin, 2011). This methodology looks at the water consumption in every step of the product life cycle, beginning with the agricultural or industrial production and processing of raw materials and packaging materials. The final outcome of a Water Footprinting study depends on the scope of the study, and the type of soft drink as well as volume and type of packaging used. Different studies therefore come up with different numbers, and these must always be placed in context. Not surprisingly most of the water footprint of a soft drink comes from its ingredients, especially water consumption in sugar cane growing and processing. The end result of the Water Footprint therefore depends heavily on the type of sugar used (cane, beet, corn) and actual growing conditions of the sugar crop (irrigation/no irrigation). The water footprint of a typical soft drink in a 0.5 litre PET bottle is estimated to be between 170 to 310 litres. The water footprint for soft drinks in various countries is provided in Figure 8.4.

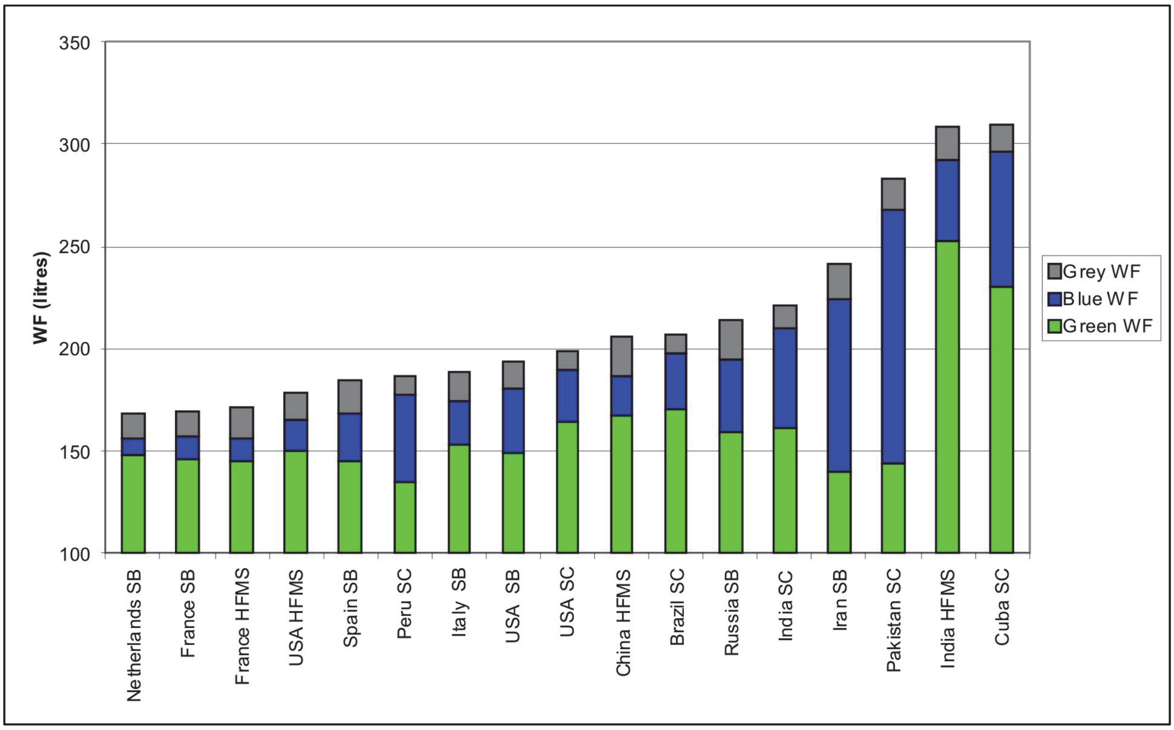


Figure 8.5: Water footprint of soft drink manufacture (0.5 L PET bottle) in various countries using different sources of sugar (SB = sugar beet; SC = sugar cane; HFMS= High Fructose Maize Syrup) (Ercin, 2011)

Blue water footprint – Volume of surface and groundwater consumed as a result of the production of a good or service.
Green water footprint – Volume of rainwater consumed during the production process
Grey water footprint – The grey water footprint of a product is an indicator of freshwater pollution that can be associated with the production of a product over its full supply chain

8.11 Estimated savings

Table 8.1 provides the estimated savings that can be made through the implementation of best practises for washing (WRAP, 2007).

Table 8.1: Estimation of savings in wash water through implementation of best practise (WRAP, 2007)

Application	Current cleaning method	Possible savings if best practices are employed (%)
Floor washing	Main hoses	60-85
	Pressure washing	20-40
Wall washing	Main hoses	60-85
	Pressure washing	20-40
Pipe Cleaning	Pressure washing	20-40
	CIP – total loss system	50-65
	CIP – chemical solution only recycled	40-55
	CIP – final rinse only recycled	40-55
	CIP – chemical solution and final rinse recycled	20-35
Vessel / tank cleaning	Main hoses	60-85
	Pressure washing	20-40
	CIP – total loss system	50-65
	CIP – chemical solution only recycled	40-55
	CIP – final rinse only recycled	40-55
	CIP – chemical solution and final rinse recycled	20-35
Container washing	Main hoses	70-98
	Pressure washing	80-95
	Automatic washer	20-30
Equipment washing	Manual / Main hoses	40-60
	Pressure washing	20-40
Bottle washing	Bottle washing	30-50
Conveyor washing	Main hoses	60-85
	Pressure washing	20-40

9 Wastewater Management: Best Practice

Based on the responses from the companies participating in the South African survey, the results indicate that the majority of the soft drink manufacturers have not implemented wastewater management programmes at their sites. In general these companies do not comply with the limits set by the local authorities for pollution concentrations, and in particular the COD limits. Some best practise options for the management of wastewater is provided in this section.

Figure 9.1 shows the typical approaches that can be adopted ranking eight approaches to effluent management comparing environmental/financial desirability with water efficiency. The top four options are considered best practise as they make the most efficient use of water and are the most desirable with respect to the environment.

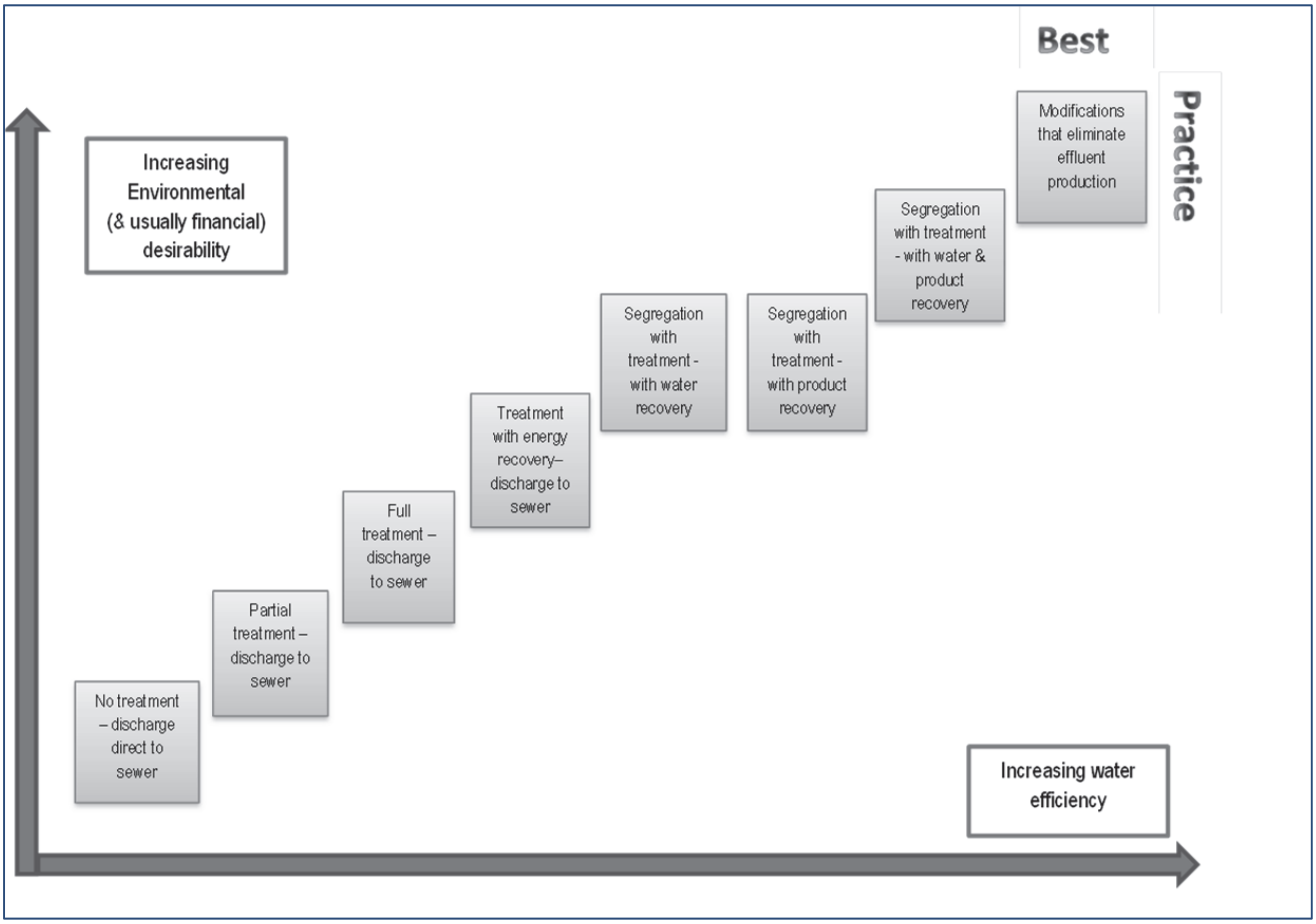


Figure 9.1: Approaches to wastewater (WRAP, No date(a)).

9.1 Measuring and Monitoring

As for water, it is important to have an understanding of the volume of wastewater discharged from the manufacturing site. This will enable a complete water balance to be prepared for the site and the identification of any losses. In addition, an accurate meter reading rather than an estimation of wastewater volumes based on water intake may result in a lower effluent charge.

It is also useful to test the wastewater pollution loads on a regular basis rather than only relying on the monthly test results from the municipality. Typical parameters that should be tested includes

COD, TDS and SS. Effective monitoring of these pollution loads will enable a trend to be observed and highlight when excessive sugar or other chemicals are being discharged to drain.

9.2 Source Reduction

One of the first steps in identifying measures to reduce the wastewater pollution load is to identify the source of the various wastewater streams in the factory and the possible contaminants.

As discussed in Section 6 the main contributor to the COD of the wastewater is the sugar losses at the various process stages. Reducing the sugar losses will result in significant reductions in the COD loading of the wastewater, as well as raw material costs. Implementation of many of the options discussed in Section 8 will result in the reduction of the volume and pollution load of the wastewater as optimisation of processes to reduce water consumption will result in a lower generation of wastewater. It will however impact on the concentration of the effluent which may results in non-compliance with regulations. Therefore, regulators aiming to encourage water efficiency methods should consider basing limits on loads rather than concentration.

In addition, options to reduce raw material and product losses along the production line will result in a lower pollution load due to less sugar and other chemicals being discharged to drain. Areas where this occurs and suggested preventative measures are provided in Table 9.1.

Table 9.1: Areas of optimisation to reduce product and raw material losses and wastewater pollution load (Ally, 2015)

Process stage	Type of loss	Suggested source reduction measures
Post-sanitation losses	CIP chemicals; product	Use of “pigging system”
Standard operating procedures (SOP) and Quality Assurance (QA)	Product	Rethink the QA testing system to avoid discarding in-spec product
Over and under-filling	Product	Regular maintenance on the filling line
Filler Bowl	Product	Prepare batches according to production schedule
Final syrup	Raw materials	Optimisation of the mixing system; training of operators
Simple syrup	Raw materials (mainly sugar)	Prepare batches according to production schedule (eliminate over production); installation of “pigging system”
Dumped batches	Product	Optimisation of whole process to improve product quality

9.3 Segregation

Once all source reduction measures have been implemented, the next step would be to identify opportunities for the segregation of wastewater streams in order to either recover water and chemicals for reuse, or to allow for efficient wastewater treatment and disposal. Knowledge of the source, volume and contaminants in each of the areas of wastewater segregation is required in order to identify the best method of segregation. This could involve the installation of additional piping or drains to re-route high COD streams to a collection tank, or to recover rinse water for reuse in another section of the factory.

By separating the “clean” and “dirty” streams the type of treatment or recovery can be tailor made to deal with the specific contaminants and therefore reduces the cost of the process compared to recovery or treatment of the combined final effluent.

9.4 Wastewater treatment

The final stage in effluent management is the installation of treatment systems or the trucking of effluent off-site for disposal or irrigation. By first segregating the streams, the cost of treatment is reduced and the number of treatment process steps reduced. An option for the high COD wastewater streams is to segregate these streams into a holding tank and truck them off-site for disposal in an anaerobic digester (see box). As a minimum, soft drink manufacturers should undertake pH adjustment and install a balancing tank prior to discharge to assist in preventing pollution load “spikes”.

> A full-scale trial is currently underway in eThekwini to investigate the use of co-digestion in the anaerobic digesters at the Amanzimtoti Wastewater Treatment Works to treat high COD liquid wastes. By segregating the high COD effluent streams produced in a soft drink plant, this waste could be transported by tanker to the anaerobic digester where it could be discharged and treated together with the sewerage sludge. In this way, the aerobic treatment systems at the WWTW would not be overloaded by the high COD effluent, the operation of the anaerobic digesters would be enhanced, and the companies would no longer exceed the COD limits set by the municipality. *(Research is being undertaken by the Pollution Research Group, University of KwaZulu-Natal, Durban funded by the Water Research Commission and eThekwini Municipality* (WRC, 2015)*).*

10 Other Best Practices

This section will highlight some other best practise options for the soft drink sector such as reducing raw material and production losses, optimisation of energy use and reducing packaging losses.

10.1 Raw Material and Product

A study undertaken by WRAP (No date(c) showed that in general, the raw material losses over the soft drink production process were in the region of 7% (see Figure 10.1).

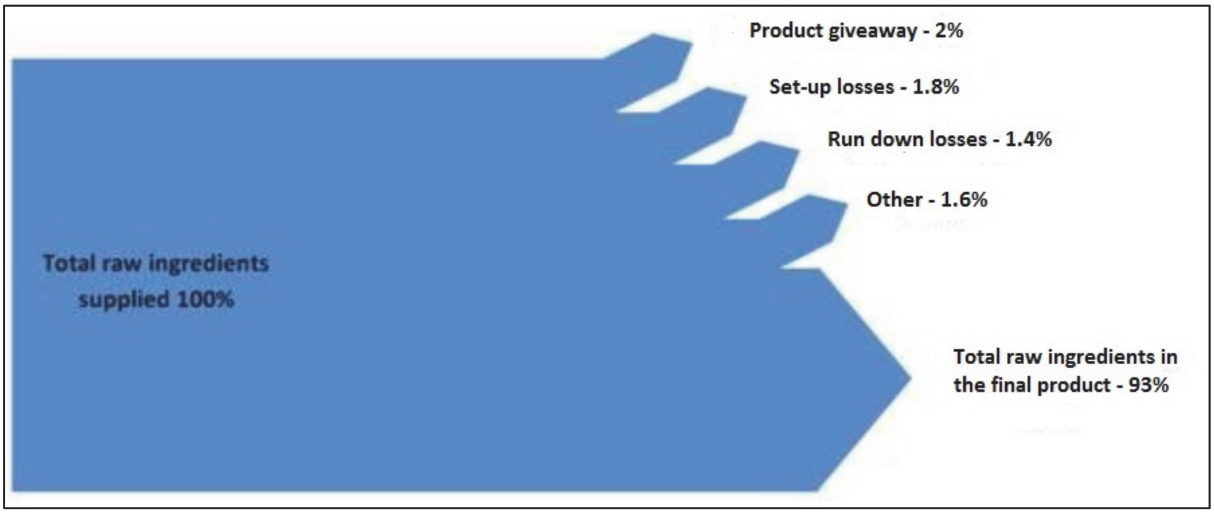


Figure 10.1: Raw material losses in the soft drink manufacturing process (WRAP, No date(c))

Figure 10.1 shows that the majority of the raw material losses occur as a result of product giveaways, generally due to overfilling. Other areas are set-up and run-down losses when there is a change-over of soft drink product. Some of these aspects are discussed in more detail in this section.

10.1.1 Filling losses

Losses due to over and under-filling can be significant in terms of water, raw materials and product losses. It is reported that under-filling can result in a 3% yield loss as under-filled containers tend to be rejected while overfilling can result in between 0.5 to 4% loss due to product giveaway (WRAP, No date(d)).

Aspects which affect the filling process include the age of the technology (older equipment is less efficient), the shape of the packaging (tall narrow-necked packaging is more difficult to fill), and the capturing and interpretation of data on the filling lines by the weight checkers. The speed of the filling line is also important with lines operating at the optimum speed resulting in lower losses. However, in many cases lines are operated faster to increase product through-put, resulting in greater filling losses with the actual product cost not being determined (WRAP, No date(d)).

Case Study (UNIDO, No date)

A soft drink manufacturer in Egypt implemented the following good housekeeping and preventative measures to reduce losses:

- Elimination of excessive floor washing,
- closing/sealing running water taps,
- rerouting forklifts pathways to avoid collision and prevent product damage and losses
- avoiding sending off-specs products to the drain through segregation, and
- offsite recycling as animal feed.

These measures resulted in the following savings:

- reduction of product losses by 3%
- reduction of raw materials losses by 8%
- reducing in BOD5 by 12 tons/year and COD by 16 tons/ year in the wastewater.

10.1.2 Product losses

In addition to product losses due to rejects, the main cause of product loss is through over production, resulting in product that cannot be sold. A company in the United Kingdom has overcome this problem by making an agreement with their customer for a tolerance limit on deliveries rather than exact quantities (WRAP, No date(c)).

10.2 Energy

There are a number of best practice options for the optimisation of energy use within the soft drink manufacturing process. Some of these are highlighted in Table 10.1, with more detail being available in the reference (The Carbon Trust, 2005).

Table 10.1: Best practices to reduce energy consumption (TheCarbonTrust, 2005)

Area	Options
Process control and measurement	Install sub-meters and initiate a monitoring and targeting programme
	Train all staff in good energy management practices
Refrigeration	Introduce a good maintenance programme – Blocked, dirty and leaking components lead to increased energy demand
	Check for leaks – As refrigerant levels drop, the system will operate less efficiently, reducing the cooling level
	Insulate all piping and check door seals
	Pre-plan production and storage needs
	Minimise air changes
	Don't over-cool as this places unnecessary stress on equipment
Compressed air	Only use compressed air where it is essential. Replace with alternatives if possible
	Train all staff in the correct use of compressed air
	Turn off compressors when not in use as an idling compressor still uses 40% of its full load
	Follow a regular maintenance routine
	Implement a regular leak checking programme
	Reduce air pressure to the required level
	Close off old and unused pipe sections
Motors and Drives	Switch off motors when not in use or install sensors for automatic switch-off
	Carry out regular maintenance – this can reduce energy use by 10%
	Make sure motors are sized correctly for their use
	Replace failed motors with high efficiency motors (HEM) which are 3 to 4% more efficient
	Install variable speed drives where possible
Boilers and steam systems	Ensure regular maintenance – a poorly maintained boiler can consume 10% more energy
	Match boiler outputs to site requirements
	Close off any old and unused steam pipes
	Insulate boiler and steam system and check regularly
	Install an isolation damper to prevent heat losses through the flue on standby
	Ensure good water quality to prevent scaling
	Recover heat from boiler flue gases

10.3 Packaging

Implementing best practices in the packaging of soft drinks can result in cost savings to the company, as well as a reduction in the environmental impact of the product post-consumer.

Since the 1987 Natsurv Guide, there has been an increase in the variety of packaging available to soft drink manufacturers. There has also been a move away from returnable glass bottles to using PET. A study in the United Kingdom shows that from 1980 to 1989, there were a 55% drop in the use of RGB and a 43% drop in NRGB use. At the same time, the use of PET bottles grew by 68.2% and cans by 19.8% (WRAP, 2008). Within South Africa, an annual PET recycling rate of 42% of post-consumer beverage PET is achieved (Petco, 2012).

There are three types of packaging associated with the soft drinks industry: primary packaging (the soft drink container); secondary packaging (packaging used to group together individual primary packaging – generally cardboard and shrink wrap); and tertiary packaging, which is used to group together secondary packaging (DEFRA, 2012).

A summary of some options for best practice for packaging is provided in Table 10.2.

Table 10.2: Best practice options for packaging

Best practise option	Description
Combining PET bottle blowing with filling	Reduces the transport of empty bottles to the bottling plant (UNIDO, 2014)
Light-weighting of packaging	The average weight of a half-litre single-serve PET plastic bottled water container has dropped by nearly 48% to 9.9 grams over the past 10 years (DEFRA, 2012)
Reducing packaging requirements	Improve handling to reduce damage; limit use of glue and tape; optimise shrink wrapping process (UNIDO, 2014)
Increase recycled content in packaging	Use recycled material for boxes and paper (UNIDO, 2014)
Replacing steel cans with aluminium cans	10% less energy is used in the manufacture and the recyclability is increased (FoodReview, 2014)
Using alternative raw materials	An example is the Coca-Cola PlantBottle© which is a recyclable PET plastic beverage bottle made partially with materials derived from plants instead of the traditional petrochemical constituents (UNIDO, 2014).
Remove all unnecessary packaging	Improve packaging design and order in bulk; reduce thickness of cardboard separators (UNIDO, 2014)
Encouraging post-consumer recycling of PET	A reduction of 25% in the carbon footprint of plastic water bottles (Petco, 2012)

10.4 Solid waste management

The volume of solid waste generated at a soft drink manufacturing site consists mainly of a combination of all three types of packaging and includes glass, cans, PET bottles, paper, cardboard, plastic, etc. Good management practice is to follow the waste management hierarchy by first aiming to eliminate the generation of waste followed by reduction at source, reuse, recycling and segregation.

Many companies are now establishing on-site waste management facilities where the waste is separated into the various waste streams for off-site recycling, with minimal waste going to landfill. There is very little hazardous waste generated in the process, and mainly consists of chemical containers, oil drums and rags, and e-Waste.

Within South Africa, companies must comply with the National Environmental Management: Waste Act (2008) in terms of on-site storage, registration with the South African Waste Information System (SAWS) and the development of a waste inventory (DEAT, 2008).

11 Status of Best Practise in Industry

A list of the common water management best practise activities was compiled for the survey and the participating companies asked to indicate which of the options were (i) implemented, (ii) planned, (iii) not planned, and (iv) not applicable. A summary of this survey is provided in Table 11.1.

Other best practice management practices are highlighted in this section.

11.1 General Management Practices

Companies participating in the site visit were also surveyed as to their environmental policy, and if this policy included aspects on water, energy and wastewater management and if it aimed for continuous improvement. The question was also asked if this policy is communicated to all employees.

Reponses indicated the following:

- Of the 7 companies interviewed, one did not respond this question, 5 had an environmental policy and 1 had no policy.
- Of the 5 with policies, 3 included water, wastewater, energy management and continuous improvement, while the remaining two did not have these aspects listed;
- Only 1 company communicated the policy to the staff via posters and meetings, while 2 companies were planning this activity. The remaining companies did not have this place or planned.

This highlights the importance of management support in ensuring that all employees are on board with respect to optimising water and energy use, and reducing the generation of waste. Communication and awareness is a key aspect of achieving best practice.

11.2 Water Management Practices

While Table 11.1 summarises the responses to the best practice list, some of the participating companies listed activities undertaken to reduce water consumption. These included:

- **RO reject recovery:** 15% of incoming water into RO becomes brine. 7% of this brine goes back into the raw water feed and is re-used. 8% is discharged.
- **Rain water harvesting:** investigations are underway into the feasibility of installing this system
- **Borehole monitoring:** digital monitoring to record flow and replenishment in order to ensure the sustainability of the resource

Table 11.1: Summary of best practices implemented by participating companies

Category	Description	Implemented	Planned	Not implemented / planned	Not applicable	No answer	Number surveyed
Metering, monitoring, & targeting	Water sub-metering	7	1	1			9
	Electricity sub-metering	5	3	1			9
	Steam sub-metering			2	7		9
	Monitoring & Targeting	2	1	2			5
	Install and monitor submeters for make-up and bleed-off water	2		1	2		5
	Measure water overall flow when plant or line is not running to determine losses (zero baseline)	2		2		1	5
Energy	Heat recovery (steam/condensate, exhaust boiler exhaust, compressors)	2	3	1	2	1	9
	Regular check for steam leaks	1		1	2	1	5
	Make staff aware of cost of steam and engage staff to recognize and report leaks (tag system)			1	2	2	5
	Regular check insulation of pipes, valves, flanges and vessels	1		2	1	1	5
	Insulate steam valves and flanges			2	2	1	5
Studies	Water footprinting		2	7			9
	Carbon footprinting	2	1	6			9
	LCA			6	3		9
System optimisation analysis	Water pinch analysis	1		7	1		9
Leak prevention	Maintenance program that gives priority to repairs of water leaks	5					5
	Make staff aware of cost of water	2		2		1	5
	Engage staff to recognize and report leaks (tag system)	4				1	5
CIP	Optimize CIP (design (pipe length, decentralise), set points, heating system, ECA)			1	3	1	5
	Use final rinse for initial rinse of following cycle	4	1	3	1		9
	Use pigging for syrup lines			3	2		5

Category	Description	Implemented	Planned	Not implemented / planned	Not applicable	No answer	Number surveyed
Steam system	Regular planned steam trap inspection & replacement	1			3	1	5
	Automatic blow down	1			3	1	5
	Regular calculation of boiler efficiency (semi-annual)	1			3	1	5
	Check boiler control set points	1			3	1	5
Bottle rinsing	Two step rinse	1		2	1	1	5
	Counter current rinse	1		2	1	1	5
	Regular check rinser setpoints	1		2	1	1	5
Water treatment	Sand filter backwash recovery	3		1	3	2	9
	Carbon filter backwash recovery	4	1	1	2	1	9
	Carbon back filter based on pressure drop or chlorine concentration	3		2	2	2	9
	Implement program to monitor RO recovery rate, reject rate, transmembrane pressure, silt density index, pH across membrane modules, and maximise recovery rate	1		3	1		5
	Re-use RO reject water	1		2	3	3	9
Ablutions	Reduce cistern size	4			1		5
	Waterless urinals	4			1		5
	Dual flush toilets	4			1		5
	water saving showerheads	3				2	5
Cooling	Use recycled water for cooling water make-up			4	1		5
	Measure drift losses + repair/install drift eliminators	2		1	2		5
	Maximise cycles of concentration			2	1	2	5
Alternative water sources	Rain water harvesting	1	1	2	1		5
Bottle washer	Re-use bottle washer waste water for crate washing	2		3			5
	Regular check boiler water pumps set points			1	3	1	5

Category	Description	Implemented	Planned	Not implemented / planned	Not applicable	No answer	Number surveyed
Pumps	Pump seal water conservation	1		2	2		5
	Smart water control system			2	1	2	5
Conveyors	Regular inspection of the whole line for: spray volume setting; clogging; ineffective spray pattern	2			3		5
	Automatic controls to stop water flow when belt not running	2			3		5
Washing of floors	Use flow restrictors	3		2			5
	Install automatic shut off hoses	1		4			5
	Dry clean and squeegees before hose use	1		4			5
	Use high pressure systems where possible for floor cleaning	3		1	1		5
Can warmers	Automatic temperature control instead of make-up to manage bath water temperature			1	3	1	5
landscaping	Use automatic irrigation systems				5		5
	Regular check of spray heads of irrigation systems				5		5
	Water wise gardening				5		5
	Use recycled water for irrigation				5		5
	Set operation times of irrigation systems in early morning or late afternoon				5		5
	Use rinse water or treated effluent for irrigation				5		5
truck washing	Use rainwater or rinse water for truck washing	1	1	2	1		5
syrup tank cleaning	Replace static spray balls with rotary spray balls			2	1	2	5
Packaging	Recycled content in bottles	1	1	2		1	5
	Light-weighting	3		1		1	5
Certification	ISO 9001	2		1			3
	ISO 14001	1		2			3
	ISO 5001		1	2			3
Training	water management		1	2			3
	Energy management	1	1	1			3
Solid waste	Segregation	1		1	1		3

12 Conclusions

Updating *Natsurv 3: Water and Wastewater Management Practices in the Soft Drink Industry* has been a difficult task due to the limited participation of the soft drink companies and the resultant lack of data. Those companies that did participate provided valuable information but further data are required before trends and averages can be determined with any degree of accuracy.

Table 12.1 summarises the main findings from the survey based on the responses from the participating companies.

Table 12.1: Summary of survey findings

Sector	Parameter	No. of companies	Range	Overall Average
Carbonated soft drinks	Production (KL/Year)	9	40 000 to > 500 000	240 000
	Water use (KL/year)	9	60 000 to > 500 000	300 000
	SWI (L/L)	9	1.2 to 2.5	1.6
	Wastewater (KL/year)	8	20 000 to 260 000	113 000
	SEV (L/L)	8	0.2 to 1.4	0.6
	pH[1]	7	2.8 to12.2	-
	COD (mg/L)[1]	7	87 to 725 000	-
	TDS (mg/L)[1]	2	10 to 3 500	-
	SS (mg/L)[1]	2	53 to 130	-
Bottled water	Production (KL/Year)	2	1 000 to 100 000	42 000
	Water use (KL/year)	1	2 000 to 5 000	-
	SWI (L/L)	1	1.2 to 1.5	1.2
	Wastewater (KL/year)	1	200 to 400	-
	SEV (L/L)	1	0.12	0.12
	pH	0	-	-
	COD (mg/L)	0	-	-
	TDS (mg/L)	0	-	-
	SS (mg/L)	0	-	-
Fruit drinks	Production (KL/Year)	5	1 000 to 60 000	17 500
	Water use (KL/year)	3	0 to 120 000	40 000
	SWI (L/L)	4	1.0 to 4.5	2.2
	Wastewater (KL/year)	3	0 to 400 000	130 000
	SEV (L/L)	4	0.1 to 3.8	1.7
	pH[1]	2	6.1 to 11	-
	COD (mg/L)[1]	2	175 to 18 000	-
	TDS (mg/L)[1]	2	600 to 19 000	-
	SS (mg/L)[1]	2	55 to 800	-

Note: [1]These figures are taken from municipality figures (Table 6.2)

This analysis shows that on average the carbonated soft drink companies use 1.6 L of water per L of soft drink and fruit drink companies 2.2 L per L of product. Data from one bottled water site provides a figure of 1.2 L of water per L of water produced. In comparison, the survey from 1987 found an average SWI of 2.7 L/L which indicates that the industry is using water more efficiently than in the past. A comparison of the survey results from the 1987 Guide and the results of this survey are given in Table 12.2 (only the results from the carbonated soft drinks from 2014 are included and not those for the fruit drinks and bottled water as it is not clear if these were included in the 1987 survey).

Table 12.2: Comparison of results from 1987 survey and 2014 survey (carbonated soft drinks only)

	Units	1987	2014
Number of companies	-	25	9
Average Production	KL/y	33 000	240 000
Average Water Use	KL/y	85 000	300 000
Average SWI	L/L	2.7	1.6
Average SEV	L/L	1.7[3]	0.6
COD range	mg/L	360 to 8 450[3]	87 to 725 000[1]
TDS range	mg/L	390 to 6 450[3]	10 to 3 500[2]
SS range	mg/L	10 to 950[3]	53 to 130[2]
pH range		4 to 11.8[3]	2.8 to12.2[1]

Notes: *[1]These figures are from 7 companies from municipality results*

[2] These figures are from 2 companies from municipality results

[3]These figures are from 11 companies

It is interesting to note, that on average, the carbonated soft drink industry is currently producing approximately seven times more soft drink than in 1987 which indicates the growth in the sector, while at the same time reducing the SWI from an average of 2.7 L/L to an average of 1.6. This therefore indicates that the sector is becoming more efficient in terms of water consumption.

Based on the best practice survey results (Section 11), this increase in efficiency in the use of water can be attributed to the following:

- Installation of sub-metering
- Leak prevention programmes
- Optimisation of CIP
- Recovery and reuse of filter water from water treatment
- Optimising water use on the conveyers
- Investigating the use of rainwater harvesting

In addition, the move away from returnable glass bottles to PET, will also be impacting on water use as it reduces the bottle washing water (and also the washing of vehicles for transporting the bottles back to the plant). However, as mentioned in Section 8.9.3, a full LCA should be undertaken to identify if the water consumption is being transferred elsewhere for the manufacture of PET.

It is clear that the implementation of best practices and the awareness of good water and wastewater management practices are not equal throughout the soft drink sector and further work is required to raise awareness and assist companies in identifying opportunities for reduction. In-house metering, monitoring and training are also required.

Information on the wastewater pollution loads was limited from the participating companies. However, some data was obtained from the local authorities, and in general it can be noted that the COD concentration range is significantly higher than in 1987, while TDS and SS concentration ranges are lower. There also seems to be a more variable pH.

Reasons for the increase in the COD concentration range include the following:

- The reduction in water use, thereby resulting in a more concentrated effluent;
- The increase in the number of different product ranges and flavours and therefore an increase in the sugars and additives going to drain (and an increase in CIP requirements);

- The move away from RGB to PET resulting in less wash water discharged to drain to dilute the effluent;
- The use of membrane technologies resulting in a more concentrated effluent;
- Outsourcing of transport and therefore a decrease in vehicle wash water (which would have diluted the effluent).

With regards to energy management, limited information on this aspect was obtained in the survey and therefore no trends or conclusions can be drawn at this stage regarding the status of energy use within the sector.

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Useful web sites:

South African National Bottled Water Association	www.sanbwa.org.za
South Fruit Juice Association	www.safja.co.za
The Beverage Association of South Africa	bevsa.campsbayshul.com
Packaging Council of South Africa	www.pacsa.co.za
PET Plastic Recycling South Africa (PETCO)	www.petco.co.za
Drinkstuff	www.drinkstuff-sa.co.za
UK Food and Drink Federation	www.fdf.org.uk
WRAP	www.wrap.org.uk
The Carbon Trust	www.carbontrust.com
Beverage Industry Environmental Roundtable	www.bieroundtable.com
American Beverage Association	www.ameribev.org
British Soft Drinks Association	www.britishsoftdrinks.com
Union of European Soft Drinks Associations	www.unesda.org
International Council of Beverages Associations	www.icba-net.org
Canadian Beverage Association	www.refreshments.ca
Water Footprint Network	www.waterfootprint.org