Natsurv 3

Water and Wastewater Management in the Soft Drink Industry

Pollution Research Group
University of KwaZulu-Natal
Durban

Overview of presentation

- Team
- Overview of structure and content of Natsurv 3
- Main outcomes
- Challenges

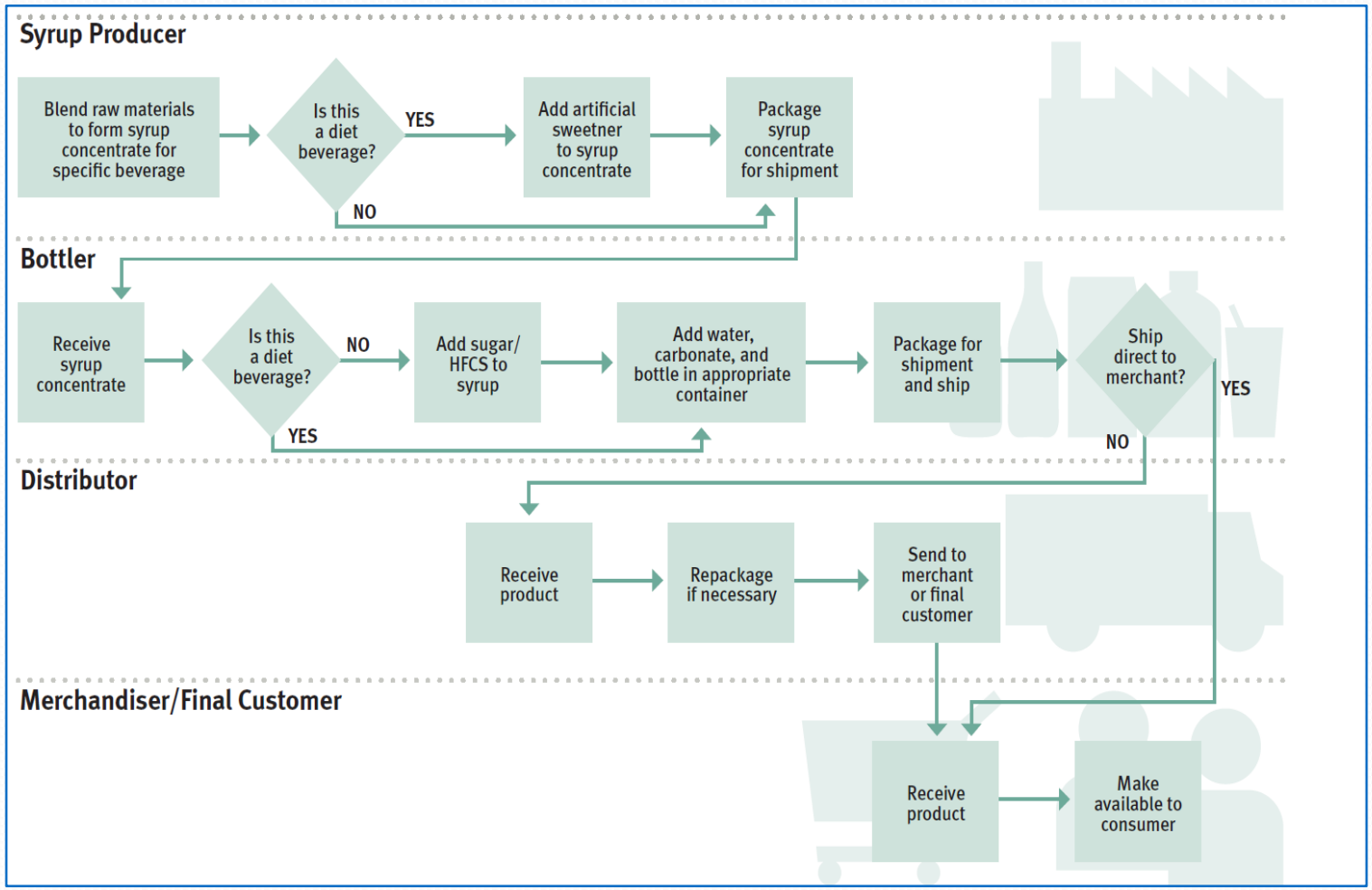
Team

- Prof Chris Buckley: Project Leader
  - Head of Pollution Research Group (UKZN, Howard College)
- Susan Mercer (Barclay): Principle Researcher
  - Pollution Research Group
- Dr Herman Wiechers: Researcher
  - Independent consultant
- Bas Kothuis: Researcher
  - Independent consultant
- MScEng students:
  - Thabani Madlada
  - Yaseer Ally (BSc Chem Eng)

Section 1: Introduction

Background and methodology
Consumption trends
Overview of the SA soft drink sector

Overview of soft drink process



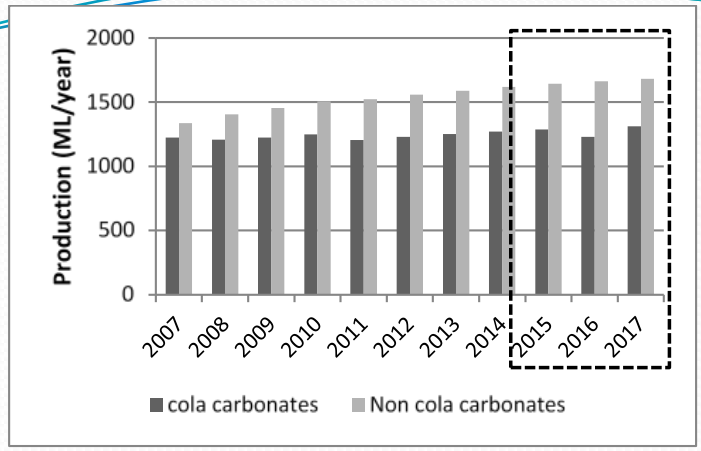
Methodology

1June 2013	• Literature survey and review
2July 2013	• Identification of main role players
Oct 20133	• Circulation of on-line survey (version 1)
Dec 20134	• Initiating contact with companies
4April 2014	• Workshop 1
April 2014	• Interviews with regulators
May 2014	• Site visits and detailed questionnaires
Oct 2014	• Circulation of on-line survey (version 2)
Nov 2014	• Collation of all data and information
Feb 2015	• Circulation of draft Guide
Feb 2014	• Regional workshops
March 2015	• Circulation of on-line survey (version 3)
March 2015	• Finalisation of the Guide

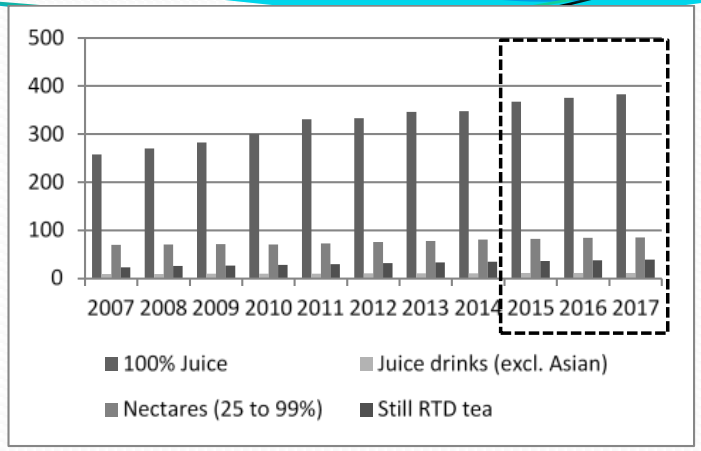
Consumption trends

- 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)

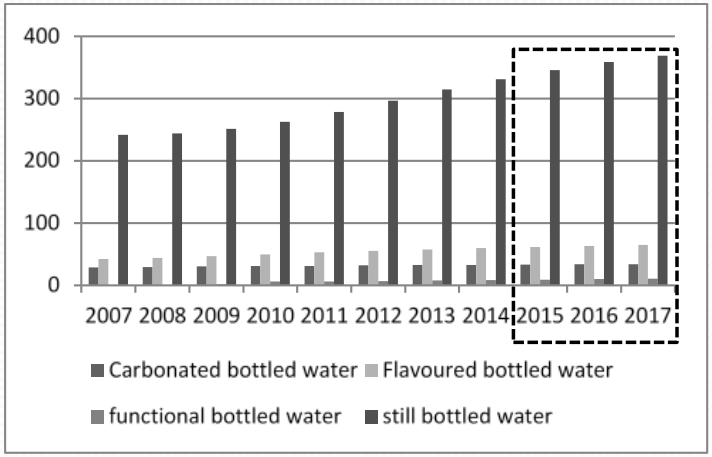
Beverage segment	Year on Year Growth in 2012
Carbonate soft drinks	2.2%
Fruit Juices	2.6%
Bottled Water	4.1%
Ready to Drink Tea	5.8%
Sports and Energy Drinks	8.3%



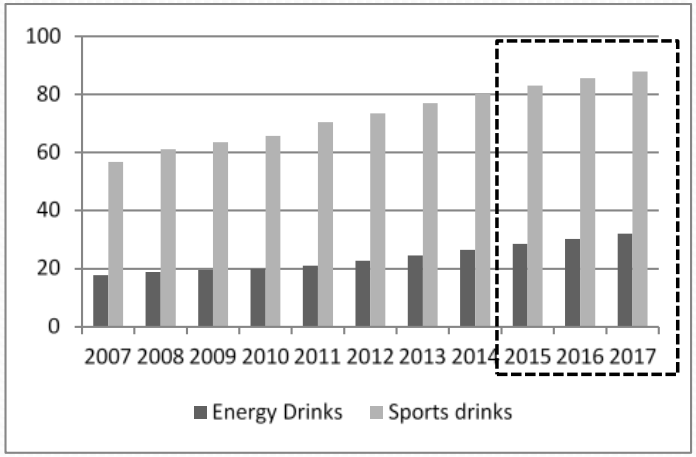
(a) Carbonates



(b) Juice and iced tea



(c) Bottled water

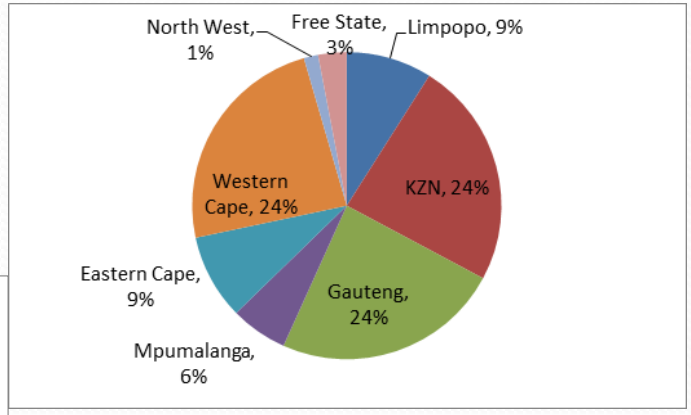


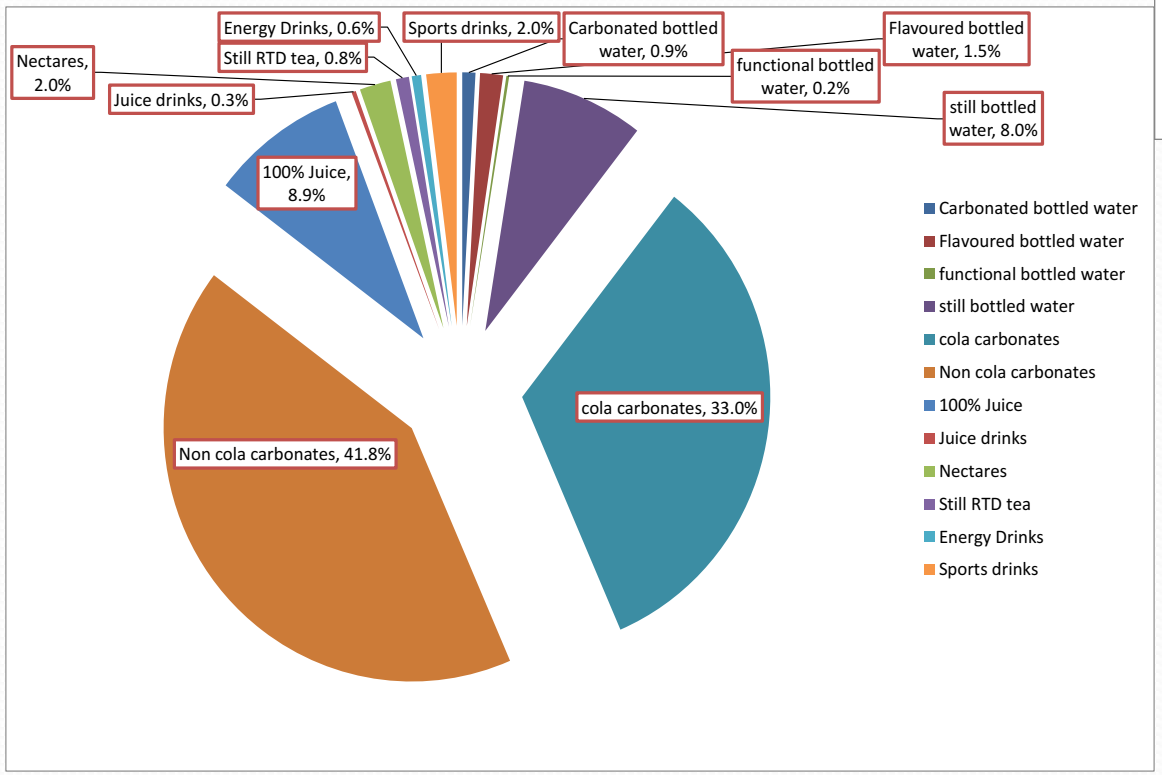
(d) Energy and sports drinks

Euromonitor 2014

South African market

Produced 3 700 ML of soft drink per year in 2012: more than double the volume recorded in 1987 (1 500 ML/year)





67 companies:

45% carbonated soft drink

34% fruit juice

21% bottled water

1987:

40 carbonated soft drink companies producing 85% of volume

SA Consumer Trends

- Consumption of carbonated soft drinks continues to grow as they generally cost less per unit volume than non-carbonated drinks such as juices.
- Consumers are moving more towards the purchase of concentrates which can be diluted at home.
- Bottled water growth is low due to the tap water being safe to drink.
- Energy and sports drinks are still a relatively small market and relies on clever marketing and promotion.
- 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.

Section 2: Process overview

Main process steps

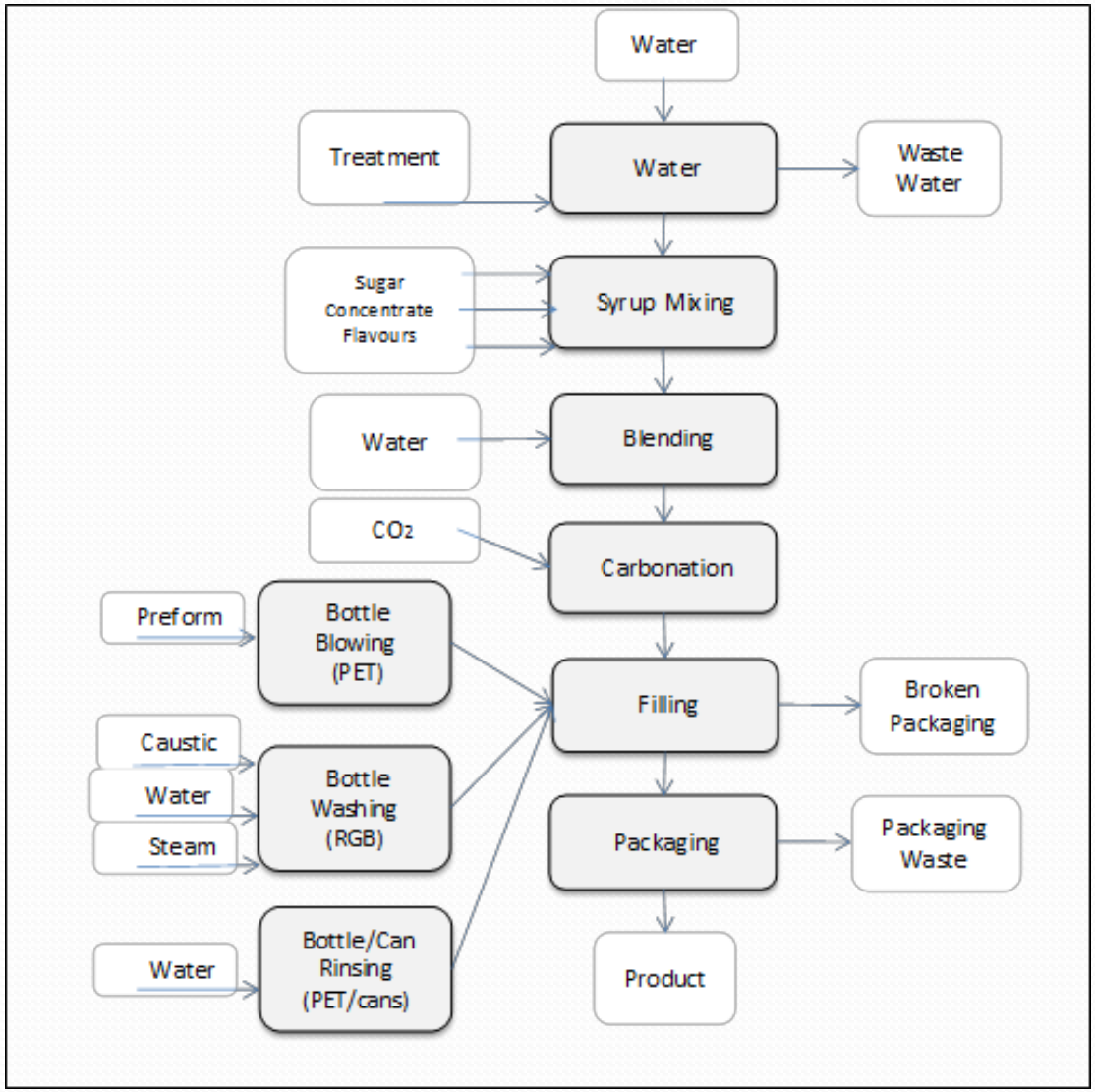
Process flow diagrams

Scale of operation

Overview

- Production processes depend on the product being manufactured and the type of packaging to be used
  - Storage of concentrate / raw product
  - Water treatment
  - Sugar dissolving
  - Blending
  - Carbonation / pasteurisation
  - Filling and Packaging
  - Bottle forming
  - Bottle washing / rinsing
  - Cleaning in place (CIP)

Carbonated Soft Drink



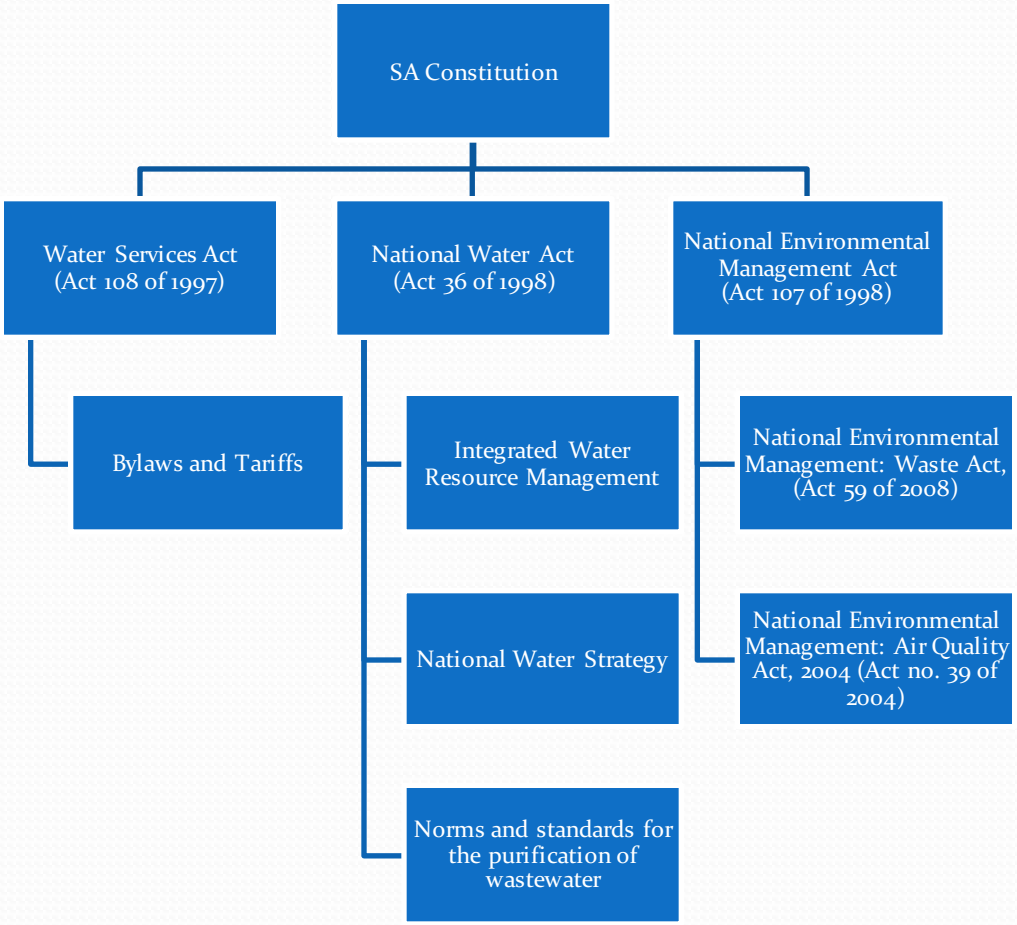
Chapter 3: Regulations

National and local policy

Local bylaws and effluent tariffs

Cost of water and wastewater trends

Policy: Water & Environment



Integrated Water Resource Management: Decision making hierarchy

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

Bylaws and Tariffs

- Each municipality has an effluent tariff
- Example for EWS:

Equation 1: **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

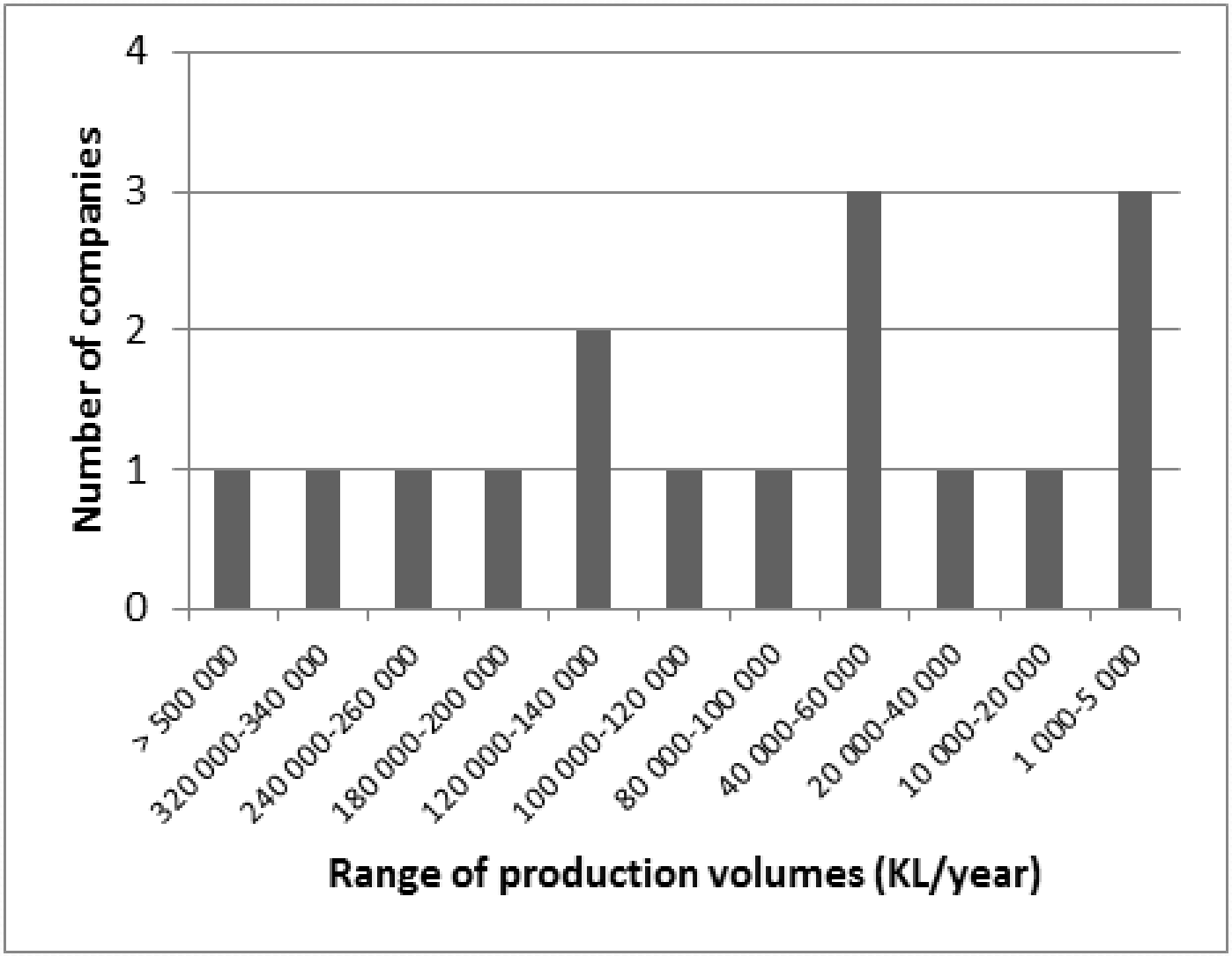
Policy: Other

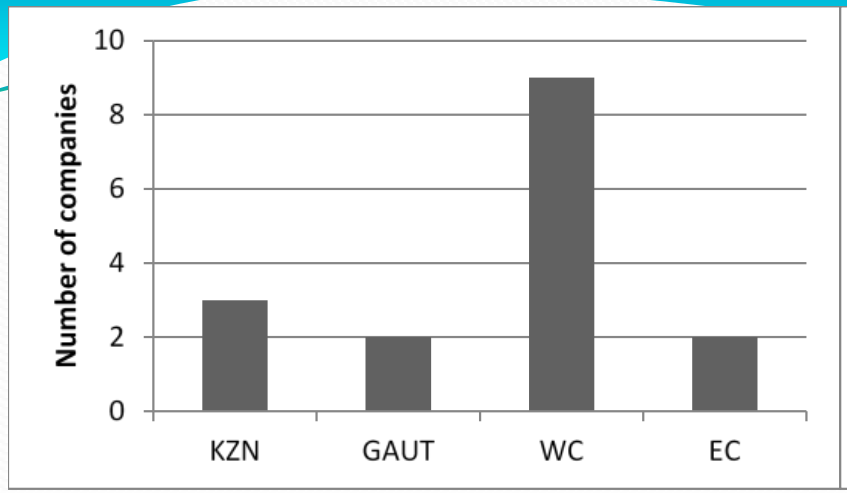
- Health and Safety: Department of Health: Food Control section
  - Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No. 54 of 1972; Amendment Act, No. 39 of 2007)
    - Hazard Analysis and Critical Control Point (HACCP) system 1972; Amendment Act, No. 39 of 2007)
    - Microbial standards for foodstuffs and related matters, GNR.692 of 16 May 1997
- Marketing and labelling of fruit drinks: Department of Agriculture, Forestry and Fisheries
  - 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

Section 4: Profile of participating companies

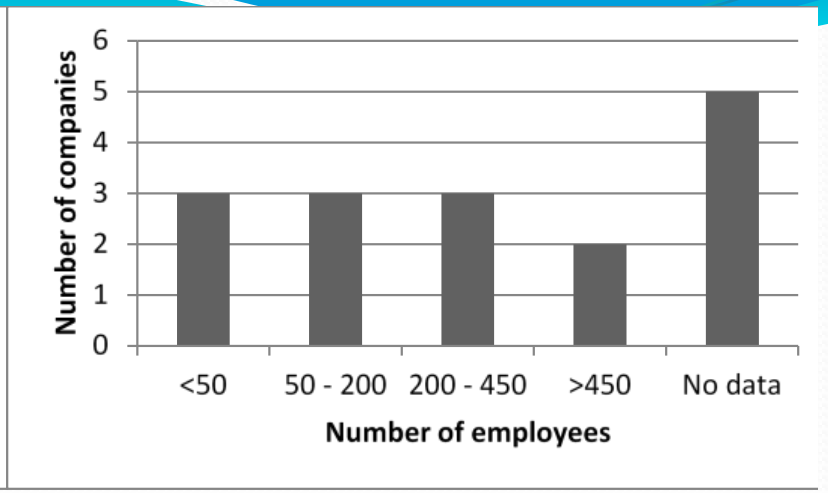
Overview of companies

Production volumes (Kl/year)

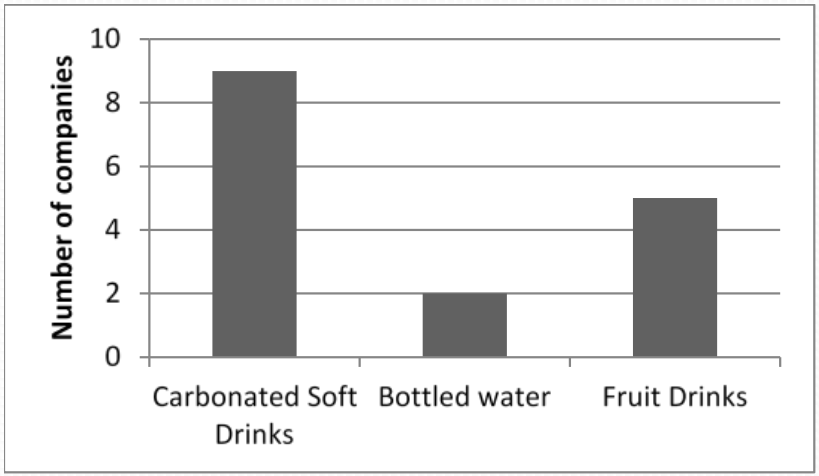


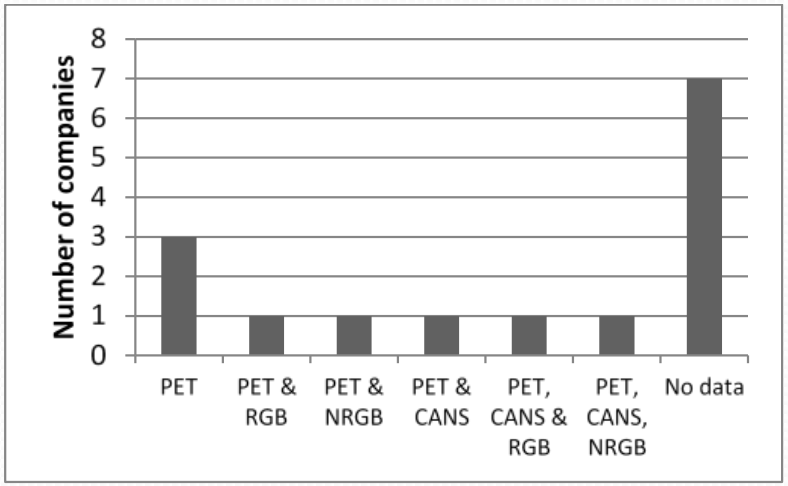


(a) Location of participating companies



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





Section 5: Water use and Water management

Source and treatment
Metering
Water use per process
Storm water management
Specific water intake
Benchmarking trends

Water source and treatment

	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

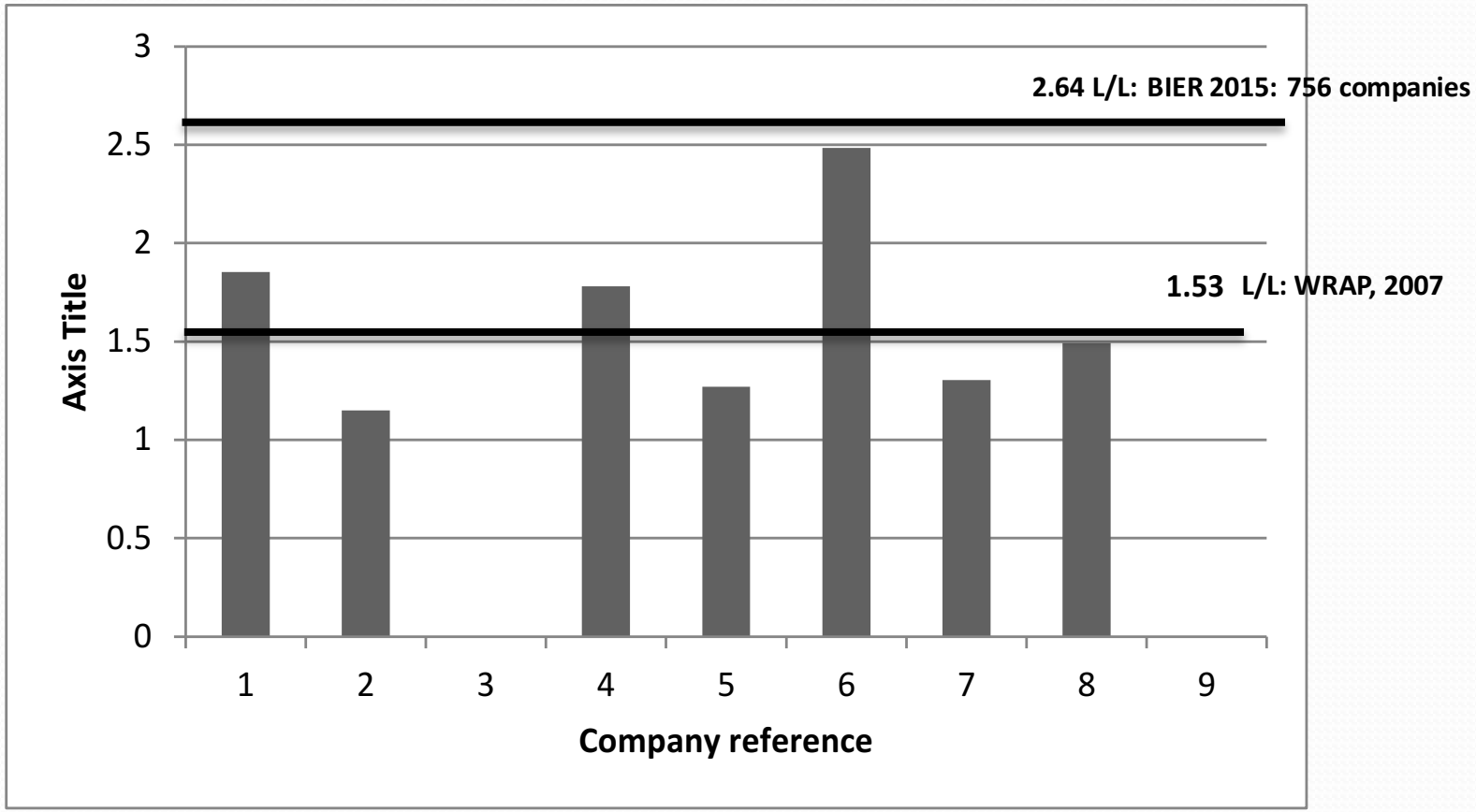
Water metering

	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	-														

Storm water management

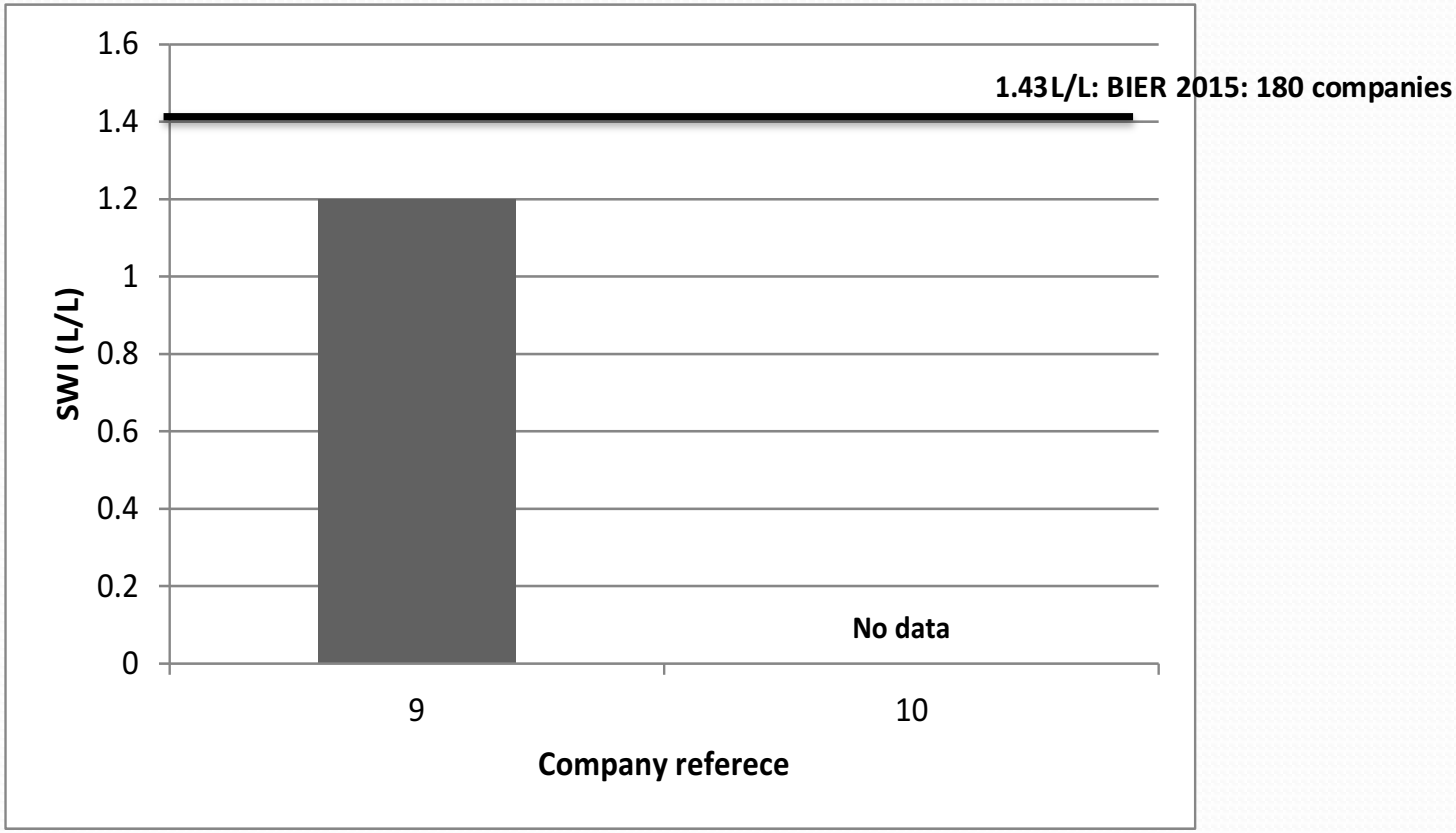
Company reference	Is there a storm water plan?	Are chemical storage areas bunded?	Are waste storage areas bunded?	Are storm water drains marked?	Other Comments
4	no	yes	yes	yes	There are map of drains but no formal plan
5	yes	yes	yes	yes	
6	no	yes	yes	yes	water runs into nearby surface water body; drains 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	

Specific water intake: Carbonated drinks

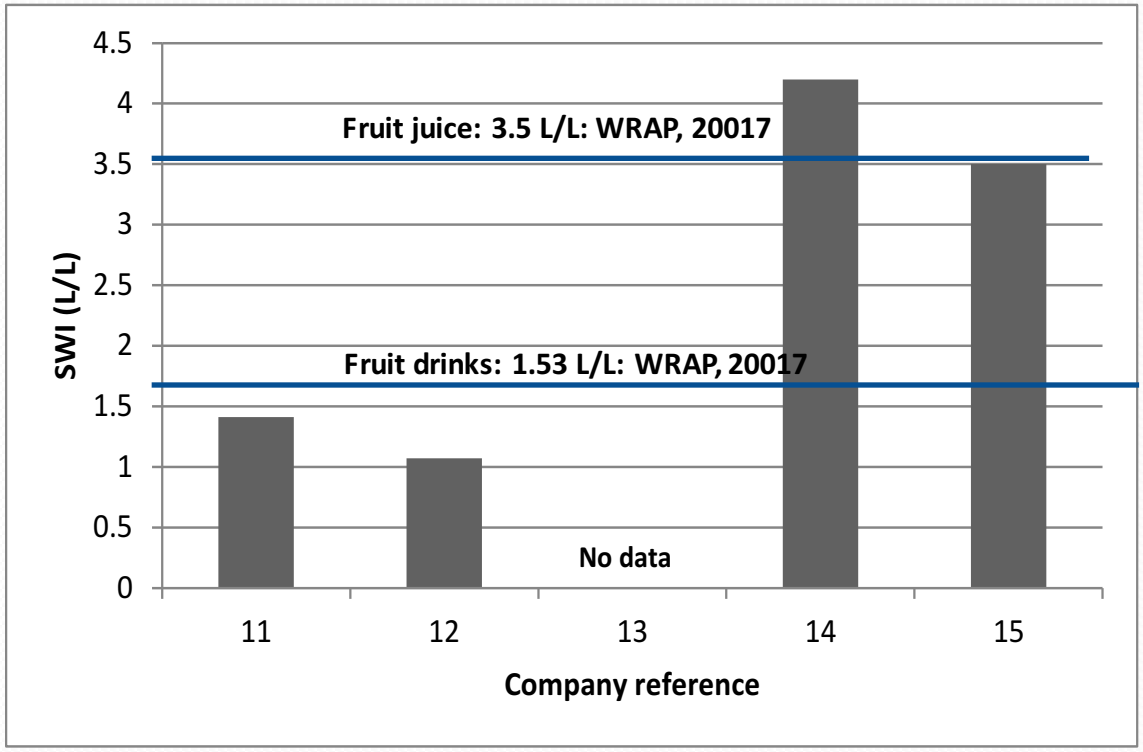


Comparison of specific water intake (L/L) for participating carbonated soft drinks companies against international benchmarks

Specific water intake: bottled water



Specific water intake: Fruit juice



Section 6: Wastewater management

Source of effluent
Source of COD
Specific effluent volume
Effluent characteristics
Effluent treatment

Source of effluent

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

Source of COD

- Study undertaken by Yaseer Ally (2015) in a carbonated soft drink factory
  - 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.

Specific effluent volume

Company reference	Annual water use (KL/year)	% Effluent of incoming water	Annual effluent (KL/Year)	SEV[1]
Carbonated drinks				
1	240 000-260 000	40-50%	100 000 – 120 000	0.88
2	260 000-280 000	10-20%	40 000 – 60 000	0.17
3	> 500 000	-	-	-
4	> 500 000	44%	240 000 – 260 000	0.78
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	-
Bottled water				
9	2 000-5 000	<10%	200 - 400	0.12
10	-	-	-	-
Fruit juice				
11	10 000-20 000	29%	4 000 – 6 000	0.41
12	0 - 2 000	6%	0 - 200	0.07
13	-	-	-	-
14	-	-	-	3.8
15	100 000-120 000	-	380 000 – 400 000	2.50

Effluent characteristics

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

Effluent management

- Little on-site treatment
- One company had an effluent meter
- Most were unsure of how often the municipality monitored their effluent

Section 7: Energy Management

Specific energy ratio

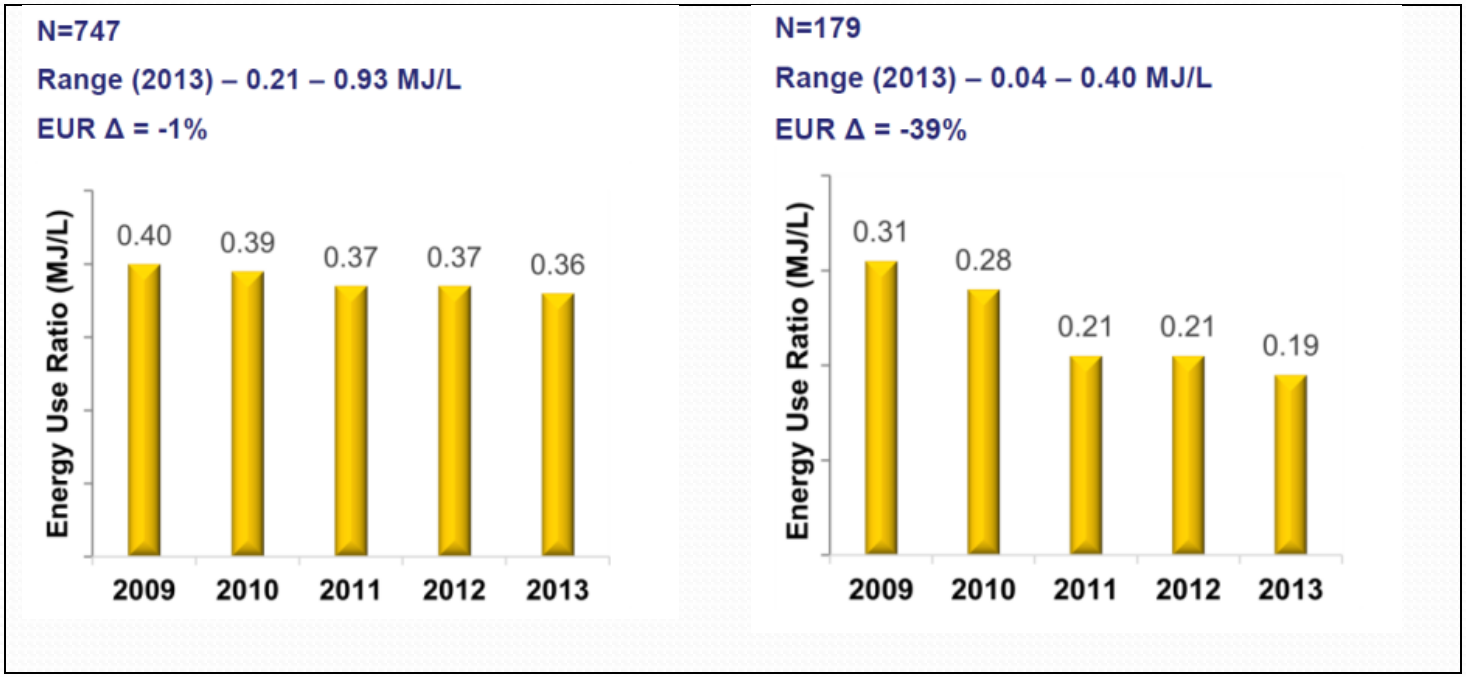
Benchmarking trends

Specific energy ratio

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

International trends



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)

Sections 8 - 11: Best practice

Overview of best practices based on literature surveys and case studies with respect to:

- Water management
- Wastewater management
- Other
  - Raw materials
  - Energy
  - Packaging
  - Solid waste management

Status of best practice - results of survey

Implementation of Best Practice

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

Section 12: Conclusions

Summary of information

Comparison to previous guide

Summary of survey results

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	-

Comparison to previous guide

	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]

On average, the carbonated soft drink industry is 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 L/L

Water savings

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
- Moving away from glass bottles to PET (but may be shifting water use)

Summary

- On average the water used by the soft drink sector has increased approximately 3-fold, however there is a much larger range in water consumption than previously reported.
- Production volumes have increased 7-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.
- Average effluent volume has increased (but not in proportion to the increase in water use).
- The average specific effluent volume (SEV) remains constant.
- The reported COD range is higher in the 2014 survey-most likely a result of the lower SWI.
- Where reported, the TDS and SS ranges were higher in 2014 – could be due to the inclusion of 100% fruit drink manufacturers.
- The pH range is more variable than previously reported.

Increase in COD

- 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).

Appendices

- **Appendix 1: Best Practise Review**
- **Appendix 2: On-line Survey questions**
- **Appendix 3: Detailed Questionnaire for Site Visits**
- **Appendix 4: Summary of Relevant Regulations**
- **Appendix 5: Reference Articles from the Internet**

Challenges in the project

- Limited response to on-line surveys
- Limited participation in site visits
- Reluctance to share information
- Lack of data from local authorities
- Lack of project team time to devote to continuous follow-up
- Lack of follow up with industrial associations to request data and keep them in the loop

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