DEVELOPMENT OF AN EXPERT SYSTEMS APPROACH TO WATER MANAGEMENT IN FRUIT AND VEGETABLE PROCESSING INDUSTRY

Final Report to the

Water Research Commission

by

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EXECUTIVE SUMMARY

1. BACKGROUND, MOTIVATION, AIMS AND OBJECTIVES

1.1 Background

The processing of fruit and vegetables for canning and freezing is a water-intensive operation generating high volumes of organically-rich effluents. Previous work sponsored by the Water Research Commission ("WRC") in the fruit and vegetable processing industry ("the Industry") has been aimed at characterizing the water intake, the generation and treatment of effluents and the disposal of waste waters within the Industry. This work has been reported on previously, *inter alia* in the published Guide [1] and in the up-dated statistics and software [2] developed.

1.2 Motivation

The present project has risen out of the identified need for a water management system which will enable factories in the Industry to monitor and thereby control their water use for the various processing activities carried out.

1.3 Aims and Objectives

The aims and objectives for the project are set out in the contract document for WRC project K5/458 [3] and are summarized below:

- the primary aim is to develop and implement a pro-active and inter-active water management system as a practicable and effective tool within the Industry;

- water use is to be monitored against realistic targets set specifically for each commodity being processed;

- the system is to be designed so that the reporting format adopted will identify problem areas automatically;

- it is intended that the system, with local modification, should be exportable to other production centres and sectors within the Industry, and it is envisaged that the water management system developed would be applicable, with appropriate modification and development, to other multi-commodity water-intensive industries.

2. PHILOSOPHY, APPROACH AND METHODOLOGY

An expert systems philosophy was adopted as the most appropriate means towards the objectives envisaged. Attention was therefore focussed on developing a systematic methodology for obtaining, assessing and combining data inputs from various levels into a coherent water management system, rather than on exhaustive measurement of specific (and possibly site-specific) water-related features and particular processing situations in the Industry. These latter aspects have been addressed in previous work [1,2] sponsored by the WRC.

To ensure that observations made and conclusions drawn were based on realistic water-related features and processing situations that were generally representative of the Industry, a model factory approach was selected using initially Langeberg Suider Paarl.

The Paarl model factory was surveyed to characterize its water supply and reticulation, and a series of commodity-specific water surveys was carried out at this model factory using a combination of existing water meters and meters installed for the project. In the course of the project, a second model factory was also incorporated, namely Langeberg Ashton. Water-related data from both model factories were analysed to compare differences and similarities.

3. SUMMARY OF RESULTS AND CONCLUSIONS

3.1 Survey of Paarl model factory

On-site surveys were carried out to determine the water supply, sources and reticulation at the Paarl model factory, and diagrams and drawings representing these aspects were produced on a CAD system. The following features are noted:

- the water supply to the factory is complex due to the number of different sources, including municipal mains water (5 incoming mains), river water, ground water, rain water, defrost water, water extracted from product, and fire mains water (not used for industrial purposes);

- the water reticulation at the factory is also complex due to the physical interlinking of various supplies on site, manually selectable routing of water to major processing areas from one or more different sources on-site, balancing and recycling of water from different sources into the water reticulation system, and the historical *ad hoc* adaptations to the water reticulation system that have been instituted on an on-going manner as various factory expansions and alterations have occurred and continue to occur.

A number of water meters were specified and installed at the Paarl model factory during the project to supplement existing meters. All existing and additional meters installed were calibrated against a standardized portable flow meter. The additional water meters were required:

- to provide essential data on the use of water for processing purposes on various commodity lines, and

- to provide a more comprehensive overview of the overall water intake and distribution at the model factory, taking into account the complexity of the water supply, sources and reticulation as noted above.

The level of water metering, monitoring and reporting that was attained during the project is not considered to be satisfactory for the water use situation that pertains. Major shortcomings are deemed to be:

- the set of meters provided does not adequately define in all cases the water supplied to specific processing areas or product lines (the exceptions vary depending on the season, the particular commodities or combinations of commodities being handled, etc);

- at a more macro-level, the set of water meters does not provide for adequate and simple auditing of the complex water supply, water reticulation and water re-distribution (after balancing, storage and blending of diverse supplies) at the factory;

- the routine monitoring and reporting procedures employed do not facilitate rapid but yet comprehensive scrutiny by management, or provide a simple and informative basis for on-going water management including taking remedial measures in a timeous manner, etc.

It is concluded that these aspects can be effectively addressed in-house at the model factory by taking account of the sub-optimal aspects identified during the project and by making use of the set of drawings of the factory water reticulation developed during the project. The broader findings of the project, as summarized below, also provide direct guidance in this respect.

3.2 Commodity surveys

Monthly production records over two consecutive annual cycles a the Paarl model factory were reviewed and assessed. A strong seasonality in production was observed, with significant features being (by inspection) an approximate division of the annual cycle into "high" and "low" season months, and correspondingly large turndown ratios (by calculation) in terms of monthly production rate (peak:min>20, peak:ave>2,5).

From the large number of raw materials (20) and commodities produced (40) at the Paarl model factory, five commodities were selected for detailed water surveying to measure the specific water use (SWU) for processing. The criteria used for selecting the commodities for individual water serveys included the commodity ranking (major/medium/minor) in relation to overall annual production, seasonal considerations (ie. whether processed in high/low season) and site-specific logistical factors (availability of installed water meters, suitable "window" for survey, etc).

The SWU-ranges for the five commodities surveyed intensively (apricots, cherries, guavas, peaches and pears) are summarized in Table 1, where the results obtained during 1992-93 in the present study are compared also with previously-determined SWU-data from 1979-84 [1] and 1987-88 [2].

TABLE 1 COMPARISON OF MEASURED SWU-VALUES WITH OTHER DATA

Commodity	SWU (m3/t) RANGE AND MEAN					
	1979-84		1987-88		1992-93	
	Range	Mean	Range	Mean	Range	Mean
Apricots	2,5-14,5	5,5	2,3-50,3	9,9	5,2-5,2	5,2
Cherries	N.D.	N.D.	N.D.	N.D.	18,8-24,4	22,0
Guavas	4,0-10,0	6,4	16,9-181,9	53,1	33,2-62,9	45,3
Peaches	2,5-11,5	5,5	4,4-14,1	10,0	3,4-7,8	5,6
Pears	19,0-25,0	22,0	7,5-48,9	22,1	18,1-37,7	23,6

The SWU-data in Table 1 reflect the influence of different kinds of factors on the efficiency of water use, including casual, occasional and line-loading effects, factory (site-specific) factors and Industry-trends. Most of these have been encountered and documented previously [1,2,3] and form the basis for one type of water-management system, whereby the overall water intake to a factory can be synthesized as the sum of a comprehensive set of sub-intakes which are defined and monitored in terms of appropriate target-ranges [4]. An example of this approach applied to a different industry [4] can be adapted and used directly by the fruit and vegetable processing industry.

The most significant conclusion drawn in this study by examination and further analysis of the data obtained is that there is a startlingly large difference in SWU-values between commodities produced at different points in the annual seasonal processing cycle. These differences are too substantial to be immediately reconcilable into the above simple cumulative model for water management as applied to the multi-commodity (raw materials and products) and seasonal fruit and vegetable processing industry.

3.3 Effect of factory production rate on water use efficiency

From Table 1, the variances in individual commodity SWU-ranges measured in the course of the project are less striking than the variances between different commodity SWU-values (on an averaged basis). For example, the widest spreads observed in individual commodity SWU-ranges were around $\pm$ 50% (0,5 - 1,5X) the mean values, while different commodities had observed mean SWU-values varying by almost 1000% (10X).

Previous work carried out [1,3] had identified various specific factors which result in commodity SWU-values varying from their appropriate minimum or target ranges. These factors include discretionary or casual water use (eg. manual cleaning with hoses), the effects of shift, batch or product changes (often initiating plant washdown procedures where water use is not proportional to production), variable corporate or managerial commitment to water conservation (discernible even on a day/night basis at some 24-hour factories), etc. Reference has also been made [1,3,4] to the effect of production rate on the efficiency of water use, both at a line-processing [1] level and also in terms of overall factory throughput [4].

In the present study, the last-mentioned aspect (ie effect of overall factory throughput on water use efficiency) was examined in greater detail as an initiative arising out of the project. The methodology applied was to analyse the monthly water intake at the model factory in relation to monthly production data (raw materials and commodities produced) over two consecutive annual cycles. To cross-check on the results obtained and conclusions reached, a further corresponding set of data from the second model factory (Langeberg Ashton) was obtained and analysed.

For each data set, the monthly water intake (WI) at the model factory concerned was correlated with the corresponding raw materials intake (tons) and production rate (basic cartons produced). The results obtained were plotted against each other in a series of graphs, which show predictable broad trends of more processing/higher water intake. The relationship observed was, however, not consistent; expressed in terms of specific water intake (SWI, kℓ/t or kℓ/BC), at any time of year or at any particular processing rate there is a large variation in the SWI-value observed, even though overall trends are apparent. The scatter observed can be linked to the variations in individual commodity SWU-values over smaller time scales, eg hours/shifts/days.

As a further step, the processing rate was normalized by expressing raw materials intake and production not as absolute values but rather as a ratio between the actual monthly rate and the peak monthly rate in each annual processing cycle studied. The ratio derived has arbitrarily been termed the "percentage of factory capacity utilized".

The results obtained are summarized in Figures 1 and 2 (for the Paarl and Ashton model factories respectively), showing clearly that at high levels (>50%) of factory capacity utilization the factory - SWI tends to a minimum level (7-8 kℓ/t on a raw material basis). Conversely, at low levels (<10%) of factory capacity utilization, the factory - SWI rises to much higher values (up to 40 kℓ/t).

An important observation on the data summarized in Figures 1 and 2 is that because two model factories (comparable but not identical) were studied over two annual cycles (similar but not identical) the normalized "factory capacity utilization" variable is not uniquely identifiable with one or more particular commodities. The implication

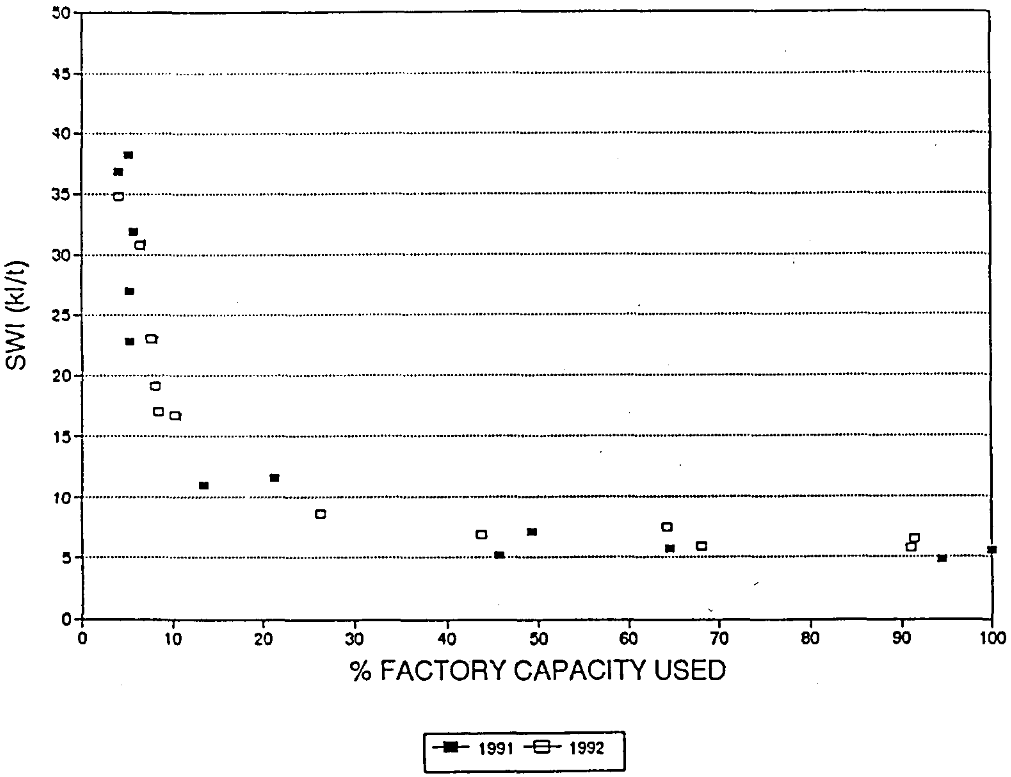


FIGURE 1 : SPECIFIC WATER INTAKE (KL/TON) VERSUS % FACTORY CAPACITY UTILIZED, SUIDER PAARL 1991-92

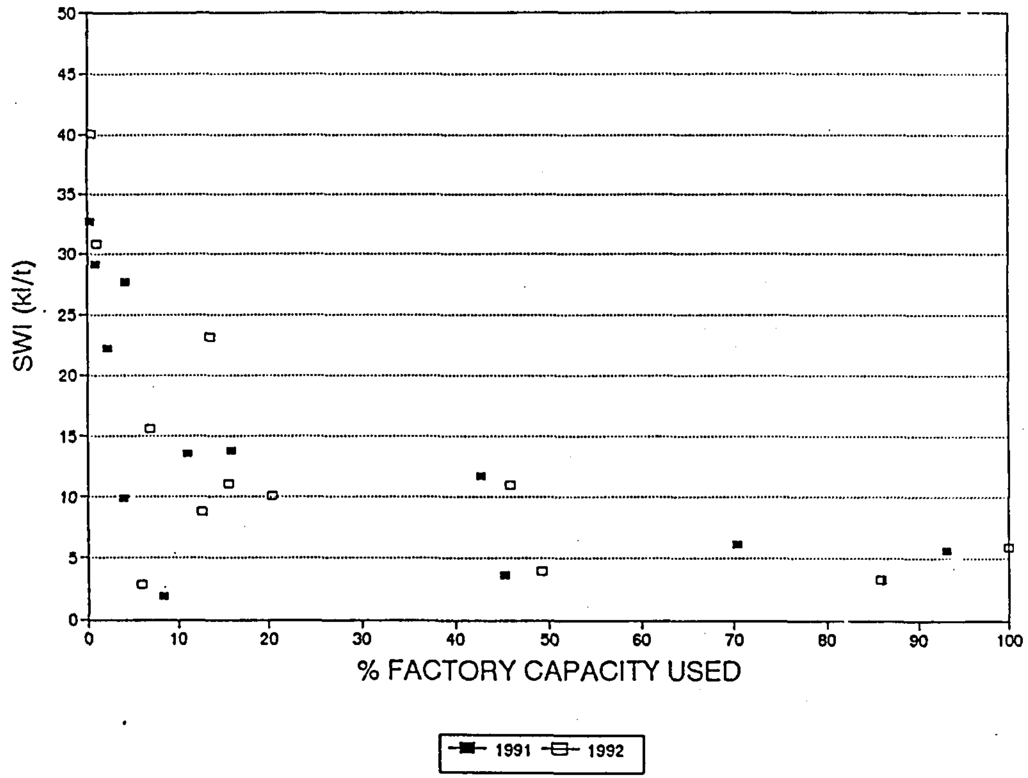


FIGURE 2 : SPECIFIC WATER INTAKE (KL/TON) VERSUS % FACTORY CAPACITY UTILISED, ASHTON 1991-92

is that the SWU-values ascribed to line-specific activities are influenced also by the overall factory production context in which individual commodities are processed. The results obtained in fact indicate strongly that it is also useful to view a factory as a single processing unit (black box) with a variable mix of raw material inputs over an annual seasonal cycle.

The rationale for this view is that in addition to line-specific water uses which are (or should be) approximately proportional to production, there are also other water uses which provide necessary support but are not directly related to processing. Examples are various utilities and amenities (boilers, cooling towers, ablutions, plant & equipment washdown, canteens, gardens, vehicle washing, etc.)

At the Paarl model factory, the level of water metering installed was generally not sufficient to isolate water use for processing purposes, either directly (by metering the water used only for processing) or indirectly (by metering non-process uses comprehensively and subtracting these from the overall water intake). Once this is achieved, non-process water uses can be stripped away and Figures 1 and 2 can be re-calculated and re-presented to show "SWI for processing" (rather than "overall SWI") in relation to factory capacity utilization. Theoretically, the results obtained should then be substantially similar to the result obtained by applying the earlier approached developed, namely synthesizing the overall factory WI (or SWI) as a summation of sub-targets associated directly with line processing activities.

In summary, it is concluded that it may at this stage be useful for factories in the Industry to initially define water management targets based on historical production/capacity utilization, before embarking on a more ambitious water metering programme in which detailed processing water uses are exhaustively monitored. These two approaches effectively define complementary aspects of an ultimate expert system for water management appropriate to the Industry.

In selecting a starting point, it is important to clarify the objectives of the water management system envisaged. These objectives could be dominated by either national or local considerations; examples are minimizing overall annual water intake (national, best deployment of available resources) or smoothing out water demand (local, minimal strain on water supply), and social considerations (e.g. enhanced level of sustained employment of labour over an annual seasonal cycle).

3.4 Development of an appropriate expert system for water management in the Industry

The results obtained provide the basis for an expert system which can be immediately applied by the Industry to effect more systematic control of water use and an enhanced level of water management. The only pre-requisite for implementing the system are (i) adequate monthly/weekly data on production (which all factories have) and (ii) adequate metering of the total water intake to the factory (which most factories have, and all factories should have inter alia as a condition of permit from the Department of Water Affairs & Forestry). The water/production data in (i) and (ii) above can be captured and correlated using the software developed in WRC Consultancy K8/56 [2].

4. ASSESSMENT OF PROJECT ACHIEVEMENTS RE: OBJECTIVES

It was originally envisaged that the project protocol would systematically develop a practicable water management system for the Industry based on monitoring and reporting the water used for individual commodities or processing activities in a format which would transparently identify problem areas to which appropriate remedial measures would be applied based on cumulative experience of the Industry. Implementation would then result in improved compliance to the water management objective(s) selected, eg. more conservative, more consistent or more cost-effective use of water to achieve the commercial production aims of the Industry.

The results obtained indicate strongly that the seasonally orientated nature of the Industry exerts a significant influence on the water management targets that can realistically be set. In particular, the water efficiencies at which various individual commodities are processed reflect the season in which the processing activity occurs: high-season processing corresponds with high water efficiency, and vice versa.

The considerations arising from this are far-reaching in terms of water management and provide a valuable basis for an expert system approach in which realistic water management objectives can be sensibly set in relation to production. It is considered that the project achievements contribute significantly to the process of defining and implementing an appropriate water management system for the Industry, and that the project objectives have thus been substantially met.

5. RECOMMENDATION FOR IMPLEMENTATION AND FURTHER WORK

The basis established for an expert system of water management should be implemented as an initiative by the Industry. Further work should also be done in extending water monitoring so that (at least) a clear allocation can be made between processing-related and non-processing water uses. The water metering system can be extended to specific line, commodity or process uses, depending on the water management objectives set.

It is also recommended that a mechanism for future liaison and co-operation be set in place, to continue the work of the present Steering Committee for the project.

6. RECOMMENDATIONS FOR TECHNOLOGY TRANSFER

At its final meeting on 23 August 1994, it was recommended that the Steering Committee give consideration to technology transfer arrangements, which could include the formation of a working group to succeed the present Committee, identifying and arranging an Industry Forum (e.g. open day) for presenting the project results, and arranging a mechanism for future follow-up and review.

DEVELOPMENT OF AN EXPERT SYSTEMS APPROACH TO WATER MANAGEMENT IN THE FRUIT AND VEGETABLE PROCESSING INDUSTRY

1 INTRODUCTION

1.1 Background

The Water Research Commission (WRC) has, for more than a decade, sponsored research into ways of assisting the fruit and vegetable processing industry ("the Industry") to improve the management of its water and effluent situation. The work carried out was landmarked initially by the publication in 1987 of Guide [1] to water and wastewater management in the industry, based on intensive on-site surveys carried out in the period 1979-1984. Subsequently, up-dated statistics reflecting the water and effluent situation in the Industry in 1990 were published [2].

Because of its food-quality nature, water is used extensively in the Industry for a variety of processing related functions. Previous work sponsored by the WRC in the Industry, as summarized very briefly above, has been aimed at characterizing inter alia the particular ways in which water is used in the course of processing, and the resulting consequences on the water intake and effluent generated during fruit and vegetable processing.

From its involvement with the Industry, the WRC recognized that the level of information available in the Industry with regard to water use was generally low, and that a need existed for developing an appropriate approach/system/ protocol/methodology whereby the research results achieved could be applied meaningfully and systematically by factory management. Accordingly, the present project was initiated with the strategic aims of investigating the factors that significantly influence water demand in the Industry, and to integrate these into a coherent expert system for attaining a more controlled water-use situation. The project objective, and the approach and methodology selected, are outlined in more detail in the sections following.

1.2 Project Objectives

The overall project objective is to develop a useful expert systems approach for achieving better water management in the fruit and vegetable processing industry.

In stating this objective, it is clear that the requirements are firstly to define and understand the Industry in terms of its water use, and then to translate this understanding into a systematic approach which the Industry can apply to effect improvements in its water management and water efficiency.

In the course of the project, various approaches were considered as means towards the end envisaged in the overall project objective. The approach adopted, and the considerations applied, are summarized in the following section.

1.3 Approach

A strategic consideration that was applied and sustained throughout the course of the project was that the research effort should be directed at "real life" situations, rather than developed abstractly. Accordingly, a "model factory" approach was selected, in terms of which the patterns of water use at a specific factory were studied in depth.

After reviewing various candidates, Langeberg's Suider Paarl factory was selected as the main model factory for the project. The selection was made on the basis that this factory incorporated many of the features considered to be typical of the Industry, in particular that a large number of the multiple commodities processed and produced in the Industry were represented, and that the factory activity was therefore seasonally orientated (due to the diversity of commodities handled) in a way that is generally characteristic of the Industry.

At Langeberg Suider Paarl, attention was paid initially to characterizing the factory's water supply and reticulation to processing. Thereafter selected commodity processing activities were studied in further detail and the factory's overall water intake was related to the processing activities being carried out over annual seasonal cycles.

To complement the information obtained at Suider Paarl, further data was also obtained from Langeberg's Ashton factory. The original project approach was thus extended to include a second model factory, on the basis that it would be useful to make comparisons of similarities and/or differences with another situation in the Industry. The selection of Langeberg Ashton for this purpose was guided by the Technical Sub-Committee for the project, taking into account also that suitable data was relatively readily available from this source.

1.4 Methodology

The broad categories of water-related information were envisaged, namely:

- data obtained by interrogating, scrutinizing and analysing existing water-related information, and

- data obtained by physically measuring at first hand those water-using aspects which were considered important in achieving the project objectives but which were not adequately represented by available existing information.

For logistical reasons, the Suider Paarl factory was selected as the site for carrying out first-hand physical surveying activities. This entailed characterizing the factory's water supply and reticulation systems, and then proceeding to measure selected water-using operations. The information obtained was reviewed in the context of the existing water-related information at the factory (including recent historical data) and then complemented by obtaining comparable water-related information from the second model factory (Ashton). Details of the steps involved in this methodological protocol are given in subsequent sections of the report.

At the first model factory (Suider Paarl), an on-site survey of relevant water aspects was planned. Early inspection showed that the level of water metering in the factory had to be supplemented in order to obtain the specific water-use data anticipated. Accordingly, a set of strategically-located water meters had to be specified and installed, which entailed acquiring a relatively complete understanding of the water supply and reticulation systems. Existing information on these systems was at a low level, and suitable drawings thus had to be prepared first-hand on site.

2 SITE SURVEYING AT SUIDER PAARL

2.1 Introduction

Surveying of the water reticulation system at Suider Paarl was commenced in 1991, as an acceleration of the original project programme [3]. The drawings of the water supply and reticulation systems provided by Langeberg proved to be out of date and required fundamental development [4]. Final resolution of the water reticulation system at the factory was never achieved, due to ongoing changes and extensions at the factory, which are however considered to be characteristic of the Industry.

2.2 Water supply and overall water reticulation

The water supply to the factory is complex as there are a number of different sources, as follows:

- Municipal water from Paarl mains supply (5 incoming lines);
- River water (abstracted from Berg River);
- Ground water (abstracted from boreholes on site);
- Rain water (collected on site);
- Defrost water (from atmosphere);
- Water from product (extracted from product on site);
- Fire mains water (not used for industrial purposes).

In addition to the complex water source/supply situation, the existing water reticulation system is also complex, due to the following factors:

- Various different and/or similar water sources are physically interlinked on site with optionally-selected manual valving.

- The interlinking is such that the water supply to some major processing areas can be selected by choice from one or two or more different sources.

- Water supplies from different sources are combined, balanced, stored and then recycled into the interlinked water reticulation system.

- The factory has been in existence for a long time and the water reticulation system has been adapted in an ad hoc manner as various factory expansions and alterations have been instituted in terms of infrastructure (buildings, services, processing equipment etc) and activities (product lines, capacity, etc).

- Such changes are considered to be either inherent or processing-driven, and therefore generally characteristic of the Industry where raw material supplies and products are market-driven by external factors [5].

These factors indicated above regarding the complexity of the water source/supply situation at Suider Paarl, particularly when considered in the low level of existing documentation found on these aspects, significantly extended and delayed the planned project programme.

Figure 1 illustrates schematically the overall water source, supply and reticulation system at the factory at the commencement of the project, although subsequent changes were introduced. Further details of the as-found situation are given in Progress Reports 1 [4] and 2 [5] for the project.

2.3 Installation of Water Meters

After surveying the processing areas and water reticulation system of the Suider Paarl factory, and preparing drawings, a set of water meters was specified for measuring the water use for selected commodities and/or processing activities. Because of the diversity of water supply sources the number of water intakes, the spread-out nature of some processing activities, and the complexity of the water reticulation system, the water meters specified were classified into "permanent" and "individual" categories, as described briefly below (ref [4] and [5] for details of the site installation programme):

- Permanent water meter positions were identified as general meters that would monitor the overall sub-reticulation in the factory and would also (by difference) give the water use for some products. These permanent water meters would remain installed at the factory after the project had been completed, and would be used by Langeberg to check the overall water balance at Suider Paarl.

- Individual water meters were specified as a set of possibly mobile water meters for dedicated monitoring of individual products, processes or process areas. These individual water meter positions would change during the course of the project as different commodities were surveyed, and would be retained after the project for use by Langeberg as appropriate.

The positions of the permanent water meters specified are shown in Figure 1 and Drawing 1 and are described briefly in Table 1.

FIGURE 1

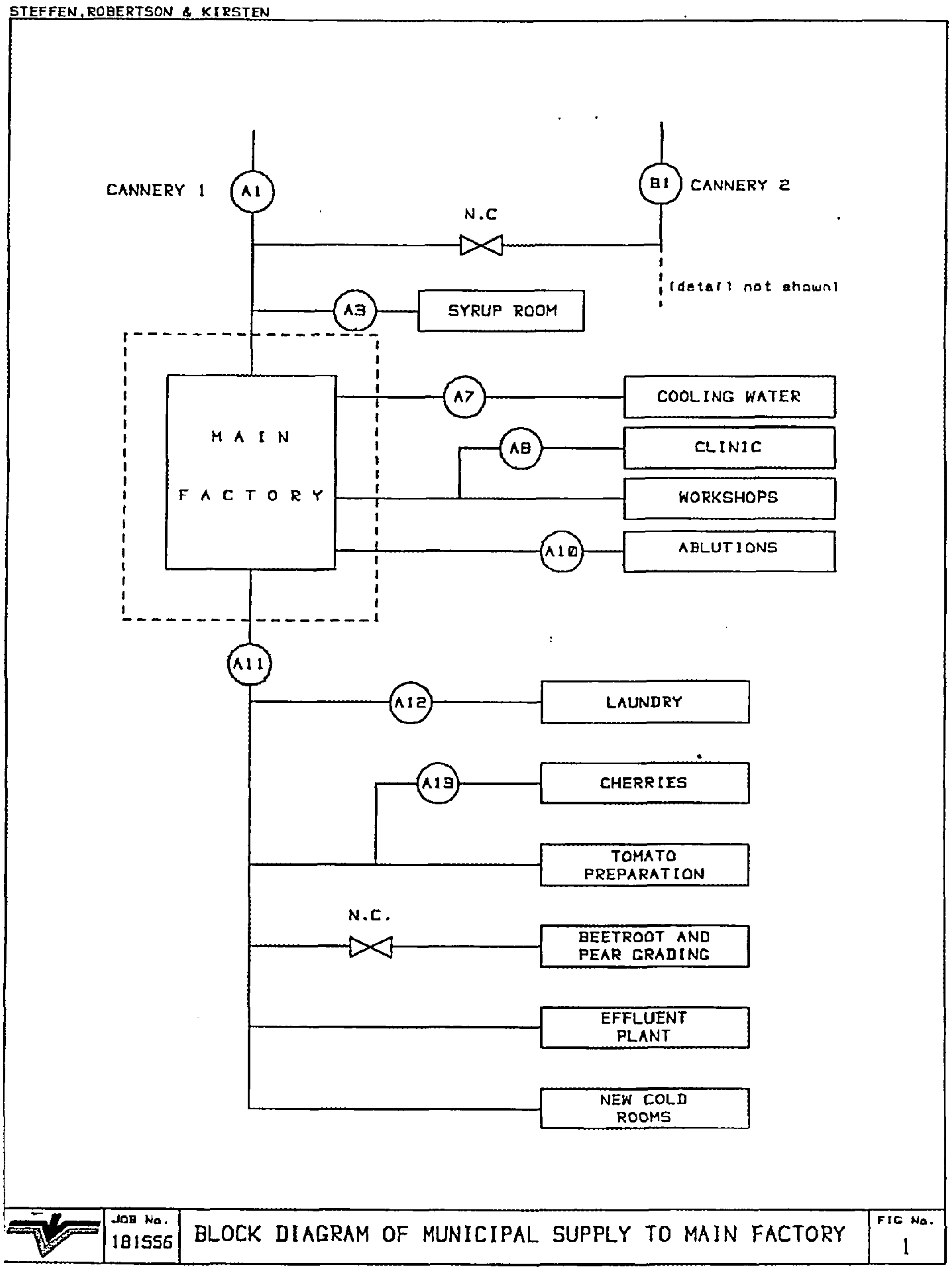

STEFFEN, ROBERTSON & KIRSTEN
CANNERY 1
A1
B1
CANNERY 2
N.C
(detail not shown)
A3
SYRUP ROOM
MAIN
FACTORY
A7
COOLING WATER
A8
CLINIC
WORKSHOPS
A10
ABLUTIONS
A11
A12
LAUNDRY
A13
CHERRIES
TOMATO PREPARATION
N.C.
BEETROOT AND PEAR GRADING
EFFLUENT PLANT
NEW COLD ROOMS
JOB No.
181556
BLOCK DIAGRAM OF MUNICIPAL SUPPLY TO MAIN FACTORY
FIG No.
1

TABLE 1 POSITIONS OF PERMANENT WATER METERS SPECIFIED

Symbol (ref Fig 1)	Position (ref Drg1)	Category	Status
A	Cannery 1	Incoming water sources	Existing
B	Cannery 2		Existing
C	Jam room		Existing
D	River water		Existing
E	Defrost and rain water		Project
F	Groundwater (from subway)		Project
G	Vacuum pump		Project
U	Main supply to palletising dam		Project
H	Five main (at jam room)		not in use
I	Boiler house supply	Utilities	Existing
J	IQF supply		Existing
K1	Jam room cooling tower make-up		Project
K2	Main factory cooling tower make-up		Project
L1	Old cold room supply		Project
L2	New cold room supply		Project
M	Garden use (river water)		Project
T	Garden use (municipal water)		Project
N,O	Ablution blocks (2)	Amenities	Project
P	Canteen and laundry		Project
Q	First-aid station		Project
R1, R2	Baked bean	Semi permanent products	Project
S	Tomato sauce/puree/paste		Project

Installed water meters (both existing and installed for the project) were calibrated against a standardized portable flow meter. The results obtained are summarized in Section 2.4 below. Water use data quoted subsequently in the report have been corrected to account for calibration errors.

2.4 Calibration of Water Meters

Each installed meter (permanent and/or individual) was calibrated against a standardized portable flow meter by monitoring the flow for a representative period of time ranging from a few hours to several days. The calibration factor was calculated in each case as a ratio between the standardized meter reading and the installed meter reading. The calibration factors were determined over a range of flow rates and plotted against flow rate. Depending on the relationship between calibration factor and flow rate, an "average" calibration factor was then calculated for each installed meter. The results obtained are summarized in Table 2.

TABLE 2 AVERAGE CALIBRATION FACTORS FOR INSTALLED WATER METERS

Reference	Symbol	Description	Calibration factor (standard/ measured)
A1	A	Cannery 1	1,3951
B1	B	Cannery 2	1,0619
B2	C	Jam room	-
D1	-	River water to cannery	1,1107
C1	-	Jones Street	0,9777
B3	J	IQF	1,0979
A11	-	Cherry colouring	1,0503
D4	-	Peas (river)	1,0512
A6	-	Peas (grader)	0,9110
A3	-	Peas (flume)	1,0447
-	I	Boiler supply	1,0650
-	-	Boiler condensate	1,1009
D3	-	Peach preparation	0,9805
A5	-	Fruit cocktail	1,0252
A4	-	Cannery preparation	1,1857
A8	N	Ablution block	1,0951
A10	P	Laundry	1,0134
A9	Q	First-aid station	-
A2	-	Syrup room	stuck
-	U	Main supply to palletising dam	stuck

The calibration results obtained are generally typical of industrial water meter installations, with measured errors in the range +-0-10% around the correct readings. Langeberg Suider Paarl do in fact have a routine daily meter reading and recording programme, with some of the major data (municipal water intake, etc) being forwarded into a summarized utilities report for management. The calibration factors measured can be used to normalize the readings taken, and also to avoid recording and drawing conclusions from the monitoring of spurious data [4].

The calibration exercise carried out was aimed at ensuring that water meter data captured in the course of the project were correct. Such data presented subsequently in the report have been duly corrected. Other benefits of the watermeter calibration exercise carried out should be taken up by the factory management and used accordingly.

2.5 Overall Factory Water Audit

As the project evolved, and as familiarity with the model factory site at Suider Paarl developed, it was envisaged [6] that the set of permanent water meters specified would be used to firstly establish and secondly maintain an overall water audit and/or balance for the factory. This would have provided a background against which the impact of specific water demands (for example from particular processing activities) could be assessed.

Because of the logistical factors, the desirable level of water metering for this purpose was not established during the course of the project. It is understood however that the advances made: (factory surveying, drawings of water reticulation system, calibration of water meters etc) will be used by Langeberg Suider Paarl in an on-going manner towards these goals [9]. The aspects mentioned in fact constitute a set of necessary infrastructural tools for successful implementation of any progressive water management system.

As an example of a way in which this can be achieved, Cowan [4] has given guidance regarding the overall protocol for auditing and target setting for improved water management, as follows:

- Define overall water use targets for the factory which are compatible with historical water use figures for that factory, where they exist;

- Determine a realistic breakdown of water use by area for a range of processing conditions;

- Determine areas or activities which do not need to be further monitored because water use is insignificant or not amenable to control;

- Identify areas or activities in the factory which are most amenable to water conservation, ie areas with

  - significant water use
  - large variability in water use
  - an element of discretionary use;

- Indicate where water is currently being used inefficiently so that these shortcomings can be largely remedied before targets are proposed;

- Provide sufficient water use information for the areas amenable to control to

  - estimate the % of water used pro rata to production
  - estimate the % of water used pro rata to time
  - estimate the % of water needed for adequate washdown
  - estimate the % of water used which is not related to any of the above;

- On the basis of this information preliminary water use targets are calculated and tabulated to take account of the different commodities to be produced and the range of production rates expected.

- After preliminary targets have been set, test them in practice and amend as appropriate when they are bettered too easily or found to be unachievable.

- Prepare detailed tables or computer spreadsheets relating the targets to relevant factory variables, usually the product, product mix and production rate.

- Prepare a schematic block diagram (or set of sub-diagrams) summarizing the factory production process and in which target and actual water use figures are entered either manually or by computer print-out.

- Arrange a suitable system of reporting and feedback within the factory organisational structure so that the completed schematic and associated action steps provide an "at a glance" basis for discussion between the responsible operators and managers concerned.

3 WATER SURVEYS ON INDIVIDUAL COMMODITIES

3.1 Overall Factory Production 1991-92

The model factory selected (Langeberg Suider-Paarl) takes in a large number (around 20) of different raw materials and processes these to an even larger number (around 40) of different products. The total raw material intake over the period 1991-92 was around 90 000 tons per annum (t/a).

While the total annual production is approximately constant from year to year, the raw material intake is obviously seasonal due to the nature of the Industry. Depending also on a combination of various external factors (farming practice, market considerations, etc), the following types of variation in production therefore occur inter alia:

- Variation in total annual production (minor);

- Variation in the quantity of a particular raw material processed in any one year, and corresponding variation in the quantity of associated products (relatively minor);

- Variation on a weekly and monthly basis of the total factory production rate (major).

The first two types of variation in factory production rate are described as "minor" and "relatively minor" because their effect is generally limited unless extraordinary circumstances apply, for example crop failure or relocating/opening/closing/doubling of a particular process line (which does happen from time to time).

The last-named type of variation in factory production rate is defined as "major" because the effect is large and also because it is strongly characteristic of the Industry. Based on monthly production data over the period 1991-92 (Tables A1.1 and A1.2 in

Appendix), Table 3 summarizes relevant aspects of the monthly production pattern over two successive annual periods.

TABLE 3 PRODUCTION PATTERN AT SUIDER PAARL 1991-92						
YEAR	ANNUAL PRODUC-TION (t/a)	MONTHLY PRODUCTION (t/month)			TURNDOWN RATIOS	
		PEAK	MINIMUM	AVERAGE	PEAK: MIN	PEAK: AVE
1991	90 811	21 933	898	7 568	24,4	2,9
1992	94 233	20 055	892	7 853	22,5	2,6

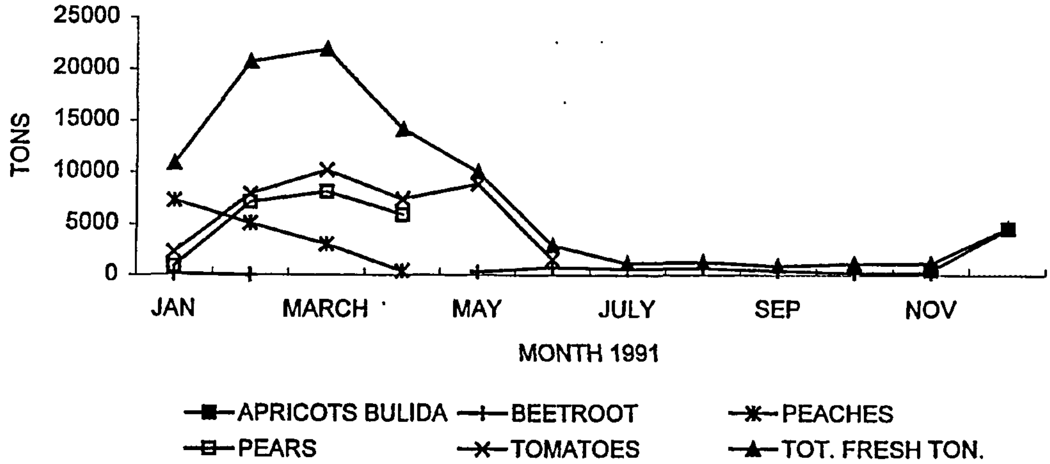
Figure 2 illustrates the total monthly processing at Suider Paarl over the period 1991-92, and also the monthly processing for the five major raw materials (mass basis) namely apricots, peaches, beetroot, pears and guavas. Figure 3 shows the % contribution of each of these raw materials in relation to the total monthly processing. For nine months of the year the combined contribution is around 95% or higher, the exception being in the months September - November when oranges, strawberries and sauerkraut contribute significantly.

The above considerations are presented to provide a background for the water surveys carried out on individual commodities, as described in the following sections. In particular, it is useful to note which of the commodities surveyed are "major" and which are "minor", and also when they are processed during the annual seasonal cycle. As discussed further in later sections of the report the question of "when the commodity is produced" has an important bearing on the relative water efficiency ascribed to it.

3.2 Objectives, Approach and Methodology for Commodity Water Surveys, Approach and Methodology for Commodity Water Surveys

For the five commodities listed previously, individual water survey were carried out to determine the efficiency with which water was used for processing and associated purposes. In each case the protocol, approach and methodology were as summarized below:

FIGURE 2 – TOTAL MONTHLY PROCESSING AT SUIDERPAARL 1991 – 1992



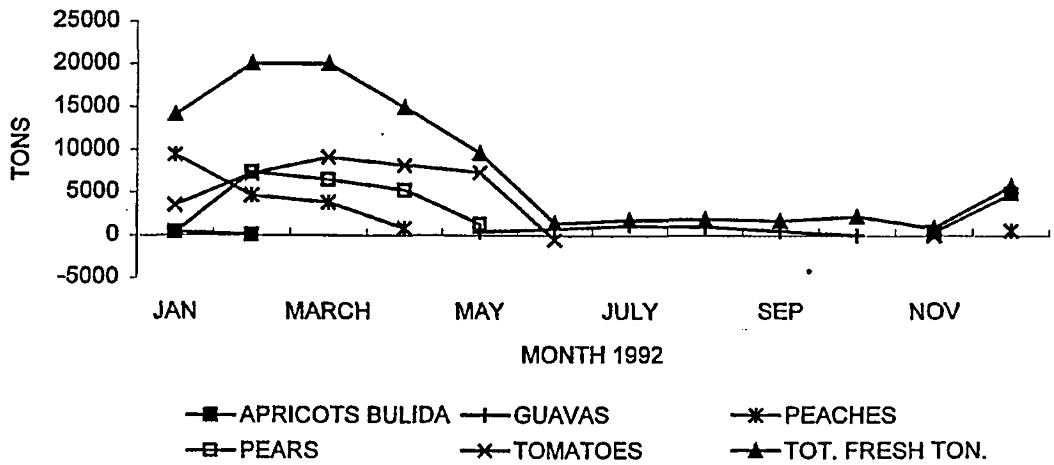
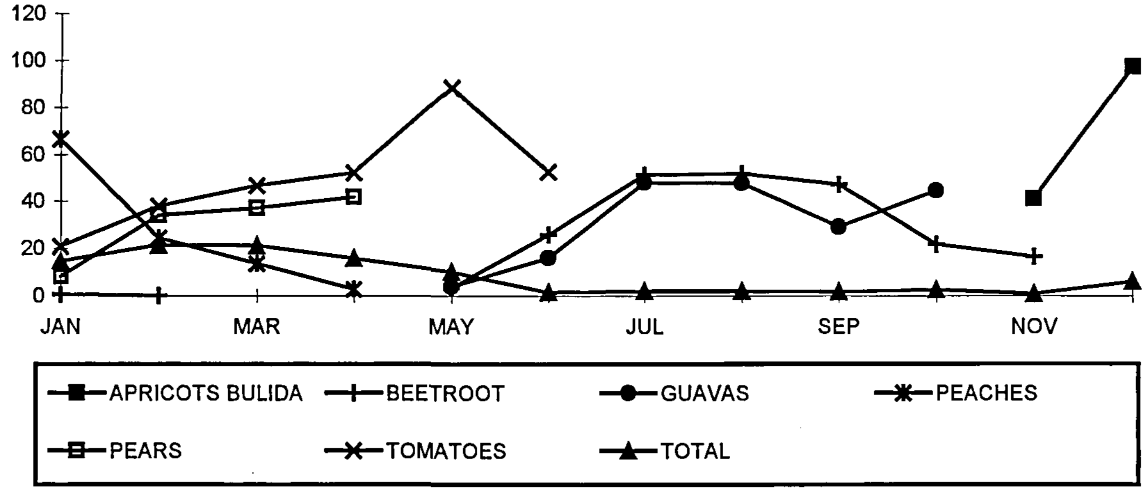
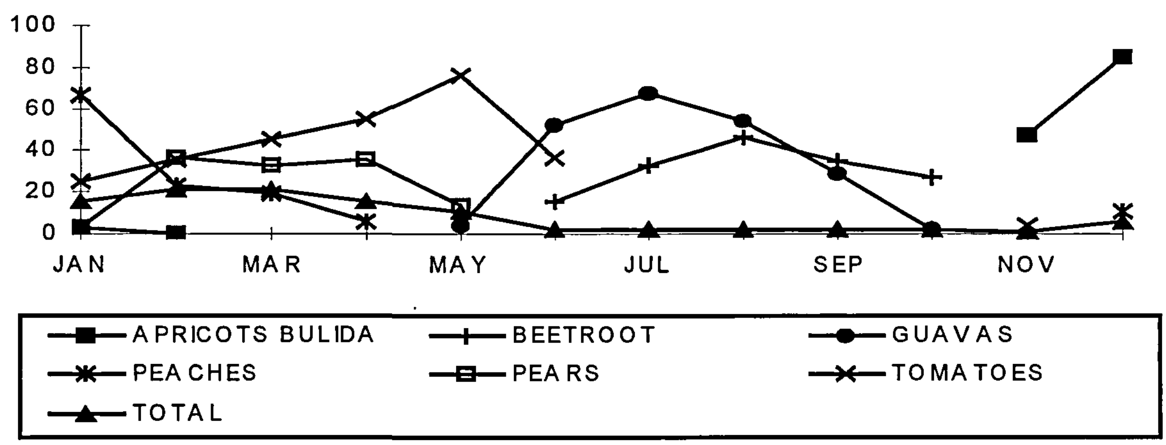


FIGURE 3 – CONTRIBUTIONS OF INDIVIDUAL RAW MATERIALS AT SUIDER PAARL 1991 - 1992





The commodity to be surveyed was selected on the basis of the considerations presented in Section 3.2.

- The processing steps involved were determined, physical points of water use were noted and the importance obtained was summarized in a process block diagram incorporating both process-related and water-related aspects.

- The water supply and reticulation to the various water-using steps of the process were surveyed and a set of water meters which would adequately monitor the processing water use was identified.

- The necessary water meters were installed and calibrated, using a combination of "permanent" and "individual" water meters as outlined in Section 2.3.

- A suitable "window" for each survey was identified, taking into account constraints by processing considerations (eg elimination of overlapping multi-product process scenarios).

- The surveys were carried out and the results obtained were compiled into a mini-survey report for each commodity studied, including for each survey, recommendations for improving routine on-going water monitoring, determining representative water-efficiency targets, and identifying specific water-saving measures that could be implemented (ie a water management system).

- It was originally envisaged that the latter steps above would be re-visited iteratively to review initial water management targets, the effect of water-saving measures and the suitability of the water management system developed. This process would culminate in the development of an expert system for water management based on target-monitoring in individual processing areas.

In practice, the last step in the above approach outline was superseded by considerations relating to the significance of overall factory production rate on the water management targets that were appropriate to particular commodities as they were processed in the annual seasonal production cycle. These considerations are presented in Section 5. The results obtained in the initial individual mini-surveys for the five products selected are summarized in Sections 3.4 - 3.8.

Dating back to 1979, research sponsored by the WRC in the fruit and vegetable processing industry has yielded a plethora of detailed data on the water used at individual water-using steps in the processing of a comprehensive range of the raw materials handled and commodities produced by the Industry. The results obtained, along with specific recommendations for optimizing water use' have been published previously by the WRC [1,2].

The strategic objective in conducting mini-surveys on a range of selected commodities at the Suider Paarl model factory was not to repeat such exercises but rather to establish with a reasonable degree of certainty whether the line-processing water uses at the factory (as measured by specific water use, SWU kl) were generally representative of the Industry ie. were not anomalous due to site-specific factors. Depending on the conclusions reached, all the water-related data obtained in the course of the project could then be confidently assessed with the aim of defining an appropriate expert system for improved water management in the Industry.

Accordingly, the mini-surveys carried out on individual commodities at the Suider Paarl factory were directed towards establishing broad-brush but yet intensive estimations of the processing water use for a range of commodities. The basis for selecting the individual commodities surveyed is outlined in Section 3.3 and the approach and methodology for each mini-survey is summarized below.

3.3 Commodities Surveyed

At different stages of the project, different commodities were targeted as candidates for carrying out intensive individual water use surveys. Two main considerations were applied in this selection process, namely:

- how the results to be achieved would benefit the strategic project objectives, which were re-defined actively during the course of the project site programme, and

- whether logistical factors such as water meter installation, availability of a suitable

- water survey "window" etc were sufficiently attractive to warrant carrying out an intensive water survey on the commodity being considered.

These deliberations during the course of the project have been fully documented in Progress Reports 1 (1992) and 2 (1993) as well as the Minutes of the various Technical Sub-Committee and Steering Committee meetings, and are not reproduced here. The commodities finally selected for carrying out individual water surveys were guavas, peas, cherries, apricots and peaches. It is relevant here to rank each commodity selected as either major/minor (based on mass % contribution to total production) and to note whether processing occurs during the high season or low season, as shown in Table 4.

TABLE 4 COMMODITIES SELECTED FOR INDIVIDUAL WATER SURVEYS

COMMODITY	% OF TOTAL ANNUAL REPRODUCTION		COMMODITY RANKING	SEASON
	1991	1992		
Apricots	5,69	6,85	Medium	High
Cherries	?	?	Minor	Low
Guavas	3,05	4,07	Medium	High
Peaches	17,29	20,52	Major	High
Peas	0	2,33	Medium	Low

NOTES:

1. **% of annual production as per Tables A1.3 and A1.4.**
2. **Commodity ranking based nominally on major > 10%, medium 1-5% and minor < 1% of total annual production.**
3. **Seasonal factor based nominally on high 10-100% and low < 10% of maximum monthly processing rate.**
4. **A new pea line was introduced into the factory in 1992.**

From Table 4, the commodities selected for individual water surveying cover a reasonable range in terms of their ranking (major/medium/minor) and seasonal distribution (high/low).

3.4 Apricots

The process block diagram for apricots is shown in Figure 4. The survey results obtained over the mini-survey period 24-26 November 1992 are summarized in Table 5. The water use data was derived by monitoring the permanent meters installed and the production data was obtained from Langeberg's factory records giving the raw material tonnage processed over each shift/day during the survey period.

TABLE 5 SURVEY OF WATER USE FOR APRICOT PROCESSING							
Survey Period (incl)		No. of shifts	Processing (tons)	Water used (kl)	SWU (kl)		
Start	Finish				Min	Max	Mean
24.11.92	26.11.92	5	357,2	1 842	5,2	5,2	5,2

3.5 Cherries

The process block diagram for cherries is shown in Figure 5. The survey results obtained over the mini-survey period 3 January to 29 March 1993 are summarized in Table 6. The water use data was derived by monitoring the individual water meter installed at the cherry processing area and the production data was obtained from Langeberg's factory records giving the raw material tonnage processed over each shift/day during the survey period.

TABLE 6 SURVEY OF WATER USE FOR CHERRY PROCESSING							
Survey period (incl)		No. of batches	Processing (tons)	Water used (kl)	SWU (kl)		
Start	Finish				Min	Max	Mean
3.1.93	29.3.93	155	372,9	8 203	18,8	24,4	22,0

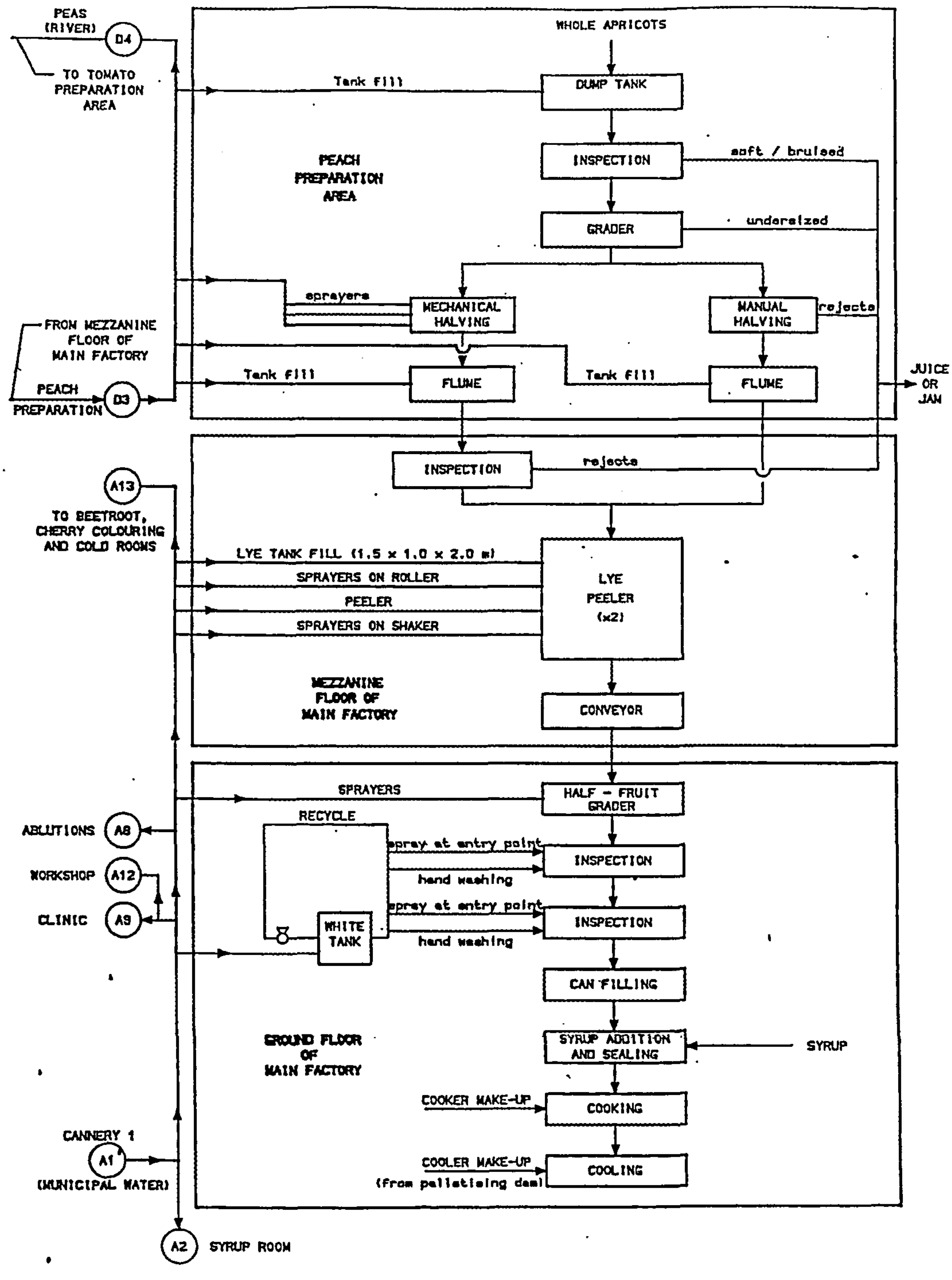
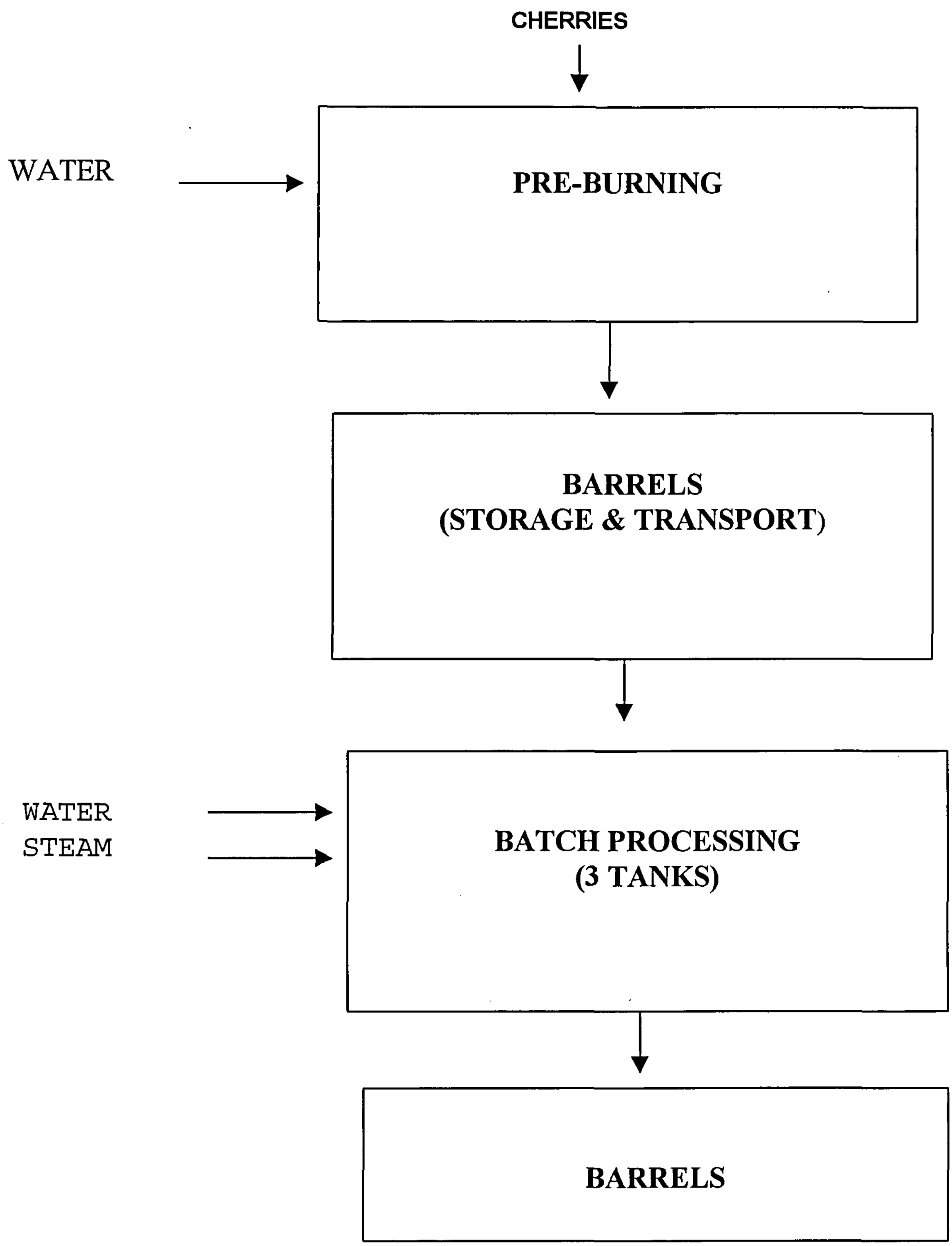


FIGURE 4 PROCESS BLOCK DIAGRAM FOR APRICOTS

FIGURE 5 – PROCESS BLOCK DIAGRAM FOR CHERRIES



3.6 Guavas

The process block diagram for guavas is shown in Figure 6. The survey results obtained over the mini-survey period 15-30 September 1992 are summarized in Table 7. The water use data was derived by monitoring the permanent meters installed and the production data was obtained from Langeberg's factory records giving the raw material tonnage processed over each shift/day during the survey period.

TABLE 7 SURVEY OF WATER USE FOR GUAVA PROCESSING							
Survey period (incl)		No. of shifts	Processing (tons)	Water used (kl)	SWU (kl)		
Start	Finish				Min	Max	Mean
15.9.92	30.9.92	10	214,9	9 733	33,2	62,9	45,3

3.7 Peaches

The process block diagram for peaches is shown in Figure 7. The survey results obtained over the mini-survey period 28 December 1992 to 22 January 1993 are summarized in Table 8. The water use data was derived by monitoring the permanent meters installed and the production data was obtained from Langeberg's factory records giving the raw material tonnage processed over each shift/day during the survey period.

TABLE 8 SURVEY OF WATER USE FOR PEACH PROCESSING							
Survey period (incl)		No. of shifts	Processing (tons)	Water used (kl)	SWU (kl)		
Start	Finish				Min	Max	Mean
28.12.92	22.1.93	34	6 674,5	37377	3,4	7,8	5,6

FIGURE 6 – PROCESS BLOCK DIAGRAM FOR GUAVAS

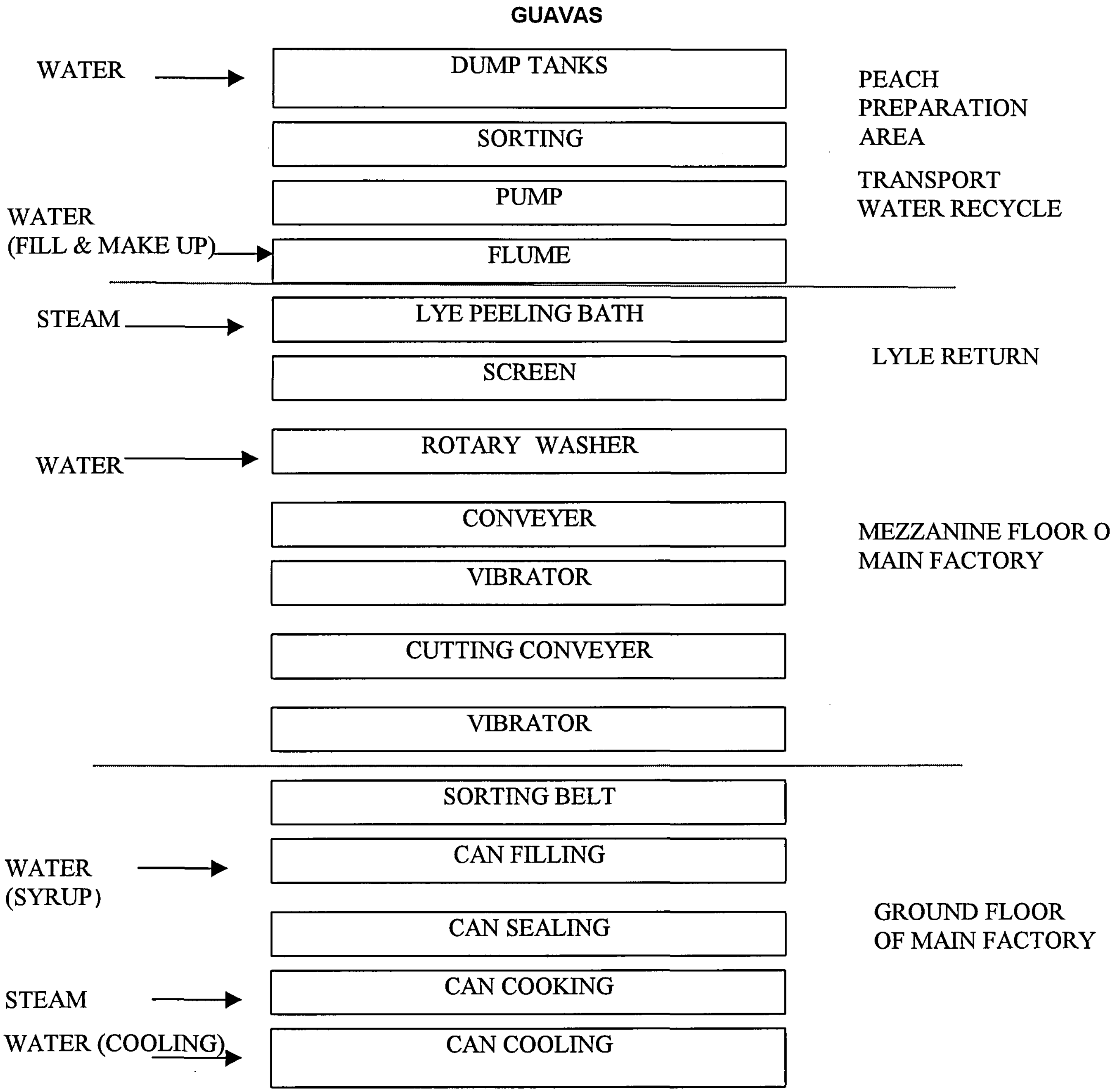


FIGURE 7 – PROCESS BLOCK DIAGRAM FOR PEACHES

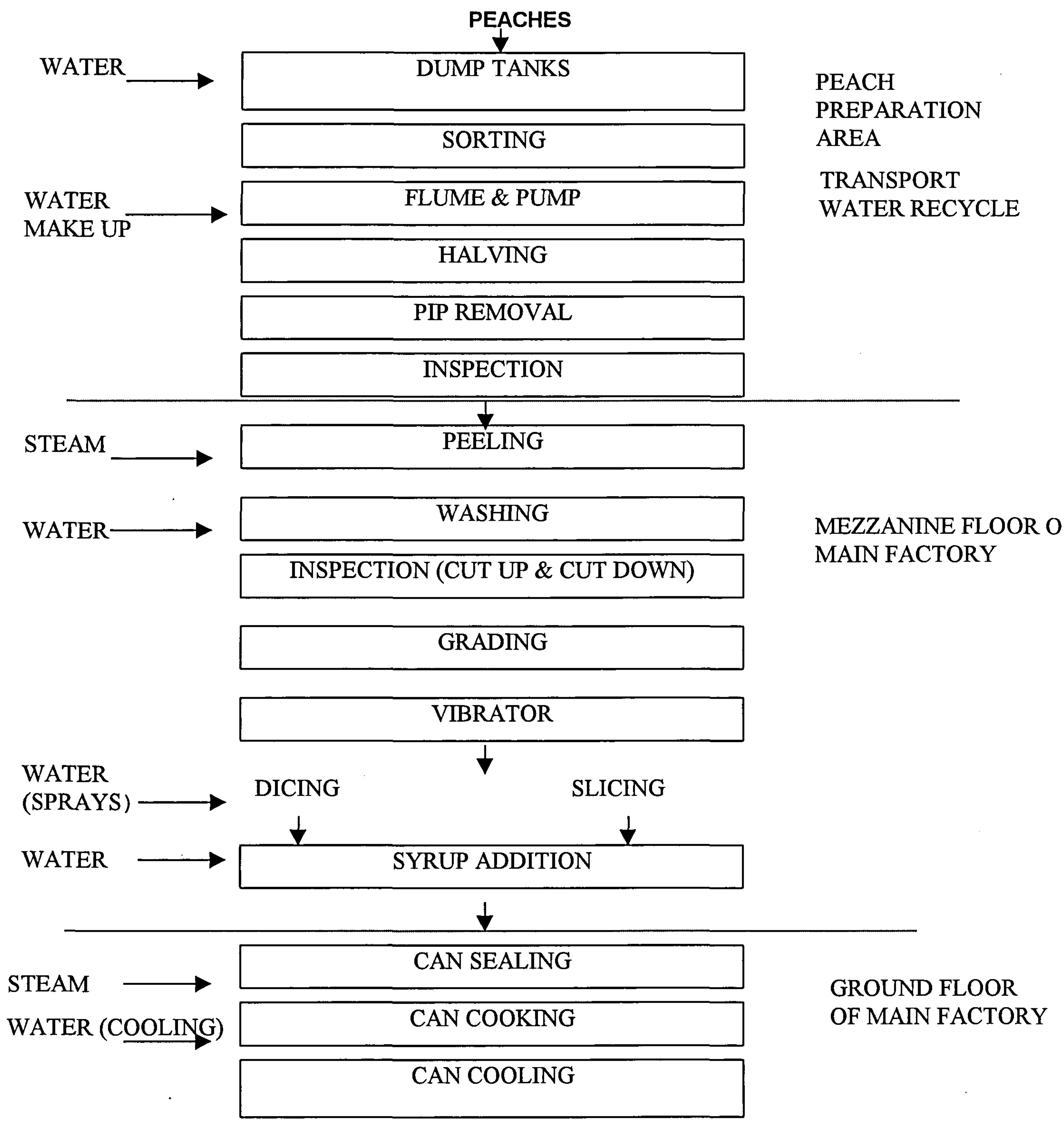
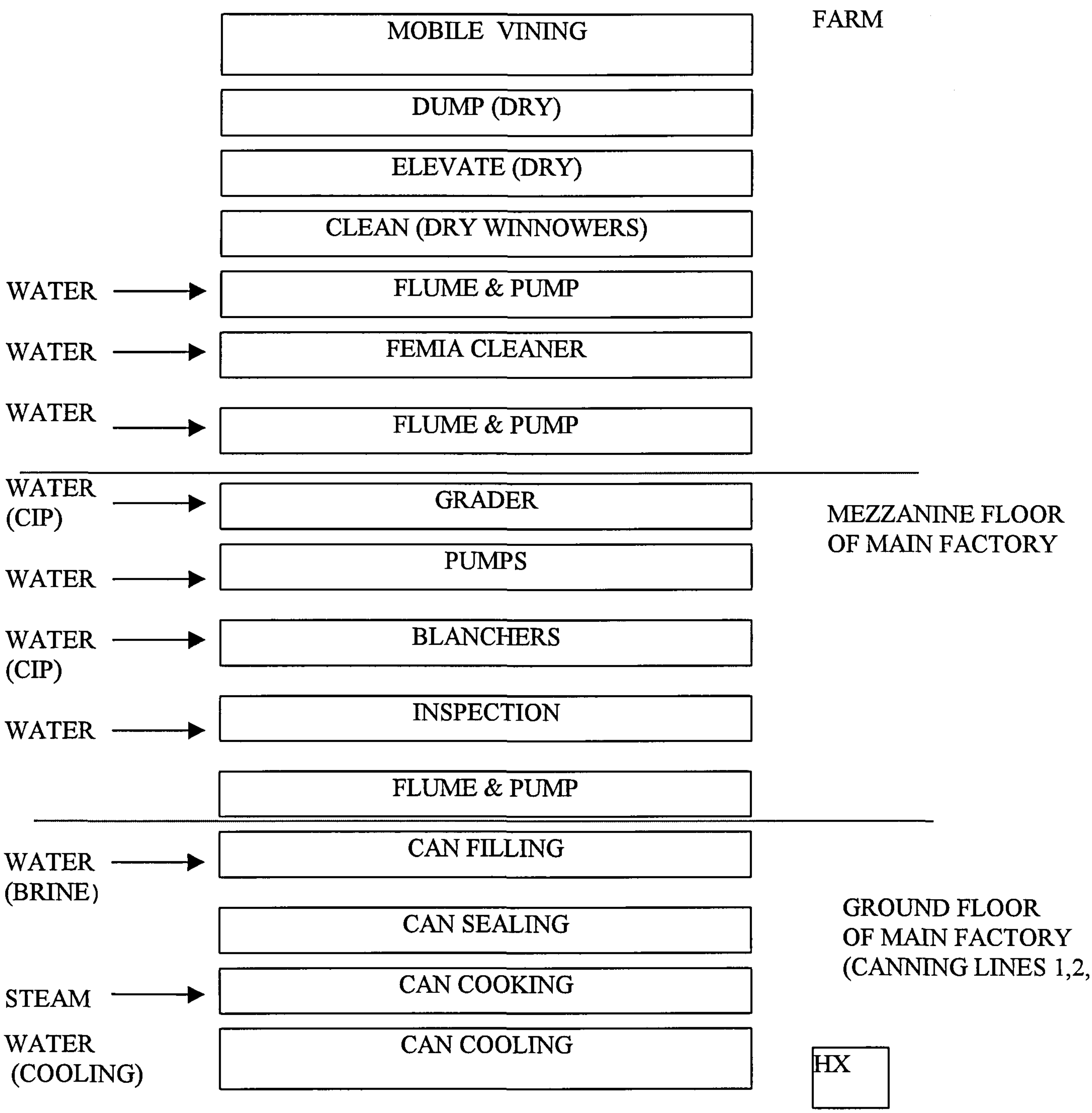


FIGURE 8 – PROCESS BLOCK DIAGRAM FOR PEAS



3.8 Peas

The process block diagram for peas is shown in Figure 8. The survey results obtained over the mini-survey period 21 September to 6 October 1992 are summarized in Table 9. The water use data was derived by monitoring a combination of permanent and individual meters and the production data was obtained from Langeberg's factory records giving the raw material tonnage processed over each shift/day during the survey period.

TABLE 9 SURVEY OF WATER USE FOR PEA PROCESSING

Survey period (incl)		No. of shifts	Processing (tons)	Water used (kl)	SWU (kl)		
Start	Finish				Min	Max	Mean
21.9.92	6.10.92	30	954,2	22 496	18,1	37,7	23,6

NB Water use includes some beetroot processing and other activities (meter no. A11 not installed at time of survey)

3.9 Conclusions

The water surveys carried out on individual commodities showed the following:

- *the system of water meters installed at the time of the surveys was not in all cases* adequate for deriving a clear and simple water use associated with a particular processing period for the particular product or process step being considered;
- the SWU-values for most of the commodity processing operations studied were found to vary widely at different times, depending inter alia on production rate but with no unvarying relationship;

- the SWU-values were also found to vary widely between different commodities, even where processing was to some extent similar or common (for example apricot and peach preparation);

- from the results obtained, the trends in SWU displayed at the Suider Paarl factory are broadly representative of the trends in the Industry, confirming that the water-related features can reasonably be expected to be validly extrapolated to other factories.

The factors that affect SWU at the line or operational level are discussed in the following section and the effect of factories' production rate on the overall efficiency of water use is discussed in Section 5.

4 SPECIFIC WATER USE (SWU) FOR INDIVIDUAL COMMODITIES

4.1 Definition

The specific water use (SWU) for processing of individual commodities is defined here as the volume of water (in kl) required to process one ton (t) of the raw material concerned.

An alternative basis is to convert material masses into equivalent "basic cartons" of 20,41 kg each. This approach however requires that the "minimum drained mass" (either as a mass or as a percentage) for each type of commodity be incorporated in order to make valid comparisons between basic cartons of different commodities. The relevant conversion factors for the various commodities have been given in the Final Report on WRC Project No. K8/56 (Volumes 1 and 2, September 1991).

Accordingly, SWU is in this report generally based on raw material intake, ie. units of kl. For illustration, some results are also presented based on production, ie.

- units of kl/basic carton.

The trends displayed are generally similar, but the proviso above should be noted - when using basic cartons as a quantitative measure, compare apples with apples!

4.2 Results obtained

The results obtained from on-site surveying of five test commodities at Suider Paarl are summarized in Table 10.

TABLE 10 SWU - VALUES OF COMMODITIES SURVEYED			
Commodity	SWU (kl) range		
	Min	Max	Mean
Apricots	5,2	5,2	5,2
Cherries	18,8	24,4	22,0
Guavas	33,2	62,9	45,3
Peaches	3,4	7,8	5,6
Peas	18,1	37,7	23,6

There is a startling range in the mean SWU-values for different commodities, with (for example) apricot and peach processing appearing to be around 4 x more water-efficient than guava processing.

To ensure that the data sets obtained are not anomalous, comparison with other data is made in the following section.

4.3 Comparison with Other Data

The SWU-ranges measured in the course of the project at the Suider Paarl model factory are compared in Table II with data from other sources [1,2,9].

TABLE 11 COMPARISON OF MEASURED SWU-RANGES WITH OTHER DATA

Commodity	SWU (kl) RANGE AND MEAN					
	1979-84		1987-88		1992-93	
	Range	Mean	Range	Mean	Range	Mean
Apricots	2,5-14,5	5,5	2,3-50,3	9,9	5,2- 5,2	5,2
Cherries	N.D.	N.D.	N.D.	N.D.	18,8-24,4	22,0
Guavas	4,0-10,0	6,4	16,9-181,9	53,1	33,2-62,9	45,3
Peaches	2,5-11,5	5,5	4,4-14,1	10,0	3,4- 7,8	5,6
Peas	19,0 25,0	22,0	7,5-48,9	22,1	18,1-37,7	23,6

The SWU data presented in Table 11 reflect both commodity-specific and factory - specific effects. The factors that affect SWU are outlined in the following section.

4.4 Factors Affecting SWU

A number of different kinds of factors affect the water-efficiency (for example SWU) with which a particular processing operation is carried out. These factors have been discussed in detail elsewhere [1,8,9] and are not repeated here.

The significant observation to be made is that the observed differences in SWU between different commodities are so large and so startling that reasons need to be sought and established before setting apparently meaningful targets or water management procedures.

4.5 Conclusions

- Each processing sequence or line is a water-use centre, with implications both for water efficiency and cost.

- Effective water management should be aimed at initially establishing representative SWU target-ranges and then seeking to control water use to the appropriate target range.

- The SWU target-range for a particular commodity may be dependent on production rate, and should be set accordingly.

- The water use associated with processing may include (for example) washdown of a particular process area and equipment, irrespective of the production that has been accomplished over a shift or batch run. Again, the SWU target-range should take cognisance of such factors.

4.6 Recommendations

- The survey work carried out at the Suider Paarl model factory has achieved the initial stage of target-setting in the protocol outlined in Section 2.5. Langeberg Suider Paarl could beneficially adapt their water metering, monitoring, recording and data analysis systems in accordance with this protocol.

- Langeberg Suider Paarl should in any event continue with on-site monitoring and defining of the specific water use factors for the various commodities produced at the factory.

5 EFFECT OF FACTORY PRODUCTION ON WATER USE EFFICIENCY

5.1 Introduction

The overall project objective is to progress towards improved water management in the Industry. The overall approach adopted was to develop an expert system which could be implemented meaningfully, rather than simply deriving a series of relatively ad hoc measures for reducing water use, which would to some extent always be site-specific and not necessarily be exportable to other situations or even sustainable at the model factory.

It was envisaged at an early stage that specific water intake (SWI) would be a useful basis for relating water use (or intake) to production. Simultaneously, it was anticipated that measured and target SWI-values would be affected by production rate, primarily on a line-specific (eg tons/hour) basis but also in relation to an overall - factory (eg tons/month) basis. It was originally assumed that line-specific effects would dominate, and that strategic improvements in water management would therefore be achieved mainly by controlling process water use in relation to specific line-processing throughput rate.

From previous experience, these considerations provide useful tools for successful water management in many situations. They remain valid since the total water for production purposes (including direct processing water use and also associated services such as boilers and cooling facilities) is by definition the sum of individual water intakes for each product/line/process.

In the course of the project it became apparent that in the multi-commodity and highly seasonal F & V Industry, the comparisons made between the relative water-efficiencies (eg SWI-values) ascribed to various products/lines/processes were less valid when considered in the context of overall factory activity, including annual seasonality. In other words, comparison of SWI-values for individual commodities should take account not only of the specific commodity processing rate (eg instantaneous line throughput rate, t/h) but also **when** the commodity is being produced in the overall seasonal processing cycle.

In order to explore further these production-related effects on water use efficiency, the project scope was complemented by a second initiative. Briefly, it was decided to place greater emphasis on characterizing the overall production background against which the commodity-specific water surveys and target monitoring studies (Sections 2,3, and 4) had been carried out. The initial assumptions made regarding the prioritization of line-specific production rate as a major factor affecting water use efficiency were therefore re-questioned, and an enhanced (potentially equal or even greater) significance was given to overall factory production rate.

5.2 Approach and Methodology

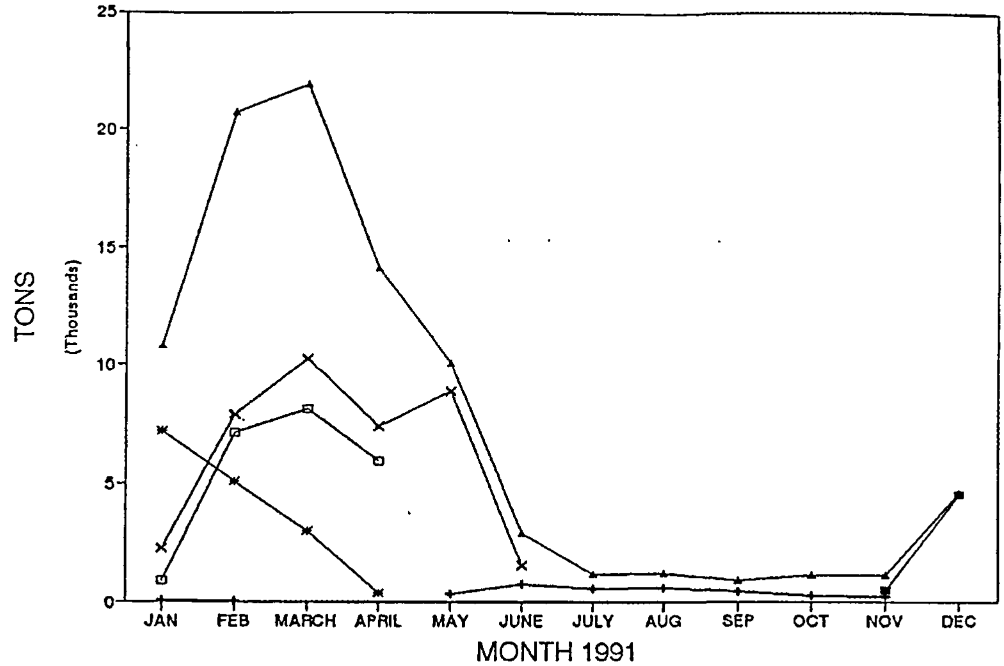
The research protocol selected to explore this second initiative arising out of the project was to view the whole model factory at Suider Paarl effectively as a single large processing unit ie. water use centre. A monthly basis was selected as an appropriate sampling rate, and information was obtained for a two-year period (1991-92) on overall water intake (kl/month), overall processing rate (raw materials intake as fresh tonnage, t/month) and overall production rate (commodities produced, basic cartons/month).

To enhance the analysis and thus enhance also the validity of the conclusions drawn, a second model factory (Langeberg Ashton) was selected and an equivalent data set (same information over the same period as above) was acquired and analysed. The second model factory was selected on the basis that the data required was available but also that it was both reasonably similar (same Industry, same group, comparable size, comparable number and range of products, etc) and at the same time sufficiently different (different commodities, different water use practices, different water management structure, etc) for comparisons to be meaningful.

The data sets and calculations for the two model factories are presented in Tables A1.1 - A1.8 (Suider Paarl) and Tables A2.1 - A2.8 (Ashton) in the Appendix. The results obtained and the conclusions reached are summarized in the following Sections 5.3 - 5.8.

5.3 Monthly Processing of Raw Materials Over Annual Cycles 1991-92

Figures 9 and 10 respectively illustrate the main features of the monthly processing activities at Suider Paarl and Ashton over the period 1991-92. In each case the total fresh tonnage processed monthly is shown, along with the quantities and seasonal (monthly) distribution of the five largest raw materials processed at each factory on an annual throughput basis. In each case, the five major raw materials displayed in Figures 9 and 10 constitute more than 90% of the total raw material intake to the factory concerned, as summarized in Table 12 below.



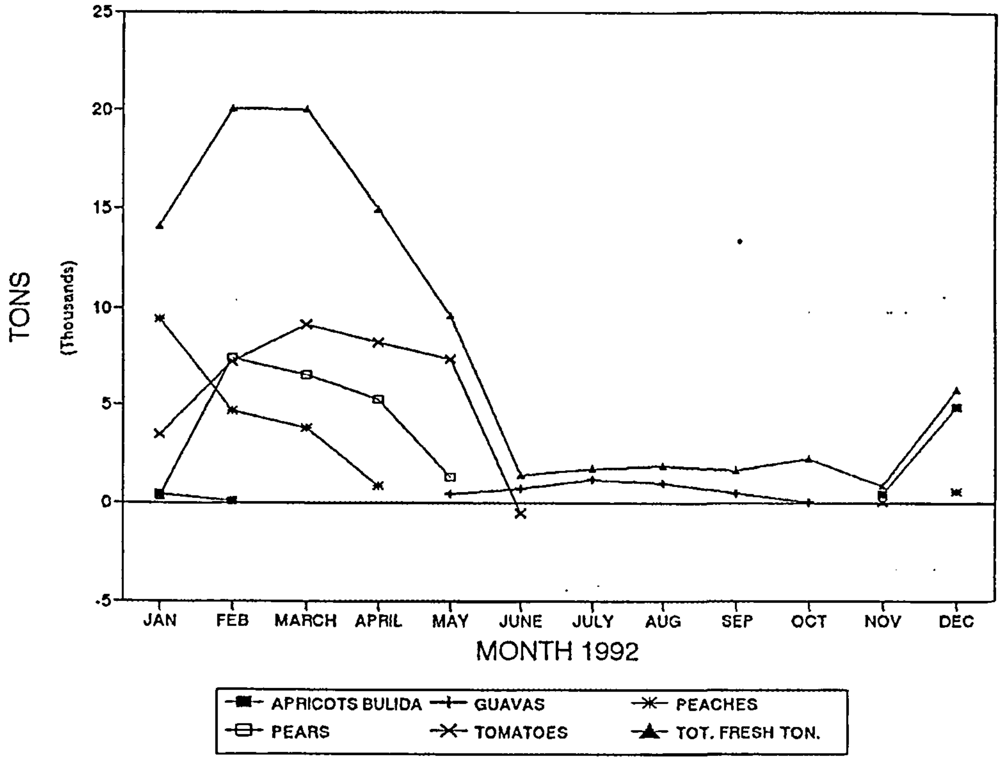


FIGURE 9: MONTHLY PROCESSING (FRESH TONNAGE) SUIDER PAARL 1991-92 : TOTAL PROCESSING AND FIVE MAJOR RAW MATERIALS

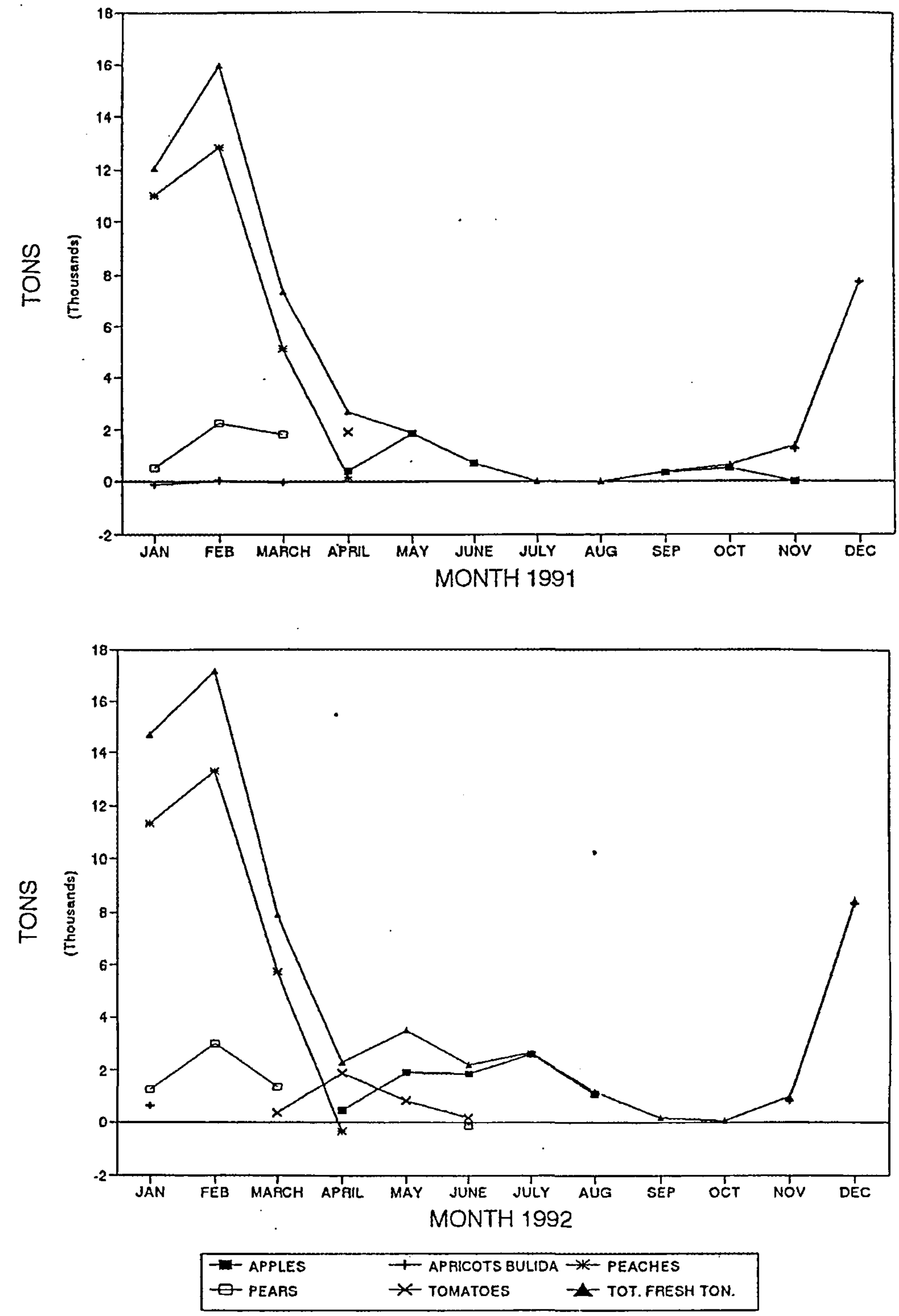


FIGURE 10: MONTHLY PROCESSING (FRESH TONNAGE) ASHTON 1991-92 : TOTAL PROCESSING AND FIVE MAJOR RAW MATERIALS

TABLE 12 MAJOR RAW MATERIALS PROCESSED 1991-92				
	% OF TOTAL ANNUAL THROUGHPUT AND RANK []			
RAW MATERIAL	SUIDER PAARL		ASHTON	
	1991	1992	1991	1992
Tomatoes	42,0 [1]	37,0 [1]	3,8 [5]	5,4 [5]
Pears	24,2 [2]	22,1 [2]	9,0 [3]	9,0 [4]
Peaches	17,3 [3]	20,5 [3]	57,3 [1]	49,0 [1]
Apricots	5,5 [4]	6,2 [4]	17,5 [2]	16,1 [2]
Guavas	3,1 [5]	4,1 [5]	0 [-]	0 [-]
Apples	0,1 [15]	0,3 [15]	7,5 [4]	12,9 [3]
Total throughput (t)	90 811	94 233	50 784	61 170

From Figures 9 & 10 and Table 12, the following are noteworthy:

- Total monthly processing (t/month) rises to an annual maximum in the period February - March (peak of high season) and falls to much lower levels over the period January - November (low season). The turndown ratio between peak: low is >20:1 at Suider Paarl and even higher (>40:1) at Ashton.

- This annual seasonal pattern is displayed consistently at the two factories over the two annual cycles considered, even though the individual raw material rankings at each factory are not the same (Table 12).

- Selecting the five major raw materials on an annual throughput basis does not mean that one or more of the five necessarily predominate in each month or that their monthly rankings remain the same in each month.

For example (ref Table A1.3 and A1.4), at Suider Paarl beetroot processing constitutes a large proportion (32-52%) of the overall processing in the months July, August and September, but constitutes only around 3% of the total annual raw material throughput at the factory. Similarly, the monthly rankings of the five major annual raw materials change from month to month.

The considerations presented above indicate strongly that it is useful to view each factory as a single processing unit with a variable mix of raw material inputs over an annual cycle.

This conclusion is borne out by the remarkably similar seasonal pattern displayed in each case examined, despite the fact that the ranked raw material mix is different at the two factories and moreover changes from month to month at each factory.

5.4 Monthly Production Over Annual Cycles 1991-92

To examine whether the fate of raw materials, ie. the commodities produced, significantly affect the picture and conclusions drawn in Section 5.3, the product output from the two model factories were also examined on the same basis. The main features of the monthly production activities at Suider Paarl and Ashton over the period 1991-92 are illustrated respectively in Figures 11 and 12.

The observations made in Section 5.3 with regard to processing (raw materials, fresh tons/month) apply equally to production (commodities produced, basic cartons/month) - only the details are different, and no further insight is gained at this stage by entering into these details.

One further comment on the production patterns at the two model factories is that the annual low season at Suider Paarl (June - November) is not as low (relatively) as at Ashton. This is seen when comparing Figure 11 to Figure 12 (also, to an extent, Figure 9 to Figure 10). At Suider Paarl "other" commodities, in particular beetroot and guavas, are processed in the low season thereby utilizing factory capacity during this period. At Ashton the only significant commodity in the low season is apples (ref Tables A2.3 and A2.4) and the factory in fact shut down its processing activities completely over July - August 1991.

Annual maintenance and refurbishment is carried out at both factories during the low season. Assuming these requirements are similar, the differences between the two factories in this respect are not understood. Apart from technical considerations, there is also obviously a local social impact in the pattern of deploying seasonal labour. Such considerations could be considered as a valid aspect of a broadly viewed water management system.

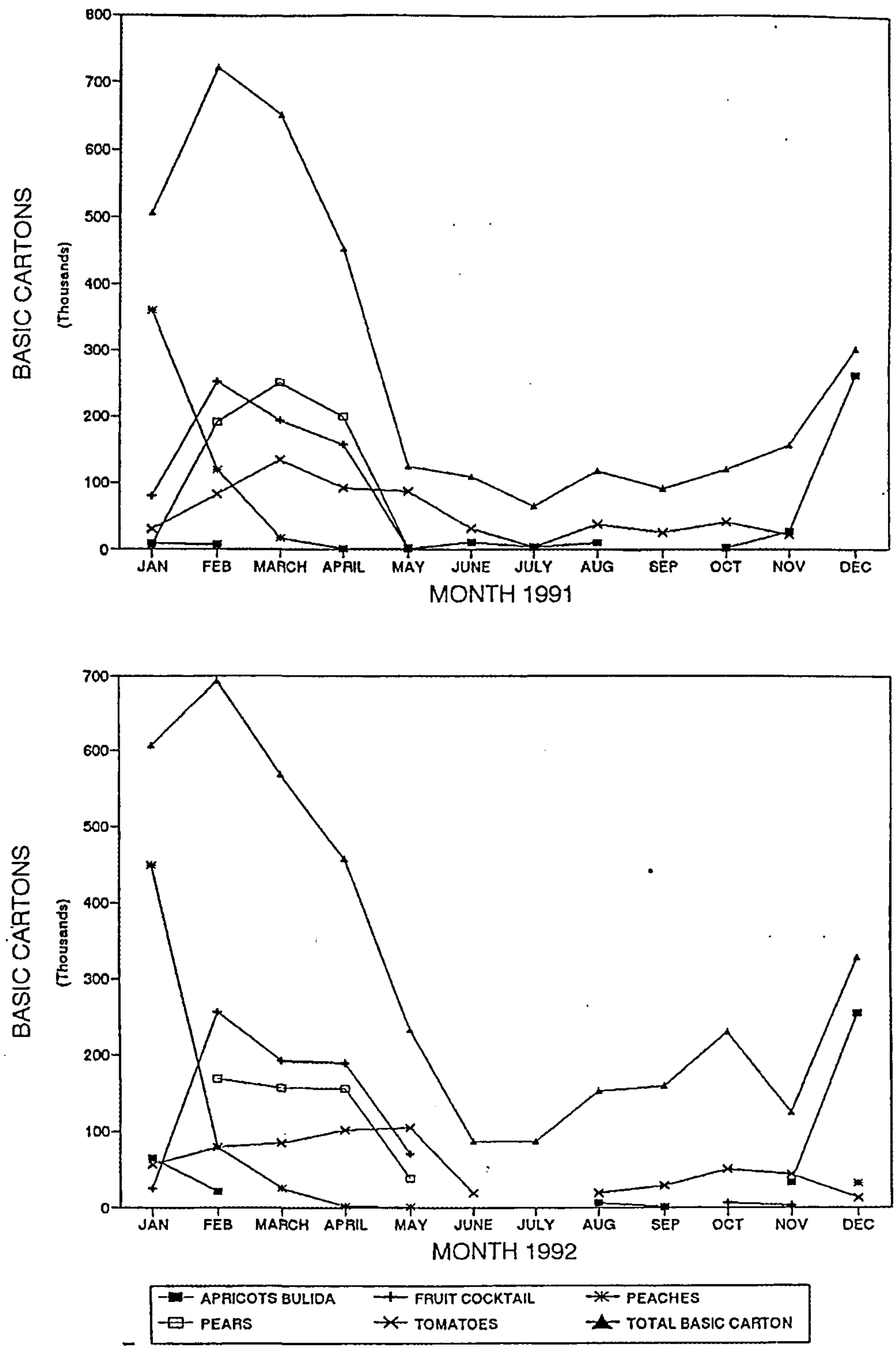


FIGURE 11: MONTHLY PRODUCTION (BASIC CARTONS) SUIDER PAARL 1991-92 : TOTAL PRODUCTION AND FIVE MAJOR COMMODITIES

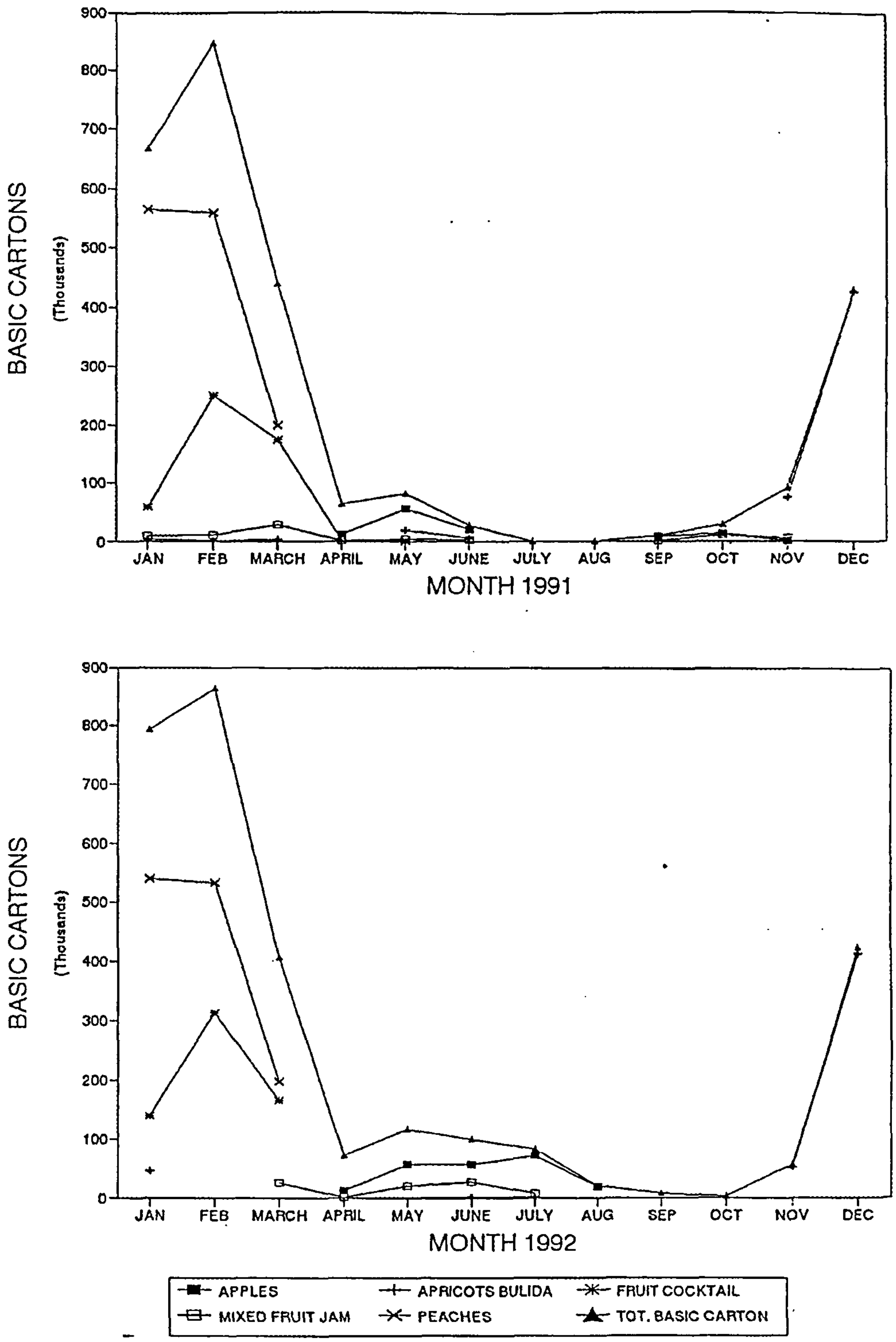


FIGURE 12: MONTHLY PRODUCTION (BASIC CARTONS) ASHTON 1991-92 : TOTAL PRODUCTION AND FIVE MAJOR COMMODITIES

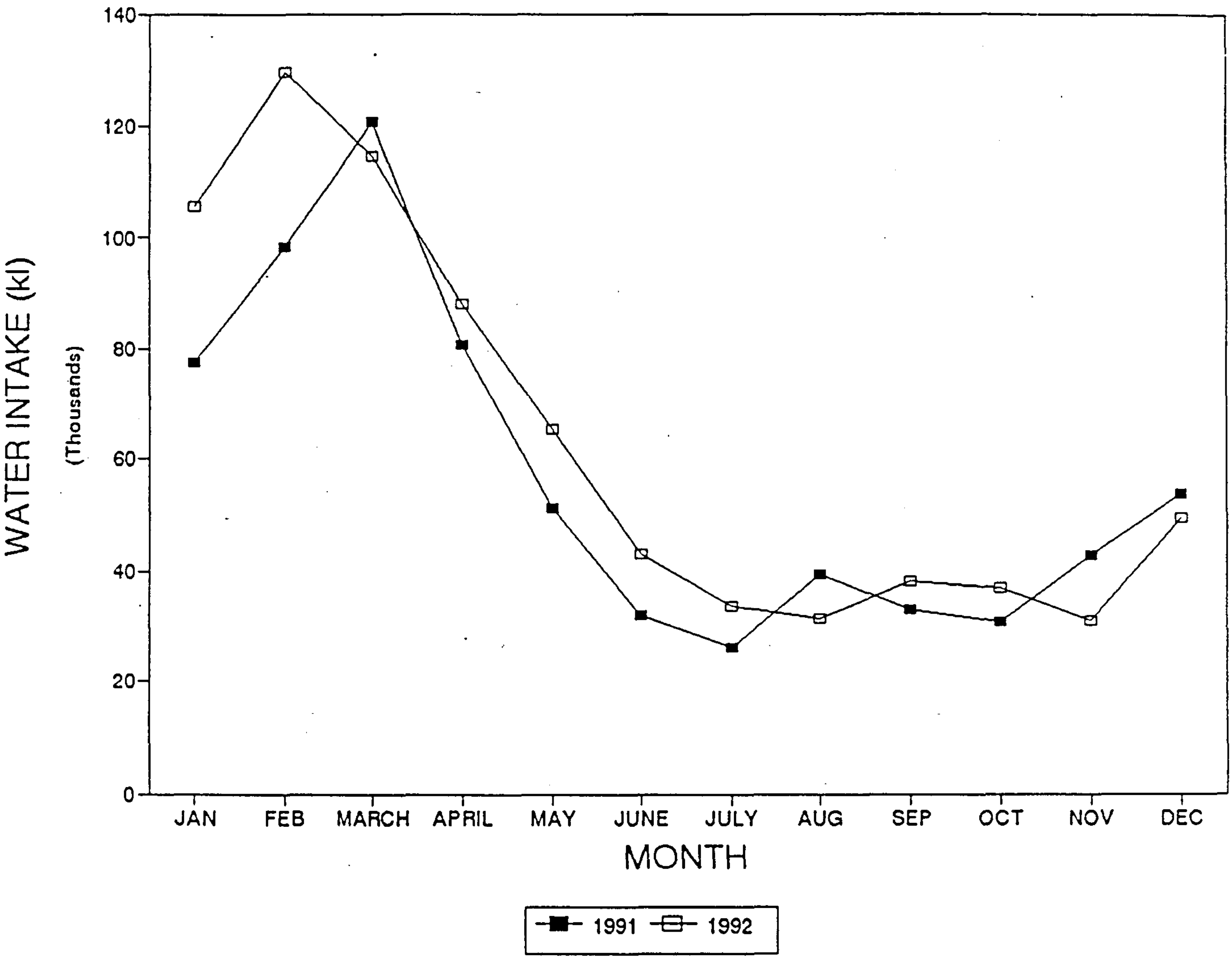


FIGURE 13: MONTHLY WATER INTAKE SUIDER PAARL 1991-92

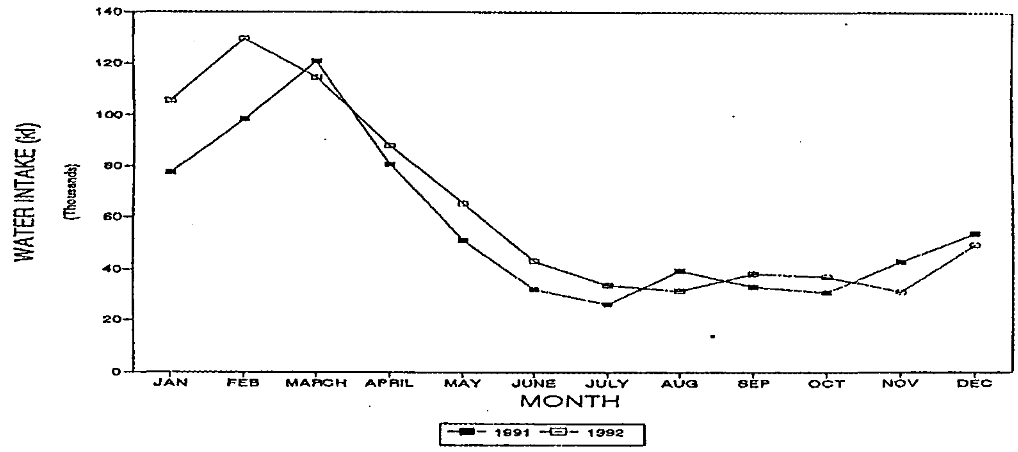


FIGURE 13: MONTHLY WATER INTAKE SUIDER PAARL 1991-92

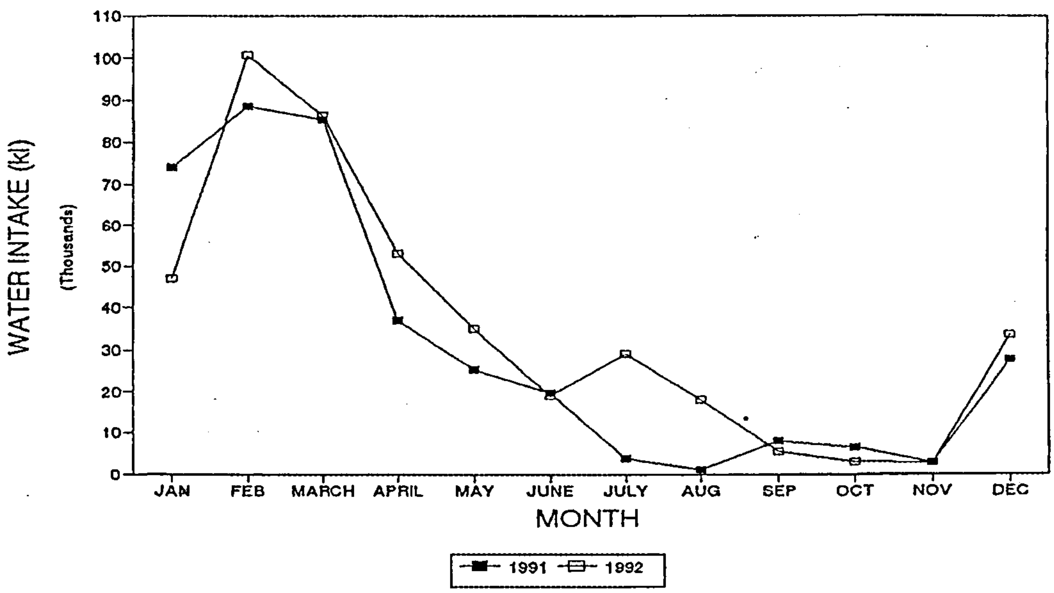


FIGURE 14: MONTHLY WATER INTAKE ASHTON 1991-92

5.5 Monthly water intake over annual cycles 1991-92

The monthly water intakes (kl/month) to the two model factories over the period 1991-92 are shown respectively in Figure 13 (Suider Paarl) and Figure 14 (Ashton).

As expected, there is a broad similarity in the annual seasonal patterns of monthly water intake (Figures 13-14), monthly processing (Figures 9-10) and monthly production (Figures 11-12). The differences noted in the low season activities at the two factories are apparent also with regard to water intake, where the water intake at Ashton drops to relatively much lower levels (albeit not zero) during the low/closed season months (July - November).

The seasonal trends displayed in terms of processing, production and water intake at the two model factories are superficially so consistent that it is tempting to stop the analysis of the relationships between these at this point and conclude (incorrectly) that "water intake is directly related or even approximately proportional to processing and production rate". Before proceeding further with the analysis it is instructive to note the various peak: mean: minimum ratios in the data sets examined (Tables A1.1-A2.8), as summarized in Table 13 below.

TABLE 13 PEAK: MEAN: MINIMUM RATIOS AT TWO MODEL FACTORIES

Determined	Suider Paarl				Ashton			
	Peak:Mean		Peak:Min		Peak:Mean		Peak:Min	
	1991	1992	1991	1992	1991	1992	1991	1992
Processing (t/month)	2,9	2,6	24,4	22,5	3,8	3,4	-	231,6
Production (BC/month)	2,5	2,2	11,3	8,0	3,8	3,5	-	404,4
Water intake (kl/month)	2,1	2,0	4,6	4,2	2,8	2,8	77,7	36,9

By inspection of Table 13, the following are noted:

- The turndown ratios for the three determinants selected are not identical, indicating that water efficiency is not constant throughout the year ie. is different at different points of the annual seasonal processing and production cycles.

- Comparable ratios at Ashton are in all cases higher than the corresponding ratios at Suider Paarl, indicating that the seasonality at Ashton is greater (NB values of - reflect zero processing and zero production in 1991 low season at Ashton).

5.6 Monthly SWI Over Annual Cycles 1991-92

Specific water intake (SWI) has been commonly used as a quantitative correlation between water intake and processing or production (ref WRC NATSURV series of Industry Guides). SWI values are thus a measure of water efficiency, commonly used to derive appropriate target ranges for improved water management.

Figures 15 and 16 respectively show the monthly SWI values (kl/t) for Suider Paarl and Ashton based on monthly water intake (kl/month) and monthly processing (fresh tonnage/month) over the period 1991-92.

In each case there is a generally clear pattern (albeit with significant data scatter, particularly in the case of Ashton) of relatively low SWI-values during the high season months (Dec, Jan, Feb, March) and relatively high SWI-values during the low season months (June-November), with intermediate values in between. The approximate ranges are summarized in Table 14 below.

TABLE 14 SEASONAL SWI-VALUES (KL/T) AT TWO MODEL FACTORIES 1991-92		
Season	Monthly SWI-range (kl/t)	
	Suider Paarl	Ashton
High	4,8 - 7,5	3,2 - 11,7
Low	22,8 - 34,7	15,6 - 30,8
Average	7,6 - 8,2	7,1 - 7,5

FIGURE 15 – MONTHLY SPECIFIC WATER INTAKE, SUIDER PAARL 1991-92:
(SWI AS KL/TON BASED ON FRESH TONNAGE)

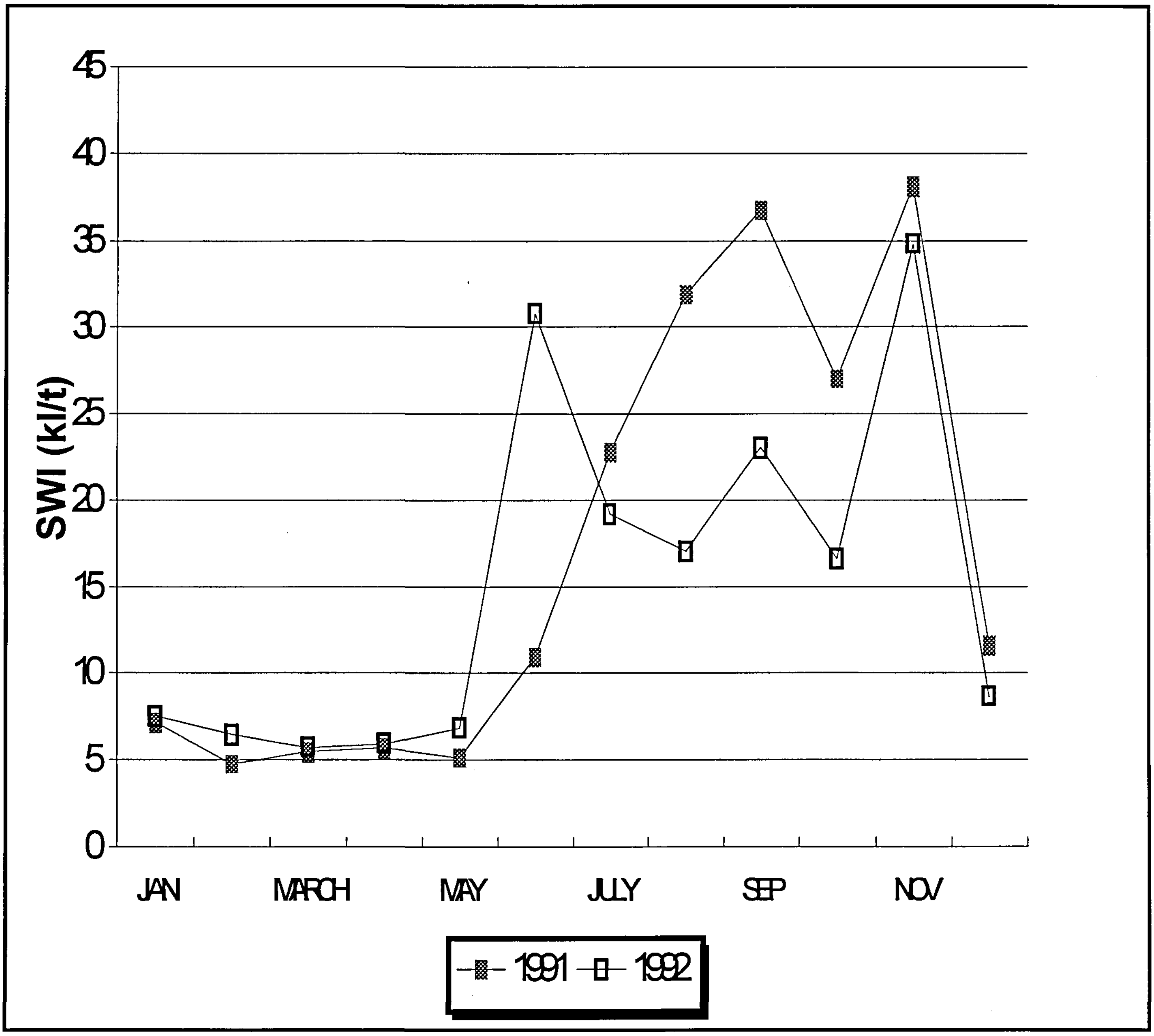
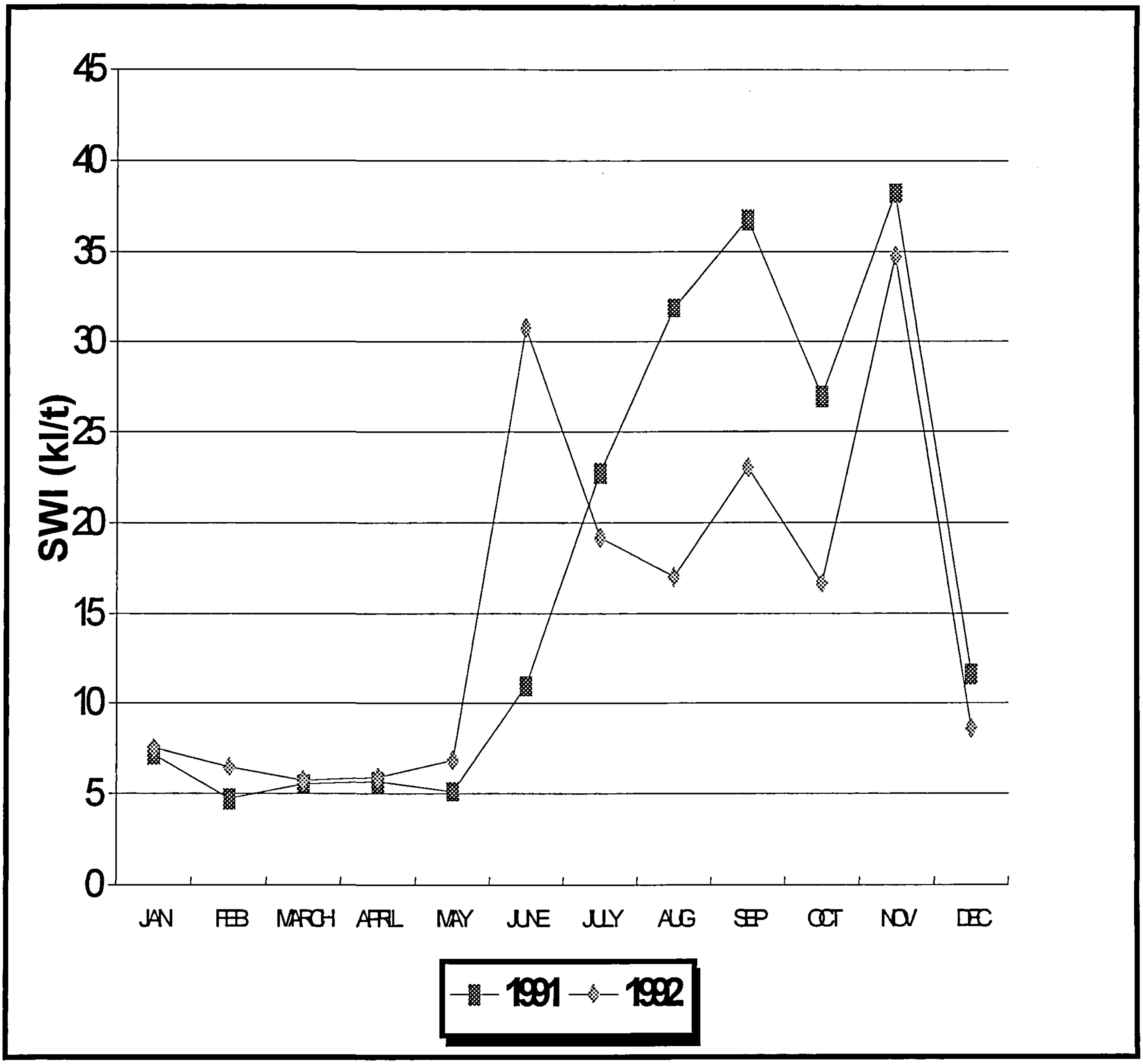


FIGURE 16 – MONTHLY SPECIFIC WATER INTAKE, ASHTON 1991-92: (SWI AS KL/TON BASED ON FRESH TONNAGE)



From Table 14, the average SWI-values at the two factories are in the same range, around 7-8 kl/t. What is significant however is that the monthly SWI-values range from < 5 kl/t to >20kl/t at each factory over the course of the annual processing cycle.

From Figures 15 and 16, and also Table 14, the obvious major conclusion drawn is that water efficiency in the model factories (as measured by their monthly SWI- values) is strongly seasonal. Because of the nature of the Industry, different raw materials and products are handled at different times of the year and via different processing sequences.

Figures 17 and 18 respectively show the monthly SWI-values (kl/basic carton) for Suider Paarl and Ashton based on monthly water intake (kl/month) and monthly production (basic cartons/month). There are interesting differences between these production-based graphs and the data plotted in Figures 15 and 16 on a processing basis, including:

- there are significant differences from year to year in the water efficiency of the factories (as measured by monthly SWI-values);

- on a percentage basis there is greater variation from year to year in the SWI-values over the low season than in the high season;

- the peaks and troughs in SWI-values for the same factory do not coincide consistently when comparing the processing-basis with the production-basis, indicating differing efficiencies of water use in different situations.

It has previously been tacitly assumed that representative SWI-ranges for different commodities are dominated by product-specific factors. In the following sections, the impact of overall processing activity on water intake and SWI-values is explored further.

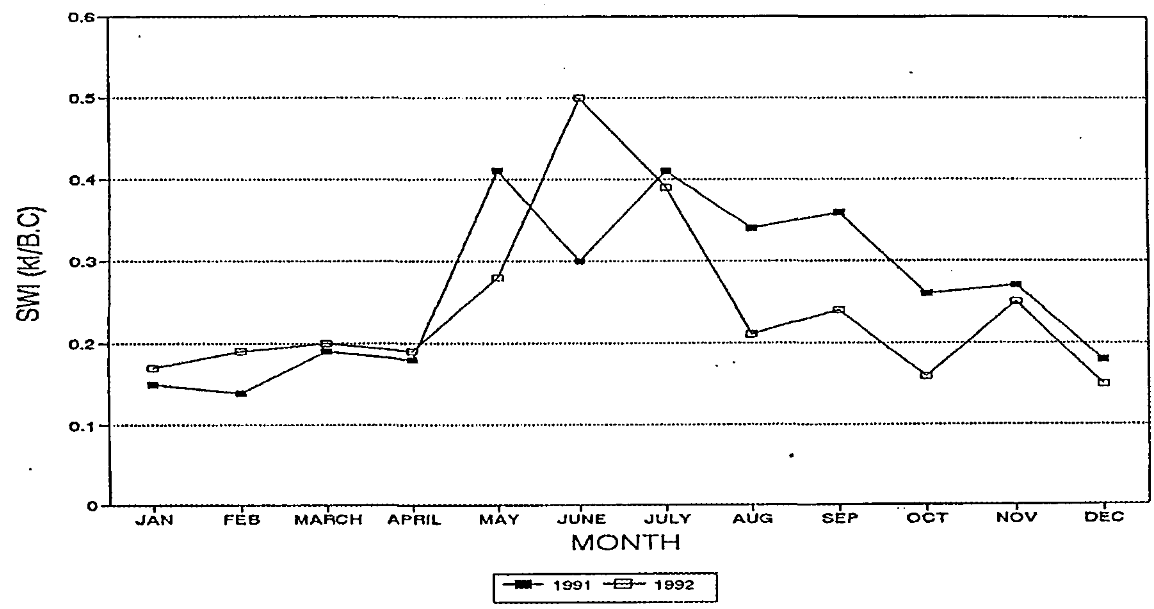


FIGURE 17: MONTHLY SPECIFIC WATER INTAKE, SUIDER PAARL 1991-92 : (SWI AS KL/BASIC CARTON PRODUCED)

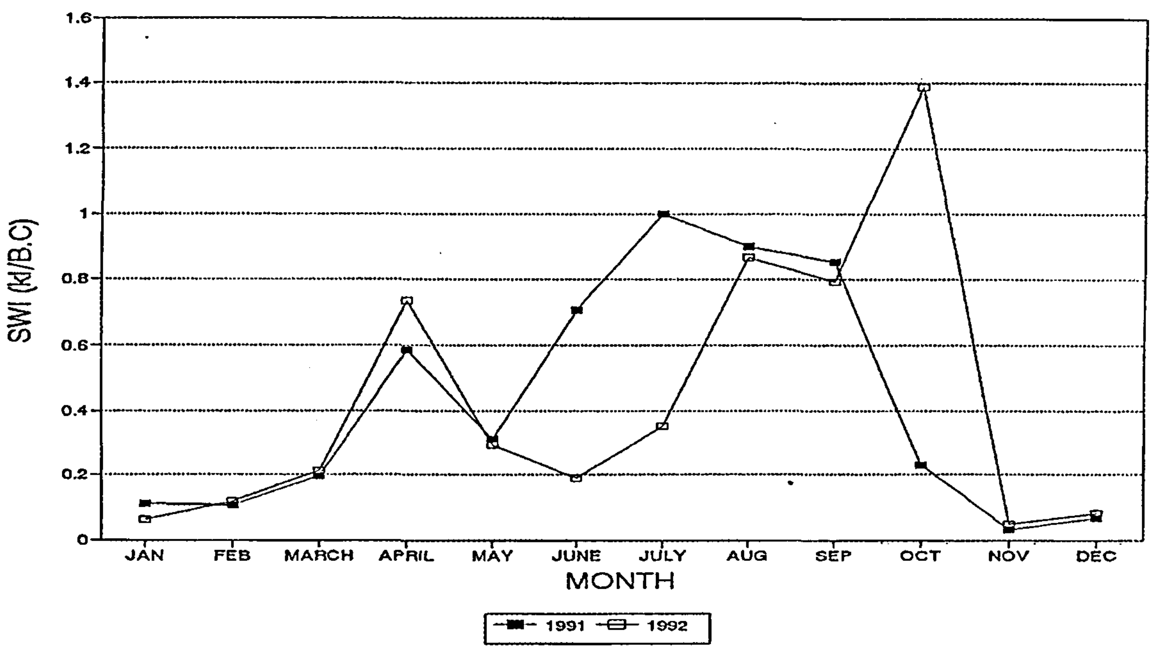


FIGURE 18: MONTHLY SPECIFIC WATER INTAKE, ASHTON 1991-92 : (SWI AS KL/BASIC CARTON PRODUCED)

5.7 Variation of Water Intake with Processing Rate

Figures 19 and 20 illustrate the correlation between water intake (kl/month) and processing rate (fresh tonnage/month) at Suider Paarl and Ashton respectively. Considering both the conformity towards and the variations away from the trends displayed, the following are apparent:

- Water intake generally rises with increasing production, as would be expected.
- The relationship is by no means linear (proportional), even though there is at Suider Paarl (Figure 19) a mathematically tempting case for correlating water intake (WI, kl/month) with processing rate (P, t/month) as a linear function of the form WI = 4,5 P + 30 000 and defining the statistical scatter appropriately.
- The data for Ashton (Figure 20) are distinctly non-linear and show more apparent scatter than the comparable data for Suider Paarl (Figure 19).
- In both cases however, it is important to note that at any selected processing rate there is a variance in the water intake. This implies simply that processing rate does not absolutely and uniquely determine the overall factory water intake. Effective water management should in practice be aimed at identifying and controlling the impacts of other factors, including variations in raw materials, line changes, processing run-lengths, shift changes, product mix, washdown procedures, etc.

5.8 Variation of Water Intake with Production Rate

Figures 21 and 22 show the correlation between water intake (kl/month) and production rate (basic cartons/month) at Suider Paarl and Ashton respectively. Generally, the same considerations as presented in Section 5.7 are relevant.

5.9 Variation of Water Intake with Factory Capacity Utilized

In order to further characterize the relationship between water efficiency (expressed as SWI) and processing (fresh tonnage) or production (basic cartons), the level of factory activity can be expressed not as an absolute throughput rate (eg tons/month or basic cartons/month) but rather as a ratio between the actual activity level at any time and the selected "optimum" factory capacity.

The "optimum" factory capacity may be defined in a variety of ways depending on the criteria selected, the prioritization accorded to various criteria, and the relevant sub-factors, for example:

- installed capacity (processing, production, energy, materials handling, etc)
- cost effectiveness (profit, turnover, RDI, market forces, etc)
- energy efficiency (seldom definitive from a commercial perspective)
- environmental compatibility (various site-specific factors apply)
- social/labour considerations (labour relations, local economy, RDP, etc.)
- water efficiency (cost factors, availability of resources, effluent, permits, etc).

For illustration, the processing rate (t/month) in the peak month over the period 1991-92 has arbitrarily been selected as the "optimum" factory capacity for Suider Paarl and Ashton. In each case, the actual processing rate (t/month) in each month over the period has been calculated as a percentage of the processing rate (t/month) in the peak month. This ratio has been defined as the "% factory capacity utilized".

The relationship between % factory capacity utilized and SWI (kl/t) is illustrated in Figures 23 and 24 for Suider Paarl and Ashton respectively. Figure 23 (Suider Paarl) shows an impressive normalization of the data and a similar trend is exhibited in Figure 24 (Ashton), but with more scatter of the data. In each case, the following conclusions appear to be clearly demonstrated:

At high levels of % factory capacity utilization, the SWI (kl/t) approaches a minimum range. This minimum SWI-range, an important measure of the water efficiency at the factory, is around 5kl/t for both Suider Paarl and Ashton.

- At low levels of factory capacity utilization, the SWI (kl/t) tends to much higher values, up to 40 kl/t in each case (Suider Paarl and Ashton).

By inspection, the factory SWI values approach their minimum level at > 50% of factory capacity utilization (SWI<5-10 kl/t). Conversely, at factory capacity utilizations below 10%, much higher SWI values (typically 15-40 kl/t) are demonstrated.

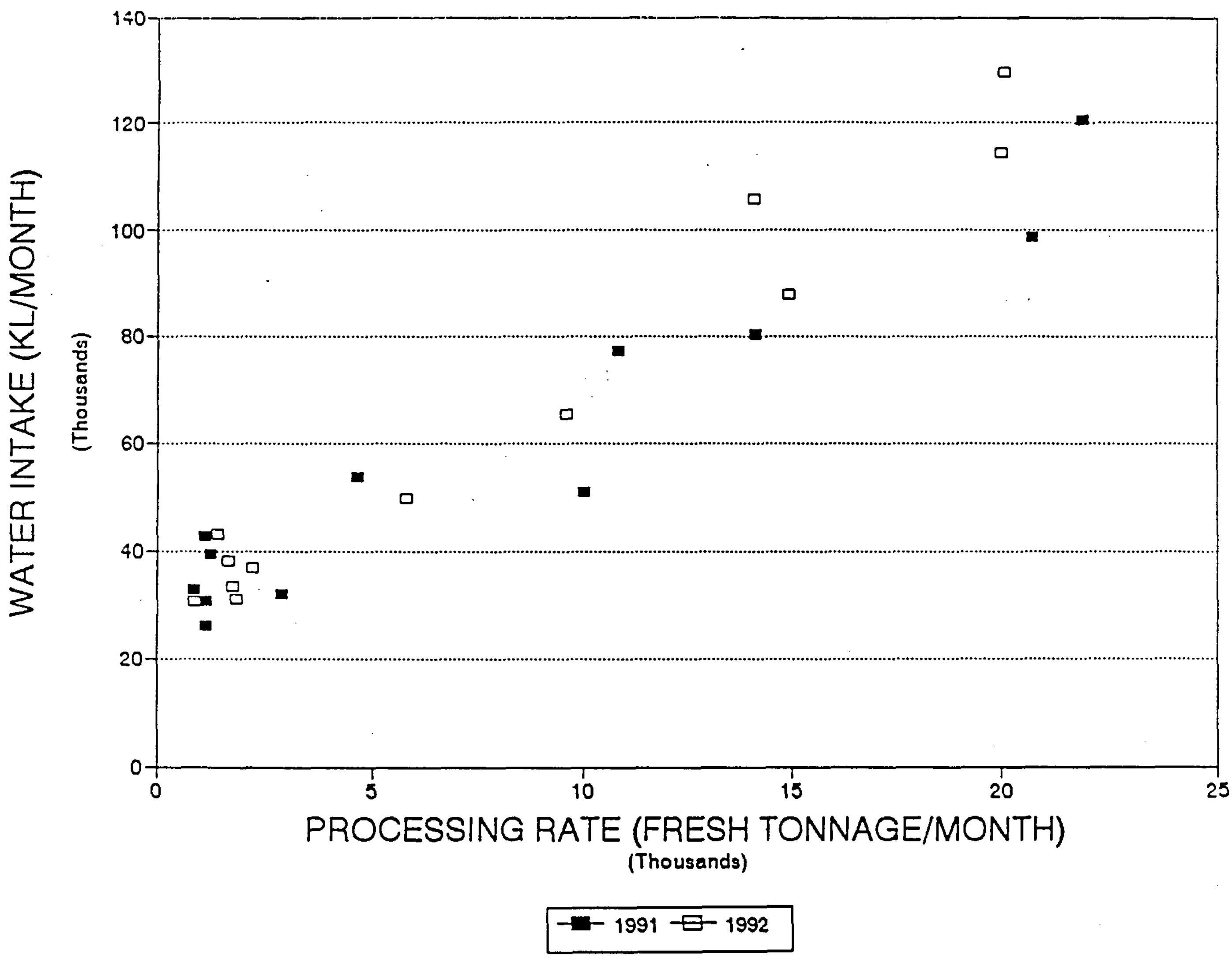


FIGURE 19: WATER INTAKE (KL/MONTH) VERSUS PROCESSING RATE (FRESH TONNAGE/MONTH), SUIDER PAARL 1991-92

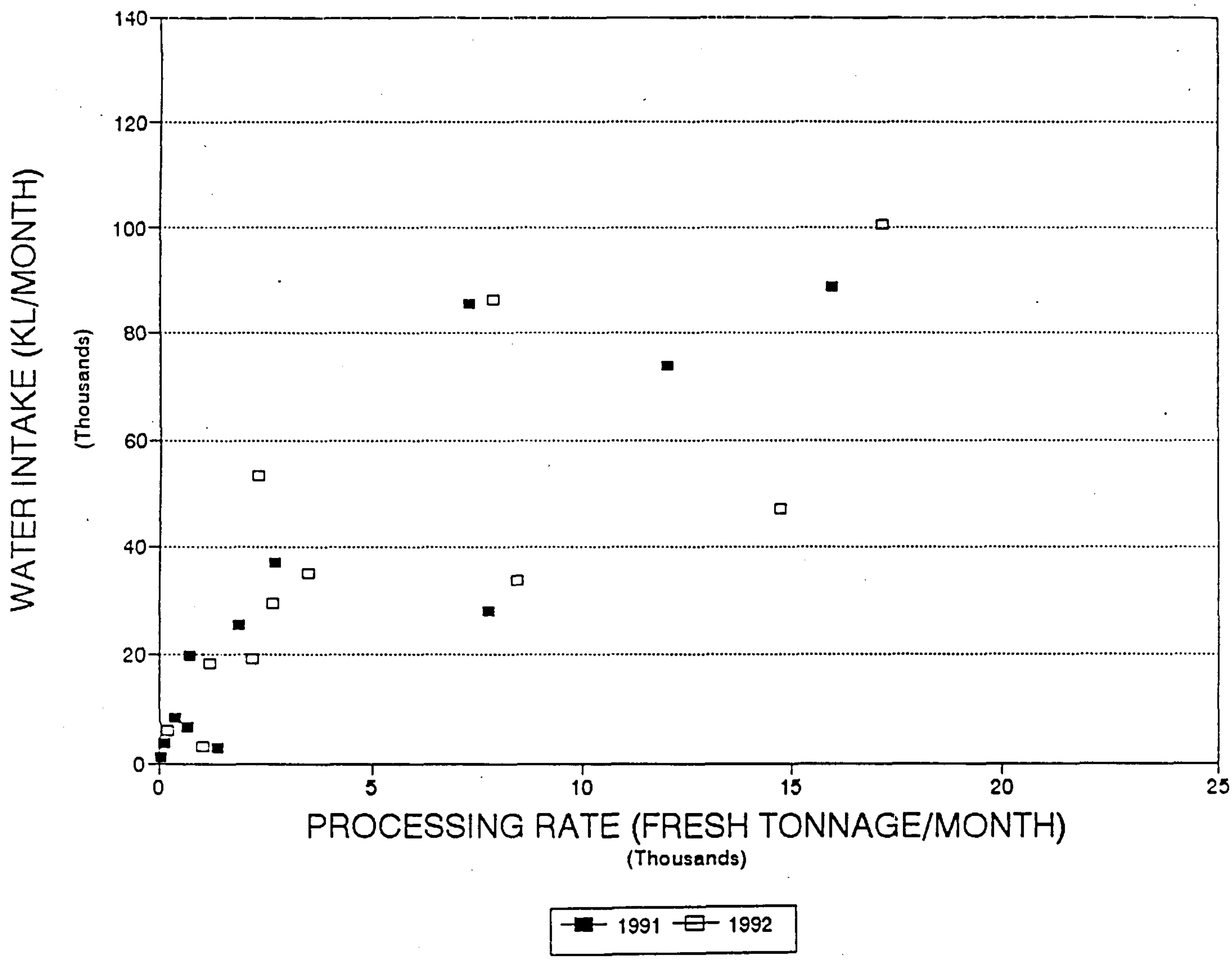


FIGURE 20: WATER INTAKE (KL/MONTH) VERSUS PROCESSING RATE (FRESH TONNAGE/MONTH), ASHTON 1991-92

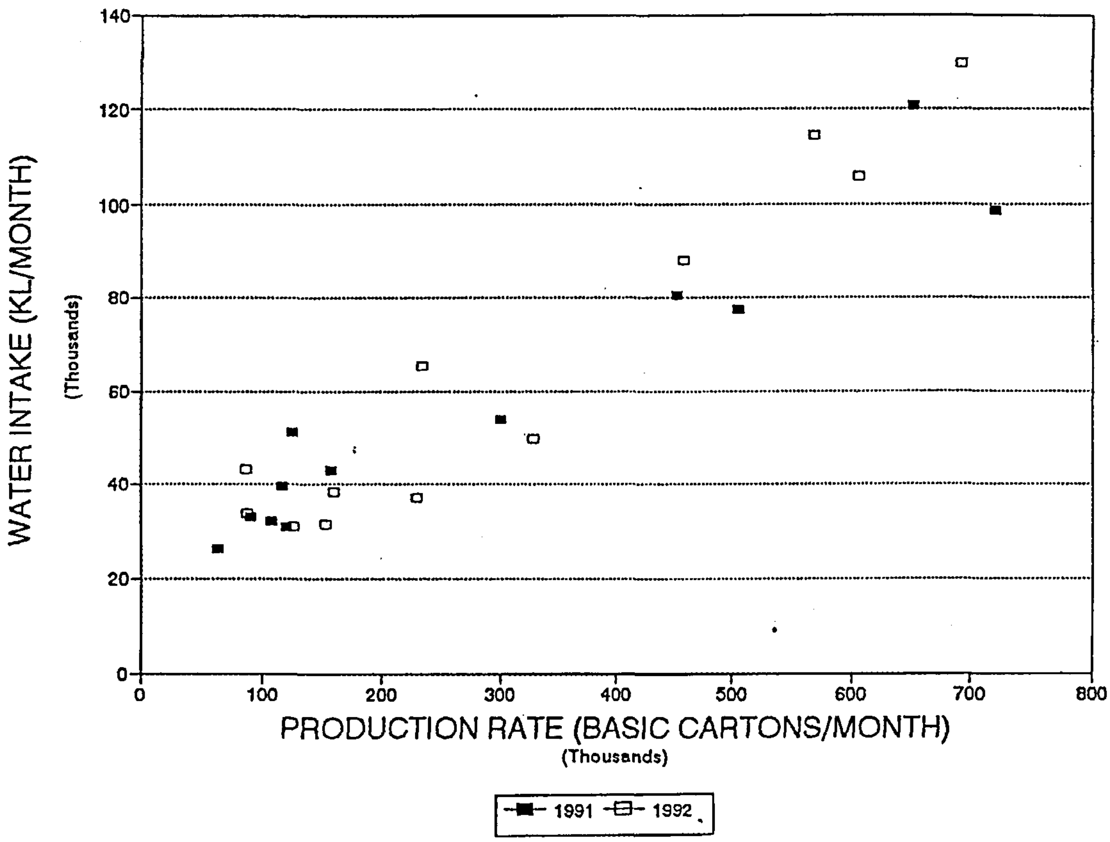


FIGURE 21: WATER INTAKE (KL/MONTH) VERSUS PRODUCTION RATE (BASIC CARTONS/MONTH), SUIDER PAARL 1991-92

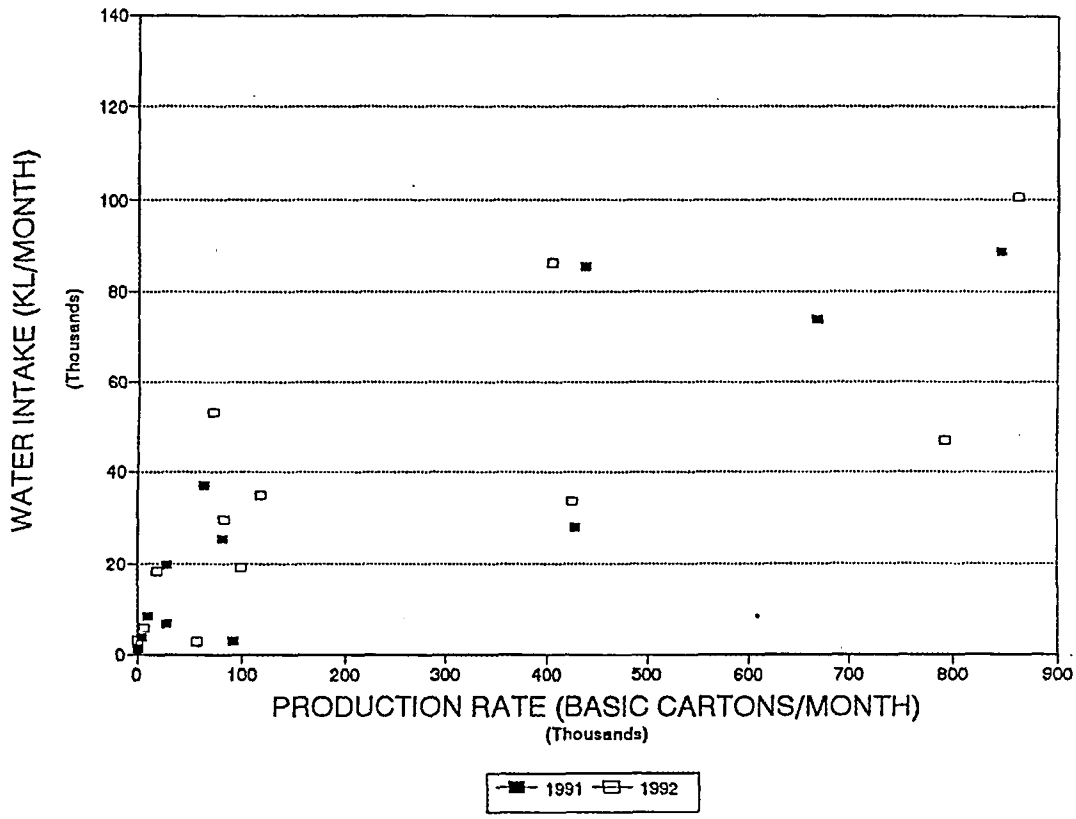


FIGURE 22: WATER INTAKE (KL/MONTH) VERSUS PRODUCTION RATE (BASIC CARTONS/MONTH), ASHTON 1991-92

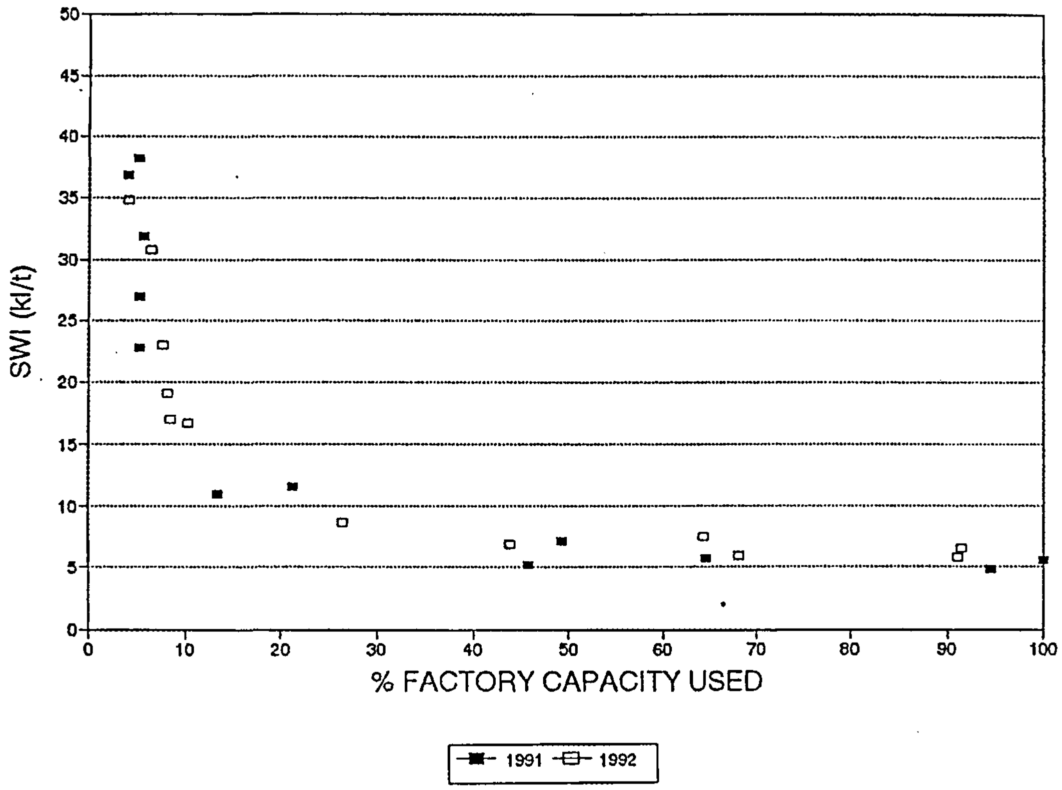


FIGURE 23: SPECIFIC WATER INTAKE (KL/TON) VERSUS % FACTORY CAPACITY UTILIZED, SUIDER PAARL 1991-92

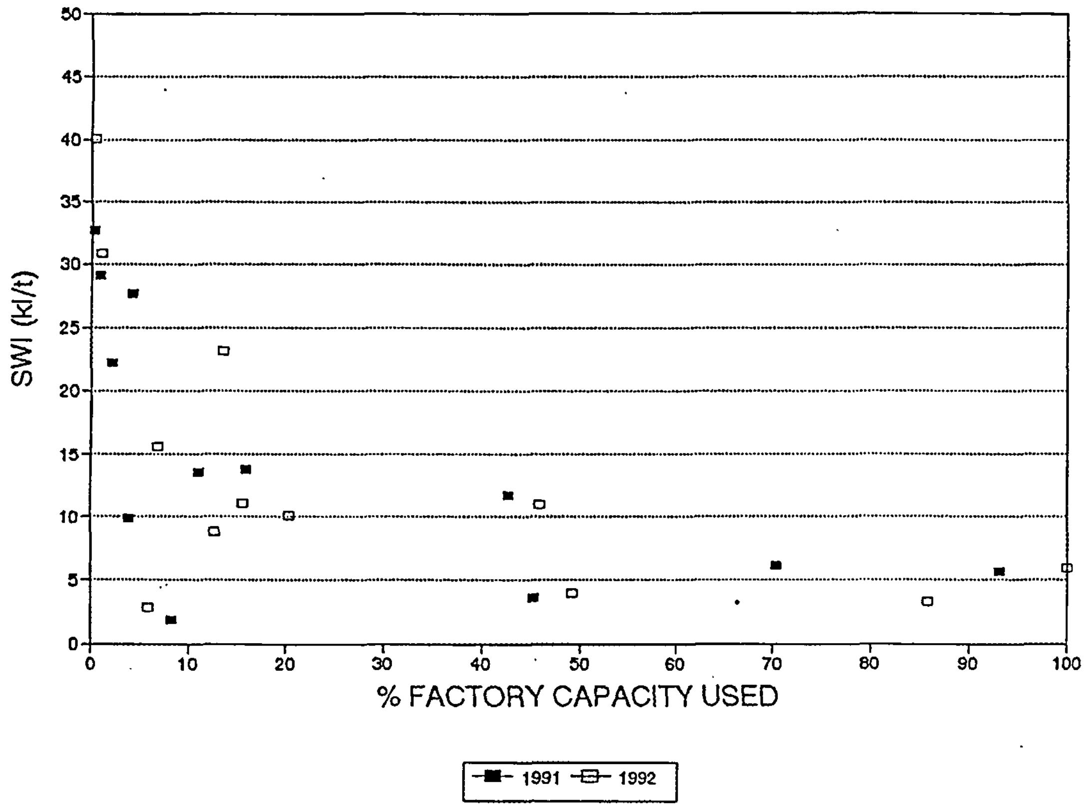


FIGURE 24: SPECIFIC WATER INTAKE (KL/TON) VERSUS % FACTORY CAPACITY UTILISED, ASHTON 1991-92

6 CONCLUSIONS

6.1 Strategic Water Information

(a) The original project approach envisaged that the strategic water information that would meet the project aims, and that therefore would need to be collected in the course of the project, would be the water use data for various individual commodities.

(b) On investigation, the water supply and reticulation system at the model factory was found to be relatively complex, with relevant features being:

- multiple sources, including 5 separate municipal water intake lines, river water (from Berg River), groundwater (extracted on site), rainwater (collected on site), defrost water (extracted on site) and fire mains water (not normally used for industrial purposes);

- optional interlinking of various water supply sources on site via a manually operated valve system;

- manually selectable choice of supplying major processing areas from one or two or more different water sources;

- combination of water supplies from different sources into common storage facilities from where mixed supply takes place into the factory water reticulation system;

- adaptation of the water reticulation system in an ad hoc manner over the long period that the factory has been in existence;

- on-going expansion and/or alteration to the factory's processing facilities, resulting in further on-going adaptations to the water reticulation system as above.

(c) In view of the complex nature of the model factory's water supply and reticulation system, a further level of strategic water information was therefore identified, viz. data on the various water intakes to the factory. It was envisaged that this would provide an important background and cross-check on the water use data for individual commodity processing.

(d) On further examination, a different level of significance was however also found to be attached to the overall water intake data. It became apparent that the overall production level at the factory, on a seasonal basis over an annual cycle, exerted a significant and semi-independent effect on the overall water efficiency of the factory and therefore on the water efficiency at which the various seasonally - distributed commodities were processed.

(e) In the course of the project, the strategically important water information has thus evolved through the following stages:

- commodity-only data;
- factory water intake data as a background to the commodity-only data;
- factory water intake data as a separate independent factor.

(f) At each stage, the previous level of water information remained valid but the significance was re-prioritized. The process has resulted in an affirmation of the appropriate research protocol for a project such as this, viz. that at each stage of information gathering the significance of what is being aimed at should be continually re-evaluated, and the approach/methodology adapted as required.

Currently therefore, it has been concluded that commodity-only data from the model factory is relatively meaningless without an understanding of the production context. Different expressions describing this conclusion are:

- proceed from the overall to specific detail;
- understand the "big picture" as completely as possible at each stage of the investigation;
- from a research-effectiveness point of view, continuously feed specific observations back to re-define the big picture.

(g) Overall conclusions drawn therefore regarding the strategic water-related data obtained in the project are as follows:

(i) Different commodities produced at various points over the annual seasonal processing cycle have significantly different SWI-values, ranging from around 5kl/t to over 30kl/t.

(ii) Explanations for these differences in commodity SWI-valves have previously been focused largely on determining the factors which affect the water-efficiency of particular processing activities. These factors may be referred to as commodity-specific or line-specific, and are valid.

(iii) Equally valid are the water management measures deduced to be effective in achieving a consistent target-monitoring approach to the controlled use of water for processing. These factors include inter alia the effect of line throughput rate, where it has long been recognised that a processing line operating at or near its optimum capacity will generally be more water-efficient (have a lower SWU) than a processing line operating away from optimum capacity, particularly when the line throughput rate is severely below optimum.

(h) To sum up, it is concluded that strategic water-related information in the F&V industry should be developed along the lines indicated in Figure 6.1 following.

For illustration, if all the water-using steps in a peach processing line (including dump tanks, peeling, flumes, washing sprays, etc) were fully deployed to process **one peach**, the SWU of the line at that time (as kl/t) would be ridiculously high. Appropriate measures to reduce this SWU would then include downsizing the line or regulating the line more effectively by, for example, accumulating sufficient peaches to produce a more optimal feed rate over a controlled batch run-time.

(iv) In the model factory study it however proved to be unsatisfactory to stop the analysis at this level: as an extension of the production-related considerations at a line processing level, it becomes useful to view the entire factory as a single multi-facetted processing unit. As this overall processing unit approaches a nominal optimal production rate, the overall water efficiency improves because the water-using facilities are being more effectively utilized, whether for one or more commodities. In addition to "processing" water-using facilities becoming more effectively utilized (as in (iii) above), "other" water-using facilities such as utilities, amenities and (to an extent) plant washdown also becomes more water-efficient. As an extreme case, the SWU of some utilities would in theory increase to very large values at near-zero production, with an inevitable consequent effect on the "average" water efficiency of the overall production sequence involved at that time.

(v) Having established the effect of overall factory production throughput rate on the water-efficiency of the various activities carried out on a repeated seasonal basis, it is then necessary to re-examine the specific contributions made on a commodity-only basis. Improvements made to water-efficient operation at a commodity level will obviously benefit the overall water efficiency of the factory, **but** within reasonable target expectations influenced by considerations of the overall factory production level.

ESTABLISH FACTORY PRODUCTION ON MONTHLY BASIS OVER REPRESENTATIVE ANNUAL PRODUCTION CYCLE

ESTABLISH DISTRIBUTION/CONTRIBUTION OF MAJOR PRODUCTS CONSTITUTING FACTORY PRODUCTION

ESTABLISH TOTAL FACTORY WATER INTAKE ON MONTHLY BASIS OVER SAME PRODUCTION CYCLE

EXAMINE DATA AND IDENTIFY APPROPRIATE WATER MANAGEMENT OBJECTIVES

IDENTIFY AREAS EG. PERIODS, COMMODITIES, PROCESSES, UTILITIES, AMENITIES WHERE MORE DETAILED STUDY COULD BENEFIT PROGRESS TOWARDS WM OBJECTIVES

IMPLEMENT APPROPRIATE ACTION STEPS, EG MORE INTENSIVE WATER MONITORING, AND INTEGRATE RESULTS

REVIEW EFFECT OF IMPROVEMENTS ON WM OBJECTIVES

FIGURE 25. LOGIC DIAGRAM FOR DEVELOPING STRATEGIC WATER INFORMATION

6.2 Development of an Appropriate Expert System for Improved Water Management in the F&V Processing Industry

(a) Previous studies have identified commodity SWU-values and measures for reducing these as the basis for making savings in water use in the F&V Industry.

(b) The current project has aimed at developing an appropriate expert system whereby improved water economy can be realistically targeted, achieved and maintained in the Industry.

(c) Considerations arising from the project have substantially modified the expected form of an appropriate expert system. It was originally envisaged that the expert system developed would be a synthesis of a comprehensive set of target monitoring procedures and water saving measures based on individual commodity-processing factors. In the course of the project, it was concluded that annual seasonal variations in the intensity of production activities exert a major influence on the water-use efficiency obtainable at any time. Consequently, it is recommended at this stage that the Industry should incorporate such considerations into its water management practices as a logical first step in progressing towards an ultimate expert system for water-efficient operation.

7 SUMMARY OF RECOMMENDATIONS

(a) The results achieved should be implemented by the Industry on a systematic basis. Specifically, individual factories should correlate their water use and production patterns on an historical updatable basis and optimise these site-specific relationships appropriately.

(b) Langeberg Suider Paarl should extend the water metering, monitoring and target-setting initiated during the course of the project, using as a basis the fundamental water-use data and related production activities correlated in the project.

(c) The data collected should be imported into the expert system protocol established in this project, and further developed by the Industry with the incorporation of more detailed (commodity/line specific) data as this becomes available with the implementation of enhanced levels of water metering and monitoring.

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APPENDIX

TABLES IN APPENDIX

TABLE A1.1 SUIDER PAARL MONTHLY FRESH TONNAGE (t) AND WATER USE (kℓ) (1991)

TOTAL FRESH TONNAGE

YEAR	1991												TOTAL
MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
APPLES					92								92
APRICOTS BULIDA											463	4526	4989
APRICOTS ROYAL	185												185
BEETROOT	69	6			325	757	593	642	425	248	189		3254
FIGS GREEN										27			27
FIGS RIPE	72	124	2										198
GRAPEFRUIT													
GRAPES HANEPOOT		5	29										34
GRAPES SULTANA	144	551	420	306									1421
GUAVAS					384	475	553	591	261	509			2773
MELONS					370	153	2						525
ONIONS		6	124	180			4						314
ORANGES SEVILLE								4	165	123	52		344
ORANGES SWEET										92	31		123
PEACHES	7203	5082	3023	389									15697
PEARS	893	7081	8104	5893									21971
PEAS													
PINEAPPLES													
PLUMS													
QUINCES													
SAUERKRAUT									42				42
STRAWBERRIES										132	377	64	573
TOMATOES	2266	7879	10231	7379	8864	1544							38163
WATERBLOMME						2	1	2	5	15	2		27
YOUNGBERRIES											10	49	59
	10832	20734	21933	14147	10035	2931	1153	1239	898	1146	1124	4639	90811
TOTAL FRESH TONNAGE	10832	20734	21933	14147	10035	2931	1153	1239	898	1146	1124	4639	90811
WATER INTAKE (KL)	77612	98554	120794	80638	51212	32082	26252	39472	33009	30933	42872	53970	687400
KL/TON	7.17	4.75	5.51	5.7	5.1	10.95	22.77	31.86	36.76	26.99	38.14	11.63	7.57

TABLE A1.2 SUIDER PAARL MONTHLY FRESH TONNAGE (t)AND WATER USE (kℓ) (1992)

TOTAL FRESH TONNAGE

YEAR / MONTH / PRODUCT	1992 JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	TOTAL
APPLES						248							248
APRICOTS BULIDA	420	96									417	4904	5837
APRICOTS ROYAL	248	73	43									8	372
BEETROOT						221	571	852	578	593			2815
FIGS GREEN										37			37
FIGS RIPE	88	103											191
GRAPEFRUIT													
GRAPES HANEPOOT			62										62
GRAPES SULTANA	82	522	421	448	181								1654
GUAVAS					410	722	1185	997	481	37			3832
MELONS					189	720							909
ONIONS			23	137	196						3		359
ORANGES SEVILLE									257	59			316
ORANGES SWEET									51	173			224
PEACHES	9407	4670	3814	854								595	19340
PEARS	355	7392	6505	5266	1299								20817
PEAS									281	970			1251
PINEAPPLES													
PLUMS													
QUINCES													
SAUERKRAUT													
STRAWBERRIES									6	348	420	15	789
TOMATOES	3490	7199	9129	8211	7336	-513					36		34888
WATERBLOMME						1	2	2	10	10	1		26
YOUNGBERRIES											15	251	266
	14090	20055	19997	14916	9611	1399	1758	1851	1664	2227	892	5773	94233
TOTAL FRESH TONNAGE	14090	20055	19997	14916	9611	1399	1758	1851	1664	2227	892	5773	94233
WATER INTAKE (KL)	105797	129677	114521	88030	65532	43034	33724	31535	38301	37058	30984	49806	767999
KL/TON	7.51	6.47	5.73	5.9	6.82	30.76	19.18	17.04	23.02	16.64	34.74	8.63	8.15

TABLE A1.3 SUIDER PAARL MONTHLY % FRESH TONNAGE PER RAW MATERIAL AND TOTAL WATER INTAKE (1991)

PERCENTAGE (%) TOTAL FRESH TONNAGE

YEAR	1991												TOTAL
MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
APPLES					0.92								0.10
APRICOTS BULIDA											41.19	97.56	5.49
APRICOTS ROYAL	1.71												0.20
BEETROOT	0.64	0.03			3.24	25.83	51.43	51.82	47.33	21.64	16.81		3.58
FIGS GREEN										2.36			0.03
FIGS RIPE	0.66	0.60	0.01										0.22
GRAPEFRUIT													
GRAPES HANEPOOT		0.02	0.13										0.04
GRAPES SULTANA	1.33	2.66	1.91	2.16									1.56
GUAVAS					3.83	16.21	47.96	47.70	29.06	44.42			3.05
MELONS					3.69	5.22	0.17						0.58
ONIONS	0.00	0.03	0.57	1.27			0.35						0.35
ORANGES SEVILLE	.							0.32	18.37	10.73	4.63		0.38
ORANGES SWEET										8.03	2.76		0.14
PEACHES	66.50	24.51	13.78	2.75									17.29
PEARS	8.24	34.15	36.95	41.66									24.19
PEAS													
PINEAPPLES													
PLUMS													
QUINCES													
SAUERKRAUT									4.68				0.05
STRAWBERRIES										11.52	33.54	1.38	0.63
TOMATOES	20.92	38.00	46.65	52.16	88.33	52.68							42.02
WATERBLOMME						0.07	0.09	0.16	0.56	1.31	0.18		0.03
YOUNGBERRIES											0.89	1.06	0.06
	100	100	100	100	100	100	100	.100	100	100	100	100	100
TOTAL FRESH TONNAGE	10832	20734	21933	14147	10035	2931	1153	1239	898	1146	1124	4639	90811
WATER INTAKE (KL)	77612	98554	120794	80638	51212	32082	26252	39472	33009	30933	42872	53970	687400
KL/TON	7.17	4.75	5.51	5.7	5.1	10.95	22.77	31.86	36.76	26.99	38.14	11.63	7.57

TABLE A1.4 SUIDER PAARL MONTHLY % FRESH TONNAGE PER RAW MATERIAL AND TOTAL WATER INTAKE (1992)

PERCENTAGE (%) TOTAL FRESH TONNAGE

YEAR	1992												TOTAL
MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
APPLES						17.73							0.26
APRICOTS BULIDA	2.98	0.48									46.75	84.95	6.19
APRICOTS ROYAL	1.76	0.36	0.22									0.14	0.39
BEETROOT						15.80	32.48	46.03	34.74	26.63			2.99
FIGS GREEN										1.66			0.04
FIGS RIPE	0.62	0.51											0.20
GRAPEFRUIT													
GRAPES HANEPOOT			0.31										0.07
GRAPES SULTANA	0.58	2.60	2.11	3.00	1.88								1.76
GUAVAS					4.27	51.61	67.41	53.86	28.91	1.66			4.07
MELONS					1.97	51.47							0.96
ONIONS			0.12	0.92	2.04						0.34		0.38
ORANGES SEVILLE									15.44	2.65			0.34
ORANGES SWEET									3.06	7.77			0.24
PEACHES	66.76	23.29	19.07	5.73								10.31	20.52
PEARS	2.52	36.86	32.53	35.30	13.52								22.09
PEAS									16.89	43.56			1.33
PINEAPPLES													
PLUMS													
QUINCES													
SAUERKRAUT													
STRAWBERRIES									0.36	15.63	47.09	0.26	0.84
TOMATOES	24.77	35.90	45.65	55.05	76.33	-36.67					4.04		37.02
WATERBLOMME						0.07	0.11	0.11	0.60	0.45	0.11		0.03
YOUNGBERRIES											1.68	4.35	0.28
	100	100	100	100	100	100	100	100	100	100	100	100	100
TOTAL FRESH TONNAGE	14090	20055	19997	14916	9611	1399	1758	1851	1664	2227	892	5773	94233
WATER INTAKE (KL)	105797	129677	114521	88030	65532	43034	33724	31535	38301	37058	30984	49806	767999
KL/TON	7.51	6.47	5.73	5.9	6.82	30.76	19.18	17.04	23.02	16.64	34.74	8.63	8.15

TABLE A1.5 SUIDER PAARL MONTHLY PRODUCTION (BASIC CARTONS) AND WATER INTAKE (kℓ) (1991)

TOTAL BASIC CARTONS

YEAR	1991												TOTAL
MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
ASPARAGUS													
APPLES					1929	29							1958
APRICOTS BULIDA	7933	7144		235	41	10386	3515	9515		2837	27043	261625	330274
APRICOT KERNELS													
APRICOTS ROYAL	14828	126											14954
BEANS TOM/SAUCE											42523	26268	
BEETROOT	3236	246			12076	35978	27643	28960	19139	9013	7177		143468
CHUTNEYS		3077											
FIGS GREEN										2432			2432
FIGS RIPE	4178	6636											10814
FRUIT COCKTAIL	78984	251586	193967	158738	1183								
FRUIT SALAD		56228	54263		161								
GRAPEFRUIT SEGMENTS													
GRAPE JAM		310	1605										1915
GUAVAS					10882	18506	23665	22912	10135	12971			99071
MAYONNAISE											10520	4241	
MELONS & GINGER					9070	4630	64						13764
MIXED FRUIT JAM				206		1584	4966	15178	2009	1522	798	746	
ORANGES SEVILLE		4609	516	215		4744		621	33021	20813	3298		67837
ORANGES SWEET						149				16699	8606		25454
PEACHES	359084	118817	16211	1189	651								495952
PEARS	6304	190196	250163	199819	1896								648378
PEAS													
PINEAPPLES													
PLUMS													
PRUNES													
QUINCES													
SAUERKRAUT													0
STEWED FRUIT													
STRAWBERRIES	87							1133		10115	34187	2885	48407
SULTANAS													
TOMATOES	30186	82097	134636	91312	86634	31336	3969	38015	26190	41794	21892		588061
WATERBLOMME						210	59	215	469	1163	170		2286
YOUNGBERRIES	108										1030	4965	6103
	504928	721072	651361	451714	124523	107552	63881	116549	90963	119359	157244	300730	3409878
TOTAL FRESH TONNAGE	504928	721072	651361	451714	124523	107552	63881	116549	90963	119359	157244	300730	3409876
WATER INTAKE (KL)	77612	98554	120794	80638	51212	32082	26252	39472	33009	30933	42872	53970	687400
KL/TON	0.15	0.14	0.19	0.18	0.41	0.30	0.41	0.34	0.36	0.26	0.27	0.18	0.20

TABLE A1.6 SUIDER PAARL MONTHLY PRODUCTION (BASIC CARTONS) AND WATER INTAKE (kℓ) (1992)

TOTAL BASIC CARTONS

YEAR	1992												TOTAL
MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
ASPARAGUS													
APPLES						5425							5425
APRICOTS BULIDA	65443	21275						5446	429		32792	253724	379109
APRICOT KERNELS													
APRICOTS ROYAL	4562		3436										7998
BEANS TOM/SAUCE													
BEETROOT						7840	22417	36539	23984	17902			108682
CHUTNEYS													
FIGS GREEN										3179			3179
FIGS RIPE	6032	5992											12024
FRUIT COCKTAIL	24889	257293	192113	190166	70182					5632	3457		743732
FRUIT SALAD		52365	79822	8166									140353
GRAPEFRUIT SEGMENTS													
GRAPE JAM			3051										3051
GUAVAS		83			11396	26005	48552	38548	19425	1325			145334
MAYONNAISE							55		4879	4830		5089	14853
MELONS & GINGER					6416	15209							21625
MIXED FRUIT JAM		24749	19419		2319	2981	8262	52675			4710	13973	129088
ORANGES SEVILLE		2129	3626		52	8304	7510		50537	9350			81508
ORANGES SWEET						2376	483		9760	31744	2295		46658
PEACHES	449049	79648	24501	2307	124							30889	586518
PEARS		169143	157263	156449	38364								521219
PEAS									20266	76978			97244
PINEAPPLES													
PLUMS													
PRUNES													
QUINCES													
SAUERKRAUT													
STEWED FRUIT													
STRAWBERRIES									605	28882	37386	486	67359
SULTANAS													
TOMATOES	56334	79748	84542	100919	104683	18685		19282	28506	49468	43269	12591	598027
WATERBLOMME						55	123	146	847	837	65		2073
YOUNGBERRIES											1673	12355	14028
	606309	692425	567773	458007	233536	86880	87402	152636	159238	230127	125647	329107	3729087
TOTAL BASIC CARTONS	606309	692425	567773	458007	233536	86880	87402	152636	159238	230127	125647	329107	3729087
WATER INTAKE (KL)	105797	129677	114521	88030	65532	43034	33724	31535	38301	37058	30984	49806	767999
KL/BCARTONS	0.17	0.19	0.20	0.19	0.28	0.50	0.39	0.21	0.24	0.16	0.25	0.15	0.21

TABLE A1.7 SUIDER PAARL MONTHLY % PRODUCTION (BASIC CARTONS) BY COMMODITY AND WATER INTAKE (1991)

PERCENTAGE (%) TOTAL BASIC CARTONS

YEAR	1991												TOTAL
MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
ASPARAGUS													
APPLES					1.55	0.03							0.06
APRICOTS BULIDA	1.57	0.99		0.05	0.03	9.66	5.5	8.16		2.38	17.2	87	9.69
APRICOT KERNELS													
APRICOTS ROYAL	2.94	0.02											0.04
BEANS TOM/SAUCE											27.04	8.73	2.02
BEETROOT	0.64	0.03			9.7	33.45	43.27	24.85	21.04	7.55	4.56		4.21
CHUTNEYS		0.43											0.09
FIGS GREEN										2.04			0.07
FIGS RIPE	0.83	0.92											0.32
FRUIT COCKTAIL	15.64	34.89	29.78	35.14	0.95								20.07
FRUIT SALAD		7.8	8.33		0.13								3.25
GRAPEFRUIT SEGMENTS													
GRAPE JAM		0.04	0.25										0.06
GUAVAS					8.74	17.21	37.05	19.66	11.14	10.87			2.91
MAYONNAISE											6.69	1.41	0.43
MELONS & GINGER					7.28	4.3	0.1						0.40
MIXED FRUIT JAM				0.05		1.47	7.77	13.02	2.21	1.28	0.51	0.25	0.79
ORANGES SEVILLE		0.64	0.08	0.05		4.41		0.53	36.3	17.44	2.1		1.99
ORANGES SWEET						0.14				13.99	5.47		0.75
PEACHES	71.12	16.48	2.49	0.26	0.52								14.54
PEARS	1.25	26.38	38.41	44.24	1.52								19.01
PEAS													
PINEAPPLES													
PLUMS													
PRUNES													
QUINCES													
SAUERKRAUT													
STEWED FRUIT													
STRAWBERRIES	0.02							0.97		8.47	21.74	0.96	1.42
SULTANAS													
TOMATOES	5.98	11.39	20.67	20.21	69.57	29.14	6.21	32.62	28.79	35.02	13.92		17.25
WATERBLOMME						0.2	0.09	0.18	0.52	0.97	0.11		0.07
YOUNGBERRIES	0.02										0.66	1.65	0.18
	100	100	100	100	100	1000	100	100	100	100	100	100	100
TOTAL BASIC CARTONS	504928	721072	652362	451714	124523	107552	63882	116549	90963	119359	157246	300730	3409878
WATER INTAKE (KL)	77612	98554	120794	80638	51212	32082	26252	39472	33009	30933	42872	53970	687400
KL/BCARTON	0.15	0.14	0.19	0.18	0.41	0.30	0.41	0.34	0.36	0.26	0.27	0.18	0.20

TABLE A1.8 SUIDER PAARL MONTHLY % PRODUCTION (BASIC CARTONS) BY COMMODITY AND WATER INTAKE (1992)

PERCENTAGE (%) TOTAL BASIC CARTONS

YEAR	1992												TOTAL
MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
ASPARAGUS													
APPLES						6.24							0.15
APRICOTS BULIDA	10.79	3.07						3.57	0.27		26.10	77.09	10.17
APRICOT KERNELS													
APRICOTS ROYAL	0.75		0.61										0.21
BEANS TOM/SAUCE													
BEETROOT						9.02	25.65	23.94	15.06	7.78			2.91
CHUTNEYS													
FIGS GREEN										1.38			0.09
FIGS RIPE	0.99	0.87											0.32
FRUIT COCKTAIL	4.11	37.16	33.84	41.52	30.05					2.45	2.75		19.94
FRUIT SALAD		7.56	14.06	1.78									3.76
GRAPEFRUIT SEGMENTS													
GRAPE JAM			0.54										0.08
GUAVAS		0.01			4.88	29.93	55.55	25.25	12.20	0.58			3.90
MAYONNAISE							0.06		3.06	2.10		1.55	0.40
MELONS & GINGER					2.75	17.51							0.58
MIXED FRUIT JAM		3.57	3.42		0.99	3.43	9.45	34.51			3.75	4.25	3.46
ORANGES SEVILLE		0.31	0.64		0.02	9.56	8.59		31.74	4.06			2.19
ORANGES SWEET						2.73	0.55		6.13	13.79	1.83		1.25
PEACHES	74.06	11.50	4.32	0.50	0.05							9.39	15.73
PEARS		24.43	27.70	34.16	16.43								13.98
PEAS													2.61
PINEAPPLES									12.73	33.45			
PLUMS													
PRUNES													
QUINCES													
SAUERKRAUT													
STEWED FRUIT													
STRAWBERRIES									0.38	12.55	29.75	0.15	1.81
SULTANAS													
TOMATOES	9.29	11.52	14.69	22.03	44.83	21.51		12.63	17.90	21.50	34.44	3.83	16.04
WATERBLOMME						0.06	0.14	0.10	0.53	0.36	0.05		0.06
YOUNGBERRIES											1.33	3.75	0.38
	100	100	100	100	100	100	100	100	100	100	100	100	100
TOTAL BASIC CARTONS	606309	692425	567773	458007	233536	86880	87402	152636	159238	230127	125647	329107	3729087
WATER INTAKE (KL)	105797	129677	114521	88030	65532	43034	33724	31535	38301	37058	30984	49806	767999
KL/BCARTONS	0.17	0.19	0.20	0.19	0.28	0.5	0.39	0.21	0.24	0.16	0.25	0.15	0.21

TABLE A2.1 ASHTON FRESH TONNAGE (t) AND WATER INTAKE (kℓ) PER MONTH (1991)

TOTAL FRESH TONNAGE

YEAR / MONTH / PRODUCT	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	TOTAL
1991													
APPLES				410	1826	714			325	521	17		3813
APRICOTS BULIDA	-112	49	-32								1262	7711	8878
APRICOTS ROYAL	474	1	10										485
BEETROOT													
FIGS GREEN													
FIGS RIPE	29	248	8										285
GRAPEFRUIT													
GRAPES HANEPOOT													
GRAPES SULTANA	114	493	297										904
GUAVAS													
MELONS													
ONIONS				167									167
ORANGES SEVILLE													
ORANGES SWEET													
PEACHES	10995	12844	5109	137									29085
PEARS	535	2248	1790										4573
PEAS													
PINEAPPLES													
PLUMS		77	1		12								90
QUINCES			40	67	40								147
SAUERKRAUT			103						42	141			286
STRAWBERRIES													
TOMATOES				1911									1911
WATERBLOMME													
YOUNGBERRIES											112	48	160
	12035	15960	7326	2692	1878	714	125	35	367	662	1391	7759	50784
TOTAL FRESH TONNAGE	12035	15960	7326	2692	1878	714	125	35	367	662	1391	7759	50944
WATER INTAKE (KL)	73946	88608	85600	36937	25377	19764	3639	1140	8168	6518	2613	27775	380085
KL/TON	6.14	5.55	11.68	13.72	13.51	27.68	29.11	32.57	22.26	9.85	1.88	3.58	7.48

TABLE A2.2 ASHTON FRESH TONNAGE (t) AND WATER INTAKE (kℓ) PER MONTH (1992)

TOTAL FRESH TONNAGE

YEAR	1992												TOTAL
MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
APPLES				493	1904	1827	2584	1068					7876
APRICOTS BULIDA	675										864	8305	9844
APRICOTS ROYAL	1038												1038
BEETROOT													
FIGS GREEN													
FIGS RIPE	96	154		13									263
GRAPEFRUIT							70	98	-8				160
GRAPES HANEPOOT													
GRAPES SULTANA	294	682	329			-59							1246
GUAVAS													
MELONS				66	619	288			61				1034
ONIONS			31	74	49	19							173
ORANGES SEVILLE													
ORANGES SWEET													
PEACHES	11336	13267	5743	-323		-47							29976
PEARS	1261	3002	1351			-114							5500
PEAS													
PINEAPPLES													
PLUMS		37	53										90
QUINCES				105	83	50							238
SAUERKRAUT									129	74		64	267
STRAWBERRIES													
TOMATOES			369	1872	834	200							3275
WATERBLOMME													
YOUNGBERRIES											132	58	190
	14700	17142	7876	2300	3489	2164	2654	1166	182	74	996	8427	61170
TOTAL FRESH TONNAGE	14700	17142	7876	2300	3489	2164	2654	1166	182	74	996	8427	61170
WATER INTAKE (KL)	46871	100732	86396	53192	35019	19006	29333	18127	5603	2962	2730	33607	433578
KL/TON	3.19	5.88	10.97	23.13	10.04	8.78	11.05	15.55	30.79	40.03	2.74	3.99	7.09

TABLE A2.3 ASHTON MONTHLY % FRESH TONNAGE PER RAW MATERIAL AND TOTAL WATER INTAKE (1991)

PERCENTAGE (%) TOTAL FRESH TONNAGE

YEAR	1991												TOTAL
MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
APPLES				15.23	97.23	100.00			88.56	78.70	1.22		7.51
APRICOTS BULIDA	-0.93	0.31	-0.44								90.73	99.38	17.48
APRICOTS ROYAL	3.94	0.01	0.14										0.96
BEETROOT													
FIGS GREEN													
FIGS RIPE	0.24	1.55	0.11										0.56
GRAPEFRUIT													
GRAPES HANEPOOT													
GRAPES SULTANA	0.95	3.09	4.05										1.78
GUAVAS													
MELONS													
ONIONS				6.20									0.33
ORANGES SEVILLE													
ORANGES SWEET													
PEACHES	91.36	80.48	69.74	5.09									57.27
PEARS	4.45	14.09	24.43										9.00
PEAS													
PINEAPPLES													
PLUMS		0.48	0.01		0.64								0.18
QUINCES			0.55	2.49	2.13								0.29
SAUERKRAUT			1.41						11.44	21.30			0.56
STRAWBERRIES													
TOMATOES				70.99									3.76
WATERBLOMME													
YOUNGBERRIES											8.05	0.62	0.32
	100	100	100	100	100	100	0	0	100	100	100	100	100
TOTAL FRESH TONNAGE	12035	15960	7326	2692	1878	714	125	35	367	662	1391	7759	50944
WATER INTAKE (KL)	73946	88608	85600	36937	25377	19764	3639	1140	8168	6518	2613	27775	380085
KL/TON	6.14	5.55	11.68	13.72	13.51	27.68	29.11	32.57	22.26	9.85	1.88	3.58	7.46

TABLE A2.4 ASHTON MONTHLY % FRESH TONNAGE PER RAW MATERIAL AND TOTAL WATER INTAKE (1992)

PERCENTAGE (%) TOTAL FRESH TONNAGE

YEAR	1992												TOTAL
MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
APPLES				21.43	54.57	84.43	97.36	91.60					12.88
APRICOTS BULIDA	4.59										86.75	98.55	16.09
APRICOTSS ROYAL	7.06												1.70
BEETROOT													
FIGS GREEN													
FIGS RIPE	0.65	0.90		0.57									0.43
GRAPEFRUIT							2.64	8.40	-4.40				0.26
GRAPES HANEPOOT													
GRAPES SULTANA	2.00	3.98	4.18			-2.73							2.04
GUAVAS													
MELONS				2.87	17.74	13.31			33.52				1.69
ONIONS			0.39	3.22	1.40	0.88							0.28
ORANGES SEVILLE													
ORANGES SWEET													
PEACHES	77.12	77.39	72.92	-14.04		-2.17							49.00
PEARS	8.58	17.51	17.15			-5.27							8.99
PEAS													
PINEAPPLES													
PLUMS		0.22	0.67										0.15
QUINCES				4.57	2.38	2.31							0.39
SAUERKRAUT									70.88	100.00		0.76	0.44
STRAWBERRIES													
TOMATOES			4.69	81.39	23.90	9.24							5.35
WATERBLOMME													
YOUNGBERRIES											13.25	0.69	0.31
	100	100	100	100	100	100	100	100	100	100	100	100	100
TOTAL FRESH TONNAGE	14700	17142	7876	2300	3489	2164	2654	1166	182	74	996	8427	61170
WATER INTAKE (KL)	46871	100732	86396	53192	35019	19006	29333	18127	5603	2962	2730	33607	433578
KL/TON	3.19	5.88	10.97	23.13	10.04	8.78	11.05	15.55	30.79	40.03	2.74	3.99	7.09

TABLE A2.5 ASHTON MONTHLY PRODUCTION (BASIC CARTONS) AND WATER INTAKE (kℓ) (1991)

TOTAL BASIC CARTONS

YEAR	1991												TOTAL
MONTH	JAN	FEB	MARC	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
ASPARAGUS													
APPLES				13078	55843	20289			8022	13295	99		110626
APRICOTS BULIDA	3381	1549	1871		19553	5903					75084	424624	531965
APRICOT KERNELS													
APRICOTS ROYAL	25588	39											25627
BEANS TOM/SAUCE													
BEETROOT													
CHUTNEY													
FIGS GREEN													
FIGS RIPE	2139	15796	1014										18949
FRUIT COCKTAIL	58939	251218	174101	49	82								484389
FRUIT SALAD			29018		24								29042
GRAPEFRUIT SEGMENTS													
GRAPE JAM			5										5
GUAVAS													
MAYONNAISE													
MELON & GINGER													
MIXED FRUIT JAM	9321	11557	29300	675	3887	1841			320	9927	5604		72432
ORANGES SEVILLE													
ORANGES SWEET													
PEACHES	565682	559527	198817		653								1324679
PEARS											20		20
PEAS													
PINEAPPLE													
PLUMS		3038	2								855	-852	3043
PRUNES													
QUINCES			768	1526	1353								3647
SAUERKRAUT										4987	71		5058
STEWED FRUIT									1257				1257
STRAWBERRIES													
SULTANAS	1931	2728											4659
TOMATOES			3641	47851	14								51506
WATERBLOMME													
YOUNGBERRIES	738										9861	4329	14928
	667719	845452	438537	63179	81409	28033	3639	1267	9599	28209	91594	428101	2681832
TOTAL BASIC CARTONS	667719	845452	438537	63179	81409	28033	3639	1267	9599	28209	91594	428101	2686738
WATER INTAKE (KL)	73946	88608	85600	36937	25377	19764	3639	1140	8168	6518	2613	27775	380085
KL/BCARTON	0.11	0.10	0.20	0.58	0.31	0.71	1.00	0.90	0.85	0.23	0.03	0.06	0.14

TABLE A2.6 ASHTON MONTHLY PRODUCTION (BASIC CARTONS) AND WATER INTAKE (kℓ) (1992)

TOTAL BASIC CARTONS

YEAR	1992												TOTAL
MONTH	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
ASPARAGUS													
APPLES				12692	57503	57610	72784	19463					220052
APRICOTS BULIDA	47257					961	617				51336	413500	513671
APRICOT KERNELS	51277											202	51479
APRICOTS ROYAL						514	602						1116
BEANS TOM/SAUCE													
BEETROOT													
CHUTNEY													
FIGS GREEN													
FIGS RIPE	8574	9072											17646
FRUIT COCKTAIL	140556	313255	166010										619821
FRUIT SALAD			5549										5549
GRAPEFRUIT SEGMENTS							1756	1408					3164
GRAPE JAM			24										24
GUAVAS													
MAYONNAISE													
MELON & GINGER				1910	17480	9455							28845
MIXED FRUIT JAM			24907	960	21169	28107	7661						82804
ORANGES SEVILLE													
ORANGES SWEET													
PEACHES	540482	532949	196903										1270334
PEARS													
PEAS													
PINEAPPLE													
PLUMS	852	1502	3181			2997							8532
PRUNES				51	752			28	2227				3058
QUINCES				2669	2062	537							5268
SAUERKRAUT									4838	2133		1470	8441
STEWED FRUIT				394	1142								1536
STRAWBERRIES													
SULTANAS	3046	5727											8773
TOMATOES			9556	53709	18908								82173
WATERBLOMME													
YOUNGBERRIES	1198										5972	9757	16927
	793242	862505	406130	72385	119016	100181	83420	20899	7065	2133	57308	424929	2949213
TOTAL BASIC CARTONS	793242	862505	406130	72385	119016	100181	83420	20899	7065	2133	57308	424929	2949213
WATER INTAKE (KL)	46871	100732	86396	53192	35019	19006	29333	18127	5603	2962	2730	33607	433578
KL/BCARTON	0.06	0.12	0.21	0.73	0.29	0.19	0.35	0.87	0.79	1.39	0.05	0.08	0.15

TABLE A2.7 ASHTON MONTHLY % PRODUCTION (BASIC CARTONS) BY COMMODITY AND WATER INTAKE (1991)

PERCENTAGE (%) TOTAL BASIC CARTONS

YEAR	1991												TOTAL
MONTH	JAN	FEB	MARC	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
ASPARAGUS													
APPLES				20.70	68.60	72.38			83.57	47.13	0.11		4.13
APRICOTS BULIDA	0.51	0.18	0.43		24.02	21.06					81.97	99.19	19.84
APRICOT KERNELS													
APRICOTS ROYAL	3.83												0.96
BEANS TOM/SAUCE													
BEETROOT													
CHUTNEY													
FIGS GREEN													
FIGS RIPE	0.32	1.87	0.23										0.71
FRUIT COCKTAIL	8.83	29.71	39.70	0.08									18.06
FRUIT SALAD			6.62										1.08
GRAPEFRUIT SEGMENTS													
GRAPE JAM													
GUAVAS													
MAYONNAISE													
MELON & GINGER													
MIXED FRUIT JAM	1.40	1.37	6.68	1.07	4.77	6.57			3.33	35.19	6.12		2.70
ORANGES SEVILLE													
ORANGES SWEET													
PEACHES	84.72	66.18	45.34		0.80								49.39
PEARS											0.02		
PEAS													
PINEAPPLE													
PLUMS		0.36									0.93	-0.20	0.11
PRUNES													
QUINCES			0.18	2.42	1.66								0.14
SAUERKRAUT										17.68			0.19
STEWED FRUIT									13.10				0.05
STRAWBERRIES													
SULTANAS	0.29	0.32											0.17
TOMATOES			0.83	75.74	0.02								1.92
WATERBLOMME													
YOUNGBERRIES	0.11										10.77	1.01	0.56
	100	100	100	100	100	100	100	100	100	100	100	100	100
TOTAL BASIC CARTONS	667719	845452	438537	63179	81409	28033	0	0	9599	28209	91594	428101	2681832
WATER INTAKE (KL)	73946	88608	85600	36937	25377	19764	3639	1140	8168	6518	2613	27775	380085
KL/BCARTON	0.11	0.10	0.20	0.58	0.31	0.71	0.00	0.00	0.85	0.23	0.03	0.06	0.14

TABLE A2.8 ASHTON MONTHLY % PRODUCTION (BASIC CARTONS) BY COMMODITY AND WATER INTAKE (1992)

PERCENTAGE (%) TOTAL BASIC CARTONS

YEAR	1992												TOTAL
MONTH	JAN	FEB	MARC	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	
PRODUCT													
ASPARAGUS													
APPLES				17.53	48.32	57.51	87.25	93.13					7.46
APRICOTS BULIDA	5.96					0.96	0.74				89.58	97.31	17.42
APRICOT KERNELS	6.46											0.05	1.75
APRICOTS ROYAL						0.51	0.72						0.04
BEANS TOM/SAUCE													
BEETROOT													
CHUTNEY													
FIGS GREEN													
FIGS RIPE	1.08	1.05											0.60
FRUIT COCKTAIL	17.72	36.32	40.88										21.02
FRUIT SALAD			1.37										0.19
GRAPEFRUIT SEGMENTS							2.11	6.74					0.11
GRAPE JAM			0.01										
GUAVAS													
MAYONNAISE													
MELON & GINGER				2.64	14.69	9.44							0.98
MIXED FRUIT JAM			6.13	1.33	17.79	28.06	9.18						2.81
ORANGES SEVILLE													
ORANGES SWEET													
PEACHES	68.14	61.79	48.48										43.07
PEARS													
PEAS													
PINEAPPLE													
PLUMS	0.11	0.17	0.78			2.99							0.29
PRUNES				0.07	0.63			0.13	31.52				0.10
QUINCES				3.69	1.73	0.54							0.18
SAUERKRAUT									68.48	100.00		0.35	0.29
STEWED FRUIT				0.54	0.96								0.05
STRAWBERRIES													
SULTANAS	0.38	0.66											0.30
TOMATOES			2.35	74.20	15.89								2.79
WATERBLOMME													
YOUNGBERRIES	0.15										10.42	2.30	0.57
	100	100	100	100	100	100	100	100	100	100	100	100	100
TOTAL BASIC CARTONS	793242	862505	406130	72385	119016	100181	83420	20899	7065	2133	57308	424929	2949213
WATER INTAKE (KL)	46871	100732	86396	53192	35019	19006	29333	18127	5603	2962	2730	33607	433578
KL/BCARTON	0.06	0.12	0.21	0.73	0.29	0.19	0.35	0.87	0.79	1.39	0.05	0.08	0.15