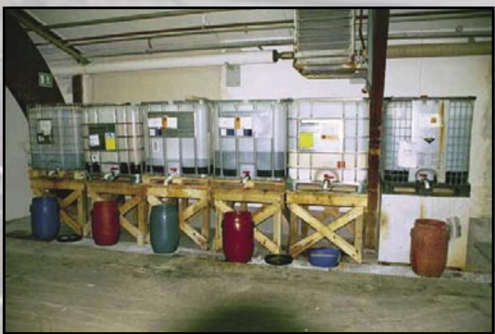
Applicability of Waste Minimisation Clubs in South Africa: Results from Pilot Studies



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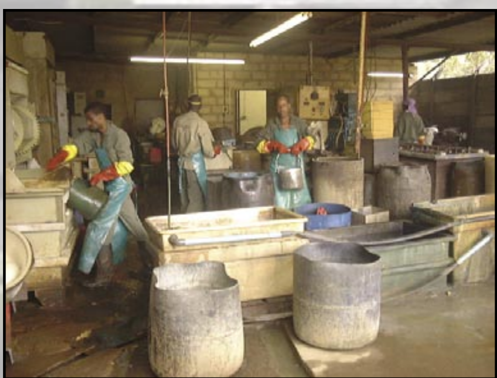

Waste Minimisation Clubs
Working Together

TT 161/05
Water Research Commission

APPLICABILITY OF WASTE MINIMISATION CLUBS IN SOUTH AFRICA:
RESULTS FROM PILOT STUDIES

Report to the Water Research Commission

by

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Executive Summary

1. Summary

Two pilot waste minimisation clubs were formed in the province of KwaZulu Natal, South Africa. The first was in the Metal Finishing sector in Pinetown and Durban, and the second, in the industrial area of Hammarsdale. This report details the establishment and management of these clubs and the results achieved.

The following points summarise the main results of the project:

i. In total, 1 030 Ml of water was saved by 17 companies over the 3 years, leading to a reduction of 990 Ml of effluent discharged to drain;
ii. A total of 65.7 GWh of energy was saved by 10 companies over the 3 years, resulting in a reduction of 45 000 tons of CO_2, 425 tons of SO_2 and 190 tons of NO_x being emitted to atmosphere (with related savings in water and coal);
iii. A total financial saving of R 13 million was made by 20 companies;
iv. The majority of the savings were achieved through improved housekeeping practices (no- or low-cost);
v. The concepts of waste minimisation were transferred to the companies through club meetings, training and site visits;
vi. A total of at least 878 people were capacitated through the project;
vii. Sector-specific clubs seem to be more successful for the smaller companies, while the larger organisations prefer to be in a regional club;
viii. A waste minimisation club should be limited to between 10 and 15 companies;
ix. Training in waste minimisation is essential for the success of the project and should involve all employees, from management to shop-floor level;
x. The main barriers experienced were a lack of time, finance, resources and commitment;
xi. The main drivers identified were cost savings, pressure from local authorities and to reduce pollution;
xii. Both the stick and carrot approach is necessary for companies to take on waste minimisation;
xiii. On average, savings accounted for between 2% and 5% of the annual turnover of the companies;
xiv. The regulators attitude has changed from one of *command and control* to discussions leading to self-regulation;
xv. The project had a payback of just over a month and a return on investment of over 100%; and
xvi. There are a number of initiatives underway to promote the waste minimisation club concept.

2. Background

The concept of sustainable development stresses the interdependence of economic growth and environmental quality. Industries are challenged to produce higher levels of output while using lower levels of inputs and producing less waste. Cleaner Production is recognised as an important approach to reducing environmental impact and leading industries in the direction of sustainable development. Cleaner Production is a general term that describes a preventative approach to industrial activity. It encompasses concepts such as pollution prevention and waste minimisation, but there is also emphasis on a change in attitude in the manner in which products are manufactured. In addition to achieving a lower level of pollution, Cleaner Production results in economic benefits as there is a more efficient use of raw materials and less waste being produced. One method of promoting Cleaner Production in industry is through the formation of waste minimisation clubs.

Waste minimisation is a systematic approach to reducing waste at source. It is applicable to all inputs (e.g. water, energy, chemicals, raw materials etc.) and outputs (products, emissions to water, land and air) of a process. The implementation of a waste minimisation programme results in a number of benefits, such as improved process efficiency, reduced operating costs, reduced environmental impact and improved public image. Waste minimisation is achieved through the implementation of a number of steps. The first steps include obtaining commitment to the programme from senior management, appointing a project champion to manage the programme and selecting a project team to assist in data collection. All process within the factory are then investigated and data collected on all inputs and outputs in terms of quantity and value. At the end of this phase, the project team should target those processes, operations or waste streams that require more detailed assessment. Targeted processes can be based on the hazardous nature of the waste, the value of the waste, the large volumes of water consumed or the use of excessive energy. These areas can then be assessed in more detail and options for improvement identified. A feasibility analysis is then conducted to determine if the option is economically, technically and environmentally feasible. Those options that are found to be feasible can then be implemented. It must be remembered that waste minimisation is not a once off activity and the programme should be continuously monitored and targets reassessed and reset at regular intervals.

A waste minimisation club is a concept that was first developed in the Netherlands in the early 1990's to encourage industries to reduce pollution. It involves a small number of companies, generally within the same geographical area, working together to exchange ideas and information on waste minimisation, and in this way, encourage one another to improve process efficiency, save money and reduce their environmental impact. It has shown to be a successful concept, with over 80 clubs established in the United Kingdom and similar initiatives in New Zealand and India.

Based on the success of this concept in other countries, it was felt that this could be a feasible method of promoting sustainable industrial development within South Africa, especially within the small, micro and medium -sized enterprise (SMME) sector. International experience has indicated that cumulatively these organisations use excessive amounts of energy and are significant sources of pollutants (air, water and solid waste). Waste minimisation practices not only promote the efficient use of recourses such as water and energy, but also leads to a reduction in emissions. By forming a club, companies are able to work together to reduce waste and save money through discussions, training and the combined use of outside consultants.

3. Project Aims

The waste minimisation club project was initiated in February 1998 with the primary aim of improving water quality through the prevention of water pollution by industries and reducing the demand for industrial water. The secondary aims of the project were to:

- develop the concept of waste minimisation clubs in South Africa,
- contribute to the establishment of competitive industrial small, micro and medium sized enterprises (SMME's),
- promote the concepts of cleaner production, waste minimisation and sustainable development amongst SMME's, and
- promote energy efficiency.

These aims were to be fulfilled through the establishment of 3 pilot waste minimisation clubs in kwaZulu-Natal.

4. Acknowledgements

This was a three-year project (1998 to 2000), funded by the Water Research Commission (WRC) and managed by the Pollution Research Group (PRG). The project was co-funded by the European Union Directorate General XVII for Energy (Thermie) which made provision for the involvement of two European consultants, namely Enviros March (United Kingdom) and Cowi (Denmark). Enviros March's focus was on energy savings and technical training, while Cowi's involvement was through the South African organisation, Kagiso Trust, and focused on general environmental awareness training for management and shop-floor employees. The School of Life and Environmental Sciences (SLES) at the University of Natal was also involved in analysing the more *social* aspects of the club, i.e. interactions between club members, and also monitoring the response to the training sessions given by Kagiso-Cowi. The ML Sultan Technikon in Durban is also involved in the project through funding from the Foundation for Research and Development (now the NRF).

5. Project Approach

A literature review was first undertaken to obtain background information on waste minimisation clubs in other regions, study the manner in which they were established and managed, and identify the lessons learnt during the course of running these clubs.

Sites for the 3 pilot clubs had then to be identified. This was to be based on which industrial area, or industrial sector, had a significant impact on the environment, especially in terms of water and energy consumed, and pollution of water resources.

The first waste minimisation club was established in the Metal Finishing Sector in the Durban Metropolitan Area (DMA) in June 1998. The second club was formed in the Hammarsdale industrial area in March 1999. The Steering Committee members unanimously agreed that a third club should not be established during the course of this project, but rather emphasis be placed on educating industries and regulators in waste minimisation through workshops and presentations.

Different approaches were used in the management and running of the 2 pilot clubs, mostly due to the differences in the size and structural organisation of the companies involved. In addition, the European partners and the SLES were involved in the Hammarsdale Club to a far greater extent than the Metal Finishing Club, resulting in a different management style. However, the basis of establishing the clubs and method of analysing the results were similar.

Waste minimisation club meetings were held on a bimonthly basis, with half of the meeting being spent on providing information to the club members on waste minimisation aspects, and the companies providing feed back as to their results, problems, experiences, etc. in the second half. Site visits were undertaken to the club member sites to assist in waste minimisation audits and identifying areas for improvements. Studies of the barriers and drivers to waste minimisation were undertaken and interviews conducted with club members to obtain their views on the success of the club approach. Training in waste minimisation was also provided to members of both clubs.

As a result of the project, a number of club members initiated waste minimisation programmes within their companies, resulting in both financial and environmental savings. These results were analysed for both clubs, together with the social aspects such as improved relationships with the local authorities and with each other.

Two workshops were held on the waste minimisation club concept; the first at the offices of the Water Research Commission in Pretoria (October 1999) and the second at the Water Institute of Southern Africa (WISA) conference in Sun City (May 2000). Representatives of local and national government bodies, industry, consultants and academics attended these workshops. In addition, a number of papers were presented at local and international conferences and presentations given at individual industrial sites and forums.

6. Summary of Results

This section will summarise the results achieved in the establishment and management of the Metal Finishing and Hammarsdale waste minimisation clubs. The methodology of forming a club is discussed first, followed by details of each club.

6.1 Establishing a Waste Minimisation Club

As mentioned in Section 4, a waste minimisation club is a group of companies, either within the same industrial sector or from different industries that are taking action to reduce waste and save money. While some of these clubs may be managed by the companies themselves, the majority are run by a partnership of organisations, coordinated by a lead organisation or a steering group. This steering group comprises the funding bodies, organisations that support industrial development and any other interested parties such as the local authorities. The leading organisation or steering group then sets goals for the club and organises the meetings. An external consultant may be contracted to aid in undertaking the waste minimisation audits.

Each club member is a company in which a *project champion* must be appointed who has the responsibility of driving the project in their company. P*roject teams* must be established and trained in waste minimisation; goals set for the programme; and the results disseminated, both internally and to the other club members. These project teams are comprised of representatives from each department in the company that have access to process information. Depending on the size of the organisation, project teams can range from 2 people to 8 people, and their composition may change depending on the nature of the information required. A typical structure of a waste minimisation club is given in Figure 1.

Club meetings are held on a regular basis, generally bimonthly, where the project champions report-back on the progress in their companies. These meetings may also be used by the steering group as training sessions for the champions, or to invite guest speakers to give presentations on relevant topics.

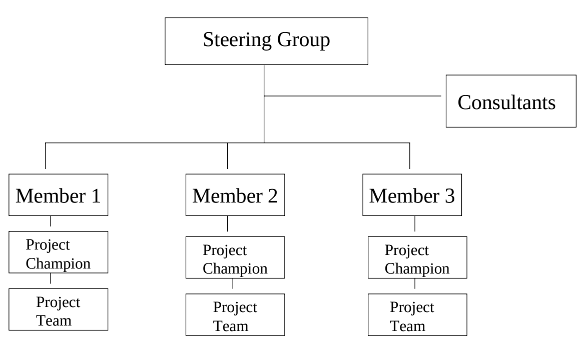

Figure 1: Typical Structure of a Waste Minimisation Club

A number of stages are involved in establishing the waste minimisation clubs. These can be broadly divided into the following steps.

6.1.1 Recruitment

The first stage in establishing a waste minimisation club involves identifying an area in which there is a significant environmental impact, either in terms of the high consumption of resources, or the type of effluent / waste produced. This area could be based either on the type of industry (i.e. a number of factories within the same industrial sector that are considered to be polluting), or geographical (i.e. different factories in close proximity to one another and discharging to the same sewage works). A meeting is then called with the companies and the proposed club discussed and initiated. In general, waste minimisation clubs consist of between 10 and 15 companies.

6.1.2 Organisation for action.

This involves establishing the club structure and management roles of the facilitators. Project champions are elected and teams formed within the companies.

6.1.3 Assessment

The assessment phase involves undertaking on-site waste minimisation audits to identify sources and quantity of waste and determine the scope for savings. This can be carried out by the project teams themselves, or by an external consultant. Ideally, the assessments should be conducted in-house such that waste minimisation becomes incorporated into the way in which the company is managed. Options for improvement are identified and feasibility analyses carried out to determine which changes are to be implemented.

6.1.4 Implementation

In the implementation phase, club members undertake the waste minimisation actions identified during the assessment phase.

6.1.5 Analysis

The final phase of establishing the clubs is to analyse the results achieved. This involves quantifying the savings achieved by the individual club members, not only in terms of financial benefits to the companies, but also the environmental benefits.

6.1.6 Training

Training is an important aspect of a waste minimisation club. It involves educating management and shop floor personnel in waste minimisation issues and ensures the long-term success of a waste minimisation programme. If all staff is not involved in the programme and encouraged to practice waste minimisation, it will not be a sustainable process.

Each of these stages will be discussed in more detail in the following sections for the Metal Finishing and Hammarsdale waste minimisation clubs.

6.2 The Metal Finishing Waste Minimisation Club

The waste minimisation club for the metal finishing sector in the Durban Metropolitan Area (DMA) was established following the issuing of new bylaws targeting effluents containing heavy metals, with stringent regulations being applied as to the acceptable levels of metal concentration. However, within these new bylaws, there is the provision for a company to apply for relaxations on these limits provided that a number of criteria are met, one of which is that the company must show that it is implementing a programme of waste minimisation. It was therefore felt that this was an appropriate sector in which to form a waste minimisation club. This club did therefore not have a *recruitment* phase as such, but was formed in response to a need by the metal finishing industry for a solution to their effluent problems.

The club consists of 29 members, 23 of which are electroplaters; 3, galvanisers; and 3, powder coaters. Of these members, more than 50% have less than 50 employees and 60% are jobbing shops. A breakdown of the statistics of the club members is given in **Table 1.**

Table 1: Profile of the Metal Finishing Waste Minimisation Club Members

No. of employees	No. of companies		Cumulative Total	
	Number	(%)	Number	(%)
< 10	4	14	4	14
10 to 20	8	28	12	42
20 to 50	5	17	17	59
50 to 200	9	31	26	90
> 200	3	10	29	100

6.2.1 Organisation for Action

The metal finishing waste minimisation club did not conform to the typical club structure (see Figure 1), the Pollution Research Group (PRG) managed and facilitated the club and acted as the consultants. In addition, the club was much larger than those formed elsewhere, although of the 29 club members who initially signed-up, only 15 actively took part in the club activities. Due to the size of the companies in the club, the project champions were often the owners of the companies and project teams consisted of 2 people in the factory. In the larger companies, project champions were typically the engineers or the health and safety officer, and teams ranged from 3 to 6 people.

Club meetings were initially held quarterly, but in 1999 they were changed to bimonthly to encourage progress. During the course of the project (June 1998 to November 2000), 12 club meetings were held, 3 special meetings (i.e. outside of club meetings to address specific issues) and 7 training sessions.

Club members were asked to sign a declaration of commitment which outlined the aims and goals of the club. These included a commitment to implementing a programme of waste minimisation, reducing all sources of waste, making continual improvements, establishing a monitoring programme, reducing their environmental impact, sharing information with other club members, and attending regular club meetings.

It must be noted that the Metal Finishing Club did not receive the same assistance from Enviros March and Kagiso-COWI as the Hammarsdale Club. The EU funding only became available from the beginning of 1999, when the Metal Finishing Club had already been running for a year. However, training was provided outside of club meetings by Enviros March to the members and site visits were undertaken to a few factories to access the potential for energy savings. Other than this input, the EU partners did not have any involvement in the running of this Club.

6.2.2 Assessments

Initial waste minimisation audits of each factory were undertaken by final year engineering students in July 1998. At the end of this time, each student produced a report detailing the processes used in the factories; mass and energy balances over the various processes; areas where waste was occurring; waste minimisation options; and the savings that would be achieved if these options were implemented. At the same time, it was stressed to the members that in order for waste minimisation to be successful they had to take ownership of the programme and not depend on the students. These reports were considered a starting point for further waste minimisation studies. A postgraduate chemical engineering student was assigned full-time to this club and was available to conduct follow-up site visits at various stages throughout the project.

6.2.3 Implementation

Once identified, waste minimisation options were implemented by the club members. Those that required little or no capital investment were implemented immediately, while those that were more capital intensive required determining the payback on investment. In most cases, the PRG was not involved in the implementation phase other than to provide advice when requested. Options that were implemented included fixing leaks, closing off unnecessary taps, controlling chemical addition, monitoring water use and flows, optimising use of heated equipment, improving process operations, reusing of rinse water and other baths, and training staff. Those companies that have made the most savings have attributed these to an increased awareness of the process requirements, improved monitoring of all utilities and a greater management presence on the shop floor.

6.2.4 Analysis of Results

Information on financial savings were obtained from the companies themselves and were generally based on monthly water, electricity, raw materials, bills, etc. Not all companies were able to quantify their savings and others did not report their results to the PRG, with the result that the actual savings of the club are in excess of those reported. Savings to the environment are difficult to quantify, but an attempt has been made to quantify these figures.

6.2.4.1 Financial Savings

Financial savings in excess of R 2 million/y in water, chemicals, energy and effluent were reported by the club members, with the potential to save a further R 650 000/y. These are results reported by 16 companies. Two of the companies reported that their savings were of the order of 5% to 7% of their annual turnover. A summary of the savings is given in Table 2.

Table 2: Summary of Financial Savings for 16 Metal Finishing Waste Minimisation Club Members

Company	Type	Employ No.	Water R/y	Chem R/y	Metals R/y	Energy R/y	Effluent R/y	Treatment R/y	Other R/y	Total
MF9	man	300	25	970			6			1001
MF1	job	10	5720			5060	1560			12340
MF2	man	800	127160			110000	34695			271855
MF4	job	10	5560	110000		88000	1515			205075
MF5	man	80	5180	0		5500	1410	24750		36840
MF6	man	26	11000	55000			3000			69000
MF8	man	180		777600	168630	78870		99880	30910	1155890
MF10	man	350	10970				4050	10260		25280
MF12	job	30	17490	30800	12100		480	33000	16860	110730
MF16	job	18	955	88000			260			89215
MF17	job	7	760				210			970
MF22	job	50	60400	68400		33000	33830			195630
MF24	job	9	550	220			150			920
MF26	job	6		550						550
MF27	job	37	4770							4770
MF28	job	14	640	13200			170			14010
	Totals		**251180**	**1144740**	**180730**	**320430**	**81336**	**167890**	**47770**	**2194076**
	% of total		11	52	8	15	4	8	2	

[1]man = manufacturer; job = job shop

It must be noted that these savings are total amounts over the course of the project. However, they can be taken as annual savings as the companies will realise these savings each year from now onwards. In most cases, chemical savings include savings in metals, but these were not quantified individually by all companies. The large chemical savings achieved by MF8, also include savings in oil and solvent due to investigating alternative suppliers. One must also be aware that these results are expected to be understated for strategic reasons.

It is evident from Table 2, that there is a wide range of savings achieved, from as little as R 300/y to as much as over R 1 million/y. In the case of those companies with low financial benefits, it was found that the social benefits were of more importance to the club member. It is also evident that the size of the company does not dictate the degree of savings, with some of the smaller companies showing substantial savings. In most cases, payback periods were less than a year.

As can be seen from the Table 2, an emphasis was placed on the reduction of water and chemical consumption. While this leads to reductions in effluent concentrations and volumes, a number of companies have not quantified that resultant saving. The highest combined financial saving was achieved in chemical costs (52%) as illustrated by the *% of total figure* in Table 2. The South African metal finishing industry is exposed to world prices when it comes to chemicals and metals, and therefore costs of chemicals are high. Thus there are considerable savings to be made by reducing chemical consumption. Savings in energy are the next highest followed by water and effluent. While reductions in water consumption have been made, water is relatively inexpensive in South Africa. Therefore great quantities must be saved to achieve a substantial financial saving.

Savings in water lead to savings in effluent charges as less effluent is being discharged to drain. These savings are reflected in the **Effluent** column and were calculated by taking 95% of the water savings and multiplying by the average cost of discharge (83c/kl). Water savings were calculated using a municipal water cost of R 2.89 / kl. The savings in the **Treatment** column refer to savings made in effluent treatment costs due to decreased volumes, chemicals and metals discharged to drain. Energy savings were made by a few companies and these were mostly through implementing power factor correction, although in some cases there was rationalisation of energy use in the factory, such as insulating tanks, rescheduling drying and so on. For MF8, the savings in the **Other** column refer to savings in solid waste disposal due to more effective sludge drying, and for MF12, reflects savings that could not be attributed to a single type and includes water, effluent and chemical savings.

6.2.4.2 Waste Minimisation Option

The club members implemented a variety of options in order to achieve their savings. A total of 384 waste minimisation options were identified for 24 companies. This figure includes options identified by the students, the companies themselves and the PRG project team. Of these, 158 (41%) have been implemented, 26 (7%) are under investigation and 8 (2%) were found to be not feasible. The status of the remaining 192 (50%) options is unknown. This is mostly due to a lack of feedback from the companies to the PRG and it is felt that more options have been implemented than have been reported, or that these options will be investigated at a later date. Of the 24 companies, 4 did not implement any changes that the project team is aware of, and this is felt to be due to a lack of commitment on the part of the management.

There are 5 main changes that can be made to a process to achieve waste minimisation. These are raw material (or input material) changes, housekeeping, technology, product and on-site recycling. The options identified for the 24 companies were then divided into these categories. The majority of options identified fall into the housekeeping category (72%). These options are generally no- or low-cost changes, with payback periods of the order of months. Technology changes accounted for 16%, recycle 9% and raw material changes, 3%.

6.2.4.3 Environmental Savings

One of the objectives of this waste minimisation club was to reduce the environmental impact of the metal finishing industry. Reductions in costs have been of particular interest to the companies themselves, but the adoption of waste minimisation by the club's members has also lead to significant environmental benefits. Reductions have been achieved in water consumption, metals discharged to drain, chemicals discharged to drain, volumes of effluent discharged to sewer, volumes of sludge disposed of to landfill, cyanide use, solvent emissions, cadmium use, and energy consumption.

It has been difficult to quantify these results due to a lack of records by companies and their reluctance to specify their previous *bad* conditions. The successful implementation of options and the corresponding financial savings proves that reductions have been made. Based on the information available, it has been estimated that of the order of 86 900 kl/year have been saved in water consumed by the club members. If effluent volumes are taken as 95% of water consumed, this implies that there has been a reduction of 82 600 kl/ year of effluent discharged to drain.

It is more difficult to quantify savings in terms of metals and chemicals discharged to the environment as not many companies quantified these amounts. From 5 companies that did report their savings, there has been a reduction of 112 tons/annum of metals and chemicals to drain.

It must be noted that while changes in concentrations discharged to drain were not recorded, the companies remained within the discharge limits set by the Metro even though water use had been reduced. This implies that reductions in chemicals and metals to drain must have been realised.

In terms of energy savings, a reduction in the use of electricity leads to a reduction in the emission of carbon dioxide and other green house gasses Figures available from the 1999 Eskom Environmental Report show that 0.8 kg of CO_2, 0.008 kg SO_2 and 0.004 kg NO_x is formed per kWh of electricity produced. If one takes the average cost of electricity to be R 0.2/kWh (not completely accurate as the companies are charged varying tariffs) and based on the total cost savings made in electricity by the club members, a total of 16 000 MWh/y have been saved. This will lead to a reduction of 1 400 tons of CO_2, 13 tons SO_2 and 6 tons NO_x being emitted to the environment. In addition, there will be associated savings in water and coal. These results are summarised in Table 3.

Table 3: Summary of Environmental Savings for the Metal Finishing Club members

Item	Cost Saving / year	Environmental Saving / year
Water and effluent	332 516	169 500 kl
Chemicals and Metals	1 325 000	112 tons (for 5 companies)
Energy	320 430	16 000 MWh
Carbon dioxide		1 400 tons
Sulphur dioxide		13 tons
Nitrous oxide		6 tons

6.2.5 Other Advantages

Further benefits of the Metal Finishing Club include an improved relationships with the Durban Metro Wastewater Department (the Metro), the chemical suppliers and with one another. Prior to the establishment of the club, there was open hostility between the metal finishers and the Metro. During the course of the project, this situation has changed to one of good communication due to a better understanding on both sides as to one another's constraints. Some of the Club members were instrumental in rewriting the guidelines for the application of effluent bylaws with the Metro such that it was agreeable to all parties. Prior to the formation of the club, the majority of the members stated that they had been aware of the other metal finishers, but had never really spoken to them. For those members that were not metal finishers by trade, the club meetings were considered to be a good learning experience. Due to this interaction and the feeling by the club members that they did not want to lose the opportunity for discussions, a metal finishing association (MFA) was formed in August 2000. The MFA has approximately 70 members and meets on a monthly basis. One of their aims is the promotion of waste minimisation and the formation of further waste minimisation clubs.

A representative of a chemical supplier was also elected a member of the club due to the assistance and support shown to the companies involved. This supplier recognised the need to offer a *service* rather than merely trying to sell chemicals and as a result was actively involved in investigating areas were the supplier may assist in waste minimisation. The same supplier was elected vice-chairperson of the MFA, indicating that the involvement of all involved in the metal finishing pipe-line are important in reducing the impacts on health, safety and environment.

A further benefit of the club has been one of a *competitive advantage*. One club member now includes the fact that they manufacture their products in such a way as to reduce their environmental impact in their promotional activities.

6.3 The Hammarsdale Waste Minimisation Club

The Hammarsdale Waste Minimisation Club followed a set procedure for its establishment. There are a number of textile factories in the area, all of which discharge to the Hammarsdale Waste Water Treatment Works (the Works). The Works do not comply with the limits set by the South Africa Department of Water Affairs and Forestry (DWAF) for the final discharge, especially in terms of colour and conductivity. There was pressure on the industries to either reduce or treat these effluents at source, and it was, therefore, felt that the region would benefit by forming a waste minimisation club.

A meeting was held in November 1998 with the textile companies in Hammarsdale and the formation of a waste minimisation club for the textile industry proposed. All present agreed that it was a good concept, but that it should not be restricted to the textile companies. The Hammarsdale Industrial Conservancy (HIC) was already in place and it was felt that this forum should be used as a basis for the club structure. As a result, the club was formed consisting of 6 textile companies, a chicken abattoir and a chemical manufacturing plant. A profile of the club members is given in Table 4.

Table 4: Profile of the Hammarsdale Club Members

Company	Industry	Type of Operation	No. Of Employees
COMP1	Chemical	Blending /formulation of specialty chemicals	250
COMP2	Textile	Cotton/Filament thread finishing and dyeing	428
COMP3	Textile	Denim cotton fabric finishing and dyeing	680
COMP4	Textile	Nylon/polyester weaving, dyeing and finishing	544
COMP5	Textile	Polyester/polyviscose finishing and dyeing	600
COMP6	Textile	Cotton finishing and dyeing	510
COMP7	Textile	Wet processing of knit, medical and acrylic fabrics	120
COMP8	Food	Chicken Processing	ca 800

6.3.1 Organisation for Action

The Hammarsdale Club consists of larger organisations than those in the Metal Finishing Club, where the project champions are representatives of the company and hold positions such as site engineers, quality control managers, and health and safety officers. Project teams consist of the heads of the various departments within the company. The steering group consists of the consultants (PRG, Enviros March, Kagiso-Cowi) and other members of the HIC.

During the course of the project, 9 club meetings were held (on a bimonthly basis) where training was provided on waste minimisation aspects by Enviros March and companies gave feedback on their progress and problems.

6.3.2 Assessments

The PRG and Enviros March conducted site visits to each of the Hammarsdale club members' factories, with the view to identifying waste minimisation options. Water and energy were the main areas of focus. Site reports were prepared for the club members, and these were used as the basis for their waste minimisation programmes. A postgraduate chemical engineering student was assigned full-time to the club and was available to assist the club members as required. The project champions were trained in the methodology of waste minimisation and given the necessary skills to implement programmes on site.

6.3.3 Implementation

Once identified, waste minimisation options were implemented by the club members. Those that required little or no capital investment were implemented immediately, while the investment payback was calculated for those that were more capital intensive. In most cases, the consultants were not involved in the implementation phase other than to provide advice when requested. Options that were implemented include optimising dyeing procedures, reuse of washing water, increasing condensate return to the boilerhouse, improved maintenance of all piping (water and steam), replacing disposable consumables with recyclable alternatives and increased monitoring of all utility use. Capital intensive options, such as the installation of new equipment, have also been implemented (or in the process of being implemented), with payback periods of the order of 1 to 2 y.

6.3.4 Analysis of Results

Results were based on the feedback provided by the club members as to their savings, personal interviews, and site visits. Focus has been on financial savings, although in some cases quantification of the savings in terms of volumes and masses have been reported. Environmental savings have been estimated based on these results.

6.3.4.1 Financial Savings

Financial savings in excess of R10 million/y were reported by the club members, with a further R10 million/y savings identified. These are summarised in Table 5. It must be noted that these savings are total amounts over the course of the project. However, they can be taken as annual savings as the companies will realise these savings each year from now onwards.

Table 5: Summary of Reported Savings by the Hammarsdale Club Members

Company	Water R/y	Energy R/y	Consumables R/y	Raw Material R/y	Effluent R/y	Other R/y	Totals R/y
COMP1	5 460	1 151 700		109 620	171 300	39 600	1 477 680
COMP4	212 400	89 700	272 000	113 500	212 400		900 000
COMP6	468 100			1 000 000	431 400	1 200 000	3 099 500
COMP3	1 655 800	1 648 000			1 879 000		5 182 800
COMP2		143 000					143 000
COMP5							0
COMP7							0
COMP8							0
Totals	**2 341 760**	**3 032 400**	**272 000**	**1 223 120**	**2 694 100**	**1 239 600**	**10 802 980**
% of Total	22	28	3	11	25	11	

Note: Other covers those areas where combined savings in water, chemicals and energy have been made and cannot be quantified individually

As can be seen, significant cost savings in energy, water, raw materials and effluent were made by 60% of the companies, with the remaining 40% identifying large potential savings. The largest savings were in energy (28%), followed by effluent and water (25% and 22% respectively). Where the savings have been achieved, they range from between 2% and 3% of the annual turnover of the company. The payback periods on implementing these options ranged from immediate to 2 years.

6.3.4.2 Waste Minimisation Options

During the course of the project, a total of 116 options were identified for the companies. Of these, 40 (34%) were implemented, 29 (25%) are under investigation and 47 (41%) the status is unknown. As for the Metal Finishing Club, this does not imply that further options have not been implemented, but rather that the status has not been reported to the project team. It is felt that a large number of these options are either under investigation or being implemented by the companies.

The waste minimisation options identified were then divided into the five main cleaner production categories. The majority (50%) of the options identified were based on improved housekeeping activities. These are generally the no- or low-cost options that are easily implemented with payback periods of months. Technology changes accounted for 35% of the identified options, and recycle 12% of the total.

6.3.4.3 Environmental Savings

By actively reducing waste at source, the Club Members are also reducing their impact on the environment. By reducing water consumption, the volume of effluent that is discharged to sewer is also decreased. Improving the efficiency of steam systems and reducing site power consumption both result in significant reductions in greenhouse gas emissions.

Use of recyclable packaging or consumables, monitoring and controlling raw material use and decreasing wastage during manufacture results in less solid waste requiring disposal to landfill. Monitoring and optimising dye and chemical usage will result in reduced discharges to sewer which reduces the load on the sewage works. Salt and dye are of major concern in the Hammarsdale region as they pass through the sewage works and enter the Sterkspruit River, which leads to the Shongweni Dam (a recreational area). Any measures that are introduced to reduce their use at source will be beneficial to the immediate environment.

Based on the total cost savings in water reported in Table 4 and the average cost of water (R2.50/kl), approximately 940 Ml/year of water was saved. Taking effluent discharge to be 96% of this, a reduction of 900 Ml/year of effluent was achieved. In total, the club members saved 49.7 GWh of electricity. Figures available from the 1999 Eskom Environmental Report show that 0.8 kg of CO_2, 0.008 kg SO_2 and 0.004 kg NO_x is formed per kWh of electricity produced. This means that saving of 49.7 GWh will lead to a reduction of 43 600 tons of CO_2, 412 tons SO_2 and 184 tons NO_x being emitted to the environment. In addition there will be associated savings in water and coal. Savings not quantified are those made in chemicals and dyes. These results are summarised in Table 6.

Table 6: Summary of Environmental Savings for the Hammarsdale Club

Item	Cost Saving R / year	Environmental Saving / year
Water and effluent	5 035 860	1 840 Ml
Energy	3 032 400	49.7 GWh
Carbon dioxide		43 600 tons
Sulphur dioxide		412 tons
Nitrous oxide		184 tons

7. Training

Both the Metal Finishing and Hammarsdale Club received training from Enviros March in the methodology of establishing and running a waste minimisation programme, and in more technical aspects such as improving energy efficiency within their factories.

Training was also provided to the Hammarsdale Club members by Kagiso-Cowi, who focussed on raising environmental awareness at both the management and shop-floor level. The subject material was developed after consultation with the project champions and training staff of the club member companies. To assist in future training initiatives of a similar nature and to continue environmental training in general, the subject material, with the participation of trainers from certain club members, will be developed into a training manual. A postgraduate student from SLES was involved in the training sessions and assisted in the analysis of the benefits.

Training is essential to the success of a waste minimisation programme in a company. If all employees are not aware of the need to minimise waste and are not given the necessary tools to achieve this, progress will not be made in the company. It is unfortunate that not all the Metal Finishing Club members took advantage of the training supplied by Enviros March as it may have resulted in more companies undertaking audits and identifying options for improvement.

It is felt that the shop-floor training provided to the Hammarsdale Club members was an important aspect to promote the concepts to all levels of employees. It is not clear why some companies did not take advantage of this training, as those that did found it to be beneficial to the company as a whole. The Metal Finishing Club members were not offered this type of training, as the EU funding only became available for the Hammarsdale Club. It is an aspect that the Metal Finishing members investigated on their own, but found the costs to be inhibitory. It is believed that they would have benefited greatly by shop-floor training as one of the barriers that was reported by the members was the inability to communicate the need to reduce waste at source to their workers.

8. Monitoring and Targeting

An important aspect of a waste minimisation programme is monitoring targeting which ensures the long-term success of the programme. It involves monitoring all inputs and outputs to a process and keeping track of any changes that have been implemented. Based on the performance of the company and best practice performance data, reasonable targets are set for, for example, water and energy use, effluent production, rejects etc. By monitoring the performance, it can easily be identified when these target levels are not being reached and the reasons for this investigated.

Enviros March have developed a software package called Montage, which is designed to manage utilities and materials in commercial and industrial sites. A copy of Montage was installed at the PRG for use for analysing data from any interested Club member. In addition, 3 of the Hammarsdale Club members received their own copies of the software.

A number of problems have been experienced with using Montage, both as a bureau service at the PRG and on-site. These include a lack of available data (production and utility use), lack of personnel to use the software, the need for specific Montage training for the companies, and a lack of commitment on the part of the company management to use the software.

Despite these problems, the software has been installed at the three Hammarsdale sites and some progress made. The Metal Finishing club members however did not make use of the bureau service at the PRG. The use of Montage by companies in the UK and Europe has been successful and it is felt that similar success can be achieved in these companies if further training is provided.

9. Lessons Learnt

These two pilot waste minimisation clubs offered the opportunity to study the methodology of their establishment and management, in order to develop guidelines for the formation of further clubs in South Africa. A number of valuable lessons were learned during the course of this project which can be used to ensure the success of similar initiatives. These included identification of barriers and success factors, problems in obtaining results from companies, the interaction between the club members, and the change in relationships with outside bodies, for example, the regulators and the chemical suppliers.

9.1 Barriers

There are two main types of barriers that have been experienced; the first being general barriers to the concept of waste minimisation and waste minimisation clubs; and the second internal company barriers to implementing waste minimization

From the experience in with the Metal Finishing Club, it is evident that there is still a widespread lack of knowledge of the benefits of waste minimisation in that only 29 of the 100 plus metal finishers in the DMA elected to join the club. Of these, only 15 are actively participating. The general feeling amongst those not implementing waste minimisation, is that if they are complying with the regulations, there is no need to make any further changes. A similar situation exists in the Hammarsdale Club, where two of the textile companies originally approached to join the club, withdrew as they felt there was nothing to gain from waste minimisation as long as there were no complaints regarding the quality of their effluent. It was also felt that due to the economic climate in South Africa it is more important to focus on production – they did not believe that waste minimisation can save the company money. Leading on from this, it is evident that the benefits of waste minimisation are largely underestimated, while the perceived costs are overestimated.

There are three main internal company barriers to implementing waste minimisation; namely:

- A lack of time - time to undertake audits, identify options, implement and monitor the results;
- A lack of resources - there is no single person dedicated to waste minimisation - each person has a number of responsibilities and waste minimisation tends to be low on the list of priorities
- A lack of finance - there is a lack of financial resources for club members to implement more capital intensive changes.

Solutions to overcoming these problems lie within the companies themselves. There must be commitment to waste minimisation from top management, such that the Project Champion and Project Team are allocated the time and resources to devote to the programme. This commitment can only be obtained by ensuring that management understands the benefits of waste minimisation to the company, in terms of financial gains and pollution liability.

9.2 Problems Experienced in Analysing Results

As mentioned in the previous sections, results on savings were obtained from feedback at meetings, site visits and personal interviews. A number of problems were experienced in collecting this information, including:

- Changes in the costs of water and electricity, resulting in changes to the figures originally quoted by the companies
- A lack of records of production, utility consumption etc.
- Increases or decreases in production, resulting in more or less water / chemicals etc. being used in that month
- Contradicting results reported by the companies

All of these factors added to the difficulty in reporting both financial and environmental savings.

9.3 Success Factors

There are a number of factors that lead to the success of these clubs. The main ones being the implementation of new regulations, training of club members, the emergence of a Club champion and the presence of the consultants to drive the clubs.

The implementation of new effluent bylaws for the DMA was the main motivating factor for the metal finishers to join the waste minimisation club. Many did not believe that there was anything to gain from implementing a programme of waste minimisation, mostly due to a lack of knowledge. Without the *stick* from the regulators, the Club may not have achieved the success that it did. Many of the Club members admit that they were reaching compliance through dilution of their effluent and were concerned that by cutting back on water use their metal concentrations would increase. Once they started investigating their processes and realising that by reducing waste at source they would not only comply with the discharge standards, but also save money, the benefits of waste minimisation were slowly disseminated to all club members. Without these new regulations however, it is felt that the metal finishes would not have elected to join the club and implement waste minimisation on site.

In the Hammarsdale Area, there was an uncertainty over the ownership of the local sewage works. Whichever authority was to operate the works, the manner in which companies were charged for effluent would differ. This demotivated the companies from investigating waste reduction at source as the effluent discharge limits were unclear to them. This issue was resolved and companies are now charged based on an effluent tariff system. This therefore provides an incentive to reduce the chemical oxygen demand and suspended solids as the costs would then be reduced. In addition, the Works is not complying with discharge standards set by DWAF in terms of colour and conductivity. There is therefore pressure on the industries to reduce these at source, thus promoting the implementation of waste minimisation on site.

As mentioned previously, members of both Clubs received training in waste minimisation from Enviros March, to provide them with the necessary knowledge and skills to undertake audits on site and investigate options for improvement. The Hammarsdale Club members have also received training from Kagiso-Cowi in the form of general environmental awareness aimed at both management and shop-floor employees. This training increased the awareness of all involved as to the benefits of waste minimisation and the impact that their pollution can cause. It highlighted that most companies underestimate the cost of their waste and do not take into account that it is not only the cost of treating the waste, but also, for example, the loss of raw materials, chemicals and energy, and work in progress.

The emergence of a Club champion was one of the main success factors of the Metal Finishing Club. One of the Club members achieved remarkable success through implementing waste minimisation on site and is willing to share his experiences and information with other metal finishers in order that they realise the same benefits. He has been invited to speak at a number of meetings to promote the concept to metal finishers in other provinces and is more successful at convincing fellow industrialists to invest in waste minimisation than an outside consultant. A similar Club champion did not emerge in the Hammarsdale Club, although some members were more pro-active than others.

It was also evident that the presence of an external driving force is necessary to ensure that companies are motivated to make changes and attend meetings. In this case, this was provided by the PRG and Enviros March. A dedicated facilitator is required to co-ordinate club activities and contact members on a regular basis.

9.4 Social Interactions

In both clubs there was open sharing of ideas and experiences between the club members. In the Metal Finishing Club there was a greater interaction between the club members as the meetings progressed, with encouragement shown for any changes and savings, commiseration when others are being penalised by regulators, sharing of information and ideas, and assistance in implementing changes. From the observations of the PRG, the interactions between club members in the Hammarsdale Club were different from those in the Metal Finishing club. The main reason for this is thought to be that the Hammarsdale club members are not in competition with one another, even manufacturers in the same industrial sector. These companies do not need to hide *trade secrets* for fear or losing customers. There is open sharing of information and support of activities for each site. The club raised the awareness and importance of waste minimisation within the companies and assisted in making these types of projects more of a priority than was previously. This is thought to be due to the exposure of the members to one another's successes and the publication of results through newsletters and at conferences.

The overall impression gained is that the Metal Finishing Club seemed to have a *tighter knit* than the Hammarsdale Club. This could possible be due to the fact that the majority of the metal finishers own their companies and this is therefore their only source of income, whereas the project champions in Hammarsdale are employees of a larger organisation - it is not as *personal*.

A further benefit of the Clubs has been an improvement in the relationship between the Club members and the local regulatory body. When the Metal Finishing Club was first established, there was open hostility between the metal finishers and the Durban Metro. During the course of the project, this situation has changed to one of good communication due to a better understanding on both sides as to one another's constraints. Some of the Club members were instrumental in rewriting the effluent bylaws with the Metro such that they were agreeable to all parties. Similarly, the active involvement of Umgeni Water in the Hammarsdale Club has resulted in open sharing of problems and constraints on both parts and the formation of a Working Group. This group is comprised of representatives of Umgeni Water, Durban Metro and the industry and is able to discuss water and effluent issues with DWAF.

10. Return on Investment

The success of a project can be determined by calculating the payback period on investment and the Return on Capital Employed (ROCE). Payback is a simple method of determining the payback on capital investment and is calculated by dividing the total capital invested by the total savings. ROCE is defined as the average annual profit divided by the capital employed. In this case, the annual profit is the savings achieved by the club members, and the capital is the funding from the WRC and the EU.

The definitions of ROCE are given in the equations in Table 7.

Table 7: Definition of Return on Capital Employed

Gross ROCE	[Total cost savings / capital] x 100 %
Net ROCE	[(Total cost savings – Capital) / Capital] x 100%
Gross annual rate of return	Gross ROCE / project life (%)
Net annual rate of return	Net ROCE / project life (%)

Based on these equations the payback, gross and net ROCE, and the annual rate of return can be calculated for the projects based on the total budgets. The results are given in Table 8.

Table 8: Calculation of payback and ROCE for the Pilot Waste Minimisation Clubs.

	WRC (budget)	EU
Payback (days)	35.12	37.69
Gross ROCE (%)	1039.43	968.31
Net ROCE (%)	939.43	868.31
Gross rate of return (%)	346.48	322.77
Net rate of return (%)	313.14	289.44

Based on the figures in Table 8, it is evident that there is significantly large return on capital investment. The payback period for the WRC portion of the project are of the order of just over a month based on the total project budget. Similarly for the EU finding, where the payback period is of the order of 38 days. The net rate of return on the investment is over 800% for the WRC funding and almost 300% for the EU funding.

Based on this cost-benefit analysis, it is evident that the project has been financially successful with the payback on the capital invested being of the order of days, and the rate of return on the investment over 100%.

A further return on investment, which cannot be quantified, is the generation of knowledge from this type of applied research, which can be used to formalise the process of waste minimisation.

11. Conclusions

From the results achieved during the course of this project, it is evident that the objectives have been realised. The companies that have participated in the waste minimisation clubs have reduced their impact on the water resources as is evident by the decrease in the volumes of water used and the effluent discharged to the environment. In addition, emissions to air and land have also been decreased.

It is felt that the experience of waste minimisation clubs in South Africa has been a successful one. A number of new clubs are currently being run or established. The concepts of cleaner production and waste minimisation have been disseminated to all companies within the clubs and all report benefiting from this knowledge. In the case of the Metal Finishing Club, where the majority of members belong to the SMME sector, it is evident that a number of the companies have become more competitive due to implementing a programme of waste minimisation. This is particularly true of two club members who reported that if it were not for the financial savings they had made they would not have continued to operate due to the weakness of the economy.

Energy efficiency has been promoted to members of both clubs through training and site audits. Substantial financial savings were made in energy, and this has resulted in a decrease in the quantity of CO_2 and other greenhouse gasses being emitted to the atmosphere, and a decrease in water and coal consumption.

It must however be stressed that waste minimisation is not an activity that requires a Club approach in order to be successful. Any company regardless of size or type can carry out waste minimisation. Companies need to take ownership of waste minimisation and not rely on outside input to make it work.

It is also evident that in order for waste minimisation to become entrenched in company policy that there needs to be a change in the manner in which a company is managed with respect to internal relationships with all employees and trade unions, and with health and safety aspects. The concepts of waste minimisation need to be transferred to the people who work on the factory floor and have the support of the unions in order to be successful. It needs to be made clear to the workers that their employment is not threatened by reducing pollution at source, but that rather it makes the company more sustainable and therefore more likely to offer long-term employment. Waste minimisation also leads to improvements in health and safety aspects, since chemical substitution, less spillages, improved maintenance and increased process knowledge benefit both the environment and the workers.

It is felt that these two pilot waste minimisation clubs were an effective means of promoting the concept to industry in South Africa. The results have been disseminated through presentations, conferences, workshops and papers. In addition, the establishment of waste minimisation clubs is cited in the National Waste Management Strategy as a route to sustaining industrial development in South Africa. It is also a concept supported by the local Durban Metropolitan Council, the Department of Water Affairs and Forestry (both on a local and national level), the

Department of Environment Affairs and Tourism and the Department of Trade and Industry (DTI).

This project demonstrates that research can stimulate policy action as the formation of Clubs has been recommended in the NWMS. This project has raised the awareness of waste minimisation in industry in South Africa.

12. Recommendations

Based on the results of this project and the number of queries received regarding the formation of further clubs, the following recommendations can be made:

- Guidelines as to establishing and managing waste minimisation clubs should be prepared in order that there is a set procedure that club facilitators can follow to ensure the concept is not damaged by inappropriate methodology;
- A centre of information should be established where interested parties can obtain information on cleaner production and waste minimisation clubs;
- Sector specific guidelines for conducting waste minimisation audits should be collated or prepared, and stored at this centre of information;
- Training material for club facilitators should be prepared in order that they can transfer the knowledge to club members;
- More emphasis should be placed on obtaining information relating to changes in concentration of chemicals and metals discharged to drain due to decreases in water use.

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Glossary

General Terms:	
Cleaner Production	The continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase eco-efficiency and reduce risks to humans and the environment.
Club Member	A company who belongs to a waste minimisation club.
Eco Efficiency	Eco-efficiency is reached by the delivery of competitively priced goods and services that satisfy human needs and brings quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle, to a level in line with the Earth's estimated carrying capacity.
Project Champion	The person within the club member site that has the responsibility of managing the waste minimisation programme.
Project Team	A team of people formed under the project champion to undertake waste minimisation activities on site.
Sustainable Development	Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs
Waste Minimisation	A systematic approach to reducing the generation of waste at source.
Waste Minimisation Clubs	A group of companies, either within the same industrial sector or geographical area, working together to reduce waste and save money through the implementation of waste minimisation.
Metal Finishing Terms:	
Anodising	An electrolytic process applied to aluminium objects to create an insoluble oxide coating.
Base metal	The metal onto which the finish is applied.
Degreasing	The removal of heavy oils, greases, and soils from the base metals.
Drag-in	The processing bath solution that is carried into another bath with the article.
Drag-out	The processing bath solution that is carried out when an article is removed from the solution.
Drip times	The time for which an article is held above a processing bath to allow the chemicals to run off before placing it into another processing bath.
Electroplating	The application of metallic coatings to metallic or other conductive surfaces by electrochemical processes.
Galvanising	A non-electrolytic process involving the coating of prepared steel surfaces with zinc.
Job Shop	A metal finishing factory that will accept any suitable article for processing.
Metal Finishing	The application of a finish (electroplating; powder coating etc.) to a metal to protect it from the effects of exposure to the environment.
Pickling	The process of cleaning the base metal in acid.
Powder Coating	The application of a dry resin onto a metal to form a coating.
Textile Terms:	
Bleaching	Improving the whiteness of the fabric by means of oxidising or reducing agents.
Desizing	The removal of sizes from the fabric prior to further processing.
Dyeing	The application of colour to the fabric by a number of different techniques.
Finishing	Both chemical and physical processing of the fabric to improve its handle, fastness properties and its appearance.

Mercerising	The treatment of cellulosic fibres with a concentrated solution of sodium hydroxide to improve the water absorbency and dye affinity, and to impart a sheen to the fabric.
Printing	Coating of the fabric with dye pastes in various colours and designs.
Scouring	Washing the fabric with detergents under hot alkaline conditions to remove any remaining natural impurities such as pectins and waxes.
Sizing	Coating yarn prior to weaving to protect it against the abrasive action in the weaving loom.

List of Abbreviations

CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
CP	Cleaner Production
DEAT	Department of Environment Affairs and Tourism
DMA	Durban Metropolitan Area
DTI	Department of Trade and Industry
DWAF	Department of Water Affairs and Forestry
ISO	International Standards Organisation
KZN	KwaZulu Natal
M&T	Monitoring and Targeting
MF	Metal Finishing
PRG	Pollution Research Group
SLES	School of Life and Environmental Sciences
SMME	Small, medium, micro enterprise
SS	Settable Solids
UND	University of Natal, Durban
WM	Waste Minimisation
WMC	Waste Minimisation Clubs
WRC	Water research Commission

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Chapter 1 - Introduction

This Chapter serves to introduce the concepts of sustainable development, cleaner production and waste minimisation. It will also briefly discuss the actions being taken on a national and local level within KwaZulu Natal to promote effective waste management practices through adopting these principles. The project aims, outputs, resources and approach are discussed and an outline of the remainder of the report provided.

1.1 Sustainable Development and Cleaner Production

Sustainable Development can be defined as (World Business Council for Sustainable Development):

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

This implies that a continued growth in consumption is not possible and that if the population of today utilises all nonrenewable resourses as if the supply were plentiful, eventually there will be nothing left for future generations. The challenges facing industry today, in order to ensure sustainable development, can best be described by the following Master Equation (Welford and Gouldson, 1993):

Global environmental burden = global population x GNP per capita x environmental impact per unit of GNP

(where GNP = Gross National Product)

If one considers that the global population is likely to double in the next 40 years, and the GNP per capita to increase by a factor of five, in order to maintain the current environmental quality, the environmental impact per unit GNP will have to decrease by a factor of 10 over the same time period. Therefore, all industries must operate in such a manner as to reduce their impact on the environment by a factor of 10. Furthermore, in most instances, the existing level of environmental degradation is considered to be unacceptable, implying that further improvements must be made.

Until recently, the acceptable method of dealing with pollution was one of end-of-pipe treatment, where pollution was dealt with after it had been generated. Common options included dilution to reduce the concentration of the contaminants, followed by discharge to river or sea, and containment of solid or toxic waste with ultimate disposal to landfill sites. However, over the last decade, the approach has been changing to one of pollution prevention, or point source reduction, where steps are taken to prevent the generation of pollution in the first instance, or reduce the pollution at source in its concentrated form rather than in combination with other effluent streams. This concept of pollution prevention forms the basis of Cleaner Production.

The term Cleaner Production was coined by UNEP IE/PAC (United Nations Environment Programme) when it launched the Cleaner Production Programme in 1989. The definition that has been adopted by UNEP is (UNEP, 1994 (1)):

Cleaner Production is the continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase eco-efficiency and reduce risks to humans and the environment.

Cleaner Production requires changing attitudes from top management to the workshop floor employees, responsible environmental management and evaluating technology options. It is an ongoing activity that must be incorporated into the everyday working practices of an organisation. As well as reducing the environmental impact of a company, cleaner production results in increased profits for a company as more efficient use of materials and process optimisation results in less waste and lower operating costs. Similar terms include clean technology, pollution prevention, waste minimisation, waste reduction and eco-efficiency.

South Africa is actively participating in the work programme on the testing of indicators for sustainable development of the UN Commission on Sustainable Development (CSD). Currently the main activities in this field are aimed at determining which of the CSD's proposed list of indicators are used in South Africa, which other indicators are used, and in obtaining data sets on various indicators.

Sustainable development principles are firmly embedded in various South African policies and legislation that have been developed since 1994. According to the Constitution of the Republic of South Africa (Act 108 of 1996), all its citizens have the right to a clean and unpolluted environment, which is not detrimental to human health. It also states that the environment must be protected to secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development. As a consequence, the importance of sustainable development is acknowledged in the country's Reconstruction and Development Programme. An important instrument that will contribute substantially towards the promotion of sustainable development in South Africa, is the National Environmental Management Act (Act 107 of 1998), which was promulgated on 27 November 1998. Legislation such as the Integrated Pollution and Waste Management (DEAT, 1999), the National Environmental Management Act and the National Waste Management Strategy (DEAT, 1999), once fully enacted and implemented will create a holistic approach to waste management, which aims at sustainability. Further information n policy in South Africa can be found on the Internet at www.policy.org.za.

1.2 Agenda 21 and Local Agenda 21

Agenda 21 is the global action plan for socially, economically, and environmentally sustainable development. It was adopted at the United Nations Conference on the Environment and Development in Rio de Janeiro in June 1992, and is aimed at improving the relationship between development and the Earth's natural resource base (Hindson et al, 1996).

Agenda 21 has targeted cities as key areas for action in the drive to achieve sustainable development. The conference proposed that the principles of Agenda 21 be implemented at the local authority level. This programme is known as Local Agenda 21. In South Africa, the cities of Johannesburg, Durban, and Cape Town have initiated Agenda 21 programmes. At the provincial level, provinces such as KwaZulu-Natal and the Northern Province initiated provincial Local Agenda 21 campaigns to encourage broadscale local authority involvement in Local Agenda 21 initiatives. The former Durban City Council adopted the programme in August 1994. The City of Durban was then accepted as a full member of the International Council for Local Environmental Initiatives (ICLEI) in 1994. ICLEI is an international organisation responsible for coordinating Local Agenda 21 initiatives worldwide (Hindson et al, 1996). The goal of the Durban Metropolitan Area's (DMA) Local Agenda 21 programme is the development of an environmental management system that guides the city towards an environmentally sustainable development path (www.durban.gov.za).

1.3 Promoting Sustainable Development within KwaZulu Natal

The Durban Metropolitan Area (DMA) covers an area of approximately 1 300 km^2 and is the largest urban area in the province of KwaZulu-Natal (South Africa). It is also the largest city and port on the East Coast of Africa (www.durban.gov.za). The natural systems in DMA have been transformed by human settlement and exploitation. The economy has impacted directly and indirectly on natural systems through resource use, patterns of consumption, and by generating industrial and domestic waste. Uncontrolled waste results in air, water, land, and soil pollution, and is unsustainable.

The Durban Metropolitan Council is actively involved in promoting integrated waste management for the metropolitan area. This includes promoting recycling and waste minimisation where feasible, identifying safe sites for future land disposal and improving management of existing landfill sites. The new Durban Metropolitan Environmental Policy sets out a range of objectives to address the metropolitan area's waste management issues in the future. This is supported by new national and provincial policy in promoting an integrated approach to waste management.

1.4 Waste Minimisation and Waste Minimisation Clubs

Waste minimisation is defined as *the continuous application of a systematic approach to reducing the generation of waste at source* (Enviros March, 1999*).* It applies to both products and processes and results in benefits, such as reduced water, raw materials, and energy use, reduced utility costs, improved environmental performance, reduced hazardous waste and financial savings for the company.

The waste minimisation club concept was devised to promote the exchange of experiences between geographically close manufacturers in the implementation of waste minimisation measures. Experience from Europe has indicated that it takes time to establish the culture of waste minimisation clubs, but once established, large savings (financial and environmental) can be achieved. This was clearly demonstrated in the Dutch PRISMA study (1988 - 90) (Dutch Ministry for Economic Affairs 1992), the Aire and Calder project in West Yorkshire (UK) and Project Catalyst in Merseyside (UK), both in the early 1990's (ENDS, 1992 and 1993). In all these studies, a variety of regional waste minimisation projects were identified and successfully implemented in a number of companies across different industrial sectors. Since then, a number of additional clubs have been established in the UK, India and New Zealand. These clubs involve both cross-sectoral as well as sector-specific industries.

Based on the success of this concept in other countries, it was felt that this could be a feasible method of promoting sustainable industrial development within South Africa, especially within the small, micro and medium-sized enterprise (SMME) sector. International experience has indicated that cumulatively these organisations use excessive amounts of energy and are significant sources of pollutants (air, water and solid waste). Waste minimisation practices not only promote the efficient use of recourses such as water and energy, but also leads to a reduction in emissions. By forming a club, companies are able to work together to reduce waste and save money through discussions, training and the combined use of outside consultants.

1.5 Project Aims

The waste minimisation club project was initiated in February 1998 with the primary aim of improving water quality through the prevention of water pollution by industries and reducing the demand for industrial water. The secondary aims of the project were to:

- develop the concept of waste minimisation clubs in South Africa,
- contribute to the establishment of competitive industrial small, micro and medium sized enterprises (SMME's),
- promote the concepts of cleaner production, waste minimisation and sustainable development amongst SMME's, and
- promote energy efficiency.

These aims were to be fulfilled through the establishment of 3 pilot waste minimisation clubs in KwaZulu-Natal.

1.6 Research Products

The following research products were envisaged from the project:

- A framework for organising waste minimisation clubs for SMME's;
- An assessment of the real research and technology transfer needs for the environmental sustainability for the SMME sector; and
- A framework to make industrial SMME's more competitive.

The target groups for these products included government departments and agencies, policy makes, water utilities, consultants, students research funding agencies, development agencies and industry.

1.7 Project Resources

This was a three-year project (1998 to 2000), funded by the Water Research Commission (WRC) and managed by the Pollution Research Group (PRG). The project was co-funded by the European Union Directorate General XVII for Energy (Thermie) which made provision for the involvement of two European consultants, namely Enviros March (UK) and Cowi (Denmark). Enviros March's focus was on energy savings and technical training, while Cowi's involvement was through the South African organisation, Kagiso Trust, and focused on general environmental awareness training for management and shop-floor employees. The School of Life and Environmental Sciences (SLES) at the University of Natal was also involved in analysing the more *social* aspects of the club (i.e. interactions between club members) and also monitoring the response to the training sessions given by Kagiso-Cowi.

The ML Sultan Technikon in Durban is also involved in the project through funding from the Foundation for Research and Development (FRD, now NRF). Their main focus is determining the feasibility of using membranes to reuse electroplating baths. To gain experience in waste minimisation and working in industry, the students are undertaking audits in various companies.

1.8 Project Approach

A literature review was first undertaken to obtain background information on waste minimisation clubs in other regions, study the manner in which they were established and managed, and identify the lessons learnt during the course of running these clubs.

Sites for the 3 pilot clubs had then to be identified. This was to be based on which industrial area, or industrial sector, had a significant impact on the environment, especially in terms of water and energy consumed, and pollution of water resources.

The first waste minimisation club was established in the Metal Finishing Sector in the Durban Metropolitan Area (DMA) in June 1998. The second club was formed in the Hammarsdale industrial area in March 1999. All Steering Committee members agreed that a third club should not be established during the course of this project, but rather emphasis be placed on educating industries and regulators in waste minimisation through workshops and presentations.

Different approaches were used in the management and running of the 2 pilot clubs, mostly due to the differences in the size and structural organisation of the companies involved. In addition, the European partners and the SLES were involved in the Hammarsdale Club to a far greater extent than the Metal Finishing Club, resulting in different management style. However, the basis of establishing the clubs and method of analysing the results were similar in both cases.

Waste minimisation club meetings were held on a bimonthly basis, with half of the meeting being spent on providing information to the club members on waste minimisation aspects, and the companies providing feed back as to their results, problems, experiences, etc. in the second half. Site visits were undertaken to the club member factories to assist in waste minimisation audits and identifying areas for improvements. Studies of the barriers and drivers to waste minimisation were undertaken and interviews conducted with club members to obtain their views on the success of the club approach. Training in waste minimisation was also provided to members of both clubs.

As a result of the project, a number of club members initiated waste minimisation programmes within their companies, resulting in both financial and environmental savings. These results were analysed for both clubs, together with the social aspects such as improved relationships with the local authorities and with each other.

Two workshops were held on the waste minimisation club concept; the first at the offices of the Water Research Commission in Pretoria (October 1999) and the second at the Water Institute of Southern Africa (WISA) conference in Sun City (May 2000). Representatives of local and national government bodies, industry, consultants and academics attended these workshops. In addition, a number of papers were presented at local and international conferences and presentations given at individual industrial sites and forums.

1.9 Report Outline

This report aims to cover the results achieved during the course of this project and to highlight the lessons learnt in order to offer recommendations for the way forward. **Chapter 1** contains a comprehensive overview of literature related to cleaner production, waste minimisation, waste minimisation clubs and the South African environmental legislature. **Chapter 2** covers the formation, management and results of the Metal Finishing Waste Minimisation Club, while **Chapter 3** discusses the Hammarsdale Waste Minimisation Club. **Chapter 4** provides an overview of monitoring and targeting and includes the barriers to implementing such a programme on-site. **Chapter 5** provides an analysis of the waste minimisation club approach, where the barriers and drivers are highlighted, a cost-benefit analysis undertaken and the lessons learnt discussed. The conclusions and recommendations of the project are discussed in **Chapter 6**, followed by the references for this report (See Figure 1.1). A number of Annexures are available in which more detail on each of these chapters is available and these will be referred to where required. These Annexures have been compiled into a separate Data Report document, which is available from the WRC on request.

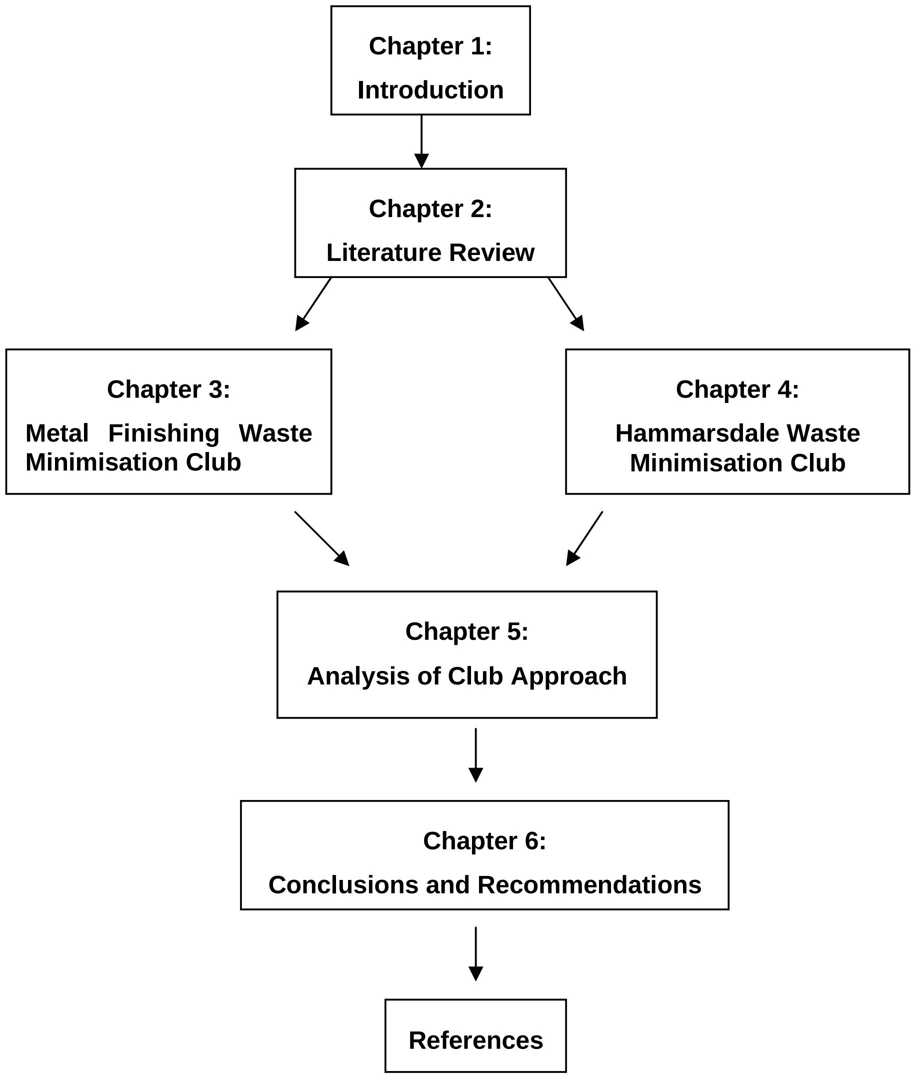

Figure 1.1 Outline of report Structure

Chapter 2 - Literature Review

An extensive literature review has been undertaken during the course of this project. Subjects covered include:

- Sustainable development,
- Cleaner production,
- Waste minimisation,
- Waste minimisation clubs,
- Environmental legislature in South Africa; and
- Monitoring and targeting

This chapter will highlight some of these literature resources. More detailed reviews are available in Goff (2001), Thambiran (2001) and Maharaj (2001).

2.1 Sustainable Development

Historically, the concept of sustainable development had many varying interpretations. The decades of the 1960's and 1970's saw the rise of environmentalists and other action groups protesting against the use of technologies that resulted in degradation of the environment. The challenge at the time was one of industrial growth without causing an adverse impact on the environment.

Developing countries and big business are thus facing a challenge of economic growth and market expansion without creating an impact on the environment and depleting valuable natural resources. The Brundtland report has, since then, defined sustainable development as (World Business Council for Sustainable Development):
Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

This report also called for economic and technological growth in a new social context, i.e. the upliftment of poorer nations through the introduction of new technologies. This would ensure that development would occur in a sustainable manner and that natural resources would be conserved for future generations.

Sustainable development for developed countries means achieving the highest and most efficient levels of output whilst using the least amounts of energy and natural resources, and the absolute minimum production of wastes and pollution (UNEP 1994 (2)).

It is difficult for industry to promote sustainable development, or gauge the extent to which they promote the concept because (World Business Council for Sustainable Development):

- Industries are diverse and consist of a wide spectrum of sizes and types.
- Very few sustainable development "indicators" have been developed.
- It is difficult to set a time frame for gauging progress.

However, the concepts of sustainable development are slowly filtering through as industry realises that savings are possible through the implementation of options that are technologically innovative. The alternative end-of-pipe capital-intensive options are thus gradually phased out or reduced in size as more efficient methods of processing are created.

Within South Africa (SA) there are two initiatives aimed at promoting sustainable development and economic growth. The National Business Initiative (NBI) is driving towards creating wealth and income generating strategies . The Industrial Environment Forum of SA (IEF) was formed out of the need for improving environmental performance (World Business Council for Sustainable Development). This forum has been instrumental in contributing to many new environmental polices, on a national level. More importantly, the IEF has provided SA business input to the Technical Committee 207, the committee responsible for drawing up the ISO 14000 series of standards for environmental management. Drivers for sustainability are (World Business Council for Sustainable Development):

- Stricter environmental regulations and pollution liability for senior management.
- Reducing wastes enhances profit.
- Conserving natural resources results in higher eco-efficiency and less environmental impact.
- Banks and investors react more favourable to companies who conserve resources and prevent pollution.

Cleaner Production is one such approach to promoting sustainable development to industry.

2.2 Cleaner Production

The term Cleaner Production was coined by UNEP IE/PAC (United Nations Environment Programme) when it launched the Cleaner Production Programme in 1989. The definition that has been adopted by UNEP is (UNEP, 1994 (1)):

Cleaner Production is the continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase eco-efficiency and reduce risks to humans and the environment.

- *For Production processes this means conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes.*
- *For Products this means reducing negative impacts along the life cycle of a product, from raw materials extraction to its ultimate disposal.*
- *For Services this means incorporating environmental concerns into designing and delivering services.*

Previously, solutions to waste focussed on end-of-pipe treatment, followed by disposal. In other words, a reactive response to the problem. Cleaner Production, on the other hand, is proactive thinking, where elimination of the problem in the first case is the most preferred option. Figure 2.1 illustrates this difference between proactive and reactive thinking leading to sustainable development. It must be noted that recycling can be considered as both reactive and proactive. Only on-site recycling is considered to be Cleaner Production.

Cleaner Production requires changing attitudes from top management to the workshop floor employees, responsible environmental management and evaluating technology options. It is an ongoing activity that must be incorporated into the everyday working practices of an organisation. As well as reducing the environmental impact of a company, cleaner production results in increased profits for a company as more efficient use of materials and process optimisation results in less waste and lower operating costs.

Eco-efficiency, life cycle assessment (LCA) and waste minimisation are all tools of Cleaner Production.

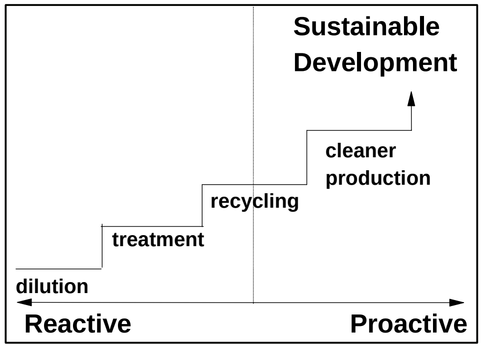

Figure 2.1: Reactive and Proactive Thinking in Relation to Cleaner Production and Sustainable Development (UNEP, 1996)

2.3 Eco-efficiency

The World Business Council for Sustainable Development explains eco-efficiency by the following statement (World Business Council for Sustainable Development):

Eco-efficiency is reached by the delivery of competitively priced goods and services that satisfy human needs and brings quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle, to a level in line with the Earth's estimated carrying capacity.

It is a management approach that drives processing companies to higher levels of output with less resource consumption and pollution. This forces companies to be more environmentally responsible and innovative in their processing techniques and operations by:

- Reducing material intensity of goods and services,
- Reducing energy intensity of goods and services,
- Reducing toxic dispersion,
- Enhancing material recyclability,
- Maximising sustainable use of renewable resources,
- Extending product durability, and
- Increasing the service intensity of goods and services.

2.4 Life Cycle Assessment

Very briefly, LCA is a study of all the positive and negative aspects of the application of a process or product and is a useful tool of sustainable development. This method is often constrained, however, by the unavailability of process information and the high costs of implementing this option (World Business Council for Sustainable Development).

LCA is a technique for assessing the environmental aspects and potential impacts associated with a product by

- Compiling an inventory of relevant inputs and outputs of a system;
- Evaluating the potential impacts associated with those inputs and outputs; and
- Interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives of the study.

LCA studies the environmental aspects and potential impacts throughout a product's life (i.e. cradle-to-grave) from raw material acquisition through production, use and disposal. The general categories of environmental impacts needing consideration include resource use, human health and ecological consequences.

2.5 Waste Minimisation

Waste minimisation can be defined as (Enviros March, 1999):

The application of a systematic approach to reducing the generation of waste ***at source.***

In other words, it is the implementation of measures to prevent the generation of waste in the first place. It applies to both product and process changes, and includes all inputs and waste outputs. Waste is not simply excess material to the requirements for a process, but it represents the loss of valuable company assets. There is always the opportunity to achieve benefits from waste minimisation in all aspects of an organisation, no matter what the size of the operation.

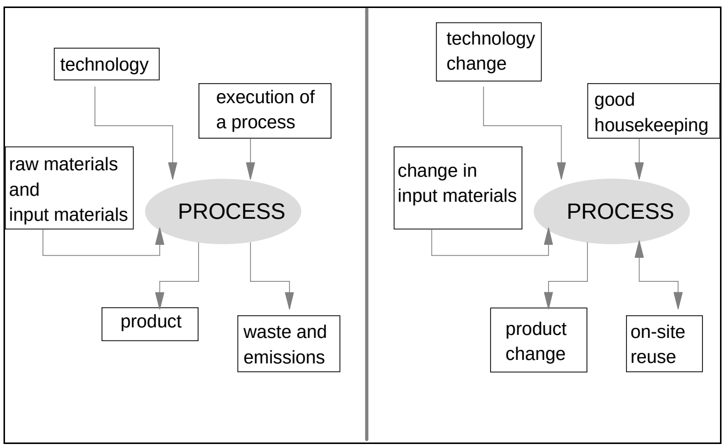

Figure 2.2: The Five Possible Changes that can be Made to a Process or Business Operation to Reduce Waste at Source (UNEP, 1996)

Within any process, there are five main aspects that should be taken into account when considering the implementation of waste minimisation. These are shown on the left-hand side of the diagram in Figure 2.2 and include:

- raw materials used and other input materials such as water, chemicals etc.,
- the type of technology,
- the manner is which the process is executed,
- the products that are formed, and
- the wastes and emissions that are generated.

The basics of a waste minimisation programme are therefore to:

- effect source control by changing raw materials, i.e. change to non-toxic or purer materials, and use renewable raw materials or materials with a long service lifetime.
- change production technology and equipment, e.g. improved process automation, process optimisation, equipment re-design and process substitution. This can create less hazardous wastes and emissions.
- improve housekeeping by making changes to procedures and management in order to eliminate waste, e.g. spill prevention, improved worker education and training.

- redesign or reformulate products by changing the product characteristics such as shape or composition. The product life may be extended or it is made easier to repair. The manufacturing process may become less polluting. This also includes changes in packaging. Changes to product design often require a life cycle assessment approach.
- on-site recycling: i.e. useful application of waste material produced by the company, e.g. reuse as raw material, recovery etc.

These changes are represented on the right-hand side of the diagram in Figure 2.2. Only on-site recycling is considered to be a source reduction technique. Off-site recycling is seen as a pollution control measure.

2.5.1 Establishing a Waste Minimisation Programme

Waste minimisation is achieved through the implementation of a number of steps. This is shown in Figure 2.3. The first steps include obtaining commitment to the programme from senior management, appointing a project champion to manage the programme and selecting a project team to assist in data collection.

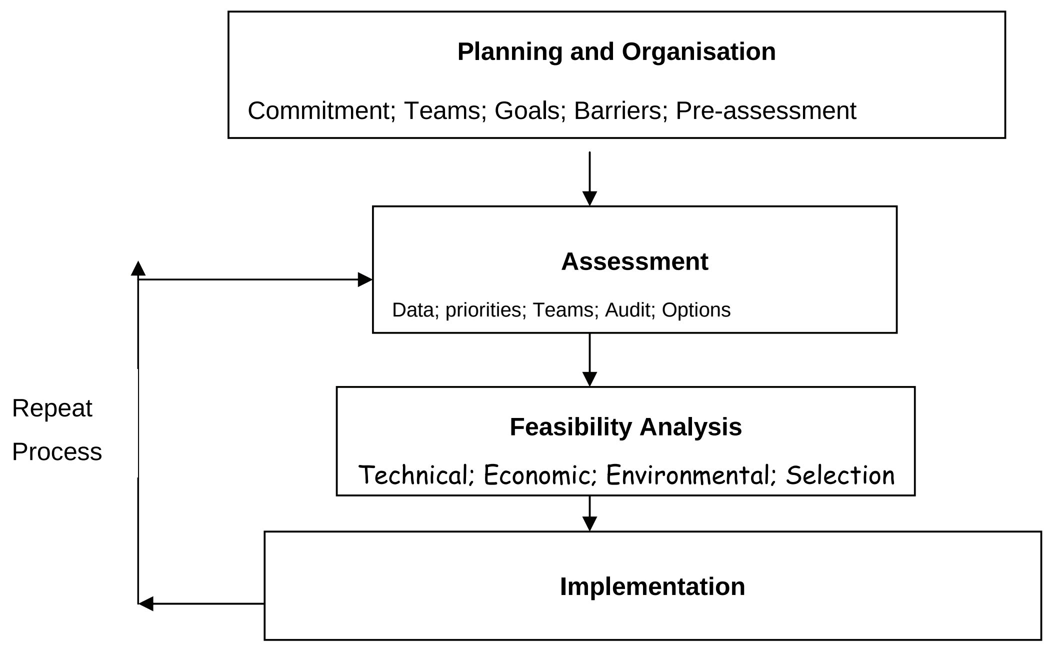

Figure 2.3: Overview of the Procedure for Establishing and Running a Waste Minimisation Programme

All process within the factory are then investigated and data collected on all inputs and outputs in terms of quantity and value. At the end of this phase, the project team should target those processes, operations or waste streams that require more detailed assessment. Targeted processes can be based on the hazardous nature of the waste, the value of the waste, the large volumes of water consumed or the use of excessive energy.

These areas can then be assessed in more detail and options for improvement identified. A feasibility analysis is then conducted to determine if the option is economically, technically and environmentally feasible. Those options that are found to be feasible can then be implemented. It must be remembered that waste minimisation is not a once off activity and the programme should be continuously monitored and targets reassessed and reset at regular intervals.

2.5.2 Barriers to Waste Minimisation

The concept of reducing waste at source rather than through the traditional *end-of-pipe* treatment methods represents a new way in thinking for most companies and there are a number of barriers that need to be identified and overcome before a successful waste minimisation programme can be implemented. These barriers can be technical, economical, regulatory and cultural.

2.5.2.1 Economic Barriers

Economic barriers occur when management believes that there are insufficient funds to implement a waste minimisation programme. If this is the case, management should at least investigate options that require low capital input such as improved housekeeping and inventory control.

2.5.2.2 Technical Barriers

Some technical barriers include concerns about changes to product quality and customer acceptance, lack of information or techniques and poor employee reaction to implementation. In these cases, the company should identify the customer needs and carry out pilot testing of the new process; obtain information from all relevant bodies such as government, trade associations, consultants etc.; and ensure that there is good feedback and employee involvement.

2.5.2.3 Regulatory Barriers

These barriers should be relatively easy to overcome, as one of the objectives of waste minimisation is to reduce the impact on the environment. If the company works in conjunction with the relevant authorities in the planning stages there should be close co-operation and limited problems.

2.5.2.4 Cultural Barriers

If there is lack of management commitment and awareness of the company policy and goals, and if there is poor communication and an inflexible organisational structure, friction and resistance to change within the company may become a barrier to an effective waste minimisation programme. This can be overcome though employee training and education, improved management and the involvement of employees at all levels.

2.5.3 Monitoring and Targeting

An important aspect of a waste minimisation is monitoring and targeting (M&T) which ensures the long-term success of the programme. It involves monitoring all inputs and outputs to a process and keeping track of any changes that have been implemented. Based on the performance of the company and best practice performance data, reasonable targets are set for, for example, water and energy use, effluent production, rejects etc. By monitoring the performance, it can easily be identified when these target levels are not being reached and the reasons for this investigated.

Monitoring and targeting consists of five main steps (Enviros March, 1999):

- monitoring consumptions of, for example, water and energy,
- determining performance levels,
- establishing regular reporting systems,
- setting up teams to discuss ways of improving performance, and

- establishing a feedback mechanism to create awareness.

Monitoring of consumption involves establishing some form of metering and then ensuring that these meters are read. Graphical methods are then used to indicate when the process is not performing as expected.

2.6 Waste Minimisation Clubs

A waste minimisation club is a concept that was first developed in the Netherlands in the early 1990's to encourage industries to reduce pollution. A Club involves a small number of companies, generally within the same geographical area, working together to exchange ideas and information on waste minimisation, and in this way, encourage one another to improve process efficiency, save money and reduce their environmental impact. It has shown to be a successful concept, with over 80 clubs established in the United Kingdom and similar initiatives in New Zealand and India. These clubs are discussed briefly in the following sections.

2.6.1 The Netherlands

The first example of a waste minimisation club, the PRISMA project (Dutch Ministry of Economic Affairs, 1992), was established in the Netherlands in 1989 and continued to the end of 1990. The project was undertaken with 10 companies in two districts, Rotterdam and Amsterdam, and were chosen from 5 different industrial sectors, namely; food, chemical, electroplating, metal processing and public transport. The main objectives of PRISMA were to prove that pollution prevention could be implemented successfully, and to translate the results achieved at various sites into recommendations for an effective pollution prevention policy. Waste reductions of 30 % and more were achievable and generated benefits in various areas. Another important outcome was the identification of the barriers that exist within industry to a preventative approach to pollution.

2.6.2 The United Kingdom

The Aire and Calder project in the UK was launched in 1992 following the success of the PRISMA project. It differed from the PRISMA project in that it was concentrated in one river basin to enable ease of communication between the companies, and its main aim was to reduce the volume or strength of wastewater and improve the quality of the rivers. Eleven industries were chosen from various industrial sectors, including beverage, chemical, laundry, printing, transport and dye manufacture to be club members. It was managed by Enviros March and is used internationally as *the* example of the success of a waste minimisation club. A summary of the results is given in Table 2.1.

Table 2.1: Main Results from the Aire and Calder Project in the United Kingdom

Number of opportunities identified :	399
Savings achieved :	R 23 million / annum
Potential savings identified :	R 89 million / annum
Environmental savings identified :	12 000 tons / annum to landfill
	1.9 million kl / annum water
	1.8 million tons / annum liquid effluent

Based on the success of Aire and Calder project, Project Catalyst was initiated in the Mersey Basin in 1993. Enviros March were also involved in the management of this club, together with WS Atkins and Aspects International. This project involved 14 industries including an airport operator, a food processing company and a brewing firm along with large and small manufacturers of equipment and chemicals. A summary of these results is given in Table 2.2.

Table 2.2: Summary of Results from Project Catalyst (United Kingdom)

Number of opportunities identified :	544
Savings achieved :	R 25 million / annum
Potential savings identified :	R 15 million / annum
Overall Payback :	Less than one year

Since the success of these clubs, further clubs have been, and are being, established in the UK. As at May 2001 there are approximately 80 clubs in total, 25 of which were supported by outside funding (www.envirowise.gov.uk). Some are formed within the same industrial sector, whereas others are cross-sectoral. The Environmental Technology Best Practice Programme (ETBPP), a joint initiative by the Department of Trade and Industry and the Department of the Environment, offers a centre for free advice and guidance on establishing waste minimisation clubs and have published numerous guides and case studies to aid the UK industry.

2.6.3 New Zealand

Two waste minimisation clubs have been established in New Zealand under a project entitled Target Zero. It is a cleaner production pilot project which was initiated in August 1997 and will run until August 1999. It involves 22 companies; 10 in Hawke's Bay, and 12 in Christchurch. The type of companies involved are varied: in Hawke's Bay there are 4 tanneries/ pelt processors, 2 abattoirs, a fruit processor (into fruit juice), and 2 packaging companies (producing cans and cardboard); and in Christchurch the companies are an abattoir, a hospital, 2 hotels, a polytechnikon, a dairy, an electronics firm, a rubber company, fertiliser company, carpet company, meat processor, and a gelatin company. The companies range in size from large to relatively small. It must be noted that in New Zealand, approximately 90 % of enterprises have less than 5 employees and these are considered medium sized; companies with greater than 5 employees are defined as being large enterprises.

2.6.4 India

A similar concept to waste minimisation clubs has been established in India. These clubs are termed Waste Minimisation Circles and differ from the clubs in that membership is limited to 5 small and medium enterprises (SME's) in the same geographical area that follow similar manufacturing processes, i.e., they are sector specific. The project is managed by the National Productivity Institute (NPI) and is sponsored by the Ministry of Environment and Forests in India. Club meetings are held at each member's site in turn, where solutions to the particular problems of that company are brainstormed.

2.6.5 Forming a Waste Minimisation Clubs

There are a number of objectives to a waste minimisation club. The most important being:

- to provide a forum for discussions and knowledge sharing about waste minimisation,
- to enable a systematic compilation and dissemination of information on waste minimisation,
- to promote the demonstration of WM techniques by a group,
- to facilitate the adoption of cleaner production technologies, and
- to facilitate compliance with environmental regulations.

These objectives are achieved through the commitment and cooperation of all the parties involved in the club.

A number of stages are involved in establishing the waste minimisation clubs; These can be broadly divided into the following steps:

- Recruitment: identifying and recruiting club members;
- Organisation for action: establishing the club structure and management roles;
- Assessment: on-site audits to determine the scope for savings;
- Implementation: undertaking waste minimisation actions;
- Analysis: quantifying results; and
- Training: educating management and shop floor personnel in waste minimisation issues.

Each of these will be discussed in more detail in the following sections.

2.6.5.1 Recruitment

The first stage in establishing a waste minimisation club involves identifying an area in which there is a significant environmental impact, either in terms of the high consumption of resources, or the type of effluent / waste produced. This area could be based either on the type of industry (i.e. a number of factories within the same industrial sector that are considered to be polluting), or geographical (i.e. different factories in close proximity to one another and discharging to the same sewage works). A meeting is then called with the companies and the proposed club discussed and initiated. In general, waste minimisation clubs consist of between 10 and 15 companies.

2.6.5.2 Organisation for action.

This involves establishing the club structure and management roles of the facilitators. Project champions are elected and teams formed within the companies.

2.6.5.3 Assessment

The assessment phase involves undertaking on-site waste minimisation audits to identify sources and quantity of waste and determine the scope for savings. This can be carried out by the project teams themselves, or by an external consultant. Ideally, the assessments should be conducted in-house such that waste minimisation becomes incorporated into the way in which the company is managed. Options for improvement are identified and feasibility analyses carried out to determine which changes are to be implemented.

2.6.5.4 Implementation

In the implementation phase, club members undertake the waste minimisation actions identified during the assessment phase.

2.6.5.5 Analysis

The final phase of establishing the clubs is to analyse the results achieved. This involves quantifying the savings achieved by the individual club members, not only in terms of financial benefits to the companies, but also the environmental benefits.

2.6.5.6 Training

Training is an important aspect of a waste minimisation club. It involves educating management and shop floor personnel in waste minimisation issues and ensures the long-term success of a waste minimisation programme. If all staff is not involved in the programme and encouraged to practice waste minimisation, it will not be a sustainable process.

2.6.5.7 Management

While some of these clubs may be managed by the companies themselves, the majority are run by a partnership of organisations, coordinated by a lead organisation or a steering group. This steering group comprises the funding bodies, organisations that support industrial development and any other interested parties such as the local authorities and trade associations. The leading organisation or steering group then sets goals for the club and organises the meetings. An external consultant may be contracted to aid in undertaking the waste minimisation audits.

Within each club member (i.e. company), a *project champion* must be appointed who has the responsibility of driving the project in their company; establishing *project teams* and training them in waste minimisation; setting goals for the programme; and disseminating the results, both internally and to the other club members. These teams are comprised of representatives from each department in the company who have access to process or financial information.

Club meetings are held on a regular basis, generally bimonthly, where the project champions report back on the progress in their companies. These meetings may also be used by the steering group as training sessions for the champions, or to invite guest speakers to give presentations on relevant topics.

2.7 Environmental Legislature and Policy in South Africa

Increased fines, clean-up orders, liability for environmental rehabilitation, personal liability of directors, and the increase in public and international pollution awareness are all issues facing the South African Industries. New developments in pollution liability were introduced at a rapid rate during 1998, and these are contained in a number of new Acts, Bills, Policies and Draft Policies. These include:

- the Water Service Act 108 (1997),
- the National Water Act (1998),
- National Environmental Management Bill (1998),
- Proposed Integrated Pollution Control and Waste Management Bill (1999),
- National Waste Management Strategies and Action Plans (1999),
- Draft White Paper on Environmental Management Policy for South Africa (1998),
- Draft White Paper on Integrated Pollution Control and Waste Management for South Africa (1998),
- Water Demand Management Conservation, and
- Catchment Mangement Agencies.

These developments stress the need for companies and their directors to assess their rights and obligations in this field (van Onsellen O,Connell, 1998). The following section will highlight some of the more important pollution liability aspects.

2.7.1 Water Services Act

The discharge of industrial effluent is controlled by either the local authorities (if discharged to sewer) or DWAF (if sent directly to a natural water resource). Permits and licenses will be issued to control standards which must be set in such a way so as to promote sustainable development, pollution prevention, waste minimisation and the Best Practicable Environmental Option. Companies will therefore, be required to either treat their effluent to a greater extent or implement some waste minimisation programme to reduce their waste. Permits are likely to be used to enforce strict pollution control measures and violation of these can lead to withdrawal of a permit and subsequent closure of operation.

2.7.2 The National Water Act (NWA) and National Environmental Management Bill (NEMB)

The NWA is aimed primarily at controlling pollution of water, whereas the NEMB covers all environmental media. Both place an obligation on owners of land on which any activity is, or was, performed which is, or has caused pollution to take place, to take all reasonable measures to prevent the pollution from occurring, continuing or re-occurring. It, therefore, imposes liability for historical activities which caused pollution as well as historical pollution itself. Both the NWA and the NEMB allow for local authorities to direct the offender to take clean-up and rehabilitation measures. If this directive is ignored, the authorities can undertake the necessary steps and recover all costs from the offender.

The NWA makes provision for the prosecution of offenders who do not comply with its regulations. The maximum penalty for a first time offender is R 50 000 and/or one-year imprisonment. This is increased to R 100 000 and one year imprisonment for second offenders. Additional penalties may be applied if deemed necessary. It has been DWAF policy not to prosecute offenders immediately. DWAF, however, due to continual deterioration in the quality of the RSA water resources, considers pollution to be a serious offence and have recently begun prosecuting offenders immediately.

Penalties that can be incurred in terms of the NEMB include:

- payment of damages, whereby any third party that was harmed / damaged due to pollution can fine the offender;
- pollution advantage; i.e. it can be shown that the company has gained financially by not disposing of waste in the correct manner, they can be forced to pay this amount; and
- Investigation and prosecution costs incurred by the investigation.

2.7.2.1 Private Prosecution

Under the NEMB, private citizens have the right to enforce pollution control by being able to prosecute any company or individual if it is felt that there is a breach of any law relating to the protection of the environment. In the event of the prosecution being unsuccessful, the accused may be required to pay the private prosecutors legal costs.

2.7.2.2 Access to Information

In terms of the NEMB, any person is allowed access to information held by the government pertaining to all emissions to the environment. In other words, the public is entitled to access the production process of a company that utilises a substance that is potentially harmful to the environment.

2.7.2.3 Director Liability

Any person who is, or was, a director of a company at the time at which the company committed an act of pollution, and it is found that the director did not take all reasonable steps to prevent the pollution from occurring, can be held liable in a personal capacity. In this case, the director can be convicted on all penalties described in the previous section, including imprisonment. There is, therefore, an obligation on the part of a director of a company to be aware of all aspects relating to the production of waste on site.

2.7.2.4 Protection of Workers

Under the NEMB, there are two clauses which aim to protect the workers. In the first instance, a worker is entitled to refuse to perform any task if they reasonably believe that it poses a threat to the environment. In this case, the employer may not take action against the worker. In the second instance, workers are encouraged to disclose any information on company activities that poses an environmental risk to the authorities. Again, no action may be taken against them by their employer.

2.7.3 The White Paper on Integrated Pollution and Waste Management

The National Waste Management Strategy (NWMS) recognises that existing legislation is still fragmented and requires a review of existing laws to produce a more integrated approach to waste management.

As a means for integrated waste management, the NWMS pays particular attention to waste minimisation. For the purposes of the NWMS, waste minimisation refers specifically to the steps taken towards source reduction and/or internal recycling so that there is a reduction in the *volume and/or environmental impact of waste that is generated, treated, stored or disposed of* (Department of Environment Affairs and Tourism, 1999). The Action Plan for this strategy encourages government to provide sufficient motivation and capacity amongst waste generators such as industry so that they can successfully implement waste minimisation and recycling practices. The plan details a programme of information dissemination on waste minimisation by 2001, the development of regulations and their enforcement by 2002 while concurrently implementing economic incentives for the adoption of these waste management strategies (Department of Environment Affairs and Tourism, 1999).

These above sections are only a summary of the new legislation in South Africa that has an effect on industrial activity. It is evident that companies are being forced to take environmental issues into account in their business strategy. In addition, all of the above serve to promote waste minimisation and therefore provide an enabling legal context for the formation of waste minimisation clubs.

2.8 Summary

This summarised literature survey serves to indicate the importance of promoting waste minimisation to industry as a means of achieving cleaner production and ultimately, contributing to sustainable development. Waste minimisation clubs have been shown to be an effective means of promoting the concepts to industry in other regions with substantial savings to both the industry and the environment. South African legislature is moving towards ensuring the uptake of cleaner production by industry in the country, by penalising those that do not take action to reduce waste at source. Some focus has been given to the promotion of waste minimisation in the KwaZulu Natal region, as this is the are of investigation for this project. The formation of waste minimisation clubs is seen as one route of achieving this goal, and has the support from both national and local government.

Chapter 3 - Metal Finishing Waste Minimisation Club

This Chapter will detail the formation, management and results of the Metal Finishing Waste Minimisation Club in KwaZulu-Natal. More details can be found in Thambiran (2001) and the **Data Report, Annexure 7**.

3.1 The Metal Finishing Process

Metal finishing operations are employed at some point during the manufacture of nearly all metal products. The most common of these include fabricated metal products, common machinery, electronic machinery, and household appliances.

Metal finishing companies are either captive shops or job shops. Captive shops perform finishing activities on the parts they manufacture, while job shops are a service industry that provides metal finishing for manufacturers and the public (EPA, 1995). Captive shops are usually larger than job shops, and are prevalent in the automotive components industry.

Metal Finishing comprises a broad range of processes and is performed on manufactured parts after they have been shaped formed, forged, etc. The metal surfaces are prepared for finishing by cleaning, pickling, and dipping. A finish is any final operation applied to the metal object to alter its surface. This is done to increase corrosion or abrasion resistance, alter appearance, add hardness, or improve solderability. These characteristics can be significant for a product and could determine its quality and usefulness. Metal finishing operations are typically carried out in batches. Processes used involve the cleaning, hardening or softening, smoothing, and conversion of the object's surface using chemicals. The metal objects are dipped into and removed from baths containing the plating solutions.

In general, the metal surface treatment and plating operations can be divided into 3 stages, namely surface preparation, surface treatment, and post treatment. During surface preparation, the object is cleaned using solvents, detergents, and caustic solutions. Surface treatment entails the actual plating, coating, or polishing of the object, while post treatment refers to further finishing such as colouring. The processes can be either manual or automated. The level of automation will depend directly on the availability of appropriate technology and capital.

The Canning Handbook on Electroplating is a valuable source of information on these processes. The book contains detailed descriptions of all types of electroplating and other metal finishing operations. It is a useful reference for researchers as well as electroplaters. Other sources such as *A Cleaner Production Manual for the Metal Finishing Industry* (UNEP Working Group, 1998) and the US EPA (1995) guide *on International Waste Minimisation Approaches and Policies to Metal Plating*, also provide good descriptions of major metal finishing processes. Further details can be found in Thambiran (2001).

3.2 The South African Metal Finishing Industry

The metal finishing industry in South Africa is widespread and diverse. It includes galvanising, electroplating, painting, and a wide range of machining processes (Danced, 1999). Due to a lack of quantitative data on the industry in South Africa, Naumann (2000) conducted an economic analysis of the industry. He found that the majority of metal finishers in SA are located in the Gauteng area, followed by Cape Town and Durban. It is estimated that there are more than 500 electroplaters and approximately 30 galvanisers in the country. The industry has a low skill requirement for it's workers, and is therefore a medium/low wage employer. However, the directly employed workforce has been declining significantly, implying that the metal finishing industry has not been creating jobs.

A survey of the SA metal finishing industry was also conducted by the University of Cape Town as part of an Industrial Symbiosis project. The survey resulted in the compilation of a database of South African metal finishing companies containing information on location, size, products, and processes. The database contains the names of 316 metal finishing companies in South Africa. Of these, 217 were surveyed. The results of the survey showed that 88% of the companies were SME's made up of job (48%) and captive (40 %) shops. Electroplaters represent the largest proportion of the industry with 42% of the industry being electroplaters. Within electroplating companies, the most common types of plating were zinc, nickel, and copper (Janisch, 2000).

Most enterprises within the metal finishing industry are SME's, and therefore are generally not as technologically advanced or environmentally conscious as the larger companies. The difficulties experienced by the SME's contributes strongly to the decline in output from the metal finishing industry that has been occurring (Naumann, 2000). Often in small job shops, the owner is responsible for a multitude of administrative and production tasks. There is little time for training the workforce. Often the managers themselves are not sufficiently knowledgeable to provide skilled supervision, and a number of companies rely on chemical suppliers for technical knowledge and expertise (Danced, 1999). The industry is regulated by the DEAT and DWAF at national level and municipal authorities on a local level.

3.3 The Impact of the Metal Finishing Industry on the Environment

Metal finishing operations are a significant source of pollution. The consumption of water and chemicals by this industry is extremely high. Due to the toxic nature of the chemicals involved in treatment and the metals being coated, releasing them into the environment results in serious environmental degradation (UNEP IE, 1989). Some of the effects are immediate whilst others are cumulative in nature and may take many years to manifest themselves. The effects include the destruction of aquatic life, the accumulation of heavy metals in the food chain and the pollution of drinking water (UNEP IE, 1989). The industry is a major source of heavy metals in the wastewater, which presents a problem at the treatment works (WRC, 1994).

A number of different stages are involved in a metal finishing operation including cleaning and pretreatment of the metal prior to coating. There are thus a number of different chemicals involved and a number of potential hazards.

Spills and careless dumping of waste or spent chemicals result in the contamination of the soil around the premises of a metal finishing concern. This leads to the contamination of ground and surface water. Waste carried in the discarded wastewater may pollute streams. The improper storage and transportation of residue containing toxic chemicals present a potential hazard to humans and the environment. The unsafe handling of process chemicals may result in workplace accidents and illness. Worker education and training is important to prevent the above problems from arising (UNEP IE, 1989).

In the past industries have been primarily concerned with water pollution from untreated waster water, but it has become more important to consider air emissions and soil and groundwater pollution. The disposal of treatment sludge and solid wastes are high priorities in society today. Metal finishers are finding it increasingly difficult to dispose of their sludge due to its high metal content.

The main sources of pollution from the metal finishing industry are shown in Figure 3.1.

3.4 Waste Minimisation Options for the Metal Finishing Industry

The potential to implement waste minimisation in the metal finishing industry is significant. Numerous guides and manuals exist on the available options and therefore the main focus issues will be highlighted in this section. More information is also available in Thambiran (2001).

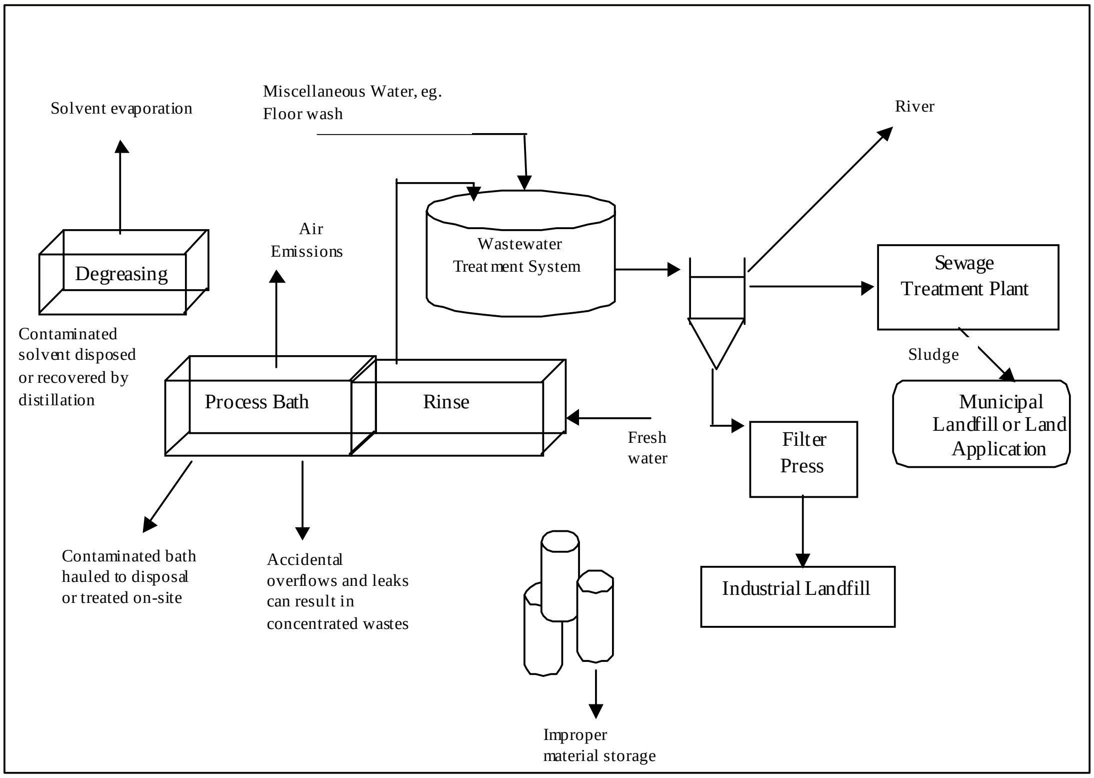

Figure 3.1: Main Sources of Pollution from the Metal Finishing Industry (UNEP IE, 1989)

For a metal finishing enterprise the following considerations are important in pollution control (UNEP IE, 1989):

- the use of low and non-waste production technology,
- proper treatment of waste,
- competent operation and maintenance of the above, and
- the education and training of workers

General waste minimisation in the metal finishing industry involves developing options to reduce rinse water consumption, recycling of rinse waters, extending the life of solutions and plating baths, and avoiding spills and overflows. The economic gains achieved are accompanied by environmental gains. The reduction of harmful effluents can be achieved by reducing effluent volume or its strength or both. By producing less effluent, it implies lower treatment costs.

In order for metal finishers to reduce the concentration of pollutant in their effluent, they may consider the following options (UNEP IE, 1989):

- recycling spent solutions to reduce loss of chemicals,
- improving maintenance of baths to increase their service life,
- avoiding the use of toxic chemicals,
- adopting alternative processes that require lower concentrations of chemicals,
- preventing spills,
- reducing drag-out into rinse tanks, and
- Preventing contamination of the bath.

Some waste minimisation options will require an initial investment, but the environmental and economic benefits usually justify this investment. The situation at a metal finishing enterprise needs to be evaluated before waste minimisation measures can be selected. The evaluation covers the consumption of process chemicals water and energy; assessment of the production methods and wastewater treatment and disposal.

3.5 The Metal Finishing Industry in the Durban Metropolitan Area

The presence of heavy metals in sewage sludge is of increasing concern, both on a national and regional level. The National Waste Management Strategy discussion document for Hazardous and Related Wastes (July 1998) highlighted the importance of addressing this issue in a number of sections. While the larger metal finishing companies in South Africa generally follow acceptable disposal procedures, many of the smaller operations do not, with effluent containing heavy metal concentrations in excess of the sewer regulations commonly being discharged to drain. The sludge from sewage treatment plants is traditionally deposited on farmlands, but this is often not possible due to this high heavy metal content, with the result that the sludge has to be disposed of to landfill. The preferred solution is to prevent the discharge of the heavy metals to sewer, although the use of penalties has not been very successful in the past due to a lack of manpower. A second approach is to provide the industry with cost effective facilities for managing wastes and effluents.

On a regional level, the Durban Metropolitan Council (Durban Metro) in KwaZulu-Natal (KZN) issued new bylaws in July 1998 (promulgated in 1999) targeting effluents containing heavy metals, with stringent regulations being applied as to the acceptable levels of metal concentration. Those companies discharging to small inland sewage works (flow < 25 Ml/d) have stricter limits than those discharging to large works (flow > 25 Ml/d) that discharge to sea. There is also a lack of landfill sites in the DMA that are able to accept hazardous waste and hence the metal finishing companies had to truck their sludge to landfill sites approximately 600 km away at great expense and risk, or they stored them on-site. The majority of the metal finishing operations in the DMA are SMME’s and found it difficult to meet these costs. However, within these new bylaws, there is the provision for a company to apply for relaxation on the limits, provided that a number of criteria are met, one of which is that the company must show that it is implementing a programme of waste minimisation, thereby reducing waste at source. This increasing pressure from the Durban Metro, together with the lack of suitable disposal sites, prompted a number of local companies to investigate waste minimisation.

Due to the problems facing the local metal finishing industries, it seemed appropriate to initiate a waste minimisation club in this sector.

3.6 Establishment of the Metal Finishing Waste Minimisation Club

The Metal Finishing Waste Minimisation Club was formed in June 1998 following a meeting called by the Durban Metro to discuss the new effluent bylaws with the Metal Finishers in the DMA. This meeting was attended by approximately 80 metal finishers, chemical suppliers and local authorities. The PRG was invited to address the meeting on waste minimisation and the proposed waste minimisation club. A recruitment meeting was held at the end of June 1998 at which time 29 metal finishers elected to join the club. A list of these club members, together with their employment statistics is given in Table 3.1.

Table 3.1: List of Metal Finishing Companies Recruited in June 1998

Company	No. employees	Type of Operation	District
MF1	10	Job shop	Jacobs
MF2	800	Manufacturer	Jacobs
[2]MF3	15	Job shop	New Germany
MF4	10	Job shop	Chatsworth
MF5	90	Manufacturer	Pinetown
MF6	26	Manufacturer	Durban
[2]MF7	330	Manufacturer	New Germany
MF8	180	Manufacturer	Prospecton
MF9	300	Manufacturer	Pinetown
MF10	350	Manufacturer	New Germany
[2]MF11	50	Job shop	Durban
MF12	30	Job shop	Pinetown
MF13	10	Job shop	Pinetown
[1]MF14	150	Manufacturer	Pinetown
[1]MF15	29	Job shop	Durban
MF16	18	Job shop	Pinetown
MF17	7	Job shop	Rossburgh
[2]MF18	80	Job shop	Phoenix
[2]MF19	14	Job shop	Pinetown
[1]MF20	5	Job shop	Pinetown
MF21	24	Manufacturer	New Germany
MF22	50	Job shop	Seaview
[2]MF23	15	Job shop	Durban
MF24	9	Job shop	Pinetown
[2]MF25	60	Manufacturer	Pinetown
MF26	6	Job shop	Durban
MF27	37	Job shop	Prospecton
MF28	14	Job shop	Clairwood
[2]MF29	200	Manufacturer	Pinetown

Notes:
[1] These companies withdrew from the club within the first year
[2]These companies expressed an interest in remaining informed of the club activities, but did not attend meetings regularly

3.7 Profile of the Metal Finishing Club Members

Of the members listed in Table 3.1, 23 are electroplaters; 3 are galvanisers; and 3, powder coaters. More than half of the companies (65%) are jobbing shops where any suitable articles are accepted for finishing, with the remaining 35% being manufacturers where metal finishing forms only a part of their operations. In order to give an indication of the overall size of the companies involved, an analysis according to the number of employees at each factory was undertaken. The results are given in Table 3.2.

Table 3.2 Profile of the Metal Finishing Club Members

No. of employees	No. of companies		Cumulative Total	
	Number	(%)	Number	(%)
< 10	4	14	4	14
10 to 20	8	28	12	42
20 to 50	5	17	17	59
50 to 200	8	28	25	86
> 200	4	14	29	100

As is evident, more than 50% of the members have less than 50 employees, thus placing the majority in the SMME sector. This waste minimisation club therefore provided the ideal opportunity for investigating the promotion and up-take of waste minimisation in the SMME sector.

3.8 Management of the Waste Minimisation Club

Due to the large amount of information and detail gathered during the running of the Waste Minimisation Club, this section will serve to highlight some of the main aspects of managing the Club. Further information can be obtained in Thambiran (2001).

3.8.1 Organisation for Action

The Club was facilitated and run by the PRG with guidance from the members as to the type of information they would like to receive at the meetings. The Durban Metro attended the meetings on an invitation-only basis as the club members felt that their presence would limit the discussions. Meetings were held over 4 hrs, with half the meeting allowing for information sharing by the PRG and other speakers on issues related to the metal finishing industry; and the second half for feedback from the industries as to their progress and problems, and discussions.

During the course of the project, 12 club meetings were held, 3 special meetings (those called outside of official club meetings to address specific issues) and 7 training sessions. Meetings were initially held at quarterly intervals, but these were increased to bimonthly to encourage interaction between the club members.

Club members were asked to sign a declaration of commitment, which outlined the aims, and goals of the club. These included a commitment to implementing a programme of waste minimisation, reducing all sources of waste, making continual improvements, establishing a monitoring programme, reducing their environmental impact, sharing information with other club members, and attending regular club meetings.

3.8.2 Assessments

As mentioned previously, 22 senior chemical engineering students were recruited to undertake waste minimisation surveys within the member companies in order to determine the process flows and identify opportunities for savings. All students were given theoretical training in implementing a waste minimisation programme and suitable waste reduction options for the metal finishing industry. These students then entered the companies and undertook an initial waste audit, identified all inputs and outputs, quantified wastes and made suggestions as to improvements. In some cases, feasibility assessments were carried out. This was carried out over a 4 to 6 week period during the July 1998 vacation. On completion of the audits, the students prepared final reports on which the companies could base their waste minimisation programmes. The PRG project team then undertook follow-up site visits during the course of the project to aid in identifying further options and providing advice on implementation. Enviros March also undertook site visits to the larger companies to assist in identifying options for energy saving.

3.8.3 Training

The club members attended training sessions on waste minimisation aspects that were presented by Enviros March. These covered both general and technical issues. There were 7 training sessions in total and these included:

- An introduction to waste minimisation
- Data gathering
- Identification of opportunities
- Structured problem solving
- Project evaluation
- Project management
- Energy savings in compressed air

More details on these courses can be found in Enviros March (2000).

Representatives from Durban Metro also attended these courses and found them to be beneficial. These training sessions also acted as an effective means of social interaction between participants.

3.8.4 Barriers and Drivers

An important aspect of implementing a waste minimsation programme within an organisation is to identify the barriers and drivers within that company, and identify ways in which the barriers can be overcome.

The Metal Finishing Club members were asked to identify barriers and drivers to waste minimisation at yearly intervals in order to assess if the barriers identified initially had been overcome during the course of the project. In addition, it was interesting to note the manner in which the drivers changed depending on the climate in which the factories were operating.

The results are discussed in Section 3.9.7 of this report.

3.8.5 Interviews

During February and March 2000, a series of interviews were conducted with the club members with the aim of determining:

- Their understanding of waste minimisation,
- Motives and reasons for joining the club,
- Their first impressions of the club idea,
- Their views on the club today,
- Their relationship to the other platers,
- The usefulness of the material they have received and the presentations given at the meetings,
- Reasons for not attending meetings,
- The benefits of the club,
- The barriers experienced in implementing waste minimisation,
- Their relationship with the Durban Metro,

- Their general environmental attitude,
- Their relationship with their workers, and
- The usefulness of the students assistance and report.

The results of this survey, together with the questionnaire are given in the **Data Report, Annexure 9**. Some of the results are highlighted in Section 3.9.8 of this report.

3.8.6 Case Studies

Based on the information obtained from the companies during club meeting and site visits, case studies have been prepared highlighting their successes. Summary case studies have been written for 24 of the club members and are given in the **Data Report, Annexure 7** to this report. Items covered in these case studies include:

- Background information on the company and its process
- A list of identified waste minimisation options together with the status of these options
- Details of waste minimisation activities
- Economic benefits
- Environmental benefits
- Contact details

The aim of these cases studies to use them as promotional material to encourage other South African industries to implement waste minimisation. Numerous case studies are available for international organisations, but no local examples exist that can be used to show that waste minimisation is also successful in South Africa. These case studies will be placed on the Internet during 2001.

In addition, detailed case studies were carried out on 4 of the club members. These served to obtain information on the waste minimisation activities of the companies from the preassesment phase through to the implementation phase. Results of these case studies can be found in Thambiran (2001).

3.8.7 Monitoring and targeting

As mention in Chapter 2, section 2.5.3, monitoring and targeting is an important aspect of a waste minimisation programme. Enviros March have developed a software package called MONTAGE, which is designed to manage utilities and materials in commercial and industrial sites. A copy of Montage was installed at the PRG for use for analysing data from the metal finishing club members. The information required included production data and utility (water and energy) usage.

Despite numerous attempts to obtain this type of information from the member companies, none of the club members took advantage of this tool, with the result that a monitoring and targeting exercise could not be carried out. The reasons for this lack of interest were mostly due to a lack of production data (in the case of the jobbing shops) and lack of time to collate the data for the PRG (larger manufacturers). It is felt that the companies would have benefited greatly from Montage and it is unfortunate that they did not use this opportunity.

3.8.8 Health and Safety Aspects

Environmental matters and occupational health and safety matters are often closely related. They may work against each other, for example, when a ventilation system causes increased pollution of the environment, but most often, when the underlying cause is choice of technology, they work together. Cyanide electrolytes for example, are both an occupational health and safety hazard and an environmental hazard, as are most organic solvents. It is thought that a forum of SMEs (i.e. a waste minimisation club) taking on small-scale cleaner production / continuous improvement activities could be a good opportunity for testing how health and safety issues can be addressed and if any synergy effects can be achieved. The objective of this project is therefore to form a group where SME owners *teach* other SME owners, and to give support by facilitating the process, rather than contributing to the process in a traditional manner. It is thus seen as an issue of facilitating a learning process rather than providing discipline focused knowledge.

A post graduate student from the University of Aalborg in Denmark undertook an investigation into the relationship between health and safety and Cleaner Production using the metal finishing waste minimisation club as a case study. Results of this analysis have not been submitted to the PRG as yet (April 2001).

3.9 Analysis of Results

This section will discuss the results achieved during the course of the project and include financial and environmental savings; options identified; barriers and drivers; and other aspects such as social interactions, the use of students, health and safety, and so forth.

3.9.1 Attendance at Meetings and Training Sessions

Of the 29 companies that elected to join the club in 1998, 3 withdrew within the first year, and 8 requested that they be kept informed of the club activities, but only attended two or three meetings. The remaining 18 members all took part in waste minimisation activities at their sites to varying degrees, with some showing substantial benefits, and others doing enough to satisfy their own requirements.

Reasons for withdrawing from the club were given as

- lack of time to attend meetings,
- lack of commitment from the senior management to allow a representative to attend the meetings,
- lack of interest and motivation (if the company was complying with the standards set by Metro, why implement any changes), and
- The company felt it was too small to benefit from the club.

Reasons for non-attendance were similar to those given for withdrawing from the meetings. Attempts were continuously made to incorporate these companies into the club activities, but ultimately it was the companies' responsibility to attend and participate.

Similarly, the training sessions provided by Enviros March were poorly attended, although interest was expressed in these courses when the club members were initially approached. Reasons offered for this lack of attendance included insufficient information on the purpose and nature of these courses, a lack of time, and the time of day the courses were held.

A correlation between the number of meetings and training sessions attended by the companies, and the savings achieved are given in Table 3.4 in Section 3.9.2 below.

3.9.2 Financial savings

The financial savings achieved by the club members were obtained from the feedback sessions at the meetings, on-site visits and personal communication. Results were obtained for 16 of the 18 companies that participated in the club. This did not imply that the other companies did not achieve savings, but that the results were quantified or not reported to the PRG project team. In addition, it is felt that the results that were reported were purposely understated for strategic reasons and therefore, the total savings will be in excess of those reported here.

Financial savings in excess of R 2 million/annum in water, chemicals, energy and effluent were reported by the club members, with the potential to save a further R 650 000 / annum. Two of the companies reported that their savings were of the order of 5% to 7% of their annual turnover. A summary of the savings is given in Table 3.3. It must be noted that these savings are total amounts over the course of the project. However, they can be taken as annual savings as the companies will realise these savings each year from now onwards.

As is evident from Table 3.3, a wide range of savings were achieved, from as little as R 300/y to as much as over R 1 million/y. In the case of those companies with low financial benefits, it was found that the social benefits were of more importance to the club member. It is also evident that the size of the company does not dictate the degree of savings, with some of the smaller companies showing substantial savings. In most cases, payback periods were less than a year.

Table 3.3: Summary of Reported Financial Savings for the Metal Finishing Club

Company	Type	Employ No.	Water R/y	Chem R/y	Metals R/y	Energy R/y	Effluent R/y	Treatment R/y	Other R/y	Total
MF9	man	300	25	970			6			1 001
MF1	job	10	5 720			5 060	1 560			12 340
MF2	man	800	127 160			110 000	34 695			271 855
MF4	job	10	5 560	110 000		88 000	1 515			205 075
MF5	man	80	5 180	0		5 500	1 410	24 750		36 840
MF6	man	26	11 000	55 000			3 000			69 000
MF8	man	180		777 600	168 630	78 870		99 880	30 910	1 155 890
MF10	man	350	10 970				4 050	10 260		25 280
MF12	job	30	17 490	30 800	12 100		480	33 000	16 860	110 730
MF16	job	18	955	88 000			260			89 215
MF17	job	7	760				210			970
MF22	job	50	60 400	68 400		33 000	33 830			195 630
MF24	job	9	550	220			150			920
MF26	job	6		550						550
MF27	job	37	4 770							4 770
MF28	job	14	640	13 200			170			14 010
	Totals		**251 180**	**1 144 740**	**180 730**	**320 430**	**81 336**	**167 890**	**47 770**	**2 194 076**
	% of total		11	52	8	15	4	8	2	

Note: Man = manufacturer; job = jobbing shop nq = not quantified

As can be seen from the Table 3.3, an emphasis was placed on the reduction of water and chemical consumption. While this leads to reductions in effluent concentrations and volumes, a number of companies have not quantified that resultant saving. The highest combined financial saving was achieved in chemical costs (52%) as illustrated Figure 3.2. The large chemical savings achieved by MF8, also include savings in oil and solvent due to investigating alternative suppliers. The South African metal finishing industry is exposed to world prices when it comes to chemicals and metals, and therefore costs of chemicals are high. Thus there are considerable savings to be made by reducing chemical consumption.

It must be noted that in most cases, chemical savings include savings in metals, but these were not quantified individually by all companies. Savings in metals were quantified for 2 companies and this accounted for 8% of the total savings.

Savings in energy are the next highest followed by water and effluent treatment costs. While reductions in water consumption have been made, water is relatively inexpensive in South Africa. Therefore great quantities must be saved to achieve a substantial financial saving. Effluent savings were quantified by taking 95% of the water savings and this accounted for 4% of the total savings. *Other* savings for MF8 refer to savings made in solid waste disposal costs due to more efficient sludge drying, and for MF12, refers to savings that could not be attributed to a single type and is a combination of water, chemical and metal savings. Water and effluent savings were calculated by taking the volumes and multiplying them by the cost of water and effluent discharge costs which were taken to be R 2.89 / kl and R 0.83 / kl respectively.

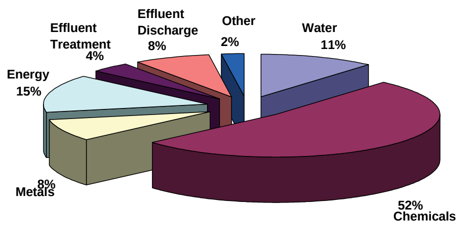

Figure 3.2. Summary of Savings Made by the Metal Finishing Club Members

As mentioned in Section 3.9.1 above, a correlation was made between attendance at meetings and the resultant savings. These results are reported in Table 3.4.

Table 3.4 Attendance at Meetings and Savings Achieved

Company	No. employees	Savings (R/y)	Meetings (of 11)	Training (of 8)
MF9	300	1 001	10	4
MF1	10	12 340	7	3
MF2	800	271 855	9	5
MF4	10	205 075	5	2
MF5	80	36 840	10	4
MF6	26	69 000	5	0
MF8	180	1 155 890	8	0
MF10	350	25 280	7	3
MF11	50	0	3	0
MF13	10	nq	2	0
MF12	30	110 730	10	6
MF16	18	89 215	5	1
MF17	7	970	6	5
MF18	80	nq	2	0
MF21	24	nq	4	0
MF22	50	195 630	9	4
MF24	9	920	10	0
MF25	60	0	1	0
MF26	6	550	8	1
MF27	37	4 770	1	0
MF28	14	14 010	9	7

Note: nq = not quantified

As can be seen from Table 3.4, no company achieved 100% attendance at the meetings or training sessions, although more than 60% attended more than half the club meetings. Attendance at the training sessions was much poorer, with only 4 companies attending more than half the sessions.

There is no apparent correlation between the number of meetings and training sessions attended and the degree of savings made; other than to comment that only those who attended these meetings achieved some form of savings. In some cases, companies that were present at almost all meetings made smaller savings than companies that attended irregularly. For example, MF5 attended 10 meetings and 4 training sessions and made savings of R 36 800, whereas, MF4 attended half the number of meetings and training sessions, yet made R 205 000 savings. One must then take into account the size of the company, the type of savings achieved (e.g. MF's main savings was in reducing electricity costs by monitoring meter readings) and the initiatives that were already in place to reduce waste.

A second method of reflecting the savings achieved, is to look at the savings made per number of employees, This indicates whether only the larger organisations achieved financial savings, or if waste minimisation is also beneficial to the SMME sector. These results are shown in Table 3.5.

Table 3.5: Savings Made per Employee in the Metal Finishing Club

Company	No. employees	Savings R/y	Savings/employee (R / employee)
MF9	300	1 001	3.33
MF1	10	12 340	1 234.00
MF2	800	271 855	339.81
MF4	10	205 075	20 508.00
MF5	80	36 840	460.83
MF6	26	69 000	2 653.85
MF8	180	1 155 890	6 421.61
MF10	350	25 280	72.23
MF12	30	110 730	3 690.67
MF16	18	89 215	4 958.89
MF17	7	970	138.57
MF22	50	195 630	3 912.60
MF24	9	920	102.22
MF26	6	550	91.67
MF27	37	4 770	128.92
MF28	14	14 010	1 000.71

As can be seen from Table 3.5, the smaller companies have, on average, made larger savings per employee than the larger organisations. This indicates that implementing waste minimisation makes good business sense for all companies, regardless of the size.

A third method of indicating the success of waste minimisation is to reflect the annual savings achieved as a percentage of the annual turnover of the company. Turnover figures were only available for 9 of the 16 companies and these are given in Table 3.6.

From Table 3.6 it can be seen that two of the SMME's achieved savings that accounted for more than 20% of their annual turnover. This indicates that without the promoting of waste minimisation within these companies, they would have continued to lose 20 of their turnover every year to waste. The savings made by MF12 accounted for almost 6% of the annual turnover, and both MF12 and MF22 have reported at meetings that if it were not for the savings achieved through waste minimisation, the companies would not have made a profit during the economic slump.

Table 3.6 Savings as a Proportion of Turnover for 9 Metal Finishing Club Members

Company	Number employees	Annual Savings / Annual Turnover (%)
MF4	10	21
MF5	80	0.6
MF8	180	3.9
MF12	30	5.5
MF17	7	0.2
MF22	50	19.6
MF24	9	0.9
MF27	37	0.05
MF28	14	1.8

3.9.3 Analysis of Financial Savings for a Metal Finishing Company

In order to ensure that club members were not reporting savings that were not actually achieved the water, chemical and electricity records of one company were analsysed to determine if their estimated savings were accurately reflected.

Water and electricity accounts were collected for 1998, 1999 and 2000 for MF22. This company was chosen, as the records were readably available. Since the company does not keep records of production in terms of mass or volume due to the variety of goods processed, the monthly turnover figures in rands were used as an indication of the production.

An analysis of the water and energy usage per rand turnover was carried out. The results of the study are summarised in **Table 3.7**. As is evident, savings in all three areas were achieved. The details of the investigation are summarise in this section. Further detail is available in the **Data Report, Annexure 10.**

Table 3.7: Summary of Water Use, Effluent Production and Electricity Use per Rand Production for MF22.

Year	Water (l/R prod)		Effluent	Electricity
	Municipal	Borehole	l/R prod.	KWh/R prod.
1998	18.6	33.64	51.55	0.24
1999	6.47	27.08	33.29	0.24
2000	5.09	18.16	23.05	0.19

As can be seen, municipal water use per Rand turnover decreased from 18.65 l/R in 1998 to 5.09 l/R in 2000. This is an overall decrease of 73% over the two years. Similarly, borehole water use decreased by 46 % and effluent production by 55%. Electricity use decreased by 21% from 1998 to 2000.

Based on the consumption of water and electricity per R turnover, the savings made during the course of the project can be calculated using the current turnover figure. If one takes this to be of the order of R 1 million / annum, then the savings made since the implementation of waste minimisation at this factory can be estimated. This is given in Table 3.8.

Table 3.8: Calculation of Savings Based on Company Records

Utility	1998 Quantity	2000 Quantity	Saving Quantity	Saving Quantity / annum	Saving R / annum
Electricity	0.24 kWh/R	0.19 kWh/R	0.05 kWh/R	50 000 kWh	10 000
Municipal water	18.6 l /R	5.09 l /R	13.51 l /R	13 510 kl	44 200
Borehole water	33.64 l/R	18.16 l/R	15.48 l /R	15 480 kl	
Effluent	51.55 l/R	23.05 l/R	28.5 l /R	28 500 kl	33 350
Total					**87 550**

Note: It must be remembered, that borehole water is only charged as effluent, therefore there is no rands saving on the borehole water as this is included in the effluent savings.

These results can be taken as annual savings as they are based on the current production rates. These results were then compared to those reported by MF22 (Table 3.9).

Table 3.9 Comparison of Calculated and Reported Savings

	Calculated Savings R / annum	Reported Savings R / annum
Electricity	10 000	33 000
Water	44 200	60 400
Effluent	33 350	33 800
Chemicals and Metals	68 400 (not verified)	68 400
Totals	**155 950**	**195 600**

As is evident, the calculated savings are less than those reported by the company. This is to be expected, as the savings reported did not take into account the variation in production figures. These savings were reported on a monthly basis and then extrapolated to give the yearly savings. The results reported were compared month for month to those given in the utility accounts and they were found to be comparable, indicating that the company were reported correct savings based only on consumption.

This indicates the importance of ensuring that utility consumption is compared to production in order to obtain an accurate indication of the savings achieved.

The savings reported on chemical use have not been verified due to a lack of records. It is thought that a similar situation will exist as for the water and electricity savings.

It must also be noted that these results do not take into account the annual price increase that the company places on its process. This implies that the savings will be slightly less than those calculated in Table 3.9.

Based on this analysis of the savings achieved by MF22, it is evident that the savings reported at meetings are higher than those calculated based on monthly accounts and production. As discussed in Section 6, this is to be expected since the reported savings did not take into account the variation in production from month to month. In addition, the price increases have not been taken into account for both the calculated and reported savings, therefore the savings will be slightly less than those given in this report.

Based on this analysis, the Project Team is confident that the company did not inflate their savings to give a good impression at Club meetings**.**

3.9.4 Problems Experienced in Quantifying Savings

A number of problems have been experienced in quantifying the savings experienced by the companies. These include :

- Changes in the costs of water and electricity, resulting in changes to the figures originally quoted by the companies
- A lack of records of production, utility consumption etc.
- Increases or decreases in production, resulting in more or less water / chemicals etc. being used in that month
- Contradicting results reported by the companies. This is due to:

- Changes in costs as explained above
- Options being implemented and then discontinued without notification of the project team
- Companies not always reporting all changes at the same time (not intentional) resulting in different results each time they are questioned
- Difficulty in relating utility consumption to production due to a lack of production details. In most cases this is due to the large variation in jobs received by the companies and no set manner in which to measure throughput. It would be beneficial if a procedure for measuring production could be developed as then savings could be reported per item / kg etc. This would eliminate the problem of reporting savings as unit consumption / month which vary depending on production.

3.9.5 Waste Minimisation Options

The club members implemented a variety of options in order to achieve their savings. A total of 384 waste minimisation options were identified for 24 companies. This figure includes options identified by the students, the companies themselves and the PRG project team. Of these, 158 (41%) have been implemented, 26 (7%) are under investigation and 8 (2%) were found to be not feasible. The status of the remaining 192 (50%) options is unknown (see Figure 3.3). This is mostly due to a lack of feedback from the companies to the PRG and it is felt that more options have been implemented than have been reported, or that these options will be investigated at a later date. Of the 24 companies, 4 did not implement any changes that the project team is aware of, and this is felt to be due to a lack of commitment on the part of the management.

Of the 158 options that were implemented, the majority had either an immediate return on investment, or paid back within one year. The PRG project team is only aware of one company where the implementation of a waste minimisation option had a payback of 18 months to 2 years.

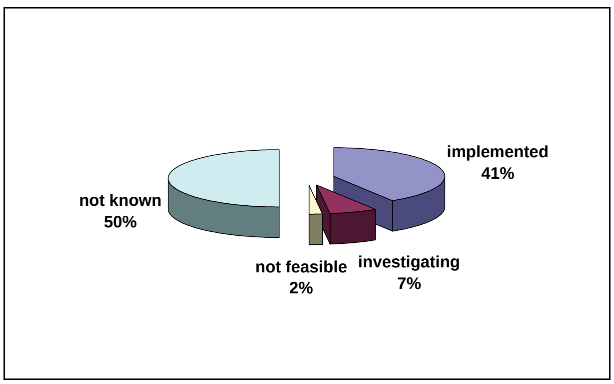

Figure 3.3: Status of the Waste Minimisation Options Identified for 24 Metal Finishing Club Members

As mentioned in Chapter 2, there are five main changes that can be made to a process to reduce waste at source; namely:

- Improved housekeeping,
- Technology changes,
- Raw material changes,
- Product changes, and
- On-site recycling.

A brief description of measures that can be placed in each of these categories is given below.

3.9.5.1 Improved Housekeeping
These include options such as:

- Improved monitoring,
- Fixing leaks and tanks,
- Shutting off of taps and pipes not essential to the process,
- Education of employees,
- Improved scheduling of jobs,
- Improved management and control,
- Improved bath control,
- Installing meters,
- Covering of baths to prevent evaporation, and
- Control over waste disposal.

3.9.5.2 Technology Changes
These include any changes to the process or the type of equipment, such as:

- Increasing drip times,
- Installing additional tanks,
- Altering jig arrangement,
- Improving process flow through rearrangement of factory floor lay out,
- Installation of drag-out tanks,
- Cascading of rinses,
- Insulation of tanks / baths, and
- Installation of new equipment (e.g. automatic lines).

3.9.5.3 Raw Material
Raw material changes include:

- Altering suppliers, and
- Substitution of chemicals.

3.9.5.4 Product
Those options considered to be product changes include:

- Altering design of product, and
- Convincing customer to change requirements.

3.9.5.5 On-site Recycle
Only on-site recycling is considered a waste minimisation option. This can include:

- Reuse of baths, and
- Reuse of water in either the same process or another process / activity.

The waste minimisation options identified for the Metal Finishing Club members were catagorised according to these 5 divisions and are presented in Figure 3.4.

As is expected, housekeeping changes accounted for the majority of the options (72%), followed by technology changes (16%) and recycle options (9%). As is evident from Figure 3.4, no product changes are reflected here. This is because at the time of categorising the options, these changes were incorporated into raw material changes rather than as a separate section as it also involved changing the input material to the process.

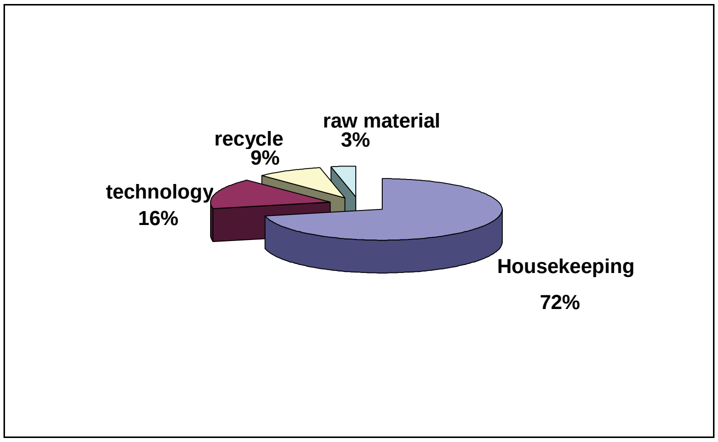

Figure 3.4 Categorisation of Identified Waste Minimisation Options

Of the 158 options implemented, 115 were due to housekeeping changes, 21 to technology changes, 16 to recycling options, and 6 to changes in input material. These are reflected as percentages of the total in Figure 3.5.

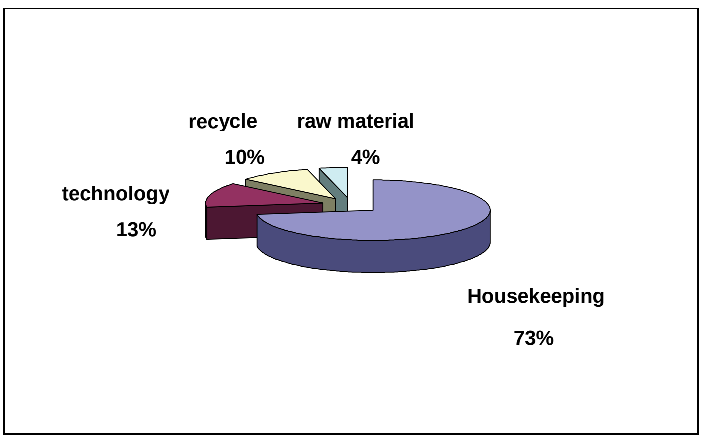

Figure 3.5 Categorisation of the implemented waste minimisation options.

From both Figures 3.4 and 3.5, it is evident that the majority of savings are achieved through making housekeeping changes. These are generally the no and low cost options and mostly involved monitoring of utility use and maintenance.

3.9.6 Environmental Savings

One of the objectives of this waste minimisation club was to reduce the environmental impact of the metal finishing industry. Reductions in costs have been of particular interest to the companies themselves, but the adoption of waste minimisation by the club's members have also lead to significant environmental benefits. Reductions have been achieved in water consumption, metals discharged to drain, chemicals discharged to drain, volumes of effluent discharged to sewer, volumes of sludge disposed of to landfill, cyanide use, solvent emissions, cadmium use, and energy consumption.

It has been difficult to quantify these results due to a lack of records by companies and their reluctance to specify their previous *bad* conditions. The successful implementation of options and the corresponding financial savings proves that reductions have been made. A summary of the savings is given in Table 3.10.

Based on the information available on the total financial savings made in water and taking the cost of water to be R 2.89 (as an average over the 3 years), 86 900 kl/y of water was saved. If effluent volumes are taken as 95% of water consumed, this implies that there has been a reduction of 82 600 kl/ year of effluent discharged to drain.

It must be noted that while changes in concentrations discharged to drain were not recorded, the companies remained within the discharge limits set by the Metro even though water use had been reduced. This implies that reductions in chemicals and metals to drain must have been realised.

It is more difficult to quantify savings in terms of metals and chemicals discharged to the environment as not many companies quantified these amounts. From 5 companies that did report their savings, there has been a reduction of 112 tons/annum of metals and chemicals to drain.

In terms of energy savings, a reduction in the use of electricity leads to a reduction in the emission of carbon dioxide and other green house gasses. Figures available from the 1999 Eskom Environmental Report show that 0.8 kg of CO_2, 0.008 kg SO_2 and 0.004 kg NO_x is formed per kWh of electricity produced. If one takes the average cost of electricity to be R 0.2/kWh (not completely accurate as the companies are charged varying tariffs) and based on the total cost savings made in electricity by the club members, a total of 16 000 MWh/y have been saved. The corresponding savings in greenhouse gasses are given in Table 3.10. In addition, there are related savings in coal and water use.

Table 3.10 Summary of Environmental Savings for the Metal Finishing Club members

Item	Cost Saving / year	Environmental Saving / year
Water and effluent	332 516	169 500 kl
Chemicals and Metals	1 325 000	112 tons (for 5 companies)
Energy	320 430	16 000 MWh
Carbon dioxide		1 400 tons
Sulphur dioxide		13 tons
Nitrous oxide		6 tons

3.9.7 Barriers and Drivers

This section will briefly discuss the barriers to implementing waste minimisation and for non-attendance at club meetings. The drivers for joining the club are also covered. These results are taken from interviews with the club members during 1999 and 2000.

3.9.7.1 Barriers to Implementing Waste Minimisation

When the club was first established in June 1998, the club members were asked to identify the barriers and drivers to implementing waste minimisation. This question was put to them again in March 1999, and again in March 2000. The top barriers identified on each occasion are listed in Table 3.11. It must be remembered that the number of companies taking part differs on each occasion, but those interviewed in 1999 and 2000 are considered to be representative of the active club members. Of the 16 companies interviewed in 2000, 4 were actively implementing waste minimisation measures and therefore did not answer this question. Some companies listed 2 or 3 barriers and therefore the total number of companies interviewed does not equal the sum of the numbers given in brackets after the barrier.

Table 3.11: Top barriers to implementing waste minimisation as identified by the club members

Year	June 1998	March 1999	March 2000
No. companies	30	10	12
1	Lack of finance (21)	Lack of time (6)	Lack of finance (6)
2	Lack of information (17)	Lack of commitment (3)	Lack of time (2)
3	Operational constraints (12)	Lack of resources (2)	Commitment from management (1)
4	Unclear legislation (11)		

As can be seen, in June 1998 when the club was first initiated, and in March 2000, the top barrier was listed as being a lack of finance. In contrast, this was not mentioned as a barrier in 1999. The reasons for this change are thought to be due to the perceived cost of implementing waste minimisation practices by the metal finishers prior to an understanding of the concept. Once the club members had initiated waste minimisation on-site and realised savings at no or low cost, this perception fell away (1999). However, once these options had been implemented, the companies then started investigating more capital intensive options and therefore finance once again became a barrier to making changes (2000).

A lack of knowledge and information were listed as barriers initially, but as can be seen, once the club was running this was no longer a constraint to the companies. Similarly, the problems with unclear legislation were no longer a barrier as the relationship between the metal finishers and the Durban Metro improved and there was better understanding on both parts as to the constraints under which each other operated.

A lack of commitment was listed as a barrier in both 1999 and 2000. Those companies that identified this as a barrier were those where management commitment was not forthcoming and the project champions were not able to attend meetings or implement waste minimisation.

A lack of time and resources is listed in all three years as been a barrier. This is to be expected as waste minimisation involves time and effort being invested in implementing changes and monitoring progress. This barrier is one that can only be overcome through the company making a conscious decision to devote time and personnel to waste minimisation activities.

3.9.7.2 Barriers to Attending Meetings

Since one of the main problems that has been experienced in running the club has been a lack of attendance at meetings, the members were asked as to reasons for not being present (March 2000). Of the 16 companies interviewed, 4 had attended most meetings and therefore did not answer this question. Of the remaining 12, the main reason given was a factory emergency, followed by not having time or being too busy. All agreed that there was good notice of meetings and it was not due to a lack of interest. Three of the companies that only attended 2 or 3 meetings gave similar reasons for not attending, although the impression is gained that these companies felt they had achieved as much as they thought possible through waste minimisation and did not see the need to attend meetings.

3.9.7.3 Drivers for Joining the Club

Table 3.12 lists the top drivers behind the companies joining the club. These are taken from interviews conducted in 1999 and 2000. They are listed in descending number of votes which are given in the brackets.

Table 3.12: Top Drivers for Joining the Waste Minimisation Club

Year	March 1999	March 2000
No. of companies	17	16
1	Increase knowledge (9)	Reduce pollution (16)
2	Legal compliance (6)	Save money (15)
3	Cost savings (1)	Learn about waste minimisation (15)
4		Proposed new limits (13)

The drivers for joining the club seem to remain constant with the exception that in 2000 the club members list cost savings as a reason for joining the club. This was not a main driver at the beginning as many did not think that there were savings to be made from waste minimisation.

3.9.8 Interviews

As mentioned in Section 3.8.5 above, interviews were conducted with the metal finishing club members to obtain their views on a number of aspects of the club (listed in Section 3.8.5). Some of these results will be highlighted here as they are interesting to analyse in terms of the success of the waste minimisation club. These include:

- Understanding of waste minimisation,
- Relationship with the Durban Metro,
- Relationship with the supplier, and
- Benefits of the waste minimisation club.

3.9.8.1 Understanding of Waste Minimisation

The companies were given five statements relating to changes that could be made within a metal plating shop and asked if they agreed / disagreed as to whether these actions represented waste minimisation. The results are summarised in Figure 3.6
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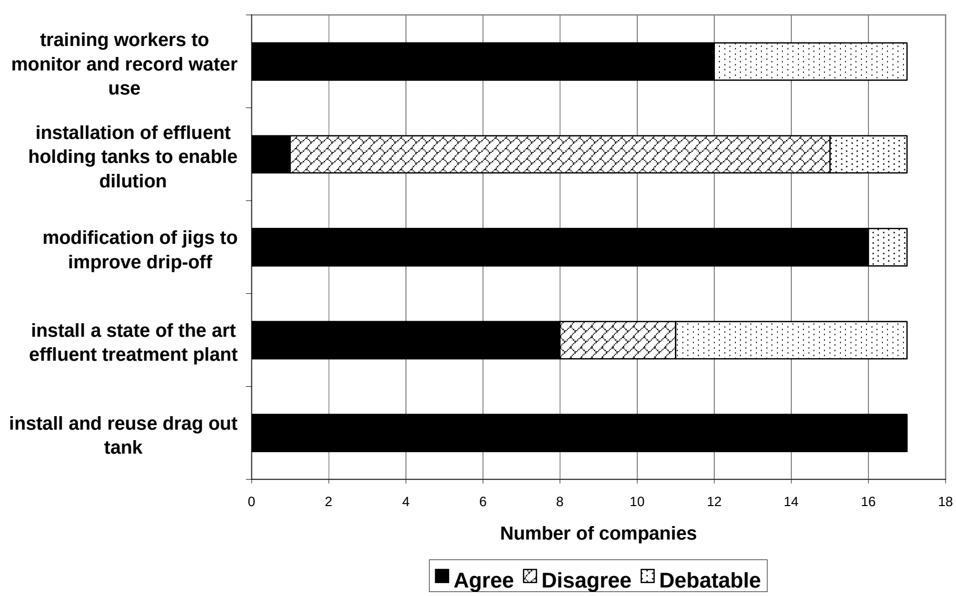

Figure 3.6: Club members views on waste minimisation

Based on these results, it is not clear whether all club members have fully grasped the concepts of waste minimisation. While all have agreed that the reuse of drag-outs, the modification of jigs and the monitoring and recording of water use constitute waste minimisation, three companies are still of the impression that dilution of effluent could be a waste minimisation action. In addition, 82% of the companies either agreed that the installation of an effluent treatment plant was waste minimisation, or thought this question was debatable. On questioning these results, the industry response was that they considered waste minimisation to be any action that reduced the waste (effluent) discharged from their premises. In this case, end-of-pipe solutions fulfilled this requirement. While it seems as though the majority of the members see monitoring of water use as waste minimisation, 5 think this is debatable, as it is only waste minimization if an action is taken based in these readings.

Therefore, although it seems as if the club members have accepted the concepts of source reduction and monitoring, there is still the view that effluent treatment is part of the process.

3.9.8.2 Relationship with Durban Metro

At a number of club meetings, members reported that the formation of the waste minimisation club had led to improved relationship with the Durban Metro. This was evident through the formation of the Working Group and the successful negotiations over the Bylaws (see Section 3.10.1), but it was felt that this was a view that might not be shared by all members. For this reason, a number of questions were put to 16 club members with regards to their feelings on the Durban Metro. A summary of some of the questions are presented in Figure 3.7.

Of the 16 companies interviewed, 75% felt that the relationship had improved with the Durban Metro. This does not necessarily imply that these companies felt that initially the relationship was poor as some members mentioned that they did not have conflict with the Metro in the first place. However, 50% still felt that the Durban Metro did not care about industry and that there was still a feeling of *us* (the metal finishers) against *them* (the Durban Metro). More than half felt that the effluent inspector was not trained properly and that the different effluent standards for the different regions were unfair.

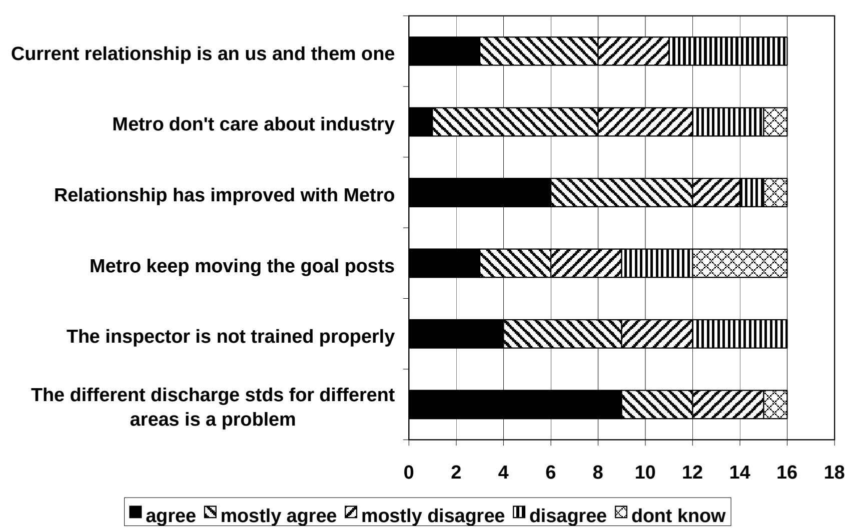

Figure 3.7 Views on the Relationship with the Durban Metro and the Metal Finishing Club Members

Based on this questionnaire, it is evident that although there is better understanding between the two parties, there is still mistrust of the Durban Metro on the part of the metal finishers. However, all metal finishers agreed that there must be some form of regulations on the industry.

3.9.8.3 Relationship with the Supplier

A representative of a chemical supply company was elected a member of the club due to the assistance and support shown the companies involved. This supplier recognised the need to offer a *service* rather than merely trying to sell chemicals, and as a result, was actively involved in investigating areas were the supplier could assist in waste minimisation. All companies that were interviewed agreed that the technical information given by the supplier was very important to them, although only 3 out of the 16 stated that they leave the bath maintenance solely up to the supplier. This emphasises the importance of incorporating waste minimisation into the entire metal finishing pipeline.

3.9.8.4 Benefits of the Waste Minimisation Club

In order to determine if the club concept was beneficial to the metal finishers who participated, a number of questions were asked as to the benefits of being club members. The replies are summarised in Figure 3.8.

Again, 75% reported the improved relationship with the Durban Metro as being a benefit of the club. All members responded that the club has increased their knowledge on waste minimisation and the pollution caused by their industry, and that it was beneficial to meet the other metal finishers in the Durban area. Similarly, all companies denied that there were no benefits to being a member.

Savings were achieved by 81% of those interviewed and 3 companies reported that if it weren't for the savings made during the club activities, they would be out of business.

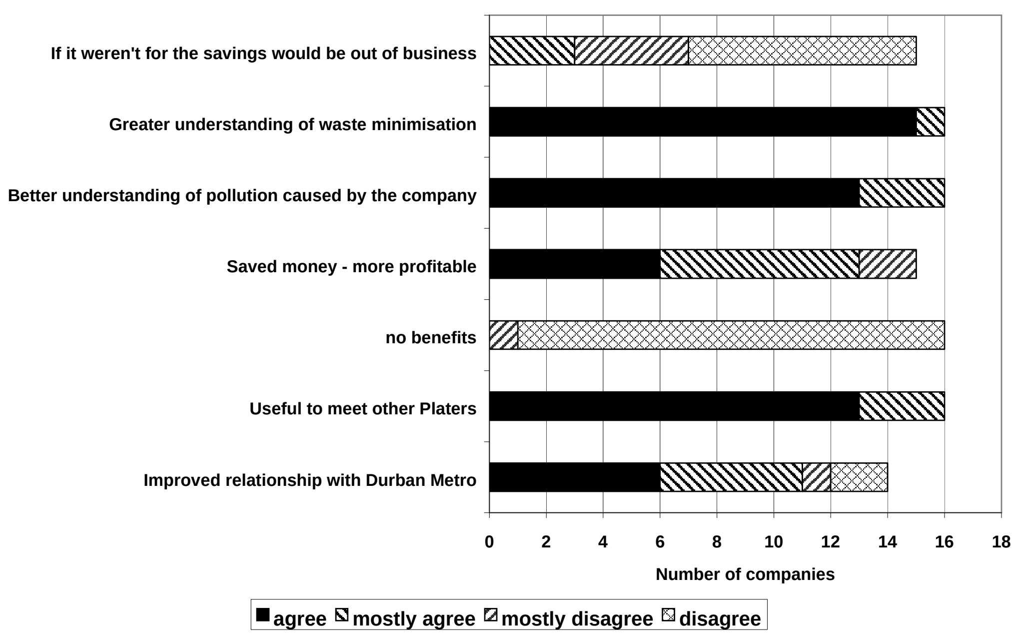

Figure 3.8 Benefits of the Waste Minimisation Club for the Metal Finishing Industry

3.9.8.5 Summary

Based on these interviews, it is evident that the waste minimisation club was successful in transferring knowledge on waste minimisation to the companies and assisted in developing relationships between the Durban Metro, the suppliers and one another. The questionnaire and further graphs are given in the **Data Report, Annexure 9**.

3.9.9 Use of Students to Undertake Waste Minimisation Audits

As mentioned previously, 25 senior chemical engineering students were recruited to undertake waste minimisation surveys within the member companies in order to determine the process flows and identify opportunities for savings. This section briefly reports the advantages and disadvantages of such an approach.

In general, the students found the vacation work interesting and demanding. Final reports were prepared by all students on each factory investigated and a summary of the results are given in Thambiran (2001). Some companies were very interested and enthusiastic, assisting the student and being open to suggestions. Others were skeptical and did not understand the concepts of waste minimisation or how it could be of benefit to them. Most students felt that the factories they investigated had poor working conditions for the workers and that health risks were high.

It was found that employing students to undertake these waste audits had both advantages and disadvantages. The advantages included:

- There would have been insufficient time for the project team to visit and audit each site individually
- It assisted companies to begin investigating waste minimisation themselves
- It separated those companies who were interested and keen from those who joined merely to comply with Durban Metro wishes
- The companies would have a greater insight into their processes and be able to make informed decisions

The disadvantages included:

- It was difficult to control 25 students
- Not all students delivered the same quality of work
- Their inexperience was at times a drawback
- The project leaders had no *hands-on* feeling for the factories

It was felt that further clubs would not receive this type of assistance and that companies would be expected to undertake the audits themselves with assistance from the PRG when required.

3.10 Social / Relational Aspects

This section will briefly discuss the more social aspects of the club. In other words, how the relationships between the club members and local authorities changed as a result of the waste minimisation club. The two main aspects to emerge were the bylaw working group and the formation of the Metal Finishing Association.

3.10.1 Bylaw Working Group

The Bylaw Working Group was established in December 1998 as a result of the new effluent discharge bylaws that were to be introduced by the Durban Metro. Before these bylaws could be promulgated, objections were invited from industry. A number of queries and objections were received, some of which were from the metal finishing industry (and club members). A meeting was held with all interested parties, and it was suggested that a working group be established that would meet on a regular basis to discuss these problems and develop bylaws that were acceptable to all parties involved.

The members of this working group were representatives from the Durban Metro Waste Water Department, the metal finishing industry (3 club members), a chemical supplier (Chemserv Trio), DWAF and the Durban Chamber of Commerce. While the industry representatives were from the metal finishing industry only, the outcomes of the working group would be applicable to all industries requiring a permit for effluent discharge.

Meetings were held regularly throughout 1999, and the following results were achieved :

- The limits for discharge to the Umbilo Sewage Works were relaxed to the original limits due to :
  - the finding that the sludge from the Works was no longer being used as soil remediant for the commercial production of grass, and
  - A study by one of the club members that showed that even if all metal finishing companies in the area no longer discharged their effluent to sewer, the limits on metal concentrations would still not be achieved.
- An environmental audit would be undertaken by the local authorities of all companies applying for a permit to discharge to sewer. This would involve an investigation into the operating practices of the factory, the condition of the equipment etc., in addition to the usual effluent analyses.
- Rules and regulations were established that were acceptable to both the authorities and the industries. For example, if a company is to be prosecuted based on an effluent sample, the company must be informed within a reasonable time period and a sample be retained for verification.
- Suggestions given as to a solution to the problem of disposing of the sludge produced by the metal finishing industry.

Besides the above *technical* outcomes, the other benefits of the Bylaw Working Group was that all parties obtained a better understanding of each others situations and limitations. The process became more transparent and fair and will prevent *fiddling* of the system such that some companies comply and others do not.

3.10.2 The Metal Finishing Association

An outcome of the Waste Minimisation Club for the Metal Finishing Industry in KZN, has been the realisation that the industry is stronger when they stand together as a unified body, rather than as individual companies. This was particularly evident during the negotiations between the Bylaws Working Group and the Durban Metro to establish effluent discharge guidelines. As a result, the formation of an association that would bring together all the metal finishers in the KZN area was proposed.

Over 100 KZN metal finishing companies were invited to attend a meeting on the 29th May 2000 to discuss the formation of the Association. The meeting was successful, with 70 people present and 9 other confirmed non-attending members. A constitution was drafted and adopted with the name *Metal Finishing Association* (MFA) being approved by all present. Six committee members were then elected.

There are 84 paid members, which includes electroplaters; hot dip galvanisers; powder coaters; other metal finishing operations; suppliers; support services; waste contractors; recycling companies, and Universities. The initiative has the support of the Durban Metro, representatives of which attend the meetings as honorary members.

The MFA will focus on issues of mutual concern, with emphasis on waste minimisation and waste treatment.

3.11 Summary

Based on the results presented in this Chapter, it is evident that the Waste Minimisation Club for the Metal Finishing Industry in the DMA, was a successful approach to promoting waste minimisation to industry. The following points summarise the results of this Club:

- The majority of the companies involved are SMME's, therefore the aim of imparting knowledge on Cleaner Production aspects to this sector has been fulfilled;
- The companies achieved financial savings of varying degrees, thus fulfilling the aim of making the SMME sector more profitable;
- Approximately 87 000 kl/year of water has been saved by these companies, thus decreasing the demand on the water resources of South Africa;
- Effluent discharge volumes have decreased along with chemicals and metals discharged to drain thus decreasing the impact on the aquatic environment;
- Savings in energy have been achieved to varying degrees by the companies, thus reducing emissions to atmosphere;
- The is a good working relationship between the companies and the Durban Metro and a clearer understanding of the constraints under which each operate; and
- The waste minimisation club was the catalyst behind the formation of the MFA, thus uniting the metal finishers

In addition, the metal finishers who participated in this project are now imparting their knowledge to other metal finishers and the MFA is actively encouraging the formation of further waste minimisation clubs in the DMA and other regions. As an outcome of this club, further metal finishing waste minimisation clubs have been established in Cape Town and Port Elizabeth, and metal finishers in Pietermaritzburg are participating in a cross-sectional club.

Chapter 4 - Hammarsdale Waste Minimisation Club

This Chapter will cover the establishment, management and results of the Hammarsdale Waste Minimisation Club. The points that are covered here are a summary of the results of the club and more detail is available in Goff (2001), Maharaj (2001), Enviros March (2000) and the **Data Report, Annexure 8**.

4.1 The Hammarsdale Industrial Area

The Hammarsdale industrial township was established as a result of the migration of large manufacturers and smaller support companies from urban to rural, semi-developed areas nearer to cheap unskilled labour pools. The government of the 1960’s had zoned this region for industrial development because of the close proximity of unskilled labour and gave the local industry every assurance of an ample water supply and proper effluent treatment and disposal (Secretary for Water Affairs, 1978).

However, over the years the boom in industrial activity together with socio-economic development of the surrounding township, has resulted in severe impact on the environment downstream from the wastewater treatment works. The area never realised the expected target industrial growth but has now become the focus of the textile industry in KwaZulu Natal. There are ten textile mills engaged in various forms of wet and dry processing, a chicken abattoir and smaller chemical processing companies.

4.2 The Hammarsdale Waste Water Treatment Works

The Hammarsdale Waste Water Treatment Works (HWWTW) is the only municipal works in this region. It accepts a very complex, highly coloured and saline wastewater, and discharges into the Sterkspruit catchment, this includes the Shongweni recreational impoundment, which has been earmarked for Eco-tourism and has been the focus of many investment companies. Of the total incoming wastewater to the works, 65% is from the textile plants, 25% from the chicken processing plant and the remaining 10% domestic (Bell, 1998). As the works is essentially a biological treatment facility, it experiences difficulty in treating textile effluents that are highly toxic, coloured and saline. In particular, the colour, conductivity and phosphate levels in the discharge from the works are constantly above the limit set by DWAF. As from September 1999, stricter discharge standards for colour and conductivity were set by DWAF.

4.3 Pollution Problems in the Hammarsdale Area

As mentioned earlier, there are 10 textile companies in the area, a chemical manufacturer and a chicken abattoir. The chemical manufacturer does not discharge to the WWTW, but rather trucks the effluent off-site for disposal. The main pollution problems experienced in the Hammarsdale area are those associated with the textile factories and the abattoir. These are highlighted in the following sections.

4.3.1 The Textile Industry

Dyehouse effluents are complex, consisting of concentrated waste process water containing a wide and varied range of dyes and other products, rinsing and cooling water. In general, the effluent is highly coloured, high in biological oxygen demand (BOD) and chemical oxygen demand (COD), has a high conductivity and is alkaline in nature. The effluent is ranked second highest by DWAF to industrial effluents discharged to sewer with respect to hazardous waste intensity and principally affects water quality.

These factors combine to present numerous operational problems for municipal works that are essentially biological processes and not intended for the breakdown of complex organic molecules. The presence of metals and other dye compounds inhibits microbial activity and in some cases may cause failure in anaerobic treatment systems.

The HWWTW is consistently exceeding standards for colour and conductivity and the only viable option is for the companies to reduce these emissions at source.

4.3.2 The Abattoir Industry

The poultry abattoir industry uses significant quantities of high quality water for processing purposes. As a result a strong organic effluent is produced which is discharged to the HWWTW. Approximately 88% of the water intake is discharged as liquid effluent. In most cases, very little treatment occurs on-site, with screening being carried out to remove particles and some effluent balancing.

As for the textile industry, the most suitable method of reducing the pollution load to the WWTW is to investigate methods of reducing the waste at source.

4.4 The Hammarsdale Industrial Conservancy

Conservancies are voluntary environmental forums registered with the KwaZulu-Natal Nature Conservation Services (KZNNCS). Hammarsdale has one of the few industrial conservancies in the DMA. The Hammarsdale Industrial Conservancy (HIC) was formed early in 1998 and acts as a forum for discussion and for action towards the improvement of the environment of the Hammarsdale area. The conservancy consists of representatives of a number of companies within the Hammarsdale area, as well as representatives from the KZNNCS, Durban Metro and Umgeni Water. The HIC meets at regular intervals to discuss activities for the improvement of the surrounding environment and has as one of its main projects the upgrading of the water quality of the Hammarsdale Falls and the Hammarsdale Dam which are currently badly polluted.

Due to the presence of the HIC, it was felt that the activities of the waste minimisation club could fall under the umbrella of the HIC.

4.5 The Establishment of the Hammarsdale Waste Minimisation Club

The Hammarsdale industrial area was identified as a potential site for a waste minimisation club at the on-set of the project in 1998. There were a number of reasons for this, including:

- The high concentration of textile industries in the area and discharging to the HWWTW;
- The inability of the WWTW to comply with discharge standards set by DWAF, especially with regards to conductivity and colour; and
- The PRG had a good working relationship with a number of the textile mills in Hammarsdale.

The establishment of the Metal Finishing Club in June 1998 delayed the initiation of the Hammarsdale Club and it was only in November 1998 that the companies in the area were approached with the invitation to establish a waste minimisation club.

In the interim, the application by Enviros March to the European Union for funding under the Thermie directorate to assist in establishing waste minimisation clubs was successful, and representatives from Enviros March were present in November 1998 to initiate the club.

Initially the focus of the waste minimisation club was to be the textile industries in Hammarsdale, but at the initial recruitment meeting in November 1998, it was agreed by all companies present that the invitation should be extended to all industry in Hammarsdale. The first club meeting took place in Mach 1999.

4.6 Profile of the Waste Minimisation Club Members

The invitation to take part in the waste minimisation club was extended to all companies based on the HIC circulation list. Of these companies, 11 elected to be involved in the waste minimisation club, including 8 textile companies, a chicken abattoir, a chemical manufacturer and the HWWTW. However, 2 of the textile companies withdrew from the club due to a lack of commitment and the HWWTW was unable to participate due to on-going negotiations as to the ownership of the works. An additional textile company joined in August 1999. These Club members are listed in Table 4.1.

Table 4.1: List of Hammarsdale Waste Minimisation Club Members

Company	Industry	Type of Operation	No. Of Employees
COMP1	Chemical	Blending /formulation of specialty chemicals	250
COMP2	Textile	Cotton/Filament thread finishing and dyeing	428
COMP3	Textile	Denim cotton fabric finishing and dyeing	680
COMP4	Textile	Nylon/polyester weaving, dyeing and finishing	544
COMP5	Textile	Polyester/polyviscose finishing and dyeing	600
COMP6	Textile	Cotton finishing and dyeing	510
COMP7	Textile	Wet processing of knit, medical and acrylic fabrics	120
COMP8	Food	Chicken Processing	ca 800

As can be seen, these companies are larger than those in the Metal Finishing Club (Section 3.6, Table 3.1). This was felt to be an advantage to the project as a comparison could be made between managing a club comprised mostly of small industries and one where the majority were medium-sized organisations.

4.7 Management of the Hammarsdale Club

This section will discuss the management of the Club and the involvement of the European Union Consultants. Further detail is available in Goff (2001), Maharaj (2001) and Enviros March (2000)

4.7.1 Organisation for Action

As mentioned in Chapter 1, the European Union partners, Enviros March and Kagiso-COWI were involved in the organisation and running of the Hammarsdale Waste Minimisation Club. The day-to-day issues were dealt with by the PRG, but club meetings were held bimonthly to coincide with visits by the Enviros March consultant.

Initially, it was proposed that the waste minimisation club activities be incorporated into those of the HIC, with the HIC co-ordinating the club meetings and acting as the steering group (see Figure 4.1). The consultants (PRG, Enviros March and Kagiso Cowi) would act as advisors to the club. Each club member was to appoint a project champion and that person would be responsible for running the waste minimisation programme on-site with project teams. However, as the project developed, this club structure did not function as expected (see Section 4.8.1) and as a result, the consultants took on the role of the steering group and assisted the project champions closely with the waste minimisation prorammes.

During the course of the project, 9 club meetings were held (on a bimonthly basis) where training was provided on waste minimisation aspects by Enviros March and companies gave feedback on their progress and problems.

The Durban Metro, DWAF and Umgeni Water (the operators of the HWWTW) were invited to attend all Club meetings. Regular feedback was provided to the members as to the situation regarding ownership of the HWWTW, the manner in which companies were charged for effluent disposal, and the problems experienced with the nature of the effluent entering the HWWTW.

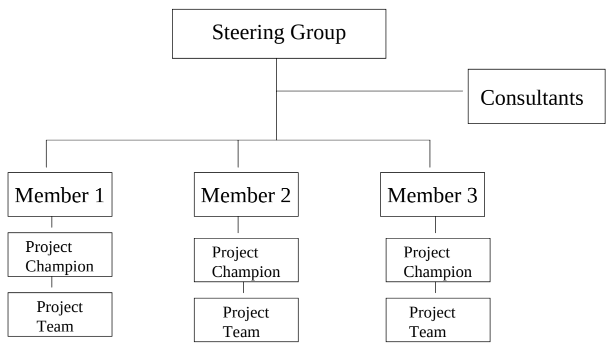

Figure 4.1: Proposed structure of the Hammarsdale Waste Minimisation Club

4.7.2 Assessments

The PRG and Enviros March conducted site visits to each of the Hammarsdale club members' factories, with the view to identifying waste minimisation options. Water and energy were the main areas of focus. Site reports were prepared for the club members, and these were used as the basis for their waste minimisation programmes. A postgraduate chemical engineering student was assigned to the project full-time and was available to assist the club members as required. The project champions were trained in the methodology of waste minimisation and given the necessary skills to implement programmes on site. Follow-up site visits were conducted every two months by Enviros March to address any problems.

4.7.3 Training

Training was undertaken at club meetings by Enviros March on waste minimisation aspects and technical issues such as reducing compressed air usage etc. Kagiso-Cowi undertook management and employee training to transfer the concepts of waste minimisation to these two levels. An outline of each of these aspects is described below.

4.7.3.1 Waste Minimisation Training Modules and Technical Courses

Technical training has been undertaken by Enviros March. These included a series of courses on waste minimisation (listed in Chapter 3, Section 3.8.3) and courses on reducing energy use by optimising compressed air systems, refrigeration plants and steam generation (Enviros March, 2000). These training courses were presented to the project champions of each company. In some cases other team members were also present.

The biggest problem that has been encountered with the training sessions is that the project champion is responsible for transferring the knowledge that they have gained to the project team within the company. Due to a lack of time, this has not always been possible, with the result that the PRG has since repeated some modules at individual companies (COMP8, COMP1, COMP4 and COMP5). In hindsight, it is felt that these training courses should have been given on an individual basis to each project team on-site at the initiation of the club.

Originally these training sessions were held separate from the meetings and most project champions could not spare the time to be away for two mornings, or a full day. As a result, they were often poorly attended. From March 2000, the training sessions were combined with the club meetings.

4.7.3.2 Environmental Awareness Training

The awareness process carried out by Kagiso-Cowi targeted both management and shop-floor level, and the approach used in each case varied considerably from site to site. A detailed report of the results is presented in Enviros March (2000).

It is believed that the environmental and awareness raising process among the Hammarsdale Club members made a considerable impact among those companies that received this training. It became clear as the project progressed, that the initial reservation towards the waste minimisation concept among certain club members changed into curiosity and then to increasing support of the club.

Senior management from all the club members was invited to participate in joint half-day awareness sessions in May 1999. Subsequently all companies were approached individually and offered workshops tailored to the specific needs and wishes of the management within the framework of the project. Issues that were covered included; general environmental awareness, identification of potential savings, sustainability (both environmental and financial), health and safety issues, legal and policy issues, labour issues, communication structures, and environmental company policies.

Training for the shop-floor level built on the existing training structures on site, and took into account previous initiatives and those planned for the near future. All training on shop-floor level was carried out through the training departments' of the club members and in close cooperation with training staff. The subject material was developed after consultation with the project champions and training staff of club member companies. To assist in future training initiatives of a similar nature and to continue environmental training in general, the subject was developed into a manual.

The attendance at both the training provided by Enviros March and Kagiso-Cowi are analysed in Section 4.8.2.

4.7.4 Barriers and Drivers

A number of barriers to implementing waste minimisation became apparent at the first Hammarsdale Waste Minimisation Club meeting in March 1999 and during subsequent site visits. Drivers were not assessed as for the Metal Finishing Waste Minimisation Club, but the motivating reasons for implementing waste minimisation became apparent through interviews conducted by the School of Life and Environmental Sciences (SLES) at the University of Natal, Durban. The results are given in Section 4.8.5.

4.7.5 Social/relational Aspects

As mentioned in Chapter 1, the SLES was requested to provide assistance on the Waste Minimisation Club project. The involvement of the SLES focused on the social/relational aspects of the Hammarsdale Waste Minimisation Club and the environmental education and training of the club members. The motivation for this collaborative work was a belief that an analysis of the relationships and partnerships formed through the club approach would be beneficial to the long-term success of waste minimisation clubs. This social assessment aimed to result in the development of guidelines for the formation of new waste minimisation clubs and to foster longevity in existing clubs.

The aims of this research were:

- To analyse the function and the structure of the club as a conduit for waste minimisation;
- To assess the extent to which the club is a voluntary, participatory organisation;
- To find out the extent of capacity building facilitated by the club;
- To measure the changes taking place in policy and practice as environmental awareness is being raised in member companies;
- To analyse the barriers and motivators towards successful waste minimisation through the club; and
- To assess the role of the club in facilitating sustainable practice and to investigate how this is taking place.

This study aimed to investigate the role of voluntary participatory organisations in sustainable development through the use of a case study of the Hammarsdale Waste Minimisation Club. The meeting of the aims and objectives of the study was carried out through a review of background material, the formulation of a theoretical framework, the collection of primary data and the qualitative analysis of this data.

Semi-structured informal interviews were carried out by SLES in all stakeholder groups, i.e. the consultants, educators (Kagiso-Cowi) and the club members. The interview questions were developed prior to the start of the interviewing. The same questions were repeated for each person in a group. There was some differentiation amongst questions asked of the three groups of interviewees as some questions related specifically to the activities, goals and interests of each group e.g. some questions were only relevant to the professionals, and these were only asked in those particular interviews. The replication of questions in each group and often across groups permits some compatibility of responses. Questions were phrased in such a way as to obtain personal views on the club, the manner in which it was being managed and the long-term sustainability of the concept. Detailed results of these interviews are given in Goff (2001). Section 4.8.8 highlights some of the more important points.

Besides observing the interactions between club members, the relationship with the local authorities (Umgeni Water, DWAF and Durban Metro) were also analysed. There was a significant amount of antagonism on the part of the industrialists with respect to the limits for discharge to sewer and the manner in which they were being charged for effluent disposal. At a meeting held in August 1999, these issues were discussed in great detail and as a result, a brainstorming session was held with all present to determine how a solution could be reached. These brainstorming results were analysed by the PRG and a follow-up meeting held with the club members to discuss the way forward. These results are discussed in Section 4.8.8.

4.7.6 Case Studies

Based on the information gathered from the club members during site visits and club meeting, summary case studies were prepared highlighting the savings that were achieved. Aspects that were covered included:

- Company information
- Process information
- Details on water and energy use

- Details on effluent production
- Waste minimisation options identified and implemented
- Economic benefits, and
- Environmental savings.

These summary case studies are given in the **Data Report, Annexure 8**.

In addition, the post-graduate student assigned to the project undertook detailed waste minimisation case studies at 3 of the club member sites. These were COMP1, COMP4 and COMP2. This involved obtaining data to determine the scope for saving, undertaking waste minimisation audits and identifying options for improvement. These case studies are presented in Maharaj (2001)**.**

These case studies are to be used as promotional material to encourage other industry to implement waste minimisation.

4.7.7 Monitoring and Targeting

Monitoring and targeting is a management process which results in reduced utility and resource consumption over a period of time through the implementation of a monitoring and targeting project. The project is set-up like any other in a typical plant environment and involves all levels of personnel from shop floor worker through to senior management. Monitoring and targeting is simply a system for measuring plant utility consumption and generating targets for this consumption based on production activities in the plant. The system is implemented through the use of sophisticated industrial software (MONTAGE) developed by Enviros March and results in more efficient management of utilities and resources.

Raw materials, chemicals and utilities are consumed during the course of an activity in a production environment. In order for the process to be viable, the consumption must not be exorbitant; i.e. the production cost must be acceptable for that particular level of output. A monitoring and targeting project will identify all the major utilities that are consumed and monitor consumption on a regular basis. The related production is also measured and logged. A target consumption is then calculated by linear regression between the utility consumption and production and compared with the actual consumption over the period where the target is effective. Finally, the reasons for differences between the actual and target consumption are determined. This will eliminate poor practice in the plant and help achieve higher operating efficiencies. As smaller amounts of utilities and chemicals are used, smaller amounts of wastes and effluents are generated and this results not only in reduced environmental impact but savings in the utilities and chemical costs, as well as savings on waste treatment and disposal costs. Figure 4.2 indicates the main stages in a monitoring and targeting programme.

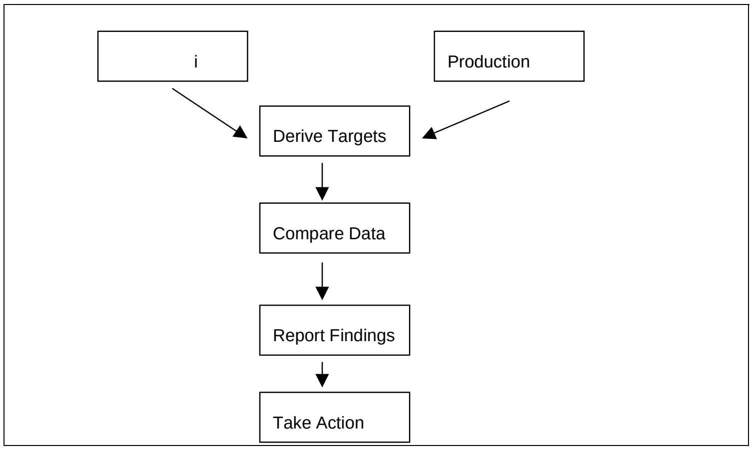

Figure 4.2 Outline of a Monitoring and Targeting programme

Montage was installed at three of the Hammarsdale Club members' sites; COMP1, COMP2 and COMP4 . The results achieved will be discussed in section 4.8.7. More details on Montage are given in Maharaj (2001).

4.8 Analysis of Results

This section will discuss the results achieved during the course of the project and covers attendance at meetings, financial results, waste minimisation options, environmental savings, monitoring and targeting and the more social aspects of the club.

4.8.1 Structural Organisation of the Waste Minimisation Club

As mentioned in Section 4.3 it was originally proposed that the HIC be the steering group for the waste minimsation club. However, as the project developed, it became evident that the HIC was not the ideal method of promoting waste minimisation. It was poorly attended by industrialists, and the other members of the HIC, while being supportive of the concept, did not view this as being the objective of the HIC. As a result, the waste minimisation club became a separate activity in the area although progress was reported on at the HIC meetings.

In addition, the inclusion of the training modules into the Club meetings resulted in at least 4 h being required for the meeting. The HIC meetings generally required 2 h, implying that a full day would have had to be devoted to meetings by the Project Champions.

In addition, only three of the club member sites formed project teams that assisted in undertaking audits and collection of data. In most cases it was the project champions responsibility to manage the entire programme. It is felt that the post-graduate student assigned to the project was essential to the on-going progress at some of the sites. Without the constant attention from the student and the consultants, it is felt that waste minimisation would not have been high on the list of priorities for the club members.

This resulted in the Project Champions and the consultants working closely together, and in some cases, resulted in very little ownership for waste minimisation projects by the companies. This is obviously not the ideal situation for a successful waste minimisation programme, as the company has to take responsibility for the projects on-site and incorporate waste minimisation into every day practices to ensure long-term results.

4.8.2 Attendance at Meetings and Training Sessions

The meetings and waste minimisation training sessions were not very well attended and this was a cause of much frustration for the Project Team. As the project progressed, attendance improved and once the meetings and training sessions were combined, more project champions were trained in waste minimisation. Table 4.2 lists the attendance of the club members at each of the meetings.

As mentioned in Section 4.7.3 some companies requested that the waste minimisation training modules be repeated at their sites for the project teams as the project champions lacked the time to train them themselves. This was carried out for 3 of the sites and is reflected in Table 4.2. It is felt that individual training for the project teams would have been a better approach from the outset of the project.

Only waste minimisation modules 1 to 5 were conducted for the Hammarsdale Club as it was felt that it would be more beneficial to conduct modules 6 (project management) and module 7 (sustaining the programme) on a one-to-one basis with the companies when they reached this stage in their waste minimisation programme.

Table 4.2: Attendance at Club Meetings and Training Sessions.

Company	Meetings (out of 9)	Training Sessions (out of 9)	Individual Modules
COMP1	9	9	2 and 3
COMP4	8	5	1, 2 and 3
COMP6	4	0	
COMP3	3	4	
COMP2	9	6	
COMP5	3	3	1
COMP7	3	1	
COMP8	6	6	1, 2 and 3

As is evident from Table 4.2, only 4 of the 8 companies attended more than half of the meetings (COMP1, COMP4, COMP2 and COMP8). Additionally, these club members also attended more than half of the training sessions and received additional training on-site. These companies actively took part in the club activities and were committed to action and achieved some form of savings. COMP8, while not achieving savings, was committed to the concepts of reducing waste at source, and was enthusiastic about implementing a waste minimisation programme on site once their situation had improved. It is also interesting to note that although COMP3 only attended a few meetings and training sessions, they were able to achieve savings of the order of 2% of their turnover (See Table 4.5). This was due to the commitment of a new project champion appointed at the beginning of 2000.

A further point to note was that 2 of the textile companies that were initially approached to be members of the waste minimisation club only attended one or two meetings, but requested copies of all training modules for their own records. The reasons for not attending were mainly due to a lack of commitment to a waste minimisation programme by senior management, although the Champions were interested and motivated. The comment was made by one of these Champions that he wanted to be ready and knowledgeable when management decided that the time was right.

As mentioned in Section 4.7.3, management and shop floor training was carried out at the club member's sites by Kagiso-Cowi. The companies who received this individual training and awareness raising by end of 2000 are listed in Table 4.3.

Table 4.3 List of Club members Who Received Training by Kagiso-Cowi

Club members	Joint Management Session	Individual Management Sessions	Shop-floor Sessions
COMP1	◆	◆	◆
COMP2	◆	◆	◆
COMP4	◆	◆	◆
COMP5	◆	◆	◆
COMP6	◆	◆	
COMP8	◆	◆	
COMP3	◆		
COMP9	◆		
COMP10	◆		

Note: The joint management session refers to the initial meeting held in May 1999.

The responsiveness towards the services offered by Kagiso-Cowi was very different from site to site. While most club-members responded positively to the concept, others either rejected or continuously delayed the training and workshops offered. COMP9 and COMP10 were excluded from the waste minimisation club after the first few months as they did not attend any meetings or further training sessions.

It is believed that the training and awareness process supported the broader objective of establishing a club for future co-operation and information sharing in the Hammarsdale region. The relevance and benefits of adhering to the waste minimisation concept, both environmentally, and financially, and in relation to human resources was made clear to the club-members. Similarly for the legal and marketing related implications of not addressing the environmental and waste problems.

The immediate objectives of the training and awareness raising were reached on both management and shop-floor level among those club-members wishing to be involved in the process. The outcome of the process did however vary considerably between the companies, and there was a clear connection between openness and commitment towards the Hammarsdale Waste Minimisation Club in general and the level of outcome.

It can be concluded that motivation and support from the management generally came slowly, which delayed the process. It become clear that management level awareness raising must be initiated at the very beginning of the process and even incorporated into the initial start-up meetings with potential club-members.

4.8.3 Financial Savings

Total financial savings in excess of R 10 million/y were reported by the Club members, with the potential to save a further R 10 million/y. These figures were calculated based on information gathered at club meetings, site visits and personal communication. A list of the savings are given in Table 4.4. It must be noted that these savings are total amounts over the course of the project. However, they can be taken as annual savings as the companies will realise these savings each year from now onwards.

Potential savings refers to savings that were possible if the companies implemented changes that were either under investigation or suggested by the consultants, at the time the project ended. They are over and above the savings achieved by December 2000.

Table 4.4: Reported Total Annual Savings for the Hammarsdale Club Members

Company	Water R/y	Energy R/y	Consumables R/y	Raw Material R/y	Effluent R/y	Other R/y	Totals R/y	Potential R/y
COMP1	5 460	1 151 700		109 620	171 300	39 600	1 477 680	
COMP4	212 400	89 700	272 000	113 500	212 400		900 000	5 925 000
COMP6	468 100			1 000 000	431 400	1 200 000	3 099 500	
COMP3	1 655 800	1 648 000			1 879 000		5 182 800	3 000 000
COMP2		143 000					143 000	
COMP5							0	708 000
COMP7							0	425 000
COMP8							0	750 000
Totals	**2 341 760**	**3 032 400**	**272 000**	**1 223 120**	**2 694 100**	**1 239 600**	**10 802 980**	**10 808 000**
% of Total	22	28	3	11	25	11		

Note: Other refers to savings that could not be separated and include savings in water, energy, dyes and chemicals.

As can be seen, similar degrees of financial savings were achieved in water, effluent, raw materials and energy. There was a high potential to save in raw materials for COMP4, but it is not known if this options has been implemented. Figure 4.3 reflects these savings as a percentage of the total savings.

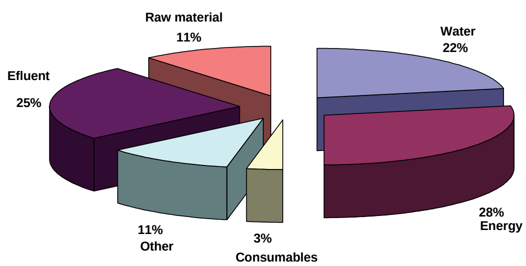

Figure 4.3: Summary of Areas in Which the Hammarsdale Club Members Achieved Savings

In most cases, these savings were achieved with payback periods of less than a year, although some were more long-term investments.

The savings achieved were compared to the number of employees and also the annual turnover of the company (where available). This was also carried out for those companies that only had potential savings. The results are shown in Table 4.5.

As is evident from these figures, both the achieved and potential savings accounted for a significant percentage of the club member's turnover. In the case of COMP8, the savings that were identified as potential savings only related to energy savings in one section of the factory. It is therefore expected that actual potential to save is far greater than that reported here.

Table 4.5: Annual Savings per Employee and as a Percentage of the Annual Turnover for the Hammarsdale Club Members

	Savings R/y	No. employees	Annual Savings/turnover (%)	Savings/employee
COMP1	1477680	250	Not available	5910
COMP4	900000	544	Not available	1654
COMP6	3099500	510	2.21	6077
COMP3	5182800	680	2.47	7622
COMP2	143 000	424	Not available	337
COMP5 (potential)	708 000	140	5.90	5 057
COMP7(potential)	425 000	120	1.21	3 542
COMP8 (potential)	750 000	800	0.03	938

The savings reported per employee again show that the size of the organisation does not influence the potential to save; with both the smaller companies (COMP1and COMP7) showing similar savings per employee to the medium sized companies such as COMP3 and COMP6.

In most cases, the savings achieved were of the order of 2% of the annual turnover, which reflects that the company was experiencing a substantial financial loss due to waste. COMP5 had a potential to save 6% of its expected turnover, and, since the site was in the process of being commissioned, it was an ideal time for the company to ensure that all waste minimisation options were in place from the beginning.

4.8.4 Waste Minimisation Options

A total of 116 waste minimisation options were identified for the Hammarsdale Club members. These included options identified by the Project Team (PRG and Enviros March) and the members themselves. Of these, 40 were implemented during the course of the project, 29 were under investigation, while the status of the remainder were not known. This is reflected in Figure 4.4.

As discussed in Chapters 1 and 3, there are 5 main changes that can be made to a process to implement waste minimisation (housekeeping, technology, recycle, raw material and product). Aspects that were referred to by each of these categories are discussed below.

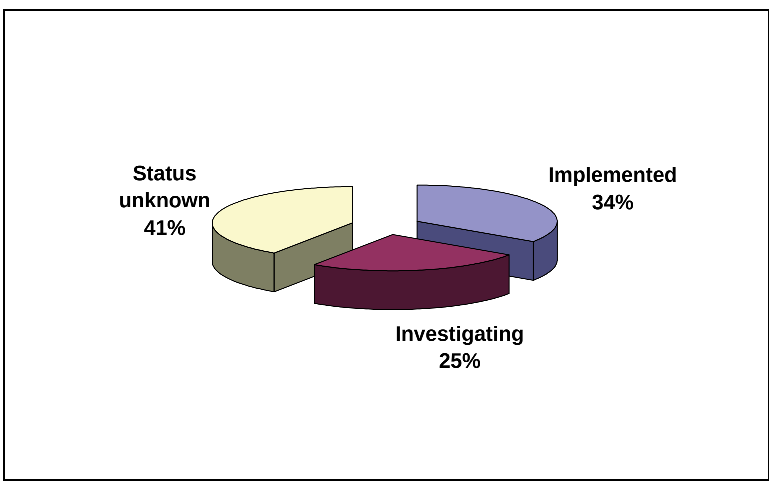

Figure 4.4 Status of Identified Waste Minimisation Options

4.8.4.1 Housekeeping
This included aspects such as:
- Installation of metering,
- Monitoring of utility consumption,
- Upgrading of steam and water pipes,
- Upgrading boilers, and
- Implementing water and effluent management programmes.

4.8.4.2 Technology
Technology changes included:
- The installation of new equipment,
- Implementing process changes,
- Reducing boiler pressure, and
- Investigating the use of new technology to improve process efficiency.

4.8.4.3 Recycle
This included:
- Reuse of cooling water,
- Recovery of condensate, and
- Use of recyclable material.

4.8.4.4 Raw Material
Aspect included in this are:
- Decreasing the use of raw materials by decreasing wastage, and
- Altering input material to reduce concentrations required in recipes.

No product changes were investigated.
Based on these categories, the 116 options identified were catagorised into the relevant section (Figure 4.5). As can be seen, housekeeping accounted for 50% of the options identified, technology changes, 35%, recycle 12% and raw materials 3%.

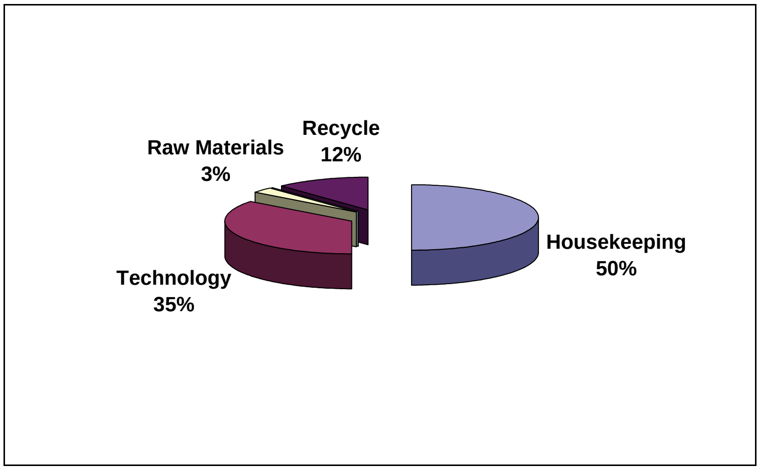

Figure 4.5: Catagorisation of Identified Waste Minimisation Options

It is to be expected that the majority of the options are related to housekeeping, as these are generally the no- or low-cost options with payback periods of less than a year.

The same exercise was carried out for the options implemented by the companies. Of the 40 that were implemented, housekeeping accounted for 45%, technology 40%, recycle 10% and raw materials, 5% (see Figure 4.6).

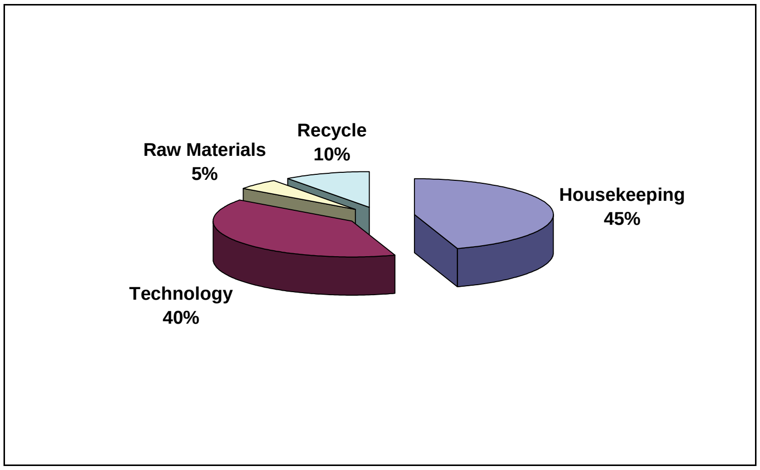

Figure 4.6: Catagorisation of Options Implemented by the Hammarsdale Club Members

The status of the waste minimisation options per club member was also analysed, and these are shown in Figure 4.7.

As can be seen, the majority of the companies (75%) have either implemented or are investigating the options identified at their companies. The fact that the status of the remaining options is unknown does not necessarily imply that they are not being investigated, but that the status has not been reported to the PRG Project Team.

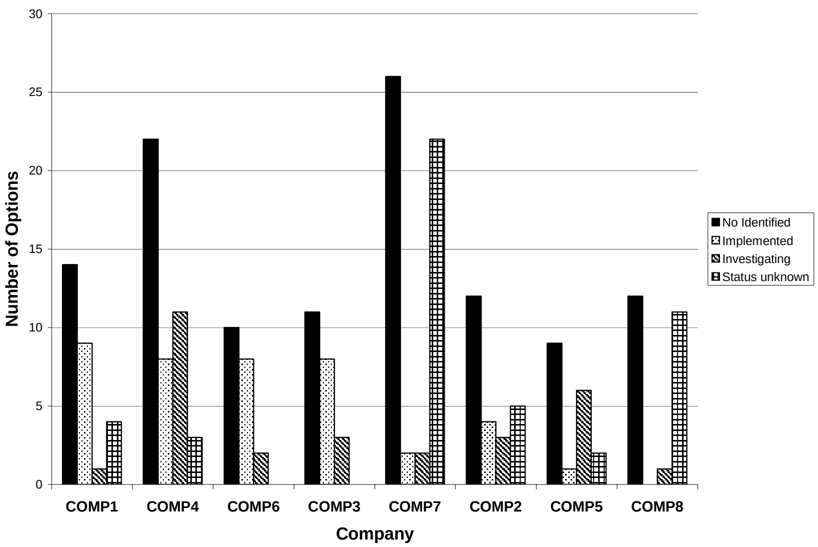

Figure 4.7: Summary of Status of Waste Minimisation Options per Club Member

4.8.5 Environmental Savings

By actively reducing waste at source, the Club Members also reduced their impact on the environment. By reducing water consumption, the volume of effluent that was discharged to sewer was also decreased. Improving the efficiency of steam systems and reducing site power consumption both resulted in significant reductions in greenhouse gas emissions.

Use of recyclable packaging or consumables, monitoring and controlling raw material use and decreasing wastage during manufacture resulted in less solid waste requiring disposal to landfill. Monitoring and optimising dye and chemical usage resulted in reduced discharges to sewer which reduced the demand on the HWWTW. Salt and dye are of major concern in the Hammarsdale region as they pass through the sewage works and enter the Sterkspruit River, which leads to the Shongweni Dam (a recreational area). Any measures that were introduced to reduce their use at source were beneficial to the immediate environment.

Based on the total cost savings in water reported in Table 4.4 and the average cost of water (R2.50/kl), approximately 940 Ml/year of water was saved. Taking effluent discharge to be 96% of this, a reduction of 900 Ml/year of effluent was achieved. In total, the club members saved 49.7 GWh of electricity. Figures available from the 1999 Eskom Environmental Report show that 0.8 kg of CO_2, 0.008 kg SO_2 and 0.004 kg NO_x is formed per kWh of electricity produced. This means that saving of 49.7 GWh leads to a reduction of 43 600 tons of CO_2, 412 tons SO_2 and 184 tons NO_x being emitted to the environment. In addition there will be related savings in water and coal. Savings not quantified are those made in chemicals and dyes. Table 4.6 summarises the environmental savings.

Table 4.6: Summary of Environmental Savings for the Hammarsdale Club

Item	Cost Saving R / year	Environmental Saving / year
Water and effluent	5 035 860	1 840 Ml
Energy	3 032 400	49.7 GWh
Carbon dioxide		43 600 tons
Sulphur dioxide		412 tons
Nitrous oxide		184 tons

Note: The total cost saving for water and effluent includes cost savings due to reduced treatment costs. Therefore, the volume of water and effluent saved only takes into account the cost saving of water (divided by cost of water) and then 96% of this as effluent volume.

4.8.6 Barriers and Drivers

Barriers and drivers were not assessed for the Hammarsdale Waste Minimisation Club in the same manner as for the Metal Finishing Club and were determined from personal communication; site visits and club meetings. The main barriers and drivers are discussed in this section.

4.8.6.1 Barriers to Waste Minimisation

The main barriers identified in the Hammarsdale Club included:

- Lack of finance,
- Lack of time,
- Lack of resources, and
- Lack of motivation / commitment to the programme.

Through the interviewing process carried out by the SLES, all project champions listed finance as one of the primary factors which hindered the implementation of waste minimisation. A lack of financial resources limits the extent of changes that can be made on the factory floor and it also slows down the rate at which changes can be made. In addition, the current economic context in which the member companies operated placed pressure on companies to maintain profitability and to limit non-essential expenditure. With these day to day financial pressures waste minimisation fell lower on the agenda. In one member company the financial pressure lead to the creation of other barriers, such as retrenchment and change of management, that prevented the company from making headway with waste minimisation, even though they belonged to the Club.

Another barrier identified was the time pressure placed on project champions. Six out of nine (67%) project champions felt that they did not have sufficient time to attend all Club meetings. In addition, the need to carry out other tasks during the working day meant less time for implementing waste minimisation than was preferred. One particular problem was that project champions also played the role of company representative at the HIC. When the meetings of the Club and the conservancy were not scheduled together, time constraints become a significant barrier, as it was difficult for individuals to devote time to both meetings.

The large size of the member companies was also recognised as a significant barrier because with large companies there is a level of inertia that is difficult to overcome in order to introduce new programmes, activities and altered methods of production. In addition, because of the larger size of the Hammarsdale Club members as compared to the Metal Finishing Club, the companies have a strongly hierarchical structure. Most of the project champions are at the middle management level of the companies which impacts on their decision-making power and slows down the implementation as proposals for changes have to be approved by higher levels of management. This size barrier is comparative to the Waste Minimisation Club for Metal Finishers where the majority of project champions own the company they represent and thus have direct control of finances and decision-making.

A further barrier was a lack of human resources. In most cases, waste minimisation was an add-on function to the daily work requirements of the project champions. This limited the time and attention that was placed on the implementation of waste minimisation. In addition some companies disseminated little of the responsibility for waste minimisation. For example, in COMP2 where the project champion shouldered all or most responsibility for waste minimisation, thus slowing down the rate of implementation. The lack of data resources were also a barrier to the waste minimisation programme, as it hindered the use of Montage and slowed down the process of identifying options for improvement.

In addition, the project champions felt that there was a strong need for the Club to be driven by one person or organisation, and that if this driver was withdrawn the Club could collapse. This would result in a drop in the level of waste minimisation in companies as motivation, assistance and fresh input would be reduced.

As the project progressed, it was found that some of these barriers were slowly overcome, mostly through a change in attitude and the realisation of the benefits of waste minimisation. Most club members are actively implementing waste minimisation measures, many through their own initiatives and in-house programmes.

4.8.6.2 Drivers

As mentioned, no exercise was undertaken to determine the drivers to implementing waste minimisation, but the following drivers have emerged through interviews with the club members:

- The club meetings as they motivated the members to implement changes in order to have progress to report on at meetings;
- Savings – once the members achieved savings, the benefits of waste minimisation motivated them to investigate further;
- The introduction of a tariff-based effluent charge;
- Requirements of ISO 14000 or the holding company (where members were part of an international group); and
- Pressure from the local authority to reduce waste at source.

Although possibly not recognised directly by the project champions as a motivating factor, proximity and accessibility played a role in encouraging membership of the Club and therefore of waste minimisation activities. Members attend the Club meetings because the venues were located close to member companies. Project champions claimed that if the Club meetings were held further away they would not have attend, or would have attend infrequently.

4.8.7 Monitoring and Targeting

As discussed in Section 4.7.7, the monitoring and targeting software, Montage was installed at three of the Hammarsdale Club members sites; COMP1, COMP4 and COMP2. This section will highlight the results achieved at each of these sites, the problems experienced and recommendations for the future. Further information is available in Maharaj (2001)**.**

4.8.7.1 COMP1

Montage was successfully installed on-site and data collection initiated. The main problems experienced at this site were a lack of metering and therefore insufficient data to enable meaningful interpretation of the results. The company is however, committed to using the software and is installing further metering.

4.8.7.2 COMP4

The software was successfully installed at the factory and data entered for analysis. There is a lack of resources to enable the software to be used to its full potential, although the company is aware of the benefits. Extensive assistance was given to the company by the post graduate student in setting-up the programme and the company aims to have a complete in-house waste minimsation guide for each department, detailing its use.

4.8.7.3 COMP2

Montage is fairly well established at this site and monitoring and targeting fully developed for the boiler house. Preliminary studies are discussed in this section. Montage has been used to monitor consumption in the boiler house and link this to the associated production variable.

The boiler house is an *activity centre*, i.e. an area in which resources are consumed in a production activity. The resources here are fuel oil and water. The activity is the generation of steam that is used exclusively in the production of dyed material. In order to study the level of production, a number of relationships have to be investigated. The dyed material production is compared to the resource consumption in the Figure 4.8. The graph is based on data for May 1999.

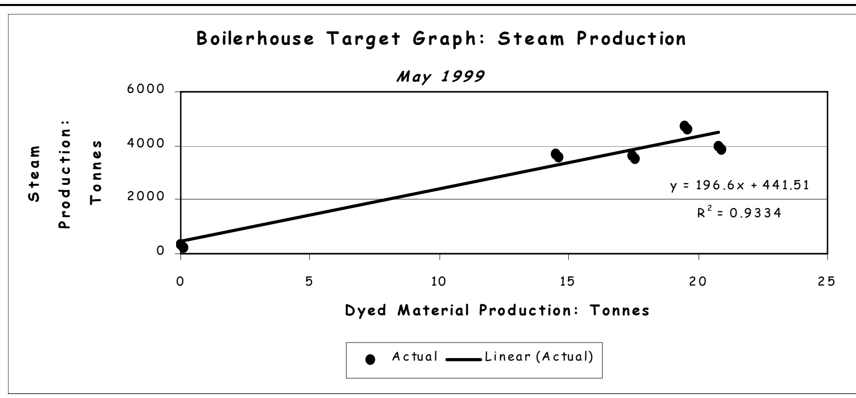

Figure 4.8: Boiler house Steam Production and Best-fit Plot for COMP2

An important observation is the amount of steam produced at zero production levels, i.e. the intersection of the best-fit line with the Y-axis. This is the baseload of approximately 441 tonnes. This indicates that on a weekly basis, a theoretical amount of 441 tonnes of steam is used in processes other than dyed material production. The object of the monitoring and targeting programme is thus to devise methods of reducing this baseload. The gradient of the linear best-fit line is simply an indication of how much more steam must be generated for a unit increase in production of dyed material, i.e. approximately 197 tonnes of steam must be raised for an extra tonne of dyed material production. The steepness of the line is also an indication of the efficiency of the process. A high correlation coefficient of 0.93 represents a good relationship between the variables and hence good level of control in the process.

A similar process was conducted for water consumption (Figure 4.9). There is significant scope for savings as indicated by the weekly baseload of 3926 litres of water. This is approximately 13% of the maximum water consumption. The high correlation coefficient of 0.8 indicates a good relationship between the variables and a good measure of control of water as a resource in the boiler house.

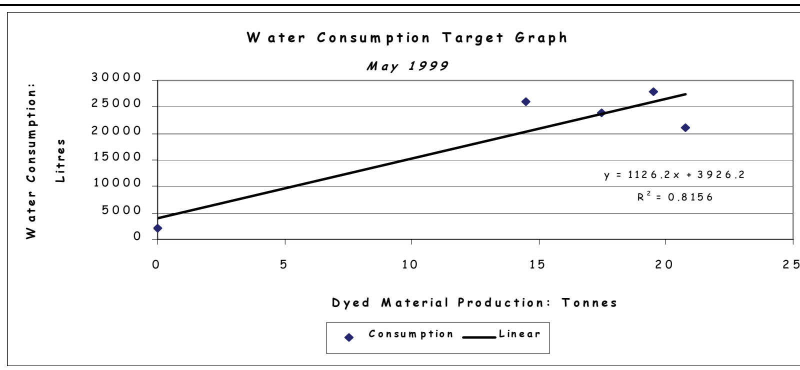

Figure 4.9: Boiler House Water Consumption and Best Fit Plot for COMP2

Metering is insufficient in other parts of the factory to make use of it in the dyehouse as yet. The company realises the importance of monitoring and targeting and are aiming to have the programme fully operational. Further results are presented in Maharaj (2001)**.**

4.8.7.4 Barriers

A number of barriers to monitoring and targeting have been experienced. These include:

- A lack of, or insufficient, metering,
- Lack of meter data,
- Poor production data,
- Lack of time of project champion,
- Lack of interest of other team members and shop-floor personnel,
- Lack of belief by senior management that the programme is useful to the company, and
- Difficulties in installing Montage onto the Network in the companies, thus limiting its use to one person.

As a result, most of the work on Montage was carried out by the post graduate student. This was obviously not sustainable on a long term. For the maximum benefits of the software to be realised, 20% of the waste minimisation champion's time should be spent on the software, and 80% in the plant and with staff finding ways of improving performance.

Under the EU funding, Montage was provided free of charge to these 3 companies. The purchasing price of the software was in the region of R 60 000. It is felt that if the companies had paid for the software, or contributed towards the costs, management may have been more committed to ensuring its success on-site.

4.8.7.5 Recommendations

The following recommendations can be made based on the experiences on-site:

- Additional metering is needed in those companies who have committed to a monitoring and targeting programme but do not have the resources to obtain metering.
- Sites who already have the software (free of charge) should consider appointing additional (or existing) staff for the running and management of such a programme
- More training on monitoring and targeting is needed for both shop floor workers and departmental heads.
- Software support and training on how to use the software is needed for the waste minimisation champions.

Monitoring and targeting is vital for managing utilities and plant consumption. The software served as a convenient mechanism for implementing a monitoring and target project. However, the integrity of the results depends strongly on the methods of data collection and transfer to the software database for processing.

The use of Montage will assist in identifying opportunities for waste minimisation as more attention is drawn to plant utility usage and raw material handling and consumption. Personnel at all levels will be made aware of plant utility consumption and the implications of bad practice.

At the final Club meeting in October 2000, the problems relating to the use of Montage were discussed with the companies present. The main issues that emerged were the lack of interest from senior management, the need for more training in using the programme and the difficulty in installing it onto the network system. COMP1 mentioned that there was management buy-in due to a presentation given by the Project Champion as to the benefits and capabilities of the programme. It was agreed that a further meeting be called by the club members were management were present and this presentation be given to them to assist the other companies in obtaining the necessary commitment. It was suggested that the information technology (IT) personnel from each company also attend the meeting in order to discuss the problems with installing Montage onto the Network System. The issue of training would have to be discussed further to identify where and how this could take place.

As of March 2001, this Club meeting had not taken place and it is not known if the companies are continuing to use Montage.

4.8.8 Social / Relational Aspects

As mentioned in Section 4.7.5, the SLES at the University of Natal were involved in analysing the more social aspects of the Hammarsdale Club. Data for this aspect of the project was obtained through observations at meetings, interviews and personal options gained during the course of the project. An in-depth analysis of these observations is given in Goff (2001). This section serves to highlight some of the points that may be beneficial to ensuring the long-term success of the concept of waste minimisation clubs. The brainstorming results from the meeting with the Durban Metro and Umgeni Water are also discussed.

4.8.8.1 Interaction between Club Members

Analysis of the data has revealed that a number of relationships have been formed amongst role-players in the Club. Constructive and supportive relationships amongst industry, the group of professionals, regulators and with the HIC have been formed through the Hammarsdale Club. These relationships facilitate action for sustainable development and enable individuals to be involved in the care of the natural environment. Due to the hierarchy within the structure of the Club, members have come to rely heavily on the professionals for leadership of the organisation and guidance in the implementation of waste minimisation. This dependency limits the role of the Club in sustainable development because it creates a weakness in the organisation's structure and lessens the ability of the industry-based members to care independently for their local environment.

It is evident from this study that there is a need for a permanent driver that is dedicated to the organisation of Club activities and functions to encourage waste minimisation in a variety of ways. The process of designating leadership should be included in a constitution and should be managed by the members themselves rather than left to an outside party.

It is notable that the Hammarsdale Club is a voluntary participatory organisation that does not have a constitution. This further weakens the organisation. The Club needs a formalised constitution with which to guide future management and which would formalise and bind the partnerships of the HWMC so that administrative and leadership needs of the organisation can be fulfilled by volunteer members or an independent party. In addition, a formalised structure stemming from a constitution can guide the reorganisation of the Club in the future so that it can adapt to changes while continuing to contribute to sustainable development.

Within the Hammarsdale Club, the long-term success of waste minimisation activity requires greater ownership by employees in the individual member companies and should not be left to the sole responsibility of the champion. Ownership of the implementation of waste minimisation, especially by top management, can serve to facilitate greater success and greatly improved production efficiency that will contribute to long-term sustainability in the industrial sector.

From the observations of the PRG, the interactions between club members in the Hammarsdale club are quite different from those in the Metal Finishing club. The main reason for this is thought to be that the Hammarsdale club members are not in competition with one another, even manufacturers in the same industrial sector. These companies do not need to hide *trade secrets* for fear or losing customers. There is open sharing of information and support of activities for each site. The club has raised the awareness and importance of waste minimisation within the companies and assisted in making these types of projects more of a priority than was previously. This is thought to be due to the exposure of the members to one another's successes and the publication of results through newsletters and at conferences.

4.8.8.2 Interaction with Local Authorities

The industry in Hammarsdale saw the uncertainty over ownership of the HWWTW as a barrier to the implementation of waste minimisation as it was not clear to them how they were charged for effluent disposal. Umgeni Water owned and operated the works, and industry was charged based on their incoming water. There was therefore no incentive for the companies to reduce their pollution load. If however, the Durban Metro were to take ownership, an effluent tariff would be introduced similar to the one used presently in the DMA. The industries were also unclear as to the discharge limits set for the Works and felt they were unreasonable, particularly those for colour and conductivity.

In order to overcome this barrier, Durban Metro DWAF and Umgeni Water were invited to the club meeting in August 1999 to discuss these problems and find possible solutions. It was made clear to the club members that the limits for discharge to sewer were necessary in order that the Works comply with the limits set by DWAF for the final effluent discharged to river. DWAF would consider relaxations on these limits if the industrialists could put forward a proposal for reducing their pollution loads over a five-year period. A brain storming session was held with the companies present to identify the strategies they felt would be appropriate.

These results were collated by the PRG and discussed with the Durban Metro and Umgeni Water. The outcome of this was the following:

- The ownership of the HWWTW was no longer an issue as whoever operated the works has to address the discharge problems;
- A task group was formed by the industry, stakeholders and authorities to lobby DWAF for suitable standards;
- Umgeni Water investigated the feasibility and costs of salt and colour treatment at HWWTW; and
- A load-based tariff was implemented. Umgeni Water undertook a reassessment of the effluent produced by each factory.

As of July 2000, a load-based tariff was introduced in the Hammarsdale area. It was based on the Durban Metro tariff and included COD, suspended solids and a fixed charge. Umgeni Water needs to recover R 10.8 million per year (50 % of which is fixed costs) and by using the existing Metro tariff they are R 2 million short of this amount. Therefore, the Umgeni tariff differs from the Metro tariff with respect to the tariff factors in order to recover this shortfall. These tariffs encouraged the contributors to implement waste minimisation at source and promoted the *polluter pays* principle.

4.9 Summary

Based on the results reported in this Chapter, it is evident that the Hammarsdale Club has been successful in promoting the concepts of waste minimisation to the companies involved. The following points summarise the results of this Club:

- Substantial financial savings have been achieved by those companies that actively participated in the club, while those that achieved little savings have been empowered with the knowledge to reduce waste at source and implement programmes on-site.
- It is felt that without the waste minimisation club, the majority of the companies would have investigated some form of waste minimisation, and indeed, COMP1and COMP4 already had programmes in place, but it raised the priority of waste minimisation in these organisations. The club members themselves reported that the club acted as a reminder to them as to the importance of reducing waste at source.
- The analysis of the Hammarsdale Waste Minimisation Club as a voluntary participatory organisation has revealed that these organisations do play a role in the achievement of sustainable development. The extent of the contribution of these organisations to sustainable development is dependent on the interactions

between the specific activities that are carried out and the way in which they are organised.

- It is also evident however, that if it were not for the involvement of the outside consultants and the post graduate student, the club would not have been as successful, as this outside driving force was necessary to ensure attendance and progress. It is felt that either the Club members themselves, or the HIC, should have played a more active role in organising and managing the club.
- The relationship with Umgeni Water, Durban Metro and DWAF improved through the common goal of finding a suitable solution to the effluent discharge problems into the HWWTW.
- The training and awareness process provided by Kagiso-Cowi has supported the broader objective of establishing a club for future co-operation and information sharing in the Hammarsdale region. The immediate objectives of the training and awareness raising have been reached on both management and shop-floor level among those club-members wishing to be involved in the process.
- It is felt that the Club would have benefited from the drawing up of a constitution to make it a more formalised process.
- Approximately 940 Ml/year of water has been saved by these companies, thus decreasing the demand on the water resources of South Africa.

The companies that participated in this Club have benefited from the process through making financial savings, increasing their knowledge on waste minimisation issues and encouraging the companies to incorporate waste minimisation into their day-to-day activities.

It must be noted that towards the end of the project (October 2000), two of the club member sites were closed due to financial constraints of the holding group.

Chapter 5 - Analysis of the Club Approach

This Chapter will discuss the results of the two pilot waste minimisation clubs in relation to one another, and analyse the similarities and differences of these results. The use of the waste mimimisation club concept to promote sustainable development will be discussed and a cost-benefit analysis conducted.

5.1 Club Management

This section will cover the differences in the management of the two waste minimisation clubs and discuss the advantages and disadvantages of each approach.

5.1.1 Regional vs. Sector Specific

The Metal Finishing Waste Minimisation Club can be considered to be a *sector-specific* club as it was comprised of only metal finishing companies, and towards the end, only electroplating organisations. This club cannot be seen as regional, although all members were in the DMA, as the companies were situated a fair distance from one another and discharged to different sewerage works depending on which suburb they were operating. The Hammarsdale Club on the other hand, can be viewed as a regional, or *cross-sectional* as there were 3 industrial sectors involved and all companies were situated in close proximity to one another and discharged to the same sewerage works. The fact that 6 out of the 8 members were textile companies does make the club more sector specific than cross-sectional, but the inclusion of the two other industries did influence the way in which the meetings and training sessions were facilitated.

There were a number of advantages and disadvantages to the each of the two approaches. These are highlighted below.

5.1.1.1 Regional

Advantages:

- all companies are under the same pressures with regard to effluent limits,
- usually no direct competition amongst club members enable free discussions, and
- Club members are in close proximity to one another; thus enabling club meetings to take place locally and reducing travel time.

Disadvantages:

- Pollution problems are not generic and individual solutions are required for individual club members.

5.1.1.2 Sector-specific

Advantages:

- pollution problems and waste minimisation solutions tend to be similar for all companies, and
- Effective communications and discussions at club meetings as all present understand the constraints the others are under.

Disadvantages:

- different regulations / discharge limits if club members are in different areas,
- competition limits discussions, and
- Club meetings are not held local to all members.

There is currently 137 waste minimisation clubs in the UK (www.envirowise.gov.uk). This number includes those clubs that are no longer running (e.g. Aire and Calder; Project Catalyst), clubs that are currently operating, and clubs that are planned. Of these 137 clubs, only 6 are sector specific (textiles, food, ceramics etc.) while the remainder are cross-sectional. It seems that clubs where there is no direct competition between members are more successful in the UK. Similarly, the two waste minimisation club projects in the New Zealand were based on geographical regions rather than industry sector.

On the other hand, the waste minimisation circle concept in India focuses on 5 or 6 companies from the same industrial sector. This has found to be a successful approach for the SMME's in India.

Based on this information and the experience from the waste minimisation clubs in KZN, it seems that those clubs that are focussed on the smaller companies are sector specific, whereas the larger organisations prefer to be part of a cross sectional organisational structure.

It is also evident that the recruitment phase is crucial. In the case of regional clubs involving large organisations, companies should only become members if they have commitment from senior management. In this way, waste minimisation becomes the idea and responsibility of management and he/she is associated with the success (or failure) of the project.

5.1.2 Size of Club

The two pilot clubs differed to a large degree on the number of companies that were involved Generally, a waste minimisation club consists of between 10 and 15 companies, with some having less than 10. This has found to be the most successful approach in the UK, as more than 15 results in less interaction between members.

The Metal Finishing Club initially consisted of 29 members. At the recruitment meeting of the club in June 1998, it was suggested that the club be divided into two smaller clubs, possibly based on the size of the sewerage works into which the factories discharged (there are more stringent discharge limits for the smaller WWTW). This would have made the club size more manageable for the PRG Project Team. However, the companies present preferred to have one large club. This did pose a number of problems:

- The PRG Project Team did not have sufficient manpower to undertake site visit to each company personally and therefore had to employ students to assist in this process;
- Informing the club members of meetings by phone and fax was very time consuming due to the large number that required contacting (similarly for distribution of the minutes and reaching consensus on times);
- The large number of companies at the meetings limited the time for individual presentations on the progress at site, and these report back sessions were not as effective as might have been with fewer members;
- It was found that some of the club members were embarrassed to talk at meetings as they could not report the same scale of savings as other members – a smaller number of members may have made them more comfortable;
- It was difficult to address the needs of the different club members, although the fact that they were all from the same sector allowed for some generalisation of solutions; and
- Collation and analysis of results was time consuming and frustrating due to the number of companies that had to be continuously contacted in order to obtain information.

However, as the club progressed, it became evident (as can be seen from the results in Chapter 3), that a core group of 16 companies emerged. The remaining 13 companies were kept informed of meetings and sent minutes however, but the reduced number of companies meant that more time could be spent assisting those that were enthusiastic. It is possible that those companies that withdrew from actively participating may have benefited from being members of smaller clubs where their individual needs could have been addressed.

The Hammarsdale Club on the other hand consisted of 8 organisations. This enabled the Project Team to spend more time on-site at each of the club member sites and assist in finding solutions to their individual problems. It allowed for more interaction and discussion at meetings and more detailed report-back sessions. Contacting the members and distributing minutes was obviously less time consuming, although collating and analysing the results were just as frustrating due to the lack of feedback by companies.

Based on the experience with these clubs, it is felt that club membership should be limited to approximately 10 companies. This enables more attention to be paid to the club members and for more detailed interaction at meetings.

5.1.3 Small vs. Medium Industry

As is evident from the profile of the club members from each of the Clubs, the Metal Finishing Club consisted of mostly small companies' (with less than 100 employees), whereas the Hammarsdale Club members generally were medium or large organisations (although two members had between 100 and 150 employees).

As discussed in Chapter 4, Section 4.8.6, the size of the companies did influence the results achieved by the club members. The large size of the Hammarsdale member companies was recognised as a barrier to implementing waste minimisation as with large companies there is a level of inertia that is difficult to overcome in order to introduce new programmes, activities and altered methods of production. In addition, because of the larger size of the Hammarsdale Club members as compared to the Metal Finishing Club, the companies have a strongly hierarchical structure. Most of the project champions are at the middle management level of the companies which impacts on their decision-making power and slows down the implementation as proposals for changes have to be approved by higher levels of management. This size barrier is not as evident in the Waste Minimisation Club for Metal Finishers where the majority of project champions own the company they represent and thus have direct control of finances and decision-making.

In addition, because the smaller metal finishing companies were owned by the Project Champion, the results were more *personal* and the benefits seen directly by the Champion, which was not the case for the Hammarsdale members where they were employees of the company.

However, as is evident from the number of companies that did not actively participate in the Metal Finishing Club, a smaller, owner-operated company will not necessarily be more successful in implementing a waste minimisation programme. If anything, the smaller companies are limited in their financial resources as opposed to the larger organisations.

In general, large companies react slowly to change. This project was run based on the time constraints of the PRG and not those within the companies. It is felt that it will take time for the concepts of waste minimisation to be incorporated into the business.

It is clear from the results obtained from both clubs, that both small and medium sized companies benefited from the programme. The deciding factors as to the success of waste minimisation are based on:

- the level of commitment from senior management,
- the enthusiasm of the Project Champion, and
- the involvement of the project team and other factory employees.

Those companies that reported savings did so due to the commitment to the programme and implementing changes. It is recognised that the Club approach is successful for both small and medium to large-sized companies as long as there is commitment to achieving results.

5.1.4 Use of Students

As discussed in Chapter 3, Section 3.9.9, there were advantages and disadvantages to using students to assist in undertaking waste minimisation audits. From the experience in the metal finishing club it was decided that students would not be used in future clubs on such a large scale.

However, the use of post-graduate students to monitor the pilot waste minimisation clubs was found to be a critical success factor as they could devote their time to the companies involved and assist them on an on-going basis. As discussed in Chapter 4, if it were not for the post graduate assistance in the Hammarsdale Club it is doubtful that the companies would have persevered in the use of Montage.

Student assistance is however invaluable in cases where companies require data gathering and monitoring of results. MF22 employed two Danish students for 4 months and these students successfully managed to implement a programme to reduce and monitor water use in the various departments.

It is felt that while it is not feasible for the facilitators of the waste minimisation club to provide student assistance, the club members should be made aware that students are available and be given the opportunity to employ students were necessary.

5.1.5 Training

Both the Metal Finishing and Hammarsdale Club members received training in waste minimisation aspects provided by Enviros March. In addition, prior to these training sessions, presentations were given to the companies on the concepts of sustainability and cleaner production.

The approach taken in training the club members differed in that the waste minimisation modules developed by Enviros March were only available in 1999 which meant that the metal finishing club had already been operational for a year. These modules were therefore presented to the club members after hours at the time of the visits by Enviros March. This resulted in limited attendance by the metal finishing club members. Those that did attend found them to be beneficial and increased their knowledge on the concepts of waste minimisation.

On the other hand, the Hammarsdale club members were trained during working hours and the training sessions combined with the club meetings.

The following points were noted with respect to the training:

- Training in general waste minimisation aspects is essential in order that companies understand the process and the benefits;

- The use of case study material and worked examples is very important in demonstrating the various stages of the programme, although some points to note about this include:
    - The case study used should be an example that the club members can relate to and of which they have some background knowledge, otherwise they get hindered by not understanding how or why certain steps are carried out; and
    - If the worked examples are closely related to the club members' process, discussions tend to focus on aspects other than those related to waste minimisation.
- In the Hammarsdale area it was found that the Project Champions did not have sufficient time to train the other team members on-site and the PRG was asked to present the modules to the individual project teams. This might have been a better approach from the outset of the project, although it would have defeated the objective of transferring the knowledge to the company and empowering the Project Champion to take charge of the programme on-site; and
- It was thought that attendance at the training sessions would have been better if a charge had been levied for those who replied they would be attending. The general feeling is that if something is given for nothing then it is not worth receiving. This might have motivated more club members to attend and receive the necessary training.
- Training was undertaken on a modular process, i.e. there were 7 modules relating to waste minimisation aspects, and each one represented a stage in establishing a waste minimisation programme. It is possible that these modules could be split further to make them slightly shorter and more focussed.

It is believed that training in waste minimisation is essential for a programme to be effectively implemented on-site. For this reason, future clubs should receive training from the start and in conjunction with the club meetings.

As mentioned, the Hammarsdale Club members were also able to receive training for the shop-floor personnel from Kagiso-Cowi. Not all the club members took this opportunity, but those that did undertake the training found it to be beneficial, as it is the people on the floor that can make the difference in operating efficiency. The training was undertaken in conjunction with the training staff at the companies such that it would be incorporated into the regular training sessions. It focussed on environmental awareness and simple waste minimisation techniques.

The Metal Finishing Club on the other hand did not have this opportunity available to them as it was only offered under the EU finding for the Hammarsdale Club. It is felt that these smaller companies would have benefited greatly from this type of training, as the operators are often not supervised and need to understand the importance of minimisation waste at source. Many club members mentioned that their efforts were undermined by the lack of understanding and co-operation from the shop-floor level. Investigations into training were undertaken on behalf of the club by the PRG and presentations given by a training organisation, but the costs were felt to be prohibitive by the club members.

This emphases the point that waste minimisation will not be effective unless all employees are involved, from top management to shop-floor level, and understand the process.

5.1.6 Meetings

The meetings for the Metal Finishing Waste Minimisation Club were initially held at quarterly intervals in 1998, but this was changed to bimonthly in 1999. It was felt that this was the ideal length of time to leave between club meetings as it ensured that momentum was maintained. The club meetings consisted of feedback from the PRG and also a presentation from an invited speaker, such as health and safety, waste issues, training, etc., and then report back from the club members as to their progress. Site visits were also arranged; one to a club member's site and another to the landfill site. Training was undertaken after hours. Meetings were planned to run from 9am to 12pm, but it was found that they tended to run until 1pm, with some companies having to leave early due to time constraints.

The Hammarsdale Club members met on a bimonthly basis. Initially it was thought to combine the club meetings with the HIC meetings, but this was not an effective approach. The meetings generally consisted of feedback from the PRG and Enviros March, information sharing from the local authorities, and discussions on the progress at the club member sites. Training was undertaken as part of the meetings. Only 2 invited speakers presented at these club meeting and no site visits were arranged. Meetings ran from 9am to 12pm, including training.

In both cases, members were notified of club meetings via the minutes of the previous meeting, a fax 2 weeks prior to their meeting and a phone call the day before the meeting.

Based on the approaches used for each of the clubs, the following summarises what is felt to be the best way in which to undertake club meetings:

- Meetings should be held bimonthly. More frequently than this does not allow time for progress to be made, and less frequent meetings is not conducive to encouraging companies to implement changes.
- Training should take part during club meetings, but these should be limited to an hour and be not be too detailed to prevent information overload. Generic waste minimisation aspects should be interspersed with sector-specific aspects.
- Meetings should be limited to 4 hours at the most (including training).
- Invited speakers should be included in the agendas for the meetings and speak on topics relevant to the club members. Club members should be asked to list the topics that would like to have addressed at the meetings.
- Feedback session from the companies tended to be informal with updates taken from around the tables. It is felt that a better approach would be to have each member make a presentation to the club on his / her progress as this would ensure that the club members took the time to quantify the savings. The disadvantage of this is that many people are not comfortable with speaking in front of others, and it may prevent them from attending meetings.

5.1.7 Involvement of European Partners

Enviros March and Kagiso-Cowi were involved mostly in the management of the Hammarsdale Waste Minimisation Club. Enviros March was involved in the establishment of a number of clubs in the UK, and therefore had the experience and knowledge in the procedures that were found to be effective in the UK. In addition, Enviros March are experts in the field of reducing energy use, and, as this is one area in which the PRG has limited knowledge, this was an ideal opportunity to combine expertise. Similarly, kagiso-Cowi had experience in training and capacity building and it was felt that the combination of the three groups would be beneficial to the project.

There were advantages and disadvantages to using outside experience. The advantages included:

- The gaps in the PRG experience were filled by Enviros and Kagiso-Cowi;

- The opportunities offered by these 2 partners were beneficial to the companies involved;
- Enviros March provided specialised and generic training which the PRG did not have access to and these are now available for the PRG to use in the training of future clubs;
- Companies tend to take the advice of an international consultant more than they do that of a local one as the perception is that the international consultant is more knowledgeable;
- The EU funding allowed for the monitoring and targeting software, Montage, to be installed at the PRG and club member sites; and
- The companies and the PRG were exposed to international experiences and results, thus enabling technology transfer.

The disadvantages included:
- It was difficult to co-ordinate all three groups activities, and communication was not effective at times, resulting in poor planning of meetings in some cases, and crossing over of objectives;
- Kagiso-Cowi tended to run their initiatives on their own without notifying the project partners of the outcomes, which made it difficult to completely assess the benefits of the training they provided;
- Since Enviros March were based in the UK, it made planning and organising meetings and sire visits time consuming. Communication was also often delayed.
- The PRG was not as involved in the running of the Hammarsdale Club as the Metal Finishing Club due to the involvement of the EU partners; and
- The experience of Enviros March in the UK was not always applicable to the South African situation, which made it necessary for a change in mind-set on the part of the Enviros March consultant.

In summary, it is felt that it was beneficial for the EU partners to be involved in terms of the technology transfer issues and capacity building. In addition, the PRG was exposed to knowledge and experience that would not have been gained without the EU involvement.

5.1.8 Constitution

On becoming members of the Metal Finishing Club, companies were asked to sign a declaration of commitment, which outlined the aims, and goals of the club. These included a commitment to implementing a programme of waste minimisation, reducing all sources of waste, making continual improvements, establishing a monitoring programme, reducing their environmental impact, sharing information with other club members, and attending regular club meetings. This certificate of commitment was framed and displayed at the company premises as a sign of their involvement in the project. This declaration was then expanded upon in 1999 to a draft constitution for the Club. However, it was never signed by the club members as it was felt that since the project was ending in December 2000, and the PRG would no longer be a part of the Club, that it would more beneficial to form the MFA with its own constitution. This was undertaken and the constitution of the MFA was drawn up based on this drat constitution and with the assistance of the SLES.

The Hammarsdale Club on the other hand did not sign declarations of commitment, nor were there discussions regarding a constitution. The reason for this is that it was felt that the members were already unified under the HIC, which had its own constitution. Possibly, this should have been altered slightly to include waste minimisation.

While it is felt that constitution may have strengthened the club, as discussed in this Chapter, a waste minimisation club can be seen as a short-term grouping of companies, and therefore, it is more beneficial for the companies to join together in a more long-term initiative (such as the MFA or HIC).

5.2 Barriers and Drivers

From an analysis of the main barriers and drivers in both the Metal Finishing and Hammarsdale Clubs, the three top barriers emerged as:

- Lack of time;
- Lack of finance; and
- Lack of resources.

These three were listed by both clubs as been the main reasons for waste minimisation not being implemented in their companies. A lack of information and technical knowledge was also listed by the club members at the beginning of the project, but once training was undertaken and information disseminated to the members, this barrier was easily overcome.

A lack of time refers mostly to the lack of time on the part of the project champion, be he/she the owner of the company or the plant engineer. This emphases the need for there to be commitment from management and the members of the project team on site. It is not clear how this barrier can be overcome, as it is an internal problem that only re-organisation of priorities can overcome.

A lack of finance is seen as a barrier for a number of reasons. In the first instance, it is due to the perception that implementing waste minimisation will cost money, and since most companies are operating with limited financial resources, it prevents them from investigating waste minimisation opportunities. This barrier can only be overcome by management realising that minimising waste can lead to improved operation and cost savings. It is therefore important to have some one on the project team of a company from the finance department as they can assist in motivating for projects to be initiated. Secondly, as mentioned in Chapter 3 (section 3.9.7), once the no- or low-cost options have been implemented, companies start investigating more capital intensive options, with the result that finance is a limiting factor. One way of overcome this is to use the savings that have been made on the low-cost options to finance these investments. Wide publicity of local savings will also create awareness of the benefits and this should be used as a marketing tool prior to recruitment.

A lack of resources is also quoted as a barrier. This can refer to the lack of manpower to assist the project champion in the implementation of a waste minimisation programme. As was evident from the two pilot clubs, in the most cases, the project champion was expected to carry out the entire programme, which is not feasible, and not sustainable. Again, this emphases the need to senior management to commit themselves to the programme and ensure that all team members participate. In the case of the smaller companies, manpower is limited due to the small number of employees. In this case, use could be made of students or one or two dedicated personnel.

Based on the experience of the PRG project team, other barriers that existed in both clubs were:

- A lack of data. In order to assess the success of waste minimisation, it is essential to determine baseline data before implementing changes, and then monitor the results. In most cases, the club members did not have sufficient baseline data and therefore could not quantify the results. In many cases, utility metering was inadequate (if it even existed at all) and this made monitoring of progress difficult.

- Lack of communication of commitment from senior management to the company project teams. When approached personally, management said they were committed to a programme of minimising waste, but the project champion did not receive the support from the team as management had not made it clear to everyone that they were to assist in the programme.
- Lack of understanding of the benefits of waste minimisation. While it is felt that the benefits were made clear to the companies, the feeling still remained that the companies were not entirely *convinced* that waste minimisation was a worthwhile investment of time.

The main drivers for the two clubs were the cost savings that could be made, pressure from the local authorities and to reduce pollution. It is felt that without the pressure from the Durban Metro and Umgeni Water, the companies would not have been as motivated to join the waste minimisation clubs. It was only after they had received training and information on waste minimisation and started to achieve savings, that the companies realised that it made business sense to implement such a programme. It is evident that both a *carrot and a stick* approach are necessary to encourage companies to take action and investigate methods of reducing waste at source. It is felt that future clubs can build on the success of the pilot clubs and that outside pressure may not be as essential as for these first clubs.

A further driver that emerged from the project is the need for a club champion. An industry person is far more effective at encouraging other industrialists to implement waste minimisation than an outside consultant. It is felt that the Metal Finishing Club may not have been as successful as it was if it were not for the enthusiasm of one or two metal finishers in the club.

5.3 Social Interactions

An important aspect of this project was to observe the interactions of the club members to determine if a *club* was a successful method of promoting waste minimisation. This involved analysing the relationships between the club members, and the interactions with outside role-players such as the local authorities and the suppliers / customers of the companies. These issues are summaries in this section.

5.3.1 Interactions of Club Members

From the experience gained in running both the pilot clubs, it is evident that the companies involved benefited from the club approach. The reasons for this can be attributed to the following:

- Peer pressure. Companies were motivated to make progress in order to have results to report on at each meeting. The success of one company spurred on progress at another.
- A feeling of unity. All companies felt that they had a forum in which to share their joint problems, be it related to waste minimisation, legislation, water charges etc. The companies were united in addressing these issues to the benefits of all involved.
- Contact. Many metal finishers stated that they had not previously met the other metal finishers and this club facilitated the forming of new working relationships. This resulted in club members making contact with one another outside of club meetings and assisting each other where possible. In the case of the Hammarsdale Club, the members knew one another from the HIC meetings, but the club meetings enabled them to meet on a more technical level and exchange information relating to process issues.

- Motivation. The fact that club meetings were held every two months encouraged the companies to undertake some form of progress on site prior to the next meeting. If club meetings were not held, waste minimisation would not have been high on the list of priorities.

An additional point that was raised by club members in the Hammarsdale Club is that the waste minimisation club was seen as a voluntary participation process. It was there to assist the companies and provide information and advice, rather than being something that the companies were forced to attend. It was pushed by the companies themselves through motivating and peer pressure, rather than by some outside regulation. In this way, the companies felt more comfortable with attending the meetings and undertaking projects.

The formation of the Metal Finishing Association (MFA) as an outcome of the club indicates that the club identified the need for the Metal Finishers to unite and have a forum where problems and issues could be discussed.

5.3.2 Local Authorities

As discussed in Chapters 3 and 4, the relationships between the club members and the local authorities improved during the course of the project, mostly due to a greater understanding on both parts as to the constraints under which each other operated. It was interesting to note, that in the Metal Finishing club there was always a slight distrust of the Durban Metro, who attended meetings by invitation only, while in the Hammarsdale Club the authorities were welcome to attend all meetings. This could possibly be attributed to the fact that the metal finishers were constantly monitored by the Durban Metro and DWAF and were under the threat of closure if there was non-compliance. In the Hammarsdale area, however, the companies did not feel threatened by the regulations.

In both cases the project was fully supported by the authorities and is something they would like to see repeated in other areas.

5.3.3 Suppliers / Customers

The relationship between the club members and their suppliers and customers was more marked in the Metal Finishing Club than the Hammarsdale Club. The reasons for this could be due to the fact that the suppliers to the Metal Finishing Club tend to have more of a relationship with their customers than those in the Hammarsdale Area. One supplier became a member of the Metal Finishing Club (on invitation by the members) and is also the vice-chair person of the MFA. This supplier is interested in learning all of the issues related to waste minimisation and in assisting club members to implement them in-house. In the Hammarsdale region, the club was not approached by suppliers to join the club and neither was any invited by the club members. This does not necessarily imply that the suppliers are not important to the club members, but perhaps that the importance of their role in supplying less harmful raw materials has not yet been realised. In addition, because the Metal Finishing Club was sector specific, the one company could supply a number of the club members. In the Hammarsdale Area, the club members obviously had a number of different suppliers.

The relationship between the club members and their customers was not explored in great detail, other than to highlight to the members that it was important to approach customers with alternate processes where toxic chemicals where being used. For example, in the Metal Finishing Club, one member persuaded his largest customer of Cadmium electroplating to change to zinc electroplating, thus reducing almost eliminating the need to undertake cadmium electroplating on site.

5.4 Verification of Financial Savings of Club Members

As discussed in Chapter 3, section 3.9.3, an analysis of the utility records of one metal finishing club member was undertaken to determine if the savings reported could be verified by account details.

The results of this analysis revealed that the calculated savings were slightly lower than those reported, but this was attributed to the fact that the company did not take production into account over the periods for which results were reported. It was felt that overall; the results reported by the members could be taken to be actual savings, rather than an attempt by the companies to look good at the meetings.

In the case of the Hammarsdale Club, it was difficult in some cases to confirm results with the club members due to a lack of feedback as to the actual savings. Therefore, it is possible that the reported results may differ from those that would be calculated from actual accounts. This would however, not be due to misrepresentation by the companies, but rather due to lack of verification of the savings determined by the PRG with the companies.

Similar analyses should be undertaken for all club members to verify the results, but due to time constraints and a lack of available data, this was not carried out in the course of this project.

5.5 Cost-benefits Analysis

In order to determine the cost-benefits of the two pilot waste minimisation clubs, details on the costs of running the clubs and the savings made were analysed. Running costs included:

- Hiring of venues and catering
- Travel to site visits and meetings
- Employment of students on a part-time basis
- Faxes and phone calls
- Time spent by the Project Team on managing the club (salary)

Therefore, these costs are only those directly related to the management of the club and not those involved in research, education, administration and dissemination matters.

The costs of running the clubs were separated based on the source of funding, i.e. WRC and EU. The reason for this separation is that the fees charged by the EU consultants are far greater than those charged by the PRG and the expenses also includes the cost of the overseas flights and the monitoring and targeting software, Montage.

A summary of the overall costs is given in Table 5.1 together with the total project budget.

Table 5.1 Summary of Expenses for Running the Pilot Waste Minimisation Clubs

Item	Water Research Commission	European Union
Salary	244 136	792 000
Running expenses	82 103	348 000
Total	**326 239**	**1 140 000**
Total project Budget	**1 062 000**	**1 140 000**

Note: The exchange was taken to be 6 Euro to the Rand.

As can be seen, approximately 30% of the WRC project budget was spent on the running of the waste minimisation clubs.

5.5.1 Salary

The salary for the PRG project team was calculated based on the estimated number of hours spent on the running of the club and attending meetings. It was divided between the time spent by the PRG Project Manager, the Project Leader and the Secretary, and included:

- Organising meetings
- Contacting members by telephone and fax
- Attending and facilitating meetings
- Undertaking site visits
- Training club members

The salary for the EU project team was divided between the two EU consultants, Enviros March and Kagiso-COWI and included:

- Facilitating meetings
- Training of club members
- Undertaking site audits
- Training of shop-floor personnel
- Preparation of training material
- Montage

It must be noted that the majority of the EU funds were allocated to the running of the Hammarsdale Waste Minimisation Club, with 10% of the fees for Enviros March being spent on the Metal Finishing Club for training and site visits. All of the fees for Kagiso-COWI were allocated to the Hammarsdale Club.

5.5.2 Expenses

Running expenses for the clubs were calculated based on the cost of organising meetings and travel to the meetings and site visits. Cost of telephone calls and fax charges have also been estimated.

Under the WRC funded portion of the project, expenses for the Metal Finishing Club were higher than those for the Hammarsdale club. Club meetings were held free of charge at a club member's site in Hammarsdale, whereas the metal finishing club meetings were held at the University of Natal, Innovation Center where venue hire and catering costs had to be paid. In addition, 22 vacation students were employed during July 1998 to undertake site visits at the metal finishing factories and these costs are included as running expenses.

A total of 16 meetings were held for the Metal Finishing Club and approximately 30 faxes and phone calls were made to inform members of the meetings each time. In Hammarsdale, only 11 meetings were held and 10 companies had to be informed for each meeting.

In the case of the EU funded portion, it is known the entire budget was utilised for the project and ruining expenses were taken to be the total allocated in the budget.
A breakdown of the costs is given in Table 5.2 for each Club.

Table 5.2 Break Down of Expenses for Both Clubs

Item	Water Research Commission		European Union	
	Metal Finishing	**Hammarsdale**	**Metal Finishing**	**Hammarsdale**
Salary	123 304	120 832	48 600	743 400
Running expenses	70 379	12 028	n\a	348 000
Total	**193 683**	**132 860**	**48 600**	**1 091 400**

Therefore, the total expenses for the Metal Finishing Club (WRC and EU) were R 242 283 and for the Hammarsdale Club, R 1 224 260.

5.5.3 Analysis of Data

Using the data provided in Tables 5.1 and 5.2, and the total savings achieved by the club members, a cost-benefit analysis can be performed.

Firstly, one can calculate the rand savings made per rand spent on running the club. This is shown in Table 5.3 for each of the Clubs taking the expenses for both the WRC project and the EU funding.

Table 5.3: Savings Achieved per Rand spent on Running the Waste Minimisation Clubs

Item	Metal Finishing Club	Hammarsdale Club
Total Expenses	242 283	1 224 260
Total Savings	2 138 846	8 899 900
R Savings / R spent	**8.83**	**7.27**

As can be seen, in both cases, approximately R 8 was saved per rand that was spent on the running of the pilot clubs. In other words, for every rand spent by the consultants in organising meetings, travel costs, etc, the companies saved R 8. These costs and savings are the total for the 3 years of the project, but as mentioned previously, the savings can be taken as annual savings as the companies will now realise these savings on an annual basis.

If one compares the savings achieved in both clubs to the total project budget, it is found that for each rand invested by the WRC the companies saved R 10.39; and for each rand invested by the EU, the companies saved R 9.68 (Table 5.4).

Table 5.4: Comparison of Total Savings Achieved to Total Project Budget

Item	WRC	EU
Total Budget	1 062 000	1 140 000
Total Savings	11 038 746	11 038 746
R Savings / R budget	**10.38**	**9.68**

The success of a project can be determined by calculating the payback period on investment and the Return on Capital Employed (ROCE). Payback is a simple method of determining the payback on capital investment and is calculated by dividing the total capital invested by the total savings. ROCE is defined as the average annual profit divided by the capital employed. In this case, the annual profit is the savings achieved by the club members, and the capital is the funding from the WRC and the EU. \

The definitions of ROCE are given in the equations in Table 5.5.

Table 5.5: Definition of ROCE

Gross ROCE	[Total cost savings / capital] x 100 %
Net ROCE	[(Total cost savings – Capital) / Capital] x 100%
Gross annual rate of return	Gross ROCE / project life (%)
Net annual rate of return	Net ROCE / project life (%)

Based on these equations the payback, gross and net ROCE, and the annual rate of return can be calculated for the projects based on both the cost of running the project and the total budget. The results are given in Table 5.6. In the case of the WRC funding, calculations have been based on the total expenses (from Table 5.1) and for the total project budget. Savings were taken as the total savings from both clubs.

Table 5.6: Calculation of Payback and ROCE for the Pilot Waste Minimisation Clubs.

	WRC (expenses)	WRC (budget)	EU
Payback (days)	10.78	35.12	37.69
Gross ROCE (%)	3380.49	1039.43	968.31
Net ROCE (%)	3280.49	939.43	868.31
Gross rate of return (%)	1126.83	346.48	322.77
Net rate of return (%)	109.50	313.14	289.44

Based on the figures in Table 5.6, it is evident that there is significantly large return on capital investment. The payback period for the WRC portion of the project are of the order of 10 d if only the running expenses are taken into account, and just over a month based on the total project budget. Similarly for the EU finding, where the payback period is of the order of 38 days. The net rate of return on the investment is over 1 000% for the WRC funding (800% for the total budget) and almost 300% for the EU funding.

5.5.4 Summary

Based on this cost-benefit analysis, it is evident that the project has been financially successful with the payback on the capital invested being of the order of days, and the rate of return on the investment over 100%.

5.6 Sustainability of Waste Minimisation Clubs

One of the outcomes of the project was to develop guidelines as to how the waste minimisation club concept could be sustained on completion of the pilot project, and to incorporate this concept into South African policy.

It is felt that this has been achieved through a number of initiatives, such as:

- The new WRC project 1171, where the outcomes of the project are to publish guidelines as to the methodology of establishing and managing waste minimisation clubs, develop training courses for waste minimisation club facilitators, and provide access to sector specific waste minimisation guides.
- The Danced Cleaner Production Demonstration project in the Metal Finishing Industrial sector is providing funding for the establishment of further waste minimisation clubs in that sector.
- The waste minimisation club concept is cited in the South African National Waste Management Strategy as a route to promoting waste minimisation to industry.
- The pilot waste minimisation clubs are cited as success stories in the Revised Version of the 1994 UNEP (United Nations Environment Programme) document on Government Strategies and Policies for Cleaner Production. The objective of the report is to provide government and other concerned parties with information based on the experience of policy implementation in other countries.
- DWAF has developed a procedure for the application of funds to establish waste minimisation clubs in South Africa. Application has been made to DWAF for co-funding of new waste minimisation clubs in the Metal Finishing sector together with Danced and the WRC.
- A number of new waste minimisation clubs have been established in South Africa and inquiries as to the methodology of establishing further clubs have been directed to the PRG.

Based on these initiatives, it is felt that the waste minimisation club concept is one that will grow within South Africa. However, in order for it to be sustained beyond the funding of the WRC project (1171), there is a need to establish a *centre* where future facilitators can gain access to the information required to run the clubs. For this reason, a web page is currently being designed where the current information can be installed and a list server will be established for all interested parties to maintain contact. It is however necessary for a person to be involved in the maintenance and updating of this *centre* and this is an issue that should be discussed further.

Based on these pilot clubs and those run in the UK and New Zealand, it is evident that the lifetime of a waste minimisation club is limited. It is felt that between 2 and 3 years of outside involvement is necessary for the programme to take root in the companies. After this time, it is evident that those companies that have taken waste minimisation on board will continue with their own initiatives. Those companies that have not implemented any changes are unlikely to make any improvements even if the outside involvement where to continue for another few years.

Therefore, although it is felt that the club concept is a sustainable one, it is evident that the clubs themselves are not, unless the companies themselves wish to continue the contact. In the case of the metal finishing club, the members felt that it was important to retain the contact made during the course of the project, and this was one of the reasons for establishing the MFA. In a similar manner, the HIC in Hammarsdale will continue to provide a forum for the companies to exchange information on a regular basis.

5.7 Summary

Clubs, by their nature are voluntary, participatory bodies. Thus their function is to facilitate the participation of members in a common project or interest. In this role, clubs differ from other participatory environmental decision-making organisations in South Africa such as forums and panels which are often constituted to monitor environmental impacts and resolve specific issues of conflict between a number of stakeholder groups, for example, bodies of authority, industry and communities (Scott, 1999). Some of the guidelines for public participation thus become largely irrelevant when applied to the concept of the waste minimisation club and the paths of these clubs remains largely uncharted within the South African context. The lessons learnt from the international, and local, experiences of waste minimisation clubs will inform new methods and progressions in participation and voluntary actions.

The analysis of the club approach has provided some insight as to the way forward for the establishment of further clubs and the preparation of guidelines for facilitators. Based on the cost-benefit analysis, this project as been economically successful and it is hoped that future clubs show as good a return on investment as these pilot clubs.

In summary, the following points can be noted from this chapter:

- There are advantages and disadvantages to sector specific and geographical clubs. Sector specific clubs have been found to be the more popular choice in South Africa.
- The size of the club should be limited to between 10 and 15 companies for ease of management and to encourage closer interaction between club members.
- The size of the companies involved in the clubs did not impact on the magnitude of the savings achieved, but did impact on the decision making process in the companies.
- The clubs were influential in changing the relationship between the companies involved and the local authorities, and also with one another.
- The barriers and drivers identified in each of the clubs were similar to one another and typical of those identified in international clubs.

- Meetings should be held bimonthly with frequent reminders to encourage members to attend. They should be limited to 4 hours at the most and include training.
- Training is essential for the success of a waste minimisation programme. Methods of training shop-floor staff should be investigated.
- Savings reported by the club members can be taken to be slightly higher than those calculated from monthly bills and monthly production. This is attributed to the fact that companies report savings at the time and do not take into account the fluctuations in production.
- It is difficult to verify savings achieved due to lack of feedback from the companies.
- The waste minimisation club project was economically successful based on the cost-benefit analysis.
- The club concept is a successful one based on the number of initiatives underway to promote the concept in South Africa.

Chapter 6 - Conclusions and Recommendations

This Chapter summarises the discussions of the previous chapters, and makes recommendations as to the future work necessary to continue the waste minimisation club concept in South Africa.

6.1 Summary of Results

Based on the discussions in **Chapters 3, 4 and 5**, it is evident that the two pilot waste minimisation clubs were successful in promoting the concepts of waste minimisation to the companies involved and that the club approach is a feasible route to promoting sustainable industrial development in South Africa.

During the course of the project, the following results were obtained:

(i) In total, 1 280 Ml of water was saved by 17 companies over the 3 years, leading to a reduction of 1 230 Ml of effluent discharged to drain;
(ii) A total of 65.7 GWh of energy was saved by 10 companies over the 3 years, resulting in a reduction of 45 000 tons of CO_2, 425 tons of SO_2 and 190 tons of NO_x being emitted to atmosphere (with related savings in water and coal);
(iii) A total financial saving of R 18 million was made by 20 companies;
(iv) The majority of the savings were achieved through improved housekeeping practices (no- or low-cost);
(v) The concepts of waste minimisation were transferred to the companies through club meetings, training and site visits;
(vi) A total of at least 878 people were capacitated through the project;
(vii) Sector-specific clubs seem to be more successful for the smaller companies, while the larger organisations prefer to be in a regional club;
(viii) A waste minimisation club should be limited to between 10 and 15 companies;
(ix) Training in waste minimisation is essential for the success of the project and should involve all employees, from management to shop-floor level;
(x) The main barriers experienced were a lack of time, finance, resources and commitment;
(xi) The main drivers identified were cost savings, pressure from local authorities and to reduce pollution;
(xii) Both the stick and carrot approach is necessary for companies to take on waste minimisation;
(xiii) On average, savings accounted for between 2% and 5% of the annual turnover of the companies;
(xiv) The regulators attitude has changed from one of *command and control* to discussions leading to self-regulation;
(xv) The project had a payback of just over a month and a return on investment of over 100%; and
(xvi) There are a number of initiatives underway to promote the waste minimisation club concept.

These points summarise the main results of the project.

6.2 Realisation of Objectives

As outlined in Chapter 1, the aims of the project were to:

- improve water quality through the prevention of water pollution by industries and reduce the demand for industrial water,
- develop the concept of waste minimisation clubs in South Africa,
- contribute to the establishment of competitive industrial small, micro and medium sized enterprises (SMME's),
- promote the concepts of cleaner production, waste minimisation and sustainable development amongst SMME's, and
- Promote energy efficiency.

Based on the results of the project, it is evident that these aims have been fulfilled. It is felt that the waste minimisation club concept is one that will promote waste minimisation to industry, thereby reducing water and energy use (see points i and ii). All companies involved reported that prior to joining the club they had no (or limited) knowledge on waste minimisation and did not realise the benefits to both themselves and the environment. The smaller companies have become more profitable, with two of the companies reported savings in the region of 20% of their turnover, and others between 2% and 5%. This is also true of the larger companies were savings are approximately 2% of their turnover.

It is felt that the concept of waste minimisation clubs is one that will grow in South Africa and this is evident through the number of new initiatives underway in the country, such as:

- The new WRC project 1171, where the outcomes of the project are to publish guidelines as to the methodology of establishing and managing waste minimisation clubs, develop training courses for waste minimisation club facilitators, and provide access to sector specific waste minimisation guides.
- The Danced Cleaner Production Demonstration project in the Metal Finishing Industrial sector is providing funding for the establishment of further waste minimisation clubs in that sector.
- The waste minimisation club concept is cited in the South African National Waste Management Strategy as a route to promoting waste minimisation to industry.
- The pilot waste minimisation clubs are cited as success stories in the Revised Version of the 1994 UNEP (United Nations Environment Programme) document on Government Strategies and Policies for Cleaner Production. The objective of the report is to provide government and other concerned parties with information based on the experience of policy implementation in other countries.
- DWAF has developed a procedure for the application of funds to establish waste minimisation clubs in South Africa. Application has been made to DWAF for co-funding of new waste minimisation clubs in the Metal Finishing sector together with Danced and the WRC.
- A number of new waste minimisation clubs have been established in South Africa and inquiries as to the methodology of establishing further clubs have been directed to the PRG.

In order for the concept to be sustained beyond the funding of the WRC project (1171), there is a need to establish a *centre* where future facilitators can gain access to the information required to run the clubs. For this reason, a web page is currently being designed where the current information can be installed and a list server will be established for all interested parties to maintain contact. It is however necessary for a person to be involved in the maintenance and updating of this *centre* and this is an issue that should be investigated under project 1171.

6.3 Realisation of Research Products

The research products that were envisaged for this project included:

- A framework for organising waste minimisation clubs for SMME's;
- An assessment of the real research and technology transfer needs for the environmental sustainability for the SMME sector; and
- A framework to make industrial SMME's more competitive

Based on the results of this project, is felt that these research products have been achieved, or the foundations are in place for their realisation.

The experience gained in the running of the pilot clubs is being used to develop guidelines for the management of clubs that can be distributed to other facilitators. This will provide a framework on which other clubs can be based and can be used to assist in making SME's more competitive. These guidelines are being developed under the WRC project 1171.

By analysing the results of the project, the needs of the SME sector in terms of promoting environmental sustainability can be identified. As discussed in Chapter 5, training of all employees is essential for a successful waste minimisation programme. All employees should be made aware of the environmental consequences of their company's pollution. It is also evident that a lack of time and personnel resources is a significant barrier to companies undertaking waste minimisation, regardless of their size. The involvement of the post graduate students was a critical success factor in promoting waste minimisation to the club members.

Marketing of the waste minimisation concept is also essential to the sustainability of the concept. It has been found that the most successful approach to disseminating the benefits of waste minimisation to industry is by having one of the Club members speak at meetings about their experiences. Industry responds more favorably to *one of their own* than to an *outsider*. The use of local case studies is also important in promoting the concept.

6.4 Recommendations

Based on the results of this project and the number of queries received regarding the formation of further clubs, the following recommendations can be made:

- Guidelines as to establishing and managing waste minimisation clubs should be prepared in order that there is a set procedure that club facilitators can follow to ensure the concept is not damaged by inappropriate methodology;
- A centre of information should be established where interested parties can obtain information on cleaner production and waste minimisation clubs;
- Sector specific guidelines for conducting waste minimisation audits should be collated or prepared, and stored at this centre of information;
- Training material for club facilitators should be prepared in order that they can transfer the knowledge to club members.
- Training for factory floor employees is important and this should be investigated by some-one with the necessary skills.

6.5 Archiving of Data

All information pertaining to the project will be placed on a CD Rom and submitted to the WRC for distribution. It is felt that this is the most effective way of storing the data. In addition, case studies will be placed on the Internet for dissemination purposes. All support documentation (Annexures) have been compiled into a Data Report and is available from the WRC on request.

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FINAL REPORT

Applicability of Waste Minimisation Clubs in South Africa: Results from Pilot Studies

Data Report
(Annexures)

by:

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May 2001

Report to the Water Research Commission on Project No. 973 entitled :

Waste Minimisation and Effluent Treatment Clubs: Phase 1

Initial Assessment and Pilot Study

Head of Pollution Research Group	:	Professor C A Buckley
Project Leader	:	Ms S J Barclay

Table of Contents – Data Report

The Annexures listed below constitute support documentation for this Data Report

Annexure	Title
1	**Capacity-Building Benefits of the Project**
2	**Technology Transfer**
3	**The Role of Participatory Organisations in Sustainable development: A Case Study of the Hammarsdale Waste Minimisation Club** *(Abstract from MA Thesis by J Goff, UKZN 2001)* • *Appendix A: Interview Schedules for Qualitative, Informal Interviews* • *Appendix B: Area Plan Map of the Development Area of the Hammarsdale Area* • *Appendix C: Preplanned Structural Organisation of the Hammarsdale Waste Minimisation Club* • *Appendix D: Training Manual for Shopfloor and Management Capacity Building* • *Appendix E: List of Process Changes in Member Companies*
4	**The Promotion of a Waste Minimisation Club for the Metal Finishing Industry** *(Abstract from MScEng Thesis by N Thambiran, UKZN 2001)*
5	**The Promotion of a Waste Minimization Club in the Hammarsdale Industrial Area** *(Abstract from unsubmitted MScEng Thesis by D Maharaj, UKZN 2001)*
6	**Energy Saving and Waste Minimisation in South Africa***, (Abstract of Final Report by Enviros March, Manchester, United Kingdom, fpr European Union, European Commission Directorate-General for Energy)*
7	**Summary Case Studies for the Metal Finishing Industry Waste Minimisation Club**
8	**Summary Case Studies for the Hammarsdale Waste Minimisation Club**
9	**Interview Data for the Metal Finishing Waste Minimisation Club**
10	**Analysis of Results for a Metal Finishing Club Member**

ANNEXURE 1
Benefits of the Research Project – Capacity Building

1. Summary

This Annexure will cover aspects relating to capacity building under the Waste Minimisation Project. Capacity building has been taking place in the waste minimisation clubs in a number of ways. The project champions have received formal training, expert advice and intensive assistance from the professionals. Furthermore, discussion and sharing between members and hands-on experiences and experimentation with waste minimisation practices has enhanced capacity. In addition, shop floor and management training has been carried out at 5 of the Hammarsdale club members by Kagiso-Cowi. Students on both the graduate and post-graduate level have also been educated in waste minimisation aspects, and the PRG project team have gained knowledge in managing waste minimisation clubs and in training companies through the involvement of Enviros March.

The concepts and success of capacity building in the Hammarsdale Club are discussed in detail in Goff (2001). It is felt that the comments and views raised in Goff (2001) are also relevant to the Metal Finishing Club. Some of the points are highlighted in this report.

2. Analysis of the Capacity Building Process

All capacity building carried out through the waste minimisation club activities has the potential to create high levels of motivation, skills for waste minimisation and the long-term improvement of environmental standards in member companies. Capacity building has had a number of results. Firstly, awareness of environment-related issues has been raised. Secondly, knowledge of waste minimisation and the skills to implement waste minimisation have been developed. Thirdly, the growth of an environmental ethic is evident in an increased sense of responsibility towards the environment and an enthusiasm to prevent degradation.

Three project champions interviewed in the Hammarsdale region felt that they were given a view of the global environmental context and were enthusiastic about being informed of the broader context of environment. Included in this greater awareness of broader environmental contacts is a growing interest by project champions in their local surroundings and the impact of industrial waste on local ecosystems, for example the toxicity of waste dumped into these ecosystems.

Prior to the capacity building programme the lack of knowledge of environmental legislation was substantial amongst shopfloor and management staff of the Hammarsdale club member companies. It is felt that this situation was similar for the metal finishing club members based on the fact that lack of knowledge was high on the list of barriers.

Awareness of national environmental legislation and the rights and responsibilities of industry in terms of the environment was raised through the inclusion of environmental legislation as one of the main focus points of capacity building in the training provided by Kaigos-Cowi to member companies. In capacity building sessions with both management and shopfloor employees, this topic caused much interest, heated discussion and brought forth the most questions indicating high level of interest and a recognition of the importance of environmental legislation in industry. It was also found that in the Metal Finishing Club, the meeting that was addressed by a representative of an environmental law firm was the best attended meeting and resulted in a high degree of discussions.

Raised environmental awareness should enable the involvement of individuals in sustainable practice (Palmer 1998). To this end, understanding of waste minimisation itself has been expanded. This has facilitated increased waste minimisation activity which is environmentally beneficial. The growth of understanding of waste minimisation is evident from comments made by members of both clubs where they admit to little, or incorrect, understanding of waste minimisation prior to being members of the club.

In addition to the increases in knowledge, practical skills for waste minimisation have been developed. This is evident especially through the comments made by project champions and through the progression of capacity building sessions with shopfloor workers in the Hammarsdale Club.

In addition, the capacity building which has occurred through the Clubs did act to increase the existent sense of responsibility for the environment and generated a greater sense of importance of environmental considerations. This is evident from the comments made by club members where prior to joining the waste minimisation club, environmental considerations were only taken into account in order to comply with regulations. After attending the first meeting, one Hammarsdale Club member returned to their factory and was appalled by the number of leaks in his factory, (which were immediately attended to). This highlights that the club meetings increased the personal responsibility to protecting the environment and saving natural resources.

3. Categorisation of Capacity Building

During the course of the project, students, project champions and club member employees were educated in waste minimisation aspects. Table 1 categorises the known number of people that received training.

Table 1: Categorisation of people receiving training during the project.

	White	Indian	Black	Male	Female
Hammarsdale club (project champions)	7	2		8	1
Metal Finishing Club (project champions)	19	10	1	29	1
Masters Students	1	2		1	2
Vacation Students	1	21		14	8
Technikon Students		2	2	4	
Shop-floor employees					
Management					
TOTAL	**28**	**37**	**3**	**56**	**12**

From Table 1, it is evident that of the known number people trained in the course of the project, 41% were white, 54% Indian and 5% black. Of these, 82% were male and 18% female.

The number of people trained by Kagiso-Cowi in the shop floor and management training sessions is unknown at this point, although it is believed that the entire shop-floor staff of 4 of the companies in Hammarsdale received training. Based on the number of employees at each of these sites, this implies that at least 800 people were capacitated and of these, the majority would be from the black population group.

4. Realisation of Project Proposal Aims

The project proposal sates the following with respect to capacity building:

This project has the potential to involve many of the partners of the kwaZulu Natal Water Research Network. It will enable students (diploma, undergraduate and postgraduate) of tertiary educational institutions in the region to obtain industrial work experience. Interested staff members from these institutions will also be able to increase their exposure to industries.

A range of secondary spin-off projects can be undertaken as a consequence of this project.

It is felt that these aims have been achieved during the course of the project. As discussed above, a number of students were exposed to industry during the project, both on an undergraduate and post-graduate level. Students from ML Sultan Technikon were also involved in the project, with their supervisors gaining further insight into industrial processes. Further projects have been initiated from this project, such as WRC Project 1171 and on-site investigations at metal finishing companies by Technikon students.

The KwaZulu Natal Water Research Network is no longer in existence.

5. Conclusions

In summary, it is evident that the waste minimisation clubs were instrumental in building capacity within the member companies, although to varying degrees depending on the level of involvement and the level of previous waste minimisation knowledge and activities. It is also pointed out in Goff (2001), that the capacity building process was greatly dependent on the involvement of the PRG, Enviros March and Kaigso-Cowi, and focused specifically on implementing waste minimisation, with little focus on providing the companies with the capacity to continue with club activities once the funding was depleted. This is an issue that should possibly be included in discussions with club members on the establishment of a new club. However, as discussed in the summary of Chapter 5, it is felt that a waste minimisation club has a limited lifetime and its aim is to encourage the incorporation of waste minimisation ethics into company management such that companies are able to continue with waste minimisation on an individual basis.

ANNEXURE 2
Technology Transfer

During the course of the project there has been interaction with other WRC projects; close co-operation with other institutions; 17 presentations, 4 workshops, 3 papers published in journals, I MA thesis and 2 MscEng theses in preparation; 4 newsletters; and the transfer of training material to the PRG from Enviros March. These initiatives are listed below.

1. Interaction with Other WRC Projects

During the course of this project there has been interaction with the following WRC projects:

- WRC Project No. 760: Waste Minimisation and Effluent Treatment Guide for the Textile Industry
- WRC Project No. 1171: The Establishment of a Methodology for Initiating and Managing Waste Minimisation Clubs

2. Co-operation with Other Institutions

There has also been close co-operation with other institutions, namely:

- Danced Cleaner Production Demonstration Projects in the Metal Finishing and Textile sectors
- Cape Metropolitan Council and the Development of the Internet Waste Exchange Programme
- BECO and the Cape Metropolitan Council on the establishment of waste minimisation clubs in the Cape region
- The KZN Waste Minimisation Interest Group (Institute of Waste Management)

3. Presentations

The following presentations have been made at local and international conferences, companies and forums:

Steenveld G, Barclay SJ and Buckley CA, *Waste Minimisation Clubs: Introducing the Concept to South African Industries*, WISA 98 Biennial Conference and Exhibition, Cape Town, 4-7 May 1998. (Paper)

Barclay SJ, Buckley CA, Thambiran N, Maharaj D, Goff J and Scott D, *Waste Minimisation Club for Metal Finishers - A First for South African Industry*, 2nd Asia-Pacific Cleaner Production Roundtable and Trade Expo, Global Competitiveness Through Cleaner Production, Brisbane Convention & Exhibition Centre, Brisbane, Australia, 21-24 April 1999. (Paper and Poster).

Barclay SJ and Buckley CA, *The Development of Waste Minimisation Clubs in South Africa*, Millenium Projects Workshop, Stellenbosch, South Africa, 18-22 July 1999.

Barclay SJ and Buckley CA, *Waste Minimisation Club for the South African Textile Industry: A Feasibility Assessment*, 18th International Federation of Association of Textile Chemist and Colourist Congress on Textile Dyeing and Finishing in the 21st Century, Scandic Copenhagen Hotel in Copenhagen, Denmark, 8-10 September 1999. (Paper)

Barclay SJ, *Waste Minimisation Club for the Metal Finishing Industry - A Case Study*; Presented by Ike Ndlovu of the Department of Environment Affairs and Tourism at the 4th International Workshop held by the Institute of Environmental Technology, Basel, Switzerland, 1999 (paper)

Maharaj D, Barclay SJ, Buckley CA and Mercer DG, *Practical Waste and Effluent Reduction: Case Studies from the Manufacturing Sector*, The Water Institute of Southern Africa (WISA 2000) Biennial Conference and Exhibition, Sun City, South Africa, 28 May - 1 June 2000. (Poster)

Barclay SJ, *Waste Minimisation Clubs*, Water Research Commission Board Meeting, University of Natal, Durban, May 2000.

Thambiran N, Barclay SJ and Buckley CA, *Pollution prevention really does pay: case studies from the metal finishing waste minimisation club,* The Water Institute of Southern Africa (WISA 2000) Biennial Conference and Exhibition, Sun City, South Africa, 28 May-1 June 2000. (Poster)

Barclay SJ, *Waste Minimisation Clubs*, Prepared for the Hammarsdale Industrial Conservancy Stand at the Shongweni Outdoor Expo., 28-30 July, Shongweni Polo Grounds, South Africa (poster).

Buckley CA and Barclay SJ*, Waste Minimisation Clubs : A Route to Sustainable Industrial Development?,* UNEP First African Cleaner Production Roundtable, Nairobi, August 2000. (Paper)

Barclay SJ, Buckley CA and Mercer DG*, Waste Minimisation Clubs – Managing them for Success*, Wastecon 2000, Cape Town, 5-7 September 2000 (paper)

Thambiran N, Barclay SJ and Buckley CA*, Waste Minimisation Success at a Metal Finishing Company*, Wastecon 2000, Cape Town, 5-7 September 2000 (paper)

Maharaj D, Barclay SJ, Buckley CA and Mercer DG, *A Practical Cost Savings through the Implementation of a Waste Minimisation Programme at a Textile Plant*, Wastecon 2000, Cape Town, 5-7 September 2000 (paper).

Freeman, SA, and Barclay SJ, An Overview of a Waste Minimisation Interest Group - A Training Ground for Business and Industry in KwaZulu Natal, Wastecon 2000, Cape Town, 5-7 September 2000 (paper)

Barclay SJ, Buckley CA, Thambiran N, Maharaj D and Mercer DG, *Waste Minimisation Clubs – A Route to Sustainable Development?* The Southern African Institution of Chemical Engineers, 9th National Meeting, Secunda, 9-12 October 2000 (Paper)

Maharaj D, Barclay SJ, Buckley CA and Mercer DG, *Practical Waste and Effluent Reduction: Case Studies in the Manufacturing Sector*, The Southern African Institution of Chemical Engineers, 9th National Meeting, Secunda, 9-12 October 2000 (Poster)

Thambiran N, Barclay SJ and Buckley CA*, Waste Minimisation Success at a Metal Finishing Company*, The Southern African Institution of Chemical Engineers, 9th National Meeting, Secunda, 9-12 October 2000 (Poster)

4. Workshops

Report Back on the Water Research Commission and European Union Project to Promote the Development of Waste Minimisation Clubs in South Africa, WRC Committee Room, Pretoria, South Africa, 21 October 1999.

Waste Minimisation Clubs: A Structured Approach to Waste Minimisation, Sasolburg, 6th March 2000.

Waste Minimisation Clubs : A Solution to Sustainable Industrial Development?, One Day Pre-Conference Workshop Held at WISA 2000 Biennial Conference, Sun City, South Africa, 28 May 2000.

5. Papers

Barclay SJ, Thambiran N, Maharaj, D, Buckley CA and Mercer D; Waste Minimisation Clubs (Part 1): A Feasible Solution to Sustainable Industrial Development? TAPPSA Journal, March 2000.

Barclay SJ, Thambiran N, Maharaj, D, Buckley CA and Mercer D; Waste Minimisation Clubs (Part 2): A Feasible Solution to Sustainable Industrial Development? TAPPSA Journal, May 2000.

Barclay SJ and Buckley CA, Waste Minimisation Clubs – Pilot Studies in KZN, SA Waterbulletin, Volume 26, No. 3, May / June 2000.

6. Newsletters

Hammarsdale Waste Minimisation Club, March 1999.
Common Goal, February 2000
Common Goal, July 2000
Common Goal, November 2000
Common Goal, June 2001

7. Masters Theses

The following MA has been awarded to one of the post-graduate students working on the project:

Jennifer Goff, The Role of Voluntary Participatory Organisations in Sustainable Development: A Case Study of the Hammarsdale Waste Minimisation Club, School of Life and Environmental Sciences, University of Natal, Durban (December 2000).

The following MScEng Theses are currently under preparation (not necessarily under these titles):

Namo Thambiran, An Analysis of the Metal Finishing Waste Minimisation Club, School of Chemical Engineering, University of Natal, Durban.

Dhiraj Maharaj, An Analysis of the Hammarsdale Waste Minimisation Club, School of Chemical Engineering, University of Natal, Durban.

8. Training

Waste Minimisation training was provided to the following companies over and above that provided during the course of the Club meetings. These training modules are now in the possession of the PRG for use for future waste minimisation clubs.

Waste Minimisation Modules 1, 2 and 3 presented at Gelvenor Textiles, Buckman Laboratories and Rainbow Farms.

Waste Minimisation Modules 1 to 4 given to Sasol, at Secunda, 16-17th October 2000.

9. Other Initiatives

An evening of informal technology transfer took place on 23rd May 2000 at the Westville Hotel in Durban. This function was sponsored by the Water Research Commission and brought together the club members from both the Metal Finishing and Hammarsdale Waste Minimisation Clubs, the Project Team (Pollution Research Group and Enviros March), members of the Steering Committee and government organisations. Presentations were given by Greg Steenveld of the Water Research Commission and Chris Buckley of the Pollution Research Group. Nicky Naiker from Buckman Laboratories spoke on behalf of the Hammarsdale Club, and John Danks of Saayman Danks Electroplating spoke on behalf of the Metal Finishing Club. The evening was a great success, with over 55 delegates attending. It allowed for the exchange of experiences between the club members and for other interested parties to talk to those involved in the project on a one-to-one basis.

Danced Cleaner Production Demonstration Projects in both the Metal Finishing and Textile Sector are building on the waste minimisation clubs established during the course of this project. Presentations have been made at these meetings.

Presentations on the success of the waste minimisation club concept have also been made at a number of meetings in Gauteng, Pietermaritzburg and Cape Town where interest has been expressed in establishing waste minimisation clubs.

Within the project proposal, reference is made to making contact with other organisations such as the SADC countries, and the Australian Co-operative Research Centre for Waste Water Management (University of New South Wales. Contact with the SADC countries was made during the course of the African Round Table on Cleaner Production in 1998. The PRG was also been approached by the University of Zimbabwe in connection with establishing a waste minimisation club. A workshop was held in May 1999 with the Australian CRC where discussions were held on the waste minimisation club concept.

ANNEXURE 3
The Role of Participatory Organisations in Sustainable development: A Case Study of the Hammarsdale Waste Minimisation Club

ABSTRACT

by:

Jennifer Goff

May 2001

In the postmodern era, the industrial sector faces a number of pressures. These pressures include keeping within the new and stricter laws, avoiding the stricter penalties in terms of finances and legal penalties, avoiding bad publicity that occurs through bad environmental action and responding to pressure groups and public concern, including industry's own work force (Stapleton, 1996). Industry can respond to these pressures to become involved in efforts to 'green' their activities, for example, introducing waste minimization practices into production.

To this end, the Pollution Research Group of the University of KwaZulu-Natal, Durban was instrumental in developing the Hammarsdale Waste Minimisation Club early in 1999. Since its inauguration, this Club has been active in two primary spheres, namely, the implementation of waste minimization into the industrial processes of member companies and the building of capacity of a range of employees of member companies.

This thesis provides a case study of the Hammarsdale Waste Minimisation Club in an attempt to assess the role of voluntary participatory organizations in sustainable development.

This study of the role of voluntary participatory organizations in sustainable development has taken place within the context of waste minimization, waste minimization clubs, and the specific characteristics of the Hammarsdale Industrial Complex and the regulatory context of South Africa. A combination of geographical and social theory has been used to study the characteristics of the Hammarsdale Waste Minimisation Club. Four bodies of literature have been drawn together to form a conceptual framework through which the case study can be analysed and understood. These bodies of literature cover the characteristics of postmodernism, the paradigm of sustainable development, social theory regarding civil society and social movements (including the environmental movement) and the impact of locality on activities.

Primary data for this study has been gathered through the use of participant observation and semi-structured interviewing techniques. The theoretical framework has played an important in a process of qualitative data analysis and interpretation that aimed to establish answers to the research questions generated in this study.

Analysis of the Hammarsdale Waste Minimisation Club as a voluntary participatory organization has revealed that these organizations do play a role in the achievement of sustainable development in two ways. Firstly, through the way in which they are organized and secondly, through the activities in which members of the organization engages.

In the case of the Hammarsdale Waste Minimisation Club, the Club has been organized in such a way as to promote the implementation of waste minimization and to provide capacity building as extensively as possible. One important characteristic of the Hammarsdale Waste Minimisation Club is the strong sense of mutual support and community that has developed. These relationships enable the organization to contribute to sustainable development as they facilitate the participation and procedural equity necessary for the achievement of sustainable

development. Despite this, the organizational structure of the Club can be seen to have some weaknesses. For example, the failure to develop a constitutional and the high level of dependency on the groups of professionals in the Club which has lead to the need for motivation and leadership. It is possible that these weaknesses may lead to the decline of activities in the organization or demise of the Hammersdale Waste Minimisation Club in the long-term thus inhibiting the role of Club is sustainable development.

By comparison, the waste minimization implementation and capacity building activities of Hammarsdale Waste Minimisation Club enable the Club to make a direct contribution to sustainable development. The implementation of waste minimization enables industry to become more efficient thus reducing its impact on the environment. Furthermore, capacity building has created a greater awareness of environmental matters while equipping employees of member companies with the skills to carry out waste minimization for the benefit of the environment. Thus these activities can contribute to sustainable development through the increased care of local ecosystems and a reduction of the impact of industry on this natural environment.

Through these findings, this study proposes that if voluntary participatory organizations can be organized to provide a long-term motivational and facilitative framework through which activities that contribute to sustainable development can take place, then these organizations have an important role to play in bringing about on-the-ground changes which can lead ultimately to the achievement of sustainable development. Contrary to this, if care is not taken to create a voluntary participatory organization that will be sustainable itself, the potential role of the organization in sustainable development is reduced.

Notably, these findings are reliant on the investigation of one case study. It is suggested that further examinations of a wide range of voluntary participatory organizations would enhance these findings by creating a more general picture.

1.1 INTRODUCTION

Currently, industry faces the challenge of needing to reduce pollution and waste outputs and their raw material inputs, thus minimising their impact on the environment. This challenge is magnified due to the pressure of reducing the environmental impact without minimising competitiveness and profitability (Gunningham et al, 1997). This forces or encourages industries and businesses to become involved in efforts to 'green' their activities.

Sustainable development is currently a prominent development theory. According to Stapleton (1996,118), "sustainable development provides a means of integrating environmental and economic goals to produce outcomes that are both environmentally acceptable and cost effective in an economic sense. Business and industry, being the chief sources of wealth creation in any community, have a major role to play in achieving these integrated goals". In accordance with the idea of 'thinking locally and acting globally' it will be beneficial for the environment and potentially, for the 'bottom line' if industry begins to 'think globally and act entrepeneurially'.

One means through which industry can begin to contribute to sustainable development is through the formation of voluntary participatory organisations such as waste minimisation clubs. The Pollution Research Group of the University of Natal, Durban has been instrumental in developing two waste minimisation clubs in Durban. These Clubs have been involved in the implementation of waste minimisation in industrial processes and in the building of capacity of employees of member companies.

The extent of the role that waste minimisation clubs can play in contributing to a sustainable future has yet to be fully determined. To this end, this chapter outlines the rationale for the study, explaining the motivation and the need for this research. In addition, the aims and objectives particular to this research are outlined in section 1.3. The structure of the thesis and a brief outline of the contents of each chapter are detailed in section 1.4.

1.2 RATIONALE FOR THE STUDY

Successful implementation of sustainable development is reliant on a fundamental acceptance of the importance of the environment and an acceptance of the necessity of considering the long term impacts of current activities. It is essential that industrialists begin to see that the environment is vitally important to the sustainability (and profitability) of their businesses. Environmental awareness needs to be greatly increased so that individuals can begin to view themselves as responsible for the quality of the environment. Environmentally friendly practices in industry need to stem from this paradigm change because if practice changes occur on the 'shaky' base of profit-motivation then it is questionable whether these changes will have any longevity.

Participation is a cornerstone of sustainable development, but often participation involves community participation in conflict or development situations. It is necessary to discover whether participatory mechanisms can play a significant role when participation occurs proactively between industries rather than between developers and community or industry and community in reaction to an existing problem or proposed development.

In order to explore these broad topics in a study of limited size, it has been necessary to direct research through the development of a specific aim and objectives of investigation. These are discussed in the following section.

1.3 AIMS AND OBJECTIVES

The aim of this study is to assess the role of voluntary participatory organisations in sustainable development. A case study of the Hammarsdale Waste Minimisation Club, as a voluntary participatory organisation, will be used to make this assessment.

A number of objectives were formulated in order to fulfil the aim of the study. These objectives determined more specific areas of investigation that could be integrated to meet the overarching aim of the research. The objectives of the study are as follows:

1. To analyse the function and the structure of the club as a conduit for waste minimisation.
2. To assess the extent to which the club is a voluntary, participatory organisation.
3. To find out the extent of capacity building facilitated by the club.
4. To measure the changes taking place in policy and practice as environmental awareness is being raised in member companies.
5. To analyse the barriers and motivators towards successful waste minimisation through the club.
6. To assess the role of the club in facilitating sustainable practice and to investigate how this is taking place.

This research has taken place in an attempt to meet the above-mentioned aims and objectives. The following section outlines the structure of the thesis as a rigorous record of this research.

1.4 STRUCTURE OF THE THESIS

This section outlines the structure of the thesis chapters as they describes the background to the study, the theoretical framework of the study, the techniques used to carry out the research and the results and discussion emerging from the analysis of the data collected in the study.

As is evident above, this first chapter introduces the study, including the aims and objectives that have formed the nexus of the research.

Chapter Two discusses the background to the study. This chapter presents the concept of waste minimisation as a mechanism for increased industrial efficiency and as a means of reducing the impact of industry on the natural environment. Waste Minimisation Clubs have been formed to facilitate waste minimisation. The experiences of these organisations internationally and the formation of Clubs in South Africa has been reviewed in Chapter Two. The Hammarsdale Industrial Area is discussed, including details of the industrial conservancy that exists in this area. Furthermore, an overview of the current regulatory context that impacts on the activities of industry is provided.

The literature reviewed for the study is presented in Chapter Three. This chapter reviews a number of bodies of literature to create a theoretical framework through which the case study of the Hammarsdale Waste Minimisation Club can be analysed. An explanation of the nature of society in the postmodern era, including the social, economic and political features of this era forms the first body of literature reviewed. Secondly, the paradigm of sustainable development has been considered, with a focus on those elements that are relevant to this study. Thirdly, social theories regarding civil society and the rise of social movements that aim to create societal change are discussed. Due to the nature of this particular study, a particular focus is directed at environmental movements. In addition, one of the tools of the environmental movement is that of environmental education. Some attention is given to theories of environmental education and the potential impact of these kinds of education. Fourthly, because the spatial context within which these processes occur has an impact on the outcomes of activities, an exploration of literature regarding space and place have been reviewed to complete the theoretical framework.

Chapter Four describes the methods of research used to carry out the study. The primary techniques of data collection for the study have been participant observation and semi-structured interviews. These data collection techniques are described. In addition details of the formulation of the sample used as the main source of data has been discussed. Qualitative methods of analysis have been used to analyse the data gathered in this study. The iterative process of data analysis is explained.

Chapter Five provides the findings of the study through a discussion of the themes emerging from the analysis of the primary data. This chapter explains the ways in which the Hammarsdale Waste Minimisation Club has been organised and describes the activities that have been carried out through the Club. The role-players in the Club, the hierarchical nature of the Club's structure and the relationships that have been formed within the Club and in a broader context have been detailed. The extent of the implementation of waste minimisation in member companies and the capacity building programme are addressed. These characteristics of the HWMC are discussed in the light of the theoretical framework developed for the study in an attempt to discover the extent of the contribution of this Club to sustainable development.

Finally, Chapter Six forms the conclusion of the study. This chapter provides a summary of the main points of the research. In addition, a number of recommendations have been formulated through the course of the research process. This chapter lists these recommendations in an attempt to provide some guidelines that will enable voluntary participatory organisations to play a greater role in future sustainable development.

1.5 CONCLUSION

This study aims to investigate the role of voluntary participatory organisations in sustainable development through the use of a case study of the Hammarsdale Waste Minimisation Club. The meeting of the aims and objectives of the study has been carried out through a review of background material, the formulation of a theoretical framework, the collection of primary data and the qualitative analysis of this data.

The following chapter provides the background to the study in order to broaden understanding of the case study used in the research.

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3 March 1999	Hammarsdale Industrial Conservancy meeting
9 March 1999	'Play Dough Factory – Learning about Waste minimisation' capacity building session
12 March 1999	Hammarsdale Waste Minimisation Club Meeting and training by Professionals
19 May 1999	Hammarsdale Waste Minimisation Club Meeting and training by Professionals
10 August 1999	Waste Minimisation Club for the Metal Finishing Industry Meeting
5 October 1999	*Buckman Laboratories* Shopfloor training
6 October 1999	*Coates SA* Shopfloor training
7 October 1999	*Coates SA* Management training
17 October 1999	*Coates SA* shopfloor training
19 October 1999	Waste Minimisation Club for the Metal Finishing Industry Meeting
20 October 1999	Hammarsdale Waste Minimisation Club Meeting and training by Professionals
21 February 2000	Waste Minimisation Club for the Metal Finishing Industry Meeting
1 March 2000	Hammarsdale Waste Minimisation Club Meeting and training by Professionals
11 May 2000	*DeNim* shopfloor training session
12 May 2000	*Coates SA* training session
24 May 2000	Hammarsdale Waste Minimisation Club Meeting
29 May 2000	Inaugural meeting of the Metal Finishing Association

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APPENDIX A

INTERVIEW SCHEDULES FOR QUALITATIVE, INFORMAL INTERVIEWS

Questions for Club Members

1. How many employees are there in your company?
2. When was your company established?
3. What is the address of the company?
4. When did your company join the waste minimisation club?
5. What position do you, as the champion, hold in the company?
6. How do you see your position (or that of your company) within the club?
7. What are your views on clubs as mechanisms for bringing about improved waste minimisation practices in industry?
8. Would the club have been formed without the stimulus and input from the outside?
9. How will the club work once the input from the outside is withdrawn?
10. Can you briefly explain how you see the club functioning?
11. What did you know about waste minimisation before joining the club?
12. In what ways has your knowledge about waste minimisation changed or grown since becoming a member of the club?
13. In what ways has your knowledge about the environment changed or grown since becoming a member of the club?
14. In what ways has your knowledge about capacity building changed or grown since becoming a member of the club?
15. Why has your knowledge changed or grown? Please give some examples.
16. What, if anything, has changed in your company practice due to membership of the club?
17. What, if anything, has changed in your company policy due to membership of the club?
18. In your opinion, how well is the club functioning?
19. What motivators might enable the club to function in the future?
20. What constraints might prevent the club from functioning in the future?
21. What changes would you make to improve the structure and functioning of the club?
22. What relationships have developed between your company and other club members?
23. What is the basis of this relationship?
24. In your opinion, what relationships have been formed between industry and the authorities?
25. In what way do you see what you're doing as public participation? Do you think you could influence the decision making process of the DMA?
26. The club is currently a voluntary initiative, is there any way that it could be institutionalised? Is this a positive thing?
27. Do you see the Hammarsdale Waste Minimisation Club fitting into a broader movement of sustainable development and environmentalism? In what ways?
28. In what way has the link between the club and the HIC fostered increased environmental concern?
29. Do you think this link is the direction the clubs should be working towards?
30. Do you think it is better for the club if industries to be based in the same place rather than being sector based?
31. Are there any other issues you would like to discuss or comment on?

Questions for Professionals

1. How was the project/your involvement in the club instigated?
2. Why was the club set up?
3. How was the Hammarsdale Waste Minimisation Club established?
4. Why was it established in this way? Please give details.
5. What was your role in setting up the club? Please give details.
6. What difficulties were encountered in establishing the club?
7. Who provides funding for this project?
8. What are the demands of the funders? Do they involve themselves in how funding is used?

9. How do you see your position within the club?
10. Do you consider yourself a member?
11. Is there a hierarchy amongst club members? Please explain your answer.
12. Why is this grouping of industries called a ‘club’?
13. Can you briefly explain how the club functions?
14. Do you consider consensus building, conflict resolution and information a role of the club?
15. In what ways has your knowledge about waste minimisation changed or grown since becoming involved with the club?
16. In what ways has your knowledge about the environment changed or grown since becoming involved with the club?
17. In what ways has your knowledge about capacity building changed or grown since becoming involved with the club?
18. Why has your knowledge changed or grown?
19. What have you learnt about waste minimisation from the members of the club?
20. In what ways have you learnt about the setting up and management of clubs?
21. To what degree is capacity building taking place within the club?
22. In your opinion, how is the club functioning?
23. What motivators might enable the club to function in the future?
24. What constraints might prevent the club from functioning in the future?
25. How will the club function without outside facilitation?
26. Do you see the Hammarsdale Waste Minimisation Club fitting into a broader movement of sustainable development and environmentalism? In what ways?
27. Do you think that the clubs contribute to sustainable development at this stage? In what ways?
28. How the club will continue into the future with regard to contributing to sustainable development?
29. What relationships have been formed with institutions?
30. In your opinion, what relationships have been formed between industry and the authorities?
31. Is the local authority fully participating in the club? Why/why not?
32. In what way do you see what you’re doing as public participation? Do you think you could influence the decision making process of the DMA?
33. Can the club improve waste minimisation control in the DMA?
34. In what way has the link between the club and the HIC fostered increased environmental concern?
35. Do you think this link is the direction the clubs should be working towards?
36. How do you see the role of the scientific experts in the club?
37. How do you see the role of the social scientists in the club?
38. How do you see the role of the educators in the club?
39. How will the waste minimisation club project benefit you as a professional?
40. With hindsight, is there anything you would have done differently in this project?
41. Are there any other issues you would like to discuss or comment on?

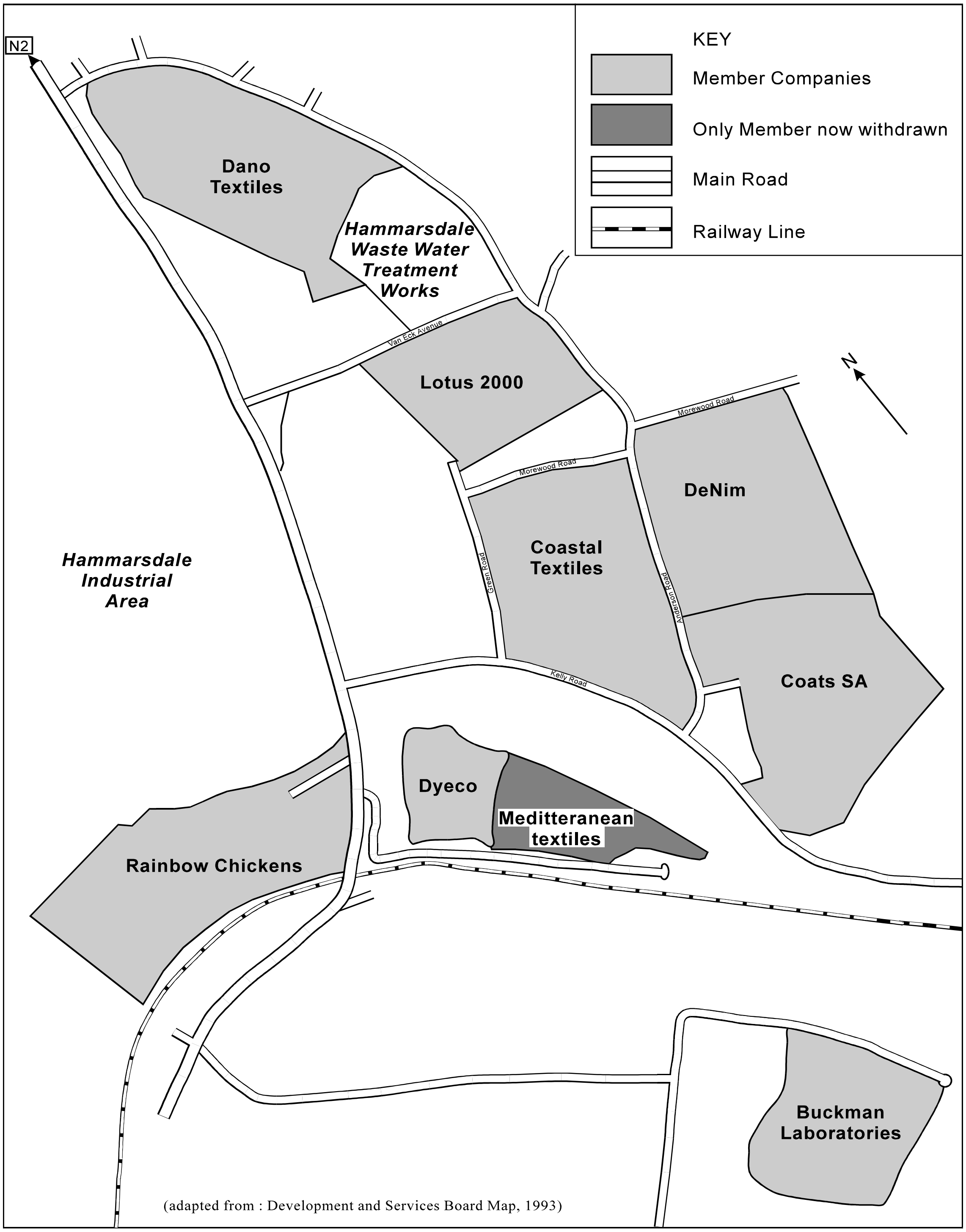
QUESTIONS FOR EDUCATORS

1. How was your involvement in the club instigated?
2. How do you see your position within the club?
3. Explain briefly how formal environmental education has occurred in the club.
4. Do you think that environmental education has occurred informally, in other ways in the club?
5. In what ways has <u>your</u> knowledge about waste minimisation changed or grown since working with the club?
6. In what ways has <u>your</u> knowledge about the environment changed or grown since working with the club?
7. In what ways has <u>your</u> knowledge about capacity building changed or grown since working with the club?
8. Why has your knowledge changed or grown?
9. How do you see the club members interpreting the term “environment”?
10. How do club members react to environmental matters in general?
11. What contribution to the success of the club has the environmental education made?

12. Has there been enough environmental education for the club to become an instrument of sustainable development?
13. Do you think that environmental education will contribute to the sustainability of the club itself?
14. In what ways do you think that environmental education through the club is important in our current context?
15. Do you think the emergence of clubs here and elsewhere links to broader environmental movements in the present context of global environmental concern?
16. Do you see the Hammarsdale Waste Minimisation Club fitting into a broader movement of sustainable development and environmentalism? In what ways?
17. In your opinion, how is the club functioning?
18. What motivators might enable the club to function in the future?
19. What constraints might prevent the club from functioning in the future?
20. With hindsight, is there anything you would have done differently in this project?
21. Are there any other issues you would like to discuss or comment on?

APPENDIX B

AREA PLAN MAP OF THE DEVELOPMENT AREA OF THE HAMMARSDALE AREA

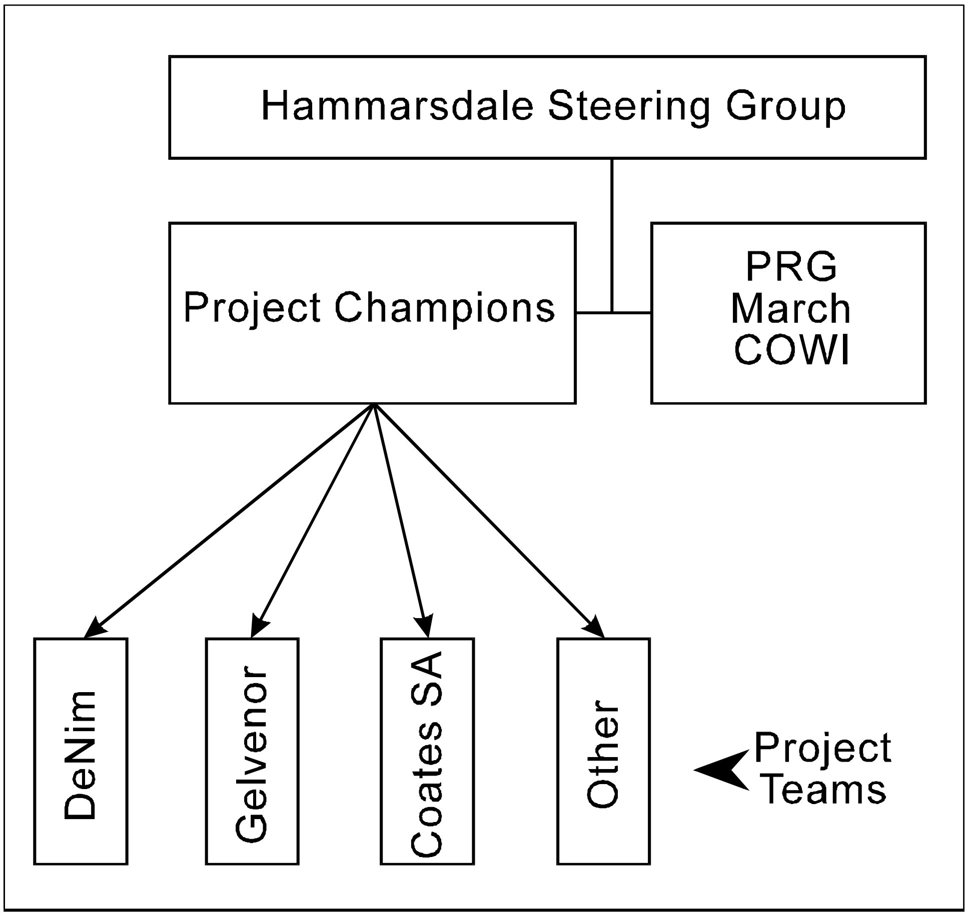


(adapted from : Development and Services Board Map, 1993)

The location of member companies in the Hammarsdale Industrial Area.

APPENDIX C

PREPLANNED STRUCTURAL ORGANISATION OF THE HAMMARSDALE WASTE MINIMISATION CLUB



APPENDIX D

TRAINING MANUAL FOR SHOPFLOOR AND MANAGEMENT CAPACITY BUILDING

Kagiso-COWI
8th Floor
Braamfontein
Centre
23 Jorissen Street
Braamfontein
2001
Johannesburg
Tel (011) 403 -6319

Kagiso-Cowi

Hammarsdale Waste Minimisation Club

Waste Minimisation Trainer's Manual

Environmental Awareness

1. Overview of our environment

What is the environment? It is everything - the air that we breathe, the water we drink, the soil on which we grow our food, where we live, work and play. In the past, South Africans were encouraged to think of the environment as the game parks, saving the rhino, and preserving the beautiful green areas of our land - the fact that Black South Africans paid the price for environmental degradation was conveniently ignored.

Most landfill sites, including those handling hazardous and toxic waste, are situated near our homes in townships. Polluting - industries are also, as a rule, situated near former Black group areas. Workers had minimal information and protection against environmental hazards, and many cases exist where workers have died from problems caused in the workplace.

The hole in the ozone layer, which amongst other things, increases the risk of skin cancer; global-warming, which could lead to radical changes in the weather and nuclear waste, terrible in it's ability to create mutant babies, are some of the issues facing the planet today.

These are not creations of countries far away - it is our actions, both at home and in the workplace, that caused these scenarios - and, in the end, it is us that will pay the full and horrible price, In suffering, illness and even death.

How are we responsible for all this? Simple - by the way we live and work. If we drive unnecessarily, we waste energy, release toxic pollutants, and contribute to global warming... when we use electricity unnecessarily, we contribute to air pollution in Mpumalanga, and also to global warming..... using too much of the resources of the planet is the common factors in all environmental degradation.

2. Health & Safety

The health impacts of products and processes on workers Environmental threats in the workplace

What impacts can participants identify that exist in their workplace?

3. Legal & policy

Implications for companies and directors

The new National Environmental Management Act changes the ground rules for the environment in our country in many ways. For example, should a company pollute, not only will it be held liable, but the director/s themselves could be held personally liable. they will also have to pay to clean up the pollution, and pay for all damage caused, including that done to human health. An example is Thor Chemicals, which imported mercury waste for local processing - this happened because our environmental legislation was less strict, if not non-existent, compared to the countries where that waste originated. This resulted in widespread toxic contamination, and also to the death of workers, with other health impacts.

There will also be a new waste register, under the national waste management strategy, which includes all discharges and waste from any production facility, whether to air, water or landfill. There are many more issues that will affect companies directly.

Implications for workers

There are also many implications for workers too. These include the responsibility to avoid causing pollution as a first step. The Act also empowers workers to decide not to carry out a specific order, on the grounds that it could lead to pollution - the company may not act against such a worker.

It is important to note that workers should be joining NGO's and CBO's that are concerned with environment, so that they may inform themselves, and be part of the solution. Many organisations are involved in hands-on work, and know many things about the environment that we may not all be aware of

4. Financial

Impacts to company profits and viability

Waste is simply a product for which no use is found - it all costs the company, because what leaves the factory as waste was bought in at a price; so waste has more of an impact on the bottom line than just the cost of handling such waste. One company, through implementing sound waste management principles, improved its profits by over R800 000 per annum! And there are many more such examples,

Also, causing and handling less waste makes the company more efficient, and it will find it easier to comply with upcoming legislation.

Impacts on job security and job creation

Why should workers be concerned about waste and pollution? In the first instance, they are the frontline when pollution is caused, and their health could be seriously affected by such incidents. Secondly, if the company continues to generate more and more waste, the local communities, which is generally where workers live, will also be negatively affected by the pollution.

If the company, on the other hand, minimises waste, then the health risks are also lessened, the company wastes less money in raw materials, and other costs, making it more viable, and thereby helping ensure it's profitability, which in turn, ensures 'job security. We know of a company in Durban which is profitable only through the waste minimisation programme - without it, they would have to close their doors, with the loss of many jobs.

Other companies did close their doors because the cost of handling waste. hazardous waste in particular, had risen dramatically. With the "polluter -pays" principle-, the cost of waste handling, will continue to rise.

One company thought there waste cost them R49 000 per year (the cost of disposing waste) - after an analysis, and a few minor changes, they were able to save over R800 000 per year!

5. Labour issues

Rights and obligations

As discussed previously, the worker has the right not to carry out a task that could lead to pollution, or that which will constitute a risk - but workers are also obliged to avoid waste and pollution as well, so it makes sense to do the training that we have begun today.

Consequences of environmental issues on labour issues in general

For general knowledge, the issues surrounding waste and labour are far beyond that which was mentioned above - it also has global implications. This would include the right to a clean environment, as stated in our constitution, but also issues such as 'job security, economic sustainability, and 'job creation are at stake. For example, if we were able to design all the processes in this company so hat all waste could be a raw material for some other product, then we would not only ensure that the company remains viable, but would lead to direct job creation, where such raw materials could be downstream businesses, often suitable for small and medium enterprises.

Waste Minimisation

Waste minimisation is more than reducing the amount of waste that is carried away by waste contractors - it means a look at how we are working, the production process, all the inputs and outputs of the process, and re-examining production management. The inputs we need to look at are:

- Raw materials
- Packaging
- Energy
- Water
- Consumables
- Product design and manufacture
- Emissions to air
- Waste water
- Solid and liquid waste

The advantages are many:

- Environmental improvement
- Cost savings
- Complying with legislation
- Reduction of risk
- Competitive advantage

To achieve waste minimisation, we need to look at people ' systems and technology. This training is a beginning. It is also important to carry out a waste audit, to see what you are actually dealing with. This will lead to:

- Understanding what the magnitude of the problem is
- Being able to identify options, beginning with low-cost and no cost.
- Implementation
- Plans for improvement
- Develop control systems
    - Continue data collection
    - Check improvements on an on-going basis
    - Analyse new data
    - Continuous improvement

Waste Minimisation Ideas

Importance of logging such ideas

Process - develop clear methodology of generating, logging, and implementing ideas. Suggest ideas are logged on a designed form, with copies to relevant personnel

Following up such ideas
Clear lines of communication and responsibility. Shop floor to management decision makers identified, and made accountable

Implementing such ideas
Laid out procedure for trial and implementation, before and after measurements are taken. Cost accounting applied to be one of the methods of evaluation and chasing progress.

Feedback on ideas
Regular feedback process and evaluation - discussion with all role-players
Re-evaluation of original idea
Monitor level of success and value to company

Communication

The importance of communication
Methodologies for improving communications
Methodologies for developing communication channels
General

APPENDIX E

LIST OF PROCESS CHANGES IN MEMBER COMPANIES

Member Company	**Practice Change** *(implemented or identified)*	**Effects of Change and Estimated Savings** *(where reported)*	**Report Details**
Company 1	Standardisation of fabric width	Saving: R1.92 / m	20/10/1999 HWMC meeting
	Use plastic cones for thread rather than cardboard	Saving: R140 000 / yr	1/3/2000 HWMC meeting
	Warping and sizing alterations	Increased efficiency in raw material use	1/3/2000 HWMC meeting
	Savings in consumables identified	Saving: R208 000 / yr	Common Goal 2/2000
	Potential chemical savings through reformulation	Possible saving: R113 000 / yr	Common Goal 2/2000
	Heat recovery: use of excess heat to heat water in the dye house	Increased energy efficiency	20/10/1999 HWMC meeting
Company 2	Increased monitoring of water usage	Monitoring to ensure efficiency	20/10/1999 HWMC meeting
	Montage* installed in the boiler house	Monitoring and targeting for waste minimisation	20/10/1999 HWMC meeting
	Electricity savings	Saving: R13 000 / month	Common Goal 2/2000
	Change in capacitors and power factor correction	Increased energy efficiency	1/3/2000 HWMC meeting
	Heat recovery project for waste heat in the dye house. Installation: July 2000	Increased energy efficiency	1/3/2000 HWMC meeting
	Installation of water meters	Monitoring to ensure efficiency	1/3/2000 HWMC meeting
	Installation of water meters	Monitoring to ensure efficiency	20/10/1999 HWMC meeting
Company 3	Replacement of 3 coal-fired boilers with electro-boilers	Energy savings No coal use, lower air pollution	20/10/1999 HWMC meeting
	Recycling of water through processes	Reduced water use	20/10/1999 HWMC meeting
	Alterations to condensate systems	68% recovery of condensate	20/10/1999 HWMC meeting
	Water meters installed and water leaks fixed	Saving: 1000 kilolitres per year	1/3/2000 HWMC meeting
	Reduction of redyes from 7,8% to 2%	Reduced dye use Reduced water and energy use	1/3/2000 HWMC meeting
	Substitution of some raw materials	Saving: 48% of raw material costs	1/3/2000 HWMC meeting
Company 4	Reuse of rinse aides	Reduced water use	1/3/2000 HWMC meeting
	New meters installed	Monitoring to ensure efficiency	1/3/2000 HWMC meeting
	New boiler installed	Energy savings 25% air pollution reduction	1/3/2000 HWMC meeting
	Good housekeeping	35% reduction of solid waste to landfill	Common Goal 2/2000
	Leaks fixed	Saving: R25 000 / month	1/3/2000 HWMC meeting

Member Company	**Practice Change** *(implemented or identified)*	**Effects of Change and Estimated Savings** *(where reported)*	**Report Details**
Company 5	Effluent monitoring meters installed	Reduced acid consumption	1/3/2000 HWMC meeting
	Plans to service and upgrade 2 boilers	(Planned)12% reduction in steam consumption	1/3/2000 HWMC meeting
	Water savings identified	Potential saving: 30% / month	Common Goal 2/2000
	Process and treatment chemical savings identified	Reduction in chemical use	Common Goal 2/2000
	Cutting waste	Saving: R3 000 000 / yr on raw material costs	Common Goal 2/2000
	Identification of water consumption as key area for change	Saving: R13 000 / month	1/3/2000 HWMC meeting
Company 6	Installation of energy and steam meters	Monitoring to ensure efficiency	1/3/2000 HWMC meeting
	Installation of water meters	Monitoring to ensure efficiency	1/3/2000 HWMC meeting
	Investigation of acid costs and planned reduction of acids in effluent	Improved effluent quality	1/3/2000 HWMC meeting
Company 7	Heat changes	Improved process efficiency	1/3/2000 HWMC meeting
	Dying changes	Reduction in chemical use	1/3/2000 HWMC meeting

* Montage is a custom developed software package produced by Enviros-March for monitoring and targeting of waste minimisation. It is available, free, to all club members.

ANNEXURE 4
The Promotion of a Waste Minimisation Club for the Metal Finishing Industry

ABSTRACT

by:
Namo Thambiran

University of Natal
Durban

May 2001

The concepts of cleaner production and waste minimisation have increased in priority in South Africa's latest environmental legislation, and feature at the top of the waste management hierarchy as described in the White Paper on Integrated Pollution and Waste Management. South African Legislation places increased responsibility on generators of waste for the proper management of waste. As a result, the pollution liability of waste generating enterprises has increased considerably. Provincial and local authorities are also expected to promote integrated waste management, and encourage industries to implement waste minimisation.

The Durban Metropolitan Unicity Council has incorporated pollution prevention in their new bylaws, which also contain new stringent regulations on acceptable levels of metal content. This change was of concern to the metal finishing industry, as companies would face heavy fines if they did not comply with the new regulations. Waste minimisation seemed a good method for this industry to achieve compliance, and further reduce their environmental impact.

The Metal Finishing Waste Minimisation Club was thus established in the Durban Metropolitan Area in June 1998 as a result of a meeting between the local government authority and 81 representatives of the metal finishing industry. The meeting was held to introduce the new municipal bylaws for the Durban Metropolitan Area. Waste minimisation was introduced to the industry by the Pollution Research Group as an effective way to reduce volumes and toxicity of effluent thereby not only facilitating compliance with the bylaws but also reducing waste treatment and disposal costs. Consequently 29 of the companies present formed a waste minimisation club. The Pollution Research Group formally manages the club, with funding from the South African Water Research Commission. The project is co-funded by the European Union Directorate General XVII for Energy (Thermie).

A number of waste minimisation options have been identified and implemented by club members.

Since the establishment of the club, the known documented combined annual savings total approximately R2 million. Significant benefits to the environment were also achieved such as a reduction in water consumption by almost 60 000 kl/annum. The club helped to build capacity on waste minimisation both within the club and externally.

ANNEXURE 5
The Promotion of a Waste Minimisation Club in the Hammarsdale Industrial Area

ABSTRACT

by:
Dhiraj Maharaj

University of Natal
Durban

May 2001

The Hammarsdale industrial township has a high concentration of textile plants that have a significant combined impact on the receiving water body. The Hammarsdale Waste Water Treatment Works is the only treatment facility available and is discharging effluent of a standard below that set by the Department of Water Affairs and Forestry. In particular, the colour and conductivity limits are being exceeded. This causes an adverse effect on the quality of the water in the Sterkspruit catchment and is also not aesthetically acceptable. In view of the impending discharge standards, particularly zero colour concentration, a major drive towards minimising waste and effluent had been undertaken by the companies in this area under the umbrella of the Hammarsdale Waste Minimisation Club. A systematic waste minimisation assessment was applied at selected sites. The potential for savings and waste reduction was first investigated. Thereafter, a waste minimisation audit was completed which resulted in a number of options for minimising waste.

The initial assessments have shown a number of important points. Management and staff were initially sceptical about implementing waste minimisation programmes, citing time, lack of resources and lack of technical expertise as the biggest barriers to the implementation of waste minimisation programmes. In-house training, personnel training and various management initiatives at each site overcame these. However, as the programme neared the audit phase, another more serious barrier became evident. The waste minimisation champions at each site could not sustain the programme, after the start of the project and the completion of the initial assessments. The monitoring and targeting programme was also hampered due to the lack of time and resources for maintaining the programme. This is a serious barrier and one that must be quickly overcome if the companies are to make a success of their involvement in the waste minimisation club project and sustain the Club.

All the clubs who actively attended meetings and participated in the club activities have reported substantial savings in water and effluent, energy, raw materials and solid waste. The club has identified a total of 43 options for minimising waste with 23 of them already implemented. The Hammarsdale Waste Minimisation club has identified potential cost savings of the order of R14m per annum, and realised actual cost savings of approximately R6m per annum. The implementation of options not only realised cost savings, but savings in water and energy consumption, and subsequent reductions in effluent, air emissions and liquid wastes.

The Hammarsdale club have realised actual reductions in water and effluent of about 2100 ML/year, reductions in energy usage of about 33000 MWh/year, and reductions in CO_2 of 6318 tonnes/year. SO_2 and NO_x been reduced by approximately 376 and 77 tonnes/year respectively.

The approach adopted in promoting waste minimisation in this area has shown that cost savings and environmental improvement can be realised simultaneously. The club management structure, subsequent training modules and technical training sessions have all combined to promote the uptake of waste minimisation at a factory and shop floor level, thereby making this initiative a success.

ANNEXURE 6
European Union Final report

ABSTRACT

by:

Enviros March
Salford Quays
Manchester
United Kingdom

May 2001

EUROPEAN COMMISSION
Directorate-general for energy
Contract NO. dis/1779/98-gb
END report
"Energy Saving and Waste Minimisation in South Africa"

October 2000

MANAGEMENT SUMMARY

Two Waste Minimisation Clubs have been formed in the Kwa-Zulu Natal province of South Africa. The first Club involved the industrial community of the Hammarsdale area, the second involved the Metal Finishing industry centred on Pinetown and Durban. This report details the development and implementation of these two clubs, as well as the results arising from them and the process of dissemination of these results.

The headline conclusions are as follows:
The Hammarsdale Waste Minimisation Club has reported combined energy, water, effluent, consumables and raw materials savings in the order of €2.25 million per annum. The majority of these savings were realised at low cost or no cost to the industries involved;

The combined energy savings achieved across all Hammarsdale Waste Minimisation Club members is in excess of 49.7 million kWh per annum, equivalent to a financial saving of €394,000 per annum;

The Metal Finishing Waste Minimisation Club has reported combined energy, water, effluent, consumables and raw materials savings in the order of €290,000 per annum. The majority of these savings were realised at low cost or no cost to the industries involved;

Although the combined fossil fuel and electricity savings achieved within the Metal Finishing Waste Minimisation Club has not been quantified in energy terms, it is reported by the Club members to be equivalent to a financial saving of €43,000 per annum;

The European partners have successfully delivered energy efficiency training and training on Waste Minimisation methodology to the majority of industries involved. The same training has also been provided to the South African partners, thereby enabling the continuation of technology transfer in the future;

Shop-floor energy and environmental training has been successfully delivered by the European/South African partners to the majority of of industries involved. This level of training has resulted in a significant increase in awareness of site staff in general, and has additionally led to improved industrial relations within the companies themselves;

The inclusion of the local environmental regulator, Durban Metro, as a stakeholder within the Waste Minimisation Club has been extremely successful. The relationship between the regulator and the two industrial communities has transformed from one of conflict to one of working towards common goals;

The issue of energy saving through Waste Minimisation is an important feature of the South African political agenda and features within the National Waste Management Strategy. The success of this THERMIE action is seen by South African Government as an important factor in the development and promotion of the National Strategy.

The Dissemination Phase of this action has been extremely successful and the project methodology and results have been delivered to a wide audience through a variety of media. Based on the dissemination of the success of the Hammarsdale and Metal Finishing Waste Minimisation clubs, two further Waste Minimisation clubs are to be established in KZN, a third in the Western Cape region and a fourth is proposed for the Gauteng region.

The results of this project have proven that the concept of Waste Minimisation Clubs is a feasible approach to promoting Waste Minimisation in South African Industries. Energy, water, chemical and raw materials usage has been reduced, thereby lowering the impact on the environment. All companies involved have a greater understanding of the concepts of Waste Minimsation, even if not all have yet implemented programmes on site. Those that have actively participated have shown remarkable results as is evident from the financial savings reported.

CONTENTS

LIST OF ABBREVIATIONS

CSIR	Council for Scientific and Industrial Research
DEAT	(South African) Department of Environment and Tourism
DSM	Demand Side Management
DTI	(South African) Department of Trade and Industry
DWAF	(South African) Department of Water Affairs and Forestry
HIC	Hammarsdale Industrial Conservancy
HWMC	Hammarsdale Waste Minimisation Club
KZN	Kwa-Zulu Natal
PRG	Pollution Research Group
SME	Small to Medium-sized Enterprise
WISA	Water Institute of South Africa
WRC	Water Research Commission (of South Africa)
WWTW	Waste Water Treatment Works

1. Introduction

Until recently, energy efficiency has not been a priority issue in South Africa. Because of abundant supplies of coal, energy has been plentiful and cheap and there has been no tradition of energy saving activity. However, the government now recognises that if the economy is to develop in a sustainable manner, greater attention must be paid to energy efficiency both to improve industry's competitiveness and to reduce environmental pollution. Despite this, energy prices to industry remain low and there is little incentive at individual enterprise level to make savings. Other issues, such as surviving in an international market and solving environmental problems related to water usage and discharge have higher priority for management.

At a Conference sponsored by THERMIE near Johannesburg in June 1997, the workshop on Energy Efficiency in Industry concluded that for the time being, energy saving technologies could only be promoted as part of activities that addressed these other concerns. This action has provided the opportunity to do just that.

A project is being carried out by the University of Natal Pollution Research Group (PRG), funded by the Water Research Commission (WRC), to demonstrate the concept of Waste Minimisation "Clubs". These have been pioneered in the UK to promote cleaner production and sustainable development particularly amongst SMEs. The early "Clubs" concentrated on water and effluent savings but they now address all areas of waste including energy, raw materials and consumables.

Originally the Natal project was aimed at the preservation of water quality through the prevention of industrial water pollution and the reduction in the demand for industrial water. However, at a meeting at the THERMIE conference involving:

- The South African Department of Trade & Industry
- the Water Research Commission (WRC)
- ESKOM, the national electricity utility
- the University of Natal Pollution Research Group (PRG)
- THERMIE representatives

It was agreed that additional sponsorship from THERMIE would enable the objectives of the project to be broadened to encompass energy saving and energy technologies. It would also allow EU expertise to be introduced to the South African situation, thus accelerating and enhancing the achievement of savings.

Two Waste Minimisation Clubs have been formed in the Kwa-Zulu Natal (KZN) province of South Africa; the first involving the industrial community of the Hammarsdale area, the second involving the Metal Finishing industry centred on Pinetown and Durban. This report details the development and implementation of these two clubs, as well as the results arising from them and the process of dissemination of these results.

2. Waste Minimisation methodology

The core methodology for Waste Minimisation is described in this section. It is based on work in previous projects carried out for industrial clients and represents a generic approach to Waste Minimisation. The key features of this core methodology are:

- detailed measurement to determine precisely energy losses and inefficiencies at each stage of the process and highlight priority areas for attention.
- continuing identification of the causes of waste and implementing the most viable solutions.

Activity during the collaborative period was, therefore, not directed at just completing a work programme but was aimed at establishing an on-going waste minimisation programme. This distinction is fundamental to long term success and the avoidance of a "quick fix" approach to waste minimisation. Clearly many improvement opportunities are identified at the commencement of a programme but the real potential lies in continuous management attention to energy wastage, to create long term cost and environmental benefits.

Another core feature of this approach to waste minimisation is the concentration on minimisation at source. Whether it be energy, water, raw materials, packaging, office waste or maintenance waste, it is vital to understand the business processes which generate the waste and how wastes can be eliminated or reduced. This requires a fundamental knowledge of business and manufacturing activities and not just the application of engineering solutions.
Waste Minimisation Methodology can be described in three fundamental Phases as follows:

- Phase 1 - Definition (Preparation for improvement)
- Phase 2 - Development (Agreeing the concept)
- Phase 3 - Implementation (Ongoing improvement)

The essential elements within each Phase are described below. A schematic representation of the process is included as Appendix 1 to this report.

2.1 Phase 1 - Definition

This is fundamentally focussed on detailed quantification of waste and waste minimisation training for the individuals involved in the project. More specifically this phase consists of:

- Setting up and running training sessions for the Project Champion and teams to equip them to carry out more detailed waste audits. They are provided with:
  - the aims and objectives of the project;
  - principles of waste minimisation;
  - guidelines on clarification of process inputs and outputs, mass balances and yield verification;
  - model output formats.
- The Project Teams then carry out detailed energy audits. In addition to the characterisation and quantification of waste, these audits enable a review of the utilities measurement techniques currently used in the company and their accuracy and appropriateness. Additional metering should be considered and introduced where justified. The Teams should also seek to identify potential environmental risks and non-compliance on the site together with the human resource issues that need to be addressed to minimise waste. Attention is focused on:
  - energy auditing, efficiencies of distribution, and overall usage of energy;
  - water and effluent usage; developing a water balance for the site and identifying key contributions to effluent load.
  - In addition, the following elements may be considered as part of a Waste minimisation programme:
    - product losses; developing mass balances for processes;
    - packaging usage; identifying areas of loss;
    - waste disposal options and practices;
    - usage of consumables.
- Training sessions are provided for the Project Champion and teams to introduce them to:
  - structured problem solving, opportunity identification, evaluation and implementation (brainstorming, cause and effect diagrams, etc.);
  - energy monitoring and targeting principles and techniques;
  - energy efficiency good practice;
  - how to get involvement from other people to create ownership and motivation;

2.2 Phase 2 - Development

The development phase includes the identification and evaluation of opportunities. Key activities in Phase 2 are:

- The Project Teams begin the process of identifying and evaluating improvement opportunities - involving other managers, supervisors and staff as appropriate;
- Project Consultants assist the Project Teams with the evaluation and prioritisation of improvement opportunities;
- It is necessary at this stage to prepare a clear implementation programme covering the selected options and identifying actions, responsibilities, and timescales on the Project Teams and other Company staff.

2.3 Phase 3 - Implementation

This phase includes the implementation of the technical, system and behavioural changes that will lead to Waste Minimisation and the achievement of savings.

Key activities in Phase 3 are:

- Implementation of the agreed opportunities and minimise energy wastage. Apply new methods and procedures. Install new waste planning, control and reporting systems;
- The further development of metering regimes, the measurement of energy wastage and the on-going development of monitoring and targeting systems as a basis for further improvement;
- Project Consultants work with senior management (including financial management) at Steering Group level to ensure that the M&T information is summarised and embedded in the high level management information used to control the business on a day to day basis. This ensures that energy and environmental performance is elevated to its rightful place alongside other key business performance indicators;
- An analysis of energy savings and other benefits obtained throughout the project is undertaken.

3. The hammarsdale waste minimisation club

This section describes the entire Work Programme associated with The Hammarsdale Waste Minimsation Club (HWMC). The section is broken down into the following sub-sections:

- Project Inception
- Recruitment
- Definition, Development and Implementation
- Training
- Monitoring and Targeting
- Results
- Conclusions

The Dissemination Phase of the project is dealt with in Section 5 of this report.

3.1 Project Inception

Five separate inception meetings were undertaken in early November 1998 as follows:

- Textile Federation, Johannesburg
- National Government, Pretoria
- Eskom (the National power utility), Cleveland
- Council for Scientific and Industrial Research (CSIR), Pretoria
- Local Government and regulators, Durban

The objective of these meetings was threefold:

- to make contact with the key players and stakeholders in South Africa thereby promoting and publicising the aims and objectives of this action;
- to ensure that this action is co-ordinated with existing initiatives promoting environmental sustainability and business efficiency;
- an opportunity for information exchange and to gain insight into local environmental issues.

The inception meetings are summarised as follows:

3.1.1 Textile Federation

Present were:

Mr B Bailey, March Consulting	Prof. C Buckley, PRG
Mr D Mercer, March Consulting	Mr B Brink, Textile Federation

The Textile Federation is primarily an employers association whose interests lie in tariff and trade issues. The Federation has no agenda for environmental matters.

The objective of the meeting was to inform the Federation of the formation of a Waste Minimisation Club in the Hammarsdale area, as at this stage it was envisaged that the Club would entirely consist of textile finishing companies.

The Federation gave its support to this action and wished to be kept informed of the outcomes.

3.1.2 National Government

Present were:
Mr B Bailey, March Consulting
Mr D Mercer, March Consulting
Prof. C Buckley, PRG
Mr H Pedersen, Kagiso-COWI
Dr J Schoeman, Council for Scientific and Industrial Research (CSIR)
Ms E du Toit, Deputy Director (Energy Efficiency), Dept. of Mineral and Energy Affairs
Mr D Naidoo, Dept. of Water Affairs and Forestry
Ms M Visagie, Deputy Director (Environment), Dept. of Trade and Industry
Mr G Steenveld, WRC
Mr P Odendaal, WRC
Mr D van der Merwe, WRC

The primary objectives of this meeting were to provide the Governmental Departments with an insight into the concept of Waste Minimisation, to present case studies of successful projects and to receive feedback on how this initiative could contribute to the formulation of Environmental Policies within Southern Africa.

The Department of Environment and Tourism (DEAT) and the Department of Water Affairs and Forestry (DWAF) together with others, including the DTI, are currently driving a "National Waste Management Strategy". Waste Minimisation, and the "Club" concept, feature within the draft version of the Strategy document.

It is proposed that DEAT, as the governmental lead agent in terms of the Strategy, shall be responsible for developing and implementing a National Programme for Waste Minimisation. Furthermore, a key component of this National Programme will be the implementation of demonstration projects, of which at least three are proposed by 2000.

The objectives of the demonstration projects are:
- to demonstrate the cost-savings and techniques associated with Waste Minimisation
- to build capacity amongst stakeholders (including SMEs)
- to address environmental issues of concern
- to test the potential for innovative policy instruments

It was agreed by all present that this THERMIE action will prove an important contribution towards the development of South Africa's National Waste Management Strategy. In particular, the opportunity to gain from European experience in such initiatives together with associated technology transfer are considered of particular benefit.

In addition to DEAT, DWAF and DTI, the Department of Mineral and Energy Affairs have vested interest in the successful outcome of this action - the promotion of efficient electricity utilisation is one of the Department's objectives. Clearly, novel energy management techniques brought to the project (for example, Monitoring and Targeting of electricity use) will serve as useful tools to this end and could be promoted throughout the Republic.

3.1.3 Eskom

Present were:
Mr B Bailey, March Consulting
Mr D Mercer, March Consulting
Mr Lawrence, Eskom
Prof. C Buckley, PRG
Mr K Nkomo, Eskom
Mr B Gore, Eskom
Ms S Scheidegger, Eskom

The objectives of this meeting were to provide Eskom with a greater depth of understanding of Waste Minimisation methodology and techniques (Monitoring and Targeting in particular), to investigate how this initiative could contribute to Eskom's own objectives and to invite their practical support to the Site Work Phase.

Eskom have a corporate policy to generate and supply to end users electricity at the lowest cost in the world. End users, therefore, have little or no motivation to save. An ongoing electrification programme to bring power to townships and rural areas further compounds this situation. Eskom fully appreciate that unless action is promoted and undertaken, the capacity of existing power stations will soon be insufficient to meet increasing demand.

Eskom has no intention of commissioning new power generating plant in the foreseeable future and has, therefore, launched energy efficiency initiatives and Demand Side Management (DSM) programmes.

It was agreed by all that this THERMIE action and the subsequent promotion of Waste Minimisation within the Republic will provide essential support towards Eskom's sustainable development strategy.

The concept of the Monitoring & Targeting of energy use is apparently novel to Eskom. Representatives present were enthused by its potential and by the high level of technological back-up (i.e. Software) available from European sources. This presents excellent opportunities for technology transfer.

3.1.4 Council for Scientific and Industrial Research (CSIR)

Present were:

Mr B Bailey, March Consulting	Prof. C Buckley, PRG
Mr D Mercer, March Consulting	Mr S O'Beirne, Business Development Manager, CSIR

The CSIR is the South African Government's scientific advisor, although it now receives circa 60% of its funding externally from private sources.

The CSIR provides a wide range of scientific and technological services to government, industry and commerce. The objectives of the meeting were to describe the background, aims and objectives of this THERMIE action and to invite CSIR support. The project was welcomed by CSIR and is viewed as an opportunity to harness novel techniques and technologies, as well as to build capacity of National Policies

3.1.5 Local Government

Present were:

Mr B Bailey, March Consulting	Mr B Pfaff, Durban Metropolitan Council
Mr D Mercer, March Consulting	Mr D Gallagher, Umgeni Water
Prof. C Buckley, PRG	Mr C Fennemore, Umgeni Water

Invitees to this meeting represented the regulatory bodies (concerned with water usage and effluent discharge and treatment) local to the Durban area. The private enterprises actively involved in this project, the Club "Members", are located in the Hammarsdale region of Kwa-Zulu Natal, which falls under the jurisdiction of the regulators present.

The objectives of this meeting were to familiarise local regulators with the background to this initiative, its aims and objectives, and to seek their feedback on how long-term development of the concept could assist in meeting their own objectives of environmental management and protection.

In addition, the methodology of Monitoring and Targeting was explained in some etail. Wide-scale application of this technique within industry is seen as a potential instrument to promote cleaner production and to give employers ownership of their local environmental obligations.

3.2 Recruitment

The recruitment phase commenced in the first two weeks of November 1998 and continued through to March 1999. The programme was structured as follows:

- Launch seminar
- Site visits
- Round-up

The recruitment phase is summarised as follows:

3.2.1 Launch Seminar

Details of the seminar were circulated to all Textile Finishing companies resident in the Hammarsdale area. The seminar was hosted by one of the companies themselves, Gelvenor Textiles.

Present were:

Mr B Bailey, March Consulting
Mr K Holdsworth, Gelvenor
Mr D Mercer, March Consulting
Mr B Gore, Eskom
Mr T Wardle, Gelvenor
Ms N Thambiran, PRG
Mr T Strong, deNim Textiles
Mr M Prior, Gelvenor
Ms S Scheidegger, Eskom
Mr M Brown, Gelvenor
Prof. C Buckley, PRG
Mr V Lawrence, Eskom
Mr M Black, Coats
Mr G Baars, SA Nylon Spinners
Mr H Pedersen, Kagiso-COWI

The primary objective was to provoke interest in this initiative and to gain commitment from the companies represented.

The seminar took the form of a series of presentations by the collaborative partners. The background to the project was explained, the outline methodology was introduced and case studies presented.

Feedback from representatives was positive and encouraging. All felt that the proposed Club would be of significant benefit to their corporate aims and environmental standing. In addition, the Club would provide an invaluable contribution to meeting the aims and objectives of the existing Hammarsdale Industrial Conservancy group (HIC).

The HIC comprises environmental/waste management representatives from a number of the industries within Hammarsdale, including non-textile companies. The HIC meets on a regular basis and although its agenda is somewhat undefined, its long-term vision is the creation of a recreational facility centred on the Hammarsdale dam. All agreed that the formation of a Waste Minimisation Club is an opportunity to bring structure and methodology towards meeting that objective.

It was proposed and agreed, therefore, that membership of the Club should be extended to include ALL those industries that preside on the HIC.

3.2.2 Site Visits

A series of visits to the individual sites was undertaken with the objective of gaining an overview of the issues relevant to each. An initial review of metering regimes, information systems and resource requirements was also undertaken. The first schedule of visits was made during November 1998 and the second during March 1999 the companies involved were as follows:

DANO Textiles
Coats South Africa (Pty) Limited
South African Nylon Spinners (SANS)
Buckman Laboratories
Coastal Group
Hammarsdale WWTW
deNim Textiles
Gelvenor Textiles
Lotus 2000
Mediterranean
Rainbow Farms

3.2.3 Round-up meeting

The recruitment phase round-up meeting was held in March 1999 and was hosted by Buckman Laboratories.

Present were:
Mr D Mercer, March Consulting
Mr M Black, Coats
Mr H Pedersen, Kagiso-COWI
Mr G Baars, SA Nylon Spinners
Prof. C Buckley, PRG
Ms S Barclay, PRG
Mr D Maharaj, PRG
Mr A King, Mediterranean
Mr K Holdsworth, Gelvenor
Mr N Naicker, Buckman Labs
Mr N Kennedy, Lotus 2000
Dr Lewis, Rainbow Farms

The objectives of this meeting were to review the HWMC, its structure and its objectives, and to provide Phase 1 core Waste Minimsation training (Appendix 9.1) in readiness for the Project Definition phase.

3.3 Definition

The Definition phase for the majority of industries involved between March and August 1999. This phase contained the following elements:

- Consolidation
- Training and awareness raising
- Auditing and Scoping Surveys

The Definition phase is summarised as follows:

3.3.1 Consolidation

ENVIROS March and PRG were invited to attend the monthly HIC meetings on a regular basis. This provided the opportunity to make initial contact with further members of the Hammarsdale industrial community. The company representatives present were provided with a précis of the launch seminar and given a review of progress to date.

It was agreed that the HIC representatives should adopt the role of Project Champion for their individual organisations. Furthermore, it was agreed that the existing format of regular HIC meetings would provide an ideal forum for progress reporting and for Steering Group meetings. To summarise, the Hammarsdale Waste Minimisation Club structure is described as follows:

- A Project Champion was appointed at each Company whose responsibility is to co-ordinate all Waste Minimisation activities within that Company. The Project Champion is the main point of contact for the project Consultants.
- There is a Steering Group that consists of nominated Directors from each Club member, the nominated Project Champions, the Project Consultants and other stakeholders. This group is responsible for the planning and control of the work programme within the Club. The Steering Group meetings are held once every two months and, where possible, are scheduled to coincide with a HIC meeting. The Project Champions present their progress to the Group at these meetings.
- Each Company formed at least one Project Team. A Project Team comprises the Project Champion and a number of team members each with different responsibilities for plant/areas/processes. The Project Team is responsible for carrying out the detailed work programme.

A schematic representation of the Hammarsdale Waste Minimisation Club (HWMC) is included as Appendix 2 to this report. All minutes of Steering Group Meetings are included in Appendix 3 to this report.

3.3.2 Training and Awareness Raising

Training delivered to the HWMC during the Definition phase comprised core Waste Minimisation training, Modules 2 and 3, as detailed in Appendices 9.2 and 9.3 respectively. The objective of the training was to equip the Project Champions with sufficient skills to undertake internal scoping audits, energy and mass balances and initial “live audits” in order to identify areas of wastage on their individual sites.

Alongside the core training programme a number of specific energy efficiency training programmes were delivered dealing with the topics of steam utilisation, compressed air and refrigeration. All three topics were highly relevant to the industries involved. Details of the training contents are provided within Appendices 10.1 – 10.3 of this report.

The importance of Senior Management commitment to the success of this initiative had previously been established. A structured approach was developed in order to make senior management fully aware of the benefits of waste minimisation and to encourage their full involvement and support. This approach was as follows:

1) Invite all senior board members of the Hammardsale industrial community to a briefing session hosted by Enviros March, PRG and Kagiso-COWI

Buckman Laboratories hosted the briefing session. It was evident that the majority of industries represented at this session had expressed commitment to Waste Minimisation at the highest level. Those present were briefed on the implications of the National Waste Management Act, the National Waste Management Strategy, the National Integrated Pollution and Waste Management Policy, the KZN Waste Management Policy and the Durban Metro Environmental Policy.

The industries own environmental policies were discussed. It emerged that whilst some have well-structured written policies, others have none at all. The importance of the development and implementation of an environmental policy was stressed and a brainstorming session was conducted to present ideas on policy structure and content

2) Follow up the briefing session through publication of a newsletter

It was agreed by all present at the briefing session that a regular newsletter would provide momentum to the project and ideas for newsletter content were invited, discussed and agreed. Two newsletters have subsequently been published and widely circulated. Copies of the newsletters are included within Appendix 12 to this report.

3) Arrange one-to-one visits with those companies not yet fully committed

Subsequently, industries which had not been represented at the Management Briefing Session were approached and arrangements made to introduce the Waste Minimisation Club at board level. A total of three companies were visited, of which two expressed immediate commitment to Waste Minimisation and one deferred commitment, due to current lack of human resources.

4) Invite Local Authority representatives to take an active role within the Club's Steering Committee

A meeting was held at the offices of Durban Metro, the objectives of which were to brief Local Authority representatives as to the progress of the Waste Minimisation Club, to invite their active participation within the Club Steering Committee and to receive feedback as to the present ownership status of the Hammarsdale WWTW.

Present were:

Mr D Mercer, Enviros March	Mrs S Redlinghuis, Durban Metro
Prof. C Buckley, PRG	Mr B Pfaff, Durban Metro
Ms S Barclay, PRG	Mr C Fennemore, Umgeni Water
Mr D Maharaj, PRG	

Umgeni Water and Durban Metro were encouraged by the progress made and by the commitment shown by the majority of industries involved. It was accepted that uncertainty over future effluent tariff structures was leading to confusion within the Hammarsdale industrial community and, in some instances, barring progress.

It was agreed that, as local regulators, both Umgeni Water and Durban Metro should play an active role within the Waste Minimisation Club and should attend future Steering Group Meetings. Furthermore, it was agreed that as a first step, local and national regulators should address the Steering Group in order to clarify the present and future situations.

3.3.3 Auditing and Scoping Surveys

The project teams carried out preliminary scoping surveys. The scoping audit allowed each Club member to establish a broad range of potential savings achievable through waste minimisation, and encompasses utility consumption, raw materials usage and consumables. The objective was to enable prioritisation of effort and to add momentum to the initiative. This having been completed, the Project Consultants visited a number of the industries in order to carry out more detailed investigations into energy usage, establish priority areas for energy savings potential and to assess additional metering requirements for the purposes of Monitoring and Targeting.

The conclusion of the scoping surveys was that considerable scope existed for energy saving within the Hammarsdale Industrial community. It was thought that minimum savings of 5% and 10% should be realised in electricity and fossil fuel respectively, through no-cost and low-cost measures. However, through the application of higher cost measures and through technology transfer, the savings potential could be 20% for both electricity and fossil fuels alike. A summary of the scoping audit findings is shown below in Table 3.3.3.

Table 3.3.3

	Minimum kWh/annum	Maximum kWh/annum	Minimum Euro/annum	Maximum Euro/annum
Electricity	6,000,000	24,000,000	88,000	353,000
Fossil Fuels	6,200,000	12,400,000	54,000	109,000
Totals	**12,200,000**	**36,400,000**	**142,000**	**462,000**

3.4 Development & Implementation

Having established the potential areas for energy efficiency improvements, the project teams commenced the Development and Implementation phases in order to prioritise these in terms of financial and technical feasibility. In actuality, the Development and Implementation phases over-lapped in the majority of industries involved. These phases generally commenced during August 1999 and the implementation aspect continues to date. The key elements were:

- Core training for Project Champions
- Awareness raising for operators
- Detailed site surveys

These are summarised as follows:

3.4.1 Core Waste Minimisation Training

Core Waste Minimisation Modules were delivered to Project Champions, and selected team members, between August 1999 and August 2000. The objective of the training was to provide the Project Champions with skills required to progress a Waste Minimsation initiative and to drive the programme forward. The training given (together with reference Appendix number) is detailed as follows:

- Structured problem solving (Appendix 9.4)
- Project evaluation (Appendix 9.5)
- Project management (Appendix 9.6)
- Sustaining the programme (Appendix 9.7)

For the majority of industries, this training was delivered as an annexe to the Steering Group Meetings. However, in some instances the training was requested to be provided to all team members, and in these cases on-site sessions were provided by PRG personnel.

3.4.2 Awareness Raising for Operators

A key element of any successful Waste Minimisation programme is the ability to involve all site staff, at all levels, including operator level and shop floor level. Indeed, experience has shown that it is these personnel who are frequently responsible for suggesting the most innovative and successful savings opportunities. In the Hammarsdale Industrial community, in common with the majority of South African industry, the shop floor and operator level staff mainly comprises indigenous peoples with little formal education or schooling. In addition, many have only rudimentary grasp of the English language.

The European/South African partners, Kagiso-COWI, played a key role in developing training at shop-floor level and encouraged the involvement of all staff in doing so. To ensure co-ordination of effort between the University of Natal and Kagiso-COWI, an additional research student was seconded to the project team from the University Geography Department. A two step approach was developed by Kagiso-COWI as follows:

Step 1 - Initial workshops informing, motivating and involving shop-floor staff by broadly presenting energy and environmental issues, and also identifying potential initiatives for their specific working environment.

Step 2 - Training of trainers/supervisors among shop-floor staff to ensure ongoing training, motivation and involvement. Supervisors were made responsible for capturing new ideas from shop-floor staff and forwarding this to management level, and also for ensuring feedback from management on recorded progress on energy efficiency initiatives and savings.

A sub-report detailing the Kagiso-COWI approach, methodology, training, results and conclusions is included as Appendix 11 to this report.

3.4.3 Detailed Site Surveys

Throughout the course of the Development and Implementation phase, the European partners, assisted by PRG, carried out a number of detailed surveys at the individual HWMC members' sites. The objective of these site visits were:

- To assist Project Champions and teams in identification and implementation of energy and water savings opportunities;
- To assimilate sufficient data to enable the assembly of individual case studies;
- To meet and discuss progress with Directors and team members.

A total of ten sites were visited and surveyed as shown in Table 3.4.3:

Table 3.4.3

Coastal Group	Textiles finishing
Coats (SA) Pty Ltd	Textiles (thread)
Dano	Textiles manufacture and finishing
Gelvenor Textiles	Textiles manufacture and finishing
Buckman Laboratories	Batch chemical manufacture
Rainbow Farms	Poultry processing
DeNim	Textiles manufacture and finishing
Dyeco	Textiles finishing
Lotus 2000	Textiles manufacture and finishing
Mediterranean	Textiles manufacture and finishing

Summary reports were provided to each Project Champion detailing the survey findings. Throughout the development phase the consultants provided assistance to Project Champions, and teams, to select and prioritise opportunities identified based upon cost/benefit analysis, risk assessment and business priorities.

Benefits of the opportunities implemented were assessed and analysed by the Project Champions and were regularly reported to the Steering Group at the bi-monthly group meetings (minutes included in Appendix 3).

Case studies have been developed for the sites highlighted in bold in Table 3.4.3 and these are included as Appendix 5 to this report. It should be noted that at the request of the industries involved, all case studies reported for the HWMC have been kept anonymous for confidentiality reasons.

3.5 *Results*

The Hammarsdale Waste Minimisation Club has reported combined energy, water, effluent, consumables and raw materials savings in the order of €2.25 million per annum. Not all members have submitted their results, and the savings will therefore be in excess of these figures. A summary of the savings is given in Table 3.5.

Most savings have been achieved through low cost measures such as optimising dyeing procedures, reuse of washing water, increasing condensate return to the boilerhouse, improved maintenance of all piping (water and steam), replacing disposable consumables with recyclable alternatives and increased monitoring of all utility use. Capital intensive options, such as the installation of heat-recovery equipment, have also been implemented (or in the process of being implemented), with payback periods of the order of 1 to 2 years.

Table 3.5

Item	**Savings Achieved**	
	€ / year	**Quantity / year**
Fossil Fuels	325,000	44,569,000kWh
Electricity	69,000	5,183,000kWh
Water and Effluent	754,000	1,653,000m^3
Chemicals, Raw Materials and Consumables	1,103,000	-
TOTAL	**2,251,000**	**-**

Case studies have been prepared for 5 of the most active Club members, which are included as Appendix 5 to this report.

3.6 Environmental Benefits

Alongside the financial savings, there are obvious benefits to the environment. These include a reduction in the demand for water and energy, less chemicals, metals and dyes being discharged to drain and a reduction in the mass of solid waste disposed of to landfill. Improving the efficiency of steam raising systems and reducing site power consumption have both resulted in significant greenhouse gas emissions.

Use of recyclable packaging or consumables, monitoring and controlling raw material use and decreasing wastage during manufacture has resulted in less solid disposal to landfill. Monitoring and optimising dye and chemical usage has resulted in less harmful chemicals being discharged to sewer and has reduced the demand upon the Hammarsdale Waste Water Treatment Works. Salt and dye are a major concern in the Hammarsdale region as they pass through the sewage works and enter the Sterkspruit River, which leads to the Shongweni Dam recreational area. The measures that have been introduced to reduce their use at source, therefore, have been highly beneficial to the immediate environment.

3.7 Conclusions

The results of this project have proven that the concept of Waste Minimisation Clubs is a feasible approach to promoting Waste Minimisation in South African Industries. Energy, water, chemical and raw materials usages have been reduced, thereby lowering the impact on the environment. All companies involved have a greater understanding of the concepts of Waste Minimsation, even if not all have yet implemented programmes on site. Those that have actively participated have shown remarkable results as is evident from the financial savings reported. To summarise:

- The Hammarsdale Waste Minimisation Club has reported combined energy, water, effluent, consumables and raw materials savings in the order of €2.25 million per annum. The majority of these savings were realised at low cost or no cost to the industries involved;
- The combined energy savings achieved across all club members is in excess of 49.7 million kWh per annum, equivalent to a financial saving of €394,000 per annum;
- The European partners have successfully delivered energy efficiency training and training on Waste Minimisation methodology to the majority of industries involved. The same training has also been provided to the South African partners, thereby enabling the continuation of technology transfer in the future;
- Shop-floor energy and environmental training has been successfully delivered by the European/South African partners to the majority of industries involved. This level of

training has resulted in a significant increase in awareness of site staff in general, and has additionally led to improved industrial relations within the companies themselves;

- The inclusion of the local environmental regulator, Durban Metro, as a stakeholder within the Waste Minimisation Club has been extremely successful. The relationship between the regulator and the Hammarsdale industrial community has transformed from one of conflict to one of working towards common goals;
- The major barrier to implementation of Waste Minimsation has been lack of internal human resources and time. It is thought that this in particular had a detrimental effect upon the progress of the Monitoring and Targeting aspect of the programme;
- The issue of energy saving through Waste Minimisation is an important feature of the South African political agenda and features within the National Waste Management Strategy. The success of this THERMIE action is seen by South African Government as an important factor in the development and promotion of the National Strategy.

4. The metal finishing waste minimisation club

The South African Water Research Commission (WRC) has sponsored a project to establish a Waste Minimisation Club centred around metal finishing industries located within the Pinetown district of Kwa Zulu Natal (KZN). The project commenced in January 1998 and is being managed by the University of Natal Pollution Research Group. The club comprises some 30 proactive members and characterises Pinetown's metal finishing industry, the majority being micro-enterprises with only a small handful of SMEs.

4.1 Overview

At the Metal Finishing Club Steering Group Meeting, on 2nd March 1999, a presentation was made by March Consulting to provide those present with an insight into the European experience of Waste Minimisation Clubs, with case studies, and to outline the methodological approach that has developed from such experience.

At that time, the focus of the Metal Finishing Club had been upon effluent minimisation and the associated water and chemical savings. The nature of the processes involved in this industry dictate that energy savings go hand-in-hand with savings in effluent discharge, as most effluents are discharged hot. It was thought, however, that considerable scope existed for energy efficiency improvements in these industries and it became the intention of the collaborative team to bring its experience and technology transfer to the Metal Finishing Club. Preliminary site visits to a small number of these industries suggested that the following measures should be considered initially:

- Monitoring and Targeting (M&T) of energy use against output
- Promotion of Good Housekeeping measures (i.e. switching off lights and machinery when not in use)
- Improved efficiency of compressed air generation, distribution and use
- In-process hot water recycling

Additional to the above, it was thought that the promotion and development of the phased approach to Waste Minimisation methodology would prove a valuable asset to the Club.

4.2 *Training*

Core Waste Minimisation Training Modules were delivered to Project Champions, and selected team members, between August 1999 and August 2000. The objective of the training was to provide the Project Champions with skills required to progress a Waste Minimsation initiative and to drive the programme forward. Training attendance is included as Appendix 7 of this report. The Waste Minimisation training material provided to these industries is included as Appendix 9.

Additionally, it was agreed by the Club members that specific technical training in Monitoring and Targeting and compressed air usage would be of benefit to the Metal Finishing club. The technical training material provided is included as Appendices 10.3 and 10.4 of this report.

4.3 *Site Visits*

The European partners, assisted by PRG, carried out a number of detailed surveys at individual Metal Finishing Waste Minimisation Club members' sites. The objective of these site visits were:

- To assist Project Champions and teams in identification and implementation of energy savings opportunities;
- To assimilate sufficient data to enable the assembly of individual case studies;

A total of seven sites were visited and surveyed as follows:

- Euro Industrials
- Gedore Tools
- Fascor
- AE Valves
- Saayman Danks Electroplating
- Xpanda

Summary reports were provided to each Project Champion detailing the survey findings. The consultants provided assistance to Project Champions, and teams, to select and prioritise opportunities identified based upon cost/benefit analysis, risk assessment and business priorities.

Benefits of the opportunities implemented were assessed and analysed by the Project Champions and were regularly reported to the Steering Group at the bi-monthly group meetings (minutes included in Appendix 6).

Case studies have been developed for the sites listed above and these are included as Appendix 8 to this report.

4.4 *Results*

The combined reported savings of the Metal Finishing Club are in excess of €290,000 year. These results are based in information obtained from 15 of the 29 club members. The remaining members have either not quantified their savings as yet, or are unable to quantify them due to a lack of data. A summary of the results is given in Table 4.4.

The majority of these savings were achieved through no- or low-cost measures, such as fixing leaks, closing off unnecessary taps, controlling chemical addition, monitoring energy and water use and flows, optimising use of heated equipment, improving process operations, reusing of rinse water and other baths, and through general awareness raising. Those companies that have made the most savings have attributed these to an increased awareness of the process requirements, improved monitoring of all utilities and a greater management presence on the shop floor.

Table 4.4

Item	**Savings Achieved**	
	€ / year	**Quantity / year**
Fossil Fuels and Electricity	43,000	Not quantified
Water and Effluent	51,000	161,800m^3
Chemicals, Raw Materials and Consumables	196,000	-
TOTAL	**290,000**	**-**

The European Partners have prepared case studies for the 7 Club members visited and advised. These are included as Appendix 8 to this report.

Environmental Benefits
Alongside the financial savings achieved, there has been a significant reduction in the environmental impact of the Club members. Quantification of the exact savings has been problematic, however, known benefits include:

- Reduced greenhouse gas emissions;
- Water usage and effluent discharge reductions;
- Reduced chemicals, metals, cyanide and cadmium discharge to drain;\
- Reduced sludge disposal to landfill;
- Reduced solvent use and emissions.

4.5 *Conclusions*
The results of this project have proven that the concept of Waste Minimisation Clubs is a feasible approach to promoting Waste Minimisation in South African micro-enterprises and SMEs. Energy, water, chemical and raw materials usages have been reduced, thereby lowering the impact on the environment. All companies involved have a greater understanding of the concepts of Waste Minimsation and most have implemented programmes on site. To summarise:

- The Metal Finishing Waste Minimisation Club has reported combined energy, water, effluent, consumables and raw materials savings in the order of €290,000 per annum. The majority of these savings were realised at low cost or no cost to the industries involved;
- Although the combined fossil fuel and electricity savings achieved across all club members has not been quantified in energy terms, it is reported by the Club members to be equivalent to a financial saving of €43,000 per annum;
- The European partners have successfully delivered energy efficiency training and training on Waste Minimisation methodology to the majority of industries involved. The same training has also been provided to the local regulator, Durban Metro, thereby enabling the continuation of technology transfer in the future;
- The inclusion of the local environmental regulator as a stakeholder within the Waste Minimisation Club has been extremely successful. The relationship between the regulator and the Pinetown metal finishing industry has transformed from one of conflict to one of working towards common goals;

5. Dissemination Phase
The Dissemination Phase commenced during July 1999, as results and conclusions regarding the two Waste Minimsation Clubs began to emerge. During the course of the subsequent 14 months a total of nine presentations and papers, four workshops and three publications have been made and delivered to a wide audience. A newsletter has also been introduced with the objective of publicising the results of the two Waste Minimisation Clubs. The dissemination material and events are summarised below and are included in full as Appendix 12 of this report.

5.1 Presentations and Papers
Barclay SJ and Buckley CA, *Waste Minimisation Club for the South African Textile Industry: A Feasibility Assessment*, 18th International Federation of Association of Textile Chemist and Colourist Congress on Textile Dyeing and Finishing in the 21st Century, Scandic Copenhagen Hotel in Copenhagen, Denmark, 8-10 September 1999. (Appendix 12.1).

Barclay SJ, *Waste Minimisation Club for the Metal Finishing Industry - A Case Study*; Presented by Ike Ndlovu of the Department of Environment Affairs and Tourism at the 4th International Workshop held by the Institute of Environmental Technology, Basel, Switzerland, 1999 (Appendix 12.2).

Maharaj D, Barclay SJ, Buckley CA and Mercer DG, *Practical Waste and Effluent Reduction: Case Studies from the Manufacturing Sector*, The Water Institute of Southern Africa (WISA 2000) Biennial Conference and Exhibition, Sun City, South Africa, 28 May - 1 June 2000 (Poster).

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Thambiran N, Barclay SJ and Buckley CA*, Waste Minimisation Success at a Metal Finishing Company*, Wastecon 2000, Cape Town, 5-7 September 2000 (Appendix 12.5).
Maharaj D, Barclay SJ, Buckley CA and Mercer DG, *A Practical Cost Savings through the Implementation of a Waste Minimisation Programme at a Textile Plant*, Wastecon 2000, Cape Town, 5-7 September 2000 (paper)

5.2 Publications

Barclay SJ, Thambiran N, Maharaj, D, Buckley CA and Mercer D*; Waste Minimisation Clubs (Part 1): A Feasible Solution to Sustainable Industrial Development?* TAPPSA Journal, March 2000 (Appendix 12.6).
Barclay SJ, Thambiran N, Maharaj, D, Buckley CA and Mercer D*; Waste Minimisation Clubs (Part 2): A Feasible Solution to Sustainable Industrial Development?* TAPPSA Journal, May 2000 (Appendix 12.6).
Barclay SJ and Buckley CA, *Waste Minimisation Clubs – Pilot Studies in KZN*, SA Waterbulletin, Volume 26, No. 3, May / June 2000 (Appendix 12.7).

5.3 Papers to be Presented

Barclay SJ, Buckley CA, Thambiran N, Maharaj D and Mercer DG, *Waste Minimisation Clubs – A Route to Sustainable Development?* The Southern African Institution of Chemical Engineers, 9th National Meeting, Secunda, 9-12 October 2000.
Maharaj D, Barclay SJ, Buckley CA and Mercer DG, *Practical Waste and Effluent Reduction: Case Studies in the Manufacturing Sector*, The Southern African Institution of Chemical Engineers, 9th National Meeting, Secunda, 9-12 October 2000 (Appendix 12.8).
Thambiran N, Barclay SJ and Buckley CA*, Waste Minimisation Success at a Metal Finishing Company*, The Southern African Institution of Chemical Engineers, 9th National Meeting, Secunda, 9-12 October 2000.

5.4 *Workshops*

Barclay SJ and Buckley CA, *The Development of Waste Minimisation Clubs in South Africa*, Millenium Projects Workshop, Stellenbosch, South Africa, 18-22 July 1999.
Report Back on the Water Research Commission and European Union Project to Promote the Development of Waste Minimisation Clubs in South Africa, WRC Committee Room, Pretoria, South Africa, 21 October 1999 (Appendix 12.9).
Waste Minimisation Clubs: A Structured Approach to Waste Minimisation, Sasolburg, 6th March 2000.
Waste Minimisation Clubs: A Solution to Sustainable Industrial Development?, One Day Pre-Conference Workshop Held at WISA 2000 Biennial Conference, Sun City, South Africa, 28 May 2000 (Appendix 12.10).

5.5 Newsletters

Common Goal, February 2000 (Appendix 12.11).
Common Goal, July 2000 (Appendix 12.12).

5.6 Training

Waste Minimisation Modules 1 to 6 were given to Sasol, at Secunda, 16-17th October 2000.

Waste Minimisation Modules 1 – 7 are presently being given to Waste Minimisation Clubs now being established in Pietermaritzburg and Durban.

5.7 Other

Waste Minimisation Clubs: Information Sharing Evening, Westville Hotel, 23 May 2000. (Sponsored by the South African Water Research Commission).

Presentations on the success of the waste minimisation club concept have also been made at a number of meetings in Gauteng, Pietermaritzburg and Cape Town where interest has been expressed in establishing waste minimisation clubs.

5.8 Conclusions

The Dissemination Phase of this action has been extremely successful and the project methodology and results have been delivered to a wide audience through a variety of media.

Based on the dissemination of the success of the Hammarsdale and Metal Finishing Waste Minimisation clubs, two further Waste Minimisation clubs are to be established in KZN, a third in the Western Cape region and a fourth is proposed for the Gauteng region.

ANNEXURE 7
Summary Case Studies for the Metal Finishing Industry

by:

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May 2001

List of Case Studies for the Metal Finishing Waste Minimisation Club
The following table lists the summarised case studies for the Metal Finishing Club Members.

Case Study Number	Company Code
1	MF22
2	MF5
3	MF2
4	MF8
5	MF1
6	MF10
7	MF6
8	MF7
9	MF9
10	MF28
11	MF17
12	MF27
13	MF18
14	MF29
15	MF12
16	MF19
17	MF21
18	MF4
19	MF11
20	MF24
21	MF26
22	MF25
23	MF23
24	MF13

Waste Minimisation at an Electroplating Company (MF22)
Case Study 1
Metal Finishing Waste Minimisation Club

Background

MF22 is a small electroplating job shop situated in Seaview, Durban, South Africa. It was established in 1981 and employs 50 staff members. Articles are brought to the factory for plating or polishing by the customer. In general the customers are either not big enough to run their own plating section or the objects to be plated are difficult to handle. Many changes have been made to the factory over the years in order to maintain a leading position among the competing companies in the area. New sections have been added and the design of the existing sections changes regularly to meet the needs of the customer.

The Process

A large number of different processes are carried out in the factory. These include: zinc electro-galvanising; nickel plating; chrome plating; copper plating; cadmium plating (minimal); silver plating; gold plating; irridising; anodising; tin plating; and brass plating. Base metals include Steel, copper, brass, dicast alloy and aluminum. Both line (jig) and barrel plating takes place.

Objects plated include screwdrivers, electrical components, fences stove parts, screws and paraffin lamps and exhaust pipes etc. The factory must therefore be flexible in its process to accommodate these varying plating requirements.

Identification of Waste Minimisation Options

Prior to implementing a waste minimisation programme, the company had one water meter, which was recorded monthly by the local authorities, and there was limited control over water, chemical and energy use in the factory. Effluent discharge was a major concern to the company due to the implementation of new bylaws for discharge of industrial effluents to sewer. This was the main motivating factor for investigating reduction of waste at source.

A total of 25 waste minimisation options have been identified for the site. These are listed in Table 1. The majority were identified by the company themselves, with assistance from students.

Implementation of Waste Minimisation

Of the options identified, 23 have been implemented. The owner of the company was initially skeptical of the benefits of waste minimisation, but has since proved to himself and others that waste minimisation results in both financial and environmental savings.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Install drag-out tanks	Implemented
2. Reduce rinse water flow	Implemented
3. Change to counter flow rinsing	Implemented
4. Fix all leaks	Implemented
5. Close municipal tap at end of Zn line and use borehole water	unknown
6. Shut - off taps permanently that are not in use	Implemented
7. Monitor water use daily	Implemented
8. Install more water meters on incoming water	Implemented
9. Employ chemical storeman to control chemical use	Implemented

10. Install automatic crane over Cr bath to increase drip times	Implemented
11. Increase drip times over all baths	Implemented
11. Eliminate the use of cyanide	Implemented
12. Reschedule oven use to reduce heating costs	Implemented
13. Reuse Electro cleaner	Implemented
14. Slow down cranes on Zn line to reduce carry over	Implemented
15. Skim oil off Electro cleaner to prevent contamination	Implemented
16. Undertake staff training	Implemented
17. Rebuild floors	ongoing
18. Optimise hanging articles on the jig to improve drainage	Implemented
19. Redesign stoppers on screwdriver plant	unknown
20. Install effluent treatment plant to reduce SS	Implemented
21. Switch off rectifiers overnight	Implemented
22. Educate customers to use less harmful metals	Implemented
23. Improve insulation on all heated tanks	Implemented
24. Install thermostats to ensure tanks operate at optimum temperature	Implemented
25. Reuse rinse water in the trichloroethylene tank	Implemented

The areas chosen for investigation for improvement included:

- Water consumption (overall and in each department),
- Chemical control,
- Reducing metal concentrations to drain,
- Energy use, and
- Effluent control.

Water consumption:
The company now has 8 water meters, which are read on a daily basis, resulting in the identification of any problems as soon as they occur. Both municipal and borehole water are used in the factory, both of which are monitored. Water flows in all rinse tanks were adjusted to the minimum and unnecessary taps shut-off. Additional drag-out tanks were installed and rinse waters reused where possible. Counter-flow rinsing was installed where ever feasible. Targets for water use in each department were set and monitored on a weekly basis. This has resulted in a 70% reduction in municipal water use (from 2 700 kl / month to 800 kl / month), and a 50% (4000 kl / month to 2000 kl / month) reduction in borehole water use. There is a corresponding decrease in the volume of effluent discharged to drain.

Chemical control:
A storeman was employed to ensure that chemicals were used only when necessary resulting in baths being used to their full potential rather than being topped up or remade at random intervals. Installation of drag-out tanks, increasing drip times and reusing chemical baths has also resulted in less chemicals being wasted. These measures have shown an overall reduction in chemical costs (excluding metals) of between 10 and 15%.

Reducing metal concentrations to drain:
By installing an automatic crane above the chrome plating tank (see diagram on right), the articles are lifted out the tank at a controlled rate and allowed to drip-off over the plating bath for a longer period of time. This has resulted in less drag-out of the chrome salt and therefore less metals being discharged to drain. 25 kg of chrome is saved per month and a corresponding decrease in sodium meta bilsulphite has been achieved due to a reduced treatment requirement.

Replacement of the zinc cyanide plating process by the zinc alkaline process (see diagram on left) has decreased the concentration of zinc being discharged to drain and eliminates the need for cyanide. This has not resulted in a cost saving to the company, but has other benefits such as:

- Reduced metals to drain
- Eliminated the health risks of storing and using cyanide
- Eliminated the need to treat the effluent for cyanide

In addition, the company has managed to convince a customer to accept an alternative finish to cadmium plating. This has resulted in the use of the cadmium plating line being decreased from one day per week to the occasional job.

Energy use:
The company has embarked on an energy survey to identify all areas where heat is used in the factory. By rescheduling the drying of articles, an oven is now used only 3 hours per day, where previously it was left operating for 8 hours a day. Switching off rectifiers overnight has also resulted in energy savings. Insulation on heated tanks has been improved and thermostats installed to ensure that tanks operate at the minimum required temperature. An overall saving of 12% on the electricity bill has been achieved.

Effluent control:
An effluent treatment plant has been installed on site to ensure compliance with the new regulations for discharge to sewer. A filter press has been commissioned to remove the sludge and this is disposed of to landfill. While it is recognised that this is an end-of-pipe solution, it is important to note that by reducing waste in-house, the plant could be sized correctly and less treatment chemicals are required than previously.

Economic Benefits

Item	Saving (Approximate Rands / annum)	Pay-back
Water	60 400	Immediate
Chemicals and Metals	68 400	Immediate
Electricity	33 000	Immediate
Effluent charges	33 800	Immediate
TOTAL	**195 600**	

Environmental Benefits

- A reduction in Zinc metal to drain from 50 to 60 ppm to less than 25 ppm
- Eliminating the need for cyanide and therefore the related health hazards
- A reduction in the use of cadmium and therefore a decrease in its discharge to the environment
- A reduction of 275 kg / year of Chrome being discharged to drain
- A 70% reduction in water use from municipal sources
- A 50 % reduction in the use of river water (borehole)
- A reduction in the volume of effluent discharged to sewer
- A reduction in the use of electricity

Note:
This company has adopted a programme of on-going improvement and therefore changes are being made on a regular basis. This case study information summarises those results achieved from June 1998 to August 2000.

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This case study was sponsored by the South African Water Research Commission through Project No. 973: *Waste Minimisation and Effluent Treatment Clubs – Phase 1: Feasibility Assessment.*

Waste Minimisation at a Manufacturing Company (MF5)
Case Study 2
Metal Finishing Waste Minimisation Club

Background
MF5 is a small manufacturing company situated in Pinetown, South Africa. The company was established in 1980 and employs approximately 90 people. The company manufactures and plates zinc and steel trims (buckles, badges etc.) for the fashion industry, 20% of which is exported.

The Process

Raw material is brought in as metal ingots and undergoes a number of processes such as zinc casting (both spin and pressure die-casting); metal processing; tumbling and electroplating. Copper Brass, Zinc, Nickel, Silver or Gold plating may be carried out on the trims. Those areas that were identified as the main sources of waste were the tumbling (see diagram on left) and plating departments.

Identification of Waste Minimisation Options
The management of MF5 has committed themselves to a programme of waste minimization and a number of options to reduce water use and effluent production were identified and implemented.

The areas chosen for investigation included:
- Water consumption
- Effluent control, and
- solid waste disposal

A total of 11 waste minimization options were identified for the site. These waste minimization options are listed in the Table 1.

Implementation of Waste Minimisation
Of these waste minimisation options identified, 6 have been implemented by the company (summarised in Table 1). Savings in water, energy and chemicals have been realised and quantified in most cases. The factory has established a waste minimisation team who meet on a regular basis. Worker education has also been carried out to increase awareness of good management and environmental practices.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Replace automatic flushes in toilets with manual	Implemented
2. Recycle water from tumbling	Implemented
3. Cover hot tanks at night to reduce evaporation	unknown
4. Fix leaks	Implemented
5. Replace overflow rinses with static rinses	Implemented
6. Install drainage bars, and drip trays	Implemented
7. Install vaporiser to remove LPG from bottles	Implemented
8. Rationalise compressed air system to eliminate dead legs	Unknown
9. Install external insulation of hot wash tanks	unknown
10. Supply outside air to moulding chiller condenser coil	unknown
11. Optimise start-up times of electric furnaces	unknown

Water Consumption
The company has 5 water meters which are recorded on a daily basis. The overall water consumption has been reduced from between 16 to 18 kl/day to 10 kl/day by implementing a number of options. These include:

- installing new rinse baths and spray rinses,
- fixing leaks,
- introducing drag-out tanks;
- replacing automatic flushes in the urinals with a manual system (saving 3 kl/month) and
- recycling of water from the tumbling area (saving approximately 6 kl/day).

Recycling in the Tumbling Department
Tumbling is a process where deburring, polishing and paint removal of the trims occurs. The trims are place in mini-grinders with a grinding media and tumbled for between 1 and 2 hours depending on the finish required. Water is used throughout the grinding process to continuously remove the fine metal particles that are created during the deburring process. As a result, large volumes of water were consumed and a large quantity of sludge produced.

In an effort to reduce both the water use and the mass of sludge produced, methods of recycling this water were investigated. The solution was to install a filter press to remove the fine metal particles and recycle the water back into the process (see diagram on left). The sludge that is produced is more compact and dryer, resulting in less volume requiring disposal. Chemical costs are also reduced as less chemicals are required for effluent treatment.

The payback on this investment is of the order of 18 months.

Energy Consumption
Liquid Petroleum Gas (LPG) use has been optimised by the installation of vapourisers on the supply system, thereby ensuring complete emptying of the gas cylinders and less frequent replacements by the supplier. This resulted in a saving of R500 / month for the company.

Chemical Usage
Chemical use has been decreased through a number of measures, such as:

- The design of drip trays that can be placed under the barrels during decanting such that any excess solution drains back into the plating bath;
- Introducing drag-out tanks
- Testing of effluent prior to disposal, resulting in a saving of R 2 250 / month in effluent treatment costs

Economic Benefits

Item	Saving Approximate Rands / year	Payback
Water (Total) • Recycling • Fixing Leaks • Flushing system	8 000	18 months
Chemicals	Not quantified	
Energy	5 500	Immediate
Effluent (treatment)	24 750	Immediate
Total	**38 250**	

Environmental Benefits

- Water use decreased by 8 kl/day
- Less chemicals and metals discharged to the environment
- Less sludge being discharged to landfill

Contact Details

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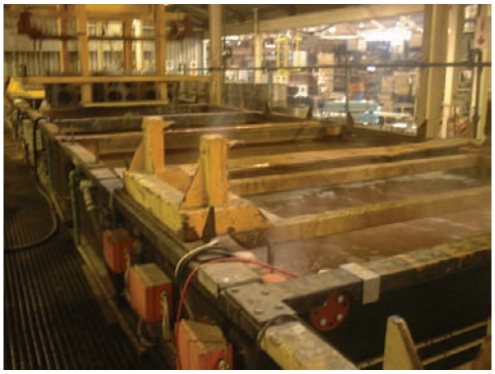
Waste Minimisation at a Large Manufacturer (MF2)
Case Study 3
Metal Finishing Waste Minimisation Club

Background

MF2 is a manufacturing company situated in Jacobs, Durban, South Africa. The company is approximately 50 years old and employs 800 people. MF2's primary concern is the production of household appliances such as stoves, washing machines, tumble dryers, air conditioners, and microwave ovens. Metal finishing is therefore only one part of the entire operation and facilitates pre-treatment and protection of the different appliance parts before assembly.

The Process

The main processes carried out on site include pressing, fabrication, plating, assembly and ballast weight preparation.



The metal finishing processes employed by MF2 are:

- A metal pre-treatment enamel line
- A zinc phosphate metal pre-coat treatment line
- A nickel/chrome plating line

All lines are automatic, although dosing of chemicals is carried out manually. These processes consume a great deal of water, energy, and chemicals, and contribute approximately 90 % of the company's waste. Therefore management at MF2 has made a commitment to waste minimisation, and as a result, their metal finishing processes have been investigated.

Identification of Waste Minimisation Options

Water and energy consumption and effluent discharge was of major concern to the company. Water has always been well metered at the factory. However, no steps were taken to counteract high water consumption prior to the implementation of waste minimisation.

The areas chosen for investigation included:

- water consumption,
- energy consumption,
- reducing metal concentrations to drain, and
- Effluent treatment and control.

A total of 54 waste minimisation options were identified for the site. These ranged from suggestions such as checking for leaks in the compressed air system, to installing counter flow rinse tanks. These waste minimisation options are listed in the Table 1.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Reuse acid rinse water for after electro-clean alkali process	
2. Alter arrangements of items on jigs to reduce carry over	implemented
3. Bund areas to prevent spillages entering sewer	
4. Replace some rinse tanks with spray rinses	
5. Prevent loss of empty chemical drums by storing them closer to the factory	
6. Reduce tank volumes	
7. Prevent evaporation by covering tanks when not in use	
8. Check concentration of Ni in plating bath on a regular basis	
9. Investigate replacement of hexavalent Cr with trivalent Cr	
10. Install conductivity controllers to monitor rinse flows	
11. Apply corrosion resistant coatings to all tanks	

12. Install a drag-out tank after Cr plating	
13. Use drag-out to top up Ni tank	
14. Install electricity meters on electric dryers, compressor house and powder coating lines	
15. Meter LPG use at painting and enamelling pre-treatment lines	
16. Eliminate use of compressed air for bath agitation and use high pressure blowers	implemented
17. Implement a programme to quantify, fix and monitor compressed air leakage	
18. Apply external insulation to pre-treatment dryers	
19. Reschedule dryer loading programme to maximise percentage utilisation	
20. Install counter flow and cascade rinses	
21. Increase drip times	implemented
22. Install water meters on plating and pre-treatment lines	
23. Install rotameters to measure flows	
24. Restrict flows to minimum requirements	
25. Install air restrictors	
26. Implement oil removal programme (use of newspapers)	
27. Turn off gas heaters when not in use	
28. Enforce safety regulations and kits	
29. Find a substitute for Tricholorethylene	
30. Install additional rinse tanks	
31. Install effluent pipes above ground	
32. Improve Ph control system on effluent	implemented
33. Conduct an air audit	
34. Investigate the possibility of suppliers taking back lubricants	
35. Investigate replacement of paint dip line by electro paint – coat	
36. Install UF on degreasing bath	investigating
37. Remove and reuse Ni	
38. Use only RO water on plating line	
39. Investigate LCA of products	
40. Control of waste bin so that only sludge is disposed of	implemented
41. Improve power factor	implemented
42. Control over dumping of baths such that permission must be obtained first	implemented
43. Worker education and operators given responsibilities for their lines	implemented
44. Replacing chemicals in phosphating line such that less sludge is produced	investigating
Waste Minimisation Option	**Status**
45. Implement a programme for regular maintenance and fixing of leaks	
46. Install a air scrubber over Cr tanks	
47. Repair carrier racks - the paint is chipping and can affect quality of plating	
48. Install drip trays between tanks to catch carry-over	
49. Check piping and joints for leaks	
50. Recycle drag-out on a regular basis rather than intermittently	
51. Install a drag-out after Cr tank and before passivation	
52. Install pressure gauge on incoming water to ensure pressure is constant for constant flow	
53. Modifying piping and removing excess	ongoing
54. Investigating dumping procedures and impact on effluent plant	ongoing

Implementation of Waste Minimisation

Of these waste minimisation options identified, 9 have been implemented by the company, 1 is under investigation and 2 currently being implemented (summarised in Table 1). Savings in water, energy and chemicals have been realised, although not quantified in all cases. Waste minimisation has been adopted by company management as a strategic business tool as the benefits to the organisation are self-evident.

Water Consumption

Despite an increase in production and the price of water, the overall water costs to the company has remained the same over the last year. There are 9 water meters, which are now read on a regular basis. Water is used mainly for rinsing purposes in the 3 metal processing lines. Measures have been taken to determine the rinsewater flowrates, and adjust them to the minimum flowrate necessary for adequate rinsing. This has resulted in a decrease in water use on each of the three lines. The introduction of cascade rinsing on the plating line and the installation of orifice plates in the tanks has resulted in a 39 % reduction in water consumption. Options for the reuse of rinse waters in the enamel metal pre-treatment line through the introduction of recycling have also been investigated. Decreases achieved to date are as follows:

- Plating line: from 75 kl/day to 46 kl/day (saving of 6 380 kl/year)
- Enamel pre-treatment line: from 30 kl/day to 18 kl/day (saving of 2 640 kl/year)
- Paint pre-treatment line: from 63 kl/day to 40 kl/day (saving of 5 060 kl/year)

The recycle system on the paint pre-treatment line has since had to be removed due to a build up of contaminants. In total, water use has decreased by 4 000 kl/month.

Energy Consumption

By implementing power factor correction an annual saving of R110 000 has been achieved for the company. A small blower has been installed on the plating line to agitate the baths in place of compressed air. A new compressor has been installed resulting in more efficient generation. The installation of heat exchangers on the paint and enamel pretreatment lines is being investigated.

Chemical Usage and Metals to Drain

Drip times have been increased on two of the three lines thus decreasing the drag-out. Drip times could not be increased on the paint pre-treatment line due to streaking. Jigs have been modified on the plating line so as to decrease the carry over of solution. In addition, operators have been made responsible for each of the lines and have to seek permission in order to dump baths – it no longer happens at irregular intervals. This results in baths being used to the full extent. Cleaners are reused where possible and only three quarters of an acid tank is dumped at a time and then topped up with fresh solution. All of these measures have resulted in a decrease in the use of chemicals (including metals), but this has not been quantified to date. The company is also currently investigating the use of ultrafiltration to extend the lifetime of the degreasing baths.

Effluent Treatment and Control

By preventing baths from being dumped at the discretion of the operator, there is no longer shock loading of the effluent treatment plant, resulting in more efficient treatment. Sludge from the various lines is segregated, enabling easier disposal.

Solid Waste Disposal

A waste skip is used by the company for the disposal of metal containing sludge. It was discovered that other types of solid waste were being discarded into this drum causing it to be collected at least 4 times a month for disposal. By placing the bin in a controlled area such that only sludge could be placed in it, the bin is now only collected once a month.

Economic Benefits

Item	Saving (Approximate Rands / annum)	Pay-back
Water	127 160	2 weeks
Chemicals and Metals	Not quantified	
Electricity	110 000	Immediate
TOTAL	**237 160**	

Environmental Benefits

- A reduction in metals to drain
- A reduction in water use
- A reduction in the volume of effluent discharged to sewer
- A decrease in solid waste disposal to landfill

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This case study was sponsored by the South African Water Research Commission through Project No. 973: *Waste Minimisation and Effluent Treatment Clubs – Phase 1: Feasibility Assessment.*

Waste Minimisation at a Manufacturing Company (MF8)
Case Study 4
Metal Finishing Waste Minimisation Club

Background

MF8 is a medium sized company situated in Prospecton, Durban (South Africa). There are approximately 190 employees and the company has been established for 30 years. Over 9 500 different products (fasteners, rivets, etc.) and 5 different rivet guns are manufactured on site. Of these, 25% is exported. The company is ISO 9000 accredited, has a NOSA 5 star safety rating and a less than 3 % in-house reject rate. The annual production is in the region of 530 million products, with an annual turnover of R 30 million.

The Process

Raw material in the form of wire is brought into the factory and undergoes a number of processes. These include cold heading, forming, degreasing, electroplating and assembly.

Zinc, nickel, copper, brass, and antique brass/copper plating is carried out on site. Zinc plating is the most frequently used line. Only barrel plating of the products takes place.

Identification of Waste Minimisation Options

The company has focused their efforts on improving the monitoring and control of all utilities and the manner is which the processes are conducted.

A total of 33 waste minimisation options were identified for the site. These waste minimisation options are listed in the Table 1.

Implementation of Waste Minimisation

Of these waste minimisation options identified, 15 have been implemented by the company (summarised in Table 1). It is important to realise, that although it seems as if few options have been implemented, large savings were realised by merely increasing management presence on the floor, improving monitoring and ensuring work practices were carried out correctly. Therefore, this may have been listed as one option in Table 1, but resulted in a number of spin-off savings. Worker education and training has also been undertaken so that the waste minimisation programme has been adopted at all levels of production.

Table 1: Summary of Identified Waste Minimisation Options

1. Increase drip time	
2. Investigate the use of an Electrowinning plant to recover metals	
3. Fix leak in rinsing tank	Implemented
4. Investigate oil leaks on machinery	Implemented
5. Keep records of water use and find meter	Implemented
6. Install an automatic controller on the rinse baths	
7. Ensure NaOCl is not stored too long as its activity decreases over time	
8. Improve monitoring and control of chemicals	Implemented
9. Improve management of shop floor	Implemented
10. Recycle treated water to rinses after degreaser	Implemented
11. Replace cyanide Zn with alkaline Zn	Discontinued
12. Automate effluent treatment plant	Implemented

13. Change type of oil used	Implemented
14. Consolidate solvent supplier	Implemented
15. Determine baseline data	Implemented
16. Install additional water meters on the 2 plating lines	
17. Install additional electricity meters to compressor house and annealing ovens	
18. Investigate the potential for electrical load management	
19. Ensure compressor air inlet filters are inspected and cleaned regularly	
20. Consider automatic control of compressor sequencing	
21. Apply additional external insulation to annealing ovens	
22. Apply insulating ball blanket to plating hot line washes	
23. Investigate local dedicated extraction units on plating lines	
24. Make more use of task lighting in production areas	
25. Investigate power factor correction	Implemented
26. Upgrade barrels	Implemented
27. Install drag out tanks	Implemented
28. Install drag in tanks	Implemented
29. Investigate alternatives to trichloroethylene	Investigating
30. Educate employees in waste minimisation	Ongoing
31. Install more rinse tanks	
32. Install spray rinses	
33. Install counterflow rinsing	

Water Consumption
Water consumption by MF8 has increased over the last year. Originally water from the clarifyer in the effluent treatment plant was reused for rinsing in the plating line. This was stopped due to problems being experienced with the change over to cyanide free plating. However, savings were initially achieved due to:

- Monitoring of water meter readings resulting in the observation that the company was being overcharged for water
- Fixing of leaks
- Adjusting water flows to the optimum level

Once all problems with the plating line have been overcome, options to recycle water will be investigated.

Energy Consumption
Power factor correction has resulted in a saving of approximately R 6 400 / month. Savings in liquid petroleum gas have also been realised (R 790 / month).

Chemical Usage
The largest savings have been achieved due to decreasing chemical use. This was achieved through:

- Increased monitoring – logs are now kept on chemical additions to the baths
- Preventing unnecessary dumping of solutions
- Increased supervision
- More frequent visits by supplier
- Investigating alternative sources of chemicals

Metals to Drain
The discharge of metals to sewer or landfill is of concern due to the environmental implications. As a result, methods of decreasing metal use have been investigated. Increased monitoring and improved control over bath additions have assisted in this process. The company also undertook extensive trials in replacing the cyanide-zinc plating process by alkaline zinc, which resulted in lower metal concentrations as well as

the elimination of the need for cyanide solutions. However, a number of problems are being experienced with this new technology and the company has since discontinued this process.

Oil Use
Initially different types of oils were used at various stages of production. One oil has now been identified that is suitable for all jobs resulting in lower costs as only one supplier is required. This was achieved through discussions with all foremen on site.

Solvent Use
Savings in solvents was achieved through a change in the supplier rather than through any process changes or adjustments. This can however be viewed as a waste minimisation activity as implementation of the programme has resulted in management investigating all areas where efficiency can be improved.

Effluent Disposal
Due to the increase in water use, effluent production also increased. However, due to the decrease in chemicals and metals discharged to drain, treatment costs and sludge disposal costs decreased by R 9 080 / month and R 2 810 / month respectively.

Economic Benefits

Item	Saving Approximate Rands / year	Payback
Chemicals	517 660	Immediate
Metals	168 630	Immediate
Energy	78 870	8 months
Oils	8 340	Immediate
Solvents	251 600	Immediate
Effluent treatment	99 880	
Sludge disposal	30 910	
Total	**1 151 890**	

Note:
Of these savings, R 630 000 was achieved within the first year of the project (August 1998 to August 1999).

Environmental Benefits:
As a result of the waste minimisation programme, benefits to the environment have also been realised. These include:

- A decrease in chemicals to drain
- A decrease in metals discharged to sewer or landfill
- Greater environmental awareness in the company

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Waste Minimisation at an Electroplater (MF1)
Case Study 5
Metal Finishing Waste Minimisation Club

Background
MF1 is a small family owned company that has been operating for approximately 8 years. It is a jobbing shop, which plates articles such as nuts and bolts, gates, burglar guards, components for vehicles; screws etc. Production varies from day to day and no records are kept on this data other than monthly turnover and number of customers.

The Process
The main processes are zinc and cadmium electroplating, both line and barrel plating. Articles are degreased, rinsed, plated, and passivated. The effluent is treated for cyanide and then discharged to sewer.

Identification of Waste Minimisation Options
A total of 25 waste minimisation options were identified for the site. These ranged from simple suggestions such as increasing drip times over tanks, to more capital intensive recommendations such as installing additional drag-out tanks. These waste minimisation options, together with the status of implementation are listed in Table 1.

Implementation of Waste Minimisation
Of the waste minimisation options identified, 10 have been implemented by the company (summarised in Table 1). Some savings in water and energy have been realised, while others are still being quantified. Water consumption has been reduced by 120 kl / month (1 320 kl / year) and energy by 1560 kWh / month (17 160 kWh / year).

Water Consumption:
Water use has decreased due to a number of actions been implemented. These include:
- Educating staff not to waste water
- Installing valves on water lines to reduce the flow into the rinse tanks
- Installing nozzles on the hoses used for rinsing
- Recording water use on a daily basis and informing the staff of their performance
- Recycling of cooling water though the installation of a cooling tower
- Re-use of drag-out baths to top-up plating baths

These efforts have resulted in savings of approximately R 7 500 / year in water and effluent disposal costs.

Energy Consumption:
Electricity costs have decreased due to the installation of timers on the heating tanks such that heating only takes place when necessary. This has decreased electricity costs by 25 %.

Table 1 : Summary of Identified and Implemented Waste Minimisation Options

Waste Minimisation Option Identified	Status
1. Install a drag-out tank after Zn plating	
2. Install timers on baths for heating	Implemented
3. Install eco rinse after rack plating	
4. Install eco rinse bath after barrel plating	
5. Increase drip times	
6. Replace flooring	Underway
7. Repair cracked baths	
8. Improve treatment for CN	
9. Implement a programme for cleaning and maintenance of tanks	
10. Install drag-out tanks	Implemented
11. Educate workers in waste minimisation	Implemented

12. Improve cooling tower operation - needs chemical treatment and install make-up and blow down	
13. Install counter flow rinsing in place of hose pipes	
14. Improve ventilation	
15. Install timers to regulate plating times	
16. Adjust speed of barrels to prevent spillages	
17. Install a sampling point for effluent samples	
18. Install valves on water lines to reduce water flow into rinsing tanks	Implemented
19. Monitor daily water use	Implemented
20. Install cooling tower and reuse water	Implemented
21. Remove oil from rinse baths	Implemented
22. Install an additional degreasing tank	Implemented
23. Monitor use of chemicals	Implemented
24. Install timer on compressor	
25. Install nozzles on hoses to reduce water use	Implemented

Chemical Consumption

Savings in chemicals have not been quantified at this stage. Re-use of the drag-out and monitoring of chemical use has been introduced.

Other Savings

The company was experiencing a number of problems with oil contamination of the plating baths. A number if measures have been taken to eliminate this problem, such as:

- Installing an additional degreasing tank
- Removing the oil from the surface of the baths with old newspapers
- Tilting the rinse bath to ensure the oil collected in one area and could be removed

This has prevented the contamination of the plating baths and eliminated the need to re-plate work that was spoilt by the oil.

Economic Benefits

Item	Savings (Approximate quantity / year)	Saving (Approximate Rands / annum)	Pay-back
Water	1 320 kl	7 500	Immediate
Energy	17 160 kWh	5 000	Immediate
Total		**12 500**	

Environmental Benefits

Savings to the environment include:

- Less use of water
- A reduction in the volume of effluent produced
- Less chemicals discharged to drain

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Waste Minimisation at a Tool Manufacturer (MF10)
Case Study 6
Metal Finishing Waste Minimisation Club

Background

MF10 is a medium sized company situated in Pinetown, South Africa. Its is a German owned company and has been operation for over 35 years. There are approximately 400 employees. The Company produces 1 600 different hand tools such as spanners and sockets, and tool boxes. These products are exported worldwide.

The Process

The raw material is bought in as metal sheets and bars. The main processes include drop-forging, socket pressing, induction heating, machining, metal hardening, electroplating, assembly, packaging and dispatch. Some powder coating also takes place on site.

The plating lines are automatically controlled and monitored. Nickel and Chrome plating of the tools takes place. Metal sheets are pretreated in a phosphating line prior to powder coating.

Identification of Waste Minimisation Options

The company has focussed on decreasing water use in the plating line and upgrading the effluent treatment plant. Options for decreasing energy use were also identified.

A total of 25 waste minimisation options were identified for the site. These waste minimization options are listed in the Table 1.

Implementation of Waste Minimisation

Of these waste minimisation options identified, 10 have been implemented by the company (summarised in Table 1). Savings in water and effluent have been realised.

Water Consumption

A number of changes have been implemented on the plating lines, resulting in a decrease in water consumption of between 20 and 35 %. Water used on the plating line is obtained from a borehole, therefore there are no charges on incoming water, only outgoing. Therefore, savings are quantified in terms of the decrease in effluent charges. These include:

- Replacing a static rinse with an overflow rinse, thus preventing the dumping of a full bath
- Installation of spray rinsing
- Reuse of drag-outs

The rinse water (municipal source) from the phosphating line is also being reused in the tumbling department.

Chemical Usage

Chemical use has also decreased due to better monitoring and use of drag-out tanks. The biggest saving has been in the decrease of treatment chemicals due to a decrease in the volume of effluent produced. The use of cyanide has been eliminated completely and a replacement for trichloroethylene implemented.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Increase drip times	
2. Use acid rinse for rinsing after cleaner	Investigating
3. Install counter flow rinsing on blackening line	
4. Cover baths to prevent evaporation	
5. Investigate recycling of Ni solution	
6. Alter arrangement of tools on jigs to minimise carry over of chemicals	
7. Change from Cr 6 to Cr 3 plating	
8. Separate hazardous and non hazardous wastes to reduce disposal costs	

9. Install meter on bore hole water	Implemented
10. Monitor chemical addition to ensure only required amount of chemicals are added	
11. Replace overflow rinse with spray rinse	Implemented
12. Eliminate the use of cyanide	Implemented
13. Replace trichlor with Formula 40	Implemented
14. Install controls on plating line to check temperatures and concentrations	Implemented
15. Evaporate Cr drag-out tank and reuse in plating tank	Implemented
16. Introduce small overflow rinse bath in place of static bath	Implemented
17. Operate filter press correctly to minimise sludge	Implemented
18. Reuse rinse water from phosphating in tumbling department	Implemented
19. Investigate reasons for 3 hour warm-up on furnaces for drop forging	
20. Introduce air blowers for agitation of plant blowers	Implemented
21. Use ball blankets to prevent evaporation on hot rinse baths	
22. Optimise compressor operation	
23. Conduct an audit on compressed air leakage	
24. Replace wide diameter lighting tubes with slimline ones	
25. Introduce a monitoring and targeting programme to relate production to utility use	

Effluent and Solid Waste

The company has made savings in effluent treatment and disposal due to a decrease in water and chemical consumption (and therefore less discharged to drain). Initially, the company was being charged R4.33/kl to discharge to drain, but this was reduced to R 1.10 in 1999. Therefore, for the first year of the project, the company saved R 15 000 in effluent charges, which then decreased to R 4000 per year from 1999. The filter press is now operating correctly, resulting in less sludge (since it is drier) that is to be dumped to landfill.

Economic Benefits

Item	**Saving Approximate Rands / year**	**Payback**
Water (due to recycling)	10 960	
Treatment Chemicals	10 260	
Effluent discharge	4 000	
Total	**25 220**	

Environmental Benefits:

As a result of the waste minimisation programme, benefits to the environment have also been realised. These include:

- Elimination of harmful chemicals such as trichloroethylene and cyanide
- Decrease in borehole water use
- Decrease in chemical consumption

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Waste Minimisation at a Trimming Manufacturer (MF6)
Case Study 7
Metal Finishing Waste Minimisation Club

Background

MF6 is a small (26 employees) owner-operated company situated in central Durban, South Africa. The business is approximately 15 years old, but the current owners have only been operating the factory for the last 3 years. The main products are decorative household items such as tablecloth weights, serviette holders, motives etc.

The Process

Raw material is brought in as metal ingots and undergoes a number of processes such as zinc spin casting; tumbling; grinding and electroplating. All silicone moulds are prepared on site (see picture on left). Nickel, brass and antique brass plating are carried out on site. Any other plating requirements are out-sourced. A wood working section has recently being commissioned to build boxes etc. that are required by the customer.

Metal waste is produced from the castings and reject articles. Zinc metal from grinding and polishing is melted and sold.

Identification of Waste Minimisation Options

The company has focused their efforts on improving the monitoring and control of water, electricity, and stock. This has resulted in an increase in profitability for the company.

A total of 18 waste minimisation options were identified for the site. These waste minimization options are listed in the Table 1.

Implementation of Waste Minimisation

Of these waste minimisation options identified, 8 have been implemented by the company (summarised in Table 1). Savings in water, energy and chemical costs have been realised, but not quantified in all cases. Worker education has also been carried out to increase awareness of good management practices.

Water Consumption

The building in which MF6 operates is shared by 3 tenants. Originally, MF6 was charged 95% of the water bill, with the remaining tenants paying the difference. Due to a water balance carried out in June 1998, it was realised that the company was being overcharged. As a result, a water meter has now been installed which is read twice a day. A saving of R 1000/month has been realised. Due to this increase in monitoring, water leaks have been detected and fixed.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Install separate water meter	Implemented
2. Increase barrel drip times	Implemented
3. Monitor chemical additions to tanks	Implemented
4. Install Cu & brass drag-out tanks	Implemented
5. Educate workers on waste minimisation	Implemented
6. Install Cu and brass drag - out tanks	
7. Use static rinse tanks after Ni plating	

8. Check the electrical wiring system	Implemented
9. Prevent evaporation losses by using a foam blanket	
10. Reduce hexavalent Cr to trivalent Cr	
11. Install a settling tank	
12. Install an automatic pH meter	
13. Improve surface of floor by using anti - corrosive covering	
14. Replace current timer on overflow rinse tanks with one that operates only when tanks are in use	
15. Establish a safe storage area for chemicals	
16. Use drip trays between tanks to reduce losses due to drag - out and spillages	
17. Implement a stock control system	Implemented
18. Redesign work flow	Implemented

Energy Consumption

As a result of the investigation into the water charges, the company called in an electrician to check on the electricity cables. It was discovered that as a result of incorrect wiring, MF6 was being charged for its neighbor's electricity. This has now been corrected. The savings have not been reported as yet.

Chemical Usage

Chemical use has been decreased through a number of measures, such as:

- Redesigning the work flow to reduce carry over and spillages on the floor
- Increasing drip times
- Installing additional drag-out tanks
- Increased control over chemical additions to bath

The chemical savings have not been quantified as yet.

Stock Control

By implementing stock control measures, the company has saved approximately R 5000/month. These included:

- Requisitions been prepared for each job
- Having a central control area
- Chemicals being added to the bath only when directed by the supplier and not on the initiative of the plater

Economic Benefits

Item	Saving Approximate Rands / year	Payback
Water	11 000	Immediate
Chemicals	Not quantified	
Stock control	55 000	Immediate
Energy	Not quantified	Immediate
Total	**66 000**	

Environmental Benefits

- Improved operating practices resulting in less chemicals and metals to drain

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Waste Minimisation at an Automotive Parts Manufacturer (MF7)
Case Study 8
Metal Finishing Waste Minimisation Club

Background
MF7 is a medium sized company (325 employees) situated in Pinetown, South Africa. It is 14 years old and manufactures car radiators and parts for airconditioners. Approximately 75% of the products are exported. The company is ISO 9000 rated and is currently preparing for ISO 14 000.

The Process
The main processes carried out include injection moulding, fabrication, braising and pretreatment. Some powder coating also takes place on site.

Identification of Waste Minimisation Options
This plant is well operated and maintained. Some waste minimisation options have been put forward to the company, the main one being to investigate the replacement of trichloroethylene with a less harmful substance.

Implementation of Waste Minimisation
The use of Trichlor as a degreasing agent was phased out over a period of time and replaced with Methaclone. This has resulted in the decommissioning of the pretreatment plant and as a result, there is no longer any effluent produced by the factory. The methaclone degreasing system is completely enclosed and any losses are due to evaporation through the extraction system. There are no disposal problems associated with this chemical as there were with trichlor.

Other changes made include rearranging the process flow on the factory floor and installing overhead conveyers. This has resulted in savings in production time.

Economic Benefits
The savings have not been reported as yet to the project team, but will include savings in effluent treatment costs and the cost of disposal of used trichlor, and production costs.

Environmental Benefits
- Elimination of Trichlor
- Elimination of effluent disposal

Note:
This company has only attended 3 of the waste minimisation club meetings, although is always interested in any new developments and willing to allow site visits by the project team.

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Waste Minimisation at a Valve Manufacturer (MF9)
Case Study 9
Metal Finishing Waste Minimisation Club

Background

MF9 is situated in Westmead, the industrial township in Pinetown, South Africa. The company manufactures automotive engine valves and exports worldwide. It is approximately 20 years old and employs in the region of 300 staff members.

The Process

Raw material is in the form of metal rods which are processed into automotive valves. The main processes include turning and milling, drop-forging, heat treatment, shot blasting, and chrome plating. The company shares a site with 2 sister companies. There is one water and one electricity meter for the site as a whole, therefore the individual companies do not have records of their water and electricity use. This makes quantification of savings difficult.

Identification of Waste Minimisation Options

A total of 17 waste minimisation options were identified for the site. These ranged from suggestions such as installing additional metering for utilities to redesigning jig orientation for better drip-off. These waste minimisation options are listed in Table 1.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Install automatic level controller in bath	
2. Redesign jig to improve draining	Implemented
3. Install a holding tank so that concentrated solution is stored rather than added to the drag-out tank	
4. Cover manhole to prevent spillage of effluent	
5. Read electricity sub meter on a daily basis	
6. Install additional electrical sub meters on tempering oven and compressor house	
7. Install dedicated site water meter	Implemented
8. Install dedicated plating meters to each line	Implemented
9. Correct power factor from 0.85 to > 0.95	
10. Insulate and cover hot wash bath in the forging department	
11. Consider additional insulation on tempering oven	
12. Alter product orientation in tempering oven to allow reduced convective loss	
13. Adopt a campaign to tackle compressed air leakage	
14. Apply insulating "ball blanket" to Plating line 2 rinse tanks	
15. Eliminate the use of compressed air for plating line agitation by installing high pressure blowers	
16. Install counter flows on plating lines	Implemented
17. Reusing caustic cleaner in forging department	Implemented

Implementation of Waste Minimisation

Of the waste minimisation options identified, 5 have been implemented by the company (summarised in Table 1). These have resulted in water and chemical savings.

Three water meters have been installed – two on the automatic chrome plating line and one on the manual line in order that the water consumption may be monitored on a regular basis. Counter-flow rinsing has also been installed on the plating line. Jigs have been modified to improve drainage and reduce carry-over. Savings have not been quantified as yet.

Reuse of caustic cleaner:

The caustic degreasing tank in the forging department used to be disposed of every 2 months and remade. The company now dumps 100 l of the 800 l at a time and tops up with fresh water and cleaner. This has saved 1 400 l of water and 15 kg (at R 11.70 / kg) of cleaner every two months (7 700 l / year and 82.5 kg / year cleaner).

The company has realised the importance of incorporating waste minimisation into the day to day operation of the business and is now ISO 14000 accredited.

Economic Benefits

Item	Savings (Approximate quantity / year)	Saving (Approximate Rands / annum)	Pay-back
Water	7 700 l	22	Immediate
Caustic	82.5 kg	970	Immediate
Total		**992**	

It must be noted that other savings were made by the company in water and chemicals, but that these were not quantified at the time of preparing this case study.

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Waste Minimisation at a Galvanising Company (MF28)
Case Study 10
Metal Finishing Waste Minimisation Club

Background
MF28 is a small jobbing shop situated in Durban, South Africa. It is 15 years old and employs 12 operators and 2 drivers. The main processes are zinc plating (galvanising) and powder coating. The annual turnover of the company is in the region of R 800 000.

The Process

MF28 is a job shop that provides galvanising and powder coating of metal objects for various customers. The objects being plated are mainly burglar guards and large gates, with some barrel plating of smaller objects. The main stages include caustic degreasing, acid pickling, zinc electroplating and rinsing. All operations are manual.

The company carries out white, black and brown powder coating. Approximately 90 % of the white powder is recovered and reused. Request for other colours are out-sourced.

Identification of Waste Minimisation Options
A total of 18 waste minimisation options were identified for the site. These ranged from increasing drip times to the repositioning of tanks to improve the workflow. A summary of these waste minimisation options are listed in the Table 1.

Implementation of Waste Minimisation
MF28 has 2 project champions; the owner of the company and the manager, who have made a commitment to implementing waste minimisation. They have been responsible for coordinating waste minimisation activities at the factory, and ensure that the workers are aware of the efforts being made.

Of those waste minimisation options identified, 8 have been implemented by the company (summarised in Table 1). Savings in water and chemicals have been realised.

Water Consumption
The company has realised a small saving in water use through the fixing of leaks of tanks and pipes, and increasing the awareness of good water management practices in the factory. These savings amount to approximately 220 kl / year.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Reposition tanks	
2. Monitor water consumption	Implemented
3. Install drip trays on floor to collect spills	Implemented
4. Install zinc dragout tank	
5. Improve ventilation in room housing cyanide zinc	
6. Install a bar above the zinc tank to increase drainage	Implemented
7. Restrict water used for rinsing with the hose	
8. Monitor chemical use	Implemented
9. Install drainage boards between tanks	Implemented
10. Train workers in waste minimisation	Implemented
11. Fix leaks in tanks and pipes	Implemented

12. Install spray rinses	
13. Remove oil from rinse tanks after degreasing	
14. Install air operated return pumps	
15. Redesign barrels	
16. Investigate the possibility of wall hanging rinse tanks	
17. Undertake a waste audit	Implemented
18. Undertake an energy audit	

Chemical Usage

Savings of R 1200 / month have been made in chemicals through the following actions:

- Monitoring chemical use
- Controlling dispatch of chemicals from the store
- Increasing drip times
- Installing drip trays on the floor to catch spillages
- Analysis of own baths
- Training of staff

This includes savings in zinc metal and treatment chemical costs which have not been quantified individually. Due to the introduction of these measures, cyanide consumption has decreased by approximately 40 kg / month, making a saving of R 350 / month.

Economic Benefits

Item	**Saving Approximate Rands / year**	**Payback**
Water	600	
Chemicals	13 200	
Total	**13 800**	

Environmental Benefits:

As a result of the waste minimisation programme, benefits to the environment have also been realised. These include:

- Less Zn to drain
- A reduction of cyanide to drain

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Waste Minimisation at a Powder Coater (MF17)
Case Study 11
Metal Finishing Waste Minimisation Club

Background

MF17 is a small owner-operated jobbing shop situated in Durban, South Africa. The company is 2 years old and has 7 employees. The main processes are pre-treatment and powder coating. The annual turnover is in the region of R 700 000.

The Process

In order to successfully paint a metal surface, the surface must be clean, free of oil, grease, scale, rust and finger marks. To achieve this, the articles undergo degreasing, derusting, phosphating and passivating processes. Rinses are carried out between each stage.

Powder coating then takes place in spray booths and the articles dried in an oven.

Identification of Waste Minimisation Options

A total of 10 waste minimisation options were identified for the site. A summary of these options is listed in the Table 1.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Increase drip times	implemented
2. Use rinse water to top up baths	
3. Ensure that no taps are left open when not in use	
4. Educate workers in waste minimisation	implemented
5. Install more rinse tanks	
6. Cover baths to reduce heat losses	
7. Remove oil from degrease rinse	
8. Undertake an energy audit	implemented
9. Monitor chemical addition to baths	implemented
10. Record water use daily	implemented

Implementation of Waste Minimisation

The owner of MF17 has made a commitment to implementing waste minimisation and undertakes regular staff training to ensure all employees are aware of good management practices.

Of those waste minimisation options identified, 5 have been implemented by the company (summarised in Table 1). Minor financial savings have been realised in terms of water and chemicals.

Water Consumption

Water use has been decreased from 4kl / day to 3 kl / day by reducing the frequency of dumping of rinse baths. Initially it was carried out on a daily basis, but are now dumped based on the contamination levels, which are determined by titration. This is a saving of R 70 per month on incoming water costs.

Chemical Consumption
Savings in chemicals have not been quantified as yet, but are minimal as the company monitors chemical use and bath addition closely. Drip times have also been increased to reduce the carry over.

Other Comments
The company monitors its water use by reading the water meter on a daily basis. Oven use is scheduled such that it only operates when full. When the factory was designed, the owner wanted to ensure that it was operated such that as little end-of-pipe treatment as possible was required.

The company initially operated an Electrocoating system, but has since sold the equipment as the costs of the chemicals were prohibitive and there were insufficient clients to justify its use.

The owner feels that the benefit to his company by this project has been an increased awareness of the pollution problems associated with metal finishing, information on waste minimisation and waste minimisation methods, and the improved relationship with his staff. He is not concerned that he is not making substantial financial savings.

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Waste Minimisation at a Hot Dip Galvaniser (MF27)
Case Study 12
Metal Finishing Waste Minimisation Club

Background
MF27is a hot dip galvanising company with an annual production of 6 000 tons and an annual turnover of R 9 million. There are 37 employees. Working hours are 7 to 4.30 pm and 7 pm to 6 am. All jobs are weighed after galvanising and articles ranging from bird cages to structural beams are received for processing.

The Process

The main processes include hot dip galvanising, pickling and passivation. The main chemicals used are hydrochloric acid, zinc chloride, zinc ammonia and passivation solution.

Grease and oil are removed from the surface of the steel to be galvanized in a degreasing bath and then rinsed. The rust and mill scale are removed from the surface by pickling in dilute hydrochloric acid. After pickling in the acid for 20 – 30 min, the work is rinsed and is then ready for fluxing in the flux bath. The purpose of fluxing is to remove or dissolve the oxides on both the steel and zinc surfaces, to ensure that the steel and zinc forms a pure metallic bond with each other. The temperature of the flux bath should be maintained between 75-80 ^{o}C.

After fluxing, the surface of the molten zinc is skimmed to remove oxides and flux residue (ash), before the work is dipped into the zinc bath. The temperature of the zinc bath is maintained at about 450 ^{o}C. The dipping time ranges from 2 to 8 minutes, depending on the thickness of the zinc layer to be produced. After withdrawal, the work is cooled in air and thereafter quenched in the passivator tank.

Identification of Waste Minimisation Options
A total of 8 waste minimisation options were identified for the site. A summary of these waste minimisation options are listed in the Table 1.

Implementation of Waste Minimisation
Of those waste minimisation options identified, 2 have been implemented by the company and further options are under investigation (summarised in Table 1). Savings in water have been realised and there are potential savings in Zn metal an electricity use.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Storing rinse water for reuse	See 4
2. Optimise orientation on the jig	Not known
3. Install counter current rinsing	Not feasible
4. Use rinse water to dilute the acid	Implemented
5. Reduce Zn splashing by predrying the work	Investigating
6. Fix all leaks	Not known
7. Investigate the use of gas to heat the Zn Kettle	Investigating
8. Education of the employees	Not known

Water Consumption
Municipal water is used for processing. It costs R 2.89 / kl and approximately 350 kl / month is used. This consumption varies depending on the jobs and the number of times an acid bath

needs to be remade (each tank holds 15 000 l of water). There is one meter on the main incoming line which is read once a month by the metro.

Previously, only fresh water was used to dilute the acid for the acid tank. Now, both water from the rinse tanks and fresh water (50 / 50) is used to prepare these tanks. This has resulted in a decrease in water use from approximately 500 kl / month to 350 kl / month. In addition, all liquid wastes (acid baths, rinse water etc.) is removed by an outside company for regeneration and therefore savings in disposal costs will also be realised due to less volumes requiring disposal. This has not been quantified in this case study.

Metal Consumption
Zinc metal is lost through *splashing* which occurs when the article is moved from the flux solution into the molten Zn. The installation of an oven between these 2 baths would assist in drying the article and raise its temperature, thereby reducing the splashing. This option has been investigated, but there is insufficient space for this installation.

By improving splash control, there is the potential for the company to save in the region of R 10 000 per month on the cost of Zn metal.

Energy Use
The kettle holding the molten Zn is operated at 450 to 460 ^{o}C and is electrically heated. As a result electricity costs are high. The company is investigating the use of gas to heat the tanks once the Sasol pipeline is complete. This will result in a 50 % saving in costs with a payback period of approximately 18 months due to the cost of installing a gas furnace.

Economic Benefits

Item	Saving Approximate Rands / year	Quantity Unit / year	Potential Savings Rands / year	Payback
Water	R 4 770	1 550 kl		Immediate
Energy			R 275 000	18 months
Metals		16 500 kg	R 110 000	
Total	**R 4 770**		**R 385 000**	

Environmental Benefits:
Possible benefits to the environment include:
- Less zinc metal discarded to land
- Decrease in water use
- Decrease in use of electricity

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Waste Minimisation at Galvanising Factory (MF18)
Case Study 13
Metal Finishing Waste Minimisation Club

Background

MF18 is a family owned business, established in 1996. It is a jobbing shop that carries out hot dip galvanising on heavy industrial goods. The company has the SABS mark and is ISO 9002 certified. The company is committed to protecting the environment and is involved in the environmental committee for the local park. The company operates 24 hours a day, 5 days a week in 3 shifts.

The Process

The items are first arranged on a jig so as to optimise the number of items galvanized at a single time. After the items have been jigged they are immersed into two degreasing tanks for approximately five to twenty minutes.

The items are then immersed in the first rinse tank. Here water is used to remove the chemicals that are carried over from the degreasing process. The items are now ready to be ‘pickled’ in a solution of hydrochloric acid and a pickling additive. The hydrochloric acid is discarded when the iron concentration is greater than 10% by volume. Five pickling tanks are available, however not all are used for a single job. The workpieces are then sent to a pickling rinse where water is used to remove the acid from the items.

Immersion in the flux follows the acid rinse. The flux is a solution of zinc chloride and ammonium chloride and operated at a temperature of around 80ºC. The flux prepares the items for the zinc bath by enhancing the bonding between the zinc and steel.

Galvanizing of the zinc onto the steel follows the flux process. This is the process of electrochemically plating the zinc onto the steel. The solution in the zinc bath needs to be at a temperature of 445ºC TO 455ºC. The solution contains molten zinc and traces of aluminium, cadmium, magnesium, iron, tin, lead and copper. After galvanising, the items are passivated.

Quality assessment is the final stage. If black marks, excess zinc lumps, bare spots, etc. are detected on an item, the item needs to be re-fraced.

Identification of Waste Minimisation Options

A total of 6 waste minimisation options were identified for the site. A summary of these waste minimisation options are listed in the Table 1.

Implementation of Waste Minimisation

Of those waste minimisation options identified, 1 has been implemented by the company and further options are under investigation (summarised in Table 1).

The company is in the process of reconstructing tanks and floors, and have enforced stricter control in the plant to improve on spillages and reduce waste. New chemicals are also been investigated to ensure that those that have a reduced environmental impact are used. No quantification of the savings have been reported to date.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Install counter - flow rinse rather than overflow	Not feasible
2. Recycling rinse water	
3. Install conductivity meter to control overflow rinse	
4. Use flow restrictors to regulate flow	
5. Replace degreaser chemical with alternative chemical	Investigating
6. Improve general housekeeping	Implemented

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Waste Minimisation at an Electroplating Company (MF29)
Case Study 14
Metal Finishing Waste Minimisation Club

Background
MF29 is a manufacturing company situated in Pinetown, South Africa, and employs 200 staff members. The main products produced by MF29 include burglar guards, security gates and garage doors. The products are mostly aimed at Urban communities were security is essential

The Process
The manufacturing process involves several stages including, cutting of raw materials, welding, epoxy coating, drying, electroplating and final assembly/dispatch. The phosphating and electroplating lines account for 80 % of the water use in the factory.

Identification of Waste Minimisation Options
A total of 13 waste minimisation options were identified for the site. There were based on observations made through site visits by an engineering student and an energy consultant. A summary of these waste minimisation options are listed in the Table 1.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Replace overflow rinse with 2 counterflow rinses	
2. Recycle acid rinse to degrease rinse	
3. Increase drip times to reduce carry over	
4. Replace existing compressor with a reciprocating compressor	
5. Conduct a compressed air leakage test	
6. Isolate extractor fans	
7. Install water meters on plating lines	
8. Use air blowers in place of compressed air for bath agitation	
9. Conduct combustion efficiency checks on drying ovens every 6 months	
10.Reduce air leakage and cold air intake from ovens	
11. Install gas metering to both ovens and monitor LPG usage	
12. Install metering on air compressors'	
13. Initiate a monitoring and targeting programme on site	

Water Consumption
The largest water consuming area in the factory is the phosphating and electroplating section, although the water use is not known. It was recommended that water meters be installed on these lines in order to measure and monitor water use.

All rinses on the lines are overflow rinses. By replacing these with static rinses, the water use can be reduced quite significantly. In addition, there is the possibility of recycling the rinse after acid pickling, to the rinse prior to the pickling process.

Energy Use
Energy use can be reduced on-site through better control of the use of compressed air and improving insulation on the drying ovens.

The implementation of a monitoring and targeting programme at the factory, whereby utility consumption is measured and monitored for the individual areas, would result in the realisation of savings through improved management.

Implementation of Waste Minimisation
Of those waste minimisation options identified, it is not known which have been implemented. There are potential savings in water, chemicals and energy (outline under economic benefits).

Economic Benefits

Item	Saving Approximate Rands / year	Quantity Unit / year	Potential Savings Rands / year	Payback
Water		6 600 kl	R 22 000	Not quantified
Energy			R 21 500	Not quantified
Total			**R 43 500**	

Environmental Benefits:
Possible benefits to the environment include:

- Reduced water use and reduced discharge of liquid effluent
- Reduced chemicals and metals to drain
- Reduced energy use

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Waste Minimisation at an Electroplating Job Shop (MF12)
Case Study 15
Metal Finishing Waste Minimisation Club

Background
MF12 is a small jobbing shop situated in Pinetown, South Africa. The company was established in 1968 and there are 30 employees. MF12 electroplates small to medium size metal objects for individuals and metal-working firms.

The Process

The main processes carried out at MF12 include zinc, tin and cadmium. There are 5 lines and both barrel and jig plating takes place. All operations are manual. The articles are received in the receiving bay, weighed and prepared for plating. The majority of plating is zinc (80 to 90 %) which is used to galvanise iron and steel to provide corrosion resistance (out-door furniture etc.). Cadmium plating is used for iron and steel products that are exposed to corrosive environments (marine environments etc.) and tin coatings are applied to those items that are in contact with food stuffs (cake stands, sieves, etc.).

Effluent from each of the lines is collected, treated, tested and discharged to sewer. Sludge disposal is still a problem that the company Is addressing.

Identification of Waste Minimisation Options
Prior to becoming a member of the Waste Minimisation Club in 1998, the owner of MF12 had already invested time and effort in reducing water use at the factory. When the company was purchased in 1995, the water consumption was approximately 31 kl / day, with an effluent tank holding volume of 20 kl / day and the condition of the equipment was poor, resulting in leaks and inefficient operation. In addition, the effluent did not comply with the limits set by the local authority for discharge to sewer. The owners therefore set themselves the priority of reducing water use and complying not only with the existing limits, but with the proposed new discharged standards.

On joining the waste minimisation club, focus was extended to other areas of the plant and a number of waste minimisation options were identified. These are summarised in Table 1.

Implementation of Waste Minimisation
Of the waste minimisation options identified, 13 options have been implemented. This has resulted in savings in water, chemicals, metals and effluent treatment charges.

Water Consumption
AS mentioned previously, the water consumption was excessive when the company was purchased by the current owners. By implementing a comprehensive water management programme, the water use has been reduced from 31 kl / day to approximately 5 kl / day giving a saving in the region of 550 kl / month. It must be remembered that there would be a corresponding saving in effluent discharged to drain, resulting in reduced effluent discharge costs. Changes that were implemented included educating the work force in waste minimisation practices, upgrading the water reticulation and cooling water systems, repairing leaking tanks, reducing spillages, reusing tanks where possible, and improving process flows. Financial savings are summarised under economic benefits.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Monitor chemical use in plating baths and effluent treatment	Implemented
2. Increase drip time to reduce drag – out	Implemented
3. Reuse rinse water from spray rinse	
4. Improve drainage system to reduce spillages on floor	Implemented
5. Immerse heaters in baths to ensure proper heating	
6. Insulate tanks	
7. Cover hot tanks to reduce evaporation	
8. Eliminate the use of Cd plating	
9. Educate employees in waste minimization	Implemented
10. Investigate alternative arrangements of pieces on jigs to improve drainage	
11. Introduce drip trays between tanks	
12. Replace leaking tanks in barrel line	Implemented
13. Install dragout and use to top up plating bath	Implemented
14. Correct process flow in cadmium line	Implemented
15. Investigate use of counterflow rinsing	
16. Replace the use of compressed air for tank agitation	
17. Investigate the use of cyanide free zinc	Implemented
18. Upgrade cooling water system	Implemented
19. Build a roof over the front yard to protect finished articles	Implemented
20. Install new water reticulation system	Implemented
21. Upgrade floor and bund tanks	Implemented
22. Use a drag-in; drag-out system	Implemented

Chemical Use

Savings in chemicals and metals were achieved at the same time as those in water, as reducing spillages, increasing drip times, fixing tanks, reusing baths and general education will also result in a reduced chemical and metal consumption. Other options introduced include the replacement of the zinc-cyanide plating line with a cyanide-free process and reducing re-processing of items by preventing rain damage after plating. These savings were quantified based on the concentration of metals in the effluent and the mass of zinc used to plate a certain mass of product. Based on these criteria, the mass of metals leaving the factory premises has reduced by 99% and 14% more product is plated per kg of Zn consumed. Overall, chemical and metal use has decreased by 10 to 15 %.

Treatment chemical use has also decreased due to the elimination of cyanide from the process and the reduced effluent volume. It must be noted that the owner realises that there is further scope to reduce treatment chemical use.

Economic Benefits

Item	Approximate Saving Rands / year	Quantity Unit / year	Payback
Water	R 17 300	5 980 kl	
Chemicals	R 30 800	Not quantified	
Metals	R 12 100	Not quantified	
Effluent treatment	R 33 000	Not quantified	
*Other	R 16 864		
Total	**R 109 764**		**11 months**

*Other = savings that have cannot be attributed to a single consumption.

These savings were achieved with a total capital outlay of R 97 640.

Environmental Benefits:
The implementation of these waste minimisation options have led to a number of environmental benefits. These include:

- Elimination of cyanide
- A 10 to 15 % reduction in metals to drain
- A 10 to 15 % reduction in chemicals to drain
- Reduced water consumption

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Waste Minimisation at an Electroplating Company (MF19)
Case Study 16
Metal Finishing Waste Minimisation Club

Background
MF19 is a small jobbing shop situated in Pinetown employing 14 staff members. The company was established in 1968, and purchased by the current owners in 1998. The main processes include nickel, chromium, copper and brass electroplating.

The Process
The company receives items from the public for electroplating. The main operations are grinding, degreasing, line plating and barrel plating. A powder coating line has also been purchased, but is not in operation as yet.

Identification of Waste Minimisation Options
Based on a waste minimisation survey, a number of options for improvement were identified. These are summarised in Table 1.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Increase drip times	
2. Reduce hanger area (Ni)	
3. replace water meter	
4. fix leaks	
5. install drip trays between baths to reduce water and drag - out losses	
6. install a timer to ensure correct duration for plating	
7. improve housekeeping	
8. Clean - up spills as they happen	
9. install a rack above the baths to ensure correct drip time	
10. Improve floor drainage systems	
11. Improve general cleanliness	
12. Install drip trays between tanks	
13. Rinse jobs over the tanks	
14. Install nozzles on hoses to limit flow	

Implementation of Waste Minimisation
As of August 2000, the company has not implemented any changes in the factory, although they were aware of the benefits of improving process efficiency. It is hoped that in time the company will realise the importance of waste minimisation in reducing their utility and chemical consumption and their pollution load.

Based on the waste minimisation survey, some potential savings were identified. These are summarised under economic benefits.

Economic Benefits

Item	Potential Saving Rands / year	Quantity Unit / year	Payback
Water & effluent	27 000		
Plating chemicals	31 000		
Total	**58 000**		

Environmental Benefits:
If a programme of waste minimisation was to be implemented, the following environmental benefits would be realised:
- Less chemicals to drain
- Less metals discharged to drain
- Reduced water consumption

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Waste Minimisation at a Manufacturing Company (MF21)
Case Study 17
Metal Finishing Waste Minimisation Club

Background

MF21 is a small manufacturing company situated in Pinetown, South Africa. They produce nickel rotary screens for textile printing and the sugar industry. The company was established in 1983 and there are 24 employees in the factory.

The Process

The main processes carried out include nickel electroforming, copper plating and hard chrome plating. A master screen is prepared first. The screen is machined to the correct proportions and then plated with copper to provide a soft surface for engraving. The pattern is then etched into the screen and the screen is chromium plated and baked. A non-conductive epoxy is sprayed onto the screen which fills the indentations formed by engraving. The screen is baked again and then ground to expose the chromium layer. Nickel plating is then carried out such that the nickel binds to the chromium and not the epoxy and in this way the mesh is created in the screen.

Master screens for the sugar nickel mesh are carried out by laser in Johannesburg.

Deionised water is used in all tanks due to quality requirements.

Identification of Waste Minimisation Options

Based on a waste minimisation survey, a number of options for improvement were identified. These are summarised in Table 1.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Switch to spray rinsing	
2. Rinse jobs over baths to reduce drag-out	
3. Install drag-out tank after nickel baths	
4. Reduce hexavalent Chrome before discharge	
5. Improve use of drag-out tanks after chromium	Implemented
6. Recycle acid rinse water for after alkaline bath	
7. Recycle additional cooling water in sugar chromium plating tank	
8. Fit spray nozzles to all rinse and washing hoses	
9. Fix all leaks and tanks	Implemented
10. Install additional drag-out tank after chrome plating in sugar-screen plating side	Implemented

Implementation of Waste Minimisation

Of the options identified, 3 have been implemented. This has resulted in savings in water and chrome salts, although these savings have not been quantified as yet.

Metal Consumption

A drag-out tank has been installed after the chrome tank in the sugar-screen plating section and an additional drag-out tank has been built and is ready for installation. This second drag-out will be used to top up the first drag-out and in this way save on the use of chromic acid. With the installation of the first drag-out, approximately 20 kg of chromic acid is saved / month.

Effluent treatment

In terms of the new regulations, the nickel and chrome streams are separated, a roof has been built over the effluent tanks and bunding of the tanks has been carried out.

Economic Benefits

Item	Approximate Saving Rands / year	Quantity Unit / year	Payback
Water			
Metals		220 kg	
Total			

Environmental Benefits:
The following environmental benefits have been realised:

- Reduced discharge of chrome to drain
- Separation of effluent streams for correct treatment

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Waste Minimisation at an Electroplating Company (MF4)
Case Study 18
Metal Finishing Waste Minimisation Club

Background

MF4 is a job shop situated in Durban, South Africa. The company was established in 1982 and there are 10 employees. A variety of objects of different shapes and sizes are electroplated. The company is ISO 9000 accredited, and is audited every 6 months. The annual turnover is in the region of R 1 million.

The Process

Zinc plating is the major process employed with some tin, nickel and cadmium plating taking place. There is a barrel as well as jig operated zinc line. The main processes include degreasing, rinsing, pickling, electroplating and passivating. Jobs are charged based on mass.

Identification of Waste Minimisation Options

A number of waste minimisation options have been identified at the company. These are summarised in Table 1.

Table 1: Summary of Waste Minimisation Options

Waste Minimisation Option	Satus
1. Improve floor drainage	
2. Install flow restrictors on hose pipes	
3. Increase drip times	
4. Install draining boards between tanks	
5. Install overhead draining bars	
6. Monitor water use	
7. Fix leaks	implemented
8. Investigate the use of spray rinsing for large jobs	
9. Educate workers in waste minimisation	
10. Change overflow rinses to static rinses	implemented
11. Install and use drag-out tanks	implemented
12. Monitor chemical consumption	implemented
13. Optimise chemical concentrations in the tanks	implemented
14. Rotate barrels out of solution to increase drainage	implemented
15. Monitor electricity use	implemented
16. Investigate the installation of transformers	investigating
17. Investigate the reuse of treated effluent for cleaning	investigating

Implementation of Waste Minimisation

Of these options identified, 7 have been implemented to date, with savings in water, chemicals and electricity reported.

Water Consumption

Previously, all of the rinses on the plating line were overflow rinses, resulting in excessive use of water. These have since been replaced with static rinses. Drag0out tanks have been installed and this saves water and chemicals. All leaks in taps, pipes and tanks have been fixed. The reuse of treated water for cleaning purposes is also been investigated. Approximately 200 kl / month water is being saved (and therefore a saving on effluent disposal).

Chemical Consumption

MF4 has saved 50 % of their monthly chemical costs by monitoring their chemical consumption and optimising the chemical concentration in all the tanks. Tanks are tested on site on a daily basis and it has been found that less chemicals are required than is recommended by the chemical supplier. In addition, on the barrel plating line the barrels are rotated as they are lifted out of solution so as to increase the drainage.

Energy Use
By monitoring the electricity consumption on a monthly basis and reporting their readings to the municipality, the company is saving in the region of R 8 000 / month. They are also investigating the installation of transformers.

Economic Benefits

Item	**Saving Approximate Rands / year**	**Quantity Unit / year**	**Potential Savings Rands / year**	**Payback**
Water	5 500	18 000 kl		Immediate
Energy	88 000			Immediate
Chemicals	110 000			Immediate
Total	**203 500**			

Environmental Benefits:
An effluent treatment plant is currently being installed to treat the effluent to the required standards for discharge to sewer. By reducing water and chemical use at source, the treatment costs will be reduced and there will be less metals and chemicals being discharged to drain.

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Waste Minimisation at a Powder Coater (MF11)
Case Study 19
Metal Finishing Waste Minimisation Club

Background
M11 is a small powder coating operation situated in Durban, South Africa. It was established in 1981 and employs 50 staff. The company powder coats aluminium and galvanised steel objects. Some of the main customers include the sugar and motor industry. It is ISO 9002 accredited and has the SABS mark.

The Process
The main processes carried out on site are metal cleaning and powder coating. The items are first degreased, pickled, phosphated, and passivated. Once cleaned, the objects are hung on jigs which are charged with an electric current. An epoxy-based powder is then sprayed onto the items. AN electrostatic filed is generated, which causes the power to stick to the object. The coated items are then cured in an oven at high temperature.

Identification of Waste Minimisation Options
Some waste minimisation options were identified for this site and these are sumarised in Table 1.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Change overflow rinse to static rinse	
2. Replace solid baskets with porous ones to reduce carry over	
3. Re-arrange bath dumping procedure to reduce pH of effluent	
4. Use rinse water to top up baths	

Implementation of Waste Minimisation
As of August 2000, it was not known if the company had implemented a waste minimisation programme on site, of if any savings had been achieved. There is the potential to save in water, chemicals and treatment chemicals.

Economic Benefits

Item	Approximate Saving Rands / year	Potential Saving Rands / year	Quantity Unit / year	Payback
Water		13 200		
Treatment Chemicals		40 200		
Total		**53 400**		

Environmental Benefits:
The implementation of waste minimisation could lead to the reduction in metals and chemicals to drain and less use of water.

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Waste Minimisation at an Electroplating Shop (MF24)
Case Study 20
Metal Finishing Waste Minimisation Club

Background

MF24 is a small jobbing shop situated in Pinetown, South Africa. It was established in 1985 and there are 13 employees. The company is a family owned and operated business, and has turnover in the region of R 100 000 / annum. Approximately 20 to 25 tons are processed per month.

The Process

The company carries out zinc electroplating on various articles. Jigs are prepared to suit the jobs received. All items are hand washed prior to processing. The main processes include degreasing, pickling, electroplating, passivating and rinsing. Items are dried outside in the air under a shelter.

Identification of Waste Minimisation Options

Some waste minimisation options were identified for this site and these are sumarised in Table 1.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Install overhead rack to reduce carry over	
2. Use float controls to reduce spillages	
3. Improve drainage from floors	Implemented
4. Monitor water use	Implemented
5. Resurface floors	Implemented
6. Use drag-out to top up process baths	Implemented
7. Introduce incentive scheme for workers	Implemented
8. Fix tanks and leaks	implemented
9. Investigate the use of alkaline zinc plating	
10. Build shelter for drying area	implemented

Implementation of Waste Minimisation

The owner of the company is committed to implementing waste minimisation on site. An incentive scheme has been introduced for the employees to improve on housekeeping issues and reduce water use. Minor savings in water and chemicals have been made, but the owner feels he has benefited from the exchange of information and advice on waste minimisation issues.

Water Use:

Water consumption has been decreased by 25 to 30 % through improved housekeeping such as fixing leaking tanks, ensuring taps are not left running unnecessarily and reusing the drag-out baths to top up the processing baths. Water meter readings are also taken on a weekly basis by the company to monitor water use. A saving of approximately R 550 / year has been made (190 kl / year).

Chemical Use
Chemical consumption has also reduced by 25 to 30 % by reducing drag-out and carry over and reusing baths. This amounts to a saving in the region of R 220 / year.

Economic Benefits

Item	Approximate Saving Rands / year	Potential Saving Rands / year	Quantity Unit / year	Payback
Water	550		190	Immediate
Chemicals	220			Immediate
Total	**770**			

Environmental Benefits:
Due to improved housekeeping, resurfacing of floors and the installation of an effluent treatment plant, the following environmental benefits have been realised:

- Reduced chemicals to drain
- Less metals to drain
- Reduced risk of spills entering the storm water system

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Waste Minimisation at an Electroplating Company (MF26)
Case Study 21
Metal Finishing Waste Minimisation Club

Background

MF26 is a small jobbing shop situated in Durban, South Africa. The company employs 6 workers and is owner-operated.

The Process

Items are received from the public. The main processes are grinding and polishing, with silver, nickel, brass, copper and chrome electroplating taking place.

Identification of Waste Minimisation Options

Some waste minimisation options were identified for this site and these are sumarised in Table 1.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Install water meter	not feasible
2. Insulate electroplating tanks	
3. Increase drip times to reduce drag-out	
4. Reposition work tanks to reduce spillages onto the floor	
5. Use rinse baths to top up process baths	
6. Top up drag-out tanks with rinse water	
7. Install Ni drag-out	implemented
8. Install additional rinse baths	implemented
9. Install triggers on hoses	implemented
10. Monitor hypochlorite use for neutralising cyanide	implemented
11. Use Chrome drag-out as a drag-in	implemented

Implementation of Waste Minimisation

Of the waste minimisation options identified, a few have been implemented to date, resulting in savings in water and chemicals. These have not been quantified as yet.

Water Use:

Water consumption has decreased due to installing triggers on hosepipes for rinsing and using drag-out baths to top-up the processing baths.

Chemical Use

Chemical use has been reduced through the use of drag-out tanks, implementing the drag-in; drag-out system on the chrome line and monitoring the use of hypochlorite for treating cyanide in the effluent to ensure that only the necessary amount is added. This has resulted in less of this chemical being purchased, amounting to a saving of approximately R 550 / annum.

Economic Benefits

Item	Approximate Saving Rands / year	Potential Saving Rands / year	Quantity Unit / year	Payback
Water	Not quantified			
Chemicals	550			Immediate
Total	**550**			

Environmental Benefits:

- Less water used
- Reduction in metals to drain

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Waste Minimisation at a Manufacturer (MF25)
Case Study 22
Metal Finishing Waste Minimisation Club

Background
MF25 is a manufacturing company situated in New Germany, Durban (South Africa). The company was established in 1950 and have been at the present site since 1970. There are 60 employees and the main products manufactured are accessories for busses and trucks such as mirrors, roof racks, etc. Electroplating constitutes only a small part of the business.

The Process
Raw materials are received in the form of stainless steel, aluminium, brass etc. and sent to the pressing shop were the various parts are manufactured. They are then cleaned and polished to remove any abrasions and defects. Some parts are then electroplated, others are sent out for powder coating, and others are phosphated and painted. Once the required finish has been added, the parts are assembled and dispatched.

Electroplating forms a small part of the business, with chrome, zinc and phosphating taking place on site approximately 3 days a week. Tanks are heated by steam generated by a 1 ton boiler.

Identification of Waste Minimisation Options
Some waste minimisation options were identified for this site and these are sumarised in Table 1.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Increase supervision	
2. improve layout of tanks to ensure correct process flow	
3. mixing and topping up of tanks should be done with more care to prevent spillages	
4. check for leaks on a more regular basis	
5. increase drip times	
6. do not fill the tanks completely as most jobs are small	
7. keep tanks at optimum temperatures	
8. solutions should be covered to prevent contamination	
9. Train staff in waste minimisation	
10. Investigate feasibility of continuing the use of the boiler	
11. Investigate out-sourcing of electroplating	

Implementation of Waste Minimisation
To date, no waste minimisation options have been implemented on site. Although the Production Manager sees the benefits of making changes, the company owner has no interest in implementing a waste minimisation programme. There is the potential to save in water, chemicals and energy, especially if the electroplating is out-sourced and use of the boiler is discontinued.

Energy use
The boiler is used to heat the baths in the Electroplating shop and steam is only required for approximately half an hour in a day. The oil costs in the region of R 1.70 / l to purchase, giving an annual cost in the region R 94 000. If the electroplating was out-sourced, the boiler could be discontinued.

Economic Benefits

Item	Approximate Saving Rands / year	Potential Saving Rands / year	Quantity Unit / year	Payback
Energy		94 000		Immediate
Total		**94 000**		

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Waste Minimisation at an Electroplater (MF 23)
Case Study 23
Metal Finishing Waste Minimisation Club

Background
MF23 is a small jobbing shop situated in Durban, South Africa. There are 15 employees and the company carries out mainly copper, nickel and chrome electroplating. The main market for this company is the general public who bring in items for plating. These include car parts, silver dinner sets, brass ornaments and jewelry. The company does have a few standing orders for plating screws, zips and nuts and bolts.

The Process
Depending on the size of the items to be plated, they are either plated in a barrel or a tank. Small items such as screws, zips, springs etc. are barrel plated, whilst larger items are plated in a tank. The shape and size of the articles plated varies greatly. The metals plated are copper, nickel, chrome, brass, silver and gold. With the exception of aluminium, all other base metals are plated.

Identification of Waste Minimisation Options
Some waste minimisation options were identified for this site and these are sumarised in Table 1.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Fix all leaks	Not known
2. Shorten hooks	Not known
3. Install rack above tanks to increase drip times	Not known
4. Investigate use of spray rinses	Not known

Implementation of Waste Minimisation
As of August 2000, it is not known is any waste minimisatin options had been implemeted as the company stopped attending waste minimisation meetings.

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Waste Minimisation at a Hard Chrome Company (MF13)
Case Study 24
Metal Finishing Waste Minimisation Club

Background

MF13 is a small jobbing shop, situated in Pinetown, South Africa. The company was established in 1964, and has been on the current premises since 1973. There are 10 employees and the company carries out grinding and hard chrome plating on items for the earthmoving industry and hydraulic companies.

The Process

Machine parts for reworking are first ground down on lathes to remove the worn, damaged metal. Thereafter the jobs are cleaning by wiping with a cloth soaked with thinners. Sections of the job which are not to be plated are painted with Fortolac Stopping-Off lacquer and covered with stopping-off tape. Any holes in the job are filled with polystyrene (except those very small holes). Cleaning and lacquering of smaller parts are performed on a workbench, while the larger jobs are placed over the rinse tank.

Once cleaned, the jobs are then placed in the plating bath. Large jobs are hung from a pulley while the smaller parts are tied to wires and hung from rods which lie across the baths. All jobs are hung in the vertical position. The jobs are secured in position by means of vice grips.

The first process which occurs in the plating tanks is etching. This is performed by reversing the polarity of the plating bath for 1 - 2 minutes. The duration of etching is determined by the type of metal of the job. The plating tanks operate at between 45 and 60 ^{o}C. The bath is kept within this temperature range by a cooling coil connected to a cooling tower. The plating process takes several hours and the jobs are usually left in the tanks overnight and also over the weekend. This means that the cooling water is run continuously. Once the plating is completed, the jobs are lifted out of the bath and while suspended above the bath, the jobs are rinsed off with the water from a drum next to each plating tank. The jobs are then taken to a rinse tank and rinsed off with water from a hose. The rinse water is pumped to the rinse water effluent tank which stands at the back of the factory.

Identification of Waste Minimisation Options

The company uses very little water. The main costs are in terms of the energy required to heat the tanks. A few waste minimisation options were identified. These are sumamrised in Table 1.

Table 1: Summary of Identified and Implemented Waste Minimisation Options

Waste Minimisation Option	Status
1. Use rinse water effluent to top up the plating tank	
2. Recycle rinse water through cooling tower	Implemented
3. Install nozzles to hosepipes	
4. Rinse job over tank	Implemented
5. Remove tape and rinse over tank	Implemented

Implementation of Waste Minimisation

Some waste minimisation options have been implemented on site, resulting in savings in water. These include recycling the rinse water through he cooling tower rather than using fresh water. In addition, items are now rinsed over tanks such that the solution can be collected and reused. The actual savings have not been quantified.

The owner feels that he has benefited from taking part in the waste minimisation club through an increased awareness of waste minimisation aspects, and tries to incorporate this into the day-to-day operation of the business.

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Waste Minimisation at a Powder Coater (MF16)
Case Study 25
Metal Finishing Waste Minimisation Club

Background
MF16 is a small powder coating company situated in Pinetown, South Africa.

The Process
The main processes carried out are phosphating and powder coating. The items are first treated in a 7-stage phosphating line, then sprayed with a powder coating and baked in an oven at 190 to 200 ^{0}C to cure.

Identification of Waste Minimisation Options
The owner of the company is committed to waste minimisation, but finds quantification of the results difficult. Each day is different in terms of the jobs he receives, which results in fluctuations in production and costs. Some waste minimisation options were identified for this site and these are sumarised in Table 1.

Table 1: Summary of Identified Waste Minimisation Options

Waste Minimisation Option	Status
1. Read water meter	
2. Monitor chemical use and addition	
3. Replace overflow rinses with static	implemented
4. Use rinse baths to top up baths	implemented
5. Remove excess oil with newspaper	implemented
6. Recover powder	implemented
7. Control oven use	implemented
8. Improve quality control	implemented
9. Train workers in waste minimisation	implemented
10. Reduce carry over by increasing drip times	implemented
11. Reduce evaporation by covering open baths	implemented
12. Improve insulation to prevent heat losses	implemented

Implementation of Waste Minimisation
Of the options identified for the site, 6 have been implemented, resulting in savings in water, chemicals and energy.

Water Consumption
Previously, the rinses on the phosphating line were overflow rinses, which led to large volumes of water being used on a daily basis. By changing these rinses to static rinses and using them to top up the treatment tanks, 30 kl / month of water has been saved. Workers have been educated on good housekeeping practices to reduce spillages.

Chemical Consumption
The company has reduced their chemical use by 20 %. This has been achieved through reducing the carry over, using the rinse tanks to top-up the treatment baths and better control during powder coating. Quality control and monitoring has also been improved, resulting in less rejects. In addition, customers have been educated in the requirements for powder coating, resulting in cleaner steel being used during the manufacturing process, and therefore less chemicals are required in the phosphating baths. White powder is also recovered through a closed cyclone system. The reported savings in powder use is R 8 000 / month. Savings in chemicals have not been reported.

Energy Consumption
Energy use has been decreased through better control over oven use, improving insulation and covering heated baths. Savings have not been quantified as yet, but were projected to be in the region of R 17 000 / year.

Economic Benefits

Item	Approximate Saving Rands / year	Potential Saving Rands / year	Quantity Unit / year	Payback
Water	1 000		330 kl	
Powder	88 000			
Energy		17 000		
Total	**89 000**	**17 000**		

Environmental Benefits:
The environmental benefits include:

- Reduced water use
- Reduced energy use
- Less chemicals discharged to drain
- Reduced air pollution due to controlled powder spraying and recovery

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ANNEXURE 8
Summary Case Studies for the
Hammarsdale Waste Minimisation Club

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May 2001

List of Case Studies for the Hammarsdale Club

The following table lists the summarised case studies for the Hammarsdale Waste Minimisation Club.

Case Study Number	Company Code
1	COMP1
2	COMP6
3	COMP5
4	COMP3
5	COMP7
6	COMP2
7	COMP4
8	COMP8

Waste Minimisation at a Chemical Manufacturer (COMP1)
Case Study 1
Hammarsdale Waste Minimisation Club

Background

COMP1 is a speciality chemicals company who has occupied the present site in Hammarsdale for 16 years. It employs 50 site personnel and operates continuously 24 hours per day. The majority of site production takes place within batch reactors, with over 300 raw materials chemicals being blended and processed to produce a range of over 250 chemical products. Annual production is around 17.4 million kg of finished product, comprising boicides, defoamers and industrial water treatment chemicals.

The company is conscious about pollution and environmental compliance and have adopted an environmental management system that led to ISO 14000 accreditation in 2000.

The Process

The reaction centre is essentially made up of a collection of batch reactors. A modern control system is installed and is essential to avoid thermal runaway of the exothermic reactions. Each reactor is equipped with indirect steam heating and cooling facilities, which are monitored and controlled by the system.

Water Use and Effluent Production

Water usage is metered at the mains inlet and at sub-meters on the boiler make-up water and factory (process) water. The latter is read daily, the remaining 2 meters are read monthly.

The local waste water treatment works refuses to accept effluent from this site for reasons of high COD and oil content. Two effluent streams are generated: a biocide effluent and an oil-based mixture of aqueous and hydrocarbon components. Part of this effluent is distilled and the aqueous component is reused in the rinse operations. The remaining 4 to 5 m^3/day is sent to an effluent pond, where the separated hydrocarbons are removed from site by tankers. Annual effluent removal costs are in the region of R160 000. Effluent treatment costs are of the order of R 140 000 / yr, which also takes into account labour and occupancy of the vessels.

Energy Use

The batch reactor heating and cooling requirements place a significant energy demand on the small plant. Electricity usage presently represents a cost of around R233 000 per annum. The major power users are refrigeration, motors, pumps, etc. for process requirements. Compressed air requirements are small for this process.

Steam is generated via a packaged gas oil fired boiler. Gas oil costs are R457 000 per annum. The majority of steam generated is used within the reactor vessels themselves and for steam tracing/storage tank heating. Condensate return is good and known to exceed 90%. It is intended to install an electronic level gauge within the gas oil storage tanks in order to provide a greater degree of accuracy in monitoring and targeting of fossil fuel usage and steam generation.

Identification and Implementation of Waste Minimisation Options

The site has adopted a consistent, methodical and rigorous approach to waste minimisation. It has targeted itself as a zero-effluent site and is working toward this objective. The Waste Minimsation team comprises the company's Environmental Coordinator (Project Champion) and a small number of key personnel from the relevant site departments.

Since undertaking their Waste Minimisation programme, the site team has identified and implemented the following savings measures:

Improvement in boiler efficiency

The original 2 tonne/hour steam boiler was approaching the end of its useful lifetime and was beginning to cause problems with steam quality and overall efficiency of generation. The plant was removed and replaced with a modern packaged boiler of approximately the same rating. This measure had an immediate cost saving in terms of improved boiler efficiency (steam generation reduced from 4.5 hrs to 2 hrs) but has also enabled reduced processing times, due to improved steam quality. Cost savings have been realised in gas oil (R 17 500 / annum) and production time (R1 130 000 / annum).

Reduced effluent generation

This has been implemented mainly through improved housekeeping and working practices. These include the manufacture of similar products back-to-back, in order to minimise wash requirements between batches, the use of a high pressure unit for cleaning, and collection of rinseates for re-use. The result has been a 20% decrease in effluent to disposal.

Reduced water use

This decrease in effluent production implies a corresponding decrease in water use. This was calculated by determining the volume of effluent saved and adding 5% to allow for any evaporative losses through the process.

Improvements through raw-material changes

The feedstock for one site process had previously taken the form of chemical constituent in powder form. The nature of the feedstock and its packaging had resulted in considerable packaging waste and raw materials wastage. An investigation was carried out into possible alternatives and it was decided to adopt a liquid-phase constituent, as a trial. The trial has proven successful and has been fully implemented, resulting in savings in production time (reduced from 4 hrs to 30 minutes), health monitoring and waste disposal.

Decrease in waste to landfill

In addition to packaging waste savings as a result of the raw material change described above, the site has specified to its suppliers the use of metal drums for feedstock. The previously used "fibre" drums were simply disposed of to landfill. This has resulted in a 35% reduction in waste volume sent to disposal.

Reduced cleaning water consumption
Water requirements for wash-down and cleaning have reduced as a result of the new effluent management programme described above. The company has not yet been able to calculate the exact volume and cost saving associated with this.

Air emmissions
A new chiller unit has been installed which has resulted in a 25 % decrease in air emmissions.

Economic Benefits

Item	Saving Units / year	Approximate Saving Rands / year	Payback
Energy		1 151 700	5 months
Water		5 500	Immediate
Effluent	20 %	171 300	1.5 months
Raw materials	48 %	109 620	Immediate
Air emissions	25 %	30 500	2.6 years
Solid waste	35 %	9 100	Immediate
Total	**-**	**1 47 7720**	**-**

Environmental Benefits:
As a result of the waste minimisation programme, benefits to the environment have also been realised. These include:

- Reduced effluent to disposal
- Reduced boiler stack emissions to atmosphere
- Reduced landfill volumes
- Reduced emissions from processes
- Improved health and safety standards on site

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Waste Minimisation at a Textiles Company (COMP6)
Case Study 2
Hammarsdale Waste Minimisation Club

Background
COMP6 has been operating since the early 60's in Hammarsdale and employs 510 staff in total. The factory operates 24 h /d and closes on public holidays and for 3 weeks during shutdown. The annual turnover is approximately R 140 million, with a production of 2 400 tons / year of finished product. The main product is terry toweling, which is made into towels and nappies.

The Process
Weaving, knitting, sewing, batch piece dyeing, yarn dyeing and finishing is carried out on site. The majority of processing takes place on 100 % cotton, with a small amount of polyester and nylon also being processed. A form of regenerated cellulose (similar to viscose) is also being investigated to add strength to the toweling. Vat dyes account for 80 % of the total use, with the other 20 % being reactive dyes.

Water Use and Effluent Production
Between 6 000 and 7 000 kl of water is consumed per week, at a cost of R2.50/kl. There are 10 water meters installed on site, which are read on a weekly basis. Effluent production is taken to be approximately the same as water usage. The total cost of water, water softening, effluent production and treatment is R2 300 000 per annum. Effluent treatment (dosing with sulphuric acid) accounts for R100 000 of this total.

Energy Use
Electricity costs are in the order of R1 200 000 per annum. There are two sub-meters on site for the electrode boiler and the other for the main site, which are both read monthly.

Steam consumption is between 3 and 10 tonnes/hour. The annual cost of steam generation is R2 300 000 per annum. There is a single steam meter on the boiler header measuring steam into the dyehouse. The meter is read monthly by the Contract Energy Management (CEM) contractor who installed and maintains the boiler. The boiler was installed at zero cost to the company, who pay a set charge of R5 500 per month for maintenance of the boiler and R42 per tonne of steam generated.

HFO is used to fire a thermal fluid heater serving one stenter, which is required to operate at high temperature to heat-set polyester. HFO costs in the region of R280 000 per annum.

There are two 200cfm compressors on site. Compressed air costs approximately R70 000 per annum. There are no air meters on the system.

Materials Wastage
Redyes account for less than 2% of the total production; this has fallen from a figure of 8% since improvements have been made. The reject rate stands at 3% of production. These are sold as rejects to the public. Cut-offs (2-3%) consisting of yarn and fabric are also sold.

Identification and Implementation of Waste Minimisation Options
All options listed here were identified and implemented by the company themselves.

Raw Material Consumption
Improved housekeeping measures have resulted in raw materials wastage reduction from 6% to 2.5%, equivalent to 84 tonnes per annum of thread and an annual cost saving of R1 428 000.

Water Consumption
A number of options have been implemented to reduce water use. These include:

Fixing of water leaks
By installing an additional meter on the fire mains, a substantial leak was noted and fixed. This leak amounted to 20 kl / week (1 040 kl / year). The savings in this case amounted to R 5 200 / year. By implemented a good water management programme, other leaks were also identified and repaired.

Recycling of cooling water and clean water
By reusing the cooling water and the last rinses, between 3 to 4000 kl / week of water is saved. This amounts to approximately 171 500 kl / year and a saving in the region of R 857 500 / year. Capital outlay was small, and the return on investment almost immediate.
Energy Use
The main energy savings at this site have arisen through the installation of an electrode boiler. Whilst the actual steam generation cost per tonne have increased, the overall cost has reduced through the number of savings that have arisen. These savings have been made achievable due to:

- Improved steam quality
- Improved steam pressure regulation
- Reduced labour costs

The steam pressure and quality improvements have had a direct impact upon the percentage redyes necessary. Redyes have reduced from 8% to less than 2% resulting in a combined energy, water and dyestuffs saving of approximately R1200 000 per annum.

Condensate return has been increased from 12% to 60%. This saving was achieved through good housekeeping measures such as attention to leaks and steam traps. The saving achieved has been in the region of 300kl per week condensate returned to the boiler. This has resulted in cost savings of R36 700 per annum in water savings and approximately the same in energy savings.

Economic Benefits

Item	**Savings (Approximate Rands / annum)**
Water	900 000
Raw materials	1 400 000
Energy	36 700
*Other	1 200 000
Total	**3 536 700**

* other refers to savings that were made in water, chemicals, dyes and energy and could not be attributed to one single item.

Environmental Savings
- A 40 l / kg reduction in water use and therefore effluent production
- A reduction in chemicals and dyes to drain due to decrease in redyes
- Less emissions to air through installation of the electrode boiler

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Waste Minimisation at a Textiles Company (COMP5)
Case Study 3
Hammarsdale Waste Minimisation Club

Background

COMP5 has been occupying the present site sine June 1998. Full production is being phased in over a 5-year period and the company is therefore only expected to be completely on line towards the end of 2002. There are currently 140 employees on site, with an expected total of between 400 and 500 when fully operational. Estimated turnover will be R12 million per annum, with a production throughput of some 330,000,000 metres per year. Currently the production throughput is 5,000 metres per month with a limited turnover due to start-up and commissioning constraints.

The Process

No weaving / knitting takes place on site, only batch dyeing, finishing and printing. Polyester and poly-viscose blends are processed. Disperse and reactive dyes make up the majority of the dyes used. Equipment in the dyehouse includes 7 rotojets; 7 long tube jets; 7 atmospheric jets and 3 L-boxes.

Water Use and Effluent Production

The current water use is 27 000 kl / month. Effluent production is taken to be the same volume. It is estimated that 230 kl / h will be consumed when fully operational. There are 4 water meters on the site - one main meter, one to each department and one on the boiler feed water. They are read monthly The site took the decision not to install additional metering on the dyeing machines.

Energy Use

Electricity cost is in the region of R25 000 per month. There are 5 internal meters in addition to the main incoming meter, which are read monthly.

Steam usage is difficult to quantify due to varying production during site commissioning, but is estimated at between 2 000-3 000 tonnes per month. Steam costs are linked to consumption and during January 2000 the cost of steam was R85/tonne. It is expected that this will reduce to R40/tonne on an ongoing basis. There are two steam flow meters, which are read monthly

Identification and Implementations of Waste Minimisation Options

A total of 9 waste minimisation options have been identified for the site, both by the project team and the company themselves. These options have focussed on water and energy use.

Waste Minimisation Team

The site's Waste Minimisation team meets monthly to discuss progress. The team is comprised of key representatives from engineering, health and safety, finance, maintenance and the two main production departments.

Water Consumption

A number of options to reduce water use have been identified, and some implemented. These include:

- Reusing cooling water on roto jet machines could save approximately 47 kl/day (R 139/d)
- Reuse of pre-dye rinse water will result in an estimated saving of 70 kl/d (R 206 / d)
- Reuse of stenter cooling water will give an estimated saving of 24 kl/d (R 71 / d)
- Introduction of a water management programme by an external consultant who has guaranteed the company an immediate saving of at least 40 %.
- Installation of nozzles on water hoses (implemented, but not quantified)
- Installation of additional water meters

Energy Use:

Options to reduce or optimise energy use have been identified. These include:

- The installation of a unit which automatically monitors the efficiency of the boiler. Each boiler requires one unit, at a capital cost of R 16 000. The suppliers guarantee a saving of R 54 000 / month in addition to the environmental savings

- Installation of further metering to enable monitoring and targeting
- Investigation of opportunities for heat recovery

Economic Benefits

Item	**Saving Units / year**	**Potential Savings (Approximate Rands / annum)**	**Payback**
Water	51400 kl	114 000	
Energy	178,00 tonnes steam	594 000	2 months
Total		**708 000**	Immediate

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Waste Minimisation at a Denim Factory (COMP3)
Case Study 4
Hammarsdale Waste Minimisation Club

Background

COMP3 has been in operation in Hammarsdale since 1962 and currently employs some 680 staff. The site is in continuous operation, 24 hours per day, and produces 8 million kg of yarn per annum, equivalent to about 13.2 million metres of finished textiles of various types.

The Process

The site manufactures cotton yarn from raw materials and carries out projectile and airjet weaving to manufacture woven textile. The subsequent processes performed include bleaching and scouring, mercerising, washing, dyeing and finishing.

The process uses 3 jig dyers, each with 6000 metres per day capacity, and 2 padder dyers, each with a capacity of 70 metres per minute. The majority of dyes used on site are reactive (65%) with the remainder comprising Sulphur and vat dyes.

Water Use and Effluent Production

Annual water usage in the various processes is 980 000 kl/y, at an approximate cost of R2.6 million/y. There are 66 water meters installed throughout the site and these are read weekly with the objective of assembling a water mass balance for the process. Effluent discharge is taken to be the same as water consumption and this accounts for an additional cost of R3.4 million/y.

Energy Use

Electricity cost is R3.6 million/y. There is a single meter covering the entire site. Energy is used primarily for driving process equipment, compressed air generation, and provision of air conditioning and lighting.

Steam is generated via coal-fired, chain-grate stoking boilers. The total steam production for the site was 143,200 tonnes, in 1999, at a total cost of R2.5 million (R38 per tonne). There are two steam meters installed, one for each dyehouse, which are read weekly.

Identification and Implementation of Waste Minimisation Options

The site commenced their Waste Minimisation activities during the early part of 2000. At that time a small site team was assembled, comprising members of the Engineering Department.

The identification of savings measures was reasonable straightforward at this site and the team soon recognised that their immediate priorities were immediate remedial action to repair steam and water leakage (which had been neglected for several years) and much closer attention to improving condensate return. Prior to January 2000, condensate return was know to be as little as 15%.

Steam Leakage Repair

The team went about a rigorous schedule of identification, recording and tagging of steam leakage. This was essential so that the limited site shut-down period could be used to maximum benefit. Having completed the initial programme of steam leakage repairs, the site team monitored the ongoing steam demand and noted a reduction of 12% upon previous figures. This is equivalent to an energy saving of over 15 million kWh/y, and a water saving of over 17 000kl/y.

Water Leakage Repair

The existence of numerous water meters enabled the site team to pinpoint leakage problem-spots with relative ease. Again, leaks were tagged and noted in readiness for repair during shut-down periods.

Additional efficiency measures were also implemented on the water distribution system, such as automatic feedwater shut-off systems for certain plant that operated sporadically.

Electricity Good Housekeeping
The site team observed that several significant electrical loads associated with production plant, etc. were habitually allowed to run regardless of production requirements. A site-wide plant shut-down procedure was introduced for integration into the standard operational procedures. This simple, zero-cost measure alone saved 11% of total site electricity consumption; a cost saving of over R396 000 per annum.

Raw Material Use
A programme has also been implemented to reduce waste of raw materials through improved housekeeping measures. It is estimated that this will save R 3 million/y once operational in all departments.

Other Options
The company is also investigating the installation of a caustic recovery plant to enable reuse of the caustic used in mercerising. This will reduce the amount of caustic entering the treatment works and therefore result in less use of sulphuric acid for pH reduction.

Economic Benefits

Item	Saving Units / year	Saving Rands / year	Payback
Fossil fuels	15 000 000kWh	300 000	<1 month
Water	637 000kl	1 680 000	< I month
Effluent	637 000kl	2 210 000	< I month
Electricity	4 200 000kWh	396 000	< I month
Total	**-**	**4 586 000**	**-**

It is worth noting that the savings achieved to date are equivalent to 2% of this company's annual turnover, and were achieved at little or no cost.

The headline savings figures shown above bear testament to the effectiveness of a well-managed and well-structured Waste Minimisation approach, and are a credit to the team who identified and implemented them. At a Club Steering Group meeting in May 2000, the Project Champion was able to advise all club members that total savings in the first quarter of the year had exceeded R1.2 million.

Environmental Benefits:
As a result of the waste minimisation programme, benefits to the environment have also been realised. These include:

- Reduced boiler stack emissions through reduced steam requirements
- Reduced effluent to drain
- Reduced chemical usage for boiler water treatment

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Waste Minimisation at a Commission Dyehouse (COMP7)
Case Study 5
Hammarsdale Waste Minimisation Club

Background

COMP7 is a family owned business which has occupied the present site since 1994. There are 4 companies on the one site. COMP7 carries out the wet processing for each of these other 3 companies, and takes in commission dyeing. A portion of the site is also rented to a chemical mixing company.

The company employs 120 people, and works 24 hours / day (2 shifts), 5 days per week. Depending on production, this may be increased to 6 days. The annual turnover of the company is approximately R 30 to 40 million, and approximately 1 650 tons / year is processed at the plant.

The Process

COMP7 carries out bleaching, scouring, dyeing, washing and drying. No specialty finishes are applied. They also bleach the cotton wool for Willcotex and dye the acrylic fibre for Unipile. These products are then returned to the respective companies for further processing.

Most processing takes place on 100 % cotton knits produced by Mortex, although some polyester and polycotton blends are dyed. Commission dyeing accounts for approximately 35 % of the total production, and may include some woven textiles (approximately 10 % of total production). Bleaching of cotton wool and dyeing of acrylic fur also takes place. Although all fabric is bleached prior to dyeing, approximately 30 % of the fabric is bleached only.

Only batch dyeing operations take place. Equipment used includes jets (some atmospheric and some high temperature), winches, package dyers and dryers. Water use in the machines is determined by the liquor ratio and not a set volume. Redyes account for 7 % of the production, but rejects stand at only 0.5 %.

Water Use and Effluent Production

Water Use:

The factory is currently using 900 kl / day, 500 kl/d of which is consumed in the dyehouse. There are 3 water meters which are read on a daily basis. Two of these meters are on the main municipal water supply (there are two incoming lines) and the third is on the water supply to the dyehouse. Apart from one jet, there are no individual meters on the machines in the dyehouse. The site is billed as one entity, and there are no meters for each of the other companies.

The cooling water from the machines is recycled. It enters into a large open dam and is then pumped back to the dyehouse. Bore hole water is used to top-up if necessary. Discharge temperature is approximately 50 deg C.

The floors in the dyehouse are washed 3 times a day. No overflow rinsing takes place, other than when sulphur dyeing takes place. There is no reuse of process water and only fresh cold water is used for the dyehouse equipment.

Effluent and Solid Waste Disposal

The effluent volume is not recorded or monitored. The company is charged on incoming water use. No treatment takes place other than dosing with sulphuric acid and some settling. There is no effluent segregation. The company has received complaints on the pH of their effluent from time to time, but there has been no pressure to reduce colour of salt loading from Umgeni water.

Sludge from the effluent tanks is disposed of twice year and is removed by a waste disposal company. Actual volumes are not known.

Off-cuts (4 to 5 %) are sold to the public. Other solid waste is removed and dumped on the landfill. The quantity is not known.

Energy Use
Electricity costs are approximately R 70 000 / month (for the site). There is one main meter for the site. Steam is used to heat the dye vessels and there are 2 boilers - one 10 ton coal fired boiler (1000 kPa), and one 5 ton oil fired boiler which is used as a standby. There is also a boiler for heating furnace oil for one of the stenters. LPG gas is on standby for the stenters. There is one steam meter.

There are 2 condensate return tanks. This returned water is softened and then sent to the boilers. There are 2 compressors on site as compressed air is used in the dyehouse and for knitting.

Identification and Implementation of Waste Minimisation Options
Based on site visits to the factory a number of waste minimisation options were identified. In addition, the company has also identified and implemented changes. In total, 26 options were identified and these are listed in Table 1 together with their Status as of October 2000.

Of these options, 2 have been implemented, 2 are under investigation, and the status of the remaining 24 are unknown. This does not necessarily imply that they are not being implemented, but that the status has not been reported to the project team.

The use of low salt dyes has resulted in savings of 5 to 10 tons of salt per month. This was achieved by:

- Reducing salt from 100 g/l to 80 g/l on dark shades;
- Reducing salt from 30 g/l to 20 g/l on light shades; and
- Reducing the liquor ratios in the dying vessel's.

The liquor ratios on some of the dying vessels have been reduced from 10:1 to 6:1 with no loss of quality. This was not successful on all machines and the company has made the decision to invest in newer equipment where lower liquor ratios are possible.

The company is also investing replacing their coal fired boiler with an electric boiler.

Table 1: List of Identified Waste Minimisation Options

Option	**Status**
Adjust boiler pressure to max required	Not known
fix all steam leaks	Not known
improve lagging on steam pipes	Not known
increase condensate recovery	Not known
fit automatic blow down controller	Not known
undertake a steam trap survey	Not known
run combustion efficiency checks on the boilers	Not known
reduce temperature in stenter in some zones	Not known
install baffles on stenter to reduce air loss	Not known
investigate use of vacuum slots to pre-dry fabric	Not known
fit a condenstae trap on the air compressor	Not known
clean air compressor inlet	Not known
inspect for compressed air leaks	Not known
isolate stand-by dryer when not in use to reduce stream use	Not known
investigate use of evaporative cooling towers	Not known
install additional metering on utilities	Investigating
implement a programme of M&T	Not known
sweep floors prior to washing	Not known
implement a recording system in the dyehouse to monitor chemical use	Not known
install air extraction units	Not known
fix all water leaks	Not known

segregate streams for effluent treatment	Not known
improve general housekeeping in the dyehouse kitchen	Not known
use low salt dyes	Implemented
reduce liquor ratio	Implemented
Investigate use of an electric boiler	Investigating

Economic Benefits
Actual savings have not been calculated, and therefore the savings reflected here are potential savings based on the implementation of the options listed in Table 1.

Item	Potential Savings (Approximate Rands / annum)
Water	146 000
Energy	278 000
Total	**424 000**

Environmental Savings
Based on the waste minimisation options implemented, the following savings to the environment have been achieved:

- A reduction in the mass of salt discharged to sewer (which is beneficial to the Waste Water Treatment Works as salt is not removed in the treatment process and enters the receiving water body downstream from the WWTW); and
- A reduction in water use due to the lower liquor ratios.

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Waste Minimisation at a Thread Manufacturer (COMP2)
Case Study 6
Hammarsdale Waste Minimisation Club

Background

COMP2 is a medium-sized textile company, which employs 428 staff and produces approximately 1 million kg of yarn per annum. It is part of an international group of companies and as such, it is required to deliver performance figures in terms of water use, energy use, waste, etc. per kg product. This information is auditable and is used for benchmarking against other similar group companies in Mid East, Far East and Asian Sub-continent (some 12 companies).

Process

COMP2 receives raw material in the form of fibres, and spins these fibres into yarn of varying tex (thickness). The yarn is also treated and dyed as required. Processes that are carried out on site include spinning, bleaching, scouring, dyeing and finishing. The majority of the fibre is polyester (70%) and the remainder is cotton (20%) and nylon. As a result, 80% of the dye used is disperse dyes. Redyes stand at 10% and rejects at 6%.

Water Use and Effluent Production

Approximately 105 000 kl/year of water is used. There are 5 water meters on site which are read on a weekly basis. Effluent discharge is taken to be 90% of the incoming water volume and is treated with sulphuric acid to adjust the pH prior to discharge to sewer.

Energy Use

Electricity use is of the order of 20 000 MWh/year. There are 3 electricity meters that are monitored monthly. Steam is generated on site by a heavy fuel oil-fired boiler. There is one steam meter which is read weekly, although boiler operation is monitored daily by means of a running chart. Fuel oil costs are approximately R 600 000 per year.

Identification and Implementation of Waste Minimisation Options

The focus of the waste minimisation programme at COMP2 has been mainly on the reduction of energy use although it is realised that there are benefits to be gained by investigating savings in water, dyes and chemicals. In addition, the company has installed a software programme to enable monitoring and targeting of utility use and this programme has highlighted areas where waste is occurring when it would normally not have been noticed.

Options that have been implemented, or which are under investigation are given in Table 1 together with their status.

Table 1: List of identified waste minimisation options

Option	Status
Initiate a monitoring and targeting programme	Implemented
check power factor correction	Implemented
monitor fuel oil use	Implemented
install heat exchangers to recover energy	Investigating
fix leaks in boiler house	Investigating
install addition metering	Investigating
improve condensate return	Not known
improve steam distribution lagging	Not known
eliminate use of compressed air for bath agitation	Not known
improve lighting	Not known
isolate steam using equipment when not in use	Not known
Train staff and management	Implemented

Power Factor Correction
By ensuring that the power factor was correctly set, the company has saved R 143 000/year. This was at no cost to the company and the benefit realised immediately.

Installation of Heat Exchanger
The installation of a heat exchanger on the effluent leaving the factory has been investigated in order to recover energy to heat the water entering the dyehouse. The project has reached the design phase, although has been put on hold due to budget constraints.

Savings in Fuel Oil
The use of the Monitoring and targeting programme highlighted that fuel oil was being wasted in the boiler house. It is not known what the potential savings are in this area.

Water savings
A number of water leaks were identified in the Boiler House on the site and the volume of water wasted quantified. For this section only, approximately 670 kl/y.

Economic Benefits
Due to the lack of information available, only the savings achieved through power factor correction can be reflected here.

Item	**Saving Rands / year**	**Payback**
Electricity	143 000	Immediate

Environmental Benefits:
By implementing a programme of waste minimisation, COMP2 can contribute to the environment by:
- Reducing water use and effluent discharge
- Reducing dyes and chemicals discharged to drain
- Reducing boiler stack emissions

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Waste Minimisation at a Speciality Textiles Company (COMP4)
Case Study 7
Hammarsdale Waste Minimisation Club

Background

COMP4 is a large textile manufacturing and processing site which supplies specialty fabrics to a niche market. The products include high-tech fabrics such as bulletproof Kevlar, nylon fabrics for medical use and parachute fabrics. The total staff compliment is 530, and total recorded production amounts to over 9 million metres per annum of dyes and finished fabric. The process is complex and intensive due to the large quantity of recipes and qualities that are required to be manufactured. A comprehensive WIP tracking system has been adopted via use of SAP and a bar-code system is use for capturing chemical and dye usage throughout the process. The company is ISO 14000 accredited.

The Process

The main factory operations are: yarn storage, warping & sizing, weaving, “Greige” fabric inspection, dyeing and finishing, inspection and dispatch. The primary raw materials are yarn (nylon, polyester and viscose), dyes and chemicals. Approximately 2 900 tonnes of yarn were consumed during 1999, accounting for approximately 46% of production costs. Dyes and chemical account for approximately 50% of production costs. A total of 700 finishes and 300 dyes are used during the wet processing operation. The dyeing process involves several treatment stages, these are:

- Singeing of polyester and viscose fabrics;
- Scouring;
- Relaxing, to impart desired qualities;
- Coating with PVC or polyurethane;
- Padding-in of reactive dyes;
- Stentering;
- “Emerising” and other finishes.

Water Use and Effluent Production

Water consumption is approximately 200 000 kl/y, with effluent production taken to be the same quantity. Combined water and effluent costs are R 1 370 000/y. The majority of water usage and effluent production is associated with dyehouse operations.

Energy Use

Electricity consumption is approximately 25.6 million kWh per annum, costing some R1 700 000. Power is consumed mainly within process machinery, pumps, lighting and compressed air. The latter is a major energy consumer and this was recognised by the site’s engineering staff; leakage is kept to a practical minimum.

3 220 tonnes of coal per annum are consumed within the site’s 2 chain-grate steam boilers, at a cost of R670 000 per annum. Steam is metered at the main header and condensate return is known to be maintained at between 70-80%, depending on production processes.

Identification and Implementation of Waste Minimisation Options

The site has adopted a methodical and structured approach to Waste Minimisation and the site team comprises key staff from each of the 7 main departments and the chief engineer. The team carried out an initial scoping audit, which identifies raw materials wastage as the key priority for Waste Minimisation activities.

The project Champion is developing Waste Minimisation handbooks for each department, which will form the basis of a “Best Practice” approach across the site. Furthermore, a Waste Minimisation video has been produced and introduced into the staff induction programme in order to encourage this approach into everyday operations.

Several savings opportunities have been identified, investigated and implemented.

Water and Effluent Reduction
Water use has been reduced from more than 30 l/m to less than 24 l/m (on average 22 l/m)– a saving of at least 6 l/m in the dyehouse. This was due to improved housekeeping and reducing the number of redyes. Other changes that have been introduced include modifying the jet dyeing machines to reduce the liquor ratio, and the installation of a new relaxer/scourer which reduced the water consumption in that process by 50%**.** The savings made by these two measures have not been included in the calculations here as they were implemented prior to the commencement of the Waste Minimisation Club initiative.

Replacing Cardboard Cores
Disposable cardboard cores were previously used for process-to-process transportation of fabric rolls. These were easily damaged and often led to mechanical problems during transit. It was recognised that plastic recyclable cores would be of benefit and this opportunity was quickly implemented resulting in a cost saving of R208 000 per annum.

Polyamide Warps Size Reduction
A 4% concentration was previously used, approximately 58kg per 400 litre mix. This accounted for an annual size consumption of 57 600kg at an annual cost of R 364 000. A reduction to 50kg per 400 litre mix was trialled and found to be successful, with no depreciation in product quality or processing problems. The annual saving is in the order of R45 500.

Polyester Size Reduction
An 8% concentration was previously used, approximately 27kg per 400 litre mix. This accounted for an annual size consumption of 155 200kg at an annual cost of R542,000. A reduction to 24kg per 400 litre mix was trialled and found to be successful, with no depreciation in product quality or processing problems. The annual saving is in the order of R 68 000.

Standardising Fabric Width
A site-wide investigation was carried out into fabric width standards and it was revealed that 5cm excess fabric width was being manufactured and processed for certain products. These products represent approximately 15% of total process throughput of the site, equivalent to 1 380 000 metres per annum. This was not only extremely costly in terms of raw materials wastage, but was also wasteful of energy, water, dyes and chemicals. A methodology to standardise fabric width throughout the process has been introduced and is in the process of implementation. Raw materials savings of R1.92 per metre are known to be achievable, representing a percentage saving of 3.8% of material processed. It is reasonable to assume that corresponding savings of similar order will be achieved for steam usage, water and effluent, dyes and chemicals. Savings achievable are, therefore:

- Raw materials, dyes and chemicals - R5 600 000 per annum
- Fossil fuel - R25 700 per annum
- Electricity - R64 000 per annum
- Water and effluent - R52 600 per annum

As of December 2000, this project was still under investigation by the company as there were difficulties in implementing the changes.

Packaging Waste
An automatic wrapping machine has been installed at the factory which has resulted in less packaging waste being produced, as only the required quantity of plastic is used. In addition, there are savings in the packaging material, compressed air and labour. The estimated savings for the packaging material alone is of the order of R 64 000 / year.

Other Initiatives
The company implemented a programme whereby the departmental leaders had to identify areas for savings and undertake a cost-benefit analysis. Some of these projects have been taken to the implementation stage, while others are in discussion. These include:

- Forerunner reduction in the dyehouse (in trial) with an estimated cost of R 30 000 and a savings of R 160 000 / year;
- Yarn waste reduction (in trail);
- Lab lead time reduction (in trial);
- Machine down-time reduction (in discussion); and
- Absenteeism reduction (in discussion) with an estimated cost of R 20 000 and a saving of R165 000 / year.

Economic Benefits

Item	Saving Rands / year	Potential Savings Rands / year	Payback
Electricity		64 000	Immediate
Fossil fuels		25 700	Immediate
Water & Effluent	424 800	52 600	Immediate
Raw materials and chemicals	113 500	5 600 000	Immediate
Consumables	208 000		< 1 year
Packaging material	64 000		Not calculated
Total	**810 300**	**5 742 300**	

This table includes savings that have been achieved and the potential savings if the fabric width was standardised.

Environmental Benefits:
As a result of the waste minimisation programme, benefits to the environment have also been realised. These include:

- Reduced stack emissions to atmosphere
- Reduced effluent to drain
- Reduced dyes and chemicals to drain
- Reduced volumes of consumables to landfill

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Waste Minimisation at a Chicken Abattoir (COMP8)
Case Study 8
Hammarsdale Waste Minimisation Club

Background

COMP8 is the largest chicken processing plant in KwaZulu Natal. The Hammarsdale site employs more than 800 people and is the headquarters for the operation.

The Process

The chickens are hung by their legs onto a rail, stunned by electric shock and their heads removed. They move through the factory on these rails passing through a number of processes including removal of feathers, and feet and evisceration. The birds are then divided 75 % to 25 % for frozen and fresh produce respectively. The birds are cut as required, packaged and then either frozen if required prior to delivery.

The by-products, or rendering, plant produces poultry meal from a variety of raw materials. These include; dead chickens; blood; offal; hatchery waste; feathers; and farm mortalities. Other inputs include additives, water, energy and effluent from other parts of the factory. These inputs are screened, then hydrolysed and sterilise at high temperature. The meal is sent for drying, then screened again for large particles and then bagged for sale.

Water Use and Effluent Production

The site use 2 500 kl /d water and process 1.4 million birds per week. Approximately 18 l / bird is used and by requirements, cannot use less that 14 l /bird. Water cannot be reused for health reasons. Large quantities of water (approximately 30 % of total consumption) are used for washing in order to maintain health standards.

The effluent has a high chemical oxygen demand. The factory is investigating installing a treatment system to reduce this by a factor of 10.

Energy Use

The site is a significant user of energy and electricity cots are high, mostly due to refrigeration requirements.

Identification and Implementation of Waste Minimisation Options

As part of the Waste Minimisation Club project, a brief site survey was undertaken to identify areas for improvement. These focussed on reducing energy use. A list of these options is given in Table 1.

The status of these options is not known, although it has been reported that the company is investigating upgrading the compressed air generators.

Table 1: List of identified waste minimisation options

Waste Minimisation Option
Recover flash steam from condensate for reuse
Monitor boiler blow down continuously by TDS
Replace passing valve on blow down line
Reduce boiler pressure
Implement a programme of M&T
Undertake an annual steam trap survey
Investigate compressor temperatures
Avoid part time load operation of compressors
Replace water coolers
Implement a water management programme
check for compressed air leakage
Install additional metering

Economic Benefits
Based on the recommendations made from the site visit, potential savings in energy and water have been estimated.

Item	Potential Saving Rands / year
Energy and water	750 000

Environmental Benefits:
By implementing an effective waste minimisation programme, COMP8 could make the following savings to the environment:
- A reduction of at least 20% in water use and therefore effluent discharge
- A reduction in the COD of the effluent
- Reduced emissions to air from the boiler house

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ANNEXURE 9
Interviews with Metal Finishing Club Members, February 2000

by:
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May 2001

A questionnaire was compiled by the Pollution Research Group and Frank Hedlund of Alborg University (Denmark) in order to obtain some understanding of the benefits of the waste minimisation club to the metal finishing industry. This questionnaire consisted of a number of one-line sentences that the companies were asked to *vote* on (i.e. agree, mostly agree, mostly disagree, disagree and don't know).

These were divided into various sections with the aim of determining the club members:

- Understanding of waste minimisation
- Motives and reasons for joining the club
- First impressions of the club idea
- Views on the club today
- Relationship to the other platers
- Views on the usefulness of the material they have received and the presentations given at the meetings
- Reasons for not attending meetings
- Benefits from attending the club
- Barriers experienced in implementing waste minimisation
- Relationship with the Durban Metro
- General environmental attitude
- Relationship with their workers, and
- Views on the usefulness of the students assistance and report

The results were then analysed and entered into a spreadsheet. From these results, the opinions of the club members can be grouped and numbered. The results are presented graphically in the figures in this document. A copy of the questionnaire is given over page.

Which of the following actions can be considered to be waste minimisation? (See Figure 1 for Responses)	1 – yes; 2 – no 3 – debatable		
	1	2	3
A company installs an extra tank after the plating bath. Plated articles are dipped into this, prior to rinsing. The solution in this tank is then used to top up the plating bath. Is this 'waste minimisation'?			
A company invests in a state-of-the-art effluent treatment plant. This reduces the amount of metals discharged to drain below regulatory requirements. Is this 'waste minimisation'?			
A company modifies the jigs to enable better orientation of the articles. This improves the drip-off. Is this 'waste minimisation'?			
A company installs a large capacity effluent holding tank. High metal content baths are discharged to this tank together with discarded rinse baths. This results in dilution of the metals before discharge to sewer. Is this 'waste minimisation'?			
A company trains two employees to monitor and record the water use in their sections on a daily basis. They must report and explain variations in the water usage. Is this 'waste minimisation'?			

A number of short statements are presented below. They are based on interviews and other sources. Read each statement and decide if you: agree or mostly agree; mostly disagree or disagree with that statement. A "don't know" option is also provided.	1 -agree 2- mostly agree 3- mostly disagree 4- disagree 5 -don't know				
	1	2	3	4	5
Motives for joining the Waste Minimisation Club (Figure 2)					
The closure of the land fill site (as a consequence of the land slide) was the primary reason for me to join the club					
The Durban Metro's new proposed limits for effluent discharge was the primary reason for me to join the club					
Reducing my company's pollution was the primary reason for me to join the club					
The other platers (Figure 11)					
Before the joining the club: I had a fairly good idea of who the other platers were, but I never spoke to them					
The metal finishers must unite in order to stand as a unified body					
The metal finishers should form some type of forum					
I am willing to share my experiences in waste minimisation					
I don't like the idea of all club members coming to my site					
I am willing to let non-competitors visit my site					

A number of short statements are presented below. They are based on interviews and other sources. Read each statement and decide if you: agree or mostly agree; mostly disagree or disagree with that statement. A "don't know" option is also provided..	1 -agree 2- mostly agree 3- mostly disagree 4- disagree 5 -don't know				
	1	2	3	4	5
When you first heard of the club idea, what did you think? (Figure 4)					
It would probably be a complete waste of time					
I might learn a few new plating techniques					
Others platers would scavenge my professional knowledge					
Academics cannot provide much useful knowledge for a practical plater like me					
I was already running an efficient business, there would not be any major savings for me to gain					
I had to be careful so that sensitive commercial info would not be disclosed to competitors					
Why did you join the Waste Minimisation Club? (Figure 3)					
The Metro was promoting it – what did I have to lose?					
I joined the club mainly because I was curious					
I joined the club to win time and delay the new proposal from the Metro					
I joined the club to stand in a better (Metro) light compared to companies that did not enter					
I joined because I saw an opportunity to negotiate relaxed conditions with the Metro					
I was not too busy at that time, if business suddenly caught up I would just drop the club					
I joined the club because I didn't know what waste minimisation was and wanted to learn about it.					
I joined the club because I thought it would help save me money					
What do you think of the Waste Minimisation Club today? (Figure 5)					
Some of it has been really interesting					
Some of it has been a complete waste of time for me					
I got some very practical and useful specific advice (I saw a really good idea and went back to my company and copied it)					
It has mostly served as a source of inspiration - the improvements I have made are my own ideas					
I am now giving more thought of the pollution that my firm is causing					
The major role of the club has been as a means (facilitator) of communication with the Metro					
I would like to see it continue, and would contribute towards someone managing and running the club					
I have made some changes but I don't think that I can improve much further					

A number of short statements are presented below. They are based on interviews and other sources. Read each statement and decide if you: agree or mostly agree; mostly disagree or disagree with that statement. A "don't know" option is also provided..	1 -agree 2- mostly agree 3- mostly disagree 4- disagree 5 -don't know				
	1	2	3	4	5
Benefits of the club (Figure 6)					
Being a club member has improved my relationship with the local authorities (Metro, Water Affairs)					
Meeting with other metal finishers has been a useful experience for me					
I have not benefited at all from being a member of the club					
I have saved money and become more profitable					
I have a better understanding of the pollution caused by my company					
I have a greater understanding of waste minimisation					
If it weren't for the savings I have made through waste minimisation, I would not be in business today					
The Metal Finishing Industry (Figure 17)					
The metal finishing industry is essentially a polluting industry					
Within South Africa, it is a profitable industrial sector					
Usefulness of material (Figure 7)					
I have gone through most of the written material I've received					
I have found all the written material useful					
The training sessions by Enviros March were really good					
The presentation on waste classification was really useful					
The presentation on filtration was really useful					
The presentation on pollution liability was really useful					
The presentation on government funding schemes was really useful					
The presentation on benchmarking studies was really useful					
I found the site visit to Fascor very interesting					
The presentation by Interactive Training Dynamics was very informative					
The visit to the land fill sites was very informative					
I would like more presentations on __________________ (list from No. 48 to 56)					
Rank the above presentations in order of usefulness to you					

A number of short statements are presented below. They are based on interviews and other sources. Read each statement and decide if you: agree or mostly agree; mostly disagree or disagree with that statement. A "don't know" option is also provided.	1 -agree 2- mostly agree 3- mostly disagree 4- disagree 5 -don't know				
	1	2	3	4	5
Attendance at Meetings (no figure)					
I have personally attended **1 2 3 4 5 6 7 8 9 10 all** meetings (circle the applicable answer)					
My company has been represented at every meeting					
Reasons for not attending meetings (Figure 9)					
I don't have the time					
I had a factory emergency and could not leave the premises					
There was poor notice of the meetings					
I was given insufficient notice of the meetings					
The meetings were not interesting to me personally					
I was too busy to attend					
I don't think there's anything to gain from attending meetings					
If the meetings were held after hours I would have attended more frequently					
Barriers to Implementing Waste Minimisation (Figure 8)					
I don't have the time					
I don't have the money					
I don't think there are any benefits for my company					
Bosses not interested in Waste Minimisation					
Future activities of the Club (Figure 10)					
The club should continue after the funding is completed					
If the club continues, it should be run by the metal finishers themselves and not by an outside person or organisation, and be self – funded					
I am interested in being part of the Danced sponsored project in Cleaner Production					
I would like more technical seminars on, for example, the theory of electroplating					
The club meetings should be held **less / more / same** frequency (circle the applicable answer)					

A number of short statements are presented below. They are based on interviews and other sources. Read each statement and decide if you: agree or mostly agree; mostly disagree or disagree with that statement. A "don't know" option is also provided.	1 -agree 2- mostly agree 3- mostly disagree 4- disagree 5 -don't know				
	1	2	3	4	5
The workers (Figure 15)					
At our site, relations between management and workers have improved over the last few years					
Changing the attitude of our workers is a major barrier for introducing better housekeeping techniques					
My workers are the single most important asset of our company					
The language barrier is a serious problem in the production					
The workers may have poor literacy skills, but they have a good idea of what goes on in the plating baths - of why they do the distinct steps					
My workers could contribute with many valuable suggestions on how to reduce the pollution of our company					
It is not necessary to supervise the plating, the workers do the jobs by routine					
For some plating jobs, I think that the workers know more about plating than I do					
My staff have received training in general environmental awareness					
My staff have received training in waste minimisation					
I would like to train my staff in waste minimisation, but do not have the necessary funds					
I am in contact with funding organisations (Dumac; DTI) to arrange finances for training					
Relationship to Suppliers (Figure 13)					
The technical information from my supplier is important and useful					
I would like my supplier to take back any depleted plating baths					
I buy chemicals on price only, there is no "relationship" with my supplier					
I leave the bath maintenance to the chemical suppliers					
Student Reports (Figure 16)					
I found the student's assistance valuable					
The student offered no useful information and was more of a hindrance than a help					
I have used the students recommendations as a basis for my waste minimisation programme					

A number of short statements are presented below. They are based on interviews and other sources. Read each statement and decide if you: agree or mostly agree; mostly disagree or disagree with that statement. A "don't know" option is also provided.	1 -agree 2- mostly agree 3- mostly disagree 4- disagree 5 -don't know				
	1	2	3	4	5
Environmental statements (Figure 18)					
A company's 'green' image is important for its relation with customers					
The introduction of new and more environmental friendly technologies is time consuming and reduces our ability to compete					
It is important for companies to be up to date with environmental requirements					
The present state of the South African economy does not justify new environmental constraints on companies					
I like the idea of going on holiday to game reserves					
Compared to similar firms, my firm is in the better half with respect to environmental performance					
Some jobs pollute, but if I don't do the job, somebody else will – I might as well benefit financially					
Some jobs pollute, but if I don't do the job, somebody else will and cause environmental damage. I would rather ensure it is carried out in the correct manner.					
I feel better morally for "cleaning up" my act					
I would be happy to live next door to my factory					
The most efficient way of improving the environmental impact of our company is to focus on technical issues rather than softer, management issues					
Relationship with Metro Water and Waste (Figure 12)					
It is a major problem that the Metro don't have the same discharge standards for all areas					
The inspector probably cannot tell the difference between a rinse bath and a plating bath					
If I comply with their current regulations, they will just formulate a new one next month (i.e. they keep moving the goal posts)					
The relation to the Metro has improved over the last 12 months					
They don't care about industry, they are bureaucrats that stick to the letter of the law					
My current relation with the Metro is an *us-and-them*, we basically have different interests					
They are basically reasonable people, you can talk to them and discuss unreasonable demands					
I would not mind more frequent visits by the factory inspector, if just my competitors were also visited more frequently					
I would be prepared to forward suggestions on improving effluent discharge standards - IF they were enforced across the board					

A number of short statements are presented below. They are based on interviews and other sources. Read each statement and decide if you: agree or mostly agree; mostly disagree or disagree with that statement. A "don't know" option is also provided.	1 -agree 2- mostly agree 3- mostly disagree 4- disagree 5 -don't know				
	1	2	3	4	5
Relationship with Metro Water and Waste (continued)					
There should be no regulations on the metal finishing industry					
Conflict with the Metro is a healthy sign					
I would be interested in self-regulation in place of regular factory inspections					
Metal finishers should form an association that would only allow companies that adhere to certain environmental standards to join					
The customers (Figure 14)					
I have not yet met a customers who was concerned about / showed any interest in the environmental performance of my company					
My customers are not interested in my pollution loads					
Customers may occasionally enquire about how pollution is addressed, but the customer is essentially interested in price ONLY					
I have lost business because the customer was not satisfied with my environmental performance					
My customers would go elsewhere for a 10% reduction in price and not ask questions why					
I have declined on certain jobs, because I think that the production process pollutes too much					
A fair amount of my customers don't have the slightest idea of the type of plating they require					
It would be advantageous if customers enquired before hand as to the best design and specification of materials					
Customers seek my advice in the design of the jobs to be plated / finished					
A fair amount of my customers specify their plating demands according to SABS/ISO standards					
A sign promoting that my company is involved in waste minimisation and is reducing its environmental impact would be useful					
A fair amount of my customers demand a plating "similar to the one last time" because that one worked fine					
I have a considerable influence over the customer's choice of plating					
I have worked up a trust relation with some core customers					

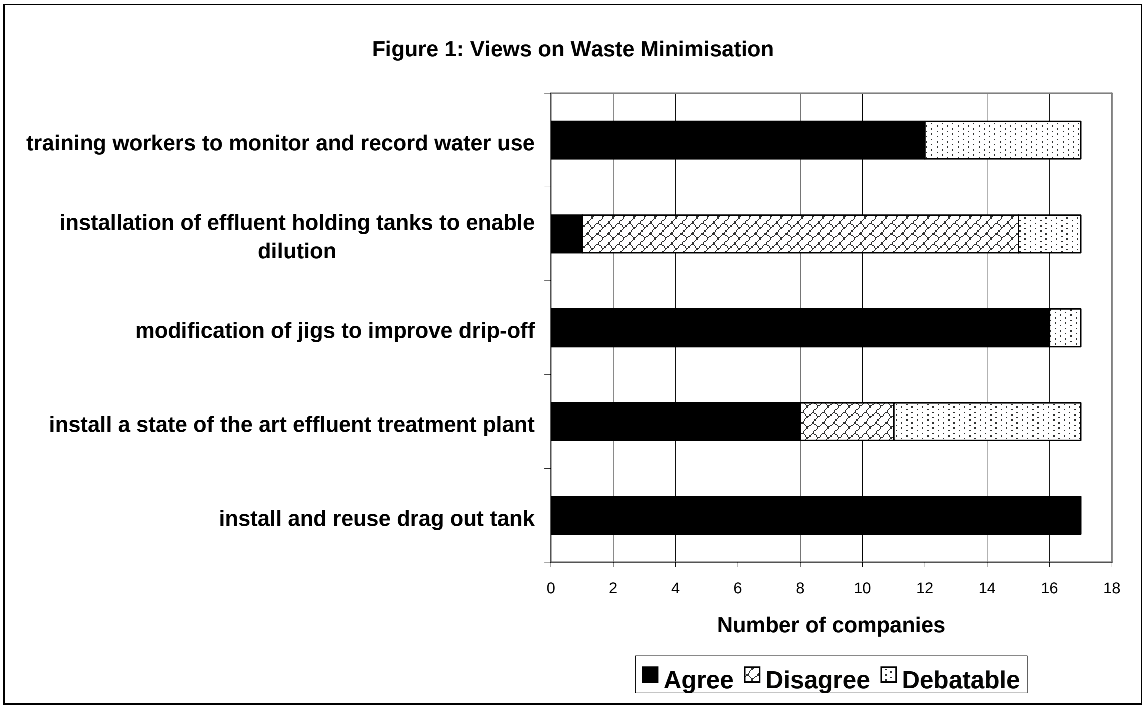


Figure 1: Views on Waste Minimisation
training workers to monitor and record water use
installation of effluent holding tanks to enable dilution
modification of jigs to improve drip-off
install a state of the art effluent treatment plant
install and reuse drag out tank
0
2
4
6
8
10
12
14
16
18
Number of companies
Agree
Disagree
Debatable

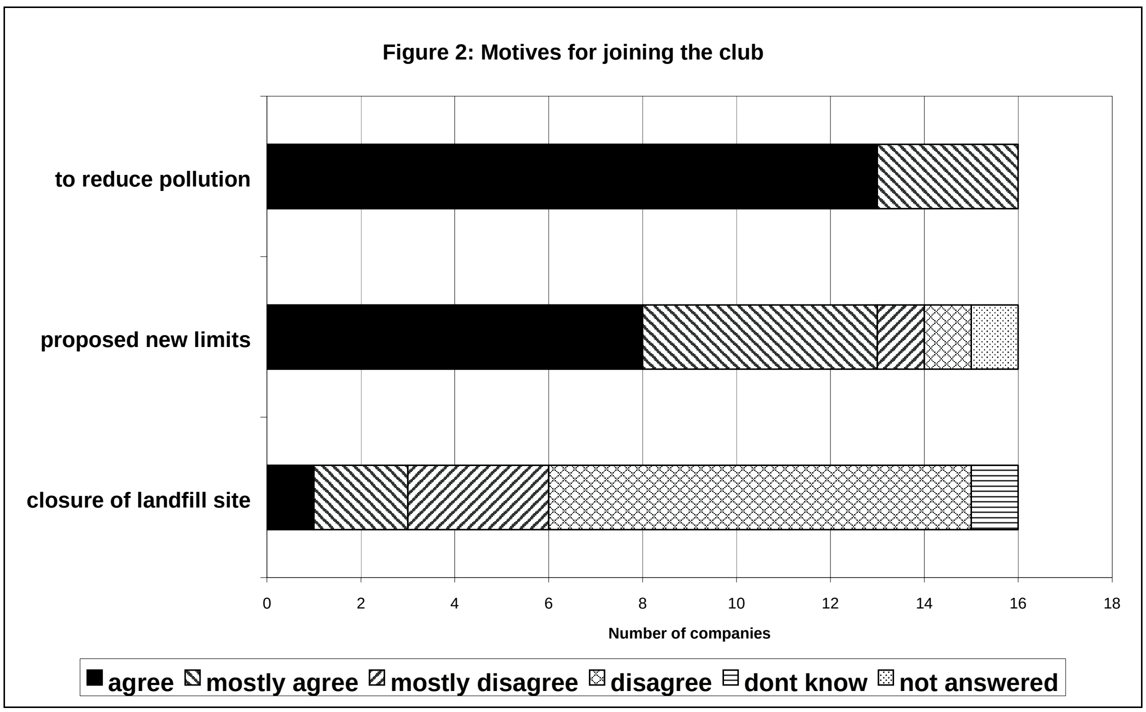


Figure 2: Motives for joining the club
to reduce pollution
proposed new limits
closure of landfill site
0
2
4
6
8
10
12
14
16
18
Number of companies
agree
mostly agree
mostly disagree
disagree
dont know
not answered

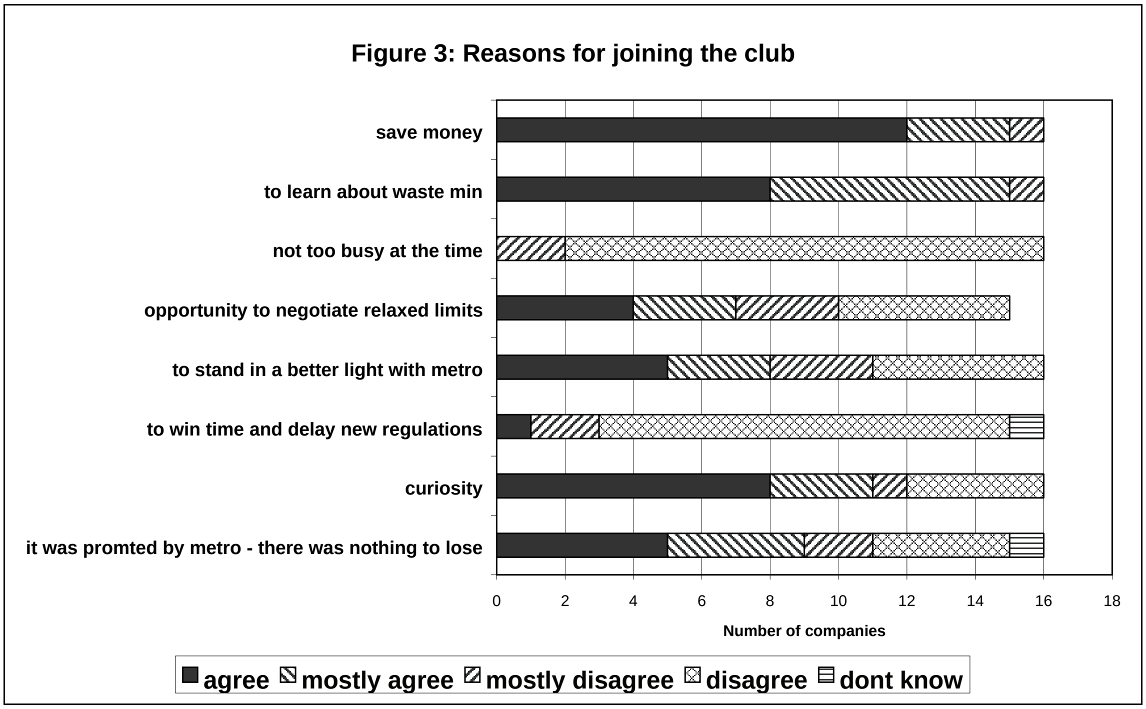


Figure 3: Reasons for joining the club
save money
to learn about waste min
not too busy at the time
opportunity to negotiate relaxed limits
to stand in a better light with metro
to win time and delay new regulations
curiosity
it was promted by metro - there was nothing to lose
0 2 4 6 8 10 12 14 16 18
Number of companies
agree mostly agree mostly disagree disagree dont know

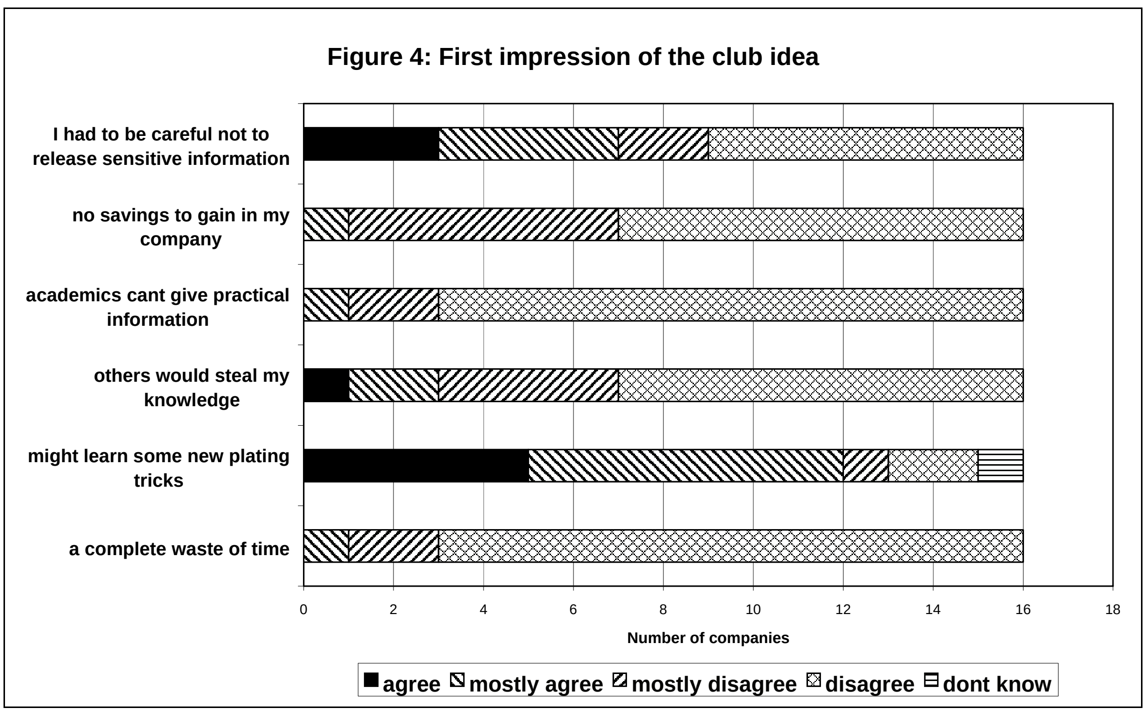


Figure 4: First impression of the club idea
I had to be careful not to release sensitive information
no savings to gain in my company
academics cant give practical information
others would steal my knowledge
might learn some new plating tricks
a complete waste of time
0 2 4 6 8 10 12 14 16 18
Number of companies
agree mostly agree mostly disagree disagree dont know

Figure 5: What do members think of the club today

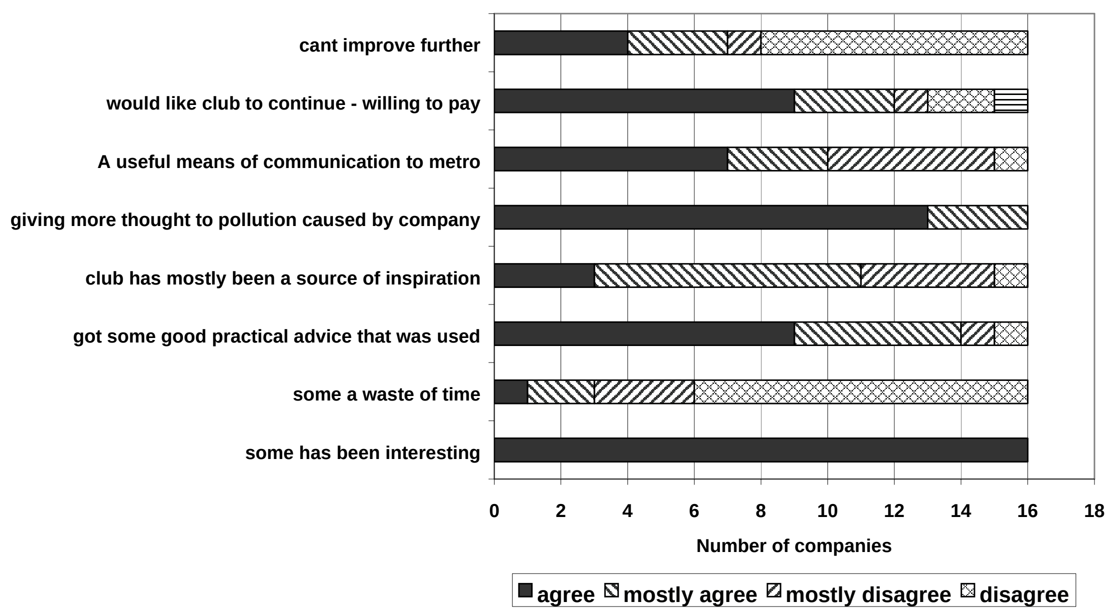
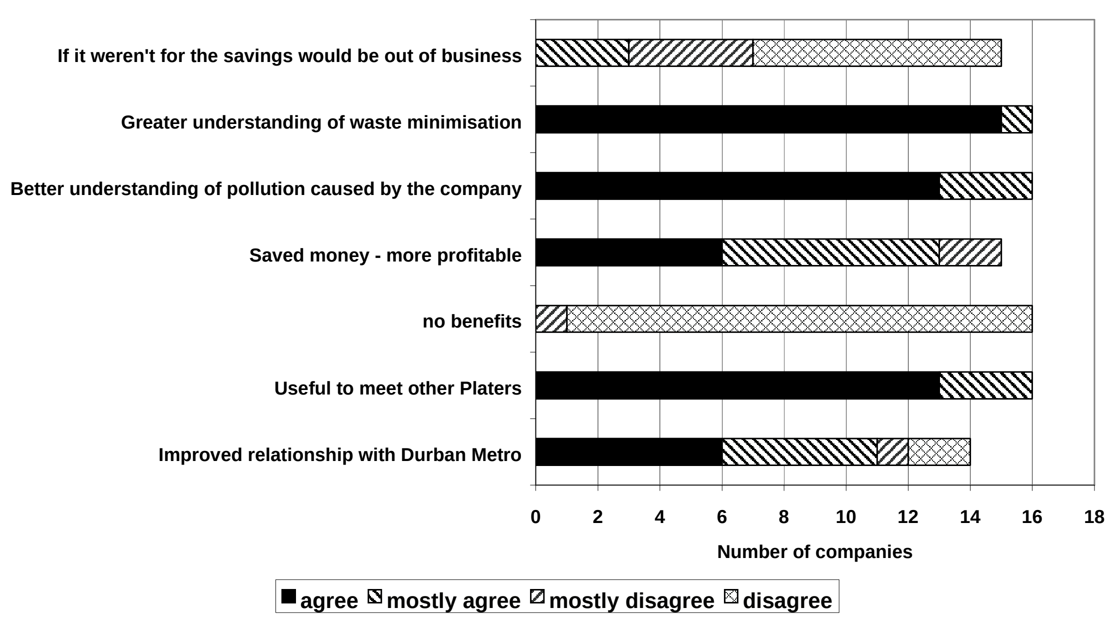


Figure 6: Benefits of the Club



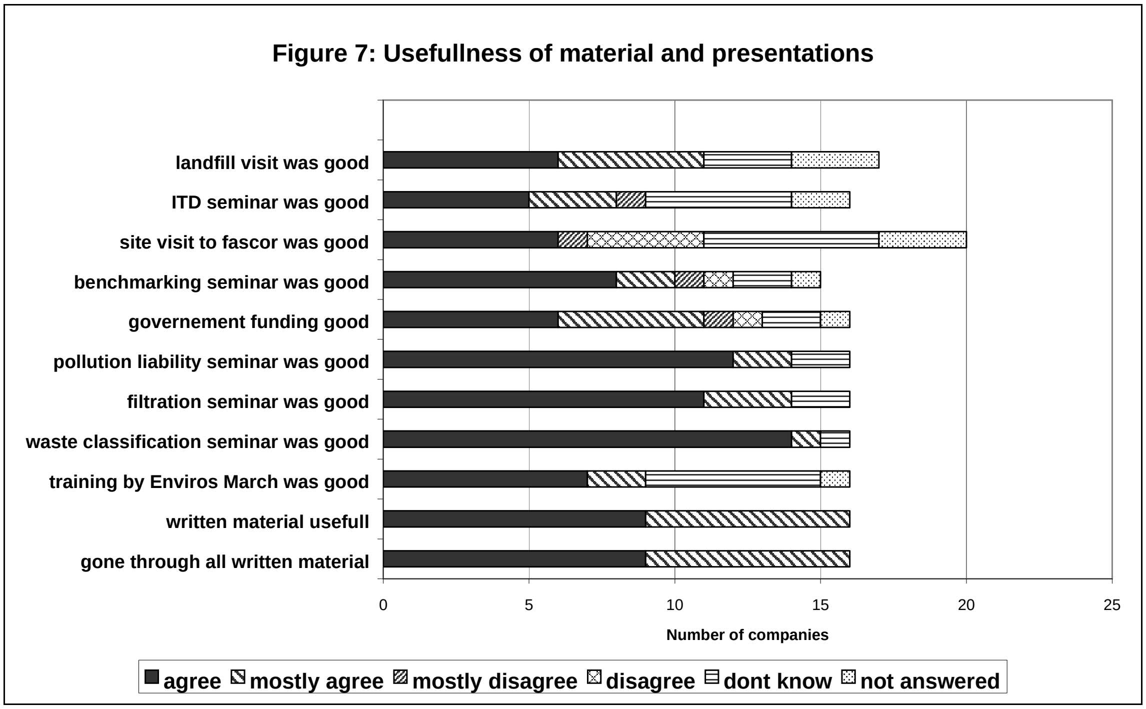


Figure 7: Usefullness of material and presentations
landfill visit was good
ITD seminar was good
site visit to fascor was good
benchmarking seminar was good
governement funding good
pollution liability seminar was good
filtration seminar was good
waste classification seminar was good
training by Enviros March was good
written material usefull
gone through all written material
0
5
10
15
20
25
Number of companies
agree
mostly agree
mostly disagree
disagree
dont know
not answered

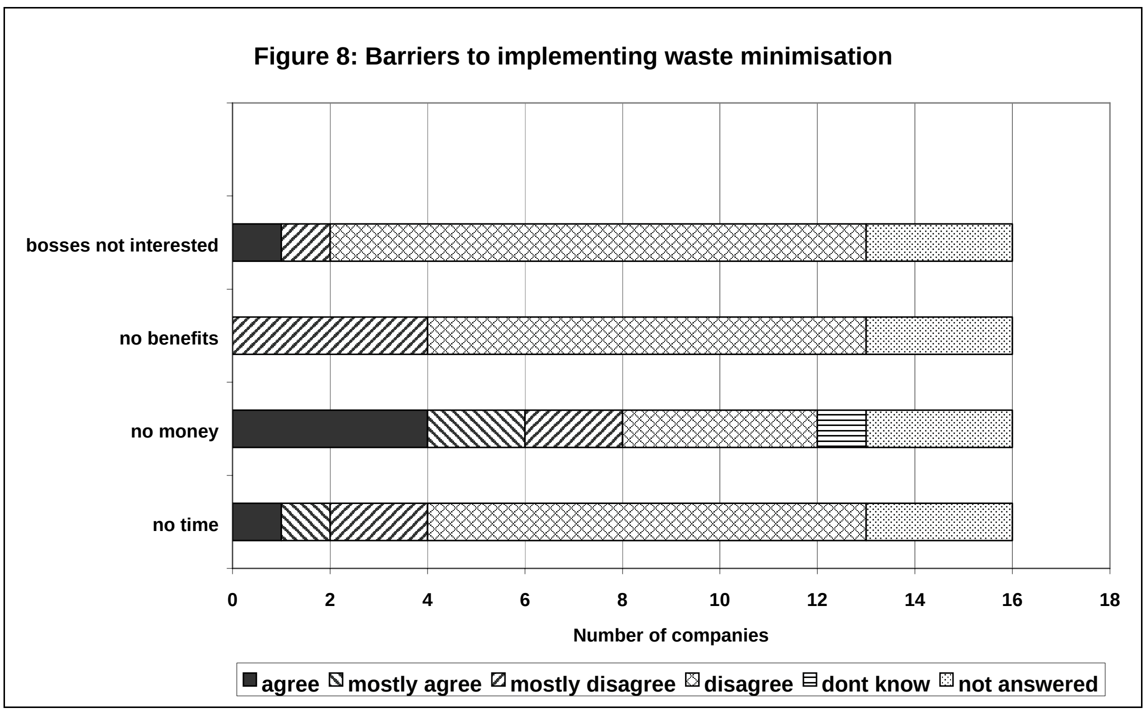


Figure 8: Barriers to implementing waste minimisation
bosses not interested
no benefits
no money
no time
0
2
4
6
8
10
12
14
16
18
Number of companies
agree
mostly agree
mostly disagree
disagree
dont know
not answered

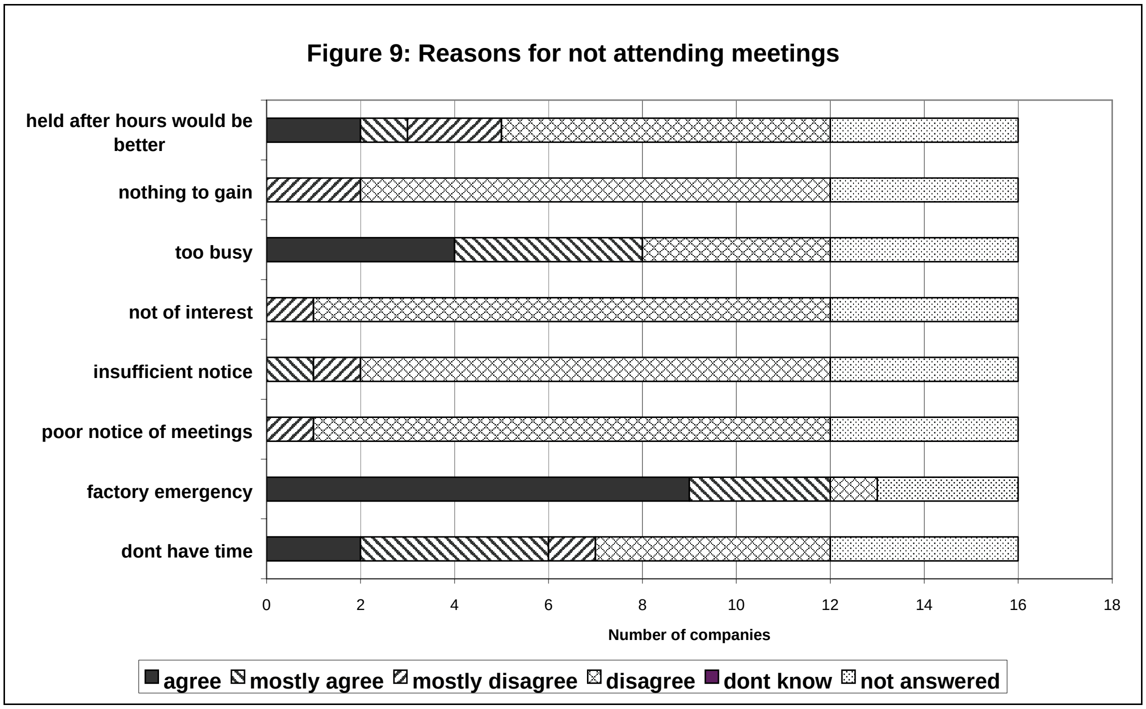


Figure 9: Reasons for not attending meetings
held after hours would be better
nothing to gain
too busy
not of interest
insufficient notice
poor notice of meetings
factory emergency
dont have time
0
2
4
6
8
10
12
14
16
18
Number of companies
agree
mostly agree
mostly disagree
disagree
dont know
not answered

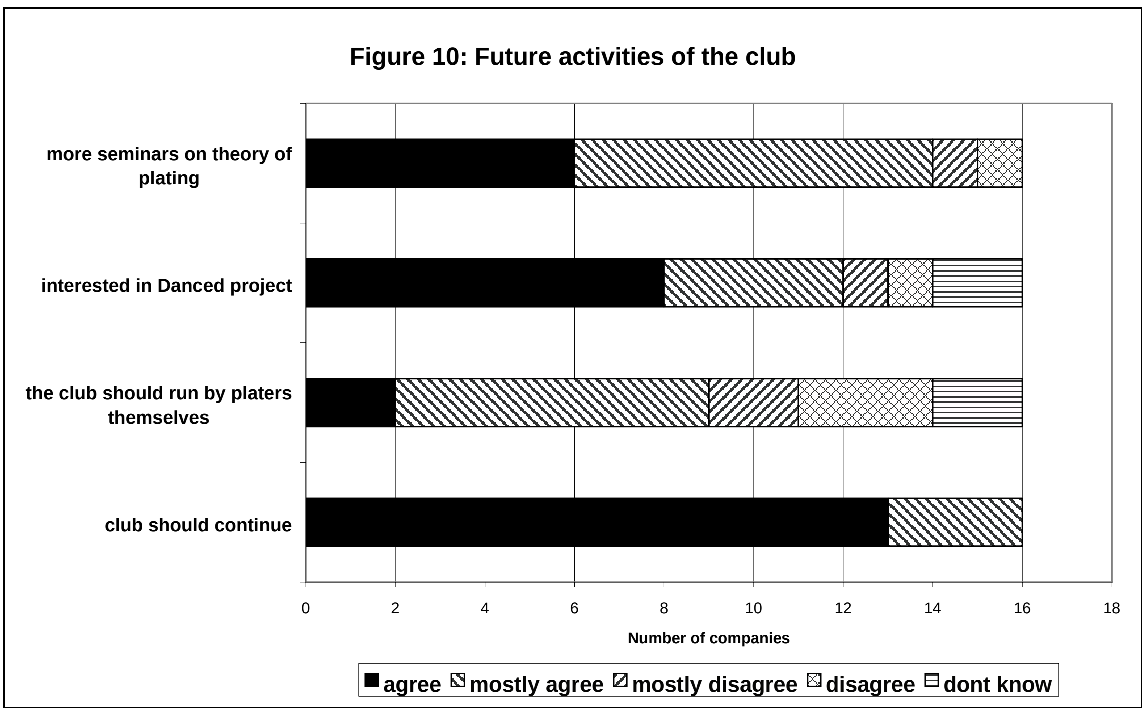


Figure 10: Future activities of the club
more seminars on theory of plating
interested in Danced project
the club should run by platers themselves
club should continue
0
2
4
6
8
10
12
14
16
18
Number of companies
agree
mostly agree
mostly disagree
disagree
dont know

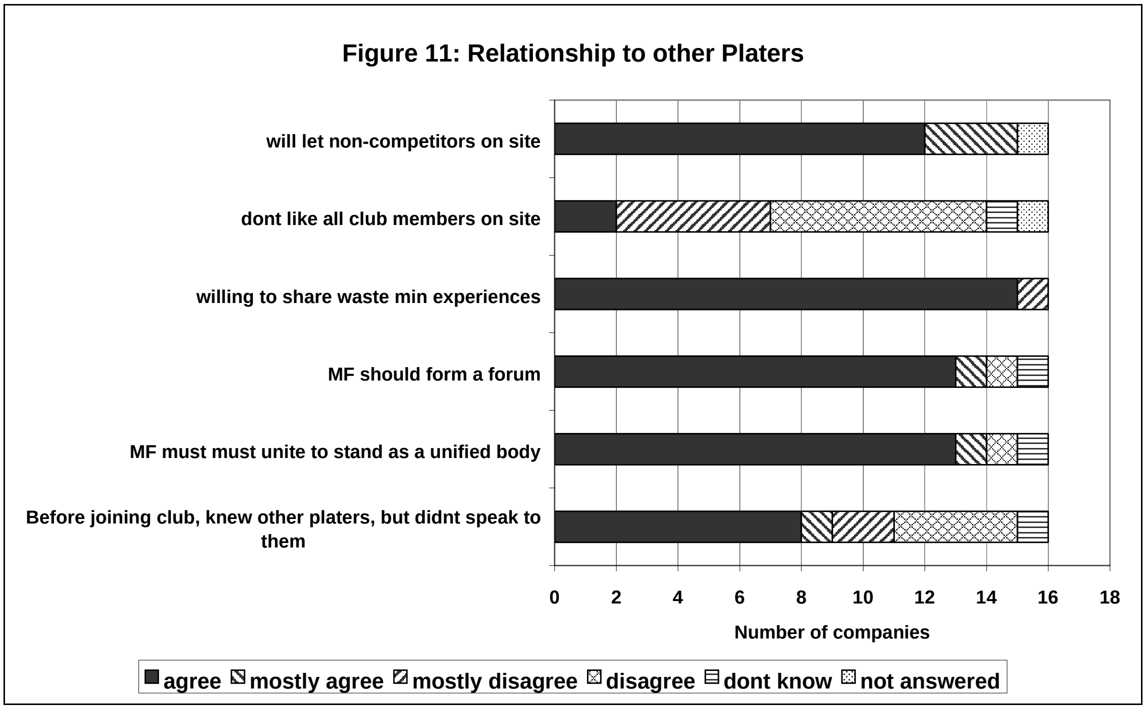


Figure 11: Relationship to other Platers
will let non-competitors on site
dont like all club members on site
willing to share waste min experiences
MF should form a forum
MF must must unite to stand as a unified body
Before joining club, knew other platers, but didnt speak to them
0 2 4 6 8 10 12 14 16 18
Number of companies
agree
mostly agree
mostly disagree
disagree
dont know
not answered

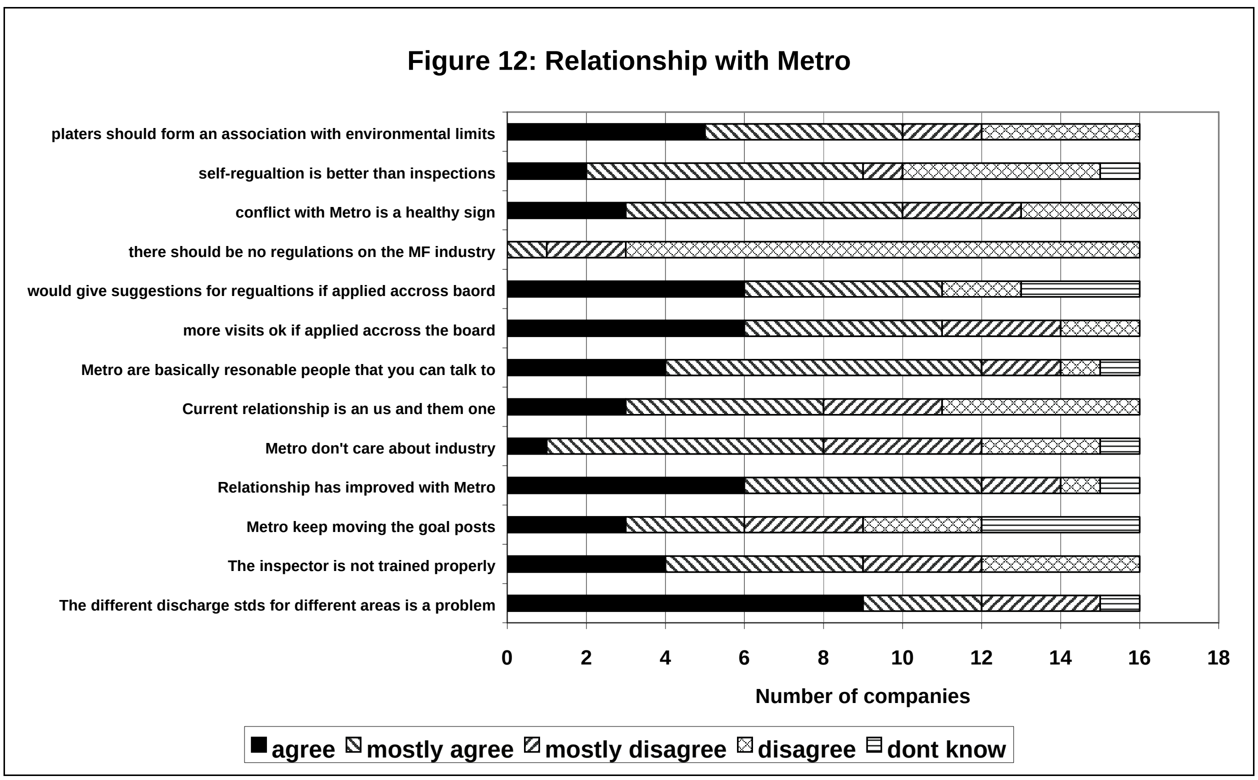


Figure 12: Relationship with Metro
platers should form an association with environmental limits
self-regualtion is better than inspections
conflict with Metro is a healthy sign
there should be no regulations on the MF industry
would give suggestions for regualtions if applied accross baord
more visits ok if applied accross the board
Metro are basically resonable people that you can talk to
Current relationship is an us and them one
Metro don't care about industry
Relationship has improved with Metro
Metro keep moving the goal posts
The inspector is not trained properly
The different discharge stds for different areas is a problem
0 2 4 6 8 10 12 14 16 18
Number of companies
agree
mostly agree
mostly disagree
disagree
dont know

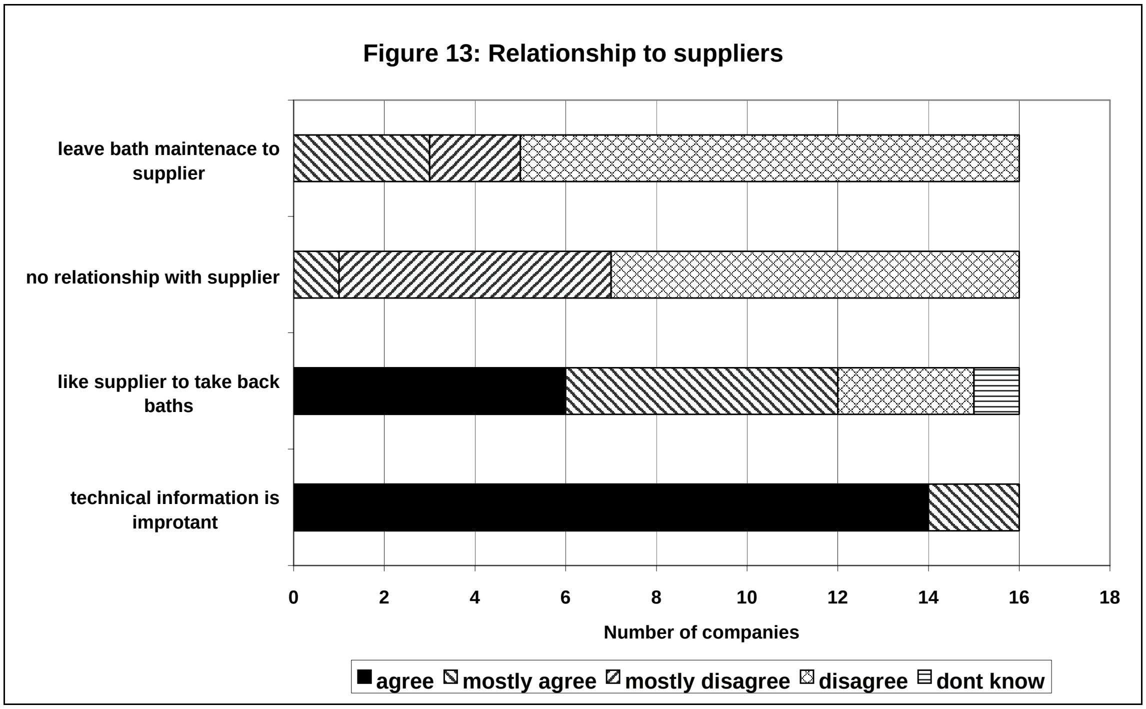


Figure 13: Relationship to suppliers
leave bath maintenace to supplier
no relationship with supplier
like supplier to take back baths
technical information is improtant
0
2
4
6
8
10
12
14
16
18
Number of companies
agree
mostly agree
mostly disagree
disagree
dont know

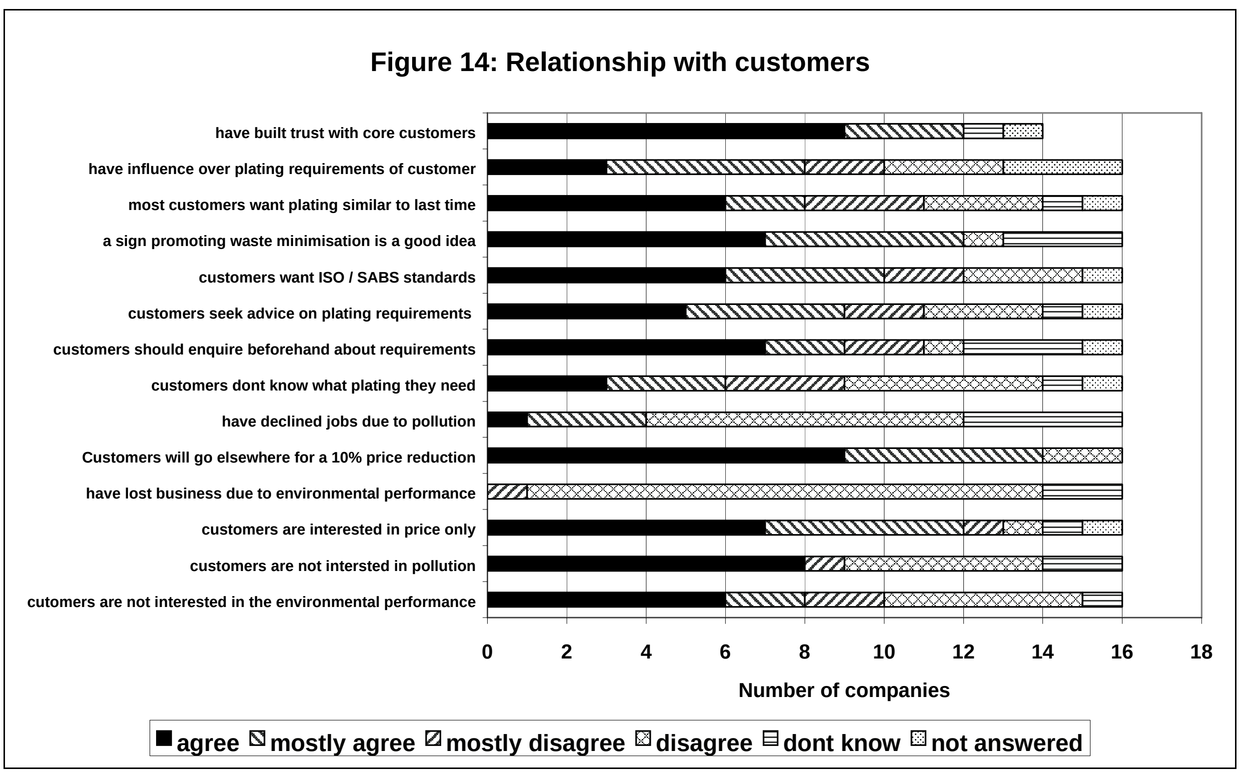


Figure 14: Relationship with customers
have built trust with core customers
have influence over plating requirements of customer
most customers want plating similar to last time
a sign promoting waste minimisation is a good idea
customers want ISO / SABS standards
customers seek advice on plating requirements
customers should enquire beforehand about requirements
customers dont know what plating they need
have declined jobs due to pollution
Customers will go elsewhere for a 10% price reduction
have lost business due to environmental performance
customers are interested in price only
customers are not intersted in pollution
cutomers are not interested in the environmental performance
0
2
4
6
8
10
12
14
16
18
Number of companies
agree
mostly agree
mostly disagree
disagree
dont know
not answered

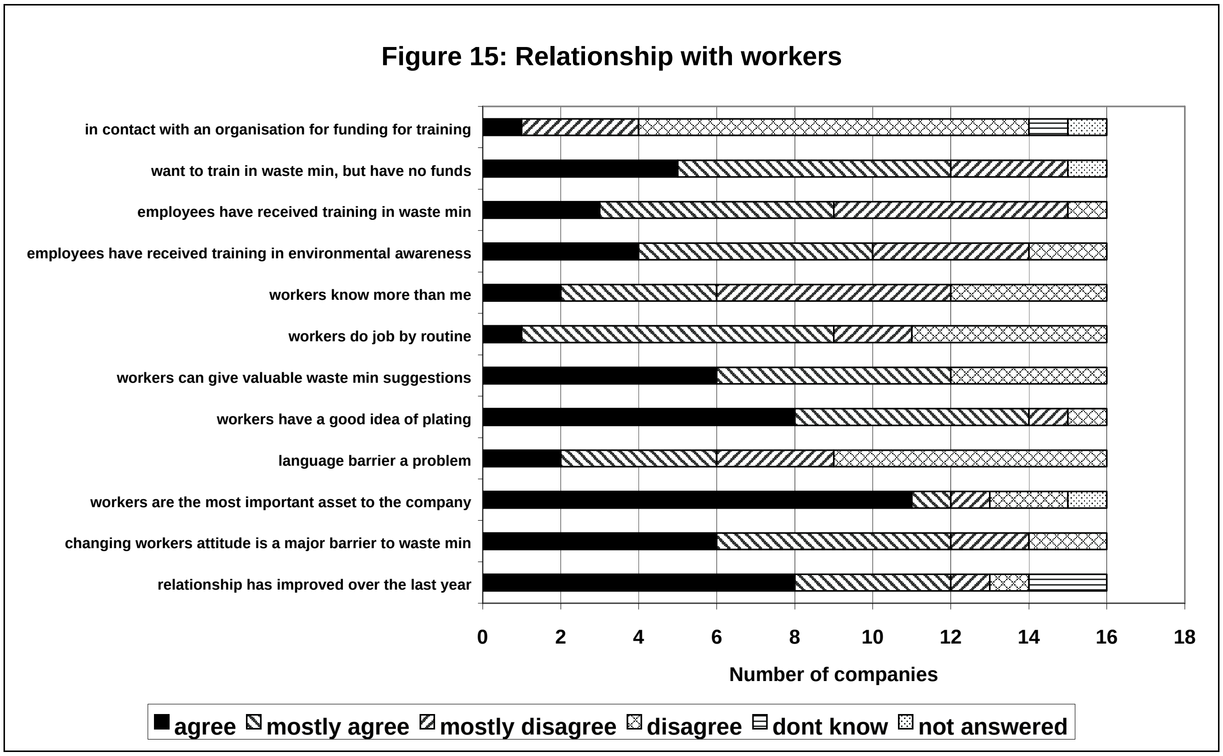


Figure 15: Relationship with workers
in contact with an organisation for funding for training
want to train in waste min, but have no funds
employees have received training in waste min
employees have received training in environmental awareness
workers know more than me
workers do job by routine
workers can give valuable waste min suggestions
workers have a good idea of plating
language barrier a problem
workers are the most important asset to the company
changing workers attitude is a major barrier to waste min
relationship has improved over the last year
0 2 4 6 8 10 12 14 16 18
Number of companies
agree mostly agree mostly disagree disagree dont know not answered

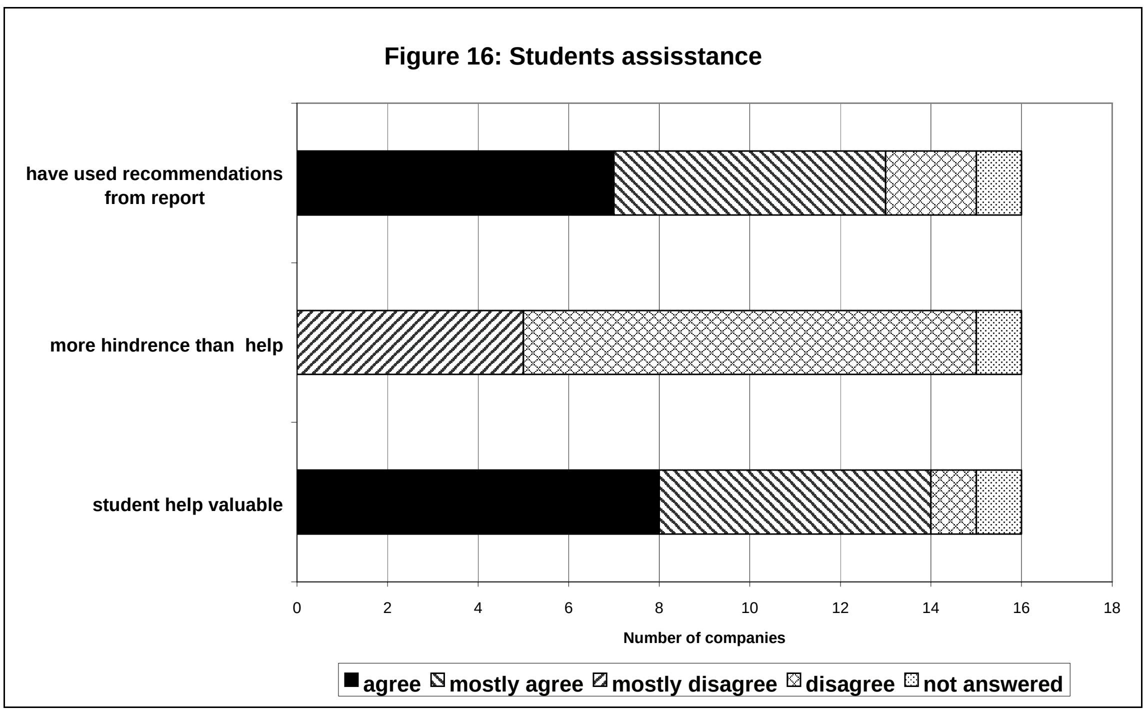


Figure 16: Students assisstance
have used recommendations from report
more hindrence than help
student help valuable
0 2 4 6 8 10 12 14 16 18
Number of companies
agree mostly agree mostly disagree disagree not answered

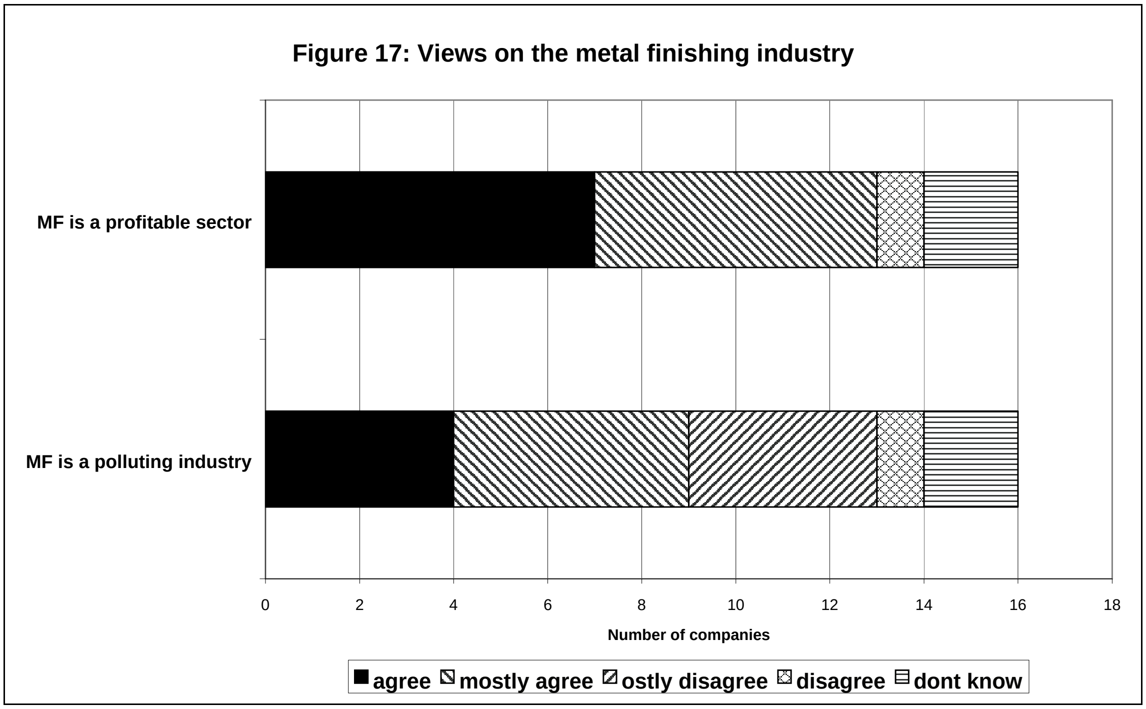


Figure 17: Views on the metal finishing industry
MF is a profitable sector
MF is a polluting industry
0
2
4
6
8
10
12
14
16
18
Number of companies
agree
mostly agree
ostly disagree
disagree
dont know

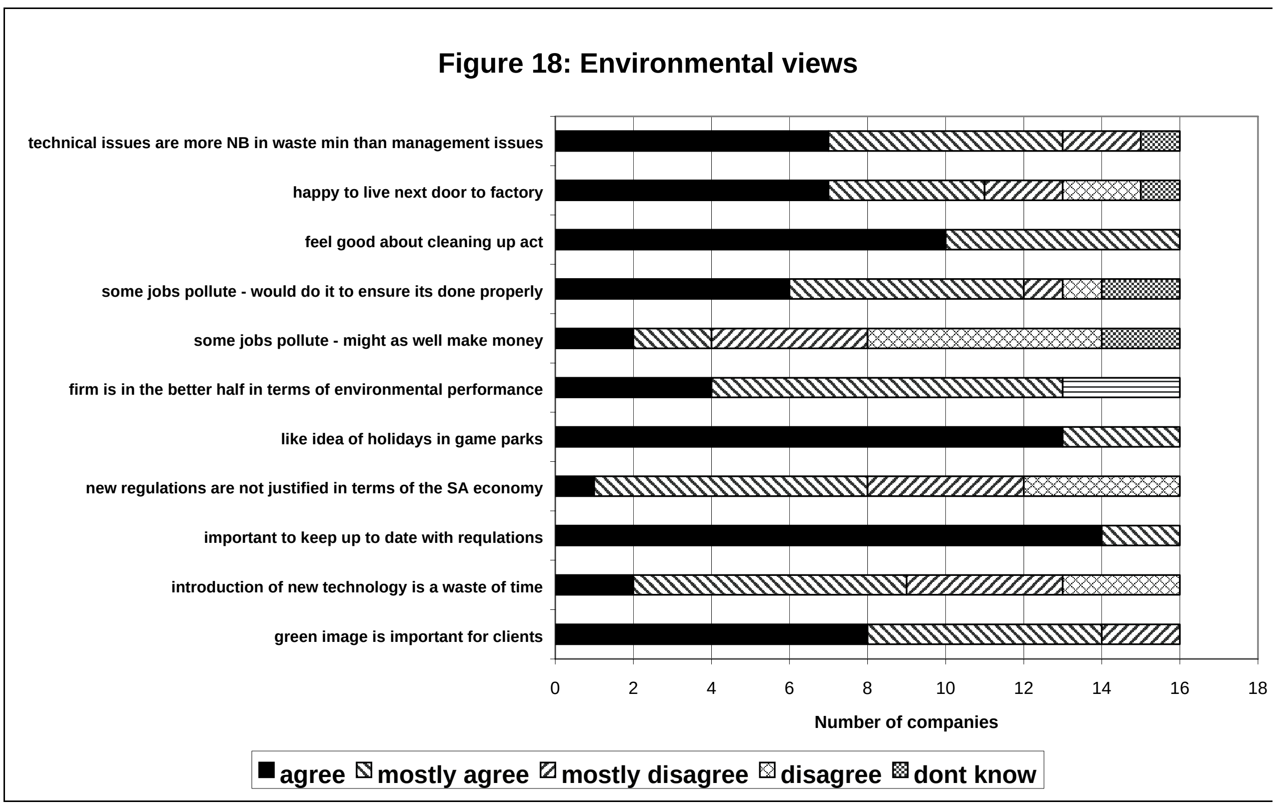


Figure 18: Environmental views
technical issues are more NB in waste min than management issues
happy to live next door to factory
feel good about cleaning up act
some jobs pollute - would do it to ensure its done properly
some jobs pollute - might as well make money
firm is in the better half in terms of environmental performance
like idea of holidays in game parks
new regulations are not justified in terms of the SA economy
important to keep up to date with requlations
introduction of new technology is a waste of time
green image is important for clients
0
2
4
6
8
10
12
14
16
18
Number of companies
agree
mostly agree
mostly disagree
disagree
dont know

ANNEXURE 10
Analysis of Data for a Metal Finishing Club Member

by Susan Barclay

1. Summary

MF22 is a small electroplating job shop situated in Seaview, Durban, South Africa. It was established in 1981 and employs 50 staff members. Articles are brought to the factory for plating or polishing by the customer. In general the customers are either not big enough to run their own plating section or the objects to be plated are difficult to handle.

A large number of different processes are carried out in the factory. These include: zinc electro-galvanising; nickel plating; chrome plating; copper plating; cadmium plating (minimal); silver plating; gold plating; irridising; anodising; tin plating; and brass plating. Base metals include Steel, copper, brass, dicast alloy and aluminum. Both line (jig) and barrel plating takes place.

Objects plated include screwdrivers, electrical components, fences stove parts, screws and paraffin lamps and exhaust pipes etc. The factory must therefore be flexible in its process to accommodate these varying plating requirements.

MF22 became a member of the Metal Finishing Waste Minimisation Club in June 1998 when it was first established. The company has reported savings in water, chemicals and energy through the implementation of a waste minimisation programme. A summary of the reported savings is given in **Table 1**.

Table 1: Summary of reported annual savings for MF22

Item	Saving **(Approximate Rands / annum)**	**Pay-back**
Water	59 400	< year
Chemicals and Metals	68 400	< year
Electricity	33 000	< year
Effluent charges	36 500	< year
TOTAL	**197 300**	

Some concern was expressed by members of the Project Steering Committee, that some club members may be reporting savings that are not actually achieved, and the question arose as to whether these results were auditable. In other words, if one checked the water, chemical and electricity records of the company, would these savings be reflected in the accounts?

For this reason, water, chemical and electricity accounts were collected for 1998, 1999 and 2000 for MF22. This company was chosen, as it was that the records were readably available. Since the company does not keep records of production in terms of mass or volume due to the variety of goods processed, the monthly turnover figures in rands was used as an indication of the production over the same period.

An analysis of the water, energy and chemical usage per rand turnover was carried out. The results of the study are summarised in **Table 2**. As is evident, savings in all three areas were achieved. The details of the investigation are described in the following sections.

Table 2: Summary of Utility and Chemical Use per Rand Production

Year	**Water (l/R prod)**		**Effluent**	**Electricity**	**Chemicals**
	Municipal	**Borehole**	**l/R prod.**	**KWh/R prod.**	**R/R prod.**
1998	18.6	33.64	51.55	0.24	
1999	6.47	27.08	33.29	0.24	
2000	5.09	18.16	23.05	0.19	

2. Methodology

Water, electricity and chemical accounts were collected for 1998 to 2000. The sales for each month were also obtained. This information was entered into a spreadsheet and the consumption per Rand turnover (or Rand production) was calculated in order that the trends for each year could be analysed.

It is important to relate the consumption of utilities and chemicals to the production, as their use is dependent on the number of articles processed in the factory. It is not possible to simply compare water or electricity use per month as the production could vary significantly from one year to the next. Since production figures were not available, the turnover figures had to suffice. A number of problems were encountered in this method, and these are described below.

Turnover figures were provided per calendar month, i.e. from the first of each month to the end of the month. Water and electricity readings were generally taken from the middle of one month to the middle of the next, or as is the case with electricity readings, only every 3 months. This means that the turnover figure did not relate to exactly the same period over which the meter readings were taken.

In an attempt to overcome this problem, water and electricity use per day was calculated based on the overall reading and divided by the number of days in the period. This gave an average consumption per day for the month (or the quarter in the case of electricity). Similarly, the Rand turnover per day was calculated for each calendar month, or quarter, and these two figures were then compared.

The ideal situated would have been to develop graphs of utility consumption per Rand turnover against Rand production per day in order to obtain a best-fit line and an equation to describe the relationship between the two. However, due to the miss-match of the data collection periods, these plots were meaningless. The next best approach was to calculate the total utility consumption per Rand turnover on an annual basis.

This in itself caused some problems, as data for 2000 was only available up to the middle of September, so for each year, figures were only totaled for the period January to September. In the case of electricity, where meter readings were taken only quarterly, the same quarters were compared.

While it is realised that this may not be the most accurate means of comparing costs per annum, it was the only method available based on the type of information provided.

Effluent sampling results were also obtained for 1998 to 2000. Regular tests on the effluent are conducted by the Durban Metro Waste Water Department to ensure that the company is complying with the discharge limits. This information was also entered into a spreadsheet and the trends analysed. These results are given in **Section 5**.

3. Water Consumption and Effluent Production

MF22 uses both municipal and borehole water. The company is charged only for the incoming municipal water, but is charged for both the municipal and borehole water as effluent. The volume of municipal effluent is calculated to be 96% of the incoming water, while the borehole is charged at 100% of the incoming borehole meter reading. The charges for incoming water and effluent are given in **Tables 4 and 5**. In addition to these rates, the company is charged a fixed service charge on the incoming water, and a monitoring charge on the effluent. These costs have not been taken into account in the analysis.

Table 4: Cost per kl for water

Period	Municipal incoming (R/kl)	% Increase
July 97-June 98	2.20	
July 98 – June 99	2.53	15
July 99 – June 00	2.89	14
July 00 – Sept 00	3.27	13

Table 5: Cost per kl for effluent discharge

Period	Effluent R/kl	% Increase
Dec 97 -June 98	0.52	
July 98 – Dec 98	0.57	9.6
Jan 99 – June 99	0.78	37
July 99 – Dec 99	0.83	6.4
Jan 00 – June 00	0.92	10.8
June 00 – Dec 00	1.17	27

Due to these increases, it was felt that the savings in terms of volume rather than Rands would be a more accurate measurement of the success of the project. It is important to note these increases however, as it indicates that the savings achieved in 2000 are greater than those reflected merely by comparing the total reduction in costs per year.

As explained in **Section 2**, it was not possible to plot the kl of water used per day against the Rand turnover per day for each year. Instead, the total water used per Rand production for each year was compared for municipal use, borehole use and effluent production. These plots are given in **Figure 1**.

As can be seen, municipal water use per Rand turnover decreased from 18.65 l/R in 1998 to 5.09 l/R in 2000. This is an overall decrease of 73% over the two years. Similarly, borehole water use decreased by 46 % and effluent production by 55%. These figures are given in **Table 6**.

Table 6: Decrease in water use per Rand turnover

Year	Municipal l/R prod.	% Decrease	Borehole l/R prod.	% Decrease	Effluent l/R prod.	% Decrease
1998	18.65		33.64		51.55	
1999	6.47	65	27.08	20	33.29	35
2000	5.09	21 73	18.16	33 46	23.05	31 55

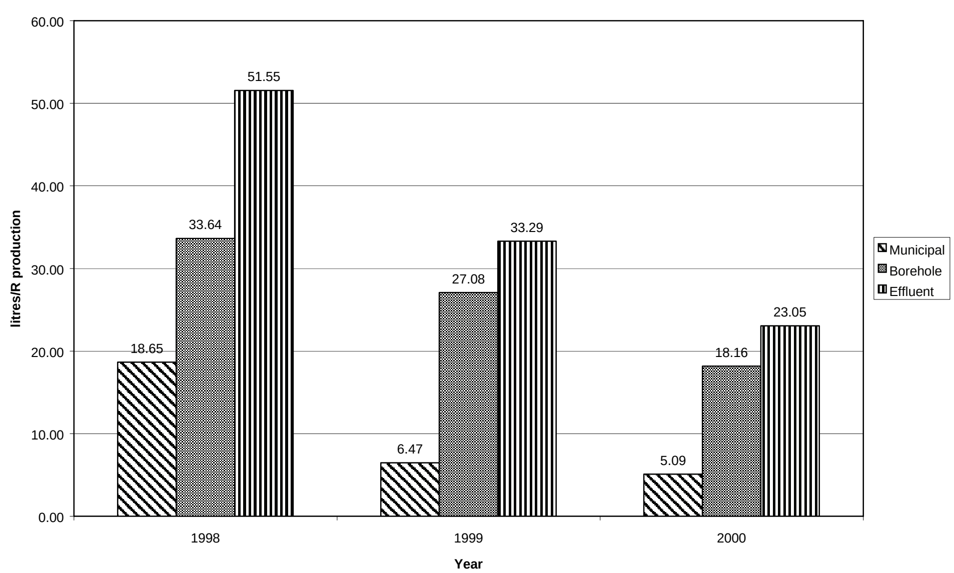


Figure 1: Historical Water Use and Effluent Production

4. Electricity Consumption

As mentioned in Section 2, electricity accounts for 1998 to 2000 were obtained from the company. The company has 3 meters that are read on a quarterly basis by the Durban Metro. There are different tariffs depending on the time of day the electricity is used. Due to the lack of monthly meter readings and the complicated method of charging for electricity, it was difficult to obtain an accurate indication of electricity use per Rand turnover on a monthly basis. For this reason, the total use per year was compared to the total turnover over the same period. It is realised that this is not an accurate means of calculating the savings, but it gives a rough indication of the reduction in use of electricity over the 3 years compared to the production.

The cost of electricity has also increased every year by approximately 14%. **Figure 2** gives the electricity consumption per Rand turnover for the 3 years. As is evident, there was a 21% decrease in energy use from 1998 to 2000.

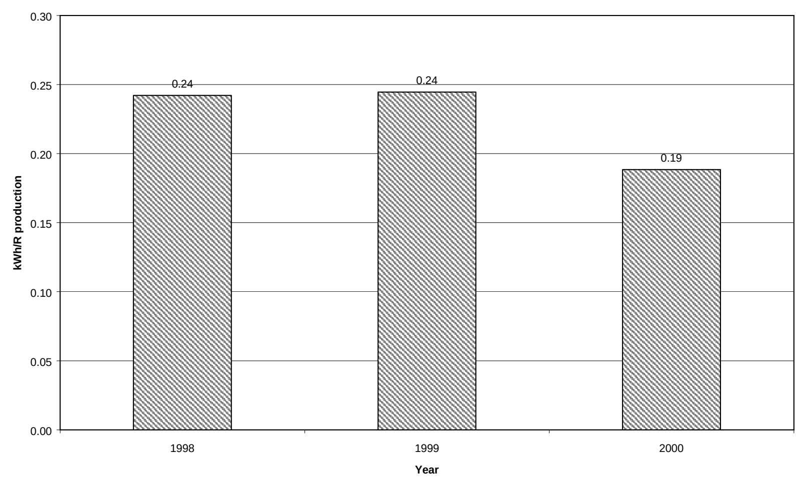


Figure 2: Historical Electricity use per Rand turnover

This implies that for an annual turnover of R 800 000, 40 000 kWh less is being used now as compared to the previous years.

Besides the monetary savings, there are also environmental savings associated with reducing electricity use, such as a reduction in carbon dioxide, sulphur dioxide and nitrous oxides. Figures available from the 1999 Eskom Environmental Report, 0.8 kg of CO_2 is formed per kWh of electricity used. This means that a saving of 40 000 kWh will lead to a reduction of 32 tons of CO_2 being emitted to the environment. In addition, there are savings in sulphur dioxide and nitrous oxides emitted to the atmosphere.

5. Effluent Analysis

Effluent sampling results were collected for 1998 to 2000. These included chemical oxygen demand (COD), settable solids (SS), pH, Chromium (Cr), Cadmium (Cd), Nickel (Ni), Zinc (Zn), and Copper (Cu). These sampling results were plotted and a trend line obtained. In all cases it is evident that there is a decrease in discharge to drain. Most noticeable is the reduction in settable solids due to the installation of the effluent treatment plant towards the end of 1999, and the reduction in cadmium to drain due to a change over to zinc plating in lieu of cadmium. These results are represented graphically in **Figures 3 to 9**.

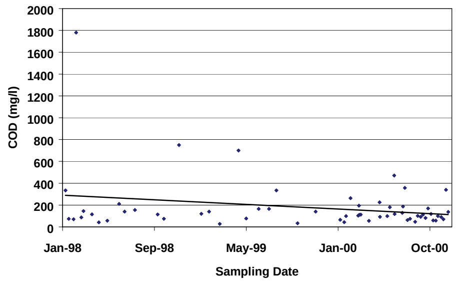


Figure 3: Historical COD analysis

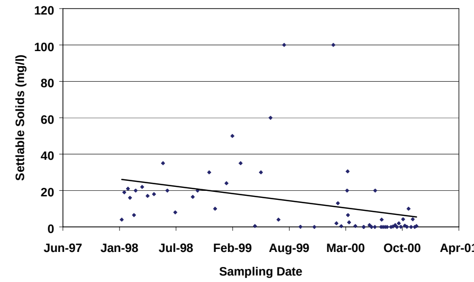


Figure 4: Historical Settable Solids Analysis

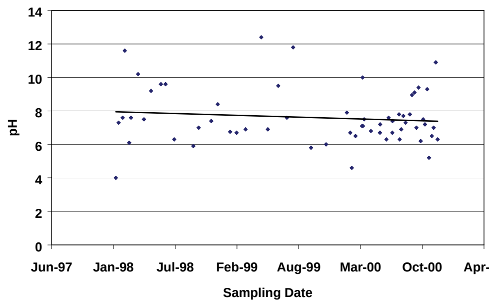


Figure 5: Historical pH Analysis

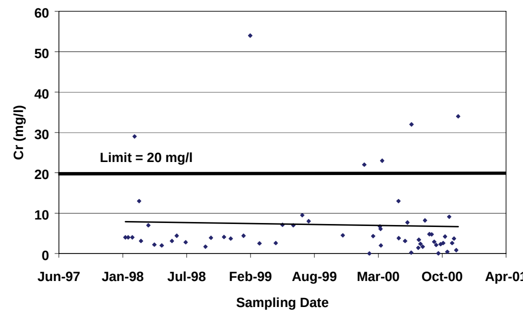


Figure 6: Historical Chromium Analysis

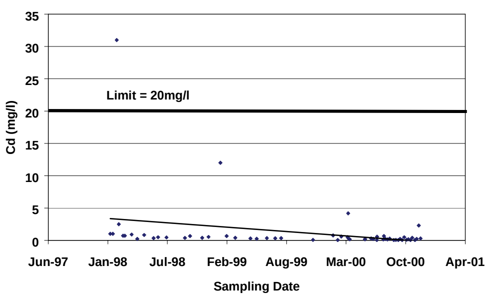


Figure 7: Historical Cadmium Analysis

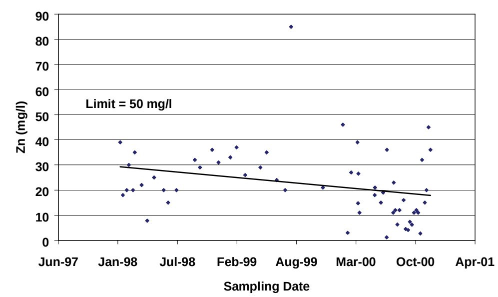


Figure 8: Historical Zinc Analysis

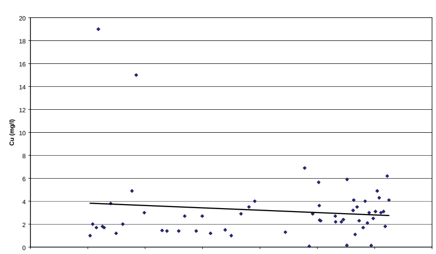


Figure 9: Historical Copper Analysis

As can be seen, there is a large amount of scatter on the graphs and this is due to problems with the operation of the effluent treatment plant. On occasion, the flocculent doing system mal-functions and it is not added to the effluent from approximately 3am in the morning. As a result, when the Durban Metro sample the effluent on these occasions the concentrations are higher than normal, resulting in fluctuating analyses.

Another point to note is that these graphs only take concentration into account, and not pollution load. Pollution loads also take the volume of effluent being discharged into account. Since the volume of effluent is significantly less than it was in 1998, it is expected that the concentration of metals will increase. The fact that there is still down-wards trend indicates that the mass of metals to drain has also decreased over the last 2 years.

6. Comparison of Reported and Calculated Savings

Based on the consumption of water and electricity per R turnover, the savings made during the course of the project can be calculated using the current turnover figure. If one takes this to be of the order of R 1 million / annum, then the savings made since the implementation of waste minimisation at this factory can be estimated. This is given in Table 7.

Table 7: Calculation of savings based on company records

Utility	98 quantity / R	2000 Quantity / R	Saving Quantity / R	Saving Quantity / annum	Saving R / annum
Electricity	0.24 kWh	0.19 kWh	0.05 kWh	50 000 kWh	10 000
Municipal water	18.6 l	5.09 l	13.51 l	13 510 kl	44 200
Borehole water	33.64 l	18.16 l	15.48 l	15 480 kl	
Effluent	51.55 l	23.05 l	28.5 l	28 500 kl	33 350
Total					**87 550**

Note: It must be remembered, that borehole water is only charged as effluent, therefore there is no rands saving on the borehole water as this is included in the effluent savings.

These results can be taken as annual savings as they are based on the current production rates. These results were then compared to those reported by MF22 (Table 8).

Table 8: Comparison of calculated and reported savings

	Calculated Savings R / annum	Reported Savings R / annum
Electricity	10 000	33 000
Water	44 200	59 400
Effluent	33 350	36 500
Chemicals and Metals	68 400 (not verified)	68 400
Totals	155 950	197 300

As is evident, the calculated savings are less than those reported by the company. This is to be expected, as the savings reported did not take into account the variation in production figures. These savings were reported on a monthly basis and then extrapolated to give the yearly savings. The results reported were compared month for month to those given in the utility accounts and they were found to be comparable, indicating that the company were reported correct savings based only on consumption.

This indicates the importance of ensuring that utility consumption is compared to production in order to obtain an accurate indication of the savings achieved.

The savings reported on chemical use have not been verified as yet due to a lack of records. It is thought that a similar situation will exist as for the water and electricity savings.

It must also be noted that these results do not take into account the annual price increase that the company places on its process. This implies that the savings will be slightly less than those calculated in Table 8.

7. Conclusions

Based on this analysis of the savings achieved by MF22, it is evident that the savings reported at meetings are higher than those calculated based on monthly accounts and production. As discussed in Section 6, this is to be expected since the reported savings did not take into account the variation in production from month to month. In addition, the price increases have not been taken into account for both the calculated and reported savings, therefore the savings will be slightly less than those given in this report.

In addition, based on the effluent analysis, it is evident that the company has saved in terms of chemicals and metals discharged to drain.

Based on this analysis, the Project Team is confident that the company did not manufacture their savings to give a good impression at Club meetings.